A Proposed Framework for Delineating Ecologically-based Planning, Implementation, and Evaluation Units for Cooperative Bird Conservation in the U.S.

Puebla Mexico, November 4-6, 1998
Memphis, TN, December 1-2, 1998

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Produced with support from the Commission for Environmental Cooperation

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North American
Colonial Waterbird
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Executive Summary

At perhaps no time in the history of natural resources management has bird conservation been more dynamic or diverse due to the emergence of national and international initiatives dedicated to conservation of game and nongame birds. Modern approaches to bird conservation reflect a convergence of many forces and ideas emanating from the maturation of the North American Waterfowl Management Plan as a model for comprehensive, partnership-oriented conservation delivery, a Partners in Flight planning effort that is the most ambitious ever undertaken in the name of bird conservation, and the establishment of continental conservation initiatives for shorebirds and colonial waterbirds. It has become increasingly clear that institutional and biological overlap among bird initiatives necessitates closer coordination among game and nongame interests. Individual philosophies about migratory bird conservation coalesced into a vision of integrated bird management during the 1998 meeting of the International Association of Fish and Wildlife Agencies at Sapelo Island, Georgia; a vision of *"regionally based, biologically driven, landscape-oriented partnerships delivering the full spectrum of bird conservation across the entirety of the North American continent"*, a vision of *"simultaneous, on-the-ground delivery of conservation for both game and nongame birds."* The framework for delineating ecologically-based bird conservation units and "Bird Conservation Regions" presented in this document are steps toward fulfilling the vision.

State, provincial, federal, and NGO representatives from Canada, Mexico, and the U.S. met in Puebla, Mexico to adopt an ecological framework that would facilitate coordinated conservation planning, implementation, and evaluation among major bird initiatives. They recognized that effective conservation delivery requires linking population responses to habitats at multiple spatial scales; from the local scale of individual habitat management projects to continental scales at which national and international program planning and evaluation occur. Consequently, an ecologically-based delineation of bird conservation units must accommodate varying spatial scales in biological planning and evaluation, and must be flexible enough to accommodate multiple scale-specific approaches to management. Moreover, they acknowledged that the framework must respect state sovereignty and facilitate innovative bird conservation within states and provinces and among state-based partnerships. The mapping group considered numerous ecoregion delineations before adopting the hierarchical framework of nested ecological units delineated by the Commission for Environmental Cooperation (CEC). The CEC framework comprises a hierarchy of 4 levels of ecoregions. Hence, CEC ecoregions at multiple spatial scales may be combined or partitioned in nearly infinite combinations to best reflect the distribution and needs of birds, while preserving the integrity of the ecologically-based framework.

U.S. conservationists that subsequently met in Memphis, TN drafted a set of 38 Bird Conservation Regions (BCRs) that cover the 50 states as well as Puerto Rico and the Virgin Islands. BCRs were created by aggregating CEC level II, III, and IV ecoregions in combinations that reflect current understanding of bird species distribution and life history requirements. They encompass regions with similar bird communities, habitats, and resource management issues. BCRs are a single application of the scale-flexible hierarchical ecological framework, and may be partitioned into smaller ecological units when finer scale conservation planning, implementation, and evaluation is

necessary. Conversely, BCRs may be aggregated to facilitate conservation partnerships throughout the annual range of a group of species.

Conservationists that drafted this document hope that innovative administrators and managers will debate the merits of the vision, ecological framework, and BCRs, and if appropriate, develop strategies to apply this framework to bird conservation in ways that benefit their partners, constituents, and wildlife trust responsibilities.

A Proposed Framework for Delineating Ecologically-based Planning, Implementation, and Evaluation Units for Cooperative Bird Conservation in the U.S.

Background

At perhaps no time in the history of natural resource management has bird conservation been more dynamic or diverse than the present. While the century began with a single three-acre island off the coast of Florida being set aside to protect migratory birds, it draws to a close with conservationists from Canada, Mexico, and the United States working together to craft a strategy for the conservation of all North American avifauna. In between lies a legacy of bird conservation that has been central to the emergence of wildlife management as a scientific discipline. The concepts of partnerships, international cooperation, refuges, resource monitoring, and landscape-level conservation have either been defined or most fully realized in the context of bird conservation. Yet today, we in the bird conservation community speak of "moving bird conservation to the next level." Such thinking reflects a convergence of many forces and ideas emanating from the continued implementation of the NAWMP, a Partners in Flight planning effort that is the most comprehensive ever undertaken in the name of bird conservation, and the emergence of national and international conservation initiatives for shorebirds and colonial waterbirds. Embodied in this convergence is the preeminent challenge facing the bird conservation community as it moves into the next century—

> ***the simultaneous, on-the-ground delivery of international conservation for both game and nongame birds.***

It is in meeting this challenge that bird conservation will move to the next level. This document seeks to facilitate that movement by offering to the bird conservation community at large *a vision* to guide the collective efforts of bird conservationists throughout North America; *a framework* for delineating ecologically-based geographic units needed to plan, implement, and evaluate the conservation of multiple species at multiple spatial scales across three nations; and lastly *an ecological delineation of cooperative "Bird Conservation Regions"* which over time would become the focus of conservation partnerships targeted at all species across all habitats.

The "vision" of integrated international bird management is an outgrowth of coordination among the major bird conservation initiatives; coordination that began in earnest with preparation of the 1998 Update of the North American Waterfowl Management Plan and that manifest itself most recently in a November 4-6, 1998 meeting of Canadian, Mexican, and U.S. bird conservationists in Puebla, Mexico. This vision is perhaps most directly an outgrowth of discussions at the September 1998 meeting of the International Association of Fish and Wildlife Agencies, in particular the Director's Forum held at Sapelo Island, Georgia, on September 11, 1998. That forum focused on the changing face of migratory bird conservation and the challenges inherent in

moving bird conservation to a higher plain, with leaders in federal (U.S. and Canada) and state conservation addressing how to meet those challenges.

The framework for delineating ecologically-based bird conservation units, and the "Bird Conservation Regions", presented in this document are a step toward fulfilling the vision. The ecological framework was adopted by Canadian, Mexican, and U.S. bird conservationists at the Puebla meeting as part of the review and refinement of the draft "North American Bird Conservation Initiative." The NABCI was crafted by representatives of federal, state and provincial agencies, and NGO's. The intent was not to replace existing bird conservation initiatives, but rather to create a strategic framework that would foster coordination among the initiatives with the aim of conserving the full spectrum of North America's avian resources.

The proposed delineation of Bird Conservation Regions for the U.S. presented in this document is intended as a model of implementing the ecological framework. Bird Conservation Region delineation began in Puebla and was completed during a meeting in Memphis, TN, December 1-2, 1998.

A Vision for Bird Conservation in North America

Any vision for bird conservation in North America must be expansive enough to capture the energy and vitality of the major national and international initiatives but yet so focused as to speak directly to the challenge of implementing those initiatives on the ground. In short, it must capture the essence of "moving migratory bird conservation to the next level." From the September 1998 Directors' Forum, a vision emerged as to what form the "next level" might take—

> ***a vision of regionally based, biologically driven, landscape-oriented partnerships delivering the full spectrum of bird conservation across the entirety of the North American continent.***

To borrow the nomenclature of the NAWMP, this vision calls for "joint ventures" focused on the conservation of all birds across all habitats. The phrase "*regionally based*" is an acknowledgment that joint ventures must have a geographically explicit focus. The proposed Bird Conservation Regions explained below were developed to provide that focus. "*Biologically driven*" is an acknowledgment that on-the-ground management should be linked to predicted population responses that are regional and continental in scope. Planning at multiple spatial scales will be necessary to establish a biological linkage between habitat objectives and population goals. "*Landscape-oriented*" is a reminder that our collective goal is landscapes capable of sustaining bird populations at prescribed levels. Implicit in this part of the vision is the need to view humans as elements of the landscape and to balance conservation and socio-economic goals. "*Full spectrum*" is an acknowledgment that partnerships would develop within Bird Conservation Regions to the point that conservation is being delivered for all birds across all habitats. "*Across the entirety of the North American continent*" is an acknowledgment that joint venture-type partnerships would eventually cover all areas of the continent.

The challenges of implementing this vision are myriad. It will affect existing NAWMP Joint Ventures and will lead to the formation of new joint ventures. Some Joint Ventures may choose to retain a waterfowl and/or wetland focus. Others may broaden their focus to deal not only with other species but other, non-wetland habitats as well. Regardless, fulfilling the vision will require that new joint ventures encompass areas of the continent not currently associated with a NAWMP Joint Venture. Moreover, the bird conservation community at large will need to increase its collective ability to plan, implement, monitor, and evaluate conservation at multiple spatial scales.

The Canadian, Mexican, and U.S. conservationists that gathered in Puebla last November concluded that an ecologically-based, hierarchical geographic framework for delineating bird conservation units at multiple spatial scales would be requisite to achieving the aforementioned vision. The remainder of this document will explain that geographic framework and the manner it which it was applied to produce Bird Conservation Regions.

An Ecological Framework for Delineating Conservation Units

Effective integrated bird conservation requires the maintenance or restoration of landscapes in which the quantity, quality, and diversity of suitable habitats are juxtaposed in ways that meet the needs of a broad array of species. Ecology-based units, i.e., areas with similar natural characteristics and human land uses, enable efficient conservation planning, implementation, and evaluation because they encompass landscapes with similar bird communities, similar habitats, and similar resource issues. Moreover, ecologically-based conservation units facilitate partnerships among groups of stakeholders that share landscapes but differ in their conservation and socio-economic values.

Conservation partnerships in an ecologically-based geographic context are not new. At their inception, North American Waterfowl Management Plan Joint Ventures, perhaps the most successful conservation delivery partnerships in history, and what some regard as an ideal model for future integrated bird management, were delineated within ecologically-based focus areas of special significance to waterfowl. These partnerships have been successful in part because they have cooperated to leverage resources and affect public policy, and in part because they have embraced diverse values, seeking win-win solutions to potential resource conflicts.

Increasing public valuation of nongame birds makes a multispecies approach to conservation partnerships desirable. New wildlife conservation funding initiatives that address the needs of game and nongame species create the potential, for the first time, to leverage resources for game species with resources dedicated to nongame. Hence, explicit multispecies management opens the door to broader constituencies and resources that only the most far-sighted and progressive conservation partnerships have begun to explore.

Effective conservation delivery requires linking population responses to habitats at multiple spatial scales; from the local scale of individual habitat management projects to continental scales at which national and international program planning and evaluation occur. Consequently, issues of

scale were at the forefront of the NABCI mapping group discussion in Puebla. The mapping group was charged with adopting a framework of ecologically-based units that would encompass North America and facilitate coordination among nations and bird conservation initiatives. They recognized that an ecologically-based delineation of bird conservation units must accommodate varying spatial scales in biological planning and evaluation, and must be flexible enough to accommodate multiple scale-specific approaches to management. Furthermore, they acknowledged that the framework must respect state sovereignty and facilitate innovative bird conservation within states and provinces and among state-based partnerships.

The mapping group considered numerous ecoregion delineations before adopting the ***hierarchical framework of nested ecological units delineated by the Commission for Environmental Cooperation*** (CEC). The CEC framework comprises a hierarchy of 4 levels of ecoregions. At each level, spatial resolution increases and ecoregions encompass areas that are progressively more similar in their biotic (plant communities and wildlife) and abiotic (soils, drainage patterns, temperature, and annual precipitation) characteristics (Appendix B). Hence, CEC ecoregions at multiple spatial scales may be combined or partitioned in nearly infinite combinations to best reflect the distribution and needs of birds, while preserving the integrity of the ecologically-based framework. Furthermore, an ecoregion approach enables coordination with other natural resource managers working at different spatial scales or in different geographic regions because the ecoregion building blocks provide common ground for coordination. CEC ecoregions correspond to ecoregions being developed under a 1996 interagency MOU that expressed the intent of federal agencies to develop a common set of ecological regions for coordinated natural resource management.

A Proposed Delineation of Bird Conservation Regions for the United States: Applying the Ecological Framework

The potential for coordinated planning and evaluation required for integrated bird conservation at regional or continental scales will be enhanced by a common set of conservation units employed by all bird conservation initiatives. U.S. bird conservationists that met in Puebla and Memphis drafted a set of Bird Conservation Regions (BCRs) by aggregating CEC level II, III, and IV ecoregions in combinations that reflect current understanding of species distribution, life history requirements, and conservation challenges (Appendix A). The purposes of BCR's were to:

- facilitate communication among bird conservation initiatives
- systematically and scientifically apportion the U.S. into conservation units
- facilitate a regional approach to bird conservation
- promote new, expanded, or restructured partnerships
- identify overlapping or conflicting conservation priorities

BCRs encompass regions with similar bird communities, habitats, and resource management issues. The size of BCRs is similar to most NAWMP Joint Ventures because joint ventures are the model for partnership-based conservation delivery. Had they existed at the inception of the

NAWMP in 1986, they would have been the logical starting point for assembling joint venture partnerships. However, they did not, and the integrity, identity, and wishes of current joint ventures must be respected. It is hoped that partners in NAWMP Joint Ventures will consider their individual and collective mandates, and that joint venture geography will evolve within the ecologically-based framework if the partners determine that it is advantageous to do so.

BCRs are not proposed as static regional units. BCRs are a single application of the scale-flexible hierarchical ecological framework adopted for integrated bird conservation. BCRs may be partitioned into smaller ecological units when finer scale conservation planning, implementation, and evaluation is necessary. Conversely, BCRs may be aggregated to facilitate conservation partnerships throughout the annual range of a group of species, much as the Flyway approach to partnering has been applied in waterfowl management. BCRs also facilitate international cooperation in bird conservation because these areas of relatively homogeneous habitats and bird communities traverse natural borders.

A total of 38 BCR's cover the 50 states as well as Puerto Rico and the Virgin Islands (Appendix B). New conservation partnerships, as well as established partnerships, may operate within the BCR framework. That is, a partnership may operate within a BCR, an ecologically-based focus area within a BCR, or within combinations of BCRs. The goal of the BCR framework is to advance the vision describe at the outset of this document --

> ***a vision of regionally based, biologically driven, landscape-oriented partnerships delivering the full spectrum of bird conservation across the entirety of the North American continent, and the simultaneous, on-the-ground delivery of international conservation for game and nongame birds.***

The "*BCR Users Guide*" comes free of rules or mandates. The conservationists that drafted the BCR framework were confident that a flexible, ecologically-based system of conservation units would be a valuable addition to the bird manager's tool kit. They were equally confident that innovative managers would debate the merits of the vision, ecological framework, and BCRs presented in this document, and if appropriate, develop strategies to apply this framework to bird conservation in ways that benefited their partners, constituents, and wildlife trust responsibilities. Reviewers of this document are asked to direct comments on the vision of integrated bird management, the ecological framework, and proposed Bird Conservation Regions to:

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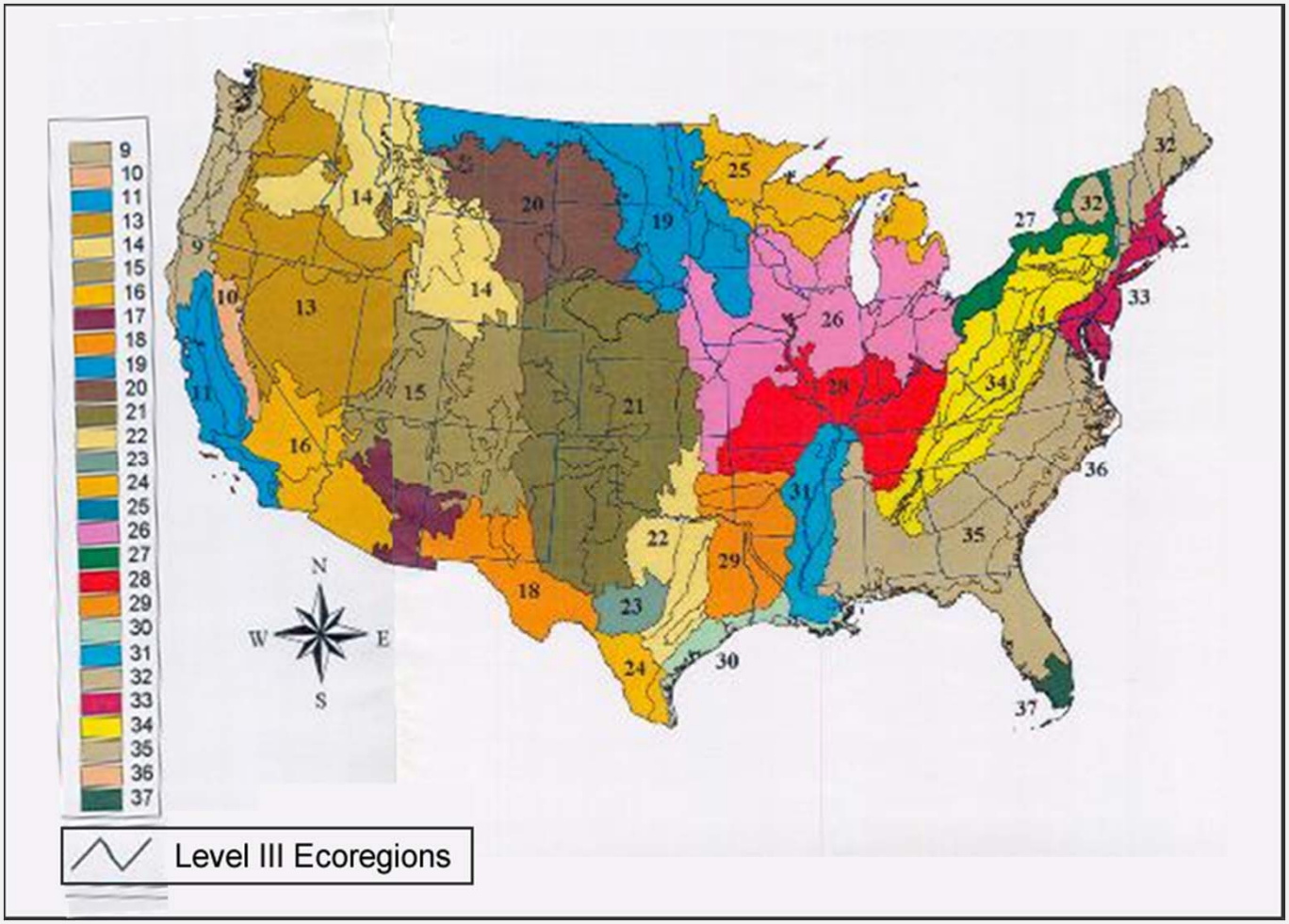
Proposed Bird Conservation Regions of the United States



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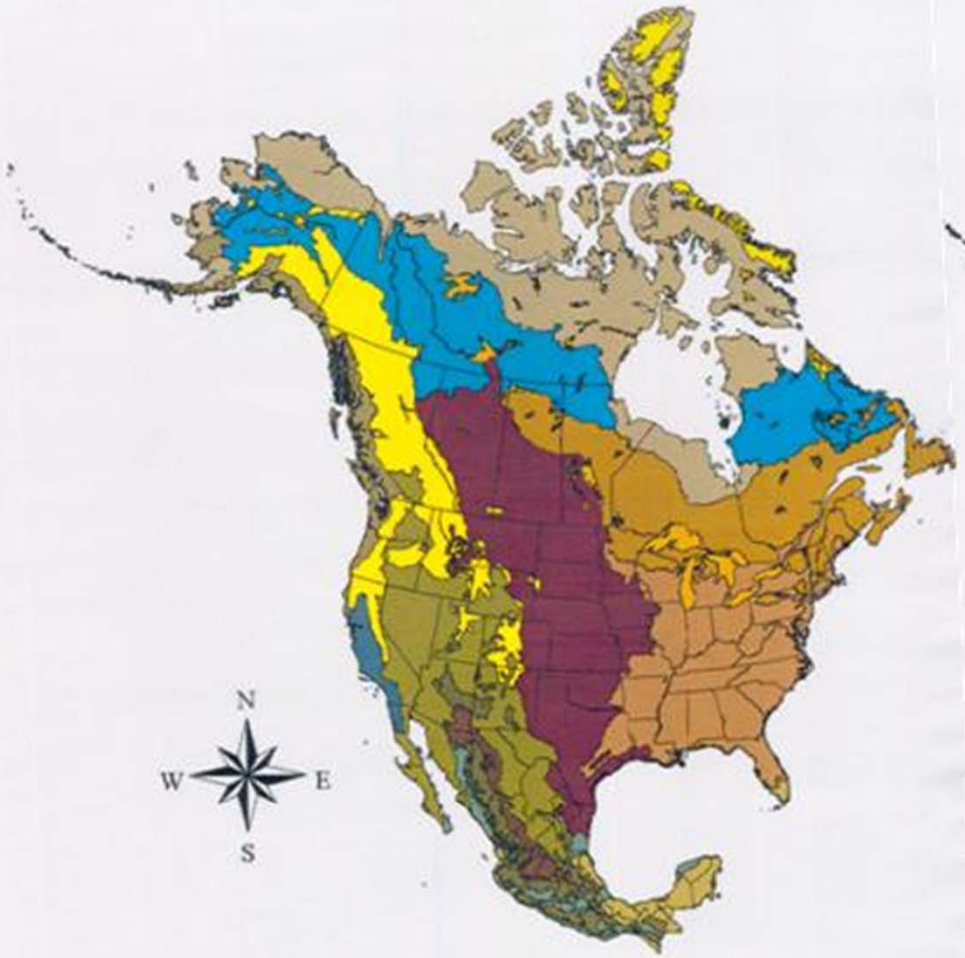

CEC Level I Ecoregions

CEC Level II Ecoregions

Appendix A:

PROPOSED BIRD CONSERVATION REGIONS
of the
UNITED STATES

BIRD CONSERVATION REGIONS of the UNITED STATES:
REGION DESCRIPTIONS and PRIORITY SPECIES

1. ARCTIC COASTAL PLAIN – This region includes low-lying, coastal tundra and drier uplands of the Arctic Foothills of the Brooks Range. It extends from the Alaska-Canada border at Demarcation Point westward, and southward, to the mouth of the Noatak River. Because of thick, continuous permafrost, surface water dominates the landscape (20-50% of the land surface on the coastal plain). Freezing and thawing form a patterned mosaic of polygonal ridges and ponds. Several rivers (e.g., Colville River) bisect the plain and flow into the Arctic Ocean. Barrow, the northernmost point in Alaska, experiences 67 days of darkness in the winter and 84 days of continuous sunlight in the summer. The ocean surface, except for leads, is frozen 9 to 10 months a year, and the ice pack is never far from shore; few bird species winter in the region. Because of the wetness, waterfowl and shorebirds dominate the avian community and passerines are scarce. The most abundant breeding birds on the coastal plain include the: Northern Pintail, King Eider, Oldsquaw, American Golden-Plover, Semipalmated Sandpiper, Pectoral Sandpiper, Red-necked Phalarope, and Lapland Longspur. Several Old World species penetrate the region from the west (e.g., Arctic Warbler, Bluethroat), and species regularly breeding in the Canadian arctic penetrate from the east (e.g., White-rumped Sandpiper, Black Guillemot). Taiga passerines (e.g., Gray-cheeked Thrush, Yellow Warbler) reach the region along drainage systems from the Brooks Range and raptors nest commonly along major rivers (e.g., Gyrfalcon, Rough-legged Hawk). The Arctic Coastal Plain supports most of the North American breeding populations of Iceland, Thayer's, Glaucous, and Sabine's Gulls.

2. WESTERN ALASKA TUNDRA – This region consists of the Subarctic Coastal Plain of the Yukon-Kuskokwim Delta and Kotzebue Sound, Seward Peninsula, Ahklun and Kilbuck Mountains, and the Bristol Bay-Nushagak Lowlands. Wet and mesic graminoid herbaceous communities dominate the lowlands and numerous ponds, lakes, and rivers dot the landscape. Tall shrub communities are found along rivers and streams and low shrub communities occupy uplands; forests of spruce and hardwoods penetrate the region on the eastern edge. Permafrost is continuous except in southern parts of the region. Sea cliffs are present as are mountains that exceed 1,000 meters in elevation. High densities of breeding waterfowl and shorebirds are found on the coastal plain of the Yukon and Kuskokwim rivers. Intertidal areas here and lagoons of the north side of the Alaska Peninsula supports millions of shorebirds during migration (e.g., Dunlin, Western Sandpiper, Red Knot, Bar-tailed Godwit). Western Alaska includes an unique Beringian breeding avifaunal element (e.g., Black Turnstone, Bristle-thighed Curlew) and several Old World species are regular breeders or migrants in this region (e.g., Sharp-tailed Sandpiper, Red-throated Pipit, White Wagtail). Passerine diversity is greatest in tall, riparian shrub habitats (e.g., Arctic Warbler, Gray-cheeked Thrush, Blackpoll Warbler) and raptors (e.g., Gyrfalcon, Rough-legged Hawk) nest along the riverine cliffs. Mainland sea cliffs contain nesting colonies of, largely, Black-legged Kittiwakes, Common Murres, and Pelagic Cormorants.

3. ALEUTIAN/ BERING SEA ISLANDS – Included in this region are the Aleutian Islands, that extend westward from the Alaskan mainland for 1,800 km, and the Bering Sea islands (that include the Pribilofs, St. Matthew, Hall, St. Lawrence, and Little Diomede). The Aleutian chain is

volcanic in origin. The climate is maritime and wind is ever present. Vegetation at higher elevations consists of dwarf shrub communities, mainly willow and crowberry. Meadows and marshes of herbs, sedges, and grasses are plentiful and some islands have ericaceous bogs. Sea ice does not extend to the Aleutians and permafrost is generally absent; however, sea ice is an important feature of the Bering Sea. Seabirds are a dominant component of this region's avifauna and several species breed only in this region (e.g., Red-legged Kittiwake, Least Auklet, Whiskered Anklet). Immense colonies of nesting seabirds are found on cliffs and isolated islands throughout the region, including vast numbers of Murres, Puffins, Kittiwakes, and other species. Southern Hemisphere procellariiforms occur regularly in the offshore waters of the southern Bering Sea and northern Gulf of Alaska during Alaskan summers. Although breeding diversity of passerines (mainly Lapland Longspur, Snow Bunting, and Gray-crowned Rosy-Finch), and shorebirds (e.g., Black Oystercatcher, Dunlin, Ruddy Turnstone, Rock Sandpiper) is low, numerous Old World species are regular migrants and visitants. Some of these species regularly breed in the region (e.g., Common Ringed Plover, Wood Sandpiper, Eurasian Skylark). Rock Sandpipers have differentiated into three races among islands within the region and the only endemic Alaskan passerine (McKay's Bunting) is found here.

4. BROOKS RANGE – The 134,000 km^2 Brooks Range ecoregion consists of several groups of rugged, deeply dissected mountains; elevations range from 800 to 2,400 m. The region stretches from the Canadian border to within 100 km of the Chukchi Sea. In most years, freezing temperatures occur in every month. The arctic climate and unstable slopes maintain a sparse cover of dwarf shrub vegetation; graminoid herbaceous communities are found in mesic and wet sites. Some spruce-hardwood forest penetrates the region from the south along river valleys. Outside of forested areas, the avifauna is sparse. The most diverse passerine assemblage is found in riparian shrub communities (e.g., American Robin, White-crowned Sparrow, Common Redpoll). Riparian associated shorebird species include Wandering Tattler, Semipalmated Sandpiper, and Spotted Sandpiper. Smith's Longspur, American Golden-Plover, and Upland Sandpiper are found in vegetated areas.

5. BOREAL FOREST/ MOUNTAINS – This region is an extensive (694,000 km^2) patchwork of ecological types and includes the Interior Forested Uplands and Lowlands, Interior Highlands, Interior Bottomlands, Yukon Flats, Ogilvie Mountains, Alaska Range, Wrangell Mountains, and Copper Plateau. A mosaic of vegetation communities arise from the interplay of elevation, permafrost, surface water, fire, and aspect. Winters are cold (average minimums -18^{0}C to -35^{0}C) and summers are warm (average maximum 17^{0}C to 22^{0}C). All forest types (needleleaf, deciduous, and mixed) are found in the region and are dominated by white spruce, black spruce, poplars, and paper birch. Tall shrub communities occur along rivers, drainages, and near treeline. Bogs, consisting of low shrubs and shrub-graminoid communities, are common in the lowlands. Alpine dwarf scrub communities are common in Interior Highlands and throughout mountainous regions; highest elevations are generally devoid of vegetation. Despite the numerous ecoregions, many bird species are shared among the regions. Lowlands, bottomlands and flats harbor many species of migrating and breeding waterfowl (e.g., Northern Pintail, Northern Shoveler, Green-winged Teal) and swans. These ecoregions, combined with forested lowlands and uplands support breeding shorebirds such as Greater and Lesser Yellowlegs, Solitary and Spotted Sandpipers, and Common

Snipe. American Golden-Plovers and Surfbirds are found in alpine habitats in Interior Highland and mountainous ecoregions. A suite of passerines inhabit forest, scrub, and graminoid communities in the region. Black-capped and Boreal Chickadees, Ruby-crowned Kinglets, Swainson's Thrushes, Yellow-rumped Warblers and Dark-eyed Juncos are common forest species. Tall shrub communities host White-crowned, American Tree, and Fox Sparrows, Wilson's and Yellow Warblers, Gray-cheeked Thrushes, and Common Redpolls, among others. At high elevations, Horned Lark and Lapland Longspur are common breeders.

6. ALASKA PENINSULA MOUNTAINS – This mountainous, 48,000 km^2, maritime ecoregion extends from Becharof Lake, southward along the Pacific coast of the Alaska Peninsula, and includes Kodiak, and southern Afognak Islands. The terrain is of sedimentary origin interspersed with volcanic peaks up to 2,600 m. Typical of maritime climates, this region is characterized by high annual precipitation, and low seasonal and diurnal temperatures (relative to continental climates). The highly erodible soils are volcanic ash and cinder underlain by glacial deposit. Vegetation communities are closely associated with elevation: dwarf scrub is dominant at high altitude and in lower windswept areas; low scrub is found at low elevations and in protected valleys; tall scrub occurs along drainages; broadleaf forest stands of poplar are present on south-facing slopes and floodplains; and poorly drained areas are characterized by bog and herbaceous communities. The adjacent coast supports high concentrations of wintering sea ducks that includes the: Steller's Eider, Harlequin, Oldsquaw, Surf Scoter, and Black Scoter. Tundra Swans are common on inland water bodies during spring. Several shorebirds breed inland and coastally, but none occur in high numbers. Rock Sandpipers and Black Oystercatchers are common wintering shorebirds, the latter being a coastal breeder. Common inland-breeding passerines include the Hermit Thrush, American Robin, Rosy Finch, Common Redpoll, and several shrub-inhabiting warblers and sparrows. The Peninsula Mountains region supports huge colonies of nesting seabirds, including continentally-significant populations of Red-faced and Pelagic Cormorants, Black-legged Kittiwakes, Aleutian Terns, Kittlitz's Murrelets, and Horned Puffins.

7. COOK INLET – The 28,000 km^2 Cook Inlet ecoregion consists of the lower Matanuska-Susitna River valley southward along both shores of Cook Inlet to Tuxedni Bay on the west, and to Anchor Point on the east. Having both maritime and continental influences, the state's most populous region enjoys a mild year-round climate. Two-thirds of Alaska's population reside in Cook Inlet. The terrain is flat to rolling relative to adjacent regions and consists of outwash plains, moraine, eskers, and drumlin fields. Elevation is from sea level to 600 m. Several vegetation communities are common in the region and include: needleleaf, broadleaf, and mixed forests; riparian and floodplain tall scrub; a variety of graminoid cover types occur in moist to dry areas; tall scrub swamp, low scrub bog, wet forb, and graminoid herbaceous vegetation is found in the wettest areas. Black, white, and Sitka (in southern portion of ecoregion) spruce dominate needleleaf forests, and quaking aspen, balsam poplar, black cottonwood, and paper birch are the dominant deciduous trees. Mixed forests comprise a combination of these species. The unvegetated intertidal area of Cook Inlet has recently been identified, not only as a major spring stopover site for Western Sandpiper and Dunlin, but also as the primary wintering site for the nominate form of Rock Sandpiper (C. *p. ptilocnemis*). Significant numbers of Long- and Short-billed Dowitchers and Hudsonian Godwits stop in upper Cook Inlet during migration. Upper Cook

Inlet is also a spring stopover for migrating Snow Geese. The passerine species assemblage is largely characteristic of interior Alaska.

8. NORTHERN PACIFIC COAST FORESTS/ MOUNTAINS – The 61,000 km^2 coastal rainforest stretches from extreme southern Alaska to Cook Inlet and is characterized by heavy precipitation and mild temperatures typical of a maritime climate. Its stark, rugged features are a result of intense glaciation during the Pleistocene and nearly all adjacent land area remains glaciated. Much of the terrain is steep sloped from sea level up to 1000 m, but large floodplains, alluvial fans, outwash plains, and river deltas also occur here. The region is dominated by needleleaf forests of Western Hemlock and Sitka Spruce; other needleleaf species also occur in coastal forests. Broadleaf forests are found along large mainland river drainages. Several other communities are present in this region and include: tall, low, and dwarf scrub; tall and low scrub bogs and swamps; and wet graminoid and forb herbaceous communities. The Copper and Stikine River deltas and the Yakutat forelands are major stopover sites for migrating shorebirds, especially Western Sandpipers and Dunlins. Black Oystercatchers, Rock Sandpipers, Black Turnstones, and Surfbirds are common wintering species. Nearshore marine areas support many breeding and wintering sea ducks (e.g. Surf Scoter) and seabirds (e.g., Rhinoceros Auklet, murrelets). Coastal forests support a host of resident and breeding passerines (e.g., Chestnut-backed Chickadee, Winter Wren, Brown Creeper, Ruby and Golden-crowned Kinglets, Red-breasted Sapsucker), raptors (Bald Eagle, Northern Goshawk, Northern Saw-whet Owl), and seabirds (Marbled Murrelet).

9. PACIFIC NORTHWEST – The Pacific Northwest region includes the moist coniferous forest of the Coast Range and the west slope and crest of the Cascades as well as the Puget lowlands and Willamette Valley lying between the mountain ranges. It includes the complex Klamath and Siskiyou Mountains of southern Oregon and northwest California, but ends just east of the Cascade crest where a drier Ponderosa pine-dominated forest replaces the moist alpine forest. High priority forest birds that breed in this area are the Spotted Owl, Marbled Murrelet, and Hermit Warbler. The coast of the Pacific Northwest is characterized by pockets of estuarine and freshwater wetlands set within steep, rocky shorelines. Despite their small size, these wetlands provide critical breeding, wintering, and migration habitat for internationally significant populations of waterfowl and other wetland-dependent species. The region winters 95% of the continental Pacific Brant population, 90% of the Trumpeter Swans that breed in Alaska, 60% of the Wrangle Island Lesser Snow Goose population, and virtually the entire Pacific population of Harlequin Ducks, Oldsquaw, and King Eiders south of Alaska. The rugged coastline also is important for resident Black Oystercatchers, and provides habitat for wintering shorebirds including Surfbirds, Black Turnstones, and Rock Sandpipers. Numerous estuaries and deltas are used by other shorebirds, notably Western Sandpipers, Dunlin, and waterfowl. Numerous offshore islands support nesting colonies of Common Murre, Tufted Puffin, Rhinoceros Auklet, Western and Glaucous Gull, and Leach's Storm-Petrel. Pelagic waters host large numbers of shearwaters, storm-petrels, alcids, and Black-footed Albatross.

10. SIERRA NEVADA – The Sierra Nevada range rises sharply from the arid basin and range on the east and slopes gently toward the Central Valley of California on the west. Vegetation at lower

elevations is dominated by ponderosa pine on the west and lodgepole pine on the east, with fir, spruce, and alpine tundra at higher elevations. The area provides habitat for Hermit Warblers, White-headed Woodpeckers, and Mountain Quail at higher elevations and the Nuttall's Woodpecker, Oak Titmouse, and California Thrasher on the western slopes.

11. COASTAL CALIFORNIA – A Mediterranean climate of hot, dry summers and cool moist winters creates conditions for chaparral vegetation in the low mountains along the coast that extend into Baja California. Characteristic high priority chaparral birds include the Nuttall's Woodpecker, Oak Titmouse, California Thrasher, and Lawrence's Goldfinch. The coastline provides habitat for several waterfowl and shorebird species, and is an important wintering area for Marbled Godwits, American Avocets, and Surfbirds. Most of the world's populations of Ashy Storm-Petrels and Xantus's Murrelets nest on a small number of offshore islands. A sizable proportion of the Elegant Tern and Heermann's Gull populations spend the non-breeding season here. Millions of Sooty Shearwaters gather in pelagic waters each fall, joined by numbers of other shearwaters, storm-petrels, and alcids. The Central Valley of California lies in this BCR between the Coast Ranges and the Sierra Nevada. Wetlands and associated uplands in the Central Valley provide roosting and foraging habitat for 60% of the waterfowl that winter in the Pacific Flyway, including 65% of the continental Northern Pintail population. Approximately 95% of historic depressional wetlands, and 84% of riparian habitats, have been lost, primarily to agriculture. Of the remaining wetland habitat, 30% is protected within National Wildlife Refuges, and most other wetlands are privately managed for waterfowl hunting. Among landbirds, the Central Valley is the center of the small ranges of the Tricolored Blackbird and Yellow-billed Magpie and also provides dwindling habitat for a host of riparian birds such as the Least Bell's Vireo.

12. HAWAII – This chain of volcanic islands is one of the richest areas for endemic landbirds in North America. Because of significant disturbances including introduced species and large amounts of land converted to agriculture or developed for other uses, the region also has the highest concentration of endangered species. The main island chain supports important breeding populations of the endangered Dark-rumped Petrel and Newell's Shearwater. The Leeward Islands host immense numbers of nesting seabirds including important colonies of Black-footed and Laysan Albatross, Bonin Petrels, boobies, frigatebirds, and Gray-backed, Sooty, Noddy, and White Terns. Pelagic waters provide essential foraging sites for numerous shearwaters, petrels, terns, and other seabirds.

13. GREAT BASIN – This large and complex region includes the Northern Basin and Range, the Columbia Plateau, and the eastern slope of the Cascade Mountains. This dry area lies in the rainshadow of the Cascades and Sierra Nevada. Grasslands, sagebrush, and other xeric shrubs dominate the flats and lowlands, with pinon-juniper woodlands and open ponderosa pine forests on higher slopes. Lodgepole pine/sub-alpine fir forests occur at higher elevations on north-facing slopes. Several substantial lowland wetlands are extremely important to shorebirds, including breeding American Avocets, Black-necked Stilt, and Willets, migrating Wilson's Phalaropes, and other water birds, notably Eared Grebes. The region also is important for breeding Mountain Plovers and Snowy Plovers. Most of North American breeding White-faced Ibis and California Gulls nest in marshes and lakes scattered across the region. The Great Salt Lake and adjacent

marshes host large numbers of American White Pelicans, Cinnamon Teal, Mallards, Pintails, Redheads, Tundra Swans, and other waterfowl, and many species of migrant shorebirds. Sage Grouse, Sage Sparrow, and Brewer's Sparrow are priority land birds of lowlands, with White-headed Woodpeckers characteristic of the region's pine forests.

14. NORTHERN ROCKIES - Included in this area are the Northern Rocky Mountains and outlying ranges such as the Blue Mountains of east Oregon, as well as the intermontane Wyoming Basin. The Rockies are dominated by a variety of coniferous trees, including lodgepole pine, Douglas fir, western white pine, western red cedar, and grand fir. The Wyoming Basin and other lower-lying valleys are characterized by sagebrush scrub habitat. High elevation priority birds include the Black Swift and Blue Grouse, with Barrow's Goldeneyes, Western Canada Geese, and Trumpeter Swans breeding in lakes. Sage Grouse and Sage Thrashers are key breeders in the Wyoming Basin.

15. SOUTHERN ROCKIES/ COLORADO PLATEAU - This topographically complex region includes the Wasatch and Uinta Mountains to the west and the Southern Rocky Mountains to the east, separated by the rugged tableland of the Colorado Plateau. Various coniferous forest types (often lodgepole pine) interspersed with aspen dominate higher elevations. These are replaced by pinyon-juniper woodlands on the lower plateaus. Important birds segregate into elevational guilds with the Brown-capped Rosy Finch and White-tailed Ptarmigan in alpine tundra, the Williamson's Sapsucker in conifers, Virginia's Warbler and Lewis' Woodpecker in mid-elevation sites, and most of the world's breeding Gray Vireos in the pinyon-juniper. High arid plains and dry upland shortgrass prairies provide critical breeding areas for Mountain Plovers. San Luis Valley wetlands and surrounding uplands support one of the highest densities of nesting waterfowl in North America, and provide migration habitat for the entire Rocky Mountain population of Greater Sandhill Cranes.

16. SONORAN AND MOHAVE DESERTS – The Mohave Desert is centered in southeast California and southern Nevada and grades into the Sonoran Desert of Southwest Arizona and northwest Mexico. This arid region is dominated by creosote, cacti, and other desert shrubs and is the center of distribution of the Rufous-winged Sparrow, LeConte's Thrasher, Bendire's Thrasher, Lucy's Warbler, and Abert's Towhee. Riparian wetlands are habitat for the Yuma Clapper Rail and Southwest Willow Flycatcher. The Salton Sea hosts large numbers of American White Pelicans, Eared Grebes, and other colonial waterbirds, shorebirds such as the Black-necked Stilt and Long-billed Curlew, and waterfowl during both migrations and winter. The Colorado River and adjacent wetlands provide wintering habitat for numerous ducks and geese. The Colorado River corridor also provides some the most significant habitat in the arid southwest for Western Grebes, Clark's Grebes, and American Avocets.

17. ARIZONA-NEW MEXICO MOUNTAINS – This region is comprised of isolated mountain ranges of southeast Arizona and southwest New Mexico that represent the northern terminus of the Sierra Madre Occidental as well as the more northerly forested Mogollon Rim. Of the many landbirds more typical of Mexico that extend into the United States in this region, priority species include the Red-faced Warbler, Strickland's Woodpecker, and Montezuma Quail. Riparian areas

in lowlands support many in-transit migrants as well as breeding Thick-billed Kingbirds, Western Yellow-billed Cuckoos, and Southwestern Willow Flycatcher.

18. CHIHUAHUAN DESERT – The Chihuahuan Desert stretches from the Madrean Mountains on the west to the Edwards Plateau in Texas, grades into the Southern Great Plains to the north, and extends over much of the central Mexican Plateau. Arid grasslands and shrublands cover broad basins and oak-juniper woodlands and confers at higher elevations occur in numerous isolated mesas and mountains. Scaled Quail are typical on lowlands, with Black-capped Vireos, Bell's Vireos, and Lucifer Hummingbirds inhabiting some riparian zones. The Colima Warbler is a rare inhabitant of a few of the taller mountains. The Rio Grande river and adjacent wetlands provide important habitat for Greater Sandhill Cranes, geese, and vast number of other waterfowl, riparian, and wetland-dependant nongame species.

19. PRAIRIE POTHOLES - The prairie pothole region remains the most important waterfowl producing region on the North American continent despite extensive wetland drainage and tillage of native mixed and tall grasslands that has reduced the suitability of many existing wetlands. Breeding dabbling duck density may exceed 100 pairs/mi^2 in some areas during years with favorable wetland conditions. The region comprises the core of the breeding range of most dabbling duck and several diving duck species, as well as providing critical breeding and migration habitat for over 200 species of migratory nongame birds including priority species such as Franklin's Gulls, Yellow Rails, and Piping Plovers. Wetland areas also provide key spring migration sites for Hudsonian Godwits, American Golden-Plovers, White-rumped Sandpipers, and Buff-breasted Sandpipers, and important breeding areas for Wilson's Phalaropes, Marbled Godwits, and American Avocets. Baird's Sparrows and Sprague's Pipits are among the many priority landbirds in this region. Continued wetland degradation and fragmentation of remaining grasslands threaten future suitability of the prairie pothole region for migratory birds.

20. NORTHWESTERN GREAT PLAINS - This semi-arid rolling plain is a mixed grass prairie lying west and south of the glaciated Prairie Potholes, east of the Rocky Mountains, and north of the true shortgrass prairie. Large contiguous grassland tracts persist in the Northwestern Great Plains Bird Conservation Region, and low density predator populations dominated by coyotes impact populations of ground nesting birds less than in regions with more extensive tillage agriculture. Created wetlands, e.g., small impoundments created as livestock water sources, may receive extensive use from upland nesting waterfowl and broods. Mountain Plovers, McCown's Longspurs, and Long-billed Curlews are among the priority breeding birds.

21. SOUTHERN GREAT PLAINS - The Southern Great Plains is a huge area that includes nearly all of North America's shortgrass prairie, the central and southern mixed grass prairie, and the southern tallgrass prairie. It extends from the Rocky Mountains on the west to the beginning of more savanna-like habitat to the east. It includes vast landscape that have been converted to intensive agriculture as well as some high quality grasslands such as the Nebraska Sandhills, Flint Hills, and Pawnee Grasslands. The Southern Great Plains BCR includes essentially the entire range of the Lesser Prairie-Chicken in the southwest, much of the breeding range of the Mountain Plover in shortgrass areas, and some of the better remaining areas for Greater Prairie-Chickens and

Henslow's Sparrows to the east. Sandbars along the larger rivers support much of the continent's breeding Interior Least Tern population. The region is an important spring migration area for American Avocets, Semipalmated Sandpipers, and Buff-breasted Sandpipers. Depressional wetlands concentrated in the Rainwater Basin and in the southern half of this BCR (playa lakes) annually provide habitat for nearly 2 million ducks and 1 million geese. The mid-continent population of Northern Pintails and White-fronted Geese are particularly dependent on these wetland resources; however, wetland drainage and modification, sediment accumulation, and growing Snow Goose populations are jeopardizing the integrity of these important landscape features.

22. OAKS AND PRAIRIES - This transition zone between the Great Plains and the forests of eastern United States is a complex mix of prairie, savannah, cross timbers, and shrubland. Priority landbirds that require this mix of woodland and open country are the Scissor-tailed Flycatcher, Painted Bunting, and Mississippi Kite, with a few Black-capped Vireos in areas of denser shrub.

23. EDWARDS PLATEAU – The dissected Hill Country of central Texas is clearly demarcated on the east and south by a fault line and grades into the Chihuahuan Desert and Great Plains to the west and north. The native vegetation is a mesquite, juniper, and oak savannah that is the core of the breeding range of the Black-capped Vireo and Golden-cheeked Warbler.

24. TEXAS BRUSHLANDS - The plain that comprises the Texas Brushlands BCR extends into northeastern Mexico. The regions historically was grassland and savanna that has been largely converted to thorny brush habitat due to continued grazing pressure. Its very distinctive avifauna includes the Botteri's Sparrow, Audubon's Oriole, Buff-bellied Hummingbird, Long-billed Thrasher, and Plain Chachalaca. Most of the Black-bellied Whistling-Ducks that breed in the United States occur in this region.

25. BOREAL FOREST TRANSITION- Part of the Canadian Shield, this region is characterized by coniferous and northern hardwood forests, numerous clear lakes, bogs, river flowage, and nutrient poor soils. All of the world's Kirtland's Warblers breed here, as do the majority of Golden-winged Warblers and Connecticut Warblers. Coastal estuaries, river flowage, and large shallow lakes dominated by wildrice are typically used by both breeding and migrating water birds. Yellow Rails are a priority wetland species. Islands in the Great Lakes support large colonies of Double-crested Cormorants, gulls, and Caspian and Common Terns. Although ducks generally nest at low densities, stable water conditions enable consistent production. Wood Ducks, Mallards, Black Ducks, Ring-necked Ducks, and Goldeneyes are common breeding species in this region. Threats to wetland habitat in the Boreal Forest Transition Region include recreational development, cranberry operations, peat harvesting, and drainage.

26. UPPER GREAT LAKES PLAINS – This region was historically a transitional zone between prairies and eastern woodlands, with the ecotone between the two marked by a broad and dynamic oak-dominated savannah. The modern landscape of the Upper Great Lakes Plains is dominated by agriculture. The effects of glaciation are obvious and include numerous pothole type wetlands, shallow lakes, coastal estuaries, and river flowage. Second only to the prairie pothole region to the

west, this regions supports high densities of breeding waterfowl including Mallards, Blue-winged Teal, Wood Ducks, and Redheads. The region plays a significant role during migration and hosts the largest concentrations of staging Canvasbacks on the continent. The northernmost breeding populations of some herons and egrets are found in this region. Threats to the wetland habitats of this region include barge fleeting, urbanization, recreational development, and agricultural expansion and conversion of wetland/grassland habitats. High priority grassland birds that persist in some areas include the Greater Prairie-Chicken and Henslow's Sparrow. Cerulean Warblers are in some wooded areas, and the Red-headed Woodpecker leads the list of savannah specialists.

27. EASTERN GREAT LAKES LOWLANDS - Formerly dominated by mesic deciduous beech-maple forest, this area is dominated by agricultural land use today. Early successional habitat is used by some Golden-winged Warblers, Henslow's Sparrows, and American Woodcock. Important waterfowl habitat in this region is found along lake shore marshes, the northern Finger Lakes region (including the Montezuma wetland complex), the Pymatuning area in Pennsylvania, the St. Lawrence Valley and the Lake Champlain Valley. Wetland types range from emergent marshes and diked impoundments to nearly ice-free deepwater habitats valuable for diving ducks. Important migration corridors in New York, Vermont, and Pennsylvania are used by Greater Scaup, Black Ducks, and the Southern James Bay population of Canada Geese. Large colonies of Common Terns and other colonial waterbirds may develop on offshore islands.

28. CENTRAL HIGHLANDS AND BIG RIVERS - The Ozark Mountains on the west and Interior Low Plateaus on the east are similar to each other, but bisected by the floodplain of the Mississippi River and its larger tributaries. The entire area is dominated by an oak-hickory deciduous forest inhabited by Cerulean Warblers, Worm-eating Warblers, and Louisiana Waterthrush. Although Wood Ducks are the primary breeding waterfowl, the region holds more significance for waterfowl as a migratory staging area. The floodplains of the river systems include diverse wetland habitats (i.e. floodplain forests, emergent wetlands, submerged aquatic beds), all of which are utilized by migrating waterbirds.

29. WEST GULF COASTAL PLAIN - Pines dominate this area, principally shortleaf pine in the north, including the Ouachita Mountains, and longleaf pine in the south. This westernmost part of the forests that historically covered the eastern United States extend to hardwood dominated areas in the Arkansas River bottoms and Ozarks to the north and the Mississippi Alluvial Valley to the east. The Red-cockaded Woodpecker is the highest priority bird in pine habitat, which is also inhabited by Bachman's Sparrows and Brown-headed Nuthatches. The river and stream bottoms that dissect this plain are bottomland hardwood habitat used by Swainson's Warblers and large numbers of nesting herons and egrets. Coastal intertidal habitats are important wintering sites for Dunlin, and key spring migration areas for Hudsonian Godwits, Lesser Golden-Plovers, and Black-Necked Stilt. Wetlands of the Gulf Coastal Plain support substantial wintering populations of a number of waterfowl species and are a primary migration corridor for significant numbers of other dabbling ducks. Bottomland hardwoods and associated wetlands are the major habitat types of the area of value to waterfowl. The principal threats to bottomland hardwoods habitats are timber harvest and subsequent conversion to pine plantations, pasture, or other land uses.

30. GULF COASTAL PRAIRIES - This flat grassland and marsh hugs the coast of the Gulf of Mexico from the mouth of the Rio Grande into the rice country of southeast Texas and southwest Louisiana, and across the great Louisiana marshlands at the mouth of the Mississippi River. It is one of the World's greatest concentration areas for colonial waterbirds, with breeding Reddish Egrets, Roseate Spoonbills, Brown Pelicans, and large numbers of herons, egrets, ibis, terns, and skimmers. The region provides critical in-transit habitat for migrating shorebirds, including Buff-breasted Sandpipers and Hudsonian Godwits, and for most of the Neotropical migrant forest birds of eastern North America. Mottled Ducks, Fulvous Whistling-Ducks, and Purple Gallinule also breed in wetlands, and winter numbers of waterfowl are among the highest on the continent. Important wetland habitats of the area are coastal marsh (especially fresh, intermediate and brackish types), shallow estuarine bays and lagoons, and wetlands on agricultural lands of the rice prairies. Loss and degradation of these wetland habitats, due to subsidence, seal level rise, shoreline erosion, freshwater and sediment deprivation, saltwater intrusion, oil and gas canals, and navigation channels and associated maintenance dredging, are critical challenges to this region's wildlife.

31. MISSISSIPPI ALLUVIAL VALLEY - The Lower Mississippi Alluvial Valley consists of approximately 24 million acres of mostly alluvial floodplain along the Mississippi south of the river's confluence with the Ohio River. Prior to European settlement, the region comprised the greatest bottomland hardwood forest on earth and was subject to the annual flood events of the Mississippi River and its tributaries. These forested wetlands were the main wintering area for mid-continent Mallards, Wood Ducks and other waterfowl species. Flood control and deforestation for agriculture began more than 100 years ago and today less than 25% of the region remains forested and flooding has been reduced by about 90%. Despite these changes, the region still winters large numbers of waterfowl, estimated at about 9% of the continental duck population. Remnant forests harbor populations of Swainson's Warblers, Prothonotary Warblers, and Swallow-tailed Kite. Many shorebird species use managed wetlands for migration stopover sites. The region provides abundant colonial waterbird habitat, particularly to the south where large numbers of White Ibis, Yellow-crowned Night-Herons, and other herons and egrets nest.

32. ATLANTIC NORTHERN FORESTS - The nutrient-poor soils of northernmost New England and the Adirondack Mountains support spruce-fir forests on more northerly and higher sites and northern hardwoods elsewhere. Virtually all of the world's Bicknells's Thrush breed on mountaintops in this region. Other important forest birds include the Canada Warbler and Bay-breasted Warbler. Coastal wetlands are inhabited by Nelson's Sharp-tailed Sparrows, rocky intertidal areas are important for wintering Purple Sandpipers, and muddy intertidal habitats are critical as Semipalmated Sandpiper staging sites. Common Eiders and Black Guillemots breed in coastal habitats, while Leach's Storm-Petrels, gulls, terns, and the southernmost populations of breeding alcids nest on offshore islands. Beaver ponds and shores of undisturbed lakes and ponds provide excellent waterfowl breeding habitat, particularly for American Black Ducks, Hooded and Common Mergansers, and Common Goldeneyes. The Hudson and Connecticut river valleys are important migration corridors for ducks and geese. Because inland wetlands freeze, coastal wetlands in Maine are used extensively by dabbling ducks, sea ducks and geese during winter and

migration. Coastal wetlands in Maine (including Merrymeeting Bay and Cobscook Bay) are important wintering sites for waterfowl.

33. NORTH ATLANTIC COASTAL PLAIN - This BCR has the densest human population of any region in the country. Much land that was formerly cleared for agriculture is now either in forest or residential use. The highest priority birds are in coastal wetland and beach habitats. These include the Saltmarsh Sharp-tailed Sparrows and Nelson's Sharp-tailed Sparrows, Seaside Sparrows, Piping Plover, American Oystercatchers, wintering Black Ducks, and Black Rails. The region includes critical migration sites for Red Knot, and key staging areas for Ruddy Turnstones, Sanderlings, Semipalmated Sandpipers, and Dunlin. Most of the continental population of the endangered Roseate Terns nests on islands off the southern New England states. Other terns, and gulls nest in large numbers and large mixed colonies of herons, egrets, and ibis may form on islands in the Delaware and Chesapeake Bay regions. Estuarine complexes in this region are extremely important to wintering and migrating waterfowl, including Great Bay (NH), Long Island Sound, Delaware Bay, Chesapeake Bay, and embayments created behind barrier beaches. Approximately 65% of the total wintering Black Duck population can be found in coastal areas between Long Island and North Carolina. Exploitation and pollution of Chesapeake Bay and Absecon Bay (NJ), and the accompanying loss of submerged aquatic vegetation, have significantly reduced their value to waterfowl.

34. APPALACHIAN MOUNTAINS - Included in this area are the Blue Ridge, the Ridge and Valley region, the Cumberland Plateau, the Ohio Hills, and the Allegheny Plateau. The rugged terrain is generally dominated by oak-hickory and other deciduous forest types at lower elevations and various combinations of pine, hemlock, spruce, and fir in higher areas. While flatter portions are in agricultural use, the majority of most segments of this region are forested. Priority forest birds include Cerulean Warblers at low elevations and Black-throated Blue Warblers higher up. Golden-winged Warblers inhabit early succession areas and Henslow's Sparrows occur in grasslands. While not as important for waterfowl as coastal regions, the Appalachian region contains the headwaters of several major Eastern river systems (Susquehanna, Potomac, Delaware) and includes other important riverine habitats, including the mainstem of the Ohio River.

35. SOUTHEASTERN PLAINS/ PIEDMONT – This region includes both the Appalachian Piedmont and the southeastern plains dominated by oak, hickory, and pine that extend to the Southern Atlantic Coastal Plain. The Piedmont is transitional between the mountainous Appalachians and the flat coastal plain, and is dominated by pine and mixed southern hardwoods. Priority landbirds include Red-cockaded Woodpeckers, Bachman's Sparrows, and Swainson's Warblers. Interior wetlands, including pocosins, Carolina bays, reservoirs, and riverine systems, provide important migration and wintering habitat for waterfowl.

36. SOUTHERN ATLANTIC COASTAL PLAIN – This region includes the extensive swamps and marshes along the Atlantic coast from the mouth of the Chesapeake Bay to southern Georgia. Interior forest vegetation is dominated by loblolly and shortleaf pine forests. Priority landbirds include the Red-cockaded Woodpeckers, Painted Buntings, Bachman's Sparrows, Swainson's Warblers, and Swallow-Tailed Kites. Coastal intertidal habitats provide critical wintering areas

for American Oystercatchers, important wintering and spring migration areas for Short-billed Dowitchers and Dunlin, and important fall staging areas for Red Knot.. Sizable numbers of Brown Pelicans and various terns breed on offshore islands. Coastal areas provide important nesting and foraging habitats for large numbers of herons, egrets, ibis, terns, and other species. The coastal region of North Carolina winters up to 80% of the eastern population of Tundra Swans.

37. SUBTROPICAL FLORIDA – The normally frost-free climate of this region is suitable for mangroves, everglades, and tropical hammocks, tying this area more closely to the Bahamas and Caribbean than to the rest of the United States. Snail Kites, Short-tailed Hawks, and Limpkin breed in interior wetlands, with Mangrove Cuckoo and Black-whiskered Vireo in coastal mangroves. One of the greatest wading bird concentrations in the world, including Wood Storks, occurs in the Everglades. White-crowned Pigeons inhabit the Florida Keys, and the most important Brown Noddy, Sooty Tern, and Magnificent Frigatebird breeding site in the country is in the Dry Tortugas. Extraordinary numbers of wintering waterfowl and wintering and in-transit shorebirds also use the region, particularly Short-billed Dowitchers. Primary waterfowl species found in the area include Ring-necked Ducks, Blue-winged Teal, Fulvous Whistling Ducks, Mottled Ducks, and Scaup.

38. PUERTO RICO/ U.S. VIRGIN ISLANDS: These islands provide important breeding sites for colonies of tropicbirds, boobies, Sooty Terns, Brown Noddies, and other species in the Carribean Ocean. Inshore habitats are important winter foraging sites for sizable numbers of terns migrating south from North America.

Appendix B:

ECOLOGICAL REGIONS OF NORTH AMERICA:
TOWARD A COMMON PERSPECTIVE

THE COMMISSION FOR ENVIRONMENTAL COOPERATION ECOREGIONS
and DELINEATION PROTOCOL

(Reproduced with Permission of the Commission for Environmental Cooperation)

CEC Level III Ecoregions

ECOLOGICAL REGIONS OF NORTH AMERICA

Toward a Common Perspective

COMMISSION FOR ENVIRONMENTAL COOPERATION

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PROFILE OF THE CEC

In North America, we share vital natural resources, including air, oceans and rivers, mountains and forests. Together, these natural resources are the basis of a rich network of ecosystems, which sustain our livelihoods and well-being. If they are to continue being a source of future life and prosperity, these resources must be protected. This stewardship of the North American environment is a responsibility shared by Canada, Mexico and the United States.

The Commission for Environmental Cooperation (CEC) is an international organization whose members are Canada, Mexico and the United States. The CEC was created under the North American Agreement on Environmental Cooperation (NAAEC) to address regional environmental concerns, help prevent potential trade and environmental conflicts and promote the effective enforcement of environmental law. The Agreement complements the environmental provisions established in the North American Free Trade Agreement (NAFTA).

The CEC accomplishes its work through the combined efforts of its three principal components: the Council, the Secretariat and the Joint Public Advisory Committee (JPAC). The Council is the governing body of the CEC and is composed of the highest-level environmental authorities from each of the three countries. The Secretariat implements the annual work program and provides administrative, technical and operational support to the Council. The Joint Public Advisory Committee is composed of fifteen citizens, five from each of the three countries, and advises the Council on any matter within the scope of the Agreement.

MISSION

The CEC facilitates cooperation and public participation to foster conservation, protection and enhancement of the North American environment for the benefit of present and future generations, in the context of increasing economic, trade and social links among Canada, Mexico and the United States.

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1. International Working Group

Members of the original Trilateral Working Group and the CEC Working Group have been fairly consistent. The latter was composed of professionals from the CCEA, Environment Canada, British Columbia Ministry of Environment, Lands and Parks (BCMELP), Canadian Plains Research Centre (University of Regina) Environmental Protection Agency (US-EPA), Instituto Nacional de Ecología (INE), Instituto de Ecología, A.C. (IdeE), Instituto Nacional de Estadística, Geografía e Informática (INEGI) and the Instituto de Ecología of the Universidad Nacional Autónoma de México (IdeE, UNAM). Members of the CEC Working Group were:

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I. NORTH AMERICA FROM AN ECOLOGICAL PERSPECTIVE

North America is a continent rich in diversity. Climatic types range from the polar arctic to tropical forests. Topographically, the continent contains a valley with the lowest elevation on earth and also extensive chains of tall mountains. It is blessed with rich natural resources as well as an unmatched variety of scenic natural beauty. Possessed of great variety among its populations of native animals and plants, since before recorded history it has also seen the development of a rich diversity in human cultures.

Ecologically, North America is a mosaic. Many of its ecosystems possess unique natural features of worldwide significance and of great individuality. Traditionally, humans in Western society have viewed themselves and their activities as separate and isolated from these ecosystems but it is ever more apparent that human activities and the environment are highly interrelated and will always be, no matter how far technological advancement proceeds, and that without healthy ecosystems, a high quality of human life and economic prosperity cannot be sustained. This view is central to what has become known as the "ecological perspective," which recognizes the importance of viewing ourselves as part of, rather than separate from, the world's ecosystems.

The science of ecology and its unit of study, "ecosystem," is vital for understanding and describing our environment. A compound of the prefix, "eco-," derived from the Greek word "oiko/oikos," meaning "house" or "habitation," and "system," referring to the relationships or connections between biological and physical parts, "ecosystem" is a dynamic complex of organisms (biota)—including humans—and their physical environment, which interact as a functional unit in nature. Ecosystems can vary greatly in size and range from completely natural, pristine conditions to those that have been heavily modified by humans (adapted from Government of Canada, 1996).

Besides its ecological richness, North America also possesses many of the environmental problems characteristic of this century. In 1994, the Commission for Environmental Cooperation (CEC) was established by Canada, Mexico, and the United States to address environmental concerns common to the three countries. The CEC derives its formal mandate from the North American Agreement on Environmental Cooperation (NAAEC), the environmental side accord to the North American Free Trade Agreement (NAFTA). This accord represents a cornerstone of the overall agreement, and is a statement of the signatory countries' intent to examine more closely mutual environmental-economic relationships. That approach will necessitate purposeful actions to think, plan, and act in terms of ecosystems. But ecosystems know no political boundries. The migration of birds, the ranging of animals, the distribution of flora, and defining geographical features transcend state or provincial, territorial, even national borders. Recognizing that environmental issues are complex and not restricted by such jurisdictional boundaries but are shared among nations, the three countries have thus accepted the need to move away from an emphasis on individual environmental and socio-economic concerns, and shift towards a more comprehensive, continental scale approach—one that includes not only assessments of trade, but also strives to foster cooperative work to protect the environment, to insure the sustainability of resources, and to study the effect of human activities on ecosystems.

Why is an ecological perspective important?

The ecosystems of North America are diverse and highly productive, containing valuable natural resources. The range of environmental conditions and of our social and economic activities attest to this fact, as our livelihood across the continent has been very much linked, historically and at present, to this inherent wealth. Ecosystems are dynamic, constantly changing over time. Humans, however, are now one of nature's foremost agents of change. Interventions by humans have impacted the continent in different ways, over local and large areas, and through different time periods. Recent signs of the widespread degradation of ecosystems, better knowledge of "cause and effect" relationships—especially those wrought by humans, concerns about sustaining basic life-support systems, and possible direct impacts on human health from ecosystem changes are among many factors that have

forced nations to re-examine policies and programs. Many questions arise: Will forestry as we know it remain sustainable? Will agricultural areas remain productive? Will wildlife species and habitats survive? Will aquatic ecosystems recover from pollution? Understanding the linkages and connections among human activities and the environment requires nations to "think, plan and act" strategically in terms of ecosystems.

It is essential that ecosystems do not become stressed beyond the threshold at which undesirable and irreversible changes will set in. We need to understand the diversity of ecosystems, their importance to a variety of human and non-human needs, and their condition and health over the long term. Failure to do so undermines our ability to assess their integrity and eventually could result in environmental degradation, impoverishing the economic wealth of nations.

The present volume and its accompanying maps represent a first attempt at holistically classifying and mapping ecological regions across all three countries of the North American continent. The study has been built upon efforts that had begun individually in all three countries. In 1993, a North American Workshop on Environmental Information was convened between Canada, Mexico, and the United States. Over eighty specialists from the three countries concurred that having a sound ecological perspective was essential for improved understanding and effective environmental management and planning. Work was supported by federal departments, universities, nongovernmental organizations (NGOs) and institutes in all three countries, and proceeded through a process of consultation, collaboration and compromise. Core support and funding were offered by the CEC, as the project goals were in keeping with its overall mission.

Concepts

Viewing people as parts of ecosystems

Like other organisms, human beings rely on specific geographical areas or spaces for our ability to provide basic needs like food, clothing and shelter. It is vital, therefore, that we have a geographic perspective as we plan and conduct our activities, and that we consider what impacts these may have on environmental resources.

Ecological regions define spaces in an ecologically meaningful way. They are effective for national and regional state of the environment reports, environmental resource inventories and assessments, setting regional resource management goals, determining carrying capacity, as well as developing biological criteria and water quality standards. The development of a clear understanding of regional and large continental ecosystems is critical for evaluating ecological risk, sustainability and health.

If the concepts of holistic ecosystem classifications are now well documented, though, the data required for its application across Canada, Mexico, and United States are still of variable quality—ranging from good to poor. The experience in applying broader-based ecosystem classification has been more extensive in Canada and the United States; however, these principles had not yet been applied to Mexico in a thorough fashion and the importance of undertaking that research in this study cannot be overstated. For this study, a common analytical methodology was required for viewing in proper perspective the continental ecosystems shared by the three countries. This methodology examines North American ecology at multiple scales, from large continental ecosystems to subdivisions of these that correlate more detailed physical and biological settings with human activities on two levels of successively smaller units. The attached maps and following report represent the working group's best consensus on the distribution and characteristics of major ecosystems on all three levels throughout the three North American countries.

The ecological perspective adopted for this study is predicated on:

- accepting that interactions between the environment (air, water, land and biota), and human activities (social, cultural and economic systems) are inseparable;
- realizing that humans are now the major driving force behind most ecological changes;
- recognizing environmental thresholds and their importance and linkage to human activities;
- incorporating the needs of current and future generations; and
- implementing a long-term perspective that is anticipatory, preventative and sustainable.

As an approach for information-gathering and reporting, an ecological perspective can improve our understanding of the conditions and trends that are shaping vital aspects of North American society and our environment. As a planning tool, an ecological perspective can ensure that a comprehensive, holistic approach is taken on environmental issues, rather than an

isolated or sector-by-sector analysis. It can assist in setting priorities for action that consider the unique and critical environmental assets found in North America.

Ecological Regions of North America, as presented here, is a view of continental ecological regions that has been developed to enhance the capability of both NGOs and governmental organizations to assess the nature, condition and trends of the major ecosystems in North America. It is offered for use to a wide range of professionals and the general public. The authors also hope that it will be seen as having educational utility, focusing on the sustainability and conservation of resources. By necessity, the notion of resources is broadly interpreted, embracing the traditional ideas of resources (i.e., timber, arable soils, water) but also including the ecosystems of which they are a part.

As resource inventories, species and environmental assessments, and general scientific knowledge have improved over the past decade, so too has the capability to see ecological perspectives on continental, national and regional levels. The growing interest in applying an ecological approach to environmental assessments, risk analysis and resource management has made these continuing improvements very timely. As examples intended to illustrate the value of this methodology in environmental description, case studies are included in Section IV. Although these analyses are founded on the broadest level of ecological regionalization, they provide valuable information that could be used in making policy decisions related to the environment, and are intended as examples of the kind of analysis that could also be applied on more detailed levels of ecological regionalization.

Ecological Characterization—Our Window on the Future

Widespread attention to environmental issues is, without any doubt, one of the most distinctive characteristics of the last two decades. The perception of impending environmental crisis held by many scientists and members of the public has led to a reconsideration of long-held tenets of biological ecology and related environmental studies. Chief among these is the realization that very close-range studies, while still important, no longer suffice because they so easily yield a picture that is too fragmented for analysis, description, and decison-making on a region-wide, continental or global level. This wider perspective is often lacking because our knowledge of ecosystems on a regional and global level is inadequate, and because the development of a common language for a coherent classification system is still in its infancy.

In addition, the relation between human societies and nature, the practice of sustainable resource management, the environmental effects of different economic and trading systems, and the basic human need for a healthy environment are all concepts newly incorporated into the public consciousness. An orientation strictly based around the family, or on local or even national issues, important as they are, simply no longer suffices. We must see and understand local events and issues in terms of their wider impact.

The Commission for Environmental Cooperation is in the privileged position of being one of the very few environmental organizations whose mandate was initiated with a supra-national, region-wide purpose. It is concerned with the whole of North America, a continent notable for its great ecosystem, species and genetic richness, spanning political borders. The CEC recognizes that it must maintain a region-wide ecological perspective in order to contribute to the development of a healthier relationship between our societies and the natural world of which we are a part and upon which we closely depend.

This project of region-wide ecosystem characterization was intended to help address these issues. The sessions involved intense research and discussion between many experts of the three countries who, in attempting to balance the great significance political frontiers have had on the history of environmental change in North America, recognized fully the importance of transboundary effects that are derived from the inherent continuity of natural ecosystems. They also recognized the importance of evolving a common language in the classification systems in order to be able to treat ecological regions in a coherent, holistic fashion. The participating experts and organizations all had a deep commitment to the development of environmentally sound strategies, based on solid knowledge of natural processes.

The workshops, meetings and discussions held during this process were an achievement on their own. The maps and the report that have resulted attempt to describe the diversity and continuity of the ecosystems of this region, and it is hoped that they will bear fruit in facilitating communication between scientists, decision makers, environmentalists and anyone interested in the enormous ecological richness of this wide continent. However, a process so complex never really ends,

and the CEC and the project working group recognize that the maps will be refined by further knowledge. To the extent that the project continues to yield improvements in knowledge, communication, and the development of better environmental policies guaranteeing our environmental legacy for future generations, we will have succeeded.

II. ECOLOGICAL REGIONALIZATION IN NORTH AMERICA

Concepts of Ecological Classification

While the need for broad ecological regionalization has long been recognized, attempts at developing a North American ecological classification based on a holistic interpretation of ecosystems are relatively recent. Some of the earliest such studies between Canada and the United States were in response to such issues as acid rain and protected areas. The focus of the initial work lay along the 49th parallel, later moving north to the Yukon and Alaska. Ultimately, the entire area of each country was the focus. These studies arose from the need to have a common basis for state of the environment reporting, particularly one that would encourage the application and use of an ecological approach to sustainable resource use.

Ecological classifications have evolved considerably over the past thirty years. Early pioneering works in North America evolved from forest and climate classifications and were often climate driven (Hills 1961; Flores et al. 1971; CETENAL (now INEGI) 1976; Bailey 1976). The use of more holistic classifications is more recent. Several more broadly based regional ecological classifications emerged during this period (Oswald and Senyk, 1977; Lopoukhine et al. 1979; Strong and Leggart 1980; Hirvonen 1984). The first national compilations of ecological classifications emerged in the mid-1980s (Wiken, comp. 1986; Omernik 1987). These were holistic approaches that recognized the importance of considering a full range of physical and biotic characteristics to explain ecosystem regionality. Equally, they recognized that ecosystems of any size or level are not always dominated by one particular factor. In describing ecoregionalization in Canada, Wiken (1986) stated:

> *Ecological land classification is a process of delineating and classifying ecologically distinctive areas of the Earth's surface. Each area can be viewed as a discrete system which has resulted from the mesh and interplay of the geologic, landform, soil, vegetative, climatic, wildlife, water and human factors which may be present. The dominance of any one or a number of these factors varies with the given ecological land unit. This holistic approach to land classification can be applied incrementally on a scale-related basis from very site-specific ecosystems to very broad ecosystems.*

The classification can be produced following various approaches. The two used for this project were:

1. opinions were sought from ecologists and other scientists on the relevant features for each region; and
2. a data matrix was produced that could be used to build each ecological level.

Because the underlying dynamics of the ecosystems produce complex, multiple patterns of correlation among the biotic, abiotic, and human factors, these two approaches tended to produce a converging depiction of regions.

The focus for this project was to develop ecological land classifications suitable for use in continental, national and regional/local environmental reporting and assessment. A similar hierarchical ecological classification of oceanic areas in Canada has been published (Hirvonen et al. 1994; CCEA 1995); however, integration of these with oceanic areas in the United States and Mexico has not yet taken place.

How Mapped Areas are Derived

Diagnostic criteria for individual mapped areas are based on "enduring" components of the ecosystems contained therein. These components are relatively stable, such as soil, landform, or major vegetation types: that is, features that do not change appreciably over ecological time. Climate is also considered but, unlike the other stable components, it needs to be assessed by looking at long-term records. Enduring components are attributes that can be determined, either visually (e.g., from aerial photographs or satellite imagery) or from pertinent field studies or resource sector maps. For any level of ecological generalization, the mosaic of components may vary from one ecological area to the next. Ecological classification is science-based, but, in a way, it is also an art because ecological cycles, characteristics and interactions are not readily apparent and need to be interpreted from soil, vegetation and landform characteristics or other factors. Thus a mapped area must be considered a partial abstraction of real ecosystems. Maps depict where major ecological areas exist as a result of major ecological interactions but they do not readily illustrate the more dynamic aspects of ecosystems. More intangible characteristics, like changing weather patterns, species dynamics and soil chemical processes, are all vital in understanding ecosystems.

Which parameter is initially used to define an area often depends on the background of the scientist doing the analysis

and on those indicators that person finds contribute most incisively to understanding the nature of the ecosystem. If vegetation serves this function, then vegetation types, forms and/or composition might initially be used. Ultimately, through the interpretive process, the broad range of ecological characteristics, including climate, soils, physiography and water bodies would be considered. Boundaries bisect transition areas, distinguishing one ecological area from another. When these transition areas are abrupt, delineation is relatively straightforward. At other times, the transition zone may be diffuse and extend for hundreds of kilometers. In these situations, boundary delineation becomes more subjective.

Current land use and other human influences are characteristics that have not been commonly accepted as useful for delineating ecological areas. However, in this study these attributes were found to be relevant and sometimes even essential to the description. In situations where human use has historically been pervasive, it may significantly and irreversibly influence the ecological processes and attributes of that area. Examples could be the Great Plains and the Temperate Sierras, where land use and human activities serve as an important interpretive parameter because they have largely transformed the regions. On the other hand, some of the larger ecosystems, like the Arctic, have not been significantly transformed by humans over long periods of time.

Key Points in Mapping Ecological Regions

- Ecological classification incorporates all major components of ecosystems: air, water, land, and biota, including humans.
- It is holistic ("the whole is greater than the sum of its parts").
- The number and relative importance of factors that are helpful in the delineation process vary from one area to another, regardless of the level of generalization.
- Ecological classification is based on hierarchy—ecosystems are nested within ecosystems.
- Such classification integrates knowledge; it is not an overlay process.

One of the key features of ecosystems is their interaction with other ecosystems. Ecosystems can be viewed as part of a "nested hierarchy" in which smaller ecosystems are amalgamated into successively larger ones.

- It recognizes that ecosystems are interactive—characteristics of one ecosystem blend with those of another.
- Map lines depicting ecological classification boundaries generally coincide with the location of zones of transition.

The Ecological Regions of North America

"Ecological region" refers to any one of the ecological areas that were mapped and described in this project. In a technical sense, they represent many things: a concept, a mapped and classified area, and an area of land with distinctive biological, physical and human characteristics. Determining ecological regions at a continental level is a challenging task. It is difficult, in part, because North America is ecologically diverse and because a nation's territorial boundaries are a strong hindrance to seeing and appreciating the perspectives across the land-mass of three countries.

Ecosystems vary in composition. The interactions that occur within and among them are many and complex. Mapped areas must reflect this complexity in a "workable" and understandable manner for planning and communication purposes. Delineating an ecological area serves to "capture" its general ecological composition as well as the links between the ecosystems it contains.

What the Maps Depict

For planning and reporting purposes, maps are essential. The level of generalization of delineated ecosystems respects different levels of planning and reporting needs. In the context of North America, ecological regions are depicted at three levels of mapping. All three levels depict the spatial distribution of ecosystems. In some cases these are simple and fairly homogeneous, but often they are heterogeneous aggregations. The actual processes underlying ecosystems are not easily reflected on maps, and nor are the specific characteristics themselves. The intent is to illustrate the net product of many interacting ecological processes and functions of living organisms. Accompanying descriptions and other supplementary information, as provided in this report, are required to depict more fully the dynamism and complexity, both spatial and temporal, of real-world ecosystems.

As an example, the Great Plains ecological region has characteristics that are easily defined in a geographic sense. They include expanses of prairie soils, plains, areas of cereal grain production and grassland communities. In contrast, other characteristics that have a major influence on prairie ecology may not readily be seen. For example, although weather and hydrological patterns may be reflected in the types of

vegetation and soil that are present, they require formal instrumentation and monitoring for their assessment and evaluation.

The names used for the level I and II ecological regions are generally those in standard use in the individual countries. This was done to maintain as much continuity in nomenclature as possible. However, the names of some of the transboundary regions were adapted to respect the broader geographical coverage of this study. Names were generally intended to describe the overall character of the regions but, in other cases, they reflect prominent biophysical features such as mountain ranges or forest types. Each region is identified by a unique color and numerical code on the accompanying maps.

LEVEL I

North America has been broken down into 15 broad, level I ecological regions. These highlight major ecological areas and provide the broad backdrop to the ecological mosaic of the continent, putting it in context at global or intercontinental scales.

Viewing the ecological hierarchy at this scale provides a context for seeing global or intercontinental patterns. Level I ecological regions are: Arctic Cordillera, Tundra, Taiga, Hudson Plains, Northern Forests, Northwestern Forested Mountains, Marine West Coast Forests, Eastern Temperate Forests, Great Plains, North American Deserts, Mediterranean California, Southern Semi-Arid Highlands, Temperate Sierras, Tropical Dry Forests and Tropical Humid Forests.

Brief narrative descriptions of each level I region can be found in Section III. These descriptions—each of which is divided into sections describing the physical setting, biological setting and human activities therein—provide an overview of the principal attributes of each region. The intent is to provide a sense of the ecological diversity, the human interactions taking place and how each region differs from adjacent ones.

Level I can be characterized as follows:

- number of ecological regions: 15
- scale of presentation: approximately 1:50 million
- continental perspectives
- determination of the areas composing the regions through satellite imagery and appropriate natural resource source maps at broad scales (approximately 1:40 million – 1:50 million)

LEVEL II

The 52 level II ecological regions that have been delineated are intended to provide a more detailed description of the large ecological areas nested within the level I regions. For example, the Tropical Humid Forests of level I is the region covering coastal portions of the United States and Mexico, and is composed of six level II regions. Level II ecological regions are useful for national and subcontinental overviews of physiography, wildlife, and land use

Three level I regions (Hudson Plains, Marine West Coast Forests and Mediterranean California) have no level II delineations. The Great Plains, Tropical Dry Forests and Tropical Humid Forests level I regions, on the other hand, each have six level II subdivisions. The table on the reverse of the level II map provides a synopsis of the major physical and biological attributes along with human activities associated with each of the level II ecological regions.

Level II can be characterized as follows:

- number of ecological regions: 52
- scale of presentation: 1:30 million
- nested within level I regions
- national/regional perspectives
- determination of the areas composing the regions through satellite imagery and appropriate natural resource source maps at broad scales (approximately 1:20 million – 1:30 million)

LEVEL III

Level III mapping, which is now in process, describes smaller ecological areas nested within level II regions. These smaller divisions will enhance regional environmental monitoring, assessment and reporting, as well as decision-making. Because level III regions are smaller, they allow locally defining characteristics to be identified, and more specifically oriented management strategies to be formulated.

Level III can be characterized as follows:

- number of ecological regions: approximately 200
- scale of presentation: approximately 1:5 – 1:10 million
- nested within level II regions
- regional perspective
- determination of the areas composing the regions through remote sensing techniques and appropriate regional natural resource source maps (at scales of approximately 1:2 – 1:4 million)

Level IV, which, like level III, will not be addressed in this report or its accompanying maps, would be nested in level III regions and should allow very localized monitoring, reporting, and decision making. In working on this level, of course,

it is very important that the larger, region-wide perspective be kept in mind.

The Next Steps

We have much to learn about ecosystems. While an ecosystem perspective is a logical and practical route for achieving sustainability goals, it has not been a working principle in most organizations and departments. This perspective has not been reflected in basic inventories, research, databases or assessments and thus, this ecological portrayal of North America had to be built initially from a variety of information sources and advice from different professionals. Many of the agencies that have traditionally looked at individual component parts of ecosystems (i.e., soils, water, wildlife, land use) are expanding their efforts to collect a broader range of information or to work more cooperatively with other resource agencies. The extension of these initiatives are strategic for environmental management and planning. For instance, region-wide cooperation, as is needed for the conservation and protection of migratory species and for the solution of transboundary environmental issues such as pollutant dispersion, should be based on the ecosystem/ecological region perspective.

The next step should be to engage specialists from the three nations to refine further what we know of these ecological regions. The construction of an ecosystem information base could be followed by projects that will enhance the analytical capabilities of researchers and decision-makers. The CEC is already involved in the creation of such a tool, the North American Integrated Information System, which functions on both a broad, regional scale and a much smaller municipality-oriented one to produce maps of the continent or selected regions within it. The user can overlay data that combine physical features, such as land and water, with such other ecological elements as forests and wildlife, and information on economic and social issues, to analyze the environmental impacts of selected physical, socioeconomic, and ecological variables. The maps (levels I, II, and III), as well as the North American Integrated Information System, will be made available on the Internet.

Such tools will allow questions of local to continental significance to be examined. This kind of analytical process requires integrating skills from different professionals and organizations, including many that do not normally work together. Such a multi-disciplinary integration process is complex, but it is the only way to approach the very involved environmental issues confronting North America today.