Biotic Provinces of the World

FURTHER DEVELOPMENT OF A SYSTEM FOR DEFINING AND CLASSIFYING NATURAL REGIONS FOR PURPOSES OF CONSERVATION

Prepared by the Secretariat of IUCN as a contribution to UNESCO's Man and the Biosphere Programme Project No. 8

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FOREWORD

This report has been prepared by the Secretariat of IUCN as a further contribution to Unesco's Man and the Biosphere Programme, Project No. 8: Conservation of Natural Areas and of the Genetic Material They Contain. The work has been undertaken as part of Unesco Contract 618.057.

The report is the third in a series relating to studies on the development of a system for defining and classifying natural areas for purposes of conservation. Previous reports are: "Towards a system for classifying natural regions of the world and their representation by natural parks and reserves", by R.F. Dasmann, Biological Conservation 4: 247-255, 1972, and "A system for defining and classifying natural regions for purposes of conservation", by R. F. Dasmann, IUCN Occasional Paper No. 7, 1973.

This report presents the background explanations and descriptions previously published in the first two papers; however, it contains more recent material on the distribution of national parks and equivalent reserves in relation to the updated classification of biotic provinces presented in IUCN Occasional Paper No. 7. Only those national parks and reserves which meet the criteria for the 1974 United Nations List of National Parks and Equivalent Reserves (IUCN Publ. New Series, No. 29) are included in this paper. This means that certain biotic provinces will have, in actuality, a greater number of reserves than are here shown. However, because of size, degree of protection, administrative status, or other reasons, these reserves fail to satisfy the criteria for the United Nations List. It is to be noted that for certain countries, and most obviously China, information on the number and distribution of national parks and equivalent reserves is not available to IUCN.

It is now apparent that for certain biogeographical regions, in particular the Neotropical Region, the classification of biotic provinces presented here requires further modification and subdivision. This revision will be carried out by a task force of experts directed by the IUCN Secretariat under contract from Unesco, and it is expected that a revised classification will be available to the Man and the Biosphere Programme by mid-year, 1975.

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INTRODUCTION

The need to establish a world-wide network of natural reserves encompassing representative areas of the world's ecosystems is now generally recognized as having high priority. It has long been a central concern of IUCN and the focus of interest of its International Commission on National Parks. In concert with the World Wildlife Fund, IUCN continues to work towards such an objective. This endeavour was given further emphasis by being included as a major activity of the International Biological Programme (IBP). More recently it has received attention by being included as part of Project 8, Conservation of Natural Areas and of the Genetic Material They Contain, in Unesco's Man and the Biosphere Programme (MAB). This project calls for the establishment of a world network of Biosphere Reserves to protect natural areas and genetic resources.

Although considerable progress has been made towards establishing a world network of reserves - over 1,100 were listed in the 1974 United Nations List of National Parks and Equivalent Reserves (IUCN/ICNP, 1974) - much remains to be done. The majority of reserves are concentrated in relatively few countries and biotic regions. In many major regions there are few, if any, protected areas.

To proceed with the establishment of the reserves that are needed to offer adequate protection to the various naturally-occurring ecosystems of the world, it is essential to arrive at a system of priorities. These must be based on a knowledge of the nature, location, and extent, of naturally-occurring ecosystems. Unfortunately, our understanding of these is limited. It is the purpose of this paper to explore the available knowledge and recommend a practical system for classification of ecosystems that may be used in future efforts to ensure the maximum possible conservation of the world's biota.

ECOSYSTEMS AND THEIR CLASSIFICATION

Ecosystems (biogeocoenoses) are functioning entities composed of plants, animals, microorganisms, an inorganic substrate of soil, rock or water, and with access, direct or indirect, to the atmosphere and to sunlight as a source of energy. Terrestrial and freshwater ecosystems exist always within a particular climate provided by the interaction of sunlight and atmosphere, and terrestrial ecosystems require a source of water. All parts within an ecosystem interact with one another, either in an immediate sense or over the long term.

The term "ecosystem" is usually attributed to Tansley (1935), who used it in the sense of a biotic community interacting with its physical environment. In this sense the ecosystem is delimited by the boundaries of a particular community - e.g. the meadow ecosystem ends at the meadow's edge where the forest ecosystem begins. However, the term is now used in

a wide variety of senses and may or may not be considered as coextensive with a particular type of vegetation; nor is it necessarily marked or delimited on a vegetation map. Climate, physiography, soils, water, animal life, or even other factors, may be of equal importance to the description and delineation of ecosystems. The presence of various microorganisms or animals may be as essential to ecosystem functioning as the particular surface arrangement of larger plants. The problems involved in any classification of ecosystems have been reviewed by Sukachev and Dylis (1968). The origin and development of the ecosystem concept has been reviewed by J. Major (c.f. Dine, 1969). From these considerations it is apparent that the systematics of ecosystems, taking into account their full structure and functioning, is not sufficiently advanced to permit detailed classification and mapping; yet we are concerned with acquiring sufficient knowledge of biotic communities and species to permit their conservation. The accomplishment of this conservation objective cannot wait on further study of the nature and extent of ecosystems, but must take advantage of the rough and generalized classifications that are now available.

One approach to the classification of biotic communities and, indirectly, of ecosystems is that developed originally by Frederick E. Clements and presented in Weaver and Clements (1938). This involves the study, description, and mapping, of major climax plant communities. According to Clements, such climax communities will be indicative of the prevailing climate of the area, and within any climatic region, vegetation will develop from various substrates along successional pathways that converge towards a single climax. Thus, in the taiga area of eastern Canada, succession on all sites will converge, in time, towards a spruce-fir climax forest. The climax formation, as mapped by Clements, is defined by the regional climax and includes all successional stages leading to that climax. Thus, the spruce-fir climax formation, if heavily disturbed, might well include very little spruce-fir forest, but a great amount of secondary successional birch-aspen woodland or jack pine forest, along with primary successional areas of bog, low heath, etc.

The Clements system was further developed through his collaboration with the animal ecologist Victor E. Shelford (Clements and Shelford, 1939) to include the presence and role of animal life. The formation of Clements as modified by Shelford becomes the biome, an area characterized by a prevailing regional climax vegetation and its associated animal life. Examples, are the tundra biome (or climax formation), the grassland biome, and so on.

Because, in theory, the biome is further characterized by a prevailing climax soil type along with its developmental states, and develops in response to particular physiographic and climatic conditions, it can be considered to delimit an extensive ecosystem. Despite much criticism, the biome system of classification and mapping has held up because, in a broad way, it conforms to observable reality - at least in areas not greatly modified by human activity. The arctic tundra, for example, as a geographical and biotic reality, appears not only on biome maps, but on those prepared by any system that takes into account the regional

vegetation. However, it is in areas much modified by people that the biome system shows the greatest weakness. There may seem to be little point in mapping as climax deciduous forest an area which has been for centuries, and probably will continue to be, an agricultural savanna.

CLASSIFICATIONS BASED ON EXISTING PLANT COMMUNITIES

Most students of plant communities have veered away from the Clementsian approach of searching for a climax which may never develop, and concentrate on describing and studying existing plant life. They have tended to group themselves into two categories - those interested primarily in vegetation, and those interested in plant species. The first, or ecological approach, and the second, or floristic approach, are not mutually exclusive, but nevertheless produce differing results.

Thus, in Europe, Braun-Blanquet (1932) and others have studied and mapped the distribution of species and the ways in which these associate into communities. The various associations, alliances, and orders, described and mapped by this system, have no necessary relation to the appearance (physiognomy) or structure of the vegetation, but show, quite clearly, its taxonomic relations. On a larger scale, the floristic regions and provinces of the world have been described and mapped by Good (1947), Gleason and Cronquist (1964), and others. These do not purport to distinguish vegetational differences, but show taxonomic differentiation from one area to another.

By contrast, Warming (1909), Rübel (1930), Schimper and Faber (1935), and others, have been concerned with vegetation. Their classifications are based on the physiognomy and structure of vegetation, with little attention to the species of which it is composed or of its successional status. The vegetation description developed by F. Raymond Fosberg (Peterken, 1967) and used in the International Biological Programme (IBP) takes little account of species. Similarly, the vegetation classification of the Unesco Standing Committee on Classification and Mapping of Vegetation (Unesco, 1969) is based almost entirely on the physiognomy and structure of vegetation. All of these systems emphasize the vegetation formation, using the term as descriptive of existing vegetation of uniform structure and physiognomy, and not in the sense of the climax formation as employed by Clements. Thus the deciduous forest climax formation of Clements would include meadows, marshes, shrublands, and so forth, as successional communities which would be mapped as separate formations in these more general systems.

Not strangely, however, the various systems tend to converge at a higher level. Thus an *Aceretum saccharophori* association in the Braun-Blanquet sense will turn out to occupy the same area as a broadleaf, summergreen, deciduous forest mapped by Schimper and Faber, and will most likely fall within the Clements-Shelford Temperate Deciduous Forest Biome.

ANIMAL COMMUNITIES

Plant communities, being stationary and easily measured, have attracted more attention from systematists and cartographers than the more mobile communities of animals. However, since the days of Sclater (1858) and Wallace (1876), attempts have been made to classify and map the world's faunal groups. Wallace's faunal regions serve to separate and distinguish the major taxonomically determined regional faunas. On a smaller scale, faunal provinces have been described for some areas. Thus Fittkau (1969) has described the faunal provinces of South America, and Hagmeier (1966) the mammal provinces of North America. The term "biotic province", originally used by Vestal (1914), has been developed by Dice (1952) for North America. These biotic provinces take into account both faunal and floral distinctions.

AN APPROACH THROUGH BIOMES

Although it is important to protect natural ecosystems and vegetation for the values and interest that these have, it is equally important to stress the conservation of species. Thus, any system of classification of communities based on soil, vegetation, or other ecosystem components, that does not take species into account is not adequate as a basis for species conservation. Furthermore, it is important to emphasize the conservation of natural areas and, particularly, of long-standing or climax communities, since these tend to be most endangered and most difficult to replace.

With this in mind, the biome system of Clements and Shelford appears to be a useful starting point, since it is a system that is readily applicable globally and takes into account both plants and animals.

However, the biome approach emphasizes ecological similarities at the expense of taxonomic differences. The jaguar is, in the biome, the ecological equivalent of a leopard. But the jaguar is not a leopard, and both must be provided for. Thus, the biome system must be balanced by one that recognizes and emphasizes taxonomic differences - the floristic, faunistic, or biotic, province approach to community description.

In the system proposed here, the biome is taken as the starting point for global classification. However, it is modified according to biogeographically-determined continental subdivisions. Thus major faunal differences occur between the Neotropical, African, and Oriental, lowland tropical rain-forests although all can be considered within the same biome type. Each must be classified and mapped separately, and measures taken for its conservation. Furthermore, within the Oriental lowland tropical rain-forest, marked floristic differences occur between the Indian, Indo-Chinese, and Indonesian, regions, and major faunistic differences separate the Indo-Malaysian complex from its Celebesian, New Guinean, or Australian counterparts.

Comparison of Eurasian and North American conditions

Both North America and Eurasia share the same biomes. These include from north to south: tundra, coniferous forest or taiga, deciduous broad-leaved forest, Mediterranean sclerophyll forest and scrub, grasslands and desert, in addition to high mountain systems that include within a restricted region altitudinal arrays of these biomes or their montane derivatives. Farther south, both continents include a number of subtropical and tropical biomes. The similarities between northern North America and northern Eurasia have long been noted by biogeographers, and Heilprin (1887) first proposed that extra-tropical North America and Eurasia be combined within a single faunal region, the Holarctic. However, the differences are also considerable and were sufficient for Wallace (1876) to recognize two different faunal regions, the Palaearctic for extra-tropical Eurasia, and the Nearctic for extra-tropical North America. Wallace's regions receive continuing acceptance (Darlington, 1957; Udvardy, 1969).

The Nearctic and Palaearctic each contain two endemic families of mammals, the Aplodontidae and Antilocapridae being Nearctic, the Spalacidae and Seleviniidae being Palaearctic. However, the Palaearctic contains four other mammal families shared with the Ethiopian faunal region but not with the Nearctic, whereas the Nearctic contains eight mammalian families shared with the Neotropical faunal region but not with the Palaearctic (Anderson and Jones, 1967). The differences at the level of mammalian families alone are therefore considerable, and at a generic and species level these differences become more marked, particularly as one proceeds from north to south in each continent. A similar degree of difference is readily noted for other faunal classes. It is further to be noted that North America is not divided only into Nearctic and Neotropical regions but includes an area that is neither one nor the other, the Central American and Antillean Regions of Allen (1892) or Drude's (1887) Mexico-Antillean Tropics. Similarly the Palaearctic faunal region of Wallace grades through transitional areas into the Oriental and Ethiopian faunal regions.

If only major faunal regions are considered, the North American and European biomes must be separated. When flora is considered, still further subdivisions must be recognized. Good (1947), for example, finds sufficient floristic difference to separate Europe, south of the Arctic, into two floristic provinces, and North America, south of the Arctic, into three which differ from those of Europe. Such considerations led Kendeigh (1961) to subdivide the biomes of the world into major continental subdivisions which he termed "biociations" and these in turn into smaller units termed "faciations". Had his classification been extended over the world with the same degree of detail used for North America, there would have been little need for development of the system proposed here. However, even within one of Kendeigh's biociations, in particular his tundra biociation, considerable differences are to be found, not only between Palaearctic and Nearctic but within the Nearctic. Greenland, for example, has a depauperate mammal fauna with only 19 per cent species in common with the transcontinental Canadian tundra. The Aleutian tundra shares only 43 per cent of mammal species with the Canadian tundra.

REGIONAL SUBDIVISIONS AND BIOTIC PROVINCES

In this system the biomes of the world are broken down first into a regional subdivision based on Wallace's faunal regions: Palaearctic, Nearctic, Oriental, Ethiopian, Neotropical, and Australian. To these a seventh, the Antarctic, is added. In addition there are various transitional areas and biotic sub-regions that have long been accepted by biogeographers. These include the Malagasy, long separated from Africa; the Caribbean or Middle American, transitional between the Neotropical and Nearctic; the New Guinean and Celebesian, transitional between the Australian and Oriental; the Polynesian, including Micronesian, Melanesian, Polynesian, New Caledonian, and Hawaiian Islands; the Indian Ocean islands; and the Atlantic islands. These form the basis for recognizing regional and sub-regional biome subdivisions. Wallace (1876) noted the major faunistic differences that separated his biotic regions. Thus the Ethiopian region was considered to contain 22 endemic families of vertebrates and the Oriental region 12. The Australian region and Neotropical region are even more distinctive, whereas the Nearctic and Palaearctic are faunistically closer together.

The Biotic Province Concept

Within a regional or sub-regional biome a further subdivision is carried out to biotic provinces. The biotic provinces to be described in this paper are comparable to the faunal provinces of Miller (1951). They have much in common with the biotic provinces described for North America by Dice (1952), Blair (1950), or Goldman and Moore (1946), or the mammal provinces of Hagmeier (1966). These writers, however, tended toward a finer level of subdivision than is proposed here, but one which on further analysis may prove to be justifiable. Had any of these authors extended their system throughout the world, the present exercise would be unnecessary. However, although Liversidge (1962) has mapped the biotic provinces of Southern Africa, Matvejev (1961) those of Yugoslavia, and Freitag (1962) those of Europe, there has been no attempt to present a global picture.

A biotic province, as here defined, is distinguished by its vegetation, flora, or fauna. The physiognomy of the prevailing climatic climax vegetation is the first basis for recognition of a biotic province. Within the area of a physiognomically defined formation, however, the presence of a distinctive flora or fauna will serve to delineate the provincial boundaries. Similarly, within an area of relatively uniform flora or fauna, a marked change in vegetation will indicate a provincial boundary. Obviously a matter of scale is involved. The number of recognizable units could easily reach the tens of thousands if only minor differences were to be considered. Hence it is important to stress that at the vegetation level, differences at the formation level of Weaver and Clements (1938) are indicative of provincial boundaries. At the foristic level, differences equivalent to those of Good's floristic regions,

subdivisions of his provinces, are adequate to separate biotic provinces. At the faunal level a direct species comparison has been used for mammals and birds, and this requires some explanation.

The biotic provinces previously defined in the 1972 paper for North America were examined in relation to Hall and Kelson's (1959) distribution maps of North American mammals. Tabular comparisons were made of the species in adjacent provinces, and similar comparisons were made at the subspecific level. From these a percentage of similarity was calculated in which the number of species (or subspecies) in common was used as the numerator, the total number of species in the two provinces as the denominator. Thus the number of species in common was considered in relation to the number that could potentially be in common if the two provinces were identical and the resemblance expressed as a percentage. After examining the data, and relating these to Miller's (1951) faunal provinces of California, defined by a different system, it was decided that two areas which had 65 per cent of their species in common, or 30 per cent of their subspecies, belonged in the same province (or rather that there were no mammalian faunistic grounds for separating them). Those with less than 65 per cent of their species in common were considered to be in separate biotic provinces. This means for recognizing separate provinces is similar to that employed by Hagmeier and Stults (1964) and Hagmeier (1966) for the mammal provinces of North America.

Ideally faunal and floral comparisons should be made for all groups of animals and plants. However, at this time an analysis of the mammal fauna for North America, of the bird fauna for California, using Miller's (1951) data, and a partial analysis of the mammal and bird faunas of Europe are all that time, and available data, have permitted.

It is noted that high mountains and mountainous islands represent special situations, since in both the vegetation and biota are likely to change markedly within short distances, and one cannot necessarily designate a prevailing vegetation formation for either the mountain or the island. This is in fact also true of any highly diversified place within which major environmental changes are to be found in a small area. Arbitrarily, therefore, mountains, some continuous mountain ranges, and all except the larger islands, are usually considered to form single biotic provinces, or several may be combined in one province (e.g. in the case of archipelagos). Their internal diversity and its importance for conservation is recognized, but because of the scale of mapping this cannot be shown at a provincial level.

A more detailed account of the methods used for defining biotic provinces, using examples from California and other areas of North America, is presented in Appendix 1.

It is recognized that this system would not go far enough to ensure species conservation if it were to be used as the only basis for the establishment of parks or reserves. Each biotic province shown in the tables (Appendices 2 and 3) must be further subdivided according to vegetational, floristic, and faunistic differences, and according to the

existence of various major habitats. Thus, within the Canadian taiga, the presence must be noted of bogs, heaths, freshwater lakes, streams, coastal strands, estuaries, salt and freshwater marshes, inland and coastal cliffs, and similar habitats or successional areas. Such a detailed classification, however, would be unwieldy on a world scale, and must be carried out within each province, as a basis for provincial classification and conservation. The survey that has been conducted by IBP can provide information for some areas on which this detailed local classification may be based.

In Appendix 2 a provisional list of the terrestrial biotic provinces of the world is presented, whereas in Appendix 3 these biotic provinces are mapped for each of the major biogeographic regions. This classification and mapping is taken directly from Dasmann (1973) without modification, although it is to be noted that both are subject to revision as work on this project continues. Coastal and marine biotic provinces are not mapped, although a system of classification and a mapping of these areas is now being prepared by IUCN consultants and will be presented in a later report.

DISTRIBUTION OF NATIONAL PARKS AND RESERVES

The provisional classification of biotic provinces is used in Appendix 4 as a basis for determining the distribution of existing national parks and equivalent reserves. For this purpose the 1974 United Nations List of National Parks and Equivalent Reserves (IUCN/ICNP, 1974) is used as a source. This list includes only those reserves that meet criteria established by the International Commission on National Parks (ICNP). Reserves that are smaller than the prescribed minimum size, that are inadequately protected or lack the necessary legal status are not included in this list. Thus the Appendix shows the distribution only of those reserves of adequate size (over 500 ha) which are considered to be adequately protected both by law and in fact. A particular weakness in the list results from lack of information on the national parks and equivalent reserves of China, a country which includes within its boundaries a considerable number of Palaearctic biotic provinces.

The comparisons shown in Appendix 4 reveal many obvious weaknesses in the existing world network of national parks and equivalent reserves and suggest priorities for conservation action. Thus, even in those continents where conservation interests are strong, such as Europe and North America, national parks or their equivalents are few or lacking in some biotic provinces (e.g. European Mediterranean provinces). In other continents the number of reserves is unevenly distributed. Some areas (e.g. the Saharan or Karroo provinces in Africa) lack adequate protection, whereas others (e.g. the woodland/savanna provinces of Africa) have a relatively large number of reserves.

Considering that international funds required for establishing biosphere reserves or other protected areas will always be limited, it appears advisable to concentrate efforts in those biotic provinces where little

or nothing has been accomplished up to the present time. With the recognized desirability of maintaining examples of every major biotope on earth, far too much international attention has been given to improving the degree of protection in areas in which it is already reasonably good, and consequently easy to accomplish. Meanwhile, major segments of the world's biota may be lost through failure to establish even a minimum degree of protection.

APPENDIX 1

Methods used in defining biotic provinces in North America (from Dasmann, 1973)

Biotic Provinces of California

To further exemplify the nature of a biotic province, techniques for separating it from adjacent provinces, and the diversity to be found within it, the provinces of the State of California are examined. This is a diversified state that contains portions of 6 separate biotic provinces. It has been well studied biogeographically. The provinces here defined are: Californian, Oregonian, Sierran-Cascade, Sonoran, Great Basin, and California Islands. The Oregonian was listed in the earlier paper under "Pacific coastal forest province", but for reasons to be explained this has been subdivided into two provinces. The California Islands were not separated in the previous paper, but are believed to be sufficiently distinct floristically and faunistically for provincial status.

Vegetation: The Californian Province is the most extensive within the State, and except for an extension in Baja California it is confined to the State. Within the province, the principal climax vegetation is of the broad-sclerophyll or Mediterranean form. Included is the chaparral, a broad-sclerophyll scrub that occupies the greatest area and is characterized by *Quercus*, *Ceanothus*, *Arctostaphylos*, and *Adenostoma*; broad-sclerophyll woodland savanna; and in sheltered areas with greater soil depth and moisture, broad-sclerophyll forests in which *Quercus*, *Lithocarpus*, *Umbellularia*, *Arbutus* and *Castanopsis* are conspicuous. The Great Valley of California is included within this province, although it bears resemblance to the grassland province of mid-continent. However, at the time of European settlement, extensive marshlands and a tree or scrub savanna and woodland were more extensive than grassland in the valley. Cooper (1922) has considered the role of fire in modifying this area from sclerophyll scrub or woodland into grassland, a process that continues throughout the hilly regions of the province today.

Characteristic of the province and not part of the overall sclerophyll vegetation is the coastal sagebrush, dominated by *Artemisia californica*, *Salvia*, and other soft shrubs or dwarf-shrubs; and also the coastal scrub in which *Baccharis* or *Rhus* are frequent dominants. Both occur in the vicinity of the ocean, although the coastal sagebrush with *Eriogonum* becoming a conspicuous element, extends well into the interior. Also characteristic of the province are stands of endemic conifers which in some areas form distinctive closed-cone pine forests. These include *Pinus radiata*, *Pinus muricata*, *Pinus torreyana*, *Cupressus macrocarpa* and others.

The California Islands Province as here defined includes the Farallon Islands, off the coast from San Francisco, the Channel Islands, off the southern Californian coast, and islands offshore from Baja California including Los Coronados, Cedros, and Guadalupe. Vegetationally these resemble the Californian province and cannot be separated on the basis of vegetation.

The Oregonian Province is characterized by forests unique in the world for the height of their trees and unique in temperate America for their biomass and productivity. Tall coniferous forests of the temperate rain forest (Rübel, 1930) or giant conifer (Unesco, 1969) formation is the most widespread climax. Some trees, such as Sequoia sempervirens and Chamaecyparis lawsoniana, are confined to this province. Others, such as Picea sitchensis, Tsuga heterophylla, and Chamaecyparis nootkatensis, extend into the Sierran-Cascade and Sitka province. Still others, including Pseudotsuga menziesii and Thuja plicata, range more widely, but reach their greatest height and density in this province.

The vegetation of the Oregonian province grades into that of the adjacent Sierran-Cascade, and in the north into the Rocky Mountains province along an ecotone that makes it difficult in some areas to draw a boundary. To the north there is no major vegetational difference separating the Oregonian and Sitkan provinces.

There is considerable internal diversity in the vegetation. In California alone, the redwood forest, douglas-fir forest, and coastal spruce-fir forest may easily be recognized. Coastal dune forests of Pinus contorta, interior woodlands and savannas dominated by Quercus garryana, riparian woodlands of Acer, Alnus, Populus and other genera, extensive areas of moist coastal scrub, and some areas of tall broad-sclerophyll forest derived from the Californian province, are all to be found. A small, but highly distinctive, area of differing vegetation and flora occurs in the Siskiyou Mountains between California and Oregon (Whittaker, 1954). Except for scale, this could deserve recognition as a separate province, and is included in a separate Humboldtian Mammal Province by Hagmeier (1966). Similarly, in Washington, the Olympic Mountains contain high alpine elements not otherwise found in the province.

The Sierran-Cascade Province is readily defined on its eastern side since it follows essentially the lower limits of the transitional life zone of Merriam (1898) along the Sierran-Cascade ranges. Thus the boundary between yellow-pine forest and sagebrush or juniper-pinyon woodland is the provincial boundary. In the west, in California, the boundary between the transition zone forests and the chaparral or oak woodland of the Californian province marks the boundary line. Coastally, in northern California and in Oregon and Washington, the boundary of the province is more difficult to define since a vegetational continuum often exists. Similarly in the north, although the Cascade volcanic range comes to an end with Mount Baker and the Fraser River, there is a broad area of vegetational continuum with the Oregonian and Rocky Mountains provinces, and the boundaries are somewhat arbitrary.

Like all high mountain provinces, the Sierran-Cascade includes several life zones. Transitional zone Pinus ponderosa or Pinus jeffreyi forests mark the lower boundary, but these species mix at higher elevations with Pinus lambertiana, Pseudotsuga menziesii, Libocedrus decurrens, and Abies concolor in a mixed conifer forest that is typically Sierran and not so well developed in the Cascades. Pinus monticola, Abies magnifica, and Pinus contorta characterize the next higher life zone, the Canadian These give way to a timberline forest of the Hudsonian zone, in which such species as Pinus albicaulis, Abies lasiocarpa, Tsuga mertensiana, and Larix lyallii often occur. Still higher are alpine fields and tundra-like communities of the Arctic-Alpine life zone. Within California, forests of Sequoiadendron gigantea are endemic and found only in a limited area of the western slopes of the southern Sierra Nevada.

The Great Basin Province is only marginally represented in California. As defined here it includes the area between the Rocky Mountains-Wasatch Mountains and the Sierran-Cascade chain, south to where vegetation characteristic of hot desert dominates in southern Nevada and south-eastern California. Included are the Palouse, Columbian Plateau, and Blue Mountains of Washington and Oregon, as well as the more strictly defined physiographic Great Basin. The southern part of the province is of basin-and-range topography in which the floor of the basins is usually at an elevation of over 1500 metres, and isolated mountain ranges may reach above 4000 metres. It follows therefore that there is great internal diversity and this ranges from the barren salt deserts formed from glacial-age lakes (e.g. Bonneville salt flats or Black Rock desert) to forests and alpine communities in the mountains that resemble those of the Sierran-Cascade or Rocky Mountains. The unity of the province is provided by prevailing sagebrush vegetation, a scrub-steppe in which Artemisia, Atriplex, Purshia, or Chrysothamnos are often dominants, but in which the species Artemisia tridentata is the most widespread. This vegetation has invaded former bunch-grass prairie in the Palouse area and elsewhere in the province, and extends in areas disturbed by excessive livestock grazing into the Rocky Mountains and Grasslands provinces Between the sagebrush covered basins and the coniferous forests of the basin ranges, woodlands dominated by nut pines (pinyons) and juniper, with a sagebrush understory, are characteristic of the province

The Sonoran Province includes the Mojave, Coloradan, Sonoran, and Bajian deserts of south-eastern California, Arizona, Sonora and Baja California. For a desert it is well vegetated and lacks the extensive ergs and hammadas of the Sahara. The most widespread climax is desert scrub dominated most commonly by Larrea with Franseria in the understory. Locally, tall cacti such as the saguaro (Cereus), Opuntia, Echinocactus, or candlewoods, such as the coachwhip (Fouquieria), or the maguey (Agave), form succulent deserts. Elsewhere various species of Yucca dominate over wide areas. Palm groves occur in sheltered riparian situations. Desert annuals cover great areas of ground after rains.

Flora: Although, with the exception of the California Islands, all of the provinces of the State of California may be distinguished on vegetational grounds, a consideration of the flora reveals further differences.

The Californian Province is the most floristically distinct and its high degree of endemism has long been observed. Jepson (1925) lists 1416 species of plants endemic to the State of California, and of these a high percentage are confined to the Californian province. Gleason and Cronquist (1964) recognize a Californian floristic province and state that it "has the most sharply differentiated flora in the nation" Good (1947) recognizes a distinct California coast floristic "region", which in his terminology is the equivalent of a province as the term is used here.

Although the California Islands are vegetationally similar to the Californian province, they are distinguished floristically. Jepson (1925) recognized them as a centre of endemism characterized by many distinct genera, such as ironwood (Lyonothamnus). The total endemic plants of the Channel Islands alone exceed 80 species and if figures for the Mexican islands, particularly the isolated, oceanic Guadalupe Island, were available, this total would be much higher.

The Sierran-Cascade Province is variously separated and combined with other western high mountains by different authors. Good (1947) recognizes a Sierra Nevada floristic region. Gleason and Cronquist (1964), however, combine it with other mountains in a Cordilleran floristic province. The vegetation is similar throughout the mountains of western North America, but considerable floristic differences do occur. Thus, in a comparison of forest trees using Sudworth (1908), I have noted 20 species that are found only in the SierranCascades, as compared to 30 species that occur in both this and the Rocky Mountains province.

The Oregonian Province is placed by Good in a Sitka-Oregon floristic region distinct from the Sierra Nevadan and Rocky Mountain. Gleason and Cronquist, however, place it in their extensive Cordilleran province. Jepson would separate the Californian area of this province from that to the north by a boundary at the Rogue River in Oregon, but his centres of endemism within the area of this province overlap with adjacent provinces. Without more analysis than is possible at this time, I would conclude that the floristic grounds within California for recognizing a separate Oregonian Province are debatable, whereas the vegetational basis is reasonably secure.

The Great Basin Province and the Sonoran Province are separable on floristics from all others north of Mexico and are recognized as distinct by both Good in his separate Great Basin and Mexican Lowlands floristic regions and by Gleason and Cronquist in their Sonoran province and Great Basin province.

Avifauna: Miller (1951) has carried out a careful analysis of the avifauna of California in relation to their distribution by life zones, ecologic formations, and faunal provinces. Only breeding birds are considered and "certain casual occurrences beyond normal zonal limits have been disregarded, and limited spatial transgression of zonal boundaries, even by numbers of individuals, has been ruled out". From his analysis of distribution by life zones he recognizes two major

faunas, a boreal avifauna and an austral avifauna. These are then analyzed separately to distinguish avifaunal provinces and their subdivisions within the State. The austral avifauna is considered to have three subdivisions, a Californian avifauna, endemic to the State, and intrusive Great Basin and Sonoran avifaunas, and these are separately analyzed. Recognizable geographic units within the State, distinguished by changes in vegetation, major physiographic barriers, or other breaks of possible distributional significance are the basis of comparison Those units found to have marked faunal differences are separated out into faunal areas, faunal districts, and faunal provinces, according to the degree of difference.

In determining faunal differences, Miller lists those species of birds known to breed within the geographical units to be compared. Points of difference are noted between areas as follows: "A count of 1 is registered for each difference in these lists, that is, for each species or race in either area which is absent in the other; an exception is made for complementary races of the same species, whereby a count of 1 (not 2) is allowed for each pair of races. The total count is an index of difference reflecting, first, the forms that reach their limits of occurrence at the boundary between the areas, and second, forms that have differentiated within the areas and are endemic to them ...".

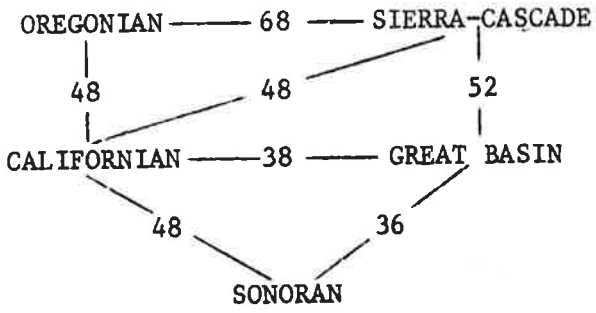
For the units of the boreal avifauna, Miller found difference scores ranging from 4 to 51 for the various geographic units. Units with scores less than 11 are combined within faunal areas; those with scores from 11 to 19 are recognized are separate faunal areas within faunal districts; with scores from 20 to 33 are recognized as separate faunal districts within faunal provinces. A score of 34 or higher marks differences between faunal provinces. On this basis, Miller distinguished three boreal provinces in California: a Coastal Province equivalent to the Oregonian as described here, a Sierran Province, including the Cascades, and a Great Basin Mountain Province.

For the units of the austral avifauna, for which a greater number of species was represented, Miller found scores ranging from 17 to 77. A difference of 57 points or higher was considered to represent a provincial boundary, whereas one of 17 or less was considered to represent two parts of the same faunal area. On this basis, Miller recognizes an Interior (Great Basin and Sonoran) province, and a Channel Islands province.

It would appear on the basis of Miller's analysis that the biotic provinces described here may be distinguished by their avifauna, at least for the Oregonian, Sierran-Cascade, Californian, and California Island provinces. For the Great Basin and Sonoran provinces, Miller finds avifaunal differences only at the district level for the austral fauna, but differentiates a Great Basin Mountain Province for the boreal fauna. In general I have followed Miller's boundaries in my mapping of the California biotic provinces. The exceptions are those isolated faunal areas or districts of relatively small size which are separated geographically from the main body of the biotic province. Miller includes such

areas with the faunal province to which they are faunistically attached. I include them, for purposes of mapping, with the biotic province by which they are surrounded, while emphasizing the importance of recognizing their differences at the next lower level of subdivision.

Mammal fauna: Comparisons of differences in mammalian faunas were made using the methods described above. A diagrammatic comparison of the California biotic provinces (except the California Islands) follows, in which the numbers represent percentage of similarity or faunal resemblance between the provinces.



It will be noted that the greatest difference exists between the Great Basin and Sonoran provinces (36%), and the least between the Oregonian and Sierra-Cascade (68%). Thus if only mammalian faunas were considered, the latter two would be included in the same biotic province.

Comparisons were also made with nearby or similar provinces outside of California, with the following results:

Oregonian x Sitkan	40%
Sierra-Cascade x Rocky Mt.	38%
Great Basin x Grasslands	39%
Californian x Sinaloan	30%
Sonoran x Sierra Madre	43%

It was not possible to compare the California Islands with other provinces from Hall and Kelson's data. Among mammals, however, they support an endemic species of fox and fur seal along with many endemic subspecies (20 on the Channel Islands alone). The herpetological fauna is also largely endemic at the subspecific level and includes an endemic genus of night lizard (Klauberina).

Revision of other North American Biotic Provinces

Using mammalian fauna and to some extent avifauna, all of the biotic provinces of North America proposed in the original paper were reexamined. These faunal comparisons forced various revisions of the provinces previously described.

It has been noted above that the Oregonian biotic province had been included in the earlier paper in a more extensive Pacific Coastal Moist Forest Province. A mammalian faunal comparison, however, revealed a similarity of only 40 per cent between the areas that are now termed the Sitkan and Oregonian biotic provinces. The original province also extended along the southern Alaskan coast to join the Aleutians province. However, a faunal comparison between what is now termed the Alaskan Highlands province (formerly Cordilleran Taiga), and the southern Alaska coast showed a similarity of 79 per cent whereas this same coastal area had only 46 per cent of its mammal species in common with the Sitkan province as now defined. As a result the original province has now been divided between Oregonian, Sitkan, and Alaskan Highlands provinces with the boundary between the latter two drawn at Cook Inlet.

Some redrawing of the boundary between the Alaskan Highlands and the Rocky Mountain provinces has been done. An attempt was made also to subdivide the Rocky Mountains province, considering that Dice (1943) had subdivided it into Montanian, Coloradan and Navahonian provinces. However I found a 70 per cent similarity in mammalian faunas between the southern and northern Rocky Mountain areas within the province. Interestingly enough, Hagmeier (1966) using mammalian fauna found room for 4 provinces in the same area.

Considerable effort was expended in an attempt to define a Forest-Tundra or Hudsonian province corresponding to Merriam's Hudsonian Life Zone. However a mammalian faunal analysis suggested only that the area shared species from the Canadian Tundra province and Canadian Taiga province but had little distinct character of its own. It seems only feasible to recognize as does Pitelka (1941) and Kendeigh (1961) that a broad ecotone of forest tundra separates the tundra and taiga provinces. Again, however, it must be noted that Hagmeier (1966) found a basis for separating out not one, but two, separate Hudsonian mammal provinces. The final word on the subjet has yet to be written.

It is with some regret also that I diverge from Weaver and Clements (1938) and Dice (1943) in eliminating the Great Lakes biotic province, and agree with Pitelka (1941) and Kendeigh (1961) in recognizing this area as ecotonal between the Canadian Taiga and Eastern Deciduous Forest provinces. There seemed to be inadequate vegetational, floral or faunal reasons for maintaining it separately. However, if aquatic biota were to be considered, as they have not been to this point, a Great Lakes province might well re-emerge. Such considerations could also lead to further subdivisions of the Rocky Mountain and eastern provinces or perhaps to greater changes.

I have been forced also to diverge from Dice (1943) and others in placing the central North American grasslands into one province. A comparison of mammalian fauna between two northern and two southern subdivisions of this province was carried out. Greater faunal differences were found from north to south than between the tall-grass prairie and short-grass steppe, but none were sufficient to justify their recognition as separate provinces. Considerable subdivision would be called for, of course, at a sub-provincial level.

The greatest change over the earlier paper is in relation to the Mexican, Antillean, and Central American area. This had been the area of greatest weakness in the previous classification. The previous and present breakdown is as follows:

1972 Provinces	1973 Provinces
Pacific Dry Forest	Sinaloan Guerreran
Tamaulipas Dry Forest	Tamaulipan
Yucatan Dry Forest	Yucatan
Middle American Rain Forest	Campeche Carib-Pacific Panama
Northern Mexican Highlands Southern Mexican Highlands	Sierra Madre
Central American Highlands	Central Cordilleran
Chihuahuan	Chihuahuan
Sonoran	Sonoran
West Indian	Bermuda Everglades Bahamas Cuba Jamaica Hispaniola Puerto Rico Lesser Antilles

In this region occurs the boundary between the Neotropical and Nearctic Faunal Regions, the change from temperate to tropical vegetation, and between the North American and Caribbean floral regions of Good (1947). There is not, however, so much a gradual transition as areas of rather sharp transition. Thus the northern Mexican provinces: Sonoran, Sierra Madre, Chihuahuan and Tamaulipan, clearly belong with the temperate or sub-tropical biomes and are part of the Nearctic Faunal Region. In mammal fauna they show greater resemblances to the provinces north of them with percentages of similarity in the 50s or 60s between them and the California, Rocky Mountain, or Grasslands provinces. However they show little resemblance to the clearly tropical provinces to the south or on the coasts, with percentages of similarity as low as 16 per cent between the Chihuahuan and Campeche provinces, or 28 per cent between Tamaulipan and Campeche. The tropical Middle-American provinces show considerable faunal resemblance among one another, with percentages of similarity in the 50s and 60s between Sinaloan, Guerreran, Campeche,

Yucatan, Central Cordilleran, and Carib-Pacific. However, there is again a break between the Cordilleran and Carib-Pacific provinces and the Panama province. Panama is clearly Neotropical. The other Middle-American tropical provinces form a Middle American Faunal Sub-Region which is neither Nearctic nor Neotropical.

- The West Indies, because of their island isolation, are biotically unique and represent numerous centres of endemism. Although the mammalian fauna is poorly represented, each major island group is clearly separated from the others at the provincial level and all are markedly different from the mainland (e.g. a 10 per cent faunal resemblance between Yucatan and the West Indies). A comparison of bird faunas would be more instructive, but this has not yet been carried out by this writer, although it may well exist in the literature. The West Indies must clearly be recognized as a West Indian Faunal Sub-Region which is neither clearly Neotropical or Nearctic in its relationships.

APPENDIX 2

Provisional List of Biotic Provinces

For the purposes of this list and in order to assign code numbers to each biotic province, the biogeographical regions of Wallace (1876) are followed, with one addition, the Antarctic. Wallace arbitrarily assigned certain island groups to one or another region (e.g. Macaronesia and Iceland to the Palaearctic; Pacific islands to the Australian; various Indian Ocean islands to the Ethiopian). This is followed for purposes of convenience. Other islands not placed by Wallace in one or another region are here assigned to the nearest region. Sub-regions such as the West Indies were included by Wallace within a region (Neotropical), and this is also followed in this listing. The Sahara and Arabian deserts, however, were arbitrarily divided down the middle by Wallace and assigned to two separate regions. In this list the Sahara is included in the Ethiopian, the Arabian in the Palaearctic.

To develop a consistent coding system, a second number is assigned to each province which automatically places it within a major biome or grouping of biomes. Thus a province numbered 1.1.1. would be recognizable as lying with the Nearctic region (the first number), as having tundra or related vegetation (or Arctic desert) as its principal "climatic climax" or "potential vegetation" (the second number). A listing of numbers assigned to biogeographical regions and to biome groupings is as follows:

Biogeographical Region

1. Nearctic
2. Palaearctic
3. Neotropical
4. Ethiopian
5. Oriental
6. Australian
7. Antarctic

Principal Biome Types

1. Tundra and related communities
2. Temperate needle-leaf forest or woodland
3. Temperate/subtropical rain forest or woodland
4. Temperate broad-leaved forest or woodland
5. Mediterranean forest/scrub or woodland
6. Tropical dry or deciduous forest (including monsoon forests) or woodland
7. Tropical humid forests
8. Mixed mountain/highland systems
9. Tropical savannas and grasslands
10. Temperate grasslands
11. Warm deserts or semi-deserts
12. Mixed island systems

Region	Biotic Provinces Code Number		Reference Map No.
Nearctic	1.1.1	Aleutians	1.1
	1.1.2	Canadian tundra	1.2
	1.1.3	Greenland	1.3
	1.2.1	Canadian taiga	1.4
	1.3.1	Sitkan	1.5
	1.3.2	Oregonian	1.6
	1.4.1	Austroriparian	1.7
	1.4.2	Eastern forest	1.8
	1.5.1	Californian	1.9
	1.5.2	California Islands	1.10
	1.8.1	Alaskan Highlands	1.11
	1.8.2	Rocky Mountains	1.12
	1.8.3	Sierra-Cascade	1.13
	1.8.4	Sierra Madre	1.14
	1.10.1	Grasslands	1.15
	1.11.1	Great Basin	1.16
	1.11.2	Sonoran	1.17
	1.11.3	Chihuahuan	1.18
	1.11.4	Tamaulipan	1.19
Palaearctic	2.1.1	Eurasian tundra	3.1, 4.1
	2.1.2	Iceland	3.20
	2.2.1	West Eurasian taiga	3.2, 4.2
	2.2.2	East Siberian taiga	4.3
	2.2.3	East European mixed forest	3.3
	2.2.4	Manchurian mixed forest	4.4
	2.2.5	Japanese mixed forest	4.5
	2.3.1	Chinese subtropical forest	4.8
	2.3.2	Japanese subtropical forest	4.9
	2.3.3	Formosan subtropical forest	4.10
	2.4.1	Baltic lowlands	3.4
	2.4.2	British forest	3.5
	2.4.3	Irish forest	3.6
	2.4.4	West European forest	3.7

Region	Biotic Provinces Code Number		Reference Map No.
Palaearctic (continued)	2.4.5	Chinese deciduous forest	4.7
	2.5.1	West Mediterranean sclerophyll	3.8
	2.5.2	Balkan sclerophyll	3.9
	2.5.3	Tyrrhenian Islands	3.10
	2.5.4	Aegean Islands	3.11
	2.5.5	West Asian sclerophyll	4.12
	2.5.6	North African sclerophyll	7.P-2
	2.8.1	Fennoscandian highlands	3.15
	2.8.2	Scottish highlands	3.16
	2.8.3	Central European highlands	3.17
	2.8.4	Iberian highlands	3.18
	2.8.5	Caucasus	3.19
	2.8.6	Atlas highlands	7.P-1
	2.8.7	Kurdistan-Iranian highlands	4.18
	2.8.8	Hindu Kush	4.19
	2.8.9	Himalayan-Karakoram	4.20
	2.8.10	Pamir-Tien Shan	4.21
	2.8.11	Altai	4.22
	2.8.12	Tibetan	4.23
	2.8.13	Szechwan	4.24
	2.10.1	Danubian steppe	3.12
	2.10.2	Ukraine-Kazakh steppe	3.13, 4.26
	2.10.3	Manchurian steppe	4.27
	2.11.1	Kazakh desert scrub-steppe	3.14, 4.29
	2.11.2	Turkish-Iranian scrub-steppe	4.28
	2.11.3	Takla-Makan-Gobi	4.30
	2.11.4	Arabia	4.31
	2.11.5	Iranian desert	4.32
	2.12.1	Azores	-
	2.12.2	Madeira	-
	2.12.3	Canary Islands	-
	2.12.4	Cape Verde Islands	-

Region	Biotic Provinces Code Number		Reference Map No.
Neotropical	3.3.1	Brazilian Araucarian forest	2.10
	3.3.2	Chilean Araucarian forest	2.11
	3.3.3	Chilean temperate rain forest	2.12
	3.5.1	Chilean sclerophyll	2.13
	3.6.1	Sinaloan	1.22
	3.6.2	Guerreran	1.23
	3.6.3	Yucatan	1.24
	3.6.4	Everglades	1.27
	3.6.5	Venezuelan deciduous forest	2.4
	3.6.6	Brazilian deciduous forest	2.5
	3.6.7	Caatinga	2.6
	3.6.8	Gran Chaco	2.7
	3.6.9	Venezuelan dry forest	2.8
	3.6.10	Ecuadorian dry forest	2.9
	3.7.1	Campeche	1.20
	3.7.2	Carib-Pacific	1.21
	3.7.3	Amazonian	2.1
	3.7.4	Colombian coast	2.2
	3.7.5	Bahian coast	2.3
	3.7.6	Panama	1.34
	3.8.1	Central Cordilleran	1.25
	3.8.2	Guyana highlands	2.21
	3.8.3	Northern Andes	2.22
	3.8.4	Southern Andes	2.23
	3.8.5	Puna	2.24
	3.8.6	Andean cloud forest	2.25
	3.9.1	Llanos	2.14
	3.9.2	Campos	2.15
	3.10.1	Pampas	2.16
	3.11.1	Argentinian thorn-scrub	2.17
	3.11.2	Patagonia	2.18
	3.11.3	Peruvian desert	2.19
	3.11.4	Atacama	2.20

Region	Biotic Provinces Code Number		Reference Map No.
Neotropical (continued)	3.12.1	Bermuda	1.26
	3.12.2	Bahamas	1.28
	3.12.3	Cuba	1.29
	3.12.4	Jamaica	1.30
	3.12.5	Hispaniola	1.31
	3.12.6	Puerto Rico	2.32
	3.12.7	Lesser Antilles	2.33
	3.12.8	Juan Fernandez	2.26
	3.12.9	Falkland Islands	2.27
	3.12.10	Galapagos	2.28
	3.12.11	Tristan-Gough Islands	-
Ethiopian	4.5.1	Cape sclerophyll	7.17
	4.6.1	West African woodland/savanna	7.7a
	4.6.2	East African woodland/savanna	7.7b
	4.6.3	Congo woodland/savanna	7.8
	4.6.4	South African woodland/savanna	7.9
	4.6.5	Miombo woodland/savanna	7.10
	4.6.6	Malagasy thorn forest	7.1
	4.6.7	Malagasy woodland savanna	7.2
	4.7.1	Congo rain forest	7.11
	4.7.2	Guinean rain forest	7.12
	4.7.3	Malagasy rain forest	7.3
	4.8.1	Ethiopian highlands	7.13
	4.8.2	Guinean highlands	7.14
	4.8.3	Central African highlands	7.15
	4.8.4	South African highlands	7.16
	4.11.1	Sahara	7.1
	4.11.2	Namib	7.2
	4.11.3	Kalahari	7.3
	4.11.4	Western Sahel	7.4a
	4.11.5	Eastern Sahel	7.4b
	4.11.6	Somalian	7.5
	4.11.7	Karroo	7.6

Region	Biotic Provinces Code Number		Reference Map No.
Ethiopian (continued)	4.12.1	St. Helena	-
	4.12.2	Ascension Island	-
	4.12.3	Mascarene Islands	-
	4.12.4	Comores-Aldabra	-
	4.12.5	Seychelles	-
Oriental	5.6.1	Thai monsoon forest	5.8
	5.6.2	Burma monsoon forest	5.9
	5.6.3	Deccan monsoon forest	5.10
	5.6.4	Ganges monsoon forest	5.11
	5.6.5	Ceylon monsoon forest	5.12
	5.6.6	Indus-Gujerat	5.13
	5.6.7	Coromandel	5.15
	5.7.1	South China rain forest	5.1
	5.7.2	Indo-China rain forest	5.2
	5.7.3	Malayan rain forest	5.3
	5.7.4	Burma rain forest	5.4
	5.7.5	Bengal rain forest	5.5
	5.7.6	Ceylon rain forest	5.6
	5.7.7	Malabar rain forest	5.7
	5.11.1	Thar Desert	5.14
	5.12.1	Sumatra	5.16
	5.12.2	Java-Bali	5.17
	5.12.3	Borneo	5.18
	5.12.4	Philippines	5.19
	5.12.5	Laccadives	5.21
	5.12.6	Andaman-Nicobar	5.22
	5.12.7	Maldive-Chagos Islands	-
	5.12.8	Cocos-Chistmas Islands	-
Australian	6.5.1	Eastern sclerophyll	6.3
	6.5.2	Brigalow	6.4
	6.5.3	Southern sclerophyll	6.5
	6.5.4	Western sclerophyll	6.6
	6.5.5	Tasmania	6.7

Region	Biotic Provinces Code Number		Reference Map No.
Australian (continued)	6.6.1	Northern coastal	6.1
	6.7.1	Queensland coastal	6.2
	6.9.1	Northern tropical savanna	6.8
	6.9.2	Northern tropical grasslands	6.9
	6.10.1	Eastern grasslands	6.10
	6.11.1	Western mulga	6.11
	6.11.2	Southern mulga/saltbush	6.12
	6.11.3	Central desert	6.13
	6.12.1	Celebes-Sunda	5.20
	6.12.2	New Guinea	5.23
	6.12.3	Bismarck Archipelago	-
	6.12.4	Solomon Islands	-
	6.12.5	New Caledonia-Loyalty	-
	6.12.6	New Hebrides	-
	6.12.7	Lord Howe-Norfolk	-
	6.12.8	North New Zealand	-
	6.12.9	South New Zealand	-
	6.12.10	Fiji Islands	-
	6.12.11	Tonga-Kermadec	-
	6.12.12	Samoa-Ellice	-
	6.12.13	Tokelau-Phoenix-Manihiki	-
	6.12.14	Gilbert-Nauru	-
	6.12.15	Mariana Island	-
	6.12.16	Caroline Islands	-
	6.12.17	Marshall Islands	-
	6.12.18	Johnston-Palmyra-Christmas	-
	6.12.19	Cook-Austral	-
	6.12.20	Society Islands	-
	6.12.21	Tuamotus	-
	6.12.22	Marquesas	-
	6.12.23	Hawaiian Islands	-
	6.12.24	Easter Island	-
Antarctic	7.1.1	Antarctica	-
	7.1.2	Sub-Antarctic Islands	-

APPENDIX 3

Maps Showing Boundaries of Biotic Provinces for Continental and Some Island Areas

Map 1. NORTH AMERICA

Region or Sub-Region	Biotic Provinces
Nearctic*	1. Aleutians
	2. Canadian tundra
	3. Greenland
	4. Canadian taiga
	5. Sitkan
	6. Oregonian
	7. Austroriparian
	8. Eastern forest
	9. Californian
	10. California Islands
	11. Alaskan highlands
	12. Rocky Mountains
	13. Sierra-Cascade
	14. Sierra Madre
	15. Grasslands
	16. Great Basin
	17. Sonoran
	18. Chihuahuan
	19. Tamaulipan
Middle American Sub-Region	20. Campeche
	21. Carib-Pacific
	22. Sinaloan
	23. Guerreran
	24. Yucatan
	25. Central Cordilleran
West Indian Sub-Region	26. Bermuda
	27. Everglades
	28. Bahamas
	29. Cuba
	30. Jamaica
	31. Hispaniola
	32. Puerto Rico
	33. Lesser Antilles
Neotropical	34. Panama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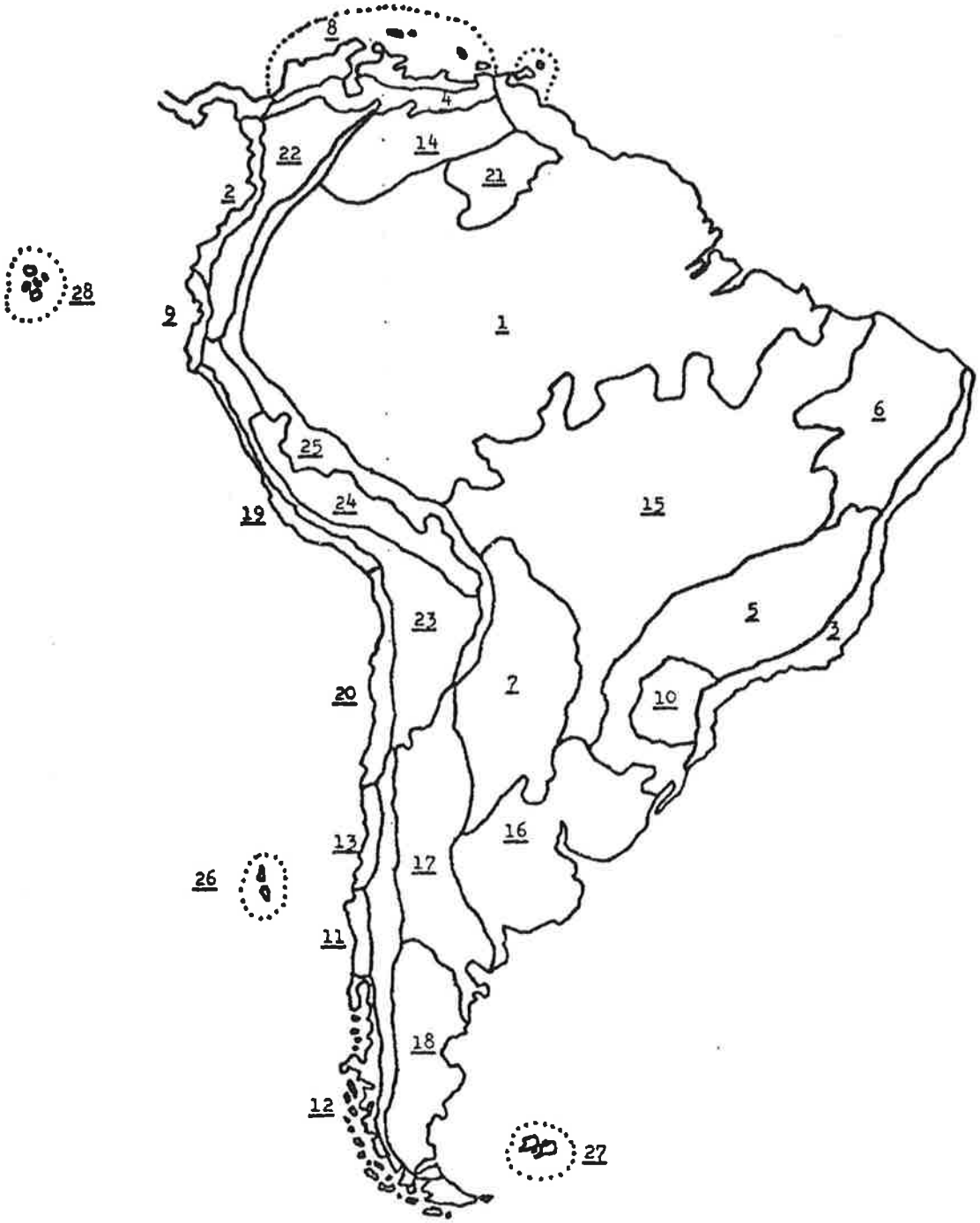
Map 2. SOUTH AMERICA

Region or Sub-Region	Biotic Provinces
Neotropical	1. Amazonian
	2. Colombian coast
	3. Bahian coast
	4. Venezuelan deciduous forest
	5. Brazilian deciduous forest
	6. Caatinga
	7. Gran Chaco
	8. Venezuelan dry forest
	9. Ecuadorian dry forest
	10. Brazilian Araucarian forest
	11. Chilean Araucarian forest
	12. Chilean temperate rain forest
	13. Chilean sclerophyll
	14. Llanos
	15. Campos
	16. Pampas
	17. Argentinian thorn scrub
	18. Patagonia
	19. Peruvian desert
	20. Atacama
	21. Guyana highlands
	22. Northern Andes
	23. Southern Andes
	24. Puna
	25. Andean cloud forest
	26. Juan Fernandez
	27. Falkland Islands
	28. Galapagos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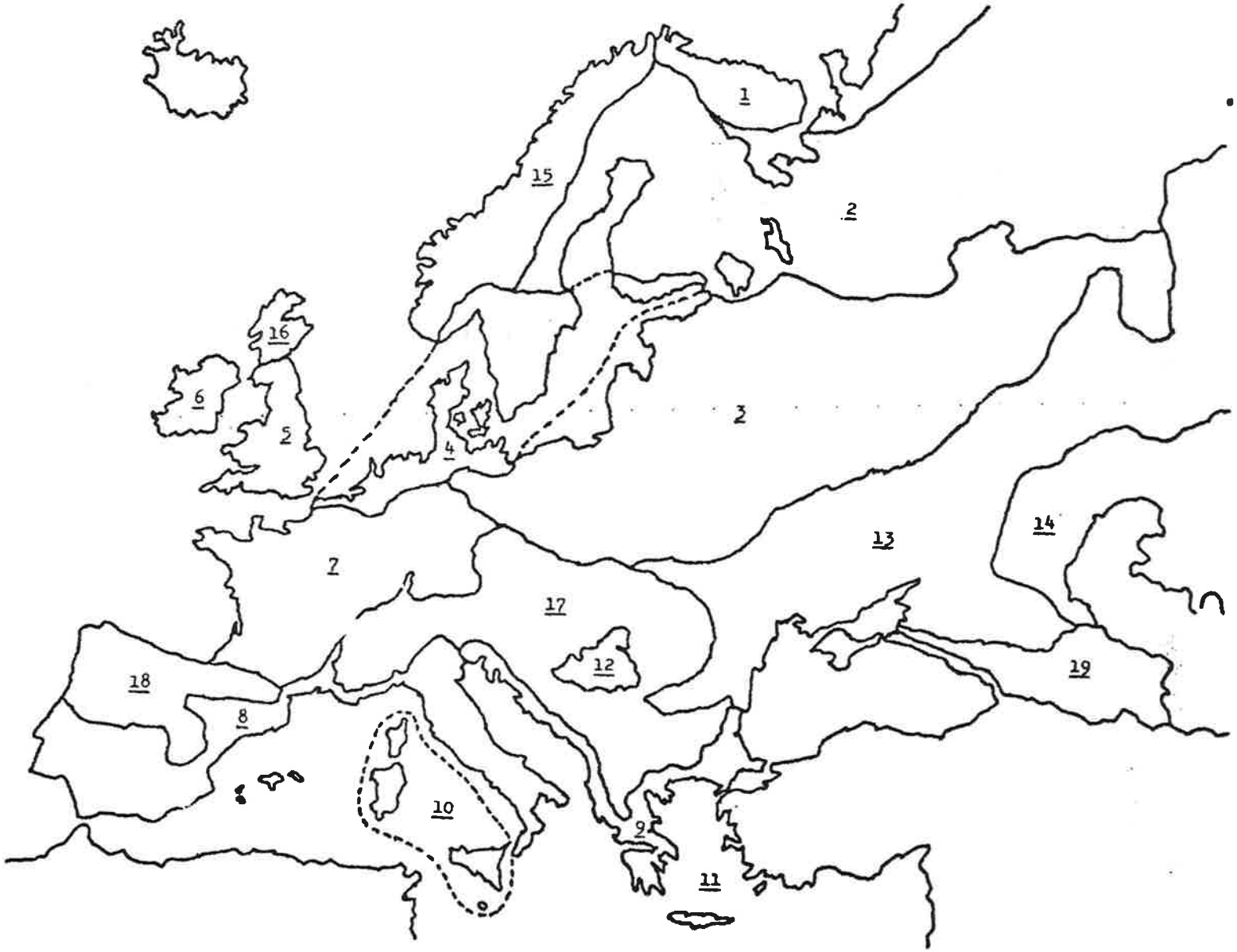
Map 3. EUROPE

Region or Sub-Region	Biotic Provinces
Palaearctic	1. Eurasian tundra
	2. West Eurasian taiga
	3. East European mixed forest
	4. Baltic lowlands
	5. British forest
	6. Irish forest
	7. West European forest
	8. West Mediterranean sclerophyll
	9. Balkan sclerophyll
	10. Tyrrhenian Islands
	11. Aegean Islands
	12. Danubian steppe
	13. Ukraine-Kazakh steppe
	14. Kazakh desert scrub-steppe
	15. Fennoscandian highlands
	16. Scottish highlands
	17. Central European highlands
	18. Iberian highlands
	19. Caucasus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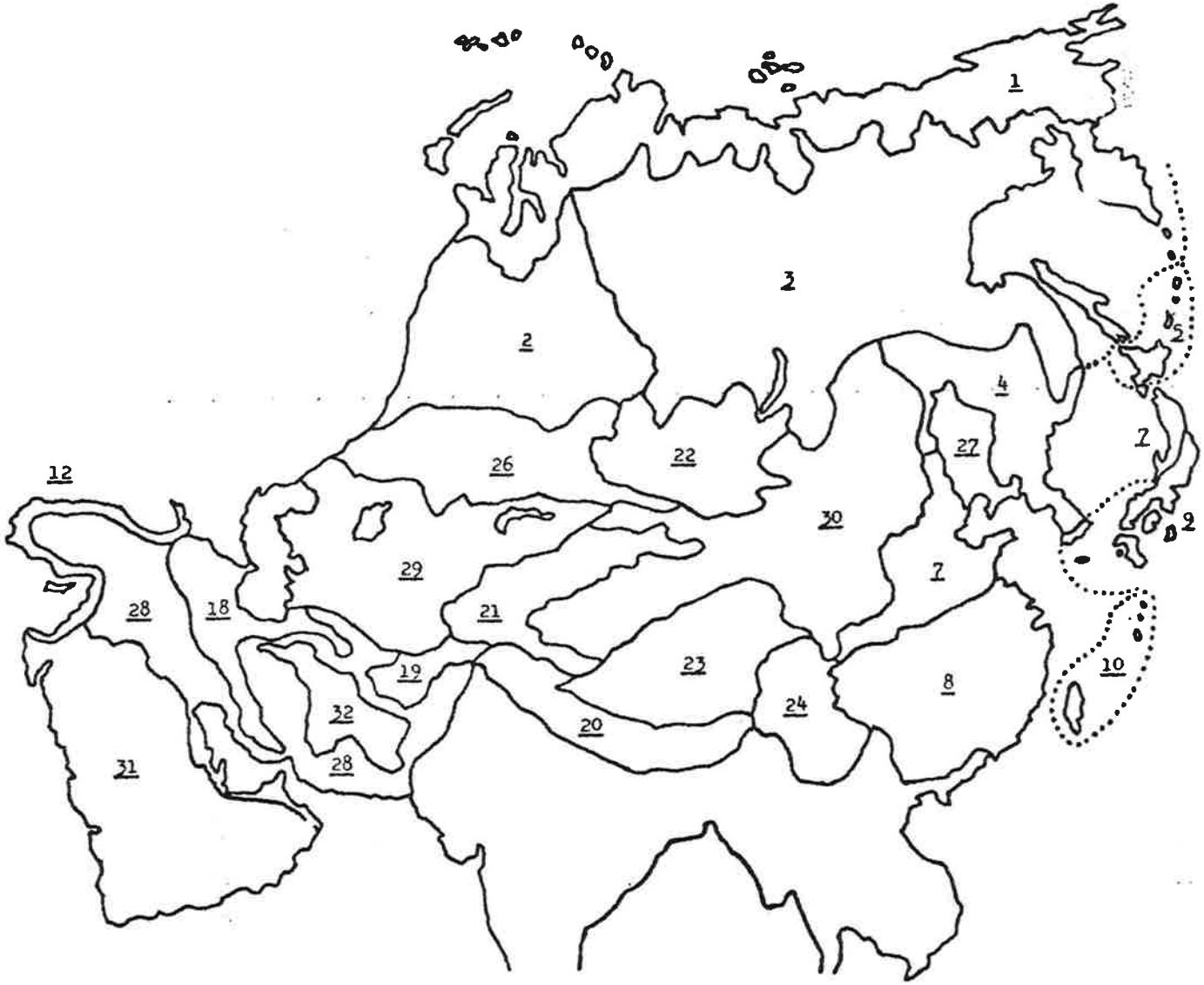
Map 4. ASIA

Region or Sub-Region	Biotic Provinces
Palaearctic	1. Eurasian tundra
	2. West Eurasian taiga
	3. East Siberian taiga
	4. Manchurian mixed forest
	5. Japanese mixed forest
	7. Chinese deciduous forest
	8. Chinese subtropical forest
	9. Japanese subtropical forest
	10. Formosan subtropical forest
	12. West Asian sclerophyll
	18. Kurdistan-Iranian highlands
	19. Hindu Kush
	20. Himalayan-Karakoram
	21. Pamir-Tien Shan
	22. Altai
	23. Tibetan
	24. Szechwan
	26. Ukraine-Kazakh steppe
	27. Manchurian steppe
	28. Turkish-Iranian scrub-steppe
	29. Kazakh desert scrub-steppe
	30. Takla Makan-Gobi
	31. Arabia
	32. Iranian desert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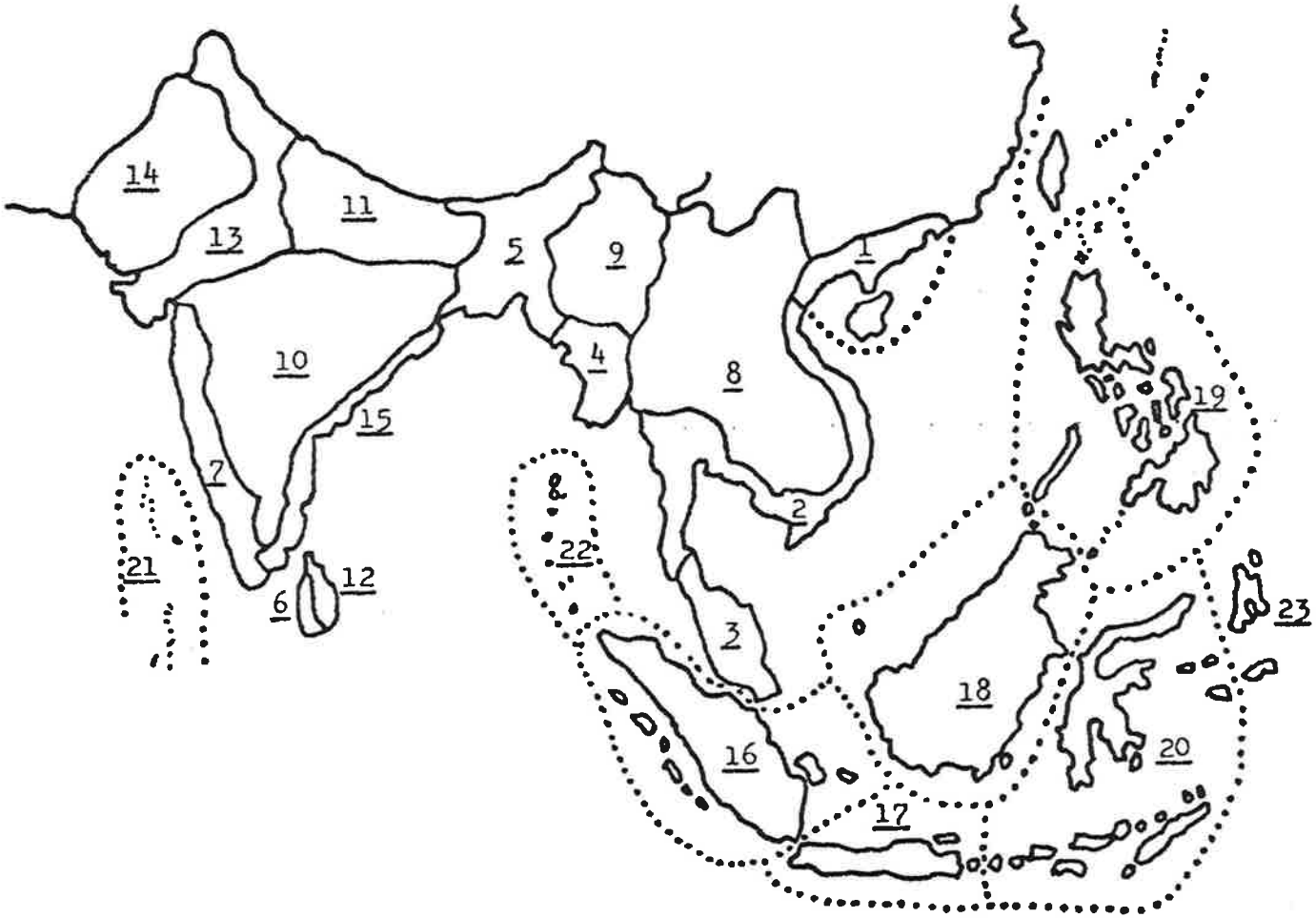
Map 5. ASIA

Region or Sub-Region	Biotic Provinces
Oriental	1. South China rain forest
	2. Indo-China rain forest
	3. Malayan rain forest
	4. Burma rain forest
	5. Bengal rain forest
	6. Ceylon rain forest
	7. Malabar
	8. Thai monsoon forest
	9. Burma monsoon forest
	10. Deccan monsoon forest
	11. Ganges monsoon forest
	12. Ceylon monsoon forest
	13. Indus-Gujerat
	14. Thar desert
	15. Coromandel
	16. Sumatra
	17. Java-Bali
	18. Borneo
	19. Philippines
	21. Laccadives
	22. Andaman-Nicobar
Wallacean Sub-Region	20. Celebes-Sunda
	23. New Guinea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Map 6. AUSTRALIA

Region or Sub-Region	Biotic Provinces
Australian	1. Northern coastal
	2. Queensland coastal
	3. Eastern sclerophyll
	4. Brigalow
	5. Southern sclerophyll
	6. Western sclerophyll
	7. Tasmania
	8. Northern tropical savanna
	9. Northern tropical grasslands
	10. Eastern grasslands
	11. Western mulga
	12. Southern mulga/saltbush
	13. Central desert


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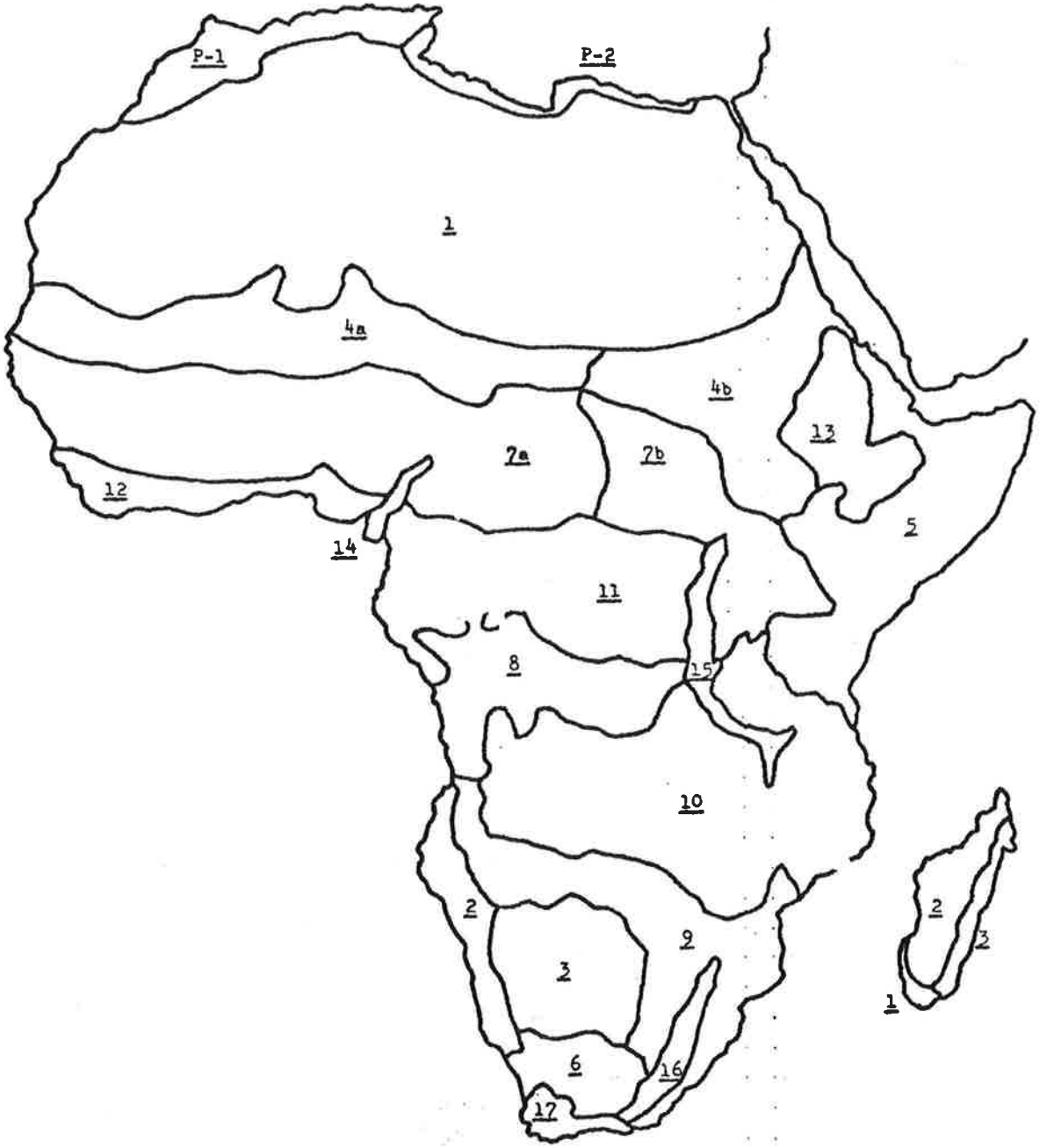
Map 7. AFRICA

Region or Sub-Region	Biotic Provinces
Palaearctic	P-1 Atlas highlands
	P-2 North African sclerophyll
Ethiopian	1. Sahara
	2. Namib
	3. Kalahari
	4a. Western Sahel
	4b. Eastern Sahel
	5. Somalian
	6. Karroo
	7a. West African woodland/savanna
	7b. East African woodland/savanna
	8. Congo woodland/savanna
	9. South African woodland/savanna
	10. Miombo woodland/savanna
	11. Congo rain forest
	12. Guinean rain forest
	13. Ethiopian highlands
	14. Guinean highlands
	15. Central African highlands
	16. South African highlands
	17. Cape sclerophyll
Malagasy Sub-Region	1. Malagasy thorn forest
	2. Malagasy woodland/savanna
	3. Malagasy rain forest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APPENDIX 4

Distribution of National Parks and Reserves in Relation to Biotic Provinces

Region	Biotic Provinces		National Parks and Related Reserves
	Code Number	Name	Number listed in 1974 UN List
Nearctic	1.1.1	Aleutians	5
	1.1.2	Canadian tundra	3
	1.1.3	Greenland	0
	1.2.1	Canadian taiga	28
	1.3.1	Sitkan	3
	1.3.2	Oregonian	2
	1.4.1	Austroriparian	4
	1.4.2	Eastern forest	4
	1.5.1	Californian	1
	1.5.2	California Islands	1
	1.8.1	Alaskan Highlands	8
	1.8.2	Rocky Mountains	36
	1.8.3	Sierra-Cascade	9
	1.8.4	Sierra Madre	7
	1.10.1	Grasslands	10
	1.11.1	Great Basin	6
	1.11.2	Sonoran	10
	1.11.3	Chihuahuan	7
	1.11.4	Tamaulipan	1
Palaearctic	2.1.1	Eurasian tundra	7
	2.1.2	Iceland	4
	2.2.1	West Eurasian taiga	20
	2.2.2	East Siberian taiga	2
	2.2.3	East European mixed forest	21
	2.2.4	Manchurian mixed forest	7
	2.2.5	Japanese mixed forest	3
	2.3.1	Chinese subtropical forest	-
	2.3.2	Japanese subtropical forest	15
	2.3.3	Formosan subtropical forest	1
	2.4.1	Baltic lowlands	27
	2.4.2	British forest	8
	2.4.3	Irish forest	1
	2.4.4	West European forest	4
	2.4.5	Chinese deciduous forest	6
	2.5.1	West Mediterranean sclerophyll	12
	2.5.2	Balkan sclerophyll	16

Note: No information available for China. USSR information incomplete. In the USA only national parks, refuges and reserves are listed.

Region	Biotic Provinces		National Parks and Related Reserves
	Code Number	Name	Number listed in 1974 UN List
Palaearctic (continued)	2.5.3	Tyrrhenian Islands	0
	2.5.4	Aegean Islands	1
	2.5.5	West Asian sclerophyll	12
	2.5.6	North African sclerophyll	0
	2.8.1	Fennoscandian highlands	20
	2.8.2	Scottish highlands	11
	2.8.3	Central European highlands	43
	2.8.4	Iberian highlands	3
	2.8.5	Caucasus	14
	2.8.6	Atlas highlands	0
	2.8.7	Kurdistan-Iranian highlands	8
	2.8.8	Hindu Kush	1
	2.8.9	Himalayan-Karakoram	0
	2.8.10	Pamir-Tien Shan	6
	2.8.11	Altai	2
	2.8.12	Tibetan	-
	2.8.13	Szechwan	-
	2.10.1	Danubian steppe	0
	2.10.2	Ukraine-Kazakh steppe	20
	2.10.3	Manchurian steppe	0
	2.11.1	Kazakh desert scrub-steppe	12
	2.11.2	Turkish-Iranian scrub-steppe	7
	2.11.3	Takla-Makan-Gobi	-
	2.11.4	Arabia	0
	2.11.5	Iranian desert	0
	2.12.1	Azores	0
	2.12.2	Madeira	0
	2.12.3	Canary Islands	0
	2.12.4	Cape Verde Islands	0
Neotropical	3.3.1	Brazilian Araucarian forest	4
	3.3.2	Chilean Araucarian forest	1
	3.3.3	Chilean temperate rain forest	11
	3.5.1	Chilean sclerophyll	2
	3.6.1	Sinaloan	0
	3.6.2	Guerreran	3
	3.6.3	Yucatan	0
	3.6.4	Everglades	4
	3.6.5	Venezuelan deciduous forest	3
	3.6.6	Brazilian deciduous forest	2
	3.6.7	Caatinga	1
	3.6.8	Gran Chaco	5
	3.6.9	Venezuelan dry forest	8
	3.6.10	Ecuadorian dry forest	0

Region	Biotic Provinces		National Parks and Related Reserves
	Code Number	Name	Number listed in 1974 UN List
Neotropical (continued)	3.7.1	Campeche	1
	3.7.2	Carib-Pacific	6
	3.7.3	Amazonian	13
	3.7.4	Colombian coast	0
	3.7.5	Bahian coast	8
	3.7.6	Panama	2
	3.8.1	Central Cordilleran	1
	3.8.2	Guyana highlands	2
	3.8.3	Northern Andes	1
	3.8.4	Southern Andes	17
	3.8.5	Puna	2
	3.8.6	Andean cloud forest	1
	3.9.1	Llanos	0
	3.9.2	Campos	7
	3.10.1	Pampas	5
	3.11.1	Argentinian thorn-scrub	0
	3.11.2	Patagonia	3
	3.11.3	Peruvian desert	0
	3.11.4	Atacama	0
	3.12.1	Bermuda	0
	3.12.2	Bahamas	1
	3.12.3	Cuba	4
	3.12.4	Jamaica	0
	3.12.5	Hispaniola	1
	3.12.6	Puerto Rico	0
	3.12.7	Lesser Antilles	2
	3.12.8	Juan Fernandez	1
	3.12.9	Falkland Islands	1
	3.12.10	Galapagos	1
	3.12.11	Tristan-Gough Islands	0
Ethiopian	4.5.1	Cape sclerophyll	3
	4.6.1	West African woodland/savanna	26
	4.6.2	East African woodland/savanna	11
	4.6.3	Congo woodland/savanna	3
	4.6.4	South African woodland/savanna	32
	4.6.5	Miombo woodland/savanna	31
	4.6.6	Malagasy thorn forest	1
	4.6.7	Malagasy woodland savanna	5
	4.7.1	Congo rain forest	7
	4.7.2	Guinean rain forest	5
	4.7.3	Malagasy rain forest	5
	4.8.1	Ethiopian highlands	3
	4.8.2	Guinean highlands	2

Region	Biotic Provinces		National Parks and Related Reserves
	Code Number	Name	Number listed in 1974 UN List
Ethiopian (continued)	4.8.3	Central African highlands	6
	4.8.4	South African highlands	4
	4.11.1	Sahara	1
	4.11.2	Namib	4
	4.11.3	Kalahari	7
	4.11.4	Western Sahel	2
	4.11.5	Eastern Sahel	5
	4.11.6	Somalian	18
	4.11.7	Karroo	0
	4.12.1	St. Helena	0
	4.12.2	Ascension Island	0
	4.12.3	Mascarene Islands	0
	4.12.4	Comores-Aldabra	1
	4.12.5	Seychelles	1
Oriental	5.6.1	Thai monsoon forest	6
	5.6.2	Burma monsoon forest	1
	5.6.3	Deccan monsoon forest	4
	5.6.4	Ganges monsoon forest	4
	5.6.5	Ceylon monsoon forest	6
	5.6.6	Indus-Gujerat	3
	5.6.7	Coromandel	0
	5.7.1	South China rain forest	-
	5.7.2	Indo-China rain forest	11
	5.7.3	Malayan rain forest	2
	5.7.4	Burma rain forest	0
	5.7.5	Bengal rain forest	0
	5.7.6	Ceylon rain forest	1
	5.7.7	Malabar rain forest	3
	5.11.1	Thar Desert	0
	5.12.1	Sumatra	8
	5.12.2	Java-Bali	11
	5.12.3	Borneo	6
	5.12.4	Philippines	14
	5.12.5	Laccadives	0
	5.12.6	Andaman-Nicobar	0
	5.12.7	Maldive-Chagos Islands	0
	5.12.8	Cocos-Christmas Islands	0
Australian	6.5.1	Eastern sclerophyll	39
	6.5.2	Brigalow	3
	6.5.3	Southern sclerophyll	11
	6.5.4	Western sclerophyll	8

Region	Biotic Provinces		National Parks and Related Reserves
	Code Number	Name	Number listed in 1974 UN List
Australian (continued)	6.5.5	Tasmania	9
	6.6.1	Northern coastal	1
	6.7.1	Queensland coastal	19
	6.9.1	Northern tropical savanna	1
	6.9.2	Northern tropical grasslands	0
	6.10.1	Eastern grasslands	7
	6.11.1	Western mulga	3
	6.11.2	Southern mulga/saltbush	4
	6.11.3	Central desert	4
	6.12.1	Celebes-Sunda	2
	6.12.2	New Guinea	2
	6.12.3	Bismarck Archipelago	0
	6.12.4	Solomon Islands	1
	6.12.5	New Caledonia-Loyalty	1
	6.12.6	New Hebrides	0
	6.12.7	Lord Howe-Norfolk	0
	6.12.8	North New Zealand	6
	6.12.9	South New Zealand	7
	6.12.10	Fiji Islands	2
	6.12.11	Tonga-Kermadec	1
	6.12.12	Samoa-Ellice	0
	6.12.13	Tokelau-Phoenix-Manihiki	0
	6.12.14	Gilbert-Nauru	0
	6.12.15	Mariana Island	0
	6.12.16	Caroline Islands	0
	6.12.17	Marshall Islands	0
	6.12.18	Johnston-Palmyra-Christmas	0
	6.12.19	Cook-Austral	0
	6.12.20	Society Islands	0
	6.12.21	Tuamotus	0
	6.12.22	Marquesas	0
	6.12.23	Hawaiian Islands	2
	6.12.24	Easter Island	0
Antarctic	7.1.1	Antarctica	*
	7.1.2	Sub-Antarctic Islands	5

* Antarctica is protected by the Terms of the Antarctic Treaty and has the overall status of a reserve.

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The International Union for Conservation of Nature and Natural Resources (IUCN) is an independent international body, formed in 1948, which has its headquarters in Morges, Switzerland. It is a Union of sovereign states, government agencies and non-governmental organizations concerned with the initiation and promotion of scientifically-based action that will ensure perpetuation of the living world - man's natural environment - and the natural resources on which all living things depend, not only for their intrinsic cultural or scientific values but also for the long-term economic and social welfare of mankind.

This objective can be achieved through active conservation programmes for the wise use of natural resources in areas where the flora and fauna are of particular importance and where the landscape is especially beautiful or striking, or of historical, cultural or scientific significance. IUCN believes that its aims can be achieved most effectively by international effort in cooperation with other international agencies, such as Unesco and FAO.

The World Wildlife Fund (WWF) is an international charitable organization dedicated to saving the world's wildlife and wild places, carrying out the wide variety of programmes and actions that this entails. WWF was established in 1961 under Swiss law, with headquarters also in Morges.

Since 1961, IUCN has enjoyed a symbiotic relationship with its sister organization, the World Wildlife Fund, with which it works closely throughout the world on projects of mutual interest. IUCN and WWF now jointly operate the various projects originated by, or submitted to them.

The projects cover a very wide range, from education, ecological studies and surveys, to the establishment and management of areas as national parks and reserves and emergency programmes for the safeguarding of animal and plant species threatened with extinction as well as support for certain key international conservation bodies.

WWF fund-raising and publicity activities are mainly carried out by National Appeals in a number of countries, and its international governing body is made up of prominent personalities in many fields.