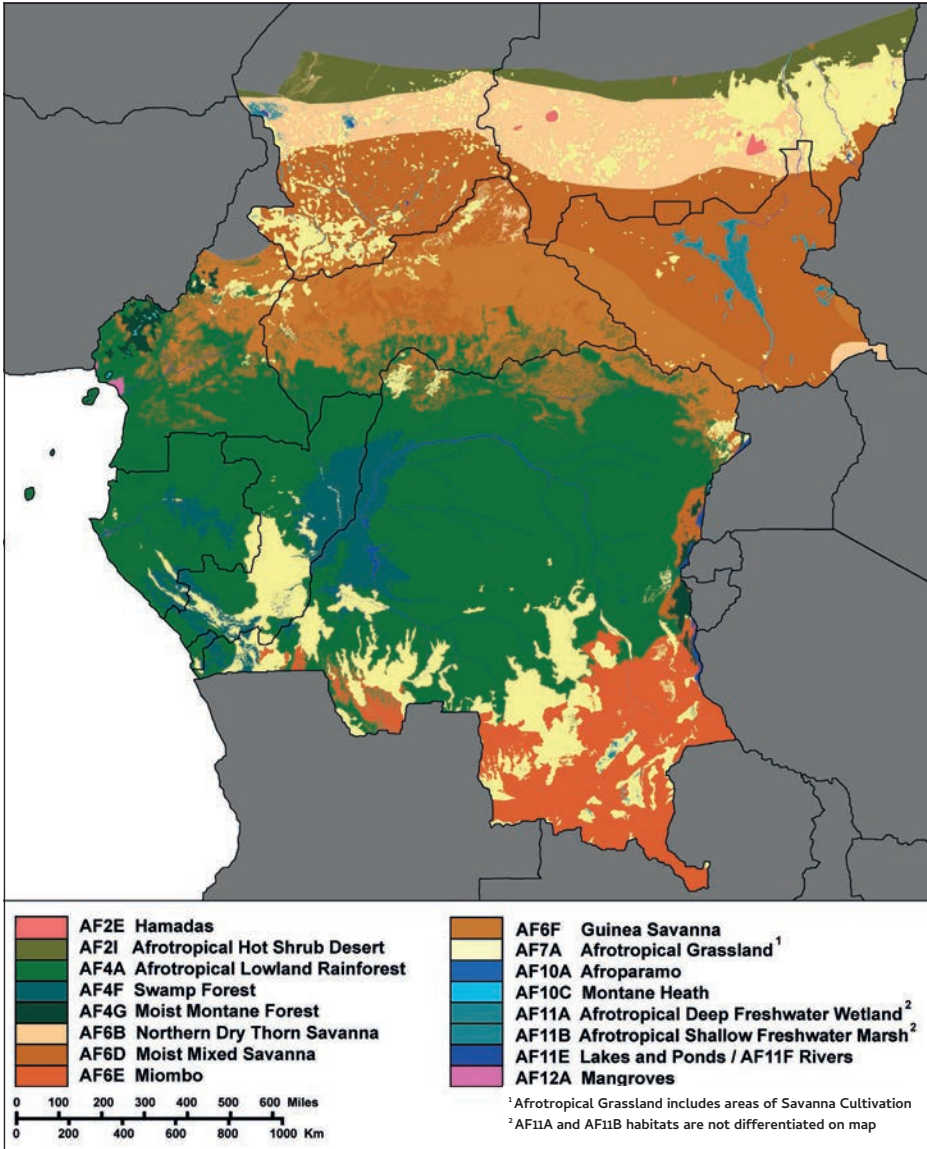


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■ Af1D Maghreb Pine Forest	67	■ Af6C Kalahari Dry Thorn Savanna	235
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■ Af8A Fynbos	300	■ Af12C Tidal Mudflats and Estuaries	393
■ Af8B Strandveld	309	■ Af12D Salt Marsh	395
■ Af8C Renosterveld	315	■ Af12E Sandy Beach and Dunes	397
■ Af8D Maghreb Maquis	321	■ Af12F Rocky Shoreline	400
■ Af8E Maghreb Garrigue	326	■ Af12G Offshore Islands	403
■ Af8F Maghreb Broadleaf Woodland	328	■ Af12H Pelagic Waters	406
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■ Af10B High Atlas Alpine Meadow	350	■ Af13D South African Temperate Cultivation	418
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MONTANE FOREST, MONTANE HEATH, and MONTANE GRASSLAND. The Ruwenzoris and Mt. Cameroon are tall enough to also have **AFROPARAMO** on their summits. As would be expected of a great rainforest, this region has remarkable biodiversity. It is the heart of the range of a rich set of rainforest mammals and birds, though many of these are very difficult to see. There are enigmatic creatures like Okapi, Bonobo, and Congo Peacock, plus some more frequently sighted ones like Western and Eastern Gorillas, and Mandrill. Both of the mountainous areas are rich areas of

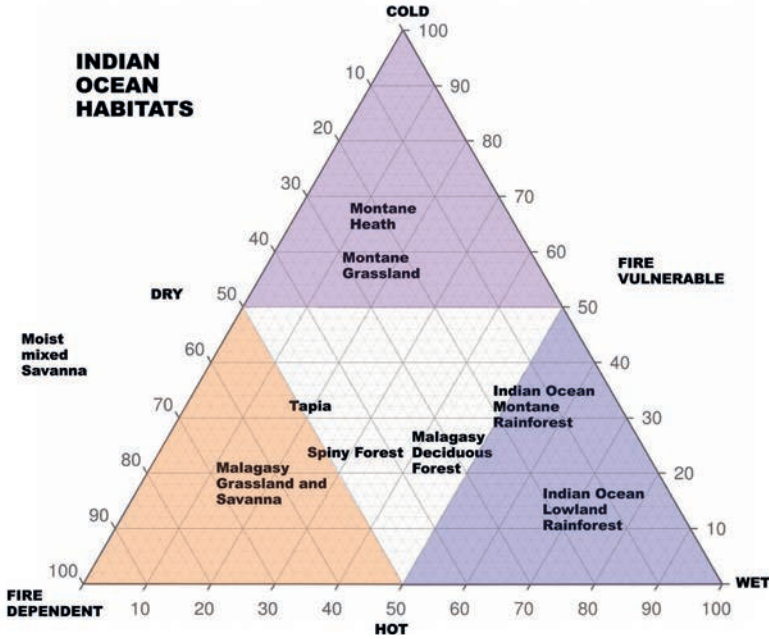
CENTRAL AND NORTH-CENTRAL AFRICAN HABITATS

CODE	CATEGORY/NAME	PAGES	CODE	CATEGORY/NAME	PAGES
	DRY CONIFERS			FRESHWATER HABITATS	
Af1C	Afrotropical Montane Dry Mixed Woodland	61–66	Af11A	Afrotropical Deep Freshwater Marsh	358–364
	DESERTS AND XERIC SHRUBLANDS		Af11B	Afrotropical Shallow Freshwater Marsh	365–369
Af2E	Hamada	94–100	Af11E	Freshwater Lakes and Ponds	379–381
Af2I	Afrotropical Hot Shrub Desert	121–126	Af11F	Rivers	382–385
	TROPICAL AND SUBTROPICAL MOIST BROADLEAF FORESTS			SALINE HABITATS	
Af4A	Afrotropical Lowland Rainforest	143–150	Af12A	Afrotropical Mangrove	386–389
Af4C	Monsoon Forest	151–156	Af12B	Salt Pans and Lakes	390–392
AF4F	Swamp Forest	169–173	Af12C	Tidal Mudflats and Estuaries	393–394
AF4G	Moist Montane Forest	174–179	Af12D	Salt Marsh	395–396
	SAVANNAS		Af12E	Sandy Beach and Dunes	397–399
Af6B	Northern Dry Thorn Savanna	227–233	Af12F	Rocky Shoreline	400–402
Af6D	Moist Mixed Savanna	243–251	Af12G	Offshore Islands	403–406
Af6E	Miombo	252–259	Af12H	Pelagic Waters	406–408
Af6F	Guinea Savanna	260–267		ANTHROPOGENIC	
Af6G	Inselbergs and Koppies	268–274	Af13A	Humid Lowland Cultivation	409–411
	GRASSLANDS		Af13B	Savanna Cultivation	412–415
Af7A	Afrotropical Grassland	280–286	Af13C	Tropical Montane Cultivation	415–417
Af7F	Montane Grassland	293–299	Af13F	Tree Plantations	422–423
	ALPINE TUNDRAS AND MONTANE HEATHS		Af13G	Cities and Villages	424–426
Af10A	Afroparamo	343–349	Af13H	Grazing Land	427–428
Af10C	Montane Heath	354–357			

endemism. The Albertine Rift montane forests are Africa’s most diverse and hold many endemic species, though these are shared with several East African countries. The western mountains also have a tantalizing set of endemics, including birds like Bannerman’s Turaco and Mount Kupe Bushshrike. In Sudan there are isolated low mountains where dry broadleaf and conifer forest occur. There is huge scope for investigation with the likelihood of new species to be discovered there.

INDIAN OCEAN

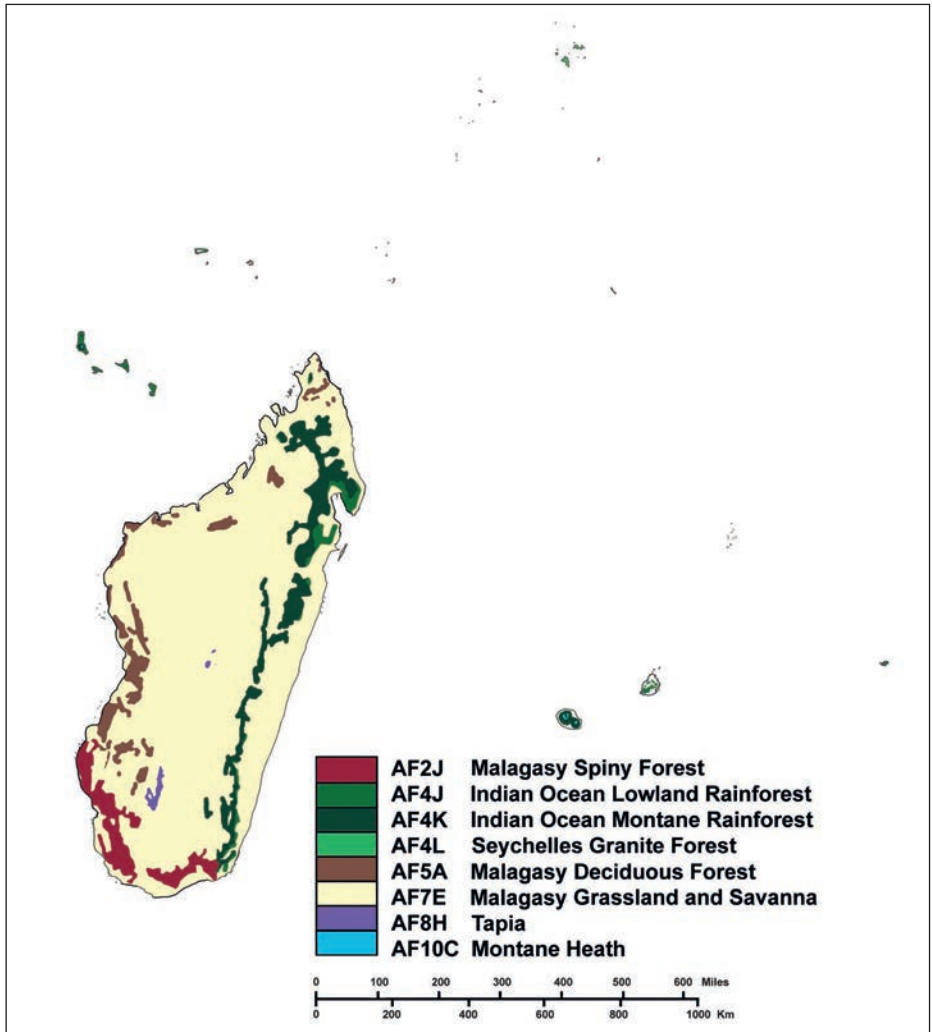
The w. Indian Ocean contains four main island groups: Madagascar, the Seychelles, the Comoros, and the Mascarenes. At 230,000 mi.² (595,700 km²) this area is slightly smaller than France or Texas. Madagascar and the Seychelles are ancient fragments of Gondwana with some rocks over 3 billion years old. Around 180 MYA, while still joined with India, they separated from Africa and started heading north. At that time there were still dinosaurs, and birds had not evolved! Around 80 MYA Madagascar split from India and started heading back toward Africa. With Madagascar’s split and resulting ocean creation, some of the oldest rocks in the Comoros formed through uplift of the ocean floor. But most of the Comoros and Mascarenes are much younger islands, formed through hotspot volcanism and formation of shield volcanoes (similar to the Galápagos and Hawaiian Islands) that is ongoing today.



INDIAN OCEAN HABITATS

CODE	CATEGORY/NAME	PAGES	CODE	CATEGORY/NAME	PAGES
DESERTS AND XERIC SHRUBLANDS			FRESHWATER HABITATS		
Af2J	Spiny Forest (endemic)	127–132	Af11A	Afrotropical Deep Freshwater Marsh	358–364
TROPICAL AND SUBTROPICAL MOIST BROADLEAF FORESTS			Af11B	Afrotropical Shallow Freshwater Marsh	365–369
Af4J	Indian Ocean Lowland Rainforest (endemic)	180–188	Af11E	Freshwater Lakes and Ponds	379–381
Af4K	Indian Ocean Montane Rainforest (endemic)	189–196	Af11F	Rivers	382–385
Af4L	Seychelles Granite Forest (endemic)	197–202	SALINE HABITATS		
TROPICAL AND SUBTROPICAL DRY BROADLEAF FORESTS			Af12A	Afrotropical Mangrove	386–389
Af5A	Malagasy Deciduous Forest (endemic)	209–214	Af12B	Salt Pans and Lakes	390–392
GRASSLANDS			Af12C	Tidal Mudflats and Estuaries	393–394
Af7E	Malagasy Grassland and Savanna (endemic)	287–292	Af12D	Salt Marsh	395–396
Af7F	Montane Grassland	293–299	Af12E	Sandy Beach and Dunes	397–399
MEDITERRANEAN FORESTS, WOODLANDS AND SHRUBS			Af12F	Rocky Shoreline	400–402
Af8H	Tapia (endemic)	338–341	Af12G	Offshore Islands	403–406
ALPINE TUNDRAS AND MONTANE HEATHS			Af12H	Pelagic Waters	406–408
Af10C	Montane Heath	354–357	ANTHROPOGENIC		
			Af13A	Humid Lowland Cultivation	409–411
			Af13B	Savanna Cultivation	412–415
			Af13C	Tropical Montane Cultivation	415–417
			Af13F	Tree Plantations	422–423
			Af13G	Cities and Villages	424–426
			Af13H	Grazing Land	427–428

This region contains 27 of the habitats covered in this book, and 7 of these are endemic. Madagascar is by far the largest island and the hotspot of biological diversity. This is partially explained by its possessing nearly a whole continent's worth of diversity in its natural environments. The eastern plain and escarpment is covered in lush rainforest, which changes character above 2600 ft. (800 m) elevation. On the highest mountains, there is heath habitat as well as some grassland. The middle of Madagascar is the "High Plateau," which has been ravaged by fire, and today is covered in biologically poor grassland but which originally held a mix of forest, woodland, and savanna. The northern two-thirds of the west is also largely deforested, but the original habitat was drier deciduous forest—shorter than eastern rainforest and with many trees that lose their leaves during the dry season. The southwestern third is the driest part of Madagascar, and the vegetation is the



semi-desert **SPINY FOREST**, an other-worldly landscape of baobab trees, succulent plants, and endemic many-armed “octopus trees.”

Madagascar is the land of lemurs—there are over 100 species of these delightful primates, found in all types of forest. Other prominent groups of mammals include tenrecs, Malagasy carnivorans, rodents, and bats. The birdlife is low in diversity but high in endemism—there are over 100 endemic birds and five endemic families. Many common groups of birds from Africa, such as woodpeckers and bushshrikes, are lacking in Madagascar. Reptile and amphibian diversity is high, and there are hundreds of endemic species.

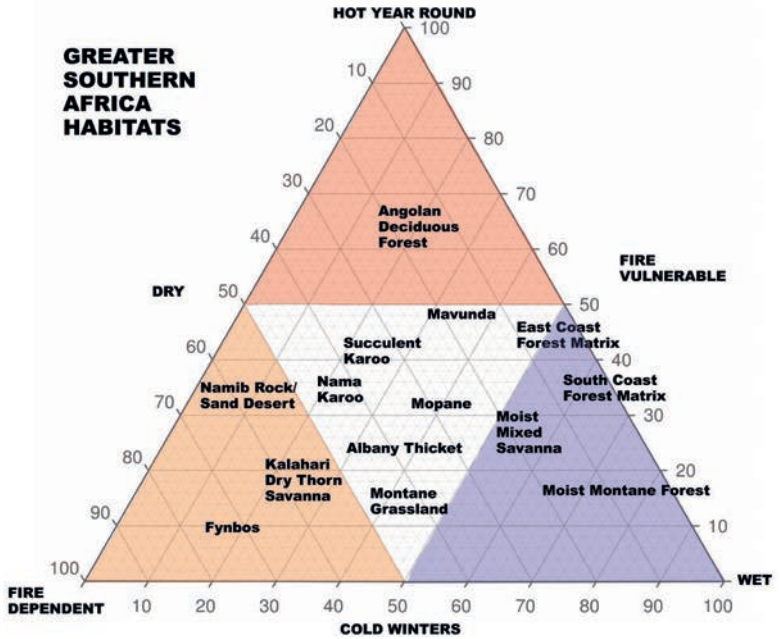
The default habitat on all the other Indian Ocean islands is rainforest, but most islands have been largely deforested. The two islands with the tallest and most rugged mountains, Réunion and Grande Comore, are also the two that have retained the most forest, mostly at higher elevations. The highest parts of these islands are above tree line and support heath habitat. The Inner Islands of the Seychelles are granite, and the remnant rainforest growing there has a distinctive character. The Outer Islands of the Seychelles, including Aldabra, are coral islands, where the natural vegetation is drier scrub and woodland. With a few exceptions, the wildlife on the other Indian Ocean island groups is similar to, but much poorer than, Madagascar. There are very few mammals, but huge flying foxes are conspicuous. The endemic bird families of Madagascar are lacking, save for the Cuckoo-Roller, which has colonized the Comoros.

Mangroves and mudflats are found throughout the region but are most common along the sheltered west coast of Madagascar. This is a generally poor sector of ocean for marine life, though sea turtles and tropical seabirds nest widely, and Round Island off Mauritius has a notable assemblage of breeding seabirds.

GREATER SOUTHERN AFRICA

Greater Southern Africa encompasses 10 nations stretching from temperate South Africa (34°S) to the tropics of Mozambique and across to Angola (5°S). At 2.25 million square miles (5.8 million square kilometers) this area is slightly larger than Western Europe and slightly smaller than Australia. The region’s extraordinary biodiversity is linked to the varied habitats it supports, including 46 habitats (15 of which are endemic) covered in this book, making this region the African champion for both overall habitat diversity and endemism. These habitats range from some of Earth’s driest deserts (Köppen **Bwk**), to lowland rainforest (Köppen **Afa**), and everything in between! This diversity is driven by complex landscapes, topography, and surrounding oceans, which affect climate. The region’s interior consists mostly of a high-elevation Central Plateau lying above 3280 ft. (1000 m), surrounded by steep-edged mountains called the Great Escarpment, which fall away to a coastal plain mostly 50–125 mi. (80–200 km) in width but much broader in Mozambique. The Central Plateau is incised by several low-lying broad river valleys, notably the Orange, Limpopo, Zambezi, and Kafue, which introduce hot coastal conditions deep into the continental interior. Africa’s Great Rift Valley enters the northern part of the region, forming Lake Malawi and terminating in the Zambezi Valley to the south.

The dominant habitats of the region (particularly in the north) are a variety of savannas varying from sparsely treed grassland to dense woodland. Rainfall and seasonality is strongly influenced by the zone where the trade winds of the Northern and Southern Hemispheres collide (the Intertropical Convergence Zone), creating a subtropical climate (Köppen **Amb**) characterized by three seasons: hot dry (Sep–Nov); wet rainy (Dec–Apr); and cool dry (May–Aug). The savannas



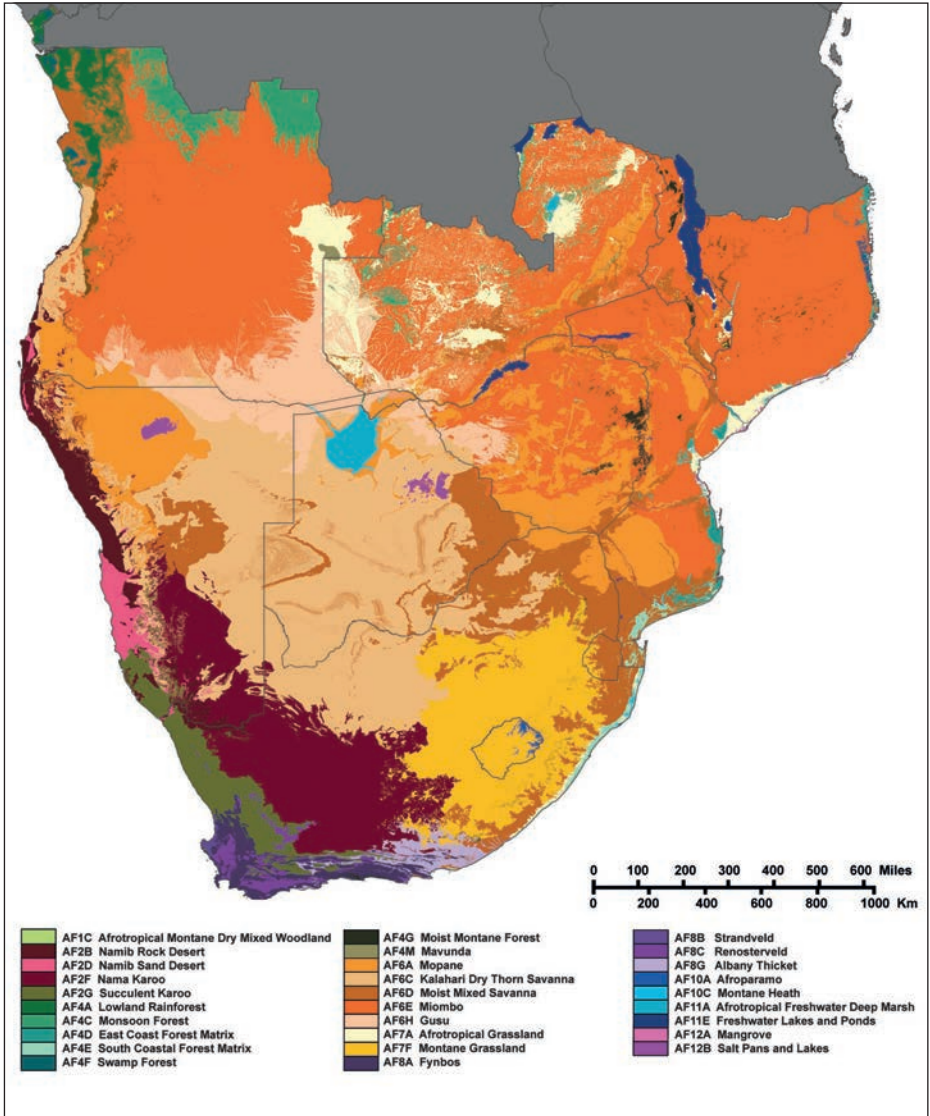
vary from more closed broadleaf-type woodlands like **MOPANE** growing at slightly lower elevations and **MIOMBO** on higher plateaus to drier **GUSU** on well-drained Kalahari sands. These are interspersed in a complex mosaic with **MOIST MIXED SAVANNA** and open **AFROTROPICAL GRASSLANDS**. In the more tropical reaches of nw. Zambia, Angola, and elsewhere, the rainfall increases but remains highly seasonal, giving rise to deciduous and monsoon forests. In localized patches in Angola, where rainfall is both heavy and less seasonal, patches of true lowland rainforest develop.

The coast has a dramatic and underappreciated influence on habitats. Two oceanic currents, the cold-water Benguela (Atlantic Ocean) and warm-water Agulhas (Indian Ocean) both radically influence the climate. The icy waters of the Benguela create a variety of arid habitats in the west, including the Namib Desert and Karoo. The rain fronts from the Southern Ocean that buffet the Cape Fold Mountains of s. South Africa during the austral winter (May–Aug) create a collection of Mediterranean-type heathlands. The east coast, in contrast, is influenced by the warm-water Agulhas current. This creates a humid environment resulting in the formation of coastal forest types. In se. South Africa, where the Agulhas starts cooling, and the drier influence of the Central Plateau becomes prevalent, the unique succulent **ALBANY THICKET** develops.

There are also plenty of mountains that emerge above the Central Plateau. Thaba Ntlenyana (Lesotho) is the tallest at 11,423 ft. (3482 m). Although peaks occur along the Namibian–Angolan escarpment and the Cape Fold Mountains in South Africa, mountains are tallest in the east, running from the Drakensberg (South Africa) north to the Nyika Plateau (Malawi–Zambia). Generally, montane habitats like **MOIST MONTANE FOREST** and **MONTANE GRASSLAND** are restricted to elevations above 4600 ft. (1400 m) on isolated tropical massifs, but farther south in temperate zones these “montane” habitats occur at progressively lower elevations until they reach the coast in South Africa. Only the region’s tallest alpine peaks support small and isolated fragments of

AFROPARAMO and **MONTANE HEATH**. Freshwater wetlands are divided between temperate ones in the cooler south and both deep and shallow freshwater marshes in the warmer north.

The wildlife of this region is legendary. It is home to almost every iconic African mammal and much more. There are tens of thousands of plants (many of which are endemic), over 1300 bird species, of which over 250 are endemic or near-endemic, and similar levels of diversity for reptiles, amphibians, fish, and insects. The details of this stunning array of biodiversity are explored in the accounts.

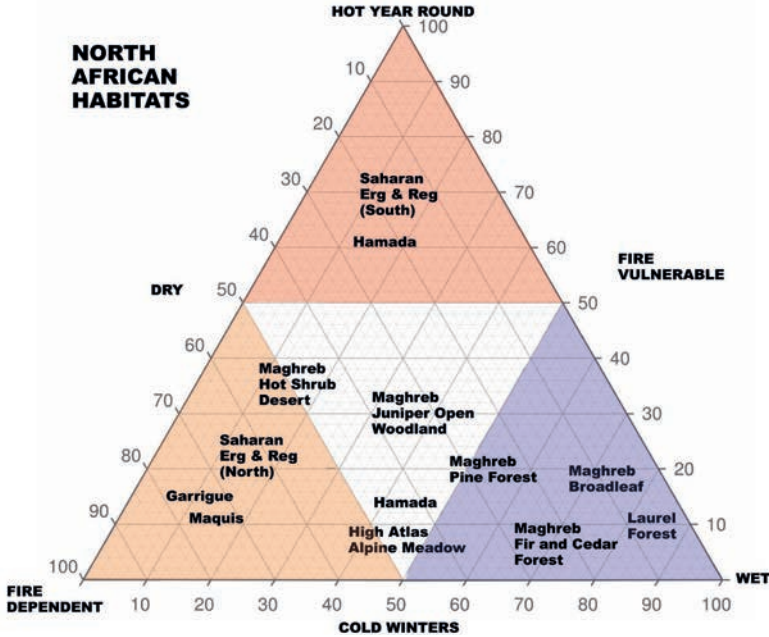


GREATER SOUTHERN AFRICAN HABITATS

CODE	CATEGORY/NAME	PAGES	CODE	CATEGORY/NAME	PAGES
	DESERTS AND XERIC SHRUBLANDS			ALPINE TUNDRAS AND MONTANE HEATHS	
Af2B	Namib Rock Desert (endemic)	77–81	Af10A	Afroparamo	343–349
Af2D	Namib Sand Desert (endemic)	88–93	Af10C	Montane Heath	354–357
Af2F	Nama Karoo (endemic)	101–106		FRESHWATER HABITATS	
Af2G	Succulent Karoo (endemic)	107–114	Af11A	Afrotropical Deep Freshwater Marsh	358–364
	TROPICAL AND SUBTROPICAL MOIST BROADLEAF FORESTS		Af11B	Afrotropical Shallow Freshwater Marsh	365–369
Af4A	Afrotropical Lowland Rainforest	143–150	Af11D	South African Temperate Wetland (endemic)	374–378
Af4C	Monsoon Forest	151–156	Af11E	Freshwater Lakes and Ponds	379–381
Af4D	East Coast Forest Matrix	157–163	Af11F	Rivers	382–385
Af4E	South Coast Forest Matrix (endemic)	164–168		SALINE HABITATS	
AF4F	Swamp Forest	169–173	Af12A	Afrotropical Mangrove	386–389
AF4G	Moist Montane Forest	174–179	Af12B	Salt Pans and Lakes	390–392
AF4M	Mavunda (endemic)	203–207	Af12C	Tidal Mudflats and Estuaries	393–394
	TROPICAL AND SUBTROPICAL DRY BROADLEAF FORESTS		Af12D	Salt Marsh	395–396
Af5B	Angolan Deciduous Forest (endemic)	215–219	Af12E	Sandy Beach and Dunes	397–399
	SAVANNAS		Af12F	Rocky Shoreline	400–402
Af6A	Mopane	221–226	Af12G	Offshore Islands	403–406
Af6C	Kalahari Dry Thorn Savanna (endemic)	235–242	Af12H	Pelagic Waters	406–408
Af6D	Moist Mixed Savanna	243–251		ANTHROPOGENIC	
Af6E	Miombo	252–259	Af13A	Humid Lowland Cultivation	409–411
Af6G	Inselbergs and Koppies	268–274	Af13B	Savanna Cultivation	412–415
Af6H	Gusu (endemic)	275–279	Af13C	Tropical Montane Cultivation	415–417
	GRASSLANDS			South African Temperate Cultivation (endemic)	418–419
Af7A	Afrotropical Grassland	280–286	Af13F	Tree Plantations	422–423
Af7F	Montane Grassland	293–299	Af13G	Cities and Villages	424–426
	MEDITERRANEAN FORESTS, WOODLANDS AND SHRUBS		Af13H	Grazing Land	427–428
Af8A	Fynbos (endemic)	300–308			
Af8B	Strandveld (endemic)	309–314			
Af8C	Renosterveld (endemic)	315–320			
Af8G	Albany Thicket (endemic)	332–337			

NORTH AFRICA

North Africa is massive; at 3.5 million square miles (9.9 million square kilometers) it is pretty close to the size of the United States. It stretches from the Atlantic Ocean in the west to the Red Sea in the east, from the Mediterranean Sea in the north to the Sahel of Mali, Niger, Chad, and Sudan in the south. The northwest is referred to as the Maghreb (Mauritania, Western Sahara, Morocco, Algeria, Tunisia, and Libya), and has a distinctly temperate Mediterranean climate (Köppen **Csa**, **Csb**) with hot dry summers and wetter winters. But the Maghreb also includes the mighty Atlas Mountains, which reach heights of 13,671 ft. (4167 m). The remainder of North Africa is part of the Saharan region with a subtropical Mediterranean desert (Köppen **Bsa**) in the north and a summer



NORTH AFRICAN HABITATS

CODE	CATEGORY/NAME	PAGES	CODE	CATEGORY/NAME	PAGES	
Af1A	DRY CONIFERS		Af11C	FRESHWATER HABITATS		
	Maghreb Fir and Cedar Forest (endemic)	54–57		North African Temperate Wetland (endemic)	370–373	
	Maghreb Juniper Open Woodland (endemic)	57–60		Freshwater Lakes and Ponds	379–381	
Af1B			Af11E	Rivers	382–385	
Af1D	Maghreb Pine Forest (endemic)	67–69	Af11F	SALINE HABITATS		
Af2A	DESERTS AND XERIC SHRUBLANDS			Af12A	Afrotropical Mangrove	386–389
	Saharan Reg Desert (endemic)	71–76		Af12B	Salt Pans and Lakes	390–392
	Saharan Erg Desert (endemic)	82–87		Af12C	Tidal Mudflats and Estuaries	393–394
	Rocky Hamada and Massif (endemic)	94–100		Af12D	Salt Marsh	395–396
	Maghreb Hot Shrub Desert (endemic)	115–120		Af12E	Sandy Beach and Dunes	397–399
Af3A	TEMPERATE BROADLEAF AND MIXED FORESTS			Af12F	Rocky Shoreline	400–402
	Laurel Forest (endemic)	138–141		Af12G	Offshore Islands	403–406
	MEDITERRANEAN FORESTS, WOODLANDS AND SHRUBS			Af12H	Pelagic Waters	406–408
	Maghreb Maquis (endemic)	321–325		Af13E	ANTHROPOGENIC	
Maghreb Garrigue (endemic)	326–327	North African Temperate Cultivation (endemic)			419–421	
Maghreb Broadleaf Woodland (endemic)	328–331	Af13F			Tree Plantations	422–423
ALPINE TUNDRAS AND MONTANE HEATHS		Af13G	Cities and Villages		424–426	
High Atlas Alpine Meadow (endemic)	350–353	Af13H	Grazing Land		427–428	
Montane Heath	354–357					

rainfall tropical-influenced desert (Köppen **Bwa**) in the south. This region contains 28 of the habitats covered in this book, and 14 of these are endemic.

The Atlas Mountains are three distinct ranges, with the tallest being the High Atlas in the center, dominated by sedimentary rocks. Counterintuitively, the Middle (in height) Atlas lie farther north, closer to the Mediterranean Sea, and comprise both sedimentary and volcanic rocks, and the Anti-Atlas are an older outlying range of predominantly much older Precambrian metamorphic rocks such as gneisses and quartzites. These lie to the south of the High Atlas and border the Sahara Desert.

The Sahara is so massive that any summary of the geology will always be an oversimplification. But in brief, it is dominated by Precambrian metamorphic complexes (4.6 billion to 500 million years old) and overlain by younger sedimentary deposits. Although these deposits range over 500 million years in age, they have mostly been deposited in shallow environments and have not been subject to much alteration since formation. The distinct landscapes of the Sahara have been produced by geomorphological processes that move this material around through wind (aeolian erosion and deposition), which creates the Reg (stony plains), Hamada (rocky terrain), and Erg (sand surfaces and seas).

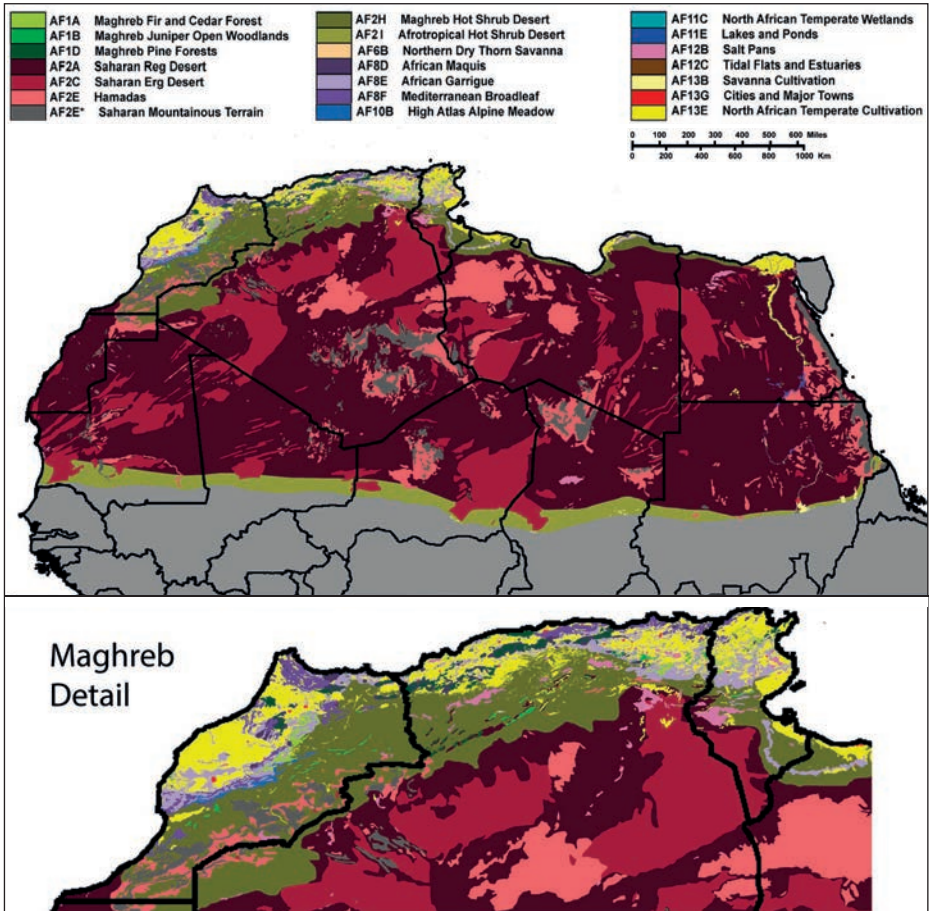
Between 5.9 and 5.3 MYA North Africa was attached to Europe by land, and what is now the bottom of the Mediterranean Sea was a basin covered in low-lying savanna and a series of smaller hypersaline seas about 6000 ft. (1800 m) lower than current sea level. That came to a sudden end with a flood that poured the equivalent of 500 times the flow of today's Amazon through the Straits of Gibraltar and into the basin to create the Mediterranean Sea. With the sea level rising at 30 ft. (10 m) per day it is hard to conceive how any terrestrial animals could have escaped that flood. The expansion of the Sahara in the east, in conjunction with the creation of the Mediterranean Sea, has split the region into two nodes of speciation: on the north side of the Mediterranean Iberian Lynx and Savi's Pine Vole evolved in Pleistocene (2.6 million–11,700 YBP) European refugia, while on the African side animals such as Barbary Ground Squirrel, Egyptian Greater Jerboa, and Cuvier's Gazelle evolved. Birds and bats are mobile and have mostly colonized both sides of the Mediterranean.

Along North Africa's Mediterranean fringe, the habitats are very similar to those occurring in s. Europe and the Middle East. Coastal areas are dominated by **MAGHREB GARRIGUE** heathland, with larger patches of dry sclerophyllous woodland called **MAGHREB MAQUIS**, coastal juniper woodlands, and oak forests dominated by Cork Oak. On the slopes of the Atlas Mountains in Morocco, Algeria, and Tunisia (Köppen **Csb**), the oak forests merge into forests dominated by cedars and pines. Above the cedar in wet areas, and also on the lower slopes in the rain shadows, junipers, surprisingly of the same species as in the littoral zone, form shrublands and low forests.

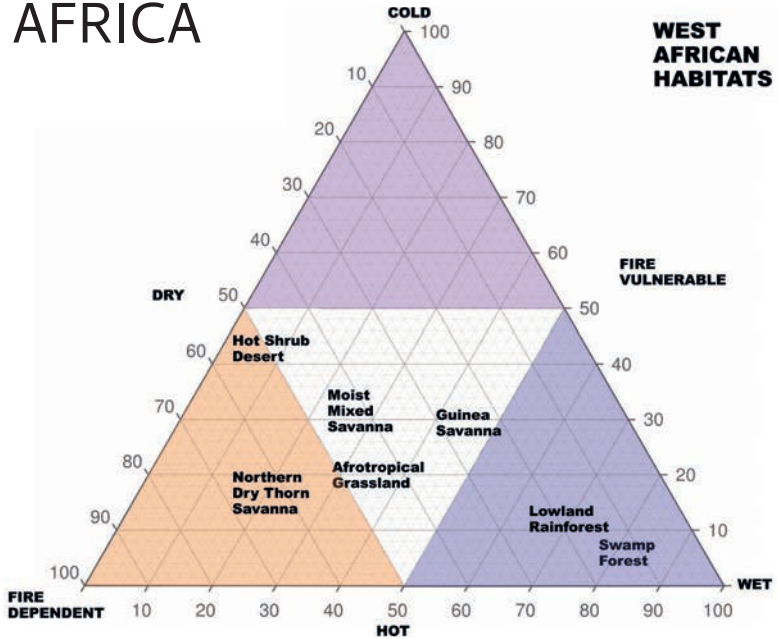
To the south of the Atlas Mountains there is hot shrub desert, where cultivation is still possible along the northern fringes of the dry Sahara. Farther east, in Libya and Egypt, the North African coast is much lower in elevation, and the Mediterranean climate continues across most of coastal Libya, petering out before reaching Egypt, where the Sahara runs all the way to the coast. Half of the Sahara is covered with small pebbles, forming a desert pavement called Reg, where most of the sand has been eroded away by wind, leaving shiny cobbles. The aforementioned sand is deposited in dunes and seas of sand called Erg, which are nearly devoid of life until stabilized by date palms and scattered vegetation. Within the Erg and Reg landscapes there are areas where freshwater comes to the surface as springs, forming oases. These areas formerly supported marshes and dense stands of palms and other trees, teeming with life. Unfortunately, the vast majority of oases have been transformed by cultivation and turned into towns with little room left for wildlife. There are also Hamada areas of barren, rocky plateau, some flat and some mountainous. Hamadas often contain wadis—valleys where the water flowing off barren rocky

plateaus feeds a water table close to the surface, allowing lush growth than would normally grow in these areas. Though few people realize this, there are rocky mountain ranges scattered across the Sahara that support pockets of montane shrubland in areas above 6000 ft. (1800 m), such as in the Tibesti range.

The Macaronesia Islands contain the last major vestiges of **LAUREL FOREST**, a habitat that was once widespread across Europe but over time has been excluded by other habitats and climates. Several endemic birds and other fauna survive only here.



WEST AFRICA



West Africa lies between the Sahara and the Gulf of Guinea, stretching east to Chad. At 1.4 million square miles (3.6 million square kilometers) it is the size of the US Eastern Seaboard across to the Great Plains, or slightly larger than India. It covers the northern half of Cameroon and the southern parts of Niger, Burkina Faso, Mali, and Mauritania. From east to west along the West African coast it includes Nigeria, Benin, Togo, Ghana, Ivory Coast, Côte d'Ivoire, Liberia, Sierra Leone, Guinea, Guinea-Bissau, Senegal, and The Gambia. It contains 26 habitats, none of which are endemic.

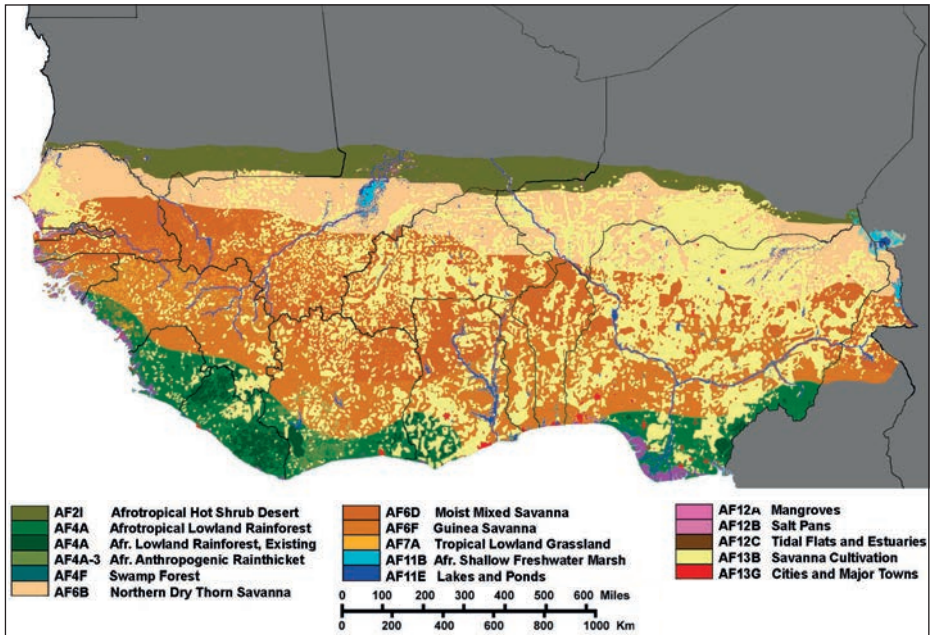
The savanna belt comprises **GUINEA SAVANNA**, **MOIST MIXED SAVANNA**, and dry thorn savanna. Guinea Savanna occurs adjacent the rainforest belt, then slowly transitions into moist mixed then dry thorn savanna to the north as the climate becomes drier (see diagram of this transition on page 20). This savanna belt extends from the Senegal coastline to Chad, and then extends eastward, gradually changing and becoming a minor habitat through north-central Africa. Guinea Savanna is structurally a woodland savanna though botanically has affinities with the rainforests to the south. The climate has a very strong seasonality (Köppen **Ama**) with extremely humid wet seasons and very dry seasons. Rainfall is sufficient to support rainforest, but the prolonged dry season combined with a fairly regular fire regime maintains the savanna.

The once extensive Upper Guinea lowland rainforests to the south of the savanna belt are separated from the similar Lower Guinea Central African lowland rainforests by the Dahomey Gap, where the Guinea Savanna reaches the coast in Togo and Benin. Upper Guinea forests contain endemics such as White-breasted Guinea fowl, Brown-cheeked Hornbill, White-necked Rockfowl, and Sharpe's Apalis. These forests, however, have been decimated, turned into secondary rainthicket to the point at which it is difficult to find any real "primary" rainforest, and even our understanding of what is a primary forest may need to change.

The habitats to the north of the Guinea Savanna gradually become dryer and shorter in stature, with thorn savanna and grassland of the Sahel merging with the shrub deserts of the Sahara. Much

WEST AFRICAN HABITATS

CODE	CATEGORY/NAME	PAGES	CODE	CATEGORY/NAME	PAGES
DESERTS AND XERIC SHRUBLANDS			SALINE HABITATS		
Af2I	Afrotropical Hot Shrub Desert	121–126	Af12A	Afrotropical Mangrove	386–389
TROPICAL AND SUBTROPICAL MOIST BROADLEAF FORESTS			Af12B	Salt Pans and Lakes	390–392
Af4A	Afrotropical Lowland Rainforest	143–150	Af12C	Tidal Mudflats and Estuaries	393–394
Af4F	Swamp Forest	169–173	Af12D	Salt Marsh	395–396
SAVANNAS			Af12E	Sandy Beach and Dunes	397–399
Af6B	Northern Dry Thorn Savanna	227–233	Af12F	Rocky Shoreline	400–402
Af6D	Moist Mixed Savanna	243–251	Af12G	Offshore Islands	403–406
Af6F	Guinea Savanna	260–267	Af12H	Pelagic Waters	406–408
Af6G	Inselbergs and Koppies	268–274	ANTHROPOGENIC		
GRASSLANDS			Af13A	Humid Lowland Cultivation	409–411
Af7A	Afrotropical Grassland	280–286	Af13B	Savanna Cultivation	412–415
Af7F	Montane Grassland	293–299	Af13F	Tree Plantations	422–423
FRESHWATER HABITATS			Af13G	Cities and Villages	424–426
Af11A	Afrotropical Deep Freshwater Marsh	358–364	Af13H	Grazing Land	427–428
Af11B	Afrotropical Shallow Freshwater Marsh	365–369			
Af11E	Freshwater Lakes and Ponds	379–381			
Af11F	Rivers	382–385			



of the birdlife of the East African savannas wraps around the northern half of West Africa, with familiar examples such as Gray-headed Kingfisher, Lappet-faced Vulture, and Red-billed Firefinch.

In contrast to all other regions of Africa, there are no extensive or very tall mountain ranges in West Africa. There are elevated areas such as the Guinea Highlands, but not to a point where they have orographic rainfall and develop true montane rainforests or **AFROPARAMO**. There are some montane grasslands, but these have likely been produced by human-caused fire. Geologically, this zone is centered on a geological craton (extremely old and highly stable parts of the world), with some ancient rock over 2 billion years old at the surface. There are some soils that developed at least 14 MYA yet have remained at the surface unaltered, having received no additional weathering. Overall, this region has an extremely stable soil environment that has remained constant despite climate and vegetation changes; the soils tend to be iron oxide and silica-rich clay, which are highly inert and contain few other minerals and nutrients for plants to use. In some areas, these ancient soils form laterite caps and, in more recent soils, ferricretes (see sidebar 11, p. 126), which prevent most woody vegetation from growing but allows the growth of an edaphic grassland.

SIDEBAR 3 THE SAHARA—THE REALM DICTATOR

The continent of Africa comprises two very distinct biogeographic realms separated by the Sahara (hence “sub-Saharan” Africa). To the south lies the Afrotropics with bird groups such as guineafowl, turacos, African barbets, mousebirds, African warblers, and hylotias, and to the north is a rapid change to the Palearctic where loons, gulls, nuthatches, grouse, redstarts, buntings, finches, and *Curruca* warblers predominate. This pattern follows with other wildlife too. The Sahara is mostly linked to the desert realms of Asia, stretching through the Middle East and Indian subcontinent all the way to Mongolia’s Gobi! Extending from the west coast of Mauritania through to the Red Sea and occupying an area the size of Brazil, some 25% of Africa, the Sahara is the world’s largest “hot” desert, being eclipsed only by both frozen poles (cold deserts) in size. The massive inhospitable expanse helps to keep the fair-weather biota of the two realms isolated, as the desert forms a formidable barrier: a mixture of bare rock mountains, barren plateaus called Hamadas, bleak stony plains called Reg, windblown sand deserts called Erg, and the rare oasis. But some wildlife is able to find a way to cross the desert (see sidebars 6, p. 76 and 42, p. 383).



African Warblers like this Cape Crombec (left) are found only south of the Sahara, while *Curruca* warblers like this Tristram's Warbler (right) are common north of the Sahara.

© KEITH BARNES (LEFT); © KEN BEHRENS (RIGHT), TROPICAL BIRDING TOURS

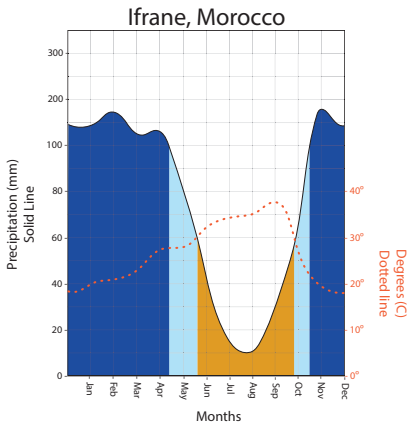
CONIFERS

Af1A MAGHREB FIR AND CEDAR FOREST



IN A NUTSHELL: Conifer forests dominated by fir and cedar trees that will be familiar to people from the Northern Hemisphere. **Global**

Habitat Affinities: MEDITERRANEAN JUNIPER AND CYPRESS FOREST; NEARCTIC MONTANE MIXED-CONIFER FOREST. **Continental Habitat Affinities:** No similar habitats in Africa. **Species Overlap:** MAGHREB JUNIPER OPEN WOODLAND; MAGHREB PINE FOREST; MEDITERRANEAN PINE FOREST; MAGHREB BROADLEAF WOODLAND.



DESCRIPTION: Cedar and fir forests of North Africa are concentrated in the Atlas Mountains from Morocco to Algeria. They form an extension of the cedar and fir forests that surround the Mediterranean and even extend into the Caucasus Mountains between the Black and Caspian Seas. Because the Atlas Cedar (*Cedrus atlantica*) is almost identical to the Lebanese Cedar (*Cedrus libani*), these forests will feel very familiar to people who have visited Israel, the Iberian Peninsula, and the Greater Caucasus Mountains.

Along with some of the deciduous and evergreen oak forests of the Maghreb oak forests, the cedar and fir forests form in the wettest part of the northern slopes of the mountain ranges, where the moisture-laden winds of the Mediterranean Sea and

Atlantic Ocean rise up the mountain ranges and orographic precipitation generates between 19 and 39 in. (500–1000 mm), rarely up to 83 in. (2100 mm), of rain and snow. Because this region mainly has a Mediterranean-type climate (hot dry summer/cold wet winter), at the higher elevations the early snowfalls can result in snow ground cover persisting from October through to April. Although some periods of the year have abundant moisture, other periods are very dry, so the plant communities of this habitat are xerophytic (adapted to low-water environments).

Atlas Cedar forest is confined to the mountains of Algeria, Morocco, and Tunisia and mainly occurs between 3280 and 9180 ft. (1000–2800 m). The Moroccan Fir (*Abies pinsapo marocana*, a subspecies of Spanish Fir) occurs between 4200 and 6890 ft. (1300–2100 m), though it is most common between 4920 and 6200 ft. (1500–1900 m). These forests almost always contain a component of Atlas Cedar, so they can be seen as clinal, where one extreme contains mainly fir and some cedar and the other

is cedar with little fir. Atlas Cedar trees can be towering giants reaching 200 ft. (60 m) tall, although most are in the 130–160 ft (40–50 m) range. The very conical shape and lower height (65–80 ft./20–25 m) of the fir contrasts with the dome crown of the cedars, though very tall and old Moroccan Firs can become irregularly shaped and be less obvious in the canopy. The Algerian Fir (*Abies numidica*), which looks very similar to the Moroccan Fir, also exists in a mosaic within the cedar forests but prefers alkaline soils and tends to associate with clusters of oaks and another conifer, the English Yew (*Taxus baccata*).

Where the forests are thickest and in the hardest-to-access areas, they are dominated by Atlas Cedar, which grows on a variety of soils. The general structure of the forest is open, and the crowns of the Atlas Cedar rarely touch, though when fir trees are present, they grow much closer together and form a thicker canopy. There is also a component of broadleaf trees such as Holly Oak (*Quercus ilex*) and Montpellier Maple (*Acer monspessulanum*), with bushes of Common Holly (*Ilex aquifolium*), Wild Service Tree (*Sorbus torminalis*), and Cade Juniper (*Juniperus oxycedrus*). The Holly Oaks generally form the succession tree when a large cedar falls, but are replaced over time by cedars, and thus the oak spends years waiting for a chance to grow quickly, only to be replaced. Very little light penetrates to the ground around the firs, and the winter snowpack takes many months to melt; subsequently ground cover is limited to a few grasses under the firs and shrubs and orchids such as Broad-leaved Helleborine (*Epipactis helleborine*) and Red Helleborine (*Cephalanthera rubra*).

At the lower elevations, where orographic rainfall is less prevalent, these forests merge with, and are eventually replaced by, Aleppo Pine (*Pinus halepensis*), with some Maritime Pine (*Pinus pinaster*), Holly Oak, and Phoenician Juniper (*Juniperus phoenicea*). At these transitions, the Atlas Cedar canopy exists as emergents reaching 130 ft. (40 m) above the more uniform oaks, pines, and junipers, which exist as a subcanopy at around 50–65 ft. (15–20 m). At their upper limit where the climate is colder and drier, the cedar and fir forests become shorter and thin out to where they become a woodland and merge into the Spanish Juniper (*Juniperus thurifera*) of the **MAGHREB JUNIPER OPEN WOODLAND** or have well-defined boundaries with the **HIGH ATLAS ALPINE MEADOW**. Over much of their distribution, tree lopping and overgrazing has made these forests become much shrubbier and take on an almost **MAGHREB MAQUIS** nature, dominated by oak and juniper shrubs, with many climbers and grasses; eventually they look like an anthropogenic form of **MAGHREB JUNIPER OPEN WOODLAND** with a few remnant cedars and fir.

Also on the massifs in the Sahara to the south are scattered patches of cypress woodlands (which resemble the upper limits of the Maghreb Fir and Cedar Forest), though these areas have a distinctly summer rainfall, a much more open canopy, and shorter structure. These cypresses are evolved from trees that may be remnants of a much broader coniferous woodland that existed during the Mesozoic. This is fascinating, because it implies that the Sahara had a climate that allowed the existence of broadleaf



Maghreb Fir and Cedar Forest can occur up to 9000 ft. (2800 m) elevation. Igunane, Morocco.

© NICK ATHANAS, TROPICAL BIRDING TOURS

forest, but not surprising, considering that angiosperms (flowering plants) only evolved in the Cretaceous (the later part of the Mesozoic), so as long as the climate was conducive to plant growth, conifers had little competition from Angiosperms.

WILDLIFE: Mammals are few in these forests. Several endemic races of megafauna that formerly inhabited these mountains have gone extinct in historical times, including Atlas Brown Bear, “North African” Savanna Elephant (the famous war elephants of Carthage), Bubal Red Hartebeest, Red Gazelle, and Atlas Wild Ass. The Roman Empire may have been responsible for the extinction of a couple of these species. Barbary Lion went extinct in the early 1900s, and “Barbary” Leopard (a subspecies of African Leopard) may still occur in these forests, although it is unlikely that a viable population persists. Barbary Macaque still exists here and relies on cedars in winter, though they seem to be doing much better in Gibraltar than in the Atlas Mountains. African Wolf (formerly known as Golden Jackal) occurs in small numbers, although it is much rarer than farther south in the continent. Lataste’s Gerbil survives in both natural stands of cedar and areas turned over to cultivation along windbreaks of cedar and hedgerows. Black-tailed Garden Dormouse and Wood Mouse occur both in cedar forests and juniper woodlands.

Birdlife in these forests is remarkably similar to that of coniferous forests of s. Europe, with species such as Common Cuckoo, Great Spotted Woodpecker, Eurasian Wren, Short-toed Treecreeper, European Robin, Common Redstart, Mistle Thrush, Spotted Flycatcher, Great Tit, Eurasian Nuthatch, Common Firecrest, Eurasian Golden Oriole, Eurasian Jay, and Hawfinch, as well as a swath of warblers such as Common Whitethroat, Eurasian Blackcap, Melodious, Western Subalpine, and Western Bonelli’s Warblers. Birds found here but not in Europe include Barbary Partridge, Levaillant’s Woodpecker, and Atlas Flycatcher. The rare endemic Algerian Nuthatch prefers forest dominated by Atlas Oak (*Quercus tlemcenensis*) and Atlas Cedar. Reptiles of these forests include Koelliker’s Glass Lizard (*Hyalosaurus koellikeri*), Atlas Mountain Viper (*Vipera monticola*), and Lataste’s Lizard (*Ophiomorus latastii*).

CONSERVATION: These forests are mere remnants of their former massive extent across the Maghreb mountain ranges. Extensive clearing for agriculture has turned lower elevations into anthropogenic farmland. Increased fire frequency and intensity has caused some cedar and fir forests to be replaced by the far more fire-resistant Spanish Juniper, while overgrazing and tree lopping has caused the upper limit to be converted to alpine grasslands and shrublands. Most of the large mammals have been extirpated, but this habitat remains important for migrating birds.

These forests combined with the **MAGHREB BROADLEAF WOODLAND** are the most important habitats for many Palearctic migrants that winter in Africa, as these are the most significant “wet” habitats between the forests of the Alps and the rainforest and moist savanna of West Africa.

Maghreb Fir and Cedar Forest mainly has plant and animal species that are shared with Europe, like Common Firecrest.

© KEN BEHRENS, TROPICAL BIRDING TOURS





Algerian Nuthatch is one of the few local and restricted-range endemics of this habitat.

© ANDREW SPENCER

Degradation of these forests is placing increasing stress on these migrants, which are already enduring harsher migration conditions across the Sahara because of climate change.

DISTRIBUTION: In Algeria Maghreb Fir and Cedar Forest is common on the northern slopes of Aurès,

and in Morocco it is extensive in the northern slopes of the Middle Atlas and Rif Mountains. Small patches exist in the Kroumirie and Mogod Mountains of Tunisia. Although cedar and fir forests still cover hundreds of thousands of hectares, they are much reduced, especially on lower slopes.

WHERE TO SEE: Ifrane, Morocco; Talassentane National Park, Morocco; Foret des Cedres de Tizi Ouzou, Algeria.

Af1B MAGHREB JUNIPER OPEN WOODLAND



IN A NUTSHELL: Open, generally low, conifer woodlands dominated by juniper, with a grassy understory. **Global**

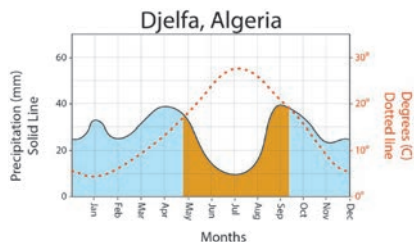
Habitat Affinities: MIDDLE EASTERN JUNIPER FOREST; PINYON-JUNIPER WOODLAND. **Continental Habitat**

Affinities: AFROTROPICAL MONTANE DRY MIXED WOODLAND. **Species**

Overlap: MAGHREB PINE FOREST; MAGHREB BROADLEAF WOODLAND.



DESCRIPTION: The Atlas Mountains tower above the Mediterranean Sea and Sahara Desert, stretching from s. Morocco to Tunisia. Part of the mix of habitats in these mountains and the surrounding lowlands is a dry, open, juniper-dominated woodland. This type of habitat is also found in many other parts of the Mediterranean, such as the Iberian Peninsula and Israel. The north-facing slopes of the Atlas Mountains have a typical Mediterranean mild wet winter–hot dry summer climate (Köppen **Csb**) and annual precipitation between 20 and 39 in. (500–1000 mm). The south-facing slopes adjoining the Sahara receive much lower annual precipitation of 10–27 in. (250–700 mm) and are subject to frequent desiccating winds from the Sahara.



Left: High-elevation juniper woodland at Oukaïmeden in the Atlas Mountains, Morocco. Juniper often grows in harsh areas where other trees cannot survive.

© NICK ATHANAS, TROPICAL BIRDING TOURS

Below: This is one of the habitats favored by the North African endemic Moussier's Redstart.

© DANIELE ARDIZZONE, FLUYENDO PHOTOGRAPHY



Throughout the semiarid parts of the Maghreb, juniper woodlands occur both as near-monotypic stands and as minor elements mixed with pines and oaks, in the case of Phoenician Juniper (*Juniperus phoenicea*), and with fir/cedar forests, in the case of Spanish Juniper (*J. thurifera*). As a general rule, juniper grows in a wide variety of areas where other trees struggle to grow. At high elevations, above the “forest” tree line and along the boundary with the Sahara, the landscape becomes dominated by junipers with their own faunal assemblage. Although the juniper forests and woodlands of the Maghreb have been seriously degraded by humans, they still form some extensive tracts. On the northern slopes, the Phoenician Juniper forests are replaced by the Spanish Juniper groves at higher elevations, and they are in turn replaced by Common Juniper (*J. communis*) shrublands in the highest areas.

Phoenician Juniper again forms large stands on the south slope bordering the Sahara. This tree usually grows in open stands as a large shrub to small rounded tree, with a height of 13–23 ft. (4–7 m) and an overall pear shape, though individuals of just under 32 ft. (10 m) in height with 23 in. (60 cm) diameter trunks have been recorded, and some larger trees take on a lopsided appearance. Spanish Juniper is found over a much wider variety of soils and seems more constrained by climate than by soil type. This species can grow very large, up to 50 ft. (15 m) tall with a 6.5 ft. (2 m) diameter trunk, though they are usually around 32–40 ft. (10–12 m) tall. The canopy is usually domed although some individual trees take on a Christmas tree-like appearance.

These juniper woodlands (though often referred to as forests) are open with little canopy overlap, and plenty of light reaches the understory and ground, though it is probable that extensive closed-canopy Spanish and Phoenician Juniper forests existed within Roman times. In most Phoenician Juniper stands the canopy is shared with species such as Algerian Ash (*Fraxinus xanthoxyloides*), Wild Olive (*Olea europaea*) and Cade Juniper (*Juniperus oxycedrus*), with a well-developed shrub layer including Balearic Boxwood (*Buxus balearica*), Mediterranean Buckhorn (*Rhamnus alaternus*), Egyptian Lavender (*Lavandula multifida*), and Scorpion Broom (*Genista scorpius*). In more open areas where the junipers cover less than half the area, White Wormwood (*Artemisia herba-alba*) becomes prevalent in the shrub layer. Perennial grasses such as Halfah (*Stipa tenacissima*) cover the ground in drier areas.

The lower reaches of the Spanish Juniper woodlands merge into **MAGHREB FIR AND CEDAR FOREST**, with their typical understory of Holly Oak (*Quercus ilex*) and Montpellier Maple (*Acer monspessulanum*), alongside bushes of Common Holly (*Ilex aquifolium*), Wild Service Tree (*Sorbus torminalis*), and Cade Juniper. In higher, more open and shrubbier woodlands the juniper share the subcanopy with shrubby trees like European Box (*Buxus sempervirens*), the deciduous hawthorn species *Crataegus laciniata*, and honeysuckles (*Lonicera*). The smaller shrub layer becomes more important with Mountain Cherry (*Prunus prostrata*) and Spurge Laurel (*Daphne laureola*), that gradually gets replaced by small, very shrubby and sometimes krummholzed (windblown in one direction) Spanish Juniper. Although fire-resistant, and thus often left as a remnant after the death of surrounding Atlas Cedars (*Cedrus atlantica*) and angiosperms (flowering plants), Spanish Juniper woodland does not easily regenerate because of intense overgrazing over most of its distribution. However, if grazing pressure were reduced, the juniper woodlands would quickly regenerate. The existing coastal juniper forests of Phoenician Juniper are limited to stunted coastal thickets associated with dunes and oaks, so are best treated as a form of **MAGHREB MAQUIS**.

CONSERVATION: Juniper woodlands have been heavily degraded over most of their range. On the northern side of the Atlas and along the coast, they have mainly been turned over to cultivation or overgrazed to the degree that they have changed to **MAGHREB MAQUIS** and **MAGHREB GARRIGUE**. On the southern side of North African mountain ranges, juniper woodlands have been severely degraded to shrub desert and even into outright desert through extensive clearing and overgrazing.

Mixed juniper and olive woodland. Most of North Africa has been heavily populated for a very long time. Middle Atlas, Morocco. © CARLOS N. G. BOCOS

WILDLIFE: For a discussion of the now-extinct megafauna of North Africa see the **MAGHREB FIR AND CEDAR FOREST** account. Where Maghreb Juniper Open Woodland is surrounded by very arid lands, it has a distinct suite of wildlife that is very different from the surrounding areas of shrub desert and dry thornscrub. Rock Dove, Stock Dove, Common Woodpigeon, and European Turtle-Dove all occur. Blue Rock-Thrush and Common Rock-Thrush breed, and Ring Ouzel is a particularly common winter migrant. Tristram's Warbler breeds in the coastal juniper woodlands, alongside Greater Whitethroat, especially where these woodlands have been degraded slightly. Barbary Partridge; Golden Eagle; Short-toed, Booted, and Bonelli's Eagles; Long-legged Buzzard; Black and Black-winged Kites; Eurasian Sparrowhawk; Common Kestrel; Little Bustard; Moussier's Redstart; and Black-eared Wheatear occur in grassy openings within Maghreb Juniper Open Woodland, where this habitat almost takes on a wooded steppe appearance.

DISTRIBUTION: Phoenician Juniper is found throughout the northern Maghreb. Related patches of juniper are dotted along the northern fringe of the Sahara all the way to Somalia.

WHERE TO SEE: Souss-Massa National Park, Morocco; Taza National Park, Algeria; Djebel Orbatat Nature Reserve, Tunisia.



Left: Spanish Sparrow is a habitat generalist that can be found in juniper woodland.

© KEITH BARNES, TROPICAL BIRDING TOURS

Below: Although the mammal population of this habitat has been vastly reduced, it retains some mammals—mostly typical of the Palearctic—such as Red Fox.

© KEITH BARNES, TROPICAL BIRDING TOURS



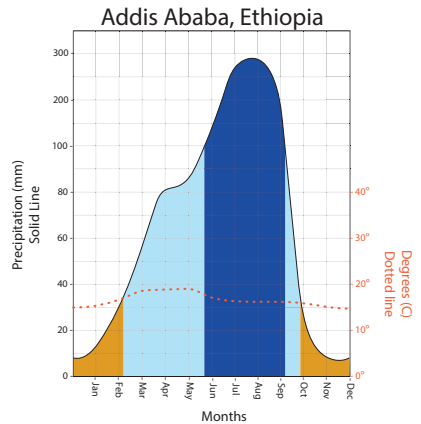
AF1C AFROTROPICAL MONTANE DRY MIXED WOODLAND

IN A NUTSHELL: Dry woodland and forest found at middle and high elevations of sub-Saharan Africa, which can be pure broadleaf, pure conifer, or more often a mix of both. **Global Habitat Affinities:** SUBHUMID YUNGAS. **Continental Habitat Affinities:** MAGHREB JUNIPER OPEN WOODLAND; MOIST MONTANE FOREST; MIOMBO; EAST COAST FOREST MATRIX. **Species Overlap:** MOIST MONTANE FOREST; MOIST MIXED SAVANNA; MONTANE HEATH; MONTANE GRASSLAND; MIOMBO; EAST COAST FOREST MATRIX.



DESCRIPTION: There is great internal complexity within Afrotropical montane forests. Much of this diversity is driven by geography—different mountain blocks have very different biodiversity—but some is linked to climatic differences. While these climatic changes often occur gradually, and incrementally, there is a striking difference between classic mossy **MOIST MONTANE FOREST** and the drier montane forests and woodlands. Teasing these apart can be difficult, but there is enough difference both in terms of drier woodlands' wildlife assemblage and their plant composition to qualify it as distinctive.

Moist Montane Forest (Köppen **Csb**) can be found in areas with annual precipitation as low as 40 in. (1000 mm), while dry montane woodland and forest grows in a narrow precipitation band just below and slightly overlapping this. The driest juniper-dominated woodland (Köppen **Bwa**) in Somalia receives around 27 in. (700 mm) of rain, while the upper limit for dry montane forest is around 45 in. (1150 mm). Dry woodland and forest represent a transition from Moist Montane Forest to other habitats. They also seem to create a sort of buffer around montane forest; fascinatingly, dry montane forest is not bound to a specific elevation but can, in some places, occur both above and below Moist Montane Forest. This odd pattern of distribution mirrors that of North Africa's **MAGHREB JUNIPER OPEN WOODLAND**. What makes this habitat a good buffer is that it is far more tolerant of fire and long dry periods than moist forest. Dry montane woodland is generally found from 5900 to 9800 ft. (1800–3000 m) but locally can be



SIDEBAR 4 **THRIVING ON MODERATION**

Every continent and region has some generalists. Even a place like Madagascar that was likely dominated by forest before humans arrived has a few generalists that use a wide variety of habitats. But something notable about sub-Saharan Africa is the huge suite of birds that use a similarly broad set of habitats, all of which have a moderately open structure. The extremes of this broad niche run from quite arid to quite moist: from the type of **MOIST MIXED SAVANNA** found along watercourses running through dry thorn savanna all the way to the edges of **MOIST MONTANE FOREST** and **AFROTROPICAL LOWLAND RAINFOREST**. These habitats include the likes of **MIOMBO**, **GUINEA SAVANNA**, **GUSU**, **MOPANE**, **AFROTROPICAL MONTANE DRY MIXED WOODLAND**, and portions of the **EAST** and **SOUTH COAST FOREST MATRICES**. This is obviously an expansive niche, stretching across a huge diversity of climatic conditions. It seems counterintuitive that so many birds would use this whole range of habitats. Perhaps it is best explained by Africa's biogeographic history, in which there was always abundant open habitat but in which wet and dry periods alternated, expanding and contracting the extent of the wettest and driest habitats. While species specialized in desert or the interior of moist forest would suffer boom or bust in this cycle, species using the intermediate, moderately open habitats, would have always found niches in which to thrive.

found as low as 3300 ft. (1000 m). Since this habitat is not strictly linked to an elevation range, it occurs in a wide variety of temperature regimens, from moderate/warm up to areas with near-freezing nighttime temperatures.

The most typical trees are African Juniper (*Juniperus procera*), Hagenia (*Hagenia abyssinica*), and yellowwoods (*Podocarpus* and *Afrocarpus*). Juniper sometimes dominates this habitat, especially in its driest forms, as in n. Somalia and Eritrea, or where it burns frequently. Juniper-dominated woodland seems to depend on fire for its propagation and has benefited from human-caused fires, the same dynamic that has permitted the expansion and proliferation of montane grasslands. But even juniper cannot absorb repeated intense fires and can eventually be replaced by grassland. The juniper woodland of Eritrea and Sudan is closely allied with outliers occurring on Saharan mountains, but those are treated under **ROCKY HAMADA AND MASSIF**. Hagenia is a broadleaf tree with large compound leaves, usually growing in a dense round shape. It can occur within Moist Montane Forest, though usually as an edge or successional tree. In both Ethiopia and East Africa, Hagenia is also typical of the high-elevation transitional zone from Moist Montane Forest to **MONTANE HEATH**. It occurs there in an odd mix alongside giant heath plants, often draped in picturesque epiphytic moss. In some dry areas, especially in Ethiopia, virtually monotypic stands of Hagenia occur. These may also be products of human disturbance. In some places, Hagenia-dominated forest may also be a product of heavy browsing by ungulates, such as African Buffalo. More typically, Hagenia is mixed with juniper and yellowwood, with the latter also being a typical tree of Moist Montane Forest. Mixed woodland and forest is the most common forest type in Ethiopia, where true Moist Montane Forest occurs in only the south. Like juniper, Hagenia is somewhat fire-resistant but can succumb after repeated intense fires.

Sub-Saharan Africa is poor in conifers, but those that do occur are fascinating in various ways. African Juniper is likely a recent colonist and is closely related to the Greek Juniper (*Juniperus excelsa*) of Eurasia. Yellowwoods are remnants of the flora of Gondwanaland and are mainly found in the southern two-thirds of the globe. The only other genus of coniferous tree in the Afrotropics is the *Widdringtonia* cedars. There are several species, distributed from the Western Cape of South Africa

north and east to s. Malawi. The Clanwilliam Cedar (*Widdringtonia wallichii*) is namesake of and endemic to the Cederberg Mountains of sw. South Africa. The closest relatives of these African cedars are two genera of cedars from Australia. While fascinating, these southern cedars occur essentially as isolated bushes and trees within other habitats, most frequently montane FYNBOS. The only place where they form a cohesive woodland is on Mt. Mulanje in s. Malawi, where two species are found along with a mix of broadleaf species.

In addition to the Hagenia, Juniper, and/or Cedar formations mentioned above, there are other types of drier montane woodland and forest that are not easily categorized. These largely or completely lack these characteristic trees but instead comprise a wide variety of broadleaf species. They often resemble moist MIOMBO, and, in terms of wildlife, have a mix of savanna and Moist Montane Forest species. Most of this dry woodland and forest was destroyed long ago, as it lies in a zone that is optimal for human cultivation. Remnants are preserved in some of the lower elevations of Arusha

National Park, in Tanzania, and the western parts of Nairobi National Park in Kenya. Some tree species typical of this dry montane broadleaf formation include yellowwood (*Podocarpus*), Olive (*Olea europaea*), Forest Elder (*Nuxia floribunda*), African Cherry (*Prunus africana*), Brittlewood (*Nuxia congesta*), Wild Peach (*Kiggelaria africana*), Cape Holly (*Ilex mitis*), Stinkwood (*Ocotea bullata*), and Cape Beech (*Rapanea melanophloeos*). Note that all these are also found in some versions of Moist Montane Forest, and many are listed in this book as typical trees of that habitat! Some are also found in MOIST MIXED SAVANNA and other moist savanna habitats. As explained in



Juniper woodland is unevenly scattered at the lower elevations of Bale Mountains National Park, Ethiopia. © KEN BEHRENS, TROPICAL BIRDING TOURS



A dry montane woodland with a mix of juniper and broadleaf elements. This habitat forms a transition between the savanna habitats of lower elevations and Moist Montane Forest at higher elevations. Arusha National Park, Tanzania. © KEN BEHRENS, TROPICAL BIRDING TOURS

the Wildlife section below, this is a habitat made up of a mix of elements from adjacent habitats. In parts of s. Tanzania, e. Zimbabwe, Malawi, Mozambique, and e. Zimbabwe, where Moist Montane Forest above transitions to Miombo broadleaf woodland below, a similar type of transitional dry forest is found, again with a mix of Moist Montane Forest and Miombo wildlife.

Another type of drier montane habitat with woody vegetation is found in Southern Africa: the Ouhout (*Leucosidea sericea*) shrublands that occur along the edges of the Highveld **MONTANE GRASSLAND** (see sidebar 32, p. 299). The wildlife of this shrubland is essentially an extremely reduced subset of what is found in South African Moist Montane Forest. Yet another formation that could be placed in the dry montane woodland category is the higher-elevation *Acacia* woodlands that are found all the way from Abyssinia south to Malawi. These also form a transition habitat from Moist Montane Forest to grassland and savanna habitats, but given the dominance of *Acacia*, we consider them a high-elevation form of Moist Mixed Savanna.

The exact structure of dry montane woodland and forest is highly variable. At the most extreme end of aridity and openness, they can form a savanna-type environment with scattered juniper trees at a height of around 20 ft. (6 m). A more typical formation is a matrix of mixed open woodland and closed forest, with a canopy of 30–65 ft. (9–20 m). The dry forest on Malawi's Mt. Mulanje has a canopy around 90 ft. (27 m), with emergent cedars as tall as 130 ft. (40 m). The n. Somali mountains can have junipers alongside a mix of evergreen shrubs that structurally resemble the **MAGHREB MAQUIS** of North Africa. Tree and shrub species in this Somali formation include *Pistacia aethiopica* and *Buxus hildebrandtii*.

CONSERVATION: Across its range, this habitat is highly threatened. Most of the lower-lying dry montane woodland and forest in East Africa has already been destroyed. The higher-elevation versions, occurring above montane forest, have been less affected. This type of woodland is prone to fire and can quickly be replaced by grassland, especially in areas where humans increase fire frequency. The Mulanje Cedar (*Widdringtonia whytei*) has been heavily logged and the extent of its woodlands reduced by around half.

WILDLIFE: Dry montane woodland is not particularly rich or distinctive in mammals. Most of the large mammals are widespread and use a broad range of habitats, including adjacent savanna and/or



The dry woodlands of the Abyssinian highlands are rich in localized birds such as the stunning White-cheeked Turaco.

© AYUWAT JEARWATTANAKANOK

MOIST MONTANE FOREST.

These include Angola and Guereza Colobuses, African Savanna Elephant, Leopard, Slender Mongoose, African Buffalo, Blue Duiker, Suni, and Bushbuck. Dry woodland is one of the key habitats for the Ethiopian-endemic Mountain Nyala and is also sometimes used by Ethiopian Wolf and Walia Ibex. All are considered Threatened by International Union for Conservation of Nature.

Dry montane woodland isn't a premier habitat for birding but does hold a good variety of birds, probably due to the prevalence in Africa of



Banded Barbet is an Abyssinian endemic that uses both montane Moist Mixed Savanna and dry woodland habitats.

© KEITH BARNES, TROPICAL BIRDING TOURS

species that key into moderately open habitats (see sidebar 4, p. 62). Some typical and widespread birds of dry woodland and forest are Rameron Pigeon, Red-eyed Dove, Dusky Turtle-Dove, Mountain Gray Woodpecker, Red-fronted Tinkerbird, Scaly-throated Honeyguide, White-eyed Slaty-Flycatcher, African Dusky Flycatcher, Brown Woodland-Warbler, several species of white-eyes, Northern and Black-backed Puffbacks, Common Bulbul, Black Sawwing, and Tacazze and Bronze Sunbirds. This is one of the preferred habitats for several raptors, including Augur Buzzard, African Cuckoo-Hawk, and African Goshawk. Although this dry habitat isn't as lush as Moist Montane Forest, there is still often a dense understory, which provides refuge for skulking species such as Abyssinian Ground-Thrush; Abyssinian Thrush; Rüppell's, White-browed, and Cape Robin-Chats; Cinnamon Bracken Warbler; Tropical Boubou; and Green-backed Camaroptera. As in adjacent savanna, there is a good variety of seedeaters, including Baglafaecht Weaver, African and Southern Citrils, Streaky Seedeater, Bronze Mannikin, and Yellow-bellied Waxbill. Dry woodland, especially that dominated by conifers, is favored by owls, notably Abyssinian Owl, African Wood-Owl, and Cape Eagle-Owl. At dusk, this habitat is often serenaded by the haunting song of Montane Nightjar. This isn't as rich a habitat for Palearctic migrants as lower-lying savanna but is favored by Tree Pipit, Eurasian Blackcap, and Spotted Flycatcher.

Endemism: Africa's most exciting dry montane woodlands for birding are those in the Abyssinian highlands, where this habitat is widespread and common. It supports more Abyssinian endemic birds than any other habitat, including Yellow-fronted Parrot, White-cheeked Turaco, Abyssinian Woodpecker, White-backed Tit, and Abyssinian Catbird. It is also used by several other endemics, such as White-collared Pigeon, Black-winged Lovebird, Prince Ruspoli's Turaco, and Banded Barbet.

The mountains of n. Somalia form another node of endemism. They share some of the characteristic birds of the Abyssinian highlands and also have a couple pure endemics, namely Somali Thrush and Warsangli Linnnet.

Southern Malawi is a minor area of endemism, though it has a mix of moist and dry forest. Species found on Mt. Mulanje include the widespread Crowned Hornbill plus local endemics Black-browed Mountain Greenbul and Yellow-throated Apalis.



DISTRIBUTION: Found from the hills of se. Sudan, across into Djibouti, then in a narrow band across the mountains of n. Somalia. This is the most common montane forest formation throughout Ethiopia. In slightly moister East Africa, the broadleaf-dominated versions of this habitat are found locally, blending gradually into **MOIST MONTANE FOREST**, from which they are not easily distinguished. Mt. Mulanje supports an outlier dry montane cedar woodland. Drier montane woodland is found in the eastern part of the **MIOMBO** zone, at the transition from Moist Montane Forest to Miombo savanna.

WHERE TO SEE: Bale Mountains National Park, Ethiopia; Debre Libanos, Ethiopia; Nairobi National Park, Kenya; Arusha National Park, Tanzania.



Top: Guereza Colobus uses a wide variety of woodland and forest types, though dry montane forest is one of its favored habitats. © KEN BEHRENS, TROPICAL BIRDING TOURS

Left: Some widespread Afrotropical savanna species such as Levallant's Cuckoo will also use dry montane woodland.

© KEITH BARNES, TROPICAL BIRDING TOURS

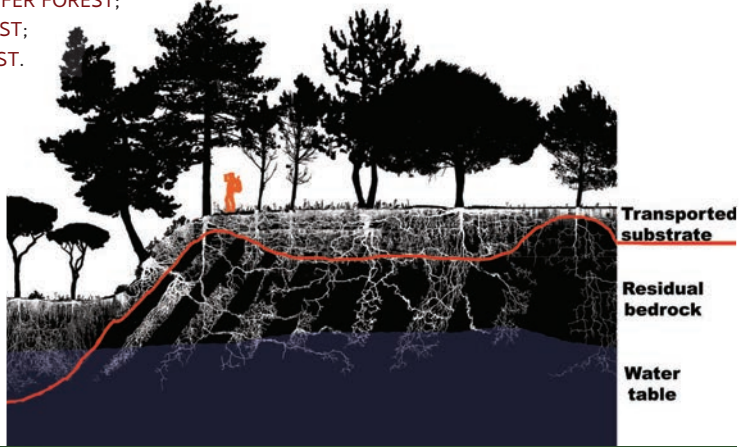
AF1D MAGHREB PINE FOREST

IN A NUTSHELL: Open, generally low conifer woodlands dominated by distinctive umbrella and snow cone-shaped pine trees, with a grassy understory.

Global Habitat Affinities: MEDITERRANEAN DRY PINE FOREST; JACK PINE FOREST; NEARCTIC MONTANE MIXED-CONIFER FOREST; LODGEPOLE PINE FOREST; HIMALAYAN PINE FOREST.

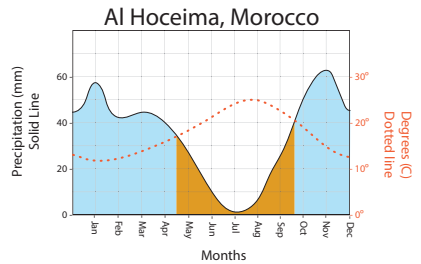
Continental Habitat Affinities: No similar habitats in Africa.

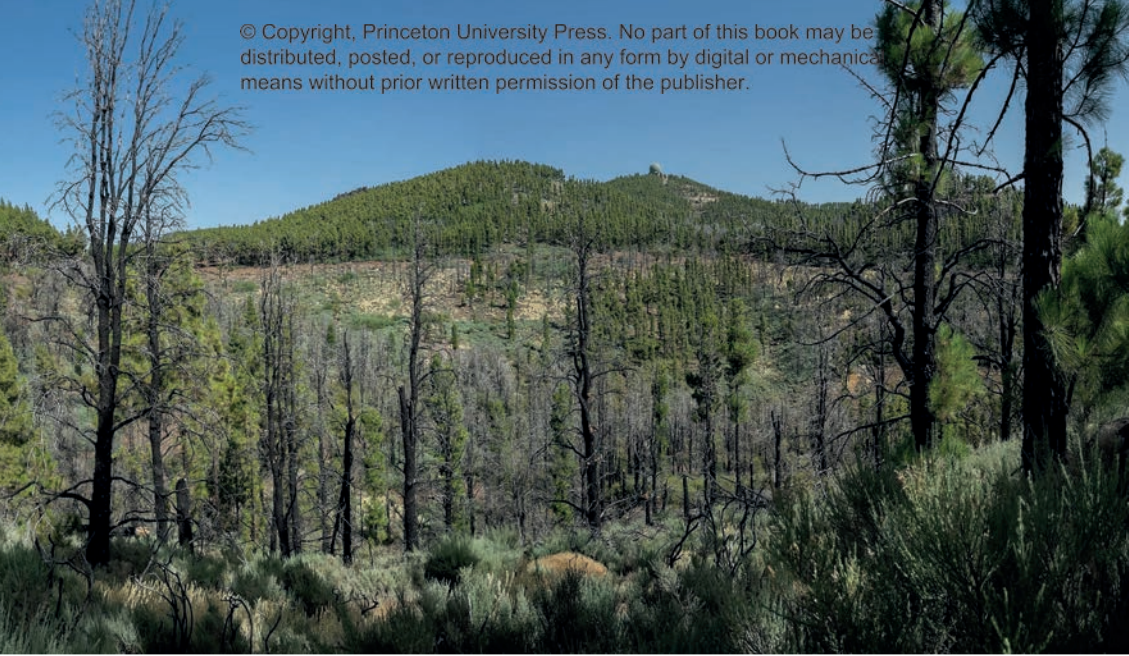
Species Overlap: MAGHREB JUNIPER OPEN WOODLAND; MAGHREB FIR AND CEDAR FOREST; MAGHREB BROADLEAF WOODLAND.



DESCRIPTION: Mixed or monotypic pine forests are the most common and widespread forests in the Maghreb (Western Mediterranean) region of Africa. The dominant pines are medium-sized (40–80 ft./15–25 m) and have an open growth form, red-stained trunk, and long needles. Although many of the individual plant species are endemic, this habitat is an extension of the widespread xerophytic (tolerant of dry conditions) conifer forests that surround the Mediterranean from the Iberian Peninsula all the way to the Middle East in regions with the hot summer-dry summer (Köppen **Csa**) Mediterranean climate.

Leppo Pine (*Pinus halepensis*) is the most prevalent of the pines in North Africa, having both a limited native distribution as well as being planted over large parts of the Mediterranean coastal plain. Artree, a *Tetraclinis* conifer that looks similar to a small juniper or even *Callitris* of Australia, is common in the west of the region. The very distinctive Umbrella or Stone Pine (*Pinus pinea*), with its distinct umbrella-shaped growth form when young and below 40 ft. (12 m) in height, existed in n. Africa in prehistoric times, was eradicated, but recently has naturally recolonized wild areas as well as being cultivated. Pine forests usually have a canopy between 40 and 60 ft. (12–18 m) in height. They are associated with Phoenician Juniper (*Juniperus phoenicea*) and broadleaf trees such as Algerian Oak (*Quercus canariensis*), Cork Oak (*Quercus suber*), Holm Oak (*Quercus ilex*), and Wild Olive (*Olea oleaster*) The shrub layer is often composed of Turbith (*Athamanta turbith*), Egyptian Lavender (*Lavandula multifida*), and multiple rosemary species.





Above: Pine forest on the Canary Islands, comprising the endemic Canary Island Pine (*Pinus canariensis*).

© VINCENT LEGRAND

Right: Maghreb Pine Forest is one of several treed habitats used by the North African endemic Levallant's Woodpecker. © KEN BEHRENS, TROPICAL BIRDING TOURS



The plants of this habitat are highly resistant to drought, desiccating winds, and fire but require lots of light, so they cannot establish as an understory in the shade of

forests dominated by preexisting larger conifers. When fires become too frequent, Aleppo Pines are replaced, and Arartree becomes the locally dominant species due to its ability to regenerate faster than other species. Pines occur on a wide range of soils in drier and hotter areas, but in higher rainfall and higher elevation areas, pines are restricted to less productive calcareous soils and are outcompeted by firs and cedars in better soils. In the sandiest soils, Umbrella Pine dominates, and it has been planted along coastlines. The lower pine forests are also restricted by temperature and can survive to about -4°F (-20°C), though Arartree is far less tolerant of the cold. An exception to the above description are the stands of Maritime Pine (*Pinus pinaster*) that occur in the subhumid zones, where precipitation is between 31.5 in. (800 mm) and 47 in. (1200 mm), and are able to withstand long periods of cold weather. This species often grows in transitional areas from other pine forests to the fir and cedar forests of higher elevations, and they share most of their shrub layer plants with oak forests and the degraded heathlands of the **MAGHREB MAQUIS**. The moister w. Canary Islands support montane pine forest and woodland of the endemic Canary Island Pine (*Pinus canariensis*).

This habitat has been extensively modified by grazing, logging, and firewood gathering, and few if any pristine examples remain. Although these forests can have an understory, ungrazed examples are so rare that almost all the existing forests have an open understory and are easy to walk through. During the moist winter, the ground is covered with grasses, forbes, and ferns. In summer, most plants die off and there are extensive areas of bare sandy ground.

CONSERVATION: Most of the original pine forests have been destroyed, and most existing pine forests are managed to some degree for cones and timber.

WILDLIFE: For a discussion of the now-extinct megafauna of North Africa, see the **MAGHREB FIR AND CEDAR FOREST** account. The Cuvier's Gazelle, endemic to the Maghreb, persists in open pine forests, which it prefers, especially in the Tunisian Atlas, although it will also use shrubby desert edges. This species underwent a dramatic decline due to overhunting and was thought extinct, but numbers have increased through captive breeding and release programs. Lataste's Gerbil occurs in the upper elevations of the Aleppo Pine forests.

There are several resident birds that are common throughout Maghreb Pine Forest, such as Great Spotted Woodpecker, Short-toed Treecreeper, Eurasian Jay, European Robin, Eurasian Blackbird, Mistle Thrush, Common Bulbul, Common Nightingale, Black Redstart, Coal and Great Tits, and Eurasian Nuthatch. Many species in this habitat are summer-breeding migrants, such as Booted Eagle, Common Nightingale, and Spotted Flycatcher. Stonechat and Blue and Common Rock-Thrushes breed in rocky areas. Barbary Partridge is a resident. Golden Eagle; Short-toed, Booted, and Bonelli's Eagles; Long-legged Buzzard; Black Kite and Black-winged Kite; Eurasian Sparrowhawk; and Common Kestrel all migrate through. Red-necked Nightjar is common in more open pine woodland with few shrubs and abundant grass. Common, Alpine, and Little Swift; Plain, House, and Crag Martins; and European and Red-rumped Swallows all breed, and they feed in the sky above pine forest. Some species are pine specialists, the most spectacular of which is the North African endemic African Blue Tit. Both Hawfinch and Red Crossbill prefer Aleppo Pine, where they can be found alongside the localized Atlas Flycatcher. Other localized specialties that use these woodlands include Maghreb Owl, Maghreb Magpie, and Levaillant's Woodpecker, which uses a variety of dry open woodlands including Aleppo Pine. Of the reptiles occurring in this habitat, perhaps the most charismatic is the Mediterranean Chameleon.

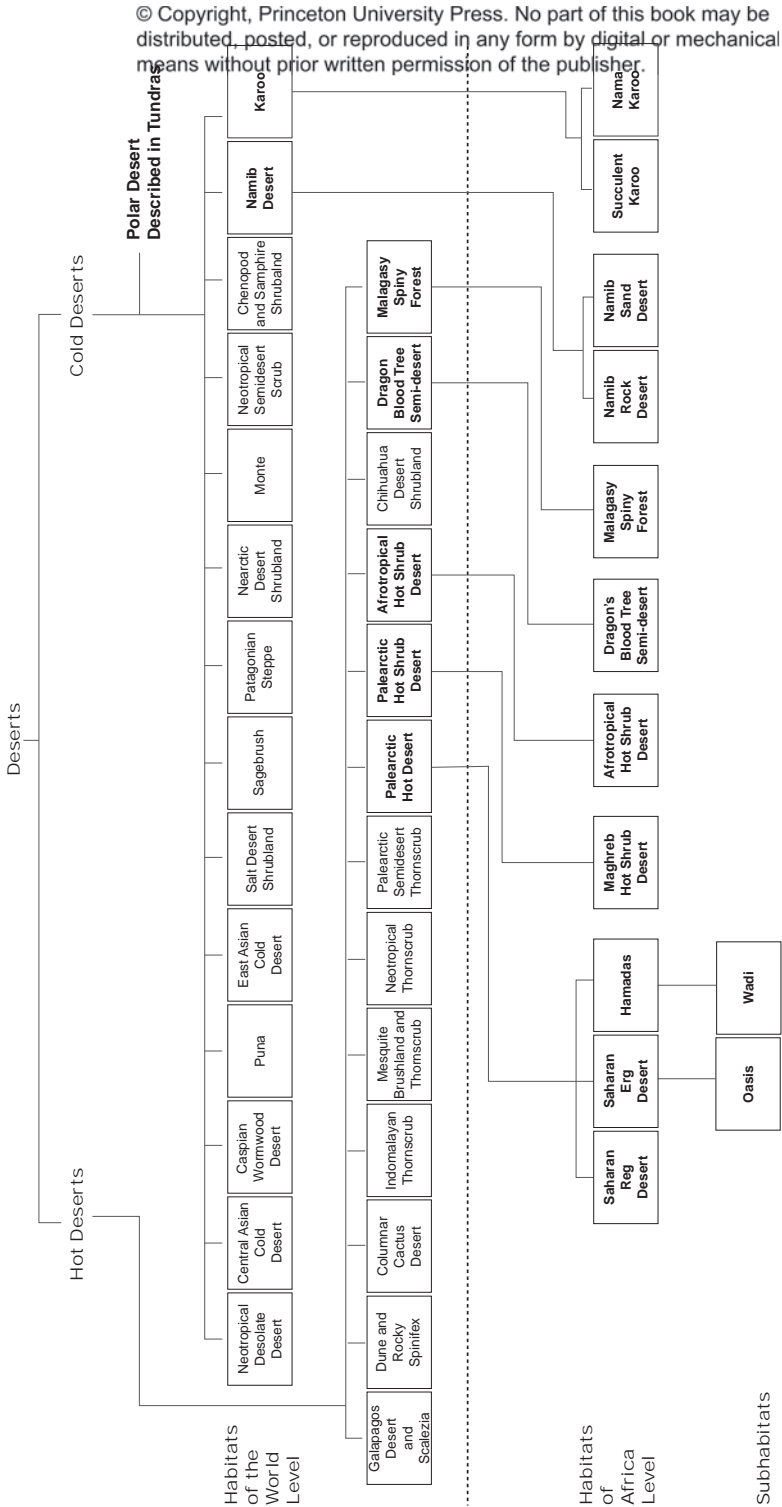
DISTRIBUTION: Maghreb pine habitat occurs widely across North Africa. Planted pine forests, particularly Aleppo Pine, can be found in various parts of Morocco from the coastal areas of Western Sahara right across the North African coastline to Egypt. Natural pine forests are also found on the coast, though are more common in the Middle Atlas and Riff Mountains. They naturally occur in the lower regions from sea level to around 6000 ft. (2000 m). Much of the area is dominated by Aleppo Pine, with tracts of tens of thousands of hectares. On the Canary Islands, pine forest occurs from 4000 to 6200 ft. (1200–1900 m).

WHERE TO SEE: Natural forests around Ifrane National Park, Morocco; planted forests around Tangiers, Morocco; Oran, Algeria; Cap Bon, Tunisia.



African Blue Tit, the “marquee bird” of North African pine forest. © DANIELE ARDIZZONE, FLUYENDO PHOTOGRAPHY

African Deserts Dendrogram



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