

## World Heritage Sites

### Protected Areas and World Heritage



## SOCOTRA ARCHIPELAGO YEMEN

*These isolated and until lately almost inviolate islands lying between three biogeographic regions, African, Oriental and Palaeartic, form a living laboratory which has preserved intact unique endemic ecosystems, a bizarre xerophytic flora and a traditional culture lived in balance with the environment. It lies in a Conservation Hotspot and is a WWF Global 200 Ecoregion, a Centre of Plant Diversity and an Endemic Bird Area.*

### COUNTRY

Yemen

### NAME

Socotra Archipelago

### NATURAL WORLD HERITAGE SITE

2008: Inscribed on the World Heritage List under Natural Criterion x.

### STATEMENT OF OUTSTANDING UNIVERSAL VALUE

The UNESCO World Heritage Committee issued the following Statement of Outstanding Universal Value at the time of inscription:

#### Values

Socotra is globally important for biodiversity conservation because of its exceptionally rich and distinct flora and fauna. 37% of Socotra's plant species, 90% of its reptile species and 95% of its land snail species do not occur anywhere else in the world. Socotra is of particular importance to the Horn of Africa's biodiversity hotspot and, as one of the most biodiversity rich and distinct islands in the world, has been termed the "Galápagos of the Indian Ocean".

**.Criterion (x):** Biological diversity and threatened species: Socotra is globally important for biodiversity conservation because of its exceptional level of biodiversity and endemism in many terrestrial and marine groups of organisms. Socotra is particularly important for its diversity of plants and has 825 plant species of which 307 (37%) are endemic. Socotra has high importance for bird species as underlined by the identification by Birdlife International of 22 Important Bird Areas on Socotra. Socotra also supports globally significant populations of other land and sea birds, including a number of threatened species. Extremely high levels of endemism occur in Socotra's reptiles (34 species, 90% endemism) and land snails (96 species, 95% endemism). The marine life of Socotra is also very diverse, with 253 species of reef-building corals, 730 species of coastal fish and 300 species of crab, lobster and shrimp, and well represented in the property's marine areas.

#### Integrity

The property is of sufficient size to adequately represent all the terrestrial and marine features and processes that are essential for the long term conservation of the archipelago's rich and distinct biodiversity. The terrestrial nature sanctuaries, national parks and areas of special botanical interest included in the property encompass about 75% of the total land area. They protect all the major vegetation types, areas of high floral and faunal values, and important bird areas. The marine nature sanctuaries included in the property encompass the most important elements of marine biodiversity. The property's integrity is further enhanced by terrestrial and marine buffer zones that are not part of the inscribed property.

#### Protection and Management Requirements

All component areas of the property have legal protection; however there is a need to strengthen the legislative framework, and management and enforcement capacity. Whilst the property's terrestrial and marine habitats are generally still in good condition, management planning needs to deal more effectively with current threats including roading, overgrazing and overharvesting of terrestrial and marine natural resources. Potential future threats

include unsustainable tourism and invasive species. Impacts of these threats on Socotra's biodiversity need to be closely monitored and minimized. A sustainable financing strategy is required to ensure the necessary human and financial resources for the long term management of the property. Appropriate linkages need to be developed between the management of the property, its buffer zones and the Socotra Biosphere Reserve.

## INTERNATIONAL DESIGNATIONS

2003: Designated a Biosphere Reserve under the UNESCO Man & Biosphere Programme (2,681,640 ha).

2007: Detwah Lagoon designated a Wetland of International Importance under the Ramsar Convention

## IUCN MANAGEMENT CATEGORY

Unassigned

## BIOGEOGRAPHICAL PROVINCE

Arabian Desert (2.19.7)

## GEOGRAPHICAL LOCATION

The Archipelago lies in the northwest Indian Ocean near the mouth of the Gulf of Aden. Socotra, the largest island, lies 330 km east of Cape Gardafui, Somaliland and 450 km south of the coast of South Yemen at 12°30'00"N by 53°50'00"E; Abd Alkuri, the second largest, lies at 12°11'22"N by 52°14' 21"E.

## DATES AND HISTORY OF ESTABLISHMENT

1996: The Socotra Island Protected Area (362,500 ha) and Socotra Biodiversity Project created;

2000: The Conservation Zoning Plan for the Socotra archipelago endorsed by Presidential Decree 275 which established the National Park and Nature Sanctuaries and the Socotra Archipelago Development Masterplan;

2001: The Socotra Conservation & Development Programme (SCDP) replaced the Biodiversity Project;

2003: Socotra Archipelago created a UNESCO MAB Biosphere Reserve;

2008: Cabinet Decrees Nos.45 to 49 were passed, providing for increased protection for the islands, limiting damage from road building, promoting sustainable ecotourism, reducing the effects of grazing by uncontrolled livestock, and securing funding for a management structure.

## LAND TENURE

The government of Yemen. The area is under the management of the Socotra branch of the Environment Protection Authority (EPA) of the Ministry of Water and Environment. Traditional land use rights are recognised.

## AREA

Core Area: 410,460 ha, Buffer Area: 1.740,958 ha:

	Land Core Area (ha)	Marine Core Area (ha)	Land Core Area (ha)	Marine Core Area (ha)
Socotra	260,008	60,041	91,997	840,325
Abd Alkuri	11,858	4,874	-	456,179
Samha	5,063	26,917	-	243,083
Darsa	544	17,624	-	109,374
Kal Farun (rock)	31	11,072	-	-
Sabunya (rock)	8	12,420	-	-
Total	277,512	132,948	91,997	1,648,961
<b>TOTALS</b>	<b>410,460</b>		<b>1.740,958</b>	

12 terrestrial and 25 marine Nature Sanctuaries, including Areas of Special Botanic Interest, form the core conservation areas. The National Park covers 73% of the land area of Socotra and some 50% of its coasts, and all the land and coasts of the other islands and islets. The buffer zone extends 12 km out from all coastlines.

## ALTITUDE

Below sea level to c.1,526m (Jabal Skand).

## PHYSICAL FEATURES

This 250 km-long archipelago of four islands and two rocky islets appears as a prolongation of the Horn of Africa. The main island of Socotra is 135km long by an average of 33km wide. The areas given in the nomination are: Socotra 3,625km<sup>2</sup>, Abd Alkuri island (33km x 2.5km) is 133 km<sup>2</sup> and Samha, 41km<sup>2</sup>. The islands of Samha and Darsa are known as the Brothers. Socotra Island consists of four main elements: 1) a jagged many-peaked granite mountain range, Jabal Haggeher, which rises to 1,526m in Jabal Skand, steeply on the north side and more gently, with six parallel valleys, on the south; 2) escarpment-edged limestone plateaus 300-700m high, in the east, south-centre and west, overlying earlier basement rocks; 3) coastal plains north and south, the northern a series of smaller fertile basins between headlands, the southern a 60km-long by 6km-wide dry strip backed by a 400m escarpment; and 4) an interior basin of plains west of the Haggeher mountains linked to the northern coastal plain. The coasts are varied: cliffs, wave-cut platforms, fossil reef, cobble beaches, sand beaches and lagoons. Abd Alkuri is a low limestone-capped granite range rising to 743m, with raised beaches on the north and sea cliffs along most of the south side. Samha is a desert platform of limestone surrounded by steep cliffs except at the east end.

Geologically, Socotra is an island of continental origin, a block of preCambrian Gondwanaland. It has an igneous and metamorphic basement of schist and gneiss extensively overlaid by sandstones, marls and limestone deposited in Cretaceous and later Eocene seas, though the preCambrian Haggeher granite was probably never submerged. It lies on an undersea platform block which extends from the tip of Somaliland. The block finally separated from the Arabian plate during the rifting which began to open the Gulf of Aden in the Oligocene to Miocene epochs some 34-23mya. The sea level has risen - a 6m fossil reef edges the south coast - and fallen by 120m during the last Ice Age when Socotra, Samha and Darsa but not Abd Alkuri were connected. The limestones are karstified and have huge solution caverns containing striking speleothems. Only 22km of these have been explored so far.

## CLIMATE

The climate is seasonal, subject to the influence of El Niño, as in the bleaching event of 1998, and dominated by two monsoons governed by the movements of the Intertropical Convergence Zone. From October to April the moist tropical northeast monsoon prevails; October and November are quite wet on the north coast and on north-facing mountain cliffs, often cloud-covered at that time; temperatures are 18°-27°C. From June to September a hot dry sub-equatorial southeast monsoon blows from Africa: tropical cyclones and strong winds up to 110 km/hour create high waves and cause upwelling of cooler nutrient-rich water when the sea temperature falls 2-4°C. Strong hot winds descend from the Haggeher; temperatures range from 30°- 45°C, and dessicating winds strongly influence the vegetation. The average rainfall at sea level is 150mm, (from 2002-4 it was 228mm), but in the mountains may rise to 1000mm. At sea level, dew, and in the highlands, condensation from clouds, may double the measured precipitation. In winter the surrounding seas are subject to the North Equatorial current from the east. In summer circulating currents surround the islands bringing up cool fertile water, but the rough seas make fishing and communication with the outside world very difficult for up to 4 or 5 months.

## VEGETATION

Socotra is a distinct ecoregion of xeric shrubland lying at the intersection of three biogeographic regions, African, Oriental and Palaeartic. Its long isolation has preserved almost intact a unique assemblage of endemic ecosystems and species, relict and adapted, many of which have long disappeared from their Eritreo-Arabian origins. Of its 825 vascular plants and ferns in 430 genera, 307 species (37%) and 15 genera are endemic, forming a living museum of archaic plants, often very local in distribution, which have adapted to the harsh conditions. Within these narrow limits there is great variety, of altitude, bedrock, and humidity; from the speciation which develops in isolation and in island groups, from the adaptations to fill specific niches, and through genetic change. Of the 200 species found in the Haggerher half are endemic; and of 34 species and 15 genera of Acanthaceae, for instance, 24 species and 3 genera are endemic.

The sparse vegetation is dominated by xeromorphic forms such as the conspicuous bottle-trunked desert rose *Adenium obesum* ssp.*sokotranum*, Socotran fig *Dorstenia gigas* and cucumber tree *Dendrosicyos socotranum* (VU). Woods survive the dessicating winds only where sheltered in deep valleys or ravines. The dry limestone plateaus are lightly covered by deciduous shrubs and low woody

herbs; the plains are bare semi-desert with sparse shrub cover or none. Abd Alkuri and Samha have 115-120 species, the first having 12, the second 9 endemics. There are 7 species on Darsa. From antiquity Socotra has been known for its medicinal plants such as bitter aloe *Aloe perryi*, frankincense *Boswellia elongata* (VU), and the dragon's blood tree *Dracaena cinnabari* (VU). This grows relatively thickly on the higher slopes of the limestone plateaus in the centre and east of the island but in general is not regenerating naturally. Its only close relation is the Macaronesian dragon tree *Dracaena draco*.

There are eight main types of vegetation: mangroves, coastal shrubland, *croton* shrubland, succulent shrubland, semi-evergreen lowland woods, woody limestone plateau herbs, submontane shrubs and a montane mosaic of evergreen woodland, grassland and dwarf shrubland. The following table from the nomination summarising the island's vegetation types is adapted from the magisterial *Ethnoflora of the Soqatra Archipelago* by A. Miller and M. Morris (2004) of the Edinburgh Botanic Garden:

Vegetation Types	Sub-types	Altitude	Description	Dominants
Coastal vegetation	Mangroves	Sea level	Sparse mangrove thickets (5m)	<i>Avicennia marina</i>
Coastal vegetation	Vegetation of the coastal plains	Sea level	Mosaic of low succulent shrubs (1.5m), woody-based herb communities (0.5m), & patches of shrubland (3m).	Various, including: <i>Limonium</i> species, <i>Tamarix nilotica</i> , <i>Suaeda</i> species, <i>Atriplex</i> species.
<i>Croton</i> shrubland of lowland plains	Coastal and inland plains; low rolling inland hills.	1-100m	Deciduous shrubland (2.5m) with scattered emergents (5m) and open dwarf shrub layer below. (1m). Heavily grazed cover is dominated by the herbs <i>Cassia holosericea</i> and <i>Tephrosia apollinea</i> .	<i>Croton socotranus</i> ; a species-poor ecotype.
Succulent shrubland	Cliffs and limestone escarpments; rocky slopes; rocky granite and limestone hills; steep wadi sides.	0-150m (-500m)	Open deciduous succulent shrubland (<4m) with emergent trees (<6m) and lower layer (<1m) of cushion vegetation & subshrubs.	<i>Jatropha unicostata</i> and <i>Croton socotranus</i> with <i>Euphorbia arbuscula</i> , <i>Adenium obesum</i> and <i>Teophrosia apollinea</i> .
Semi evergreen woodland of lowland escarpments and sheltered ravines.	Steep limestone escarpments and sheltered parts of limestone plateau & on granite outliers	150-750m	Semi-deciduous thicket (<5m) with emergent trees (<8m).	<i>Rhus thyrsoiflora</i> , <i>Buxanthus pedicellatus</i> , <i>Carphalea obovata</i> , <i>Sterculia africana</i> .
Open and woody-based herb communities of limestone plateau	Limestone plateau	500-750m	Mosaic of woody-based herb communities (<0.5m), cleared grassland and dwarf shrubland (<2m). Some relict woodlands are occasionally found in this zone, typically with <i>Dracaena cinnabari</i> and <i>Boswellia elongata</i> .	<i>Jatropha unicostata</i> , <i>Lycium sokotranum</i> , <i>Gnidia socotrana</i> , <i>Buxanthus pedicellatus</i> , <i>Croton socotranus</i> , <i>Leucas virgata</i> and <i>Cissus hamaderoensis</i> .
Submontane shrubland	Granite mountains, slopes and cliffs.	150-750m	Semi-deciduous shrubland (<5m) with emergent <i>Dracaena</i> (<8m) and cleared grassland.	<i>Dracaena cinnabari</i> , <i>Rhus thyrsoiflora</i> , <i>Euryops arabicus</i> , <i>Buxanthus pedicellatus</i> , <i>Gnidia socotrana</i> and <i>Cocculus balfourii</i> .
Montane mosaic of evergreen woodland, dwarf shrubland, grassland and cushion	Exposed pinnacles, cliff slopes, sheltered ravines and patches of cleared grassland,	950 - 1,000m	Mosaic of dense evergreen woodland & thicket (<5m), patches of dwarf shrubland cleared grassland	<i>Dracaena cinnabari</i> , <i>Rhus thyrsoiflora</i> , <i>Hypericum</i> species, <i>Helichrysum</i> species and <i>Euryops arabicus</i> .

vegetation. all on granite. (<1.5m) and cushion vegetation on exposed summits.

157 plant species are classified as critically endangered, endangered and vulnerable. The three critically endangered plants are *Cadaba insularis*, *Duvaliandra dioscoridis* and *Perlargonium insularis*. Of 15 endangered species, the pretty Samha begonia *Begonia samhaensis* and Abdelkuri euphorbia *Euphorbia abdelkuri* are among the better known. The 138 species classified as vulnerable include all the islands' eight frankincense *Boswellia* species, and both dragon and cucumber trees. The main threats to them are from lowered rainfall due to climate warming, less control over grazing goats than formerly, plant collection, increased felling for construction and the subsequent lopping of formerly neglected trees for fodder. Marine ecosystems are numerous: wadi mouths, salt marshes and coastal lagoons (*khaurs*), cobble, sandy, bouldery and rocky beaches, and silt, sand, rock and coral substrates which support 7-10 species of sea grass and 124 species of macro-algae.

## FAUNA

Because of the dry climate and small size of the islands the terrestrial fauna of the archipelago is not large, except for reptiles, although the avifauna is rich. Marine life is very diverse and the marine habitats are in good condition. The following preliminary species numbers are given in the nomination (amended by Cheung & DeVantier, 2006):

Groups	Number of Species	Endemic Species	Groups	Number of Species	Endemic Species
VERTEBRATES			MARINE LIFE		
Mammals	14		Marine mammals	15	-
Reptiles	34	27	Marine reptiles	4	-
Birds	192	6+10 ssp.	Reef-building corals	253	regional ssp.
Freshwater fish	1	-	Soft corals	30	
Freshwater-adapted fish	44	<5%	Coastal fish	686	<5%
INVERTEBRATES					
Arachnids	~ 40	60%	Marine decapod crustaceans	300	16
Crustaceans	~ 45	high	Inter-tidal molluscs	129	?
Myriapods	~ 15	?			
Insects	~ 600	50%+			
Molluscs	~ 65	95%			

Socotra has so few native mammals that several of their roles are filled by birds, reptiles and arthropods. The livestock of goats, cattle, donkeys and camels are nearly all subtly different forms of imported species, which include the small Indian civet *Viverricula indica*, introduced for its musk which used to be collected for sale abroad. There are four species of bats and two shrews. one the pygmy white-toothed shrew *Suncus etruscus*, the smallest mammal in the world. Among the 34 reptiles the six snakes are endemic; 15 out of 18 geckoes are endemic, as are two skinks, two lizards and a chamaeleon. The only freshwater fish is an introduction. Three-quarters of the terrestrial fauna is composed of the 600 or more insects; these also have a high proportion of the endemism which has led to the archipelago to be called the Galapagos of the Indian Ocean. Over 60 species of butterflies and moths are recorded. Moreover the full extent of the islands' fauna is yet to be known, including the hidden fauna of the vast underground caves.

Of the 192 species of birds, in more than 100 genera, 44 breed on the islands, 85 are regular migrants and 63 are vagrants (Cheung & DeVantier, 2006). The archipelago has the highest number and concentration of several Middle Eastern species outside the Yemen highlands, and is designated an Endemic Bird Area: 22 Important Bird Areas have been identified. Six species are endemic, in order of rarity: Socotra sparrow *Passer insularis*, Socotra sunbird *Nectarinia balfouri*, Socotra warbler *Incana incana*, Socotra starling *Onychognathus frater*, Socotra cisticola *Cisticola haesitatus* (VU), and Socotra bunting *Emberiza socotrana* (VU); 10 subspecies may be endemic. 26 birds have internationally important populations on Socotra. Notable seabirds include osprey *Pandion haliaetus*, the near endemic Jouanin's petrel *Bulweria fallax*, Persian shearwater *Puffinus persicus*, masked booby *Sula dactylatra*, red-billed tropicbird *Phaethon aethereus* and Socotra Cormorant *Phalacrocorax nigrogularis*

(VU). On land there is a large population of Egyptian vultures *Neophron percnopterus* (EN), the islands' scavenger, Socotra buzzard *Buteo socotraensis*, Socotran scops owl *Otis socotranus*, Lichtenstein's sandgrouse *Pterocles lichtensteinii*, cream-coloured courser *Cursorius cursor* and white-browed coucal *Centropus superciliosus*. Greater flamingos *Phoenicopterus ruber* visit the lagoons of the north coast.

Because of its pivotal location, subject to many converging ocean currents and lying between the major endemic populations of the Red and Arabian Seas, the marine life of the archipelago contains many regionally endemic species, often variants on other regional populations. The seasonal upwelling, the variety of habitats and environments and the openness to larvae from many directions all contribute to a marine diversity of international importance. Algal species have even been recorded from Japan and Hawaii. The 283 species of coral are of both African and Arabian species with large populations of some regional endemics. The areas are small, and were affected by the high sea temperatures of 1998 except round the outer islands. They are also in competition with large populations of macroalgae, especially along the nutrient-rich south coast of Socotra. However, they are notably less degraded than most Indian Ocean reefs, and the archipelago itself is a major centre of dispersal and replenishment for the surrounding seas.

The highly productive waters support a wide range of animals: 730 species of fish, counting the 44 freshwater adapted species which colonise the rivers, great hammerhead shark *Sphyrna mokarran* (EN) tiger shark *Galeocerdo cuvier*, marlin *Makaira* spp. and other sailfish, giant manta ray *Manta birostris*, smooth-tail devil ray *Mobula thurstoni* and whale shark *Rhincodon typus* (VU). Many whales cruise the vicinity: blue, sei and Bryde's whales *Balaenoptera musculus* (EN), *B. borealis* (EN), and *B. edeni*, killer, false and pygmy killer whales *Orcinus orca*, *Pseudorca crassidens* and *Feresa alternata*, pilot whale *Globocephala* spp., melonheaded whale *Peponocephala electra*, sperm whale *Physeter macrocephalus* (VU) and dwarf sperm whale *Kogia simus*. There are also at least six dolphin species: long-beaked common *Delphinus capensis*, humpback *Sousa chinensis*, spotted *Stenella attenuata*, spinner *Stenella longirostris*, bottlenose *Tursiops truncatus* and Risso's dolphins *Grampus griseus*. The islands have two breeding species of sea turtle: loggerhead *Caretta caretta* (EN) and green turtle *Chelonia mydas* (EN), and hawksbill *Eretmochelys imbricata* (CR) and olive ridley turtles *Lepidochelys olivacea* (EN) are recorded. 16 species of decapod crustaceans new to science were discovered in 2000, and Socotra is the type locality for two newly discovered species of cuttlefish, *Sepia sokotriensis* and *Sepia mirabilis*.

## CONSERVATION VALUE

This isolated and until recently almost unviolated island lying between three biogeographic regions, African, Oriental and Palaearctic, is a living museum which has preserved intact three unique endemic ecosystems and their species with a traditional culture living in balance with them. It is within a Conservation International-designated Conservation Hotspot, is a WWF Global 200 Eco-region, a WWF/IUCN Centre of Plant Diversity, a BirdLife-designated Endemic Bird Area, is part of a regional protected area network, and overlaps a UNESCO Biosphere Reserve.

## CULTURAL HERITAGE

Though remote, the island lies in the path of seagoing cultures and of the incense trade which was a thriving business in pagan Classical times. It was inhabited in the 6th century BC, known to the Hellenistic Greeks as Dioscorida and to Classical, Arab and Indian merchants for its medicinal bitter aloes, frankincense and dragon's blood. By the first century Hadhrami and Indian settlers had settled there. But as a dry land in a harsh climate with poor harbours it attracted few colonists. In the 3rd century the cave of Hoq was a place of pilgrimage, attested by multi-lingual petroglyphs in pre-Arabian and Ethiopian languages. From the 4th century for at least 1,000 years when Vasco Da Gama's pilot Ibn Majid wrote of it, Socotra was Christian, if increasingly heterodox. In the 9th century it was colonised by Mahri tribesmen from southern Yemen and by the 10th was subject to the Mahri Sultanate of Bani Afrar. The Portuguese occupied Socotra 1507-11 as a post on the way to India, and when the British first occupied it in the late 1830s for the same reason, it was under the rule of the mainland Kathiri Sultanate of Fartak. The British took control in 1876, and in 1886 established a Protectorate which lasted to 1967 after which, till 1994, it was a closed military zone.

The population has long been a mixture of races, the Mahri and Hadhrami strains predominating. As a poor land isolated by the violence of the southeast monsoon for five months of the year, the culture was expert in protecting its resources and balancing its economy in harmony with these, a tradition which still survives though it has started to come under siege. There were marine protected areas with restrictions on fishing gear and seasons, and on land, restrictions on the uses of wood, on rangeland

grazing by rotation and transhumance, and in the care of medicinal plants. Old wall, track and irrigation systems in the west suggest a rain-fed agriculture in a wetter past. Many archaeological remains are yet to be investigated.

### **LOCAL HUMAN POPULATION**

The population of the islands is 44,000, dependent till very recently entirely on fishing - for two-thirds of the year only - herding, palm groves and medicinal plants, all regulated against overgrazing and over-harvesting by tribal elders. A tradition of transhumance still persists among the bedu of the interior. Socotri, their unwritten language, is pre-Islamic, related to Mahri, but is giving way to Arabic. Hadibo on the north coast and smaller Qalansiyya in the northwest are the only towns. The first airport was built near Hadibo in 1999, the first roads followed in 2001, and a new port is planned. The island has since been subject to roads planned and built with a notable lack ecological sensitivity and seaside construction which will disrupt the ecological balance of the past unless controlled.

### **VISITORS AND VISITOR FACILITIES**

Past visitors were few. Before 2000 no tourists are recorded. In 2000 arrivals totalled 140, in 2004, 450 foreigners and 250 Yemenis, by 2005, 1,000, and by 2007, 2,500 (SCDP). Littering and vandalism as has occurred at Hoq cave has followed the first large tourist groups who come mainly for sandy beaches. The Environmental Protection Agency is therefore hoping to develop high quality ecotourism instead: a Socotra Ecotourism Society is already providing tour services. There are few facilities as yet: four hotels in Hadibo and one at the airport, two tourist campsites, and two information centres, at the airport and Hadibo. Training has started of guides, territorial, marine and archaeological, diver guides, drivers and in foreign languages.

### **SCIENTIFIC RESEARCH AND FACILITIES**

The islands are living laboratories of evolution. The first detailed western description was by Wellsted in 1834. The flora has been well researched since 1880-2 when the first British and Austrian (Schweinfurth & Riebeck) expeditions arrived, on the first of which I. Balfour discovered 200 species and 20 genera new to science. In 1895 collections were made by the Bents. In 1898 the Vienna Museum of Natural History sponsored an expedition and a 3-month study was made by Forbes and Ogilvie-Grant. 55 years later, Popov, then Botting (1957) and Boxhall (1967), visited. It was then believed that the flora was already lost to goats and tree-cutting, but in 1982, missions from the University of Aden and in 1985 by Cronk revived scientific interest. In the 1990s, a major multidisciplinary expedition was led from the Royal Botanic Garden, Edinburgh (RBG) and, financed by FAO and UNESCO, a series of detailed studies began.

The Environmental Protection Authority/GEF/UNDP-funded Socotra Biodiversity Project, started in 1997, was succeeded by the Socotra Conservation & Development Programme (SCDP) to which WWF, UNESCO, IUCN, BirdLife International and the International Plant Genetic Resources Institute all contributed support. In 1999 a multidisciplinary zoological and botanical expedition directed by the RBG began systematically to inventory the whole fauna of the archipelago. Investigations into the terrestrial vegetation and people, bird populations and fish and underwater habitats, marine turtle nesting, fishing and meteorology were made by the RBG, BirdLife International, the Senckenberg Institute, Frankfurt and the Universities of Aden and Rostock. A herbarium is being completed. From 2000-2004, exploration of the fauna of the very extensive cave systems began. Between 1998 and 2005 an international team was permanently stationed on the islands and the studies, which greatly increased knowledge of the islands' biodiversity, resulted in the Socotra Conservation Zoning Plan of 2000. Several excellent reports by experts remain unpublished. Except for reptiles, the terrestrial fauna and ecology have been less well studied than the flora, and it is clear that many smaller species remain to be discovered. Monitoring, mapping and description is done of bird populations, meteorological conditions, marine biodiversity, undersea and tidal/subtidal habitats, fishing, turtles and vegetation by plots, transects and key species.

### **MANAGEMENT**

The archipelago is one of the best preserved semi-tropical islands in the world and the integrity of its biodiverse ecology is almost intact, but it is also the poorest region of Yemen, and is being developed as part of the government's drive to alleviate poverty. A UNDP Programme for the Conservation and Sustainable Use of the Biodiversity of the Archipelago provides for the health, education, agriculture and local government of the islands. It is the aim of the Environment Protection Authority (EPA) through the Socotra Conservation and Development Programme (SCDP) to maintain its integrity in the terrestrial and marine protected areas designated by the Conservation Zoning Plan. The core area

nominated includes the existing National Parks and Nature Sanctuaries; the buffer zone includes all Natural Resource Use areas. These zones are: National Parks for protection, perpetuation and appreciation of unique natural characteristics: (72.6% of the total land, and sea 1,514km<sup>2</sup>); Resource Use Reserve for traditional uses of the land: (23.5% of the land, and sea 16,498km<sup>2</sup>); Nature Sanctuary for strict protection (9,500ha / 2.5%, and sea 15,400ha) and General Use Zone for infrastructural development (5,500ha / 1.4% + sea 100ha). An EU sponsored Masterplan was produced in 2001: Phase 1, to inventory 12 major sectors of the economy, Phase 2, to develop selected pilot protected area projects, at DiHamri, Homhil, Detwah lagoon in the northwest, and Skand. The EPA has subsequently developed four detailed management plans and a Nature-Based Tourism Development Program. Several environmental NGOs now also exist to complement its work, notably the Socotra Conservation Fund which raises funds and, with the EPA and SCDP, runs specific projects such as measures to reduce anticipated damage by uncontrolled livestock.

In February 2008, following submission for World Heritage status, five Cabinet Decrees were passed to provide for increased environmental protection (Decree #45), give clear guidelines to limit the damage from road construction (#46), to promote sustainable ecotourism (#47), to reduce damage from uncontrolled livestock (#48) and seek funding for a management structure, 'The Socotra Authority' (#49). The Ministry of Environment and Water is to coordinate this development with four other ministries. Biodiversity studies by the EPA, SCDP, RBG and BirdLife are providing a basis for the updating the roads masterplan (El-Eryani, A. *in.litt.*, 2008). The land is government property but outside Hadibo and Qalansyya its resources are owned by tribal groups that manage them according to long proved customs. The EPA is the best equipped and staffed of all government agencies on the island and maintains a series of programs to monitor biodiversity and educate the local people and tourists about its importance. These studies will provide a database of all the environmental and development data for the archipelago by which to gauge future changes in the status and distribution of species and in key ecosystems (the Decision Support System). But nationally the EPA is a young organisation, and enforcement of its guidelines on the ministries responsible for the island's development is weak. Much training of staff will need to continue for some time in all its protected area development, operation and management. Jordan's Royal Society for Conservation and Galapagos National Park are helping this work. Ultimate success will depend on the creation of the centralised government Authority to coordinate the various and conflicting agencies responsible for the islands' burgeoning development, with much of the conservation funding and expertise still sourced from overseas. The EPA's capacity to continue this successfully will depend on educating, training and winning the support of local people.

A paper prepared by ten experts for the SCDP (Scholte *et al.*, 2008) argues that the landscape and unique vegetation of Socotra have evolved with goats for millennia, and have traditionally been managed sustainably. However, land division, less movement but more transportation of livestock, provision of water, fodder and veterinary care, abandonment of controls on breeding and of walled pastures in the mountains have begun to create overgrazing and overbrowsing. Conservation measures such as botanical exclosures have been trialled; also research into dragon tree and bird populations, monitoring of changes in vegetation and in old management systems, and improved, or reinstated, traditional herding techniques. The authors' argument is that it is not grazing pressure but reduced grazing management which is beginning to degrade the environment.

## MANAGEMENT CONSTRAINTS

Unless controlled, the coming developments, at a time of warming climate, are bound to damage or destroy some of the unique habitats of the island by over-exploitation, with a consequent loss of species. Other threats are invasion by alien pests such as the Mexican poppy *Argemone mexicana* and the aggressive Indian house crow *Corvus splendens*; also erosion, pollution by wastes, over-extraction of water, and coastal land speculation. The traditions of rural conservation may be lost as people move to the towns. Infrastructure developments by other ministries and the profitable mass tourism promoted to investors by the Yemeni General Tourism Development Authority, may not have the benign effect on the environment of the ecotourism preferred by the Environmental Protection Agency. Quarrying, dumping and drastic excavating for roads have prompted calls for Environmental Impact Assessment and mitigation. Rare plants such as cucumber trees have been threatened by two recent trends. Increased prosperity has led to the building of houses to replace caves and the consequent overcutting of trees suitable for construction, resulting in less suitable species being lopped for fodder. The unprecedented failure of the summer rains in 1999 after several good years when numbers of livestock increased, also led to great pressure on rare trees and on less accessible rare plants searched out by unattended goats. Threats continue from lowered rainfall due to climate warming, from plant and coral collection, and the abandonment of controls on overgrazing. There is pressure on artisanal fishing from

larger boats and international fishing fleets. Fishing with bottom nets and dynamite are being resorted to, and customary regulations no longer control the fishery as they once did.

## COMPARISON WITH SIMILAR SITES

The main bases for comparison with similar existing World Heritage reef sites are:

- The range of habitats it provides for a wide marine, avian, reptilian and above all floristic diversity especially of rare xerophytes which exist nowhere else in such a variety of extraordinary forms;
- The adaptations to the climatic and altitudinal conditions of this vulnerable range of endemic species in a continuum of ecosystems which combines elements from three biogeographic regions developed in long isolation from other influences;
- A still intact example of a tradition of adaptations by human tribespeople to the same conditions;
- An opportunity for scientific discovery, research and education which can provide a model for the development of protected areas in the rest of the country.

In addition to its exceptional biodiversity and flora, Socotra is fairly unusual for the Middle East in having scenic high wild mountains so near to the sea. However, comparable island groups exist, as shown in this table from the nomination of comparative botanical endemism in oceanic islands, ranged by percentage:

Islands	Area (km <sup>2</sup> )	Number of Plant Species	Number of Endemics	% Endemic
Juan Fernandez	93	147	118	80
Ascension	94	25	11	44
Galapagos	7,844	543	229	42
<b>Socotra</b>	<b>3,799</b>	<b>825</b>	<b>307</b>	<b>37</b>
Mauritius	1,865	800-900	280	31-35
Rodriguez	104	145	48	33
Canary	7,273	2000	569	28
Norfolk	13	174	48	28
Madeira	769	760	760	17
St Helena	121	320	49	15
Cape Verde	4,033	724	65	11.1
Azores	2,235	(spermatophyte) 600	55	9

This compares sites in differing biomes, of differing areas, character, and degrees of development and investigation, and only the Galapagos is already a World Heritage site. Of these there is a wide range though again few sites are strictly comparable with Socotra. The volcanic Hawaiian Islands (16,615 sq.km) have an overall endemism of 89%. New Caledonia, another island of continental geologic origin, not yet designated, also has far higher endemism of 75%, and Coiba, off Panama has 43%, all higher than the figure quoted for Socotra. But these are all so different in character and in degree of development, as to make comparison difficult. Socotra is *sui generis* and deserves consideration on its own merits. It has also been very expertly studied for some years and provides a useful model for future sites on the Arabian peninsula. Though its marine and avian resources are rich, the chief grounds for comparison are botanical.

## STAFF

Socotra is Yemen's first Protected Area. From 1997 2-4 permanent UN advisors plus many specialist advisors supported the initial work when the Socotra branch of the Environmental Protection Authority employed only 4 staff. In 2008 it has 51 staff with a few more in Sana'a, funded by GEF and the EU via the Dutch and Italian governments which also contribute training programs (El-Eryani, A. *In litt.*, 2008). There are 17 technical and management staff at the Hadibo and Qalansiyya offices, with extension officers, meteorologists and support staff.

## BUDGET

Annual Government funding for the Socotra branch of the Environmental Protection Authority increased from US\$360 in 1997 to US\$171,000 in 2008. Between 1997 and 2001 US\$5million came from the

GEF and UNDP; in 2001-3 US\$1,350,000 came from the Netherlands government and UNDP; and for the period 2003-2009, US\$5.5million came from the governments of the Yemen, Italy and the UNDP. Increased funding to meet the long-term needs for maintaining a World Heritage site is being sought through the UN-led Socotra Conservation & Development Programme and the GEF. Starting in 2009, entry fees for non-resident visitors and fines for violations of environmental laws will be levied. GEF is preparing a US\$2.7million five-year project to improve governance and protection with US\$1million each from GEF and UNDP plus 0.7million from the Government. The French government is to grant €200,000 (US\$300,000) towards establishing the central administrative authority, and FFEM/France is to contribute €1million (US\$1.5million) for projects for marine conservation and sustainable fisheries. An internationally supported endowment fund is also being sought. Donors through the Socotra Conservation Fund also raise specific project funds (El-Eryani, A., *in litt.*, 2008).

## LOCAL ADDRESSES

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## REFERENCES

The principal sources for the above information were the original nomination for World Heritage status and Cheung & DeVantier.

Apel, M. & Hariri K.(eds), (2001). *Conservation and Sustainable Use of the Biodiversity of Soqatra Archipelago. Marine Habitat, Biodiversity and Fisheries Management. Progress Report of Phase III.* Senkenberg Research Institute, Frankfurt a.M. Germany. Report for SCDP/EPA, Sana'a, Yemen, 191pp. (Unpublished)

Attore, F.*et al.* (2007). Will dragonblood survive the next period of climatic change? Current and future potential distribution of *Dracaena cinnabari* (Socotra, Yemen). *Biol. Conserv.* 138: 430-439.

Beydoun, Z.& Bichan, H. (1970). *The Geology of Soqatra Island, Gulf Of Aden.*

Botting, D. (1958). *The Island of the Dragon's Blood.* Hodder & Stoughton, London. 251 pp.

Caruso, M. (2006). *Socotra Archipelago. Proposal for Inclusion in the World Heritage List.* Socotra Conservation and Development Programme, Environment Protection Authority. Ministry of Water and Environment, Sana'a, Yemen. [Contains a bibliography of 74 references]

Cheung, C. & DeVantier, L. with Van Damme, K.(2006). *Sokotra. A Natural History of the Islands and their People.* Odyssey Books, Hong Kong. 408 pp.

Devantier, L.*et al.* (2004). Reef-building corals and coral communities of the Socotra Islands, Yemen: A zoogeographic 'crossroads' in the Arabian Sea. *Fauna of Arabia*, 20: 117-168.

Di Micco De Santo, T. & Zandri, E. (2004). Main features of the Socotra Archipelago and ongoing conservation efforts. *Fauna of Arabia*, 20: 1-19.

Doe, B.(1992). *Soqotra: Island of Tranquillity.* 81 plates. Immel Publishing Ltd, London. 219 pp.

El-Eryani, A. (2008). *Clarifications re the IUCN Evaluation Socotra Archipelago (Yemen) Nominated for Inclusion on the World Heritage List.*. Letter to IUCN and UNESCO from the Minister of Water and Environment.

Evans, M. (2000). *Royal Botanic Gardens of Edinburgh, UK. Multidisciplinary Expedition Final Report - Zoology.* UNDP/GEF/EPA Project Report, Sana'a, Yemen. (Unpublished)

Fleitmann, D. *et al.* (2004). Geology and Quaternary climate history of Socotra. *Fauna of Arabia*, 20: 27-43.

Forbes, H.O. (1903). Natural history of Soqotra and Abd-El-Kuri. *Bull.Liverpool Mus.* (Spec. Bull.): 1-598, Liverpool.

Hariri, K. & Krupp, F. (eds). *Conservation and Sustainable Use of Biodiversity of Socotra Archipelago - Marine Habitat, Biodiversity and Fisheries Surveys and Management. Final Report, Phase III* Senckenberg Research Institute & Natural History Museum, Frankfurt a.M, Germany.

IUCN (2008). *The Red List of Threatened Species*. IUCN, Gland, Switzerland / Cambridge, U.K.

Klaus, R. & Turner, J. (2004). The marine biotopes of the Socotra Archipelago. *Fauna of Arabia*, 20: 45-115.

Klaus, R., Turner, J. & West, F. (2002a). *Sublittoral and Littoral Biotope Manual for the Socotra Archipelago*. Report for the Senckenberg Research Institute, Frankfurt a.M. Germany. 221 pp. (Unpublished)

----- (2002b). The marine biotopes of the Socotra Island group. In Hariri, K. & Krupp, F. (eds) (2002). *Conservation and Sustainable Use of Biodiversity of Socotra Archipelago - Marine Habitat, Biodiversity and Fisheries Surveys and Management. Final Report of Phase III*. Senckenberg Research Institute, Frankfurt a.M, Germany.

Krupp, F. & Hariri, K. (eds) (1999). *Conservation and sustainable use of the biodiversity of Soqotra Archipelago. Marine habitat, biodiversity and fisheries management. Progress Report of Phase I*. Senckenberg Research Institute, Frankfurt a-Main, Germany. Report for UNDP-GEF-EPA. 212 pp. (Unpublished)

Kurshner, H. *et al.* (2006). Diversity and zonation of the forests and woodlands of the mountains of northern Socotra, Yemen. *Englera* 28: 11-43

Mies, B. & Beyhl, F. (1996). The vegetation ecology of Socotra. In Dumont, H. (ed.) *Proceedings of the First International Symposium on Soqotra Island: Present And Future*. Pp. 35-81.

Miller, A., Boulos, L. & Mill, R. (1994). Regional Overview: South West Asia and the Middle East. In Davis, S. *et al.* (eds) *Centres of Plant Diversity - A Guide and Strategy for their Conservation*. Pp. 239-248. WWF & IUCN, Cambridge U.K.

Miller, A & Morris, M. (2000). *Conservation and Sustainable Use of the Biodiversity of the Soqotra Archipelago. Final Report: Target Areas*. Report to GEF/UNOPS program YEM/96/G32. 349 pp. + xxiv.

----- & Atkinson, R. (2003). Conservation on Soqotra: ravaging goats or climatic change. *Proceedings of the Yemeni Scientific Research Foundation, Science Conference 2002*. Pp. 173-182.

Miller, A. & Morris, M. (2004). *Ethnoflora of the Soqotra Archipelago*. Royal Botanic Garden, Edinburgh, Scotland. 759 pp.

Naumkin, V. (1993). *Island of the Phoenix: An Ethnographic Study of the People of Soqotra*. Vol.16: *Yemen*, Middle East Cultures Series, Reading: Ithaca Press, Reading, U.S.A. 421 pp.

Porter, R. & Stone, F. (1996). An introduction to Soqotra and its birds. *Sandgrouse* 17:73-80. *Quarterly Journal of the Geological Society of London* 125(3): 413-46.

Randall, J. (1996). *Coastal Fishes of Oman*. Crawford House, Australia. 439 pp.

Roesler, H. & Wranik W. (2004). A key and annotated checklist to the reptiles of the Socotra Archipelago. *Fauna of Arabia*, 20: 505-533.

Royal Botanic Garden Edinburgh (n.d.). *Socotra Bibliography*. 115 pp. [Contains 683 references]

Schils, T. & Coppejans, E. (2003). Phytogeography of upwelling areas in the Arabian Sea. *Journal of Biogeography*, 30: 1339-1356.

Senckenberg Research Institute, (1999). *Marine Biotopes Classification Manual*. Report for SCDP/EPA, Sana'a, Yemen. (Unpublished).

----- (2000a). *Marine Habitat, Biodiversity and Fisheries Surveys and Management (Progress Report of Phase II)*. Report for SCDP/EPA, Sana'a, Yemen. (Unpublished).

Scholte, P. *et al.* (2008). *Goats: Part of the Problem or the Solution to Biodiversity Conservation on Socotra?* Socotra Conservation and Development Programme. Hadibo, Socotra, Yemen.

Stein, L. (1996). Traditional forms of housing and economical life in Soqotra. In Dumont, H. (ed.) *Proceedings of the First International Symposium on Soqotra Island: Present and Future*. United Nations Publications, New York. Pp. 271-284.

Wranik, W. (2003). *Fauna of the Socotra Archipelago-Field Guide*. with contributions from Al-Saghier, O., Aspinall, S., Porter, R. & Roesler, H.. Konrad Reich Verlag, Germany. 542 pp.

W S Atkins International (2001). *Socotra Archipelago Master Plan (SAMP). Phase I Final Reports*. EU Project. Sana'a, Yemen.

----- (2002). *Socotra Archipelago Master Plan (SAMP). Phase II Final Reports*. EU Project. Sana'a, Yemen.

Zajonz, U. & Khalaf, M. (2002). Inshore fishes of the Socotra Archipelago. In Hariri, K. & Krupp, F. (eds). *Conservation And Sustainable Use of Biodiversity of Socotra Archipelago - Marine Habitat, Biodiversity and Fisheries Surveys and Management . Final Report, Phase III*, Senckenberg Research Institute & Natural History Museum, Frankfurt a.M, Germany.

#### **DATE**

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