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Review

Turkey's globally important biodiversity in crisis

Çağan H. Şekercioğlu^{a,b,*}, Sean Anderson^c, Erol Akçay^d, Raşit Bilgin^e, Özgün Emre Can^f, Gürkan Semiz^g, Çağatay Tavşanoğlu^h, Mehmet Baki Yokeşⁱ, Anil Soyumert^h, Kahraman İpekdağ^j, İsmail K. Sağlam^k, Mustafa Yücel^l, H. Nüzhet Dalfes^m

^a Department of Biology, University of Utah, 257 South 1400 East, Salt Lake City, UT 84112-0840, USA

^b KuzeyDoğa Derneği, İsmail Aytemiz Caddesi 161/2, 36200 Kars, Turkey

^c Environmental Science and Resource Management Program, 1 University Drive, California State University Channel Islands, Camarillo, CA 93012, USA

^d National Institute for Mathematical and Biological Synthesis (NIMBioS), University of Tennessee, 1534 White Ave., Suite 400, Knoxville, TN 37996, USA

^e Institute of Environmental Sciences, Boğaziçi University, 34342 Bebek, İstanbul, Turkey

^f WildCRU, Department of Zoology, University of Oxford, Recanati-Kaplan Centre, Tubney House, Abingdon Road, Tubney, OXON.OX13 5QL, Oxford, UK

^g Department of Biology, Pamukkale University, Kınıklı Campus, 20017 Kınıklı, Denizli, Turkey

^h Division of Ecology, Department of Biology, Hacettepe University, 06800 Beytepe, Ankara, Turkey

ⁱ Department of Molecular Biology and Genetics, Haliç University, Sıracevizler Cd. No: 29, 34381 Bomonti, İstanbul, Turkey

^j Department of Biology, Ahi Evran University, Aşık Paşa Kampüsü, Kırşehir, Turkey

^k Ecological Sciences Research Laboratories, Department of Biology, Hacettepe University, 06800 Beytepe, Ankara, Turkey

^l Université Pierre et Marie Curie – Paris 6, Observatoire Océanologique, 66650 Banyuls-sur-mer, France

^m Eurasia Institute of Earth Sciences, İstanbul Technical University, 34469 Sarıyer, İstanbul, Turkey

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ABSTRACT

Turkey (Türkiye) lies at the nexus of Europe, the Middle East, Central Asia and Africa. Turkey's location, mountains, and its encirclement by three seas have resulted in high terrestrial, fresh water, and marine biodiversity. Most of Turkey's land area is covered by one of three biodiversity hotspots (Caucasus, Irano-Anatolian, and Mediterranean). Of over 9000 known native vascular plant species, one third are endemic. However, our scientific knowledge of Turkey's biodiversity and associated conservation challenges is insufficient, mainly due to limited research and language barriers. Addressing this gap is increasingly relevant as Turkey's biodiversity faces severe and growing threats, especially from government and business interests. Turkey ranks 140th out of 163 countries in biodiversity and habitat conservation. Millennia of human activities have dramatically changed the original land and sea ecosystems of Anatolia, one of the earliest loci of human civilization. Nevertheless, the greatest threats to biodiversity have occurred since 1950, particularly in the past decade. Although Turkey's total forest area increased by 5.9% since 1973, endemic-rich Mediterranean maquis, grasslands, coastal areas, wetlands, and rivers are disappearing, while overgrazing and rampant erosion degrade steppes and rangelands. The current "developmentalist obsession", particularly regarding water use, threatens to eliminate much of what remains, while forcing large-scale migration from rural areas to the cities. According to current plans, Turkey's rivers and streams will be dammed with almost 4000 dams, diversions, and hydroelectric power plants for power, irrigation, and drinking water by 2023. Unchecked urbanization, dam construction, draining of wetlands, poaching, and excessive irrigation are the most widespread threats to biodiversity. This paper aims to survey what is known about Turkey's biodiversity, to identify the areas where research is needed, and to identify and address the conservation challenges that Turkey faces today. Preserving Turkey's remaining biodiversity will necessitate immediate action, international attention, greater support for Turkey's developing conservation capacity, and the expansion of a nascent Turkish conservation ethic.

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Abbreviations: ha, hectare; GDF, General Directorate of Forestry; GDNCNP, General Directorate of Nature Conservation and National Parks; HEPP, hydroelectric power plant; IUCN, International Union for Conservation of Nature; MEF, Ministry of Environment and Forestry; MPA, Marine Protected Area; NGO, non-governmental organization; PA, protected area; SİT site, a strictly protected area.

* Corresponding author at: Department of Biology, University of Utah, 257 South 1400 East, Salt Lake City, UT 84112-0840, USA. Tel.: +1 801 585 1052.

E-mail address: c.s@utah.edu (Ç.H. Şekercioğlu).

1. Introduction

Turkey is the only country covered almost entirely by three of the world's 34 biodiversity hotspots: the Caucasus, Irano-Anatolian, and Mediterranean (Mittermeier et al., 2005; Conservation International, 2005). Turkey has a diverse ecology (Fig. 1) and is estimated to host around 10,000 plant species (Adil Güner, pers.

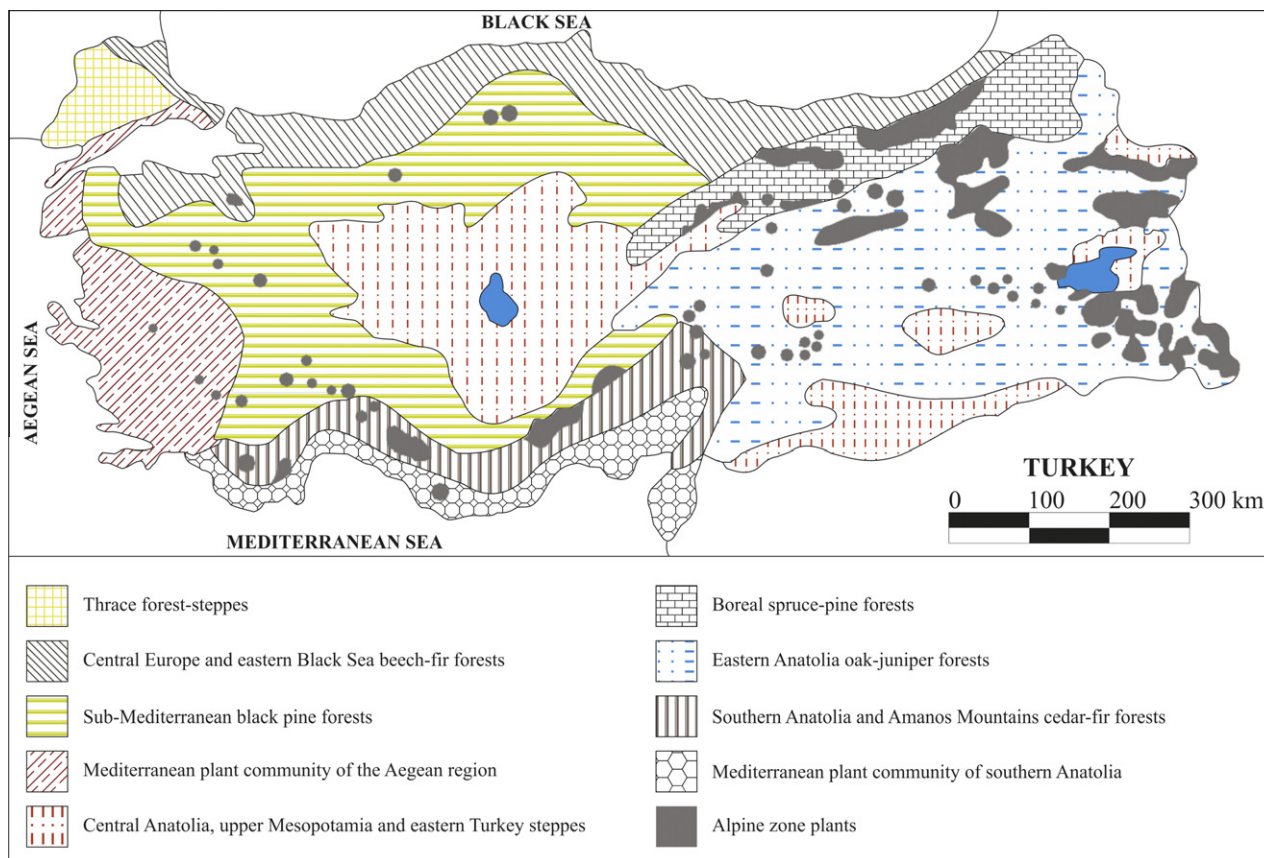


Fig. 1. Map of Turkey's "original" vegetation cover (Based on Altan, 1993).

comm.) and 80,000 animal species (Demirsoy, 2002). With a current population of 75 million (1.1% of the world population), Turkey is a sizeable country¹ (783,562 km²) seated at the crossroads of civilization, with a rich cultural history and an archeological record extending to the Paleolithic era (Joukowsky and Blackburn, 1996). Although Turkey is the world's 15th largest economy (World Bank, 2011), it is still in many respects a developing country, ranking 77th out of 163 countries in the 2010 Environmental Performance Index and 140th in biodiversity and habitat conservation (Yale Center for Environmental Law and Policy, 2010).

The history of Turkey's conservation problems is as old as the history of civilization. As part of the *Fertile Crescent*, Turkey hosted some of the earliest human settlements (see Fig. 2 for all localities mentioned in the text), such as Çatalhöyük (Roberts and Rosen, 2009) and Göbeklitepe (Mann, 2011). Despite a 10,000-year history of often intense natural resource exploitation and human land use (settlements, hunting, logging, burning, agriculture, water extraction, habitat loss, etc.), Turkey has retained an astonishing amount of biodiversity for a temperate country of its size (Kışlalioğlu and Berkes, 1987), is a center of genetic diversity (Bilgin, 2011), and has a rich heritage of traditional knowledge of biocultural diversity. Nevertheless, Turkey lacks the biological "charisma" of many tropical countries and suffers from the international misconception that, as a European nation (though not a part of the European Union), it must have adequate funds and priorities to support conservation. These factors, combined with the Turkish public's general

disinterest in conservation (Kalaycıoğlu and Çarkoğlu, 2011) and the government's unrelenting "developmentalist obsession" (Aktar, 2011a,b,c; Şenerdem, 2011a), have created a conservation crisis which began in the 1950s and has peaked in the past decade (Gibbons and Moore, 2011). Turkey is entirely covered by crisis ecoregions, most of them critically endangered (Fig. 4 in Hoekstra et al., 2005). Consequently, there is an urgent need to summarize Turkey's important but overlooked biodiversity and highlight the country's unique conservation challenges.

In this paper, we review Turkey's habitats and ecological communities, summarize the diversity of the major taxonomic groups, and highlight specific conservation issues. We conclude with an overview of Turkey's current and future conservation challenges. We reviewed the *Web of Science*TM for papers on Turkey's biodiversity and its conservation, also drawing upon the Turkish literature, including books, reports, and gray literature not accessible to the international scientific community. Due to the rapidly evolving state of environmental conservation in Turkey, some of the issues covered in this paper arose as recently as September 2011, and have not been addressed in the scientific literature. Consequently, we also cite recent news reports and scientists' statements published in the media. In July 2011, the Ministry of Environment and Forestry (MEF), frequently mentioned in this paper, was divided into the Ministry of Environment and Urban Planning and the Ministry of Forestry and Water Works. The former Minister of Environment and Forestry became the Minister of Forestry and Water Works, and he will continue to oversee forestry, dams, nature conservation, and protected areas. The former head of TOKI, the government's mass housing administration became the Minister of Environment and Urban Planning (Hattam, 2011).

¹ Turkey is broken into two geographic regions by the Bosphorus and Dardanelles straits. The smaller region on continental Europe is known as Thrace. The remainder (97% of the county's land area) resides in Asia Minor and is known as Anatolia. For most practical purposes "Anatolia" and "Turkey" can be used interchangeably.

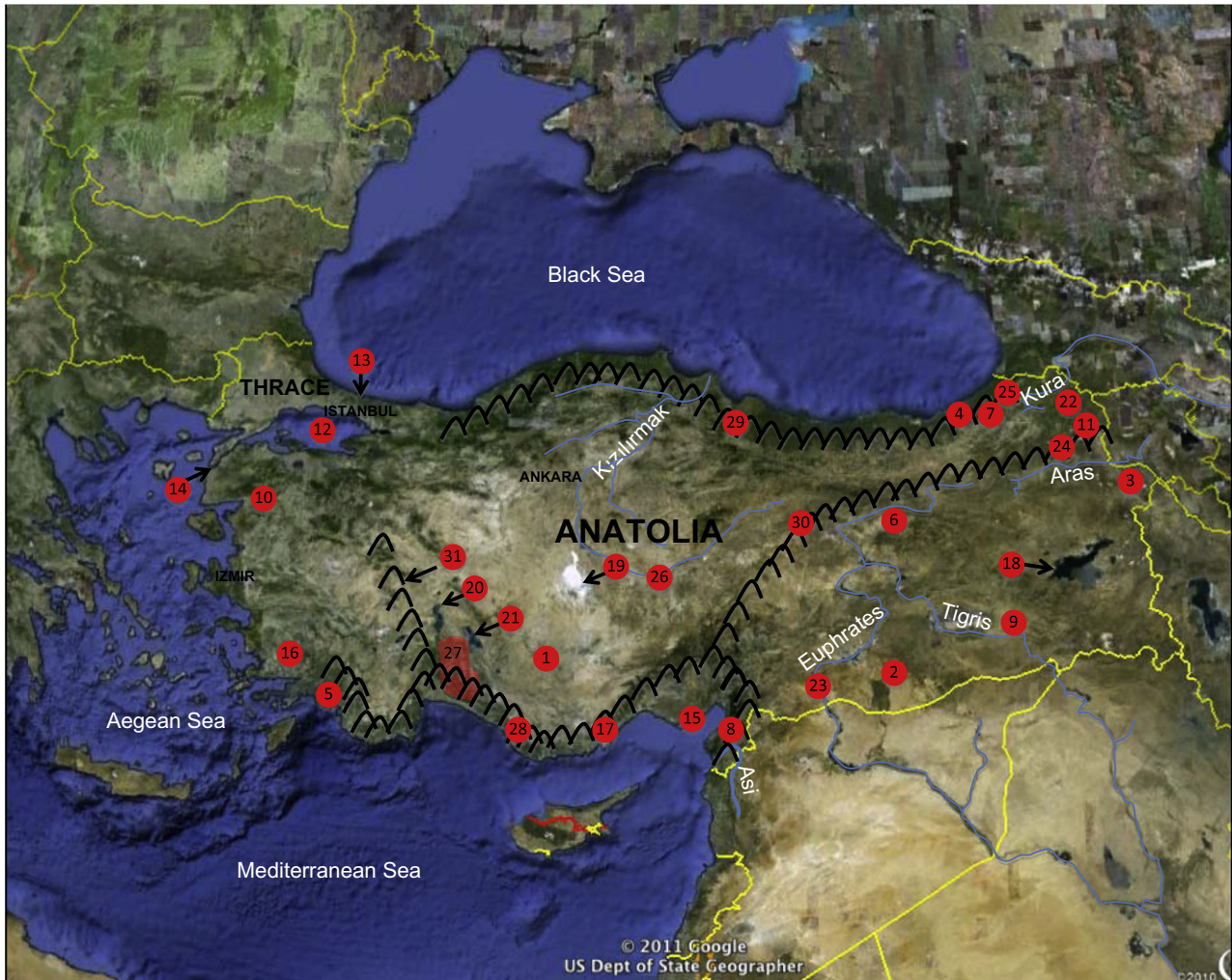


Fig. 2. Map of the localities in the order they were mentioned in the text. Nearby localities are given the same number. 1 – Çatalhöyük; 2 – Göbeklitepe; 3 – Iğdır and Mount Ağrı; 4 – Rize and İkizdere Valley; 5 – Mount Sandras; 6 – Mount Munzur; 7 – Mount Kaçkar; 8 – Amanos Mountains and locality of mountain gazelle (*Gazella gazella*); 9 – Hasankeyf; 10 – Havran; 11 – Lake Kuyucuk and Ani; 12 – Marmara Sea; 13 – Bosphorus Strait; 14 – Dardanelles Strait; 15 – Yumurtaşlık Bay, Akyatan, Ağyatan and Tuzla; 16 – Yatağan; 17 – Akkuyu; 18 – Lake Van; 19 – Lake Tuz; 20 – Lake Eğirdir; 21 – Lake Beyşehir; 22 – Lake Çıldır; 23 – Birecik; 24 – Sarıkamış Forest-Allahuekber Mountains National Park; 25 – Borçka Pass; 26 – Cappadocia; 27 – The distribution of Taurus ground squirrel (*Spermophilus taurensis*); 28 – Toros Mountains; 29 – Northern Anatolian Mountains; 30 – The Anatolian Diagonal; 31 – Western Anatolian Mountains.

2. Climate

Turkey's unique tectonic history and its location between the temperate and subtropical regions at the convergence of three continents have created a variety of climates, ecosystems, and habitats within a relatively limited area (35–42°N and 25–45°E). Although a Mediterranean climate regime dominates an important section of the country (Csa in the Köppen-Geiger classification system; Kottek et al., 2006), the range of represented climates includes maritime temperate (Cfb), warm summer continental (Dfb), and a large steppe climate (BSk) regions. Turkey's average yearly rainfall is 641 mm (TSMS, 2011), but precipitation varies greatly by location (Fig. 2), from nearly 100 mm in eastern Iğdır (in 1970) to 2700 mm in northeastern Rize (in 1988). In Rize, the cultivation of 5.2% of the world's tea (*Camellia sinensis*) output at the plant's northern limit (FAO, 2010) and the presence of temperate rainforest is indicative of the wet subtropical climate of northeastern Turkey.

2.1. Climate change

Since the Industrial Revolution, Turkey's CO₂ emissions constituted 0.4% of the global emissions, and Turkey promised a 9%

reduction in its greenhouse gases by the end of 2012 (Anadolu Ajansı, 2010). However, Turkey's CO₂ emissions increased by 98% between 1990 and 2009 (TUIK, 2011). Moreover, 72% of Turkey's energy consumption is based on fossil fuels and Turkey is expected to double its energy use by 2020 (Kaygusuz, 2011). The increase in forest cover in the past three decades (see below), a favorable development for CO₂ sequestration, is counterbalanced by the loss of 1.3 million ha of wetlands since 1950 (Nivet and Frazier, 2004), combined with grassland losses and the degradation of rangelands.

Climate records dating from the 1950s indicate that winter temperatures have decreased along the Black Sea coast since 1951, but summer temperatures have increased in the western and southeastern regions (Tayanç et al., 2009). Since the 1960s, heat wave intensity, length, and number have increased six to sevenfold (Kuglitsch et al., 2010). Autumn precipitation has increased in the interior and winter precipitation has declined in the more populated west. Turkey's highest mountain, 5137-m Mt. Ağrı (Fig. 2), has lost 30% of its glaciers since 1976, an average of 7 ha per year (Sarıkaya and Bishop, 2010).

Turkey is expected to experience a temperature increase of 0.5–1.5 °C over the next 30 years, depending on the global model

considered (Dalfes et al., 2010). Dynamic downscaling of the output of several global climate models considered in the AR4 report of the Intergovernmental Panel on Climate Change (IPCC, 2007) suggests a geographically variable response. Winter precipitation (the main precipitation period for most of the region) is projected to increase generally, but may decrease along the Mediterranean coast (Dalfes et al., 2010). This spatial variation must be taken into account when planning for conservation in the face of climate change. For example, drier winters along the Mediterranean coast might increase stress on freshwater ecosystems. Ultimately, an ecoregional analysis is needed to identify the areas of particular concern in relation to climate change. The boundaries of protected areas (PAs) must be reconsidered in light of the climate-related vegetation and habitat shifts.

Because of its landscape diversity, Turkey is relatively well-positioned for buffering the effects of climate change on biodiversity. Climatic diversity and refugia created by the mountainous terrain enabled plant species to persist during the past glacial periods (Médail and Diadema, 2009). These refugia (Bilgin, 2011), which form the core of existing biodiversity hotspots, will be crucial during rapid climate change (IPCC, 2007). However, Turkey's PAs, not designed with climate change in mind, are generally surrounded by agriculture and human settlements, and are isolated from each other. Organisms' responses to climate change will be mostly idiosyncratic and heavily dependent upon individual species' ability to disperse across Turkey's increasingly fragmented landscape matrix. For instance, climate envelope model analyses of eastern Mediterranean bats suggest a general decrease in diversity by 2080 (Keşişoğlu, 2010), whereas a similar analysis of Turkey's resident birds suggests distributional shifts among different regions, but no significant decrease in diversity (Abolafya, 2011).

3. Vegetation communities and habitats

Turkey's prominent orographic features and various climatic regions are deeply interwoven. Along with three overlapping phytogeographical regions, the presence of glacial refugia, and a wide elevational range (sea level to 5137 m), this diverse topography has produced various macro- and microclimates and vegetation types (Atalay, 1994). Major ecological communities include forest, shrubland, grassland, mountain, river, wetland, coastal, and marine pelagic ecosystems, all of which currently face significant conservation challenges.

3.1. Forests

Turkey's temperate forests, originally covering most of the country (Fig. 1), now cover 27.3% (21.4 million ha), consisting of coniferous (60.8% of total forested area) and broad-leaved deciduous (39.2%) forests (GDF, 2009). Coniferous forests around the Mediterranean (*Pinus brutia*, *Pinus nigra*, *Abies cilicica*, *Cedrus libani*) range from sea level to 2000 m, while Black Sea region conifers (*Pinus sylvestris*, *Pinus orientalis*, *Abies nordmanniana*) are found primarily between 1000 and 1200 m, but occasionally as high as 2000 m (Atalay, 2006). Broad-leaved deciduous forests (*Castanea*, *Carpinus*, *Tilia*, *Alnus*, and *Acer* species) prevail at lower elevations across the Anatolian plain. Two Tertiary relict endemic species in Turkey's southwest, the Turkish sweetgum (*Liquidambar orientalis*) and the Near Threatened Cretan date palm (*Phoenix theophrasti*), are of high conservation concern. Between 1973 and 2009, Turkey's total forest area increased by 5.9% (GDF, 2009), but erosion, illegal logging, fires, residential development, agriculture, pollution, and introduced species remain important threats (Kaya and Raynal, 2001; Güneş and Elvan, 2005).

3.1.1. Key conservation challenge: forest fires

Anatolia has been contested territory for millennia, with lands often burned during conflicts. Examples range from when the Assyrians "[set] fire to forests as thick as reedbeds" (Akin, 2006) between 900 and 600 BCE, to when the Greek armies burned pine forests during their retreat after the Turkish War of Independence in 1922 (Günay, 2003). Fire continues to be an important natural and human-induced disturbance. Every year, an average of 1900 fires burn 11,500 ha of forest in Turkey, although this average has declined over the past several decades (GDF, 2009) as a result of intense fire prevention and suppression efforts by the Ministry of Environment and Forestry (MEF). High fire intensity and return rates drive ubiquitous post-fire soil erosion and plant community shifts (Pausas et al., 2008). However, fire-adapted traits of the Mediterranean flora (Paula et al., 2009) allow natural post-fire regeneration (Boydak et al., 2006; Tavşanoğlu and Gürkan, 2009). The General Directorate of Forestry (GDF) also replants burned areas in the Mediterranean region with *Pinus brutia* (Turkish pine; Gezer, 1986). Post-fire rehabilitation and management should be conducted carefully to allow maximum natural regeneration and minimum artificial reforestation.

3.1.2. Key conservation challenge: deforestation and the 2/B lands

During much of Turkey's history, forests were unregulated, leading to a "tragedy of the commons" (*sensu* Hardin, 1968). Beginning in the Bronze Age, massive forest clearing and other practices, including the use of fire to clear fields for agriculture, have led to devegetation across Turkey (Thirgood, 1981). Major deforestation in the Roman and Ottoman Empires drove collapses of human economies and populations (Angel, 1972; Willcox, 1974), spurring the first restrictions on tree cutting. Nonetheless, before 1915, the only task of forest officers was to license woodcutters (Vehbi, 1951 in Akin, 2006).

Half of Turkey's current forest area (10.4 million ha) is classified as degraded (tree canopy cover <10%) due to overexploitation, although degraded forest area has decreased by 8.9% since 1973 (GDF, 2009). Forest rehabilitation plans emphasize monoculture conifer plantations, sometimes eliminating important non-forest communities such as sand dunes and steppe vegetation (Vural and Adıgüzel, 2006). Over 45,000 ha of trees were planted in 2009 alone (over two million ha since 1945), mostly on degraded lands or open spaces in existing forests (GDF, 2009). Plantations currently comprise 9.0% of the total forested area (GDF, 2009).

Turkey's forests are regulated under the Forest Law (#6831) with GDF primarily responsible for their protection. While 99% of Turkish forests are public (SPO, 2007), only 4.0% of Turkey's forest area has *de jure* protection (Konukçu, 2001). As much as 45% of "protected" forest is open to legal logging (SPO, 2007). Because conservation measures have mostly failed to benefit local populations (particularly over 7 million impoverished forest villagers; GDF, 2009), illegal logging is still a threat (Güneş and Elvan, 2005).

Furthermore, residential development and the recent 2/B Lands Amendment (named for the relevant section of the Forest Law) also threaten to increase deforestation rates. This legislation, which allows the government to convert degraded forest areas to other uses and/or sell them to private owners, affects an estimated 473,419 ha of forested land (Köktürk and Köktürk, 2004; TKGM, 2010). It was initially intended to provide either new agricultural lands for neighboring villages or new residential areas for adjacent metropolitan sites (Türker, 2003). However, the sale of 2/B lands has become a means to balance budget deficits, with projected revenues of \$25 billion USD. Currently, 95% of these lands have vegetation cover and can be reforested or left as natural habitats. Furthermore, because many 2/B lands are buffer zones for intact forests and PAs, the selling and subsequent exploitation of these lands will negatively impact adjacent national parks, nature

conservation areas, forests, wetlands, and other habitats. Most problematic, the decision to classify an area as degraded may be made by zoning teams with no forestry expertise, creating a large loophole for developers to access previously protected land. The 2/B amendment also effectively encourages squatters to build on protected forest land, and villagers to use forest land for agriculture or grazing, because degraded forest land may become available for purchase by the very individuals who damaged it. Similar laws previously passed by the Turkish Parliament were either vetoed by the former president or struck down by the Constitutional Court. On July 23, 2011, Turkey's Constitutional Court approved the sale of 2/B Lands and the amendment is on track to pass in late 2011, the International Year of Forests. The ecological and social consequences of settlement or agriculture must be evaluated carefully before these activities are permitted on 2/B lands.

The most recent threats to Turkey's forests are two mega-scale construction projects announced in May 2011 (Gibbons and Moore, 2011): the “new Bosphorus channel” (Kanal İstanbul), projected to cut through 64 km of mostly forested land west of the Bosphorus and to be lined with new settlements, and the “Two New Cities” to be built in mainly forested land along the Black Sea coast of İstanbul, a province that already hosts 17 million people (Gibbons and Moore, 2011). If realized, these projects will destroy the last of İstanbul's once extensive forests, which also constitute the city's watershed.

3.2. Shrublands

Shrublands (maquis) cover 8.1 million ha (10%, Koç, 2000) of Anatolia (Fig. 1), but are most common in the Mediterranean phytogeographical region, extending up to 400 m above sea level in the Marmara region, 600 m in the Aegean region, and 1000 m in the Mediterranean region (Atalay, 1994; Kaya and Raynal, 2001; Aksoy, 2006). Turkey's Mediterranean region, including maquis shrublands, hosts approximately 5000 plant species, of which 30% are endemic (Thompson, 2005).

3.2.1. Key conservation challenge: habitat loss

Maquis and phrygana shrublands are among Turkey's most threatened terrestrial communities (Olson and Dinerstein, 1998). Although such communities are fairly resilient to fires, with some species resprouting quickly and others having fire-dependent germination (Türkmen and Düzenli, 2005; Paula et al., 2009; Tavşanoğlu and Gürkan, 2009), increasingly frequent and intense fires due to climate change may promote invasions in Mediterranean basin ecosystems (Gritti et al., 2006). Other threats to endemic-rich communities include luxury development projects like summer homes (Hepcan et al., 2010) and golf courses (Kuvan, 2005), especially in coastal areas (below). Maquis vegetation, not recognized as forest, lacks even the limited conservation protections under Turkey's Forest Law (Aksoy, 2006). Also threatening maquis shrublands are misguided reforestation efforts that sometimes replace native vegetation with monotypic conifer plantations (Aksoy, 2006; Vural and Adigüzel, 2006). Most Mediterranean shrublands are typically classified in management plans as “degraded forest” or “forest soil,” leaving them without any effective protection status, and the Mediterranean biodiversity hotspot in general faces major threats (Cuttelod et al., 2009).

3.3. Steppes

Steppe grasslands (Fig. 1) cover 21.2 million ha (27%, Koç, 2000) of Turkey and are particularly dominant in an arc from central to southeastern Anatolia with 20–60 cm annual rainfall (Vural and Adigüzel, 2006). Steppes may soon overtake forest as the country's most expansive natural community, having replaced much of the

historic woodland cleared by timber overharvesting over the previous millennia (e.g. Marsh, 1885; Vural and Adigüzel, 2006). Grassland PAs are mostly established to protect cultural heritage or geomorphologically unique areas (e.g. Cappadocia). No national parks exist in predominantly steppe vegetation, and only the steppes around Lake Tuz are part of a special PA.

Many endemic Turkish grassland species have intentionally or unintentionally been introduced throughout much of the western hemisphere via agriculture and animal husbandry. Some of these (e.g. *Vulpia myuros*, *Bromus hordeaceus*, and *Brassica nigra*) have become problematic invasive species, while others have become some of the world's most important domesticated cereal crops (e.g. Özkan et al., 2002).

3.3.1. Key conservation challenge: overgrazing and erosion

Turkey's extensive grasslands, essential for much of Turkey's endemic flora and as habitat for herbivores and their predators, are intensely overgrazed by cattle, sheep, and goats (11, 24, and 6 million head, respectively; FAO, 2010). This grazing intensity is reflected in the frequent absence of vegetation taller than 2–4 cm by late summer across wide swaths of Anatolia. Overgrazing (Fırıncioğlu et al., 2009) appears responsible for limiting the expansion of shrublands and forests (Camcı-Çetin et al., 2007) and for the loss of 90% of Turkey's rooted climax vegetation (Gençkan et al., 1990), resulting in severe to moderate erosion across 90% of Turkey's grasslands (Koç et al., 1994). Every year, Turkey loses 1.4 billion tons of soil to erosion (Özer, 2011), which has exacerbated and accelerated the wholesale degradation of the landscapes' ability to retain sediment. One third of all modern Black Sea sediments come from Turkey's rivers (Hay, 1994). Northwestern Anatolian erosion rates have doubled in the 20th century (Kazancı et al., 2004) and levels of erosion have risen in more than 86% of Turkey's land area (Özden et al., 2000; Güçlü and Karahan, 2004).

3.4. Mountains

Four major mountain belts run through Turkey (Fig. 1); the Western Anatolian Mountains, the Toros (Taurus) ranges in the south, the Northern Anatolian Mountains, and the Anatolian Diagonal running from the northeast to the Mediterranean. Turkey also has several smaller ranges and volcanic mountains (Fig. 2). The highest peak in Turkey is the volcanic Mount Ağrı (5137 m), with Cilo and Süphan mountains over 4000 m and dozens of peaks over 3000 m.

The varied topography and microclimates created by elevation and exposure differences (Atalay, 2006) have fostered high plant biodiversity. The Toros range harbors 950 plant species, many of them endemic; Sandras Mountain in southwest Turkey contains 650 plant species, with 76 endemic species and 11 species that are found only on this mountain (Özhatay, 1986; Zeydanlı, 2001). These numbers continue to increase with further study, especially in the east, where fewer systematic surveys have been conducted.

Turkey's mountains also harbor high vertebrate diversity, particularly among amphibians (Duellman, 1999), including two globally Vulnerable (IUCN, 2011) and endemic newt (*Neurergus*) species. Mountains offer refugia to large predators such as brown bears (*Ursus arctos*), grey wolves (*Canis lupus*), lynx (*Lynx lynx*), and caracals (*Caracal caracal*), which are often hunted out in more populated areas (Zeydanlı, 2001). Turkey's last few remaining leopards (*Panthera pardus*) may be roaming the remote mountains of eastern Turkey, but conclusive evidence remains elusive. The Important Bird Areas of the Amanos mountains in the south and the Borçka Pass in the northeast are critical passage ways on the migration routes between Africa, Middle East, and Eastern Europe.

Overall, Turkey's mountain habitats remain severely understudied. Addressing this deficiency is particularly urgent in light of

global climate change likely to turn these mountains into critical refugia (Médail and Diadema, 2009). Across Turkey, rangeland grazing regulations are rarely enforced and are routinely ignored. In spring and summer, livestock herds are taken to high mountain pastures, where sheep and goats can be found grazing some of the steepest slopes, sometimes exceeding 60°. Montane vegetation throughout the country is threatened most seriously by overgrazing and erosion, as well as by increasing tourism impacts.

3.5. Rivers

Turkey has 107 major (>1500 km² catchment area) rivers and 26 main drainage basins, reviewed in detail by Akbulut et al. (2009). These include the Dicle (Tigris – 1850 km; 400 km in Turkey) and Fırat (Euphrates – 3000 km; 1230 km in Turkey), the defining rivers of Mesopotamia. Other major rivers include the Aras (1072 km), Kızılırmak (1350 km), and Kura (1515 km). Turkey's complex geography yields rivers with widely varied physical characteristics and relatively high levels of endemism. Most known endemic species are threatened, principally by pollution, water diversion, and unchecked dam construction. The Asi (Orontes) River houses Turkey's greatest concentration of threatened endemic Mediterranean freshwater fish species (Smith and Darwall, 2006). High sediment loads and low coastal erosion tend to foster large deltas, which are centers of biodiversity. However, due to their fertile soils, deltas are threatened by heavy agricultural use and widespread dam construction (Hay, 1994).

3.5.1. Key conservation challenge: dams and hydropower plants

The damming and appropriating of flows for urban, agricultural or energy development has been a primary policy goal of all administrations since the founding of the modern Turkish Republic in 1923. Devlet Su İşleri (DSİ – State Hydraulic Works), which is responsible for the construction of dams and hydroelectric power plants, is one of the government's most powerful divisions. In October 2007, DSİ was incorporated into the MEF, and the former director of DSİ was made the Minister of Environment and Forestry. The same ministry became responsible for both building dams and assessing and reducing their environmental impact, creating a clear conflict of interest. The Minister of Environment and Forestry has declared “My job is to build dams,” (Hürriyet Daily News, 2010b; Hattam, 2011) and environmental laws are increasingly changed or ignored in favor of dam construction (Hürriyet Daily News, 2010a; TWA, 2011).

Hydroelectric power plants (HEPPs), currently provide 24% of Turkey's energy supply (Table 2 in Kaygusuz, 2011). Nearly all of Turkey's running waters, approximately 10,000 km, are planned to be dammed by 2023, almost 4000 HEPPs, diversions, and dams altogether (Gibbons and Moore, 2011; TMMOB, 2011; TWA, 2011). Energy-generation projects will constitute 1738 of these (TWA, 2011), including 264 in operation, 236 in construction, and 1200 in planning (Dalkır and Şeşen, 2011), with as many as 32 HEPPs on a single stream in solaklı (Chapron et al., 2010). The construction of 2000 additional irrigation and drinking water dams is also underway (TWA, 2011). This staggering increase in the number of HEPPs will severely damage riparian ecosystems and will leave virtually no healthy river ecosystems, while meeting only 20% of Turkey's future energy needs (Table 2 in Kaygusuz, 2011). Even though Turkey has significant potential for wind and solar energy production (Kaygusuz, 2011), state loans for renewable energy projects go almost entirely to hydropower plants (Anatolia News Agency, 2011). The 1515-km Kura River, which passes through Turkey (200 km) as well as Georgia and Azerbaijan, has the largest catchment area of any river in Turkey (193,800 km²) and the third highest discharge after the Tigris and Euphrates (Akbulut et al., 2009). Recent plans to generate power by diverting the river via

canal to the Çoruh River are being opposed by the local population, while the Minister of Environment and Forestry's statement that “Kura's water is ours, and we can make it flow wherever we want,” has created international controversy (Anonymous, 2010).

Assessments of HEPPs by the members of the Chamber of Electrical Engineers has shown that HEPPs are being built with a pure profit motive, deficient background research, little oversight, superficial environmental mitigation measures, and high environmental impact (TMMOB, 2011). The report states that streams and rivers are being leased by the government to private companies for 49 years, the minimum water flow requirement of 10% of the long-term average is arbitrary, unscientific, unregulated, and ecologically harmful, and the resulting HEPPs are creating large-scale environmental, cultural, and historical damage (TMMOB, 2011).

The construction of dams and water transmission channels also creates additional environmental damage, habitat loss, and pollution, due to the associated construction of roads and powerlines (Anonymous, 2011a; TMMOB, 2011). These additional impacts are not incorporated into the environmental impact assessments and the technical approval process for dam construction, violating the Turkish Constitution and various international laws and treaties signed by Turkey (Anonymous, 2011a). The negative, often illegal effects of these dams on local people, habitats, and wildlife have triggered nearly 100 lawsuits and environmental campaigns (Şan, 2009; TWA, 2011). Of the 46 lawsuits concluded, 45 decided against HEPP construction (TMMOB, 2011). For example, in October 2010, the local Protection of Cultural and Natural Heritage Board declared the İkizdere valley in the Black Sea region a strict natural conservation site (1. Derece Doğal SİT Alanı), partly due to the globally important breeding population of the Near Threatened Caucasian grouse (*Tetrao mlokosiewiczii*; Gavashelishvili and Javakhishvili, 2010). Although the construction of 22 HEPPs was stopped, the MEF proposed a new law that week, giving this ministry the sole power to declare new SİT sites and to determine the future of existing ones (Evin, 2010; Hürriyet Daily News, 2010a), potentially removing the last major legal obstacle to unchecked dam construction (TWA, 2011). Faced with vocal opposition, on December 29, 2010, the government hastily modified and passed an amendment of the Renewable Energy and Resources Act (Law 6094) that now allows the construction of a hydroelectric power plant in any “protected” area (Alwash, 2011; TWA, 2011; Yazgan, 2011). On March 16, 2011, the passing of the misleading and much opposed “Draft Act on Nature and Biodiversity Conservation” empowered the government to revoke a location's SİT status without local input (Anonymous, 2011b). A recent amendment allows dam investors to hire private firms to monitor environmental impacts, creating conflicts of interest and violating the Turkish Constitution (Anonymous, 2011c). In August 2011, the newly-created Ministry of Environment and Urban Planning decreed that 1685 SİT strict nature conservation areas created since the founding of the Turkish Republic in 1923 have been annulled, and their status will be reevaluated by the ministry (Kıvanç, 2011; Radikal, 2011a). The ministry also terminated the local Natural and Cultural Assets Conservation Committees (formerly the sole determinants of SİT sites) and centralized the decision-making process (Radikal, 2011a). The future of each SİT will be determined by a committee to be appointed by the Ministry of Environment and Urban Planning, potentially making it possible to revoke SİT status in areas where dams and HEPPs will be constructed.

As in other regions of the world, extensive damming in Turkey has degraded water quality (raising temperature, reducing suspended soils, etc.), created barriers to native species movement, and facilitated species invasions (TMMOB, 2011). The Southeastern Anatolia Project, one of the largest dam projects in the world, appropriates much of the flow of the Tigris and Euphrates rivers (together

carrying nearly 28.5% of all surface flow in the country) and damages the region's high biodiversity (Boşgelmez et al., 1997). These dams have caused water scarcity in downstream countries, especially the marshes in southern Iraq, provoking controversy, tension, and protests (Alwash, 2011). The planned Ilisu Dam will flood Hasankeyf, which is protected due to its rich and globally significant biological, historical and cultural heritage (Bolz, 2009; MCT, 2009). European banks stopped providing credit in response to protests against the Ilisu Dam, but Turkish banks stepped in with financing (Gibbons and Moore, 2011). In the opposite corner of Turkey, in Havran, an irrigation dam finished in 2008 has flooded a cave hosting the country's second-largest bat colony, comprising 15,000–20,000 bats of eight species (Tan, 2009). These examples illustrate significant damage to Turkey's biodiversity caused by the MEF's unilateral control of dam construction and the lack of proper environmental oversight resulting from a major conflict of interest.

3.6. Wetlands

Turkey has 135 delineated “wetlands of international significance” covering 2.2 million ha (GDNCNP, 2010). At least 500 other large wetlands exist across Turkey, but a rigorous national wetland inventory has yet to be undertaken. Vernal pools, wet meadows, and other less conspicuous wetland types which likely make up a significant fraction of Turkey's true wetlands (perhaps 40–60%; Sean Anderson, unpublished data) and provide much of the wetland functions across central and eastern Anatolia, remain under-represented in the estimates of internationally significant wetlands. Turkey has 13 Ramsar wetlands, with the most recent, Lake Kuyucuk in Kars (www.kuyucuk.org), being the only exemplar in the 350,000 km² eastern half of Turkey. Virtually all remnant wetlands reside on government lands. In 2010, the Wetland Law was modified to exclude rivers and other riparian areas, likely removing the last legal obstacles to the construction of hydroelectric facilities (Yazgan, 2011).

Across Anatolia, wetlands constitute one of the most important *de facto* wildlife refugia, often the best places to observe large vertebrates. Since much of the surrounding landscapes are heavily altered and utilized by human activity, such systems afford a relatively high level of protection to migratory and resident wildlife that are obligate or facultative wetland species. Inventory and management efforts to date have primarily focused on wetlands that harbor important bird populations.

3.6.1. Key conservation challenge: wetland loss and degradation

No comprehensive database or inventory of Turkish wetlands exists. Preliminary hydrogeomorphic inspection of focal areas in eastern Anatolia suggests that historic (pre-Ottoman) wetlands likely covered at least twice the area of extant wetlands (Sean Anderson, unpublished data). Turkey has lost at least 1.3 million ha of its historic wetlands over the past 60 years, mostly due to draining by the government for malaria control and to create agricultural lands (Nivet and Frazier, 2004). Altered surface and subsurface flows, eutrophication, and exceedingly high sedimentation rates have been the greatest regional threats to wetlands, especially in the last 50 years (Reed et al., 2008). Locally, overexploitation of peripheral vegetation by livestock or local people often further degrade the quality of wetlands and negatively affect their inhabitant communities. Nevertheless, wetland restoration can deliver positive results (Beklioğlu and Tan, 2008; Anderson and Şekercioğlu, in prep.), and many of Turkey's wetlands need urgent ecological restoration.

3.7. Coasts

Turkey is surrounded by seas on three sides—the Black Sea on the north, the Aegean on the west, and the Mediterranean on the

south—comprising a coastline of over 8300 km (Uras, 2006). The Sea of Marmara, an inland sea connecting the Black Sea and the Aegean via the Bosphorus and Dardanelles straits, serves simultaneously as a barrier and a corridor for gene flow, as well as an acclimatization zone for many marine species (Öztürk and Öztürk, 1996). The salinity ranges from 17 ppm in the Black Sea to 39 ppm in the eastern Mediterranean. This salinity gradient is directly correlated with the average temperature gradient. This physio-chemical diversity, combined with a range of microhabitats such as deltas, small isolated bays, lagoons, sandy and rocky beaches, and cliffs, results in a diverse fauna and flora along the Turkish coasts (Uras, 2006).

3.7.1. Key conservation challenge: pollution

Along the Black Sea coast, pollution from industrial discharge, particularly heavy metal pollution, is a major problem for marine organisms and the people who consume them (Topçuoğlu et al., 2002; Galatchi and Tudor, 2006). Chemical pollution *via* waste water discharged from ships is another chronic problem (Ocak et al., 2004). The number of fish species harvested in the Black Sea decreased from 26 a quarter century ago to 10–15 today (Uras, 2006). Industrial facilities are also major polluters around the Sea of Marmara, where fish species declined from over 100 species in the 1960s to tens of species today (Uras, 2006). Further, the Bosphorus Strait is the seventh biggest chokepoint of oil in the world, with a high risk of a major oil spill. On the eastern Mediterranean coast, green sea turtles (*Chelonia mydas*) nest and forage in the Yumurtalık Bay Nature Protection Area (Yılmaz, 1997), located in the immediate vicinity of both a major industrial zone and an international export harbor. Because many cities and industries are located near or on the coast, air pollution often has high impact at local scales. For instance, the populations of sensitive plant species near coal-based power plants (e.g. *Pinus brutia* near Yatağan plant in the Aegean region) have been severely reduced (Kaya and Raynal, 2001). Mining-related pollution, including cyanide and arsenic pollution from silver and gold mines, remains a major threat (Ocak, 2010; Emeksiz, 2011; Radikal, 2011). However, investigating incidences of pollution in Turkey carries risks (Lewis and Christie-Miller, 2011). For example, a professor was recently sued by the mayors of an industrial region, on the basis of his report that high amounts of heavy metals, including mercury and arsenic, were detected in mother's milk and babies' excrement (Lewis and Christie-Miller, 2011; Hürriyet Daily News, 2011). Though he was enlisted by the Parliamentary Research Commission, which reported that the rate of death from cancer in Dilovası was more than 2.5 times the national average, professor Hamzaoglu faces a 2–4-year jail term for “threatening to incite fear and panic among the population”.

A potential future threat is nuclear contamination and thermal pollution from Turkey's first nuclear power plant to be constructed at Akkuyu, a seismically active area on the Mediterranean coast (Özyurt et al., 2001; Cigna et al., 2002). A second plant is planned for Sinop on the Black Sea coast. Despite the worldwide outcry regarding the 2011 nuclear accident at the Fukushima Daiichi power plant, the Turkish government has strongly reaffirmed its intention to move ahead with the Akkuyu plant construction (Aktar, 2011a; Gibbons and Moore, 2011), expected to begin in 2013.

3.7.2. Key conservation challenge: residential and touristic development

Turkey's densely populated coasts also experience large-scale habitat loss, disturbance, and pollution from rapidly increasing residential and tourism development (Uras, 2006). The “Kanal İstanbul” and “Two New Cities” mega-construction projects, mentioned above, will destroy coastal habitats in İstanbul and Thrace (Gibbons and Moore, 2011). Tourism development is a particular

threat to the Aegean and Mediterranean coastal biodiversity (Yezdani, 2011). The endangered loggerhead sea turtle (*Caretta caretta*) an emblematic species for nature conservation in Turkey, is under further threat from fisheries by-catch (Baran et al., 1992) and from the increasing use of illegal drift nets (Mehmet Baki Yokeş, personal observation) that also kill other non-target species such as dolphins and porpoises. Between May and September, loggerhead turtles nest at about 15 sites along 175 km of Turkey's Mediterranean coast (Canbolat, 2004). The turtle nesting period coincides with peak tourist activity (Uras, 2006). Illegal activities such as sand removal from beaches, often for local hotel construction, create additional major problems (Canbolat, 2004). Since the early 1980s, significant government and non-government conservation efforts have focused on protecting the species' nesting sites. The nesting population remained stable (albeit with large fluctuations) between 1987 and 2005 at one important nesting beach (Türkdoğan and Yılmaz, 2008), but declined at another beach 50 km to the south (Ilgaz et al., 2007).

3.8. Marine habitats

The Black Sea, an isolated and unique inland sea, contains the Earth's largest permanent anoxic-sulfidic water body (see Section 4.8), as well as the world's only known active undersea river (Gray, 2010). The biodiversity of the inland Sea of Marmara has diminished significantly due to eutrophication and pollution from industrial centers like İstanbul (Balkas et al., 1990; Uras, 2006). The eastern Mediterranean Sea is one of the most oligotrophic regions in the world, with low primary productivity (Berman et al., 1984).

Seagrasses are key marine biogenic species in Turkey. *Zostera marina*, *Zostera noltii*, *Ruppia spiralis*, and *Potamogeton pectinatus* occur in the Sea of Marmara and the Black Sea, *Cymodocea nodosa* dominates in the eastern Mediterranean, and *Posidonia oceanica* in the Aegean. All are declining. Another important habitat-forming species is the Mediterranean mussel (*Mytilus galloprovincialis*) which densely covers large areas on the shallow rocky substrata in the Black Sea and the Sea of Marmara.

Many of Turkey's 3000+ marine plant and animal species are severely threatened by habitat degradation and destruction, pollution, and overexploitation (especially overfishing, FAO, 2009). Twelve Marine Protected Areas (MPAs) cover 4603 km² of water (Wood, 2007), but protect only 2.8% of Turkey's 8300 km coastline (UNDP Turkey, 2009). More than 60% of these MPAs are on the Aegean coast, where seagrass meadows are relatively dense and abundant. However, as with the rest of Turkey's PAs, most of these MPAs are not primarily designed or managed to protect biodiversity or ecosystem services, and rarely prevent extractive activities. Currently, a United Nations Development Programme project is underway to expand Turkey's MPAs by 100,000 ha, including the creation of the first restricted fishing area in Turkey (UNDP Turkey, 2009).

3.8.1. Key conservation challenge: introduced and exotic species

Exotic and introduced species constitute an important part of Turkey's marine and freshwater fauna. While introduced fish species often compete with and prey upon native species, other introduced taxa also have negative impacts on marine and fresh-

water communities. Of the new species regularly added to the marine fish fauna, most are exotic. More than 380 marine exotics have been recorded, including 98 mollusc, 58 crustacean, and 53 fish species (Çınar et al., 2005; Yokeş and Galil, 2006a; Zenetos et al., 2008; Çınar, 2009; Yokeş, 2009). Almost all of the shallow waters of the Mediterranean coast have been invaded by the Red Sea mussel *Brachidontes pharaonis*. The majority of recorded marine exotics have Indo-Pacific origins and were introduced to the Eastern Mediterranean via the Suez Canal (Galil, 2008). At least 25 additional freshwater fish species have been introduced since the middle of the 20th century (İnnal and Erk'akan, 2006), by either fisheries or local fishermen. As exemplified by two herbivorous fish from the Red Sea (*Siganus luridus* and *Siganus rivulatus*) that converted well-developed native algal assemblages to 'barrens' on the Mediterranean coast of Turkey, alien species can cause dramatic declines in biogenic habitat complexity, biodiversity, and biomass (Sala et al., 2011).

Species introduced to Turkish waters are not limited to fish and invertebrates. Introduced coypu or nutria (*Myocastor coypus*) populations, first recorded in 1941 (Turan, 1984), are well established in some northwestern and northeastern wetlands, but their ecological impacts have not been assessed (Anderson and Şekerciöğlü, personal observation). Exotic species can deplete food resources, prey on native species, change the habitat structure, and modify environmental conditions, driving native species locally extinct (Yokeş and Meriç, 2004). The introduction of zander (*Sander lucioperca*) into Lake Eğirdir in 1955 led to the disappearance of three endemic *Phoxinellus* species (Çıldır, 2001). Similar collapses of native fish stocks are underway in lakes Beyşehir and Çıldır.

4. Biodiversity

4.1. Plants

For a medium-sized temperate country, Turkey harbors extraordinary plant diversity; of more than 9000 known native vascular plant species, at least 3022 (33%) are endemic (Davis, 1965–1985; Davis et al., 1988; Güner et al., 2000; Özhatay et al., 2011). Including sub-species, the number of endemic taxa exceeds 3500 (Table 1). The actual number of plant species is thought to be around 10,000 (Adil Güner, pers. comm.) Turkey's flora includes 300 species of trees (Thompson, 2005), 1215 species of Asteraceae, 1071 of Fabaceae, 575 of Lamiaceae, 548 of Brassicaceae, and 485 of Poaceae (Ekim, 2006). Turkey has 122 Important Plant Areas (Özhatay et al., 2010) and eight plant diversity centers covering approximately 286,000 km², compared to 24 diversity centers for Europe and 21 for the Middle East (Çolak, 2006). High levels of endemism make southern Anatolia one of the most irreplaceable plant biodiversity regions in the temperate zone in general and the Mediterranean basin in particular (Médail and Quézel, 1997).

This diversity results from the combination of geography, topography, climatic diversity, and geology (Çolak and Rotherham, 2006). Turkey is situated at the junction of three of the world's 37 phytogeographical regions: Euro-Siberian, Mediterranean, and Irano-Turanian. The latter two regions are major gene centers in western Asia (with 42% and 49% plant endemism, respectively) and have contributed much to the origin of many cultivated plant species (Ekim, 2006). Anatolia is a speciation center of many plant genera (Dönmez, 2004; Thompson, 2005). The Anatolian Diagonal, extending from northeastern Anatolia to the Mediterranean Toros mountains (Fig. 2), has been critical for plant diversification (Ekim, 2006). The presence of many mountains harboring different environmental conditions within a limited area further promotes plant diversity (Atalay, 2006). Moreover, several plant species are restricted to specific geological parent materials, exemplified by serpentine endemics (Reeves and Adıgüzel, 2004). Nearly all of

Table 1
IUCN categories of endemic and threatened non-endemic plant taxa in Turkey (based on Ekim, 2006). Note that non-endemic plant taxa that were Least Concern, Near Threatened, Data Deficient or Not Evaluated are not included.

	EX	EW	CR	EN	VU	NT	LC	DD	NE
Endemic	3	–	171	774	688	817	769	270	3
Non-endemic	–	–	10	69	769	–	–	–	–
Total	3	–	181	843	1457	817	769	270	3

Turkey's endemic plants are range-restricted species (global range <50,000 km²) and 68% of these have a distribution of <500 km² (Langhammer et al., 2007). 70% of Turkey's endemic plant taxa are threatened or near threatened with extinction, and at least three are already extinct (Table 1; Ekim, 2006).

4.2. Insects

Insect diversity is relatively high in Anatolia, with over 17,600 known pterygot species in 16 orders (CESA, 2010). Actual insect species richness is thought to be substantially higher (Ali Demirsoy, pers. comm.) with high endemism. 40% of all known Orthoptera species are endemic (Çıplak et al., 2002). However, little is known about smaller, cryptic orders such as Strepsitera, Phthiraptera or Psocoptera, where new species are likely to be discovered (e.g. Dik et al., 2010, 2011). Even within the well-studied groups, large-scale biogeographic information is available only for a few taxa such as Lepidoptera (Baytaş, 2007; Karaçetin and Welch, 2011), Odonata (Riservato et al., 2009), and Orthoptera (Çıplak et al., 2002). However, most data consist of checklists and point distributions. Çağlar and İpekdal (2009) revealed that Turkey's 45 known Simulid species significantly underrepresented the true diversity of the group, with a high probability of finding 21 additional species known from the neighboring countries. Such underrepresentation is probably common for most insect taxa. Few studies include long-term ecological monitoring, analyzing large-scale patterns of biodiversity change, conservation assessments, or determining extinction risk. One recent and welcome exception is by Karaçetin and Welch (2011), who studied Turkey's 380 butterfly species, of which 45 are endemic (20 endemic species were known until recently) and 21 are near-endemic. Currently, only the endemic *Polyommatus dama* is listed as Endangered in the IUCN Red List (2011) and three non-endemic species are listed as Vulnerable. However, the Red List assessment by Karaçetin and Welch (2011) has shown that 26 species (11 endemic, four near-endemic) are threatened and four species (two endemic, two near-endemic) are near threatened with extinction. Although butterflies are the best-known invertebrate class in Turkey, at least 26 species new to science have been discovered in the past 20 years (e.g. Kandul et al., 2004), and 57 species remain Data Deficient (22 endemic, three near-endemic).

Similar assessments are also needed for other invertebrates. Although Anatolia does not contain any known endemic Odonata species, four species have globally restricted ranges, and five are classified as Vulnerable (*Brachythemis fuscopalliat*a, *Ceragrion georgifreyi*, *Onychogomphus assimilis*, *Somatochlora borisi* and *Onychogomphus macron*) (IUCN, 2011). Though nearly half the Orthopteran fauna of Anatolia is endemic (Çıplak, 2008) and are found in restricted habitats vulnerable to habitat loss and climate change, none have been included in the IUCN Red List. Çıplak (2003) proposed that 23 species of Anatolian Tettigoniinae be categorized as Vulnerable. Long-term, systematic monitoring of well-known indicator groups, such as Odonata, Orthoptera, and Lepidoptera, is essential for the conservation of populations and habitats.

With rapid habitat loss, cryptic taxa in Turkey may go extinct before being identified. Molecular methods recently revealed six *Agrodietus* butterfly species and five subspecies new to science in eastern Turkey (Kandul et al., 2004); the same expedition found that approximately half of the visited localities for this genus listed in Hesselbarth et al. (1995) had been destroyed by overgrazing, and no food plants or butterflies were observed (Çağan Şekercioğlu, personal observation). Without comprehensive and comparative biogeographic, phylogeographic, and population genetic studies using molecular methods, we will continue to overlook cryptic taxa and to have difficulty identifying the ecological and evolutionary mechanisms behind observed insect biodiversity patterns.

4.3. Marine invertebrates

Most Turkish marine invertebrates are not well studied, with the exception of polychaetes (e.g. Çınar, 2006), crustaceans (e.g. Kocataş et al., 2004; Gönügür-Demirci, 2006), and mollusks (e.g. Demir, 2003). In a recent study, 26 of 147 opisthobranch species were new records for Turkey (Yokeş, 2009). Exotic species constitute an important part of the polychaete fauna (Çınar, 2006; Dağlı and Ergen 2008; Çınar, 2009). Recent additions to the crustacean fauna were also mostly exotic species (Özcan et al., 2006; Yokeş and Galil, 2006a,b).

4.4. Fish

Of the 694 known marine and freshwater fish species in Turkey (Fricke et al., 2007), 252 are on the IUCN Red List (IUCN, 2011). Twenty-six marine species, including green wrasse (*Labrus viridis*), sturgeons, sharks, and relatives, are globally threatened, eight are near threatened (IUCN, 2011), but none are endemic. Of the 236 inland freshwater species and subspecies (Kuru, 2004), 61 are endemics, 59 have restricted distributions, and 18 are known from a single locality (Erk'akan, 2006). Currently, 42 freshwater fish species are threatened and two are near threatened with extinction (IUCN, 2011). Approximately 30 of the freshwater endemics are estimated to be Critically Endangered, although many of these species lack adequate data or even formal classification (Erk'akan, 2006). One species, *Alburnus akili*, has not been observed since 1998 and is presumed extinct. Factors threatening Turkey's fish include pollution, damming for hydroelectric power, diversions for irrigation, exotic species introductions, and overfishing.

No comprehensive studies of overfishing in Turkey exist, but species-specific studies show a decline in fisheries (Özbilgin et al., 2004), especially bluefish and Atlantic bonito (Şenerdem, 2011b). Eastern Mediterranean fisheries constitute 85% of the landings on the Mediterranean coast of Turkey. Catch rates are very low relative to historic landings across the entirety of the Mediterranean coast, indicating extensive fishing pressure (Kara and Aktaş, 2001). Overharvesting of Black Sea fish stocks, combined with the introduction of the predatory ctenophore *Mnemiopsis*, have made the Black Sea a classic study of fishery collapse, though there are recent signs of recovery (Kideys, 2002). Fishing bans in Turkey are often ignored or cut short, there are not enough qualified fisheries inspectors, and fish stocks risk being exhausted in a few decades (Şenerdem, 2011b). In response, Greenpeace Turkey recently started the "How many centimeters is your...[fish]?" campaign, to lobby for an increase in the legal fish size limit, but the resulting increases determined by the Ministry of Food, Agriculture and Livestock were not big enough (Doğan News Agency, 2011).

4.5. Amphibians and reptiles

At least 30 amphibian and 120 reptile species have been recorded in Turkey (Baran and Ilgaz, 2006), a growing number comparable to the entire herpetofauna of Europe (Demirsoy, 2002). Eleven amphibian and 20 reptile species are globally threatened with extinction, five amphibian and nine reptile species are Near Threatened (IUCN, 2011), and two amphibian and seven reptile species are Critically Endangered. Specialized habitat requirements result in elevated levels of endemism and localized distributions, exemplified by Middle Eastern desert species in southeastern Turkey and Caucasian montane species in northeastern Turkey. Ten amphibian and 17 reptile species are endemic (Baran and Ilgaz, 2006; IUCN, 2011), with new discoveries being made regularly. Amphibians have higher levels of endemism, including six species in the endemic genus *Lyciasalamander*, all threatened (IUCN, 2011).

Main threats are habitat loss and illegal collection from the wild for the international pet trade (Baran and Ilgaz, 2006).

4.6. Birds

Turkey's diversity of vegetation, topography, and climates has resulted in a rich avifauna with a diverse mix of Balkan, Mediterranean, Middle Eastern, and Central Asian species (Sekercioglu, 2006; Kirwan et al., 2008). Despite the scarcity of professional ornithologists and limited long-term ornithological research in Turkey, the number of birdwatchers has grown in the past decade from a few dozen to hundreds, becoming the major force in recording new bird species for the country. In the first 5 months of 2011 alone, Turkish birdwatchers observed three species new for the country, raising the number of Turkey's known bird species to 468. With increasing studies and observers, this number is likely to exceed 500 in the coming decades. With 319 out of 556 European breeding bird species (BirdLife International, 2004), including 32 breeding only in Turkey, Turkey has the most breeding bird species of any European country—as well as the highest number of bird species threatened in Europe (148 of 226). At the global level, Turkey hosts three Critically Endangered, three Endangered, eight Vulnerable, and 17 Near Threatened bird species (IUCN, 2011). Of these, slender-billed curlew (*Numenius tenuirostris*) and Houbara bustard (*Chlamydotis undulata*) are considered extinct in Turkey. At the country level, an additional 23 bird species are Critically Endangered, 26 are Endangered, 51 are Vulnerable, and 15 are Near Threatened (Kılıç and Eken, 2004).

The populations of 53.6% of Turkey's bird species have declined between 1994 and 2004 (BirdLife International, 2004). The biggest threat to birds is habitat loss, especially the draining of 1.3 million ha of Turkey's wetlands since 1950 (Nivet and Frazier, 2004). Bird numbers at Akyatan, Ağyatan, Tuzla, and Yumurtalık lagoons on the Mediterranean coast have declined 40-fold, from 3 million in 1962 to 76,500 in 2007 (Küyük, 2007). Eighty-three of Turkey's 319 breeding bird species are threatened with local extinction due to the construction of dams (Doğa Derneği, 2005), including the recently discovered and Critically Endangered sole breeding population of the brown fish-owl (*Ketupa zeylonensis*) in the Mediterranean region (van den Berg et al., 2010). Nevertheless, dozens of bird species that are threatened and declining in Europe are common and numerous in Turkey, including farmland birds that comprise the most threatened bird group in Europe. Many farmland species declining in Europe (PECBMS, 2011), such as common kestrel (*Falco tinnunculus*), northern lapwing (*Vanellus vanellus*), European turtle dove (*Streptopelia turtur*), crested lark (*Galerida cristata*), Eurasian skylark (*Alauda arvensis*), red-backed shrike (*Lanius collurio*), whinchat (*Saxicola rubetra*), yellow wagtail (*Motacilla flava*), common starling (*Sturnus vulgaris*), Eurasian linnet (*Carduelis canabina*), and corn bunting (*Miliaria calandra*), are still common and widespread in Turkey's extensive traditional agricultural landscapes. However, some populations may be declining with increasing mechanization and chemical use, especially in western Turkey, but good long-term data are lacking.

Birds and birdwatchers have been at the forefront of the Turkish conservation movement. The Critically Endangered northern bald ibis or Walldrapp (*Geronticus eremita*), now consisting of a semi-captive population of 132 birds at Birecik, has been a conservation symbol since the 1970s (Akçakaya, 1990). Although birds are one of the best known groups in Turkey, monitoring is limited and inconsistent, and the country only has three long-term bird banding (ringing) stations. For example, at the Aras River Bird Research and Education Center situated in the threatened and unprotected wetlands of Yukarı Çıyıklı (Tuzluca, Iğdır), over 30,000 birds of 157 species have been banded and 231 species have been observed since 2006 (Çağan Şekerciöğlü, in prep.). These numbers, in a

previously little-studied region, comprise nearly half of the bird species ever recorded from Turkey and show the importance of systematic monitoring. Similarly, systematic monitoring at Lake Kuyucuk (Arpaçay, Kars) has recorded 220 bird species (Çağan Şekerciöğlü, in prep.). This was a key factor in this lake being declared the first Ramsar wetland of eastern Turkey, greatly helping its conservation. Recent successful bird conservation projects (e.g. the construction of Turkey's first artificial bird nesting island at Lake Kuyucuk (Braun, 2009) and the country's first vulture "restaurant" (feeding station) in Iğdır (Braun, 2010)) aim to combine effective community-based habitat conservation with systematic monitoring, lobbying, ecological restoration, public outreach, ecotourism, and environmental education.

4.7. Mammals

The mammal community of Turkey is diverse for a temperate country (Karataş, 2006), currently consisting of 168 species and with discoveries made regularly (Gündüz et al., 2007). At least 128 small mammal species occur in 18 families (Demirsoy, 2002; Wilson and Reeder, 2005), and eight species are endemic (Kryštufek et al., 2009). Fourteen mammal species are globally threatened, 11 are Near Threatened (including newly-discovered, Vulnerable mountain gazelle (*Gazella gazella*) no longer near threatened), 8 are Data Deficient, and at least six have gone extinct in Turkey (IUCN, 2011). No national red data list or explicit conservation action plan exist for Turkey's mammals (Karataş, 2006).

Until the 20th century, Turkey had possibly the most impressive assemblage of large mammalian carnivores in a temperate region, including Persian lions (*Felis leo persica*), Caspian tigers (*Panthera tigris virgata*), Asiatic cheetahs (*Acinonyx jubatus venaticus*), Anatolian leopards (*Panthera pardus tulliana*), brown bears (*Ursus arctos*), gray wolves (*Canis lupus*), striped hyenas (*Hyaena hyaena*), and four species of smaller felids (Demirsoy, 2000; Johnson, 2002). Large carnivores fed on other large mammals such as red deer (*Cervus elaphus*), roe deer (*Capreolus capreolus*), wild boar (*Sus scrofa*), wild goat (*Capra aegagrus*), chamois (*Rupicapra rupicapra*), mouflon sheep (*Ovis aries*), *Gazella* species, and now extinct auroch (*Bos primigenius*), Persian fallow deer (*Dama mesopotamica*) and wild ass (*Equus hemionus*).

Persian lions, the same sub-species often portrayed in Greek mythology and on Babylonian tablets, persisted in Anatolia until late 19th century (Demirsoy, 2000). Drawings of Ottoman sultans hunting gazelles with Asiatic cheetahs were common (Johnson, 2002), but cheetahs went extinct in Turkey in late 19th century (Demirsoy, 2000) (a population of 71–122 individuals persists in neighboring Iran; Schaller and O'Brien, 2005; Breitenmoser et al., 2009). Caspian tigers, officially extinct since 1950 (Harper, 1945), clung to existence in Turkey until hunters killed the last known individual in Uludere, Hakkari in 1970 (Baytop, 1974). Extant species such as caracal (*Caracal caracal*), Egyptian mongoose (*Herpestes ichneumon*), Egyptian fruit bat (*Rousettus aegyptiacus*), long-eared hedgehog (*Hemiechinus auritus*), and Indian crested porcupine (*Hystrix indica*), are other indicators of Turkey's unique Palearctic mammalian fauna shaped by the influence of Africa and Asia (Karataş, 2006).

Among 11 species of marine mammals is the Critically Endangered Mediterranean monk seal (*Monachus monachus*), whose estimated population of ~100 individuals comprise 20% of the world population (Aguilar and Lowry, 2008). Other marine mammals known from Turkey's waters include the common dolphin (*Delphinus delphis*), Risso's dolphin (*Grampus griseus*), long-finned pilot whale (*Globicephala melaena*), false killer whale (*Pseudorca crassidens*), Cuvier's beaked whale (*Ziphius cavirostris*), fin whale (*Balaenoptera physalus*), and sperm whale (*Physeter catodon*) (Karataş, 2006).

Turkey's remaining large mammals are in decline due to extensive poaching and the frequent lack of environmental law enforcement. Limited information is available on their conservation, ecology or management (Can and Togan, 2009). Many small mammal species are either Data Deficient and/or are threatened by habitat loss.

4.8. Potential for discovery

The surprising 2009 discovery near the Syrian border (Fig. 2) of the mountain gazelle (*Gazella gazella*), a large, diurnal mammal, is the perfect symbol of the many species yet to be discovered in Turkey and the threats they face. The population of this Vulnerable species (IUCN, 2011) became threatened within only a year of its discovery by the planned construction of a cement factory in its small range (Öğünç, 2010), and by the local officials' insistence to cross it with the goitered gazelle (*Gazella subgutturosa*), despite the efforts of Turkish mammalogists (Ahmet Karataş, pers. comm.). Another surprising discovery (Fig. 2) was the Taurus ground-squirrel (*Spermophilus taurensis*), a medium-sized, easily-observed land mammal, described to science only in 2007 (Gündüz et al., 2007; Özkurt et al., 2007)). Turkey hosts thousands of endemic plant species and is likely home to hundreds more. In recent years a new plant taxon has been added to the Turkish flora every 5.5 days (Özhatay et al., 2010), and since 1988, 1049 new taxa have been added to the flora (Özhatay et al., 2011). Tremendous potential exists for discovering new taxa via molecular methods, tools underutilized for biodiversity assessments in Turkey (e.g. Kandul et al., 2004; Gündüz et al., 2007; Bilgin et al., 2008; Furman et al., 2010). Even without molecular methods, dozens of animal species new to Turkey are being discovered every year from cryptic and little-known groups such as bird lice (Dik et al., 2010, 2011).

Lake Van and the Black Sea also hold potential for discovery. Turkey's largest lake (3755 km²), Lake Van, is highly alkaline and has low salinity, making it the largest soda lake on Earth. Despite relatively low animal diversity, its unique habitat harbors much microbial biodiversity such as microbialites (Kempe et al., 1991), carbonate structures up to 40 m thick covered by cyanobacteria. They host alkaliphilic and/or heterotrophic bacteria that are able to degrade complex organics (López-García et al., 2005). In the Black Sea, anoxic-sulfidic conditions exist between about 100–2000 m, above which a stable suboxic lid is present from 50–80 to 100–120 m (Glazer et al., 2006). The suboxic zone harbors microbes that mediate unique, possibly ancient biogeochemical processes such as hydrogen sulfide oxidation (Jannasch, 1991) and anaerobic ammonium oxidation (Kuypers et al., 2003). These under-researched microbial processes hold important clues for life under extreme conditions and the early evolution of life on our planet.

4.9. Biodiversity's contribution to Turkey's rural economy

Traditional knowledge of biodiversity in Turkey is substantial. In addition to life-sustaining ecosystem services (Şekercioğlu, 2010), biodiversity has important cultural and commercial value for nearly 20 million rural people, especially in terms of fishing and non-wood forest products such as honey. Approximately 80 million hives spread throughout the country produce honey for domestic use and export, making Turkey the world's second biggest honey producer (FAO, 2010; Akyol, 2011; Özgenç, 2011). Honey production contributes around 1 billion USD to Turkey's economy annually. One fifth of production comprises "forest honey," which the MEF plans to increase by establishing "honey forests" with native plant species favorable to honey production (Forestry General Director Osman Kahveci quoted in Özgenç, 2011). Despite government efforts, hive productivity has not increased since 1990, due to pollution, loss of natural meadows and honey forests, increased

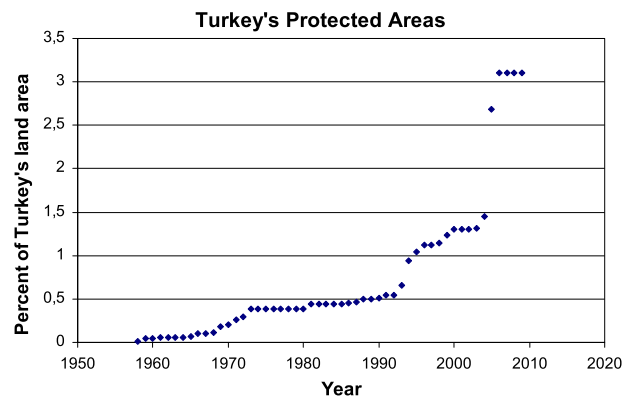


Fig. 3. Yearly change in the percent land cover of Turkey's main protected areas (national parks, natural monuments, nature parks, nature conservation areas, nature recreation areas (types A and B), wildlife development areas, and Ramsar wetlands listed by the Ministry of Environment and Forestry (GDF, 2009; pages 54–57)). Strict nature conservation SİT sites under the jurisdiction of the Ministry of Culture and Tourism, and areas protected for the primary purpose of sustainable forestry and sustainable fishery are excluded. The increase in 2005 is mostly due to the announcement of new national parks, Ramsar wetlands, and especially the creation of the new category Yaban Hayatı Geliştirme Sahası (so called "Wildlife Development Area" equivalent to a Wildlife Reserve – 79 sites), which is the equivalent of a wildlife refuge system where hunting may be allowed. However, a recent law now permits mining in these areas (Republic of Turkey, 2010).

pesticides, and excessive chemical and drug use in honey production (Akyol, 2011). Turkey's other non-wood forest products, such as medicinal plants, aromatic and culinary herbs, vegetables, mushrooms, and fruits, also economically important (Kızmaz, 2000), are regulated by the Forest Law (Kızmaz, 2000). These products generated 50.1 million USD in the first 10 months of 2010, a 5% increase from 2009 (Karasu, 2010). Aromatic plants constitute one third of the Turkish flora (Başer, 2002). At least 123 plant species are used as dyes, especially for carpets (Doğan et al., 2003), while at least 346 taxa of wild medicinal plants are commercially traded (Özhatay et al., 1994). Other plants are used as pesticides, detergents, musical instruments, furniture, ornaments, or domestic animal feed (Kızmaz, 2000). Most geophytes and bulbous plants exported for use in medicine and cosmetics (Kızmaz, 2000) are endemic and threatened (Ekim et al., 2000), often by poaching. Additionally, tuberous orchids have been used to obtain *sahlep*, an ingredient used in ice cream and in a traditional Turkish beverage (Sezik, 2002). Botanists frequently report that orchids have been overharvested dramatically, causing some species to decline to critical levels (Tamer et al., 2006).

4.10. Hunting

Hunting is by far the most common human-wildlife interaction across Turkey; hence the codification of wildlife conservation and management under the Terrestrial Hunting Law. Small game hunting provides supplemental protein for many rural and subsistence households. Meanwhile, recreational trophy hunting offers a potential for international tourism that may come at the expense of Turkey's large mammal populations. Almost 20,000 pieces of game fur or leather are sold every year (Kızmaz, 2000). However, the enforcement of hunting regulations is generally inadequate. Many protected species, even flamingos and pelicans, are killed for fun, resulting in local extinctions, including of leopards, wolves, striped hyenas, Eurasian lynxes, and brown bears.

4.11. Ecotourism

Turkey's considerable ecotourism potential (Demircan et al., 2006; Bulut et al., 2007) is constrained by poor infrastructure

and planning (e.g., [Yılmaz and Karahan, 2003](#)). Currently, birdwatching is the most popular type of wildlife tourism in Turkey and Turkey's rich avifauna has been a major focus of birding tourism for decades ([Sekercioglu, 2006](#)). The Ministry of Culture and Tourism has specifically targeted ecotourism as a growth sector since 1990, indirectly supporting various PA designations. Turkey has enormous potential for community-based ecotourism. This is especially the case in eastern Turkey where traditional agricultural landscapes with high biodiversity and low per capita incomes mean that village-based biocultural tourism can contribute to local economies, provide a significant financial incentive for the conservation of biocultural diversity, and promote traditional knowledge and its custodians. However, Turkey's approach continues to emphasize mass tourism that often destroys critical habitats and leads to other environmental problems. Continued training and the development of sustainable infrastructure are necessary before ecotourism can hope to resolve the conflicts between development and conservation goals.

5. Discussion

5.1. Protected areas: planning, implementation, and enforcement

Currently, about 5.1% of Turkey's land area (40,342 km²) is nominally protected, significantly lower than the average of Organisation for Economic Cooperation and Development countries ([OECD, 2008](#)). According to the World Database of Protected Areas ([IUCN and UNEP-WCMC, 2010](#)), however, this figure is 1.89% of Turkey's terrestrial area and 2.43% of its marine area (territorial waters up to 12 nautical miles), and the protected areas listed by the Ministry of Environment and Forestry ([GDF, 2009](#)) cover 3.1% of the terrestrial area ([Fig. 3](#)). The existence of 18 categories of environmental protection under various government ministries and departments complicates the calculation, jurisdiction and status of protected areas (PAs; [Eken et al., 2006](#)), most of which are threatened by various combinations of building construction, infrastructure projects, dams, water extraction, tourism, mining, poaching, burning, overgrazing, overfishing, overharvesting, introduced species, pollution, and other types of use and abuse. PAs are concentrated in wetland and forest habitats. River, high mountain, shrubland, and steppe ecosystems are especially under-represented ([Eken et al., 2006](#)).

The total area of PAs has increased significantly since 1990 ([Fig. 3](#)). Nonetheless, the 5.1% of national territory protected fell short of the Convention on Biological Diversity target of 10% by 2010. Furthermore, only 1.2% of Turkey's terrestrial area is "strictly" protected, qualifying for IUCN categories I and II, with an additional 1.6% in IUCN categories III and IV ([OECD, 2008](#)). The remaining protected areas, lacking IUCN classification, primarily comprise wildlife reserves that once provided relative protection from extraction and land-use changes ([OECD, 2008](#)), but are now being opened to mining and dam construction ([Aktar, 2011b; Gibbons and Moore, 2011; Alwash, 2011](#)). The Ministry of Culture and Tourism can also designate PAs for natural beauty (SİT designation). Though not originally intended as a comprehensive conservation status, this strict conservation designation has been effective in preventing development from encroaching on valuable habitats. Twenty-five percent of Turkey's Important Bird Areas have only SİT designation ([Eken, 2003](#)). However, as mentioned above (Section 3.5.1), the current government plans to abolish or overhaul the SİT designation altogether, as it can prevent dam building and other types of development ([Evin, 2010; Anonymus, 2011a,b,c; Kivanç, 2011](#)).

International studies, assessments, and reviews of Turkey's conservation efforts mainly use government statistics and reports, which often paint a rosier picture than the reality on the ground.

As with most regions of the globe, Turkey's PAs have typically been designated on off-limits (e.g. borderlands), difficult to exploit (e.g. wetlands), undesirable (e.g. steep mountains), and/or remote lands. PAs frequently do not take the habitat needs of wide-ranging species into consideration and are therefore too small to support viable populations of these species (e.g. [Can and Togan, 2004](#)). Recent interest in ecotourism might foster PAs that encompass core habitat for populations, species, and assemblages of concern. Planning PA networks, rather than single parks with idiosyncratic locations, would benefit both biodiversity and sustainable rural development, especially in the face of climate change. In particular, conifer assemblages and wide-ranging mammalian carnivores in the Kaçkar/Anti-Toros/Toros Mountains, migratory waterfowl and wetland plants across the eastern Anatolian Plateau, migratory and resident avian assemblages along the Marmara and Aegean coasts, and marine vertebrate and invertebrate communities along the southern Mediterranean coast would benefit from such potential networks. Important but isolated protected areas harboring large mammal populations (e.g. Sarıkamış Forest-Allahuekber Mountains National Park in Kars) should be connected to the extensive forests on the Black Sea or Toros mountains by creating wildlife corridors via reforestation, habitat restoration, and forest rehabilitation ([Sekercioglu, 2011](#)). Well-designed networks could also benefit from and augment transboundary conservation efforts with Turkey's neighbors.

However, the fundamental problem regarding PA conservation in Turkey is the disconnect, at the administrative, planning, and executive levels, between policies and their enforcement. Three separate agencies within the MEF (GDNCNP, GDF, and the Environmental Protection Agency for Special Areas) and the Ministry of Culture and Tourism are responsible for 18 different kinds of PAs, resulting in confusion, lack of coordination, overlapping jurisdictions, and waste. The recent division of the Ministry of Environment and Forestry into two ministries (see Introduction) may create additional confusion in PA planning and management.

PAs frequently lack adequate management plans, although recent increased efforts have resulted in management plans for a third of national parks, nature parks, special PAs, Ramsar sites, and wildlife reserves (58 of 174; [Belen et al., 2008](#)). However, management plans still need better preparation, implementation, and assessment ([OECD, 2008](#)). A significant problem is that management plan creation is frequently outsourced to private companies that often minimize the field assessments to maximize their profits. Further, these companies usually have no direct geographic or political relationship to the PA site, creating a disconnect with the local government or environmental NGOs who end up implementing the plans ([OECD, 2008](#)). More generally, PAs are often established without the necessary participatory approach ([Özesmi and Özesmi, 2003; Belen et al., 2008](#)), creating conflicts and challenges at the local, regional, and national levels. Efforts to achieve public participation in PA planning have been increasing ([Özesmi and Özesmi, 2003](#)), but remain inadequate. Poorly prioritized funding hamstring local management ([Belen et al., 2008](#)), while PA revenue returns to the often distant central government. This centralized financial model limits the beneficial effects of conservation to the local economy. Popular areas with high human pressure frequently lack funds for proportionate conservation action. A growing threat, worse than benign neglect, is the development-oriented approach to protected area management. Various government departments, sometimes without knowledge of each other's plans and without any environmental impact assessments, implement unnecessary, costly, and ecologically harmful projects, ranging from "supplementing" a pristine lake with water from a polluted river, to "landscaping" natural meadows in a protected area, building on the shoreline of a protected Ramsar lake next to the breeding area of the globally Endangered white-headed duck

(*Oxyura leucocephala*), or installing permanent barbeque stands in a seasonally-dry national park dominated by conifers (Çağan Şekercioğlu, personal observation).

The current patchwork legislation is inadequate to implement modern conservation strategies. Many of the conservation designations are in fact intended to regulate the use of the area for specific purposes, such as seed, timber or game production. Many of Turkey's existing PAs are practically “paper parks” (*sensu* Dudley and Stolton, 1999). Strict nature protection areas (SİT), affording the highest level of protection, have declined in area since 2006, and may be abolished (Evin, 2010; Anonymous, 2011a,b,c). Illegal construction and tourism development occur in some PAs, including in national parks (OECD, 2008).

Enforcement in PAs often remains inadequate or non-existent due to lack of expertise, limited coordination within and between agencies, and even collusion and corruption. Furthermore, several new government initiatives directly threaten protected areas and their biodiversity. “Wildlife Development Areas” (Yaban Hayatı Geliştirme Sahası) are *de facto* wildlife reserves established to protect large and/or threatened wildlife populations in over 1.2 million ha. Formerly, any development that could negatively affect these areas was banned, but a law passed in 2010 (Act 5995; Republic of Turkey, 2010) allows mining in Wildlife Development Areas. Another law, the “Draft Act on Nature and Biodiversity Conservation”, prepared with almost no public input, has led to widespread opposition by the civil society (Anonymous, 2011a,b,c), triggered the “We Won’t Give up Anatolia” movement (Aktar, 2011b; TWA, 2011), and caused national and international controversy (Evin, 2010; Anonymous, 2011a,b,c; Alwash, 2011; TKIG, 2011). While this bill was supposed to enact a more rational conservation framework in agreement with the European Union norms, the accepted version is cynically and decidedly pro-development (Gibbons and Moore, 2011). The law has redefined terms such as “sustainable use,” “common good,” and the “balance between use and conservation” in order to enable development in protected areas (Evin, 2010; Anonymous, 2011a,b,c; TKIG 2011). The law has also made it possible for the government to overrule local decisions and to abolish a location’s SİT conservation status without any local input in order to remove any environmental obstacles to dam building, tourism construction, and other development in these formerly strictly protected areas (Anonymous, 2011a,b,c). In light of such bureaucratic and legal threats, local communities, NGOs, and government ministries need to coordinate their efforts and identify the most cost-effective management actions to enforce PAs.

5.2. The role of non-governmental organizations (NGOs)

Given the inconsistent and often hostile position of the government toward conservation priorities (Food and Water Watch, 2011), the small conservation NGO community in Turkey has assumed significant responsibility for initial conservation planning and assessment efforts. An NGO will commonly identify an issue, bring in a local academic institution, approach a local government agency, and lobby to create a multi-sector team to address the challenge. Frequently, conservation-oriented university societies evolve into independent NGOs. Many of these NGOs are now repositories of geospatial, field biology, and planning skill sets. Turkish conservation NGOs also act as centers where young biologists are trained on the practical aspects of conservation. Unfortunately, weak public support (Benmayor, 2011) has left most NGOs understaffed and crippling dependent on international funding. Excluding support staff, we estimate that around 50 full-time conservation professionals with adequate training and experience are employed in Turkey's conservation NGOs; i.e. fewer than one in a million.

Most major environmental organizations are based in big cities, far from the rural areas where their year-around presence is most needed. Conservation projects are often conducted remotely and part-time, reducing local grassroots support, weakening the credibility of the “city environmentalists” in the eyes of the rural population, and making it difficult to quickly counter novel threats. Furthermore, Turkish environmental organizations often prioritize competition for limited funding over effective collaboration. These problems, combined with a lack of coordination, have made it difficult for the Turkish environmental movement to be widely accepted by the general public and to achieve widespread success. Consequently, the overall consensus of Turkey's conservationists is that they largely failed in their mission (Oruç, 2011). The increasing availability of funds from the European Union may help Turkey's conservation movement, but this funding has also resulted in an explosion in the number of “environmental” organizations and consultants whose sole mission is writing projects to receive funding, not achieving meaningful conservation.

While environmental NGOs and researchers historically avoided adversarial relationships with the Turkish government, this situation is changing, especially regarding pollution, the government's recent mining and damming initiatives (Anonymous, 2010; Republic of Turkey, 2010; Food and water watch, 2011; Gibbons and Moore, 2011), and the “Draft Act on Nature and Biodiversity Conservation” (Aktar, 2011b; Anonymous, 2011a,b,c; TKIG, 2011; TWA, 2011). In response, environmental activists and protestors have increasingly been denied their democratic rights to protest, detained, arrested, met with disproportionate force and accused of being the “agents of foreign powers” (Food and Water Watch, 2011) disproportionate force.

5.3. Fostering a culture of conservation

Turkey faces a host of major challenges as it looks to preserve its natural heritage while rapidly developing over the coming century (Gibbons and Moore, 2011). In addition to the legal and governmental issues related to conservation planning and enforcement, perhaps the most troubling is a general lack of good conservation education and a broad conservation ethic. Public opinion polling in late 2010 shows that while 63% of Turks believe their government should pass laws to protect the environment, only 1.3% view environment-related issues as a major concern (Kalaycıoğlu and Çarkoğlu, 2011). Conservation biology and environmental science education in the universities is in its infancy. Only a handful of Turkey's 170 universities offer courses in conservation biology or advanced degrees (M.Sc. or Ph.D.) in wildlife management or conservation biology. Turkey's citizens do appreciate nature, as evidenced by the popularity of picnicking (Akatay, 2011) and hunting, but the general lack of awareness about environmental issues and the absence of a strong conservation ethic prevents large-scale support for conservation (Bodur and Sarıgöllü 2005; Yörek et al. 2008; Taşkın 2009). Building a constituency to support protection and rehabilitation of natural resources is necessary and has been the focus of many non-profit ventures in recent years. Some nascent environmental NGOs such as KuzeyDoğa (www.kuzeydog-a.org) have particularly targeted public outreach. Books, magazines, TV programs, and other nature-oriented media have been expanding their viewerships rapidly over the past decade.

Turkey's unparalleled cultural and historical heritage is often ignored in conservation and management efforts. While many Turkish people may not be aware of basic ecological principles or natural history, most are very familiar with and passionate about the history of Turkey. This passion could be exploited such that, for example, rather than starting a conversation on the Sarıkamış forests in eastern Turkey with a description of the area's diverse plants and animals, one might introduce the forest as the location

of the martyrdom of 90,000 brave Turks fighting the Russians. In fact, this was the main reason for the creation of the Sarıkamış Forest-Allahuekber Mountains National Park. Likewise, instead of beginning a dialog on large predator conservation by describing ecological interactions, one could describe the Roman-era stone traps for Anatolian tigers and leopards still visible in the Toros Mountains. Alternatively, one could detail the abundant, still-vibrant felid murals at important ancient sites, such as 1000-year-old Ani, 3000-year-old Ephesus, 9500-year-old Çatalhöyük or 11,600-year-old Göbeklitepe, depicting the reverence and focal role that animals played in various civilizations from pre-history to the Ottomans. Nostalgia for nature and the outdoors can also be a powerful means to engage city-dwellers who often fondly recall their childhoods in rural Turkey. Historical, cultural, and personal tie-ins are therefore effective yet underutilized ways to raise awareness and interest in conservation.

5.4. The road ahead

The greatest proximate threat to Turkey's biodiversity is the continued active destruction and fragmentation of remnant ecological communities. In particular, the “hardening” of the matrix (via intensification of agricultural practices, hydroelectric projects, expanding cities, towns, and tourism developments, etc.) between the remaining patches of relatively intact communities may trigger additional extinctions of species and reduce ecosystem functions and services in the coming decades. Irrigation projects, wetland draining, dam construction, poaching, and unchecked development are the most widespread threats (Eken et al., 2006; Gibbons and Moore, 2011). The current government, practically unopposed, easily and cynically modifies existing laws and passes new ones to remove any environmental obstacles to the construction of dams, mines, factories, roads, bridges, housing projects, and tourism developments. Such construction increasingly occurs in “protected” areas, often at the expense of local people (Gibbons and Moore, 2011). Overdrafting of surface and subsurface waters, overgrazing and overharvesting of natural vegetation, and overexploitation of large mammals and fish stocks also need to be addressed immediately.

While we do not advocate an absolute cessation of water diversions, hunting, and other extractive practices, it is imperative that the needs of ecological communities be genuinely included in the planning and management of such activities (Chapron et al., 2010). Despite some excellent examples of government officials in various ministries and locations taking such steps, such concerns are usually given mere lip service. Ecological considerations and prioritizations need to be enacted throughout all institutions dealing with natural resource management. In addition, more needs to be done in terms of field-based case studies and reviews of existing and completed conservation projects, their goals, challenges, management, implementation, and results.

Mitigation requirements for recent national and multinational development efforts (hydroelectric projects, pipelines, railways, etc.) have bolstered numerous conservation activities in the past decade. Turkish conservation efforts historically emphasized single-species management, but recent efforts are more likely to take ecosystem-based management approaches, framing project benefits in the context of tangible ecosystem services and sustainable development, often at the scale of single villages.

Looking to the future, we are encouraged by improving relationships with Turkey's neighbors and its burgeoning role as a regional and global economic and political leader. Warming relations and a reduction in conflicts and poverty are bringing more large-scale development to Turkey's eastern and southeastern borderlands. Our enthusiasm surrounding these changes is tempered by the threats of additional construction, transportation corridors, dams,

intensive agriculture, pollution, overexploitation, and other activities resulting from a “developmentalist obsession” (Aktar, 2011a,b). Turkey's rapidly improving relationships with its neighbors and the consequent increase in trade, traffic, and tourism urgently require international and transboundary conservation efforts. Turkey's public and private conservation community is still young and emerging. Continued and increasing support from national and international partners will help Turkey place natural resource protection and sustainable development on par with other concerns.

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References

- Abolafya, M., 2011. Environmental Distribution Modeling of Resident and Migratory Passerine Birds from Turkey from a Climate Change Perspective. M.Sc. Thesis, Boğaziçi University, İstanbul.
- Aguilar, A., Lowry, L., 2008. *Monachus monachus*. In: IUCN Red List of Threatened Species, Version 2009.2. <<http://www.iucnredlist.org>> (accessed 15.01.10).
- Akatay, 2011. The Turkish picnic has become more than a family affair. *Hürriyet Daily News*. <<http://www.hurriyetdailynews.com/n.php?n=mom-the-turks-are-picnicking-2011-05-10>> (accessed 20.05.11).
- Akbulut, N., Bayarı, S., Akbulut, A., Şahin, Y., 2009. Rivers of Turkey. In: Tockner, K., Robinson, C.T., Uehlinger, U. (Eds.), *Rivers of Europe*. Academic Press, London, pp. 643–672.
- Akçakaya, H.R., 1990. Bald ibis (*Geronticus eremita*) population in Turkey - an evaluation of the captive breeding project for reintroduction. *Biological Conservation* 51, 225–237.
- Akın, G., 2006. Geçmişten günümüze Anadolu ormanları ve insan. *Kırsal Çevre Yıllığı. Kırsal Çevre ve Ormanlık Sorunları Araştırma Derneği*, Ankara, pp. 19–31 (in Turkish).
- Aksoy, N., 2006. Maki. In: Eken, G., Bozdoğan, M., İsfendiyoğlu, S., Kılıç, D.T., Lise, Y. (Eds.), *Türkiye'nin Önemli Doğa Alanları. Doğa Derneği*, Ankara, pp. 40–42 (in Turkish).
- Aktar, N., 2011a. Good news: as government imposes its views environmental awareness increases. *Hürriyet Daily News*. <<http://www.hurriyetdailynews.com/n.php?n=good-news-as-government-imposes-its-views-environmental-awareness-increases-2011-04-14>> (accessed 18.05.11).
- Aktar, N., 2011b. March of Anatolia against the plunder of nature, culture, cities. *Hürriyet Daily News*. <<http://www.hurriyetdailynews.com/n.php?n=the-great-march-of-anatolia-against-the-plunder-of-nature-culture-and-cities-2011-04-29>> (accessed 18.05.11).
- Aktar, N., 2011c. On growth and growth disorder. *Hürriyet Daily News*. <<http://www.hurriyetdailynews.com/n.php?n=on-growth-and-growth-disorder-2011-05-13>> (accessed 18.05.11).
- Akyol, Ç.V., 2011. Türkiye'de arıcılık ve sorunları. *İnternet Haber*. <<http://www.internethaber.com/turkiyede-aricilik-ve-sorunlari-11091y.htm>> (accessed 13.02.11) (in Turkish).
- Altan, T., 1993. Türkiye'nin Doğal Bitki Örtüsü. Çukurova Üniv., Ziraat Fak. Ders Kitabı No: 70, Adana, s. 204.
- Alwash, A. 2011. Letter to the Turkish Speaker of the Grand National Assembly and the Minister of Environment. <<http://www.natureiraq.org/site/en/node/226>>.
- Anadolu Ajansı, 2010. Eroğlu: Sera gazını düşürelim ama kalkınma engellenmesin. <<http://www.haber7.com/haber/20101112/Eroglu-Sera-gazini-dusurelim-ama-kalkinma-engellenmesin.php>> (accessed 12.02.11) (in Turkish).

- Anatolia News Agency, 2011. Loans for renewables go to dams only. *Hürriyet Daily News*. <<http://www.hurriyetdailynews.com/n.php?n=loans-for-renewables-go-to-dams-only-2011-03-14>> (accessed 24.05.11).
- Angel, J.L., 1972. Population. *World Archaeol.* 4, 88–105.
- Anonymous, 2010. Turkey's plan to redirect river sparks controversy. *AzerNews*. <http://www.azernews.az/en/Region/21946-Turkey%E2%80%99s_plan_to_redirect_river_sparks_controversy> (accessed 03.01.11).
- Anonymous, 2011a. Dams in Turkey's Black Sea region not as clean as presumed. *Hürriyet Daily News*. <<http://www.hurriyetdailynews.com/n.php?n=dams-not-so-clean-as-pretended-to-be-2010-07-21>> (accessed 02.05.11).
- Anonymous, 2011b. Tartışmalı kanun kabul edildi. NTVMSNBC Turkey. <<http://www.ntvmsnbc.com/id/25193267/>> (accessed 20.03.11) (in Turkish).
- Anonymous, 2011c. Turkish amendment on monitoring dams worries environmentalists. *Hürriyet Daily News*. <<http://www.hurriyetdailynews.com/n.php?n=amendment-on-monitoring-of-dams-worries-environmentalists-2011-02-15>> (accessed 26.05.11).
- Atalay, İ., 1994. *Vegetation Geography of Turkey*. Aegean University Press, İzmir, Turkey.
- Atalay, İ., 2006. The effects of mountainous areas on biodiversity: a case study from the northern Anatolian Mountains and the Taurus Mountains. In: *Proceedings of the 8th International Symposium on High Mountain Remote Sensing Cartography*, vol. 41, pp. 17–26.
- Balkas, T. et al., 1990. Review of the State of the Marine Environment of the Black Sea. UNEP Reg. Seas Rep. Stud. No. 124. UNEP, Nairobi.
- Baran, İ., Ilgaz, Ç., 2006. Türkiye'nin Çift Yaşamlıları ve Sürünenleri. In: Eken, G., Bozdoğan, M., İsfendiyaroğlu, S., Kılıç, D.T., Lise, Y. (Eds.), *Türkiye'nin Önemli Doğa Alanları*. Doğa Derneği, Ankara, Turkey, pp. 51–52 (in Turkish).
- Baran, İ., Durmuş, H., Çevik, E., Üçüncü, S., Canbolat, A.F., 1992. Türkiye Deniz kaplumbağaları stok tespiti. *Doğa-Türk. J. Zool.* 16, 119–139 (in Turkish).
- Başer, K.H.C., 2002. Aromatic biodiversity among the flowering plant taxa of Turkey. *Pure Appl. Chem.* 74, 527–545.
- Baytaş, A., 2007. *A Field Guide to the Butterflies of Turkey*. NTV Yayınları, İstanbul.
- Baytop, T., 1974. The presence of the tiger (*Panthera tigris*) in Turkey. *Saugetierkd. Mitt.* 22, 254–256 (in French with German summary).
- Beklioğlu, M., Tan, C.O., 2008. Restoration of a shallow Mediterranean Lake by biomanipulation complicated by drought. *Fundamental and Applied Limnology* 171, 105–118.
- Belen, İ., Başara, H., Lise, Y., 2008. Türkiye ulusal doğa koruma raporu. Man and the Biosphere Workshop, Antalya, Turkey (in Turkish).
- Benmayor, G., 2011. Why the reluctance towards NGOs? *Hürriyet Daily News*. <<http://www.hurriyetdailynews.com/n.php?n=why-the-reluctance-toward-ngos-2011-07-15>> (accessed 21.07.11).
- Berman, T., Townsend, D.W., El Sayed, S.Z., Trees, C.C., Azov, Y., 1984. Optical transparency, chlorophyll and primary productivity in the eastern Mediterranean near the Israeli coast. *Oceanol. Acta* 7, 367–372.
- Bilgin, R., Karataş, A., Çoraman, E., Morales, J.C., 2008. The mitochondrial and nuclear genetic structure of *Myotis capaccinii* (Chiroptera: Vespertilionidae) in the Eurasian transition, and its taxonomic implications. *Zool. Scripta* 37, 253–262.
- Bilgin, R., 2011. Back to the Suture: the distribution of intraspecific genetic diversity in and around Anatolia. *Int. J. Mol. Sci.* 12, 4080–4103.
- BirdLife International, 2004. *Birds in Europe: Population Estimates, Trends and Conservation Status*. BirdLife International, Cambridge, United Kingdom.
- Bodur, M., Sarıoğlu, E., 2005. Environmental sensitivity in a developing country: consumer classification and implications. *Environ. Behav.* 37, 487–510.
- Bolz, D.M., 2009. Endangered Site: The City of Hasankeyf, Turkey. *Smithsonian March 2009*. <<http://www.smithsonianmag.com/travel/Endangered-Cultural-Treasures-The-City-of-Hasankeyf-Turkey.html>>.
- Boşgelmez, A., Boşgelmez, İ., Savaşçı, S., Paşlı, N., Kaynaş, S., 1997. *Ekoloji-I*. ISVAK Yayınları, Ankara, Turkey (in Turkish).
- Boydak, M., Dirik, H., Çalıköğü, M., 2006. *Biology and Silviculture of Turkish Red Pine (Pinus brutia ten.)*. OGEEM-VAK Publ., Ankara, Turkey.
- Braun, D., 2009. Turkey's First Island Sanctuary for Birds is Built from an Old Dirt Road. *National Geographic Society, Washington, DC*. <<http://blogs.nationalgeographic.com/blogs/news/chiefeditor/2009/05/turkey-bird-island.html>> (accessed 13.02.11).
- Braun, D., 2010. Turkey Opens Restaurant for Vultures. *National Geographic Society, Washington, DC*. <<http://blogs.nationalgeographic.com/blogs/news/chiefeditor/2010/02/turkey-vulture-restaurant.html>> (accessed 13.02.11).
- Breitenmoser, U., Alizadeh, A., Breitenmoser-Würsten, C., 2009. Conservation of the Asiatic Cheetah, its Natural Habitat and Associated Biota in the I.R. of Iran. Project Number IRA/00/G35 Terminal Evaluation Report. Bern.
- Bulut, İ., Zaman, M., Hadimli, H., 2007. Alternative tourism activities for the riviera of Turkey (AKSEKİ). In: *International Symposium on Geography, Environment, and Culture in the Mediterranean Region*. <<http://web.deu.edu.tr/geomed2010/2007/Bulut.pdf>> (accessed 27.01.11).
- Camcı-Çetin, S., Karaca, A., Haktanır, K., Yıldız, H., 2007. Global attention to Turkey due to desertification. *Environ. Monit. Assess.* 128, 489–493.
- Can, Ö.E., Togan, İ., 2004. Status and management of brown bears in Turkey. *Ursus* 15, 48–53.
- Can, Ö.E., Togan, İ., 2009. Camera trapping of large mammals in Yenice Forest, Turkey: local information versus camera traps. *Oryx* 43, 427–430.
- Canbolat, A., 2004. A review of sea turtle nesting activity along the Mediterranean coast of Turkey. *Biol. Conserv.* 116, 81–91.
- Center for Entomological Studies Ankara (CESA), 2010. Number of the Pterygot Species Recorded in Turkey Based Upon Info-system of the CESA. <<http://www.cesa-tr.org/numbertr.htm>> (accessed 13.07.11).
- Chapron, G., Ottery, C., Holmes, T., Monbiot, G., Randerson, J., 2010. *Biodiversity 100: Actions for Europe*. <<http://www.guardian.co.uk/environment/2010/oct/04/biodiversity-100-actions-europe>> (accessed 04.10.10).
- Cigna, A.A., Vosniakos, F.K., Vasilikiotis, G., Foster, P., 2002. Environmental impact assessment of a nuclear power plant in the eastern Mediterranean area. *J. Environ. Protect. Ecol.* 3, 407–413.
- Conservation International, 2005. *Map of Biodiversity Hotspots*. <<http://www.conservation.org/Documents/cihotspotmap.pdf>> (accessed 13.02.11).
- Cuttelod, A., Garcia, V., Abdul Malak, D., Temple, H.J., Katariya, V., 2009. The Mediterranean: a biodiversity hotspot under threat. In: Vié, J.-C., Hilton-Taylor, C., Stuart, S.N. (Eds.), *Wildlife in a Changing World: An Analysis of the 2008 IUCN Red List of Threatened Species*. IUCN, Gland, Switzerland, pp. 89–101.
- Çağlar, S.S., İpekbal, K., 2009. A biogeographical evaluation of the Turkish Simuliidae fauna. *Acta Zool. Lit.* 19, 148–151.
- Çıldır, H., 2001. *Introduction of Exotic Vertebrates in Turkey: A Review and an Assessment of Their Impact*. Department of Biology, Middle East Technical University, Ankara, Turkey.
- Çınar, M.E., 2006. Serpulid species (Polychaeta: Serpulidae) from the Levantine coast of Turkey (eastern Mediterranean), with special emphasis on alien species. *Aquat. Inv.* 1, 223–240.
- Çınar, M.E., 2009. Alien polychaete species (Annelida: Polychaeta) on the southern coast of Turkey (Levantine Sea, eastern Mediterranean), with 13 new records for the Mediterranean Sea. *J. Nat. Hist.* 43, 2283–2328.
- Çınar, M.E., Bilecenoglu, M., Öztürk, B., Katakçı, T., Aysel, V., 2005. Alien species on the coasts of Turkey. *Med. Mar. Sci.* 6, 119–146.
- Çıplak, B., 2003. Distribution of Tettigoniinae (Orthoptera, Tettigoniidae) bush-crickets in Turkey: the importance of the Anatolian Taurus Mountains in biodiversity and implications for conservation. *Biodivers. Conserv.* 12, 47–64.
- Çıplak, B., 2008. The analogy between interglacial and global warming for the glacial relicts in a refugium: a biogeographic perspective for conservation of Anatolian Orthoptera. In: Fattorini, S. (Ed.), *Insect Ecology and Conservation*. Research Signpost, Kerala, India, pp. 135–163.
- Çıplak, B., Yalın, B., Demirsoy, A., Sevgili, H., 2002. Türkiye Orthoptera (Düzkanatlı - Çekirge) faunası. In: Demirsoy, A. (Ed.), *Genel ve Türkiye Zooğrafyası*, third ed. Meteksan, Ankara, pp. 681–707 (in Turkish).
- Çolak, H.A., 2006. Dağlar. In: Eken, G., Bozdoğan, M., İsfendiyaroğlu, S., Kılıç, D.T., Lise, Y. (Eds.), *Türkiye'nin Önemli Doğa Alanları*. Doğa Derneği, Ankara, Turkey, pp. 37–40 (in Turkish).
- Çolak, H.A., Rotherham, I.D., 2006. A review of the forest vegetation of Turkey: its status past and present and its future conservation. *Biol. Environ.* 106B, 343–354.
- Dağlı, E., Ergen, Z., 2008. First record of *Polydora cornuta* Bosc, 1802 (Polychaeta: Spionidae) from the Sea of Marmara, Turkey basin. *Aquat. Inv.* 3, 231–233.
- Dalfes, H.N., Şen, Ö.L., Önel, B., Turunçoğlu, U.U., Bozkurt, D., Kindap, T., Karaca, M., Fer, İ., Ural, D., 2010. *Climate Projections for Turkey through Downscaling*. MDGF-1680 Project, Unpublished Report, Ankara, Turkey.
- Dalkır, Ö., Şesen, E., 2011. Çevre ve Temiz Enerji: Hidroelektrik. Çevre ve Orman Bakanlığı, Devlet Su İşleri Genel Müdürlüğü, Ankara (in Turkish).
- Davis, P.H. (Ed.), 1965. *Flora of Turkey and the East Aegean Islands*, vol. 1–9. Edinburgh University Press, Edinburgh.
- Davis, P.H., Mill, R.R., Tan, K., 1988. *Flora of Turkey and the East Aegean Islands*, vol. 10. Edinburgh University Press, Edinburgh.
- Demir, M., 2003. Shells of mollusca collected from the Seas of Turkey. *Turk. J. Zool.* 27, 101–140.
- Demircan, N., Öz, İ., Stephenson, R., Karahan, F., 2006. Ekoturizm ve botanik turizm: Türkiye'nin sukkulent bitki çeşitliliğinin turizm potansiyeli. In: *Proc. 5th GAP Eng. Congr.*, 26–28 April, 2006, Şanlıurfa, Turkey (in Turkish).
- Demirsoy, A., 2000. Türkiye Omurgalıları: Memeliler. Meteksan, Ankara (in Turkish).
- Demirsoy, A. (Ed.), 2002. *Genel ve Türkiye Zooğrafyası*, third ed. Meteksan, Ankara (in Turkish).
- Dik, B., Sekercioğlu, C.H., Kırpık, M.A., İnak, S., Uslu, U., 2010. Chewing lice (Phthiraptera) species found on Turkish shorebirds (Charadriiformes). *Kafkas Univ. Vet. Fak. Derg.* 16, 867–874.
- Dik, B., Sekercioğlu, C.H., Kırpık, M.A., 2011. Chewing lice (Phthiraptera) species found on birds along the Aras River, Iğdır, Eastern Turkey. *Kafkas Univ. Vet. Fak. Derg.* 17, 567–573.
- Doğa Derneği, 2005. Kuşlar barajı geçemedi. <<http://www.dogaderneği.org/kuslar-barajı-gecemedi.aspx>> (accessed 13.02.11) (in Turkish).
- Doğan, Y., Başlar, S., Mert, H.H., Ay, G., 2003. Plants used as natural dye sources in Turkey. *Econ. Bot.* 57, 442–453.
- Doğan News Agency, 2011. Fishing season starts in Turkey amid activist worries. <<http://www.hurriyetdailynews.com/n.php?n=fishing-season-starts-in-turkey-amid-activist-worries-2011-09-01>> (accessed 09.04.11).
- Dönmez, A.A., 2004. The genus *Crataegus* L. (Rosaceae) with special reference to hybridisation and biodiversity in Turkey. *Turk. J. Bot.* 28, 29–37.
- Dudley, N., Stolton, S., 1999. *Conversion of Paper Parks to Effective Management: Developing a Target*. Report to the WWF-World Bank Alliance from the IUCN/WWF Alliance for Forest Conservation and Sustainable Use.
- Duellman, W.E., 1999. *Patterns of Distribution of Amphibians: A Global Perspective*. Johns Hopkins University Press, Baltimore, MD.
- Eken, G., 2003. *Biyolojik çeşitlilik ve doğal sitler*. Yeşil Atlas (in Turkish).
- Eken, G., Bozdoğan, M., İsfendiyaroğlu, S., Kılıç, D.T., ve Lise, Y. (Eds.), 2006. *Türkiye'nin Önemli Doğa Alanları*. Doğa Derneği, Ankara, Turkey (in Turkish).
- Ekim, T., 2006. Türkiye'nin bitkileri. In: Eken, G., Bozdoğan, M., İsfendiyaroğlu, S., Kılıç, D.T., Lise, Y. (Eds.), *Türkiye'nin Önemli Doğa Alanları*. Doğa Derneği, Ankara, Turkey, pp. 47–48 (in Turkish).

- Ekim, E., Koyuncu, M., Vural, M., Duman, H., Aytaç, Z., Adıgüzel, N., 2000. Red Data Book of Turkish Plants (Pteridophyta and Spermatophyta). Turkish Association for the Conservation of Nature and Van Centennial University, Ankara, Turkey.
- Emeksiz, I., 2011. Turkey's Kütahya at Major Risk from Potential Cyanide Spill, Experts Say. *Hürriyet Daily News*. <<http://www.hurriyetdailynews.com/n.php?n=8216constructing-a-new-dam-is-not-a-permanent-precaution8217-2011-05-09>>.
- Erk'akan, F., 2006. Türkiye'nin İçsu Balıkları. In: Eken, G., Bozdoğan, M., İsfendiyoğlu, S., Kılıç, D.T., Lise, Y. (Eds.), *Türkiye'nin Önemli Doğa Alanları*. Doğa Derneği, Ankara, Turkey, pp. 53–55 (in Turkish).
- Evin, M., 2010. Hukuk çığnendiği için SİT kararı alınıyor. *Milliyet*. <<http://www.milliyet.com.tr/hukuk-cignendigi-icin-sit-karari-aliniyor/mehvesevin/guncel/yazardetay/29.10.2010/1307370/default.htm>> (accessed 03.11.10) (in Turkish).
- Fıncıoğlu, H.K., Seefeldt, S.S., Şahin, B., Vural, M., 2009. Assessment of grazing effect on sheep fescue (*Festuca valesiaca*) dominated steppe rangelands, in the semi-arid Central Anatolian region of Turkey. *J. Arid Environ.* 73, 1149–1157.
- Food and Agriculture Organization (FAO), 2009. State of the World Fisheries and Aquaculture 2008. Fisheries and Aquaculture Department, Rome, 178 pp.
- Food and Agriculture Organization (FAO), 2010. FAOSTAT Database. <<http://faostat.fao.org/site/339/default.aspx>> (accessed 28.01.11).
- Food and Water Watch, 2011. Harrassment of Turkish water activists continues after death of Metin Lokumcu. <<http://www.foodandwaterwatch.org/blogs/harrassment-of-turkish-water-activists-continues-after-death-of-metin-lokumcu/>> (accessed 28.07.11).
- Fricke, R., Bilecenoğlu, M., Sarı, H.M., 2007. Annotated checklist of fish and lamprey species of Turkey, including a Red List of threatened and declining species. *Stuttgarter Beiträge Naturkunde Ser. A (Biol.)* 706, 1–169.
- Furman, A., Postawa, T., Öztunç, T., Çoraman, E., 2010. Cryptic diversity of the bent-wing bat, *Miniopterus schreibersii* (Chiroptera: Vespertilionidae), in Asia Minor. *BMC Evol. Biol.* 10, 121.
- Galatchi, L.-D., Tudor, M., 2006. Europe as a source of pollution – the main factor for the eutrophication of the Danube Delta and Black Sea. In: *Chemicals as Intentional and Accidental Global Environmental Threats*. NATO Security through Science Series, pp. 56–63.
- Galil, B.S., 2008. Alien species in the Mediterranean Sea – which, when, where, why? *Hydrobiologia* 606, 105–116.
- Gavashelishvili, L., Javakhishvili, Z., 2010. Combining radio-telemetry and random observations to model the habitat of Near Threatened Caucasian grouse *Tetrao mlokosiewiczii*. *Oryx* 44, 491–500.
- GDF (General Directorate of Forestry), 2009. 2009 Forestry Statistics. <<http://web.ogm.gov.tr/Dkmanlar/istatistikler/OrmancilikIst2009.rar>> (accessed 20.05.11) (in Turkish).
- Gençkan, M.S., Avcıoğlu, R., Soya, H., Doğan, O.O., 1990. Suggestions for the problems of usage, conservation and improvement of Turkey's rangelands. In: *Proc. 3rd Tech. Congr. Turkish Agr. Eng.*, Ankara, Turkey, pp. 53–61 (in Turkish).
- General Directorate of Nature Conservation and National Parks (GDNCNP), 2010. Sulak alanlar (Wetlands). <http://www.milliparklar.gov.tr/dkmp/anasayfa/dogakorumahaber/10-02-14/Sulak_Alan_Nedir.aspx?sflang=tr> (accessed 13.02.11) (in Turkish).
- Gezer, A., 1986. The sylviculture of *Pinus brutia* in Turkey. *CIHEAM, le pin d'Alep et le pin brutia dans la sylvi-culture méditerranéenne*. Options Méditerranéennes, Sér. Etudes, Paris 1, 55–66.
- Gibbons, F., Moore, L., 2011. Turkey's Great Leap Forward risks cultural and environmental bankruptcy. *The Guardian*. May 30, 2011, p. 19. <<http://www.guardian.co.uk/world/2011/may/29/turkey-nuclear-hydro-power-development?INTCMP=SRCH>> (accessed 30.05.11).
- Glazer, B.T., Luther, G.W., Konovalov, S.K., Friederich, G.G., Nuzzio, D.B., Trouwburst, R.E., Tebo, B.M., Clement, B., Murray, K., Romanov, A.S., 2006. Documenting the suboxic zone of the Black Sea via high-resolution real time redox profiling. *Deep Sea Res. II* 53, 1740–1755.
- Gönlügür-Demirci, G., 2006. Crustacean fauna of the Turkish Black Sea coasts: a check list. *Crustaceana* 79, 1129–1139.
- Gray, R., 2010. Undersea river discovered flowing on sea bed. *The Telegraph*, London. <<http://www.telegraph.co.uk/earth/environment/7920006/Undersea-river-discovered-flowing-on-sea-bed.html>> (accessed 30.04.11).
- Gritti, E.S., Smith, B., Sykes, M.T., 2006. Vulnerability of Mediterranean basin ecosystems to climate change and invasion by exotic plant species. *J. Biogeogr.* 33, 145–157.
- Güçlü, K., Karahan, F., 2004. A review: the history of conservation programs and development of the national parks concept in Turkey. *Biodivers. Conserv.* 13, 1373–1390.
- Günay, T., 2003. Ormanlığımızın tarihçesine kısa bir bakış. *Tarım Orkam-Sen, Form Ofset*, Ankara (in Turkish).
- Gündüz, I., Jaarola, M., Tez, C., Yeniurt, C., Polly, P.D., Searle, J.B., 2007. Multigenic and morphometric differentiation of ground squirrels (Spermophilus, Scuriidae, Rodentia) in Turkey, with a description of a new species. *Mol. Phylogenet. Evol.* 43, 916–935.
- Güner, A., Özhataş, N., Ekim, T., Başer, K.H.C. (Eds.), 2000. *Flora of Turkey and the East Aegean Islands*, vol. 11. Edinburgh University Press, Edinburgh.
- Güneş, Y., Elvan, O.D., 2005. Illegal logging activities in Turkey. *Environ. Manage.* 36, 220–229.
- Hardin, G., 1968. The tragedy of the commons. *Science* 162, 1243–1248.
- Harper, F., 1945. *Extinct and Vanishing Mammals of the Old World*. American Committee for International Wild Life Protection, New York.
- Hattam, J., 2011. Big builders to lead Turkish environmental ministries. *Treehugger*. <<http://www.treehugger.com/files/2011/07/build-builders-to-lead-turkish-environmental-ministries.php>> (accessed 30.08.11).
- Hay, B.J., 1994. Sediment and water discharge rates of Turkish Black Sea rivers before and after hydropower dam construction. *Environ. Geol.* 23, 276–283.
- Heçan, Ç.C., Turan, İ.A., Özkan, M.B., 2010. Monitoring land use change in the Çeşme coastal zone, Turkey using aerial photographs and satellite imaging. *Land Degrad. Develop.* doi:10.1002/ldr.997.
- Hesselbarth, G., Van Oorschot, H., Wagener, S., 1995. Die Tagfalter der Türkei unter Berücksichtigung der angrenzenden Länder: (Lepidoptera, Papilionoidea, und Hesperioidea). Goecke and Evers, Keltern (in German).
- Hoekstra, J.M., Boucher, T.M., Ricketts, T.H., Roberts, C., 2005. Confronting a biome crisis: global disparities of habitat loss and protection. *Ecol. Lett.* 8, 23–29.
- Hürriyet Daily News, 2010a. Draft law will make it harder to fight dams, Turkish activists say. <<http://www.hurriyetdailynews.com/n.php?n=turkish-govt-counterattacks-to-win-war-over-hydro-power-2010-10-28>> (accessed 16.01.11).
- Hürriyet Daily News, 2010b. Turkish environment minister defends controversial dams. <<http://www.hurriyetdailynews.com/n.php?n=environment-minister-defends-controversial-dams-2010-10-21>> (accessed 16.01.11).
- Hürriyet Daily News, 2011. Professor may be tried over scientific report. <<http://www.hurriyetdailynews.com/n.php?n=professor-may-tried-over-scientific-report-2011-05-20>> (accessed 24.05.11).
- İlgaz, Ç., Türkozan, O., Özdemir, A., Kaska, Y., Stachowitsch, M., 2007. Population decline of loggerhead turtles: two potential scenarios for Fethiye beach, Turkey. *Biodivers. Conserv.* 16, 1027–1037.
- International Panel on Climate Change Working Group (IPCC), 2007. Fourth Assessment Report: Climate Change 2007. Cambridge University Press, Cambridge. <http://www.ipcc.ch/publications_and_data/publications_and_data_reports.shtml#1> (accessed 13.02.11).
- IUCN, UNEP-WCMC, 2010. The World Database on Protected Areas (WDPA). UNEP-WCMC, Cambridge, UK.
- IUCN, 2011. IUCN Red List of Threatened Species. Version 2011.1. <<http://www.iucnredlist.org>>.
- İnnal, D., Erk'akan, F., 2006. Effects of exotic and translocated fish species in the inland waters of Turkey. *Rev. Fish. Biol. Fish.* 16, 39–50.
- Jannasch, H.W., 1991. Microbial processes in the Black Sea water column and top sediment: an overview. In: Izdar, E., Murray, J.W. (Eds.), *Black Sea Oceanography*. Kluwer Academic Publishers, Dordrecht, The Netherlands, pp. 271–286.
- Johnson, K., 2002. The status of mammalian carnivores in Turkey. *Endangered Species Update* 19, 232–240.
- Joukowsky, M.S., Blackburn, J., 1996. *Early Turkey: An Introduction to the Archaeology of Anatolia from Prehistory Through the Lydian Period*. Kendall Hunt Pub Co., Dubuque.
- Kalaycıoğlu, E., Çarkoğlu, A., 2011. Report on Environment in Turkey. Sabancı University, İstanbul. <<http://www.hurriyetdailynews.com/n.php?n=protecting-the-environment-is-not-the-highest-priority-for-turkish-people-says-report-2011-05-16>>.
- Kandul, N.P., Coleman, J.W.S., Lukhtanov, V., Dantchenko, A., Sekercioğlu, Ç.H., Haig, D., Pierce, N.E., 2004. Phylogeny of *Agrodiaetus* (Hubner 1822, Lepidoptera: Lycaenidae) inferred from mtDNA sequences of COI and COII and nuclear sequences of EF1- α : karyotype diversification and species radiation. *Syst. Biol.* 53, 278–298.
- Kara, Ö.F., Aktaş, M., 2001. Akdeniz endüstriyel balıkçılığı üzerine araştırma. *T.C. Tarım ve Köyişleri Bakanlığı, Bodrum Su Ürünleri Araştırma Enstitüsü Yayınları* No. 7, Seri B, 59 s (in Turkish).
- Karaçetin, E., Welch, H. (Eds.), 2011. *Red Book of Butterflies of Turkey*. Nature Conservation Center, Ankara.
- Karasu, A.R., 2010. Ormandaki bitkilerin ihracatı 50 milyon dolar getirdi. *Zaman*, November 23, 2010. <<http://www.zaman.com.tr/haber.do?haberno=1055842>> (accessed 13.02.11) (in Turkish).
- Karataş, A., 2006. Türkiye'nin memelileri. In: Eken, G., Bozdoğan, M., İsfendiyoğlu, S., Kılıç, D.T., Lise, Y. (Eds.), *Türkiye'nin Önemli Doğa Alanları*. Doğa Derneği, Ankara, Turkey, pp. 50–51 (in Turkish).
- Kaya, Z., Raynal, D.J., 2001. Biodiversity and conservation of Turkish forests. *Biol. Conserv.* 97, 131–141.
- Kaygusuz, K., 2011. Prospect of concentrating solar power in Turkey: the sustainable future. *Renew. Sustain. Energy Rev.* 15, 808–814.
- Kazancı, N., Leroy, S., İleri, O., Emre, O., Kibar, M., Öncel, S., 2004. Late Holocene erosion in NW Anatolia from sediments of Lake Manyas, Lake Ulubat and the southern shelf of the Marmara Sea, Turkey. *Catena* 57, 277–308.
- Kempe, S., Kazmierczak, J., Landmann, G., Konuk, T., Reimer, A., Lipp, A., 1991. Largest known microbialites discovered in Lake Van, Turkey. *Nature* 349, 605–608.
- Keşioğlu, A., 2010. Distribution Patterns of Bats in Eastern Mediterranean Region Through A Climate Change Perspective. M.Sc. Thesis, Boğaziçi University, İstanbul.
- Kılıç, T., Eken, G., 2004. Türkiye'nin Önemli Kuş Alanları Güncellemesi. Doğa Derneği, Ankara (in Turkish).
- Kıslaloğlu, M., Berkes, F., 1987. *Biyolojik Çeşitlilik. Türkiye Çevre Sorunları Vakfı*, Ankara (in Turkish).
- Kıvanç, A., 2011. Çevre Bakanlığı sit'leri sildi. *Milliyet*. <<http://gundem.milliyet.com.tr/cevre-bakanligi-sit-leri-sildi/gundem/gundemdetay/23.08.2011/1430323/default.htm>> (accessed 23.08.11) (in Turkish).
- Kızmaz, M., 2000. Policies to promote sustainable forest operations and utilisation of non-wood forest products. In: *Seminar Proceedings Harvesting of Non-Wood Forest Products*, p. 432.

- Kideys, A.E., 2002. Fall and rise of the Black Sea ecosystem. *Science* 297, 1482–1484.
- Kirwan, G.M., Boyla, K.A., Castell, P., Demirci, B., Özen, M., Welch, H., Marlow, T., 2008. *The Birds of Turkey*. A.C. Black, London.
- Kocataş, A., Katağan, T., Ateş, A.S., 2004. Atlanto-Mediterranean originated Decapod crustaceans in the Turkish seas. *Pakistan J. Biol. Sci.* 7, 1827–1830.
- Koç, A., 2000. Turkish rangelands and shrub culture. *Rangelands* 22, 25–26.
- Koç, A., Gökkuş, A., Serin, Y., 1994. The state of Turkey's rangelands and their importance for erosion problems. *J. Ecol. Environ.* 13, 36–41 (in Turkish).
- Köktürk, E., Köktürk, E., 2004. Orman Kadastro ve 2/B Gerçeği, Orman Kadastro ve 2/B Sorunu Sempozyumu, 17-18 Eylül 2004, Bildiriler Kitabı, 90–120. <http://www.hkmo.org.tr/resimler/ekler/b7da66eb5bb0e80_ek.pdf> (accessed 09.05.11). TMMOB, İstanbul Şubesi, İstanbul (in Turkish).
- Konukçu, M., 2001. Forests and Turkish Forestry. State Planning Organization Series No. 2630, Ankara, Turkey (in Turkish).
- Kottke, M., Grieser, J., Beck, C., Rudolf, B., Rubel, F., 2006. World map of the Köppen-Geiger climate classification updated. *Meteorol. Z.* 15, 259–263.
- Krystufek, B., Vohralík, V., Obuch, J., 2009. Endemism, vulnerability and conservation issues for small terrestrial mammals from the Balkans and Anatolia. *Folia Zool.* 58, 291–302.
- Kuglitsch, F.G., Toreti, A., Xoplaki, E., Della-Marta, P.M., Zerefos, C.S., Türkeş, M., Luterbacher, J., 2010. Heat wave changes in the eastern Mediterranean since 1960. *Geophys. Res. Lett.* 37, L04802. doi:10.1029/2009GL041841.
- Kuru, M., 2004. Recent systematic status of inland water fishes of Turkey. *Gazi Eğitim Fakültesi Dergisi* 24, 1–21 (in Turkish, with English abstract).
- Kuvan, Y., 2005. The use of forests for the purpose of tourism: the case of Belek Tourism Center in Turkey. *J. Environ. Manage.* 75, 263–274.
- Küyük, A., 2007. Çukurova deltasında kuşlar 45 yılda% 95 azaldı. *Anadolu Ajansı*. <<http://haber.mynet.com/detay/teknoloji/cukurova-deltasinda-kuşlar-45-yilda-95-azaldi/264544>> (accessed 13.02.11) (in Turkish).
- Kuypers, M.M.M., Sliemers, A.O., Lavik, G., Schmidt, M., Jørgensen, B.B., Kuennen, J.G., Damsté, J.S.S., Strous, M., Jettens, M.S.M., 2003. Anaerobic ammonium oxidation by anaerobic bacteria in the Black Sea. *Nature* 422, 608–611.
- Langhammer, P.F., Bakarr, M.I., Bennun, L.A., Brooks, T.M., Clay, R.P., Darwall, W., De Silva, N., Edgar, G.J., Eken, G., Fishpool, L.D.C., da Fonseca, G.A.B., Foster, M.N., Knox, D.H., Matiku, P., Radford, E.A., Rodrigues, A.S.L., Salaman, P., Sechrest, W., Tordoff, A.W., 2007. Identification and Gap Analysis of Key Biodiversity Areas: Targets for Comprehensive Protected Area Systems. IUCN, Gland, Switzerland.
- Lewis, J., Christie-Miller, A., 2011. Turkey: Whistleblower on Toxic Town's Cancer Problem Faces Investigation. <<http://www.eurasianet.org/node/63552>> (accessed 25.05.11).
- López-García, P., Kazmierczak, J., Benzerara, K., Kempe, S., Guyot, F., Moreira, D., 2005. Bacterial diversity and carbonate precipitation in the giant microbialites from the highly alkaline Lake Van, Turkey. *Extremophiles* 9, 263–274.
- Mann, C.C., 2011. The birth of religion. *Natl. Geogr.* 219 (6), 34–59.
- Marsh, G.P., 1885. *The Earth as Modified by Human Action*. Scriber, New York.
- Médail, F., Diadema, K., 2009. Glacial refugia influence plant diversity patterns in the Mediterranean Basin. *J. Biogeogr.* 36, 1333–1345.
- Médail, F., Quézel, P., 1997. Hot-spots analysis for conservation of plant biodiversity in the Mediterranean basin. *Ann. Mol. Bot. Gard.* 84, 112–127.
- Ministry of Culture and Tourism (MCT), Republic of Turkey, 2009. Hasankeyf. <<http://www.kultur.gov.tr/TR/Genel/BeleGoster.aspx?F6E10F8892433CF679A66406202CCB01D3BB7E94B37162B>> (accessed 13.02.11) (in Turkish).
- Mittermeier, R.A., Gil, P.R., Hoffman, M., Pilgrim, J., Brooks, T., Mittermeier, J.C., Lamoreux, J., da Fonseca, G.A.B., 2005. Hotspots Revisited: Earth's Biologically Richest and Most Endangered Terrestrial Ecoregions. Amsterdam University Press, Amsterdam.
- Nivet, C., Frazier, S., 2004. A Review of European Wetland Inventory Information. Collaborative Report by Wetlands International and Institute for Inland Water Management and Waste Water Treatment. 262 pp.
- Ocak, S., 2010. Gold prospecting may devastate Turkey's Kaz Mountains. *Hürriyet Daily News*. <<http://www.hurriyetdailynews.com/n.php?kaz-mountains-are-dug-for-gold-from-11-directions-2010-11-07>> (accessed 26.05.11).
- Ocak, M., Ocak, Z., Bilgen, S., Kele, S., Kaygusuz, K., 2004. Energy utilization, environmental pollution and renewable energy sources in Turkey. *Energy Convers. Manage.* 45, 845–864.
- Olson, D.M., Dinerstein, E., 1998. The global 200: a representation approach to conserving the Earth's most biologically valuable ecoregions. *Conserv. Biol.* 12, 502–515.
- Organization for Economic Co-operation and Development (OECD), 2008. Environmental Performance Reviews, Turkey.
- Oruç, S., 2011. Egosistem ekosistemi yok ediyor. <<http://www.ntvmsbc.com/id/25187888>> (accessed 13.03.11) (in Turkish).
- Öğünç, A., 2010. Hatay'da Ceylanlar çimento tehdidi altında. <http://www.ttkder.org.tr/index.php?option=com_content&view=article&id=175> (accessed 13.02.11) (in Turkish).
- Özbiçgin, H., Tosunoğlu, Z., Bilecenoğlu, M., Tokaç, A., 2004. Population parameters of *Mullus barbatus* in Izmir Bay (Aegean Sea) using length frequency analysis. *J. Appl. Ichthyol.* 20, 231–233.
- Özcan, T., Galil, B.S., Bakır, K., Katağan, T., 2006. The first record of the banana prawn *Fenneropenaeus merguensis* (De Man, 1888) (Crustacea: Decapoda: Penaeidae) from the Mediterranean Sea. *Aquat. Inv.* 1, 286–288.
- Özden, D.M., Dursun, H., Sevinç, A.N., 2000. The land resources of Turkey and activities of general directorate of rural services. In: Proc. Intl. Symp. Desertification, 13-17 June 2000, Konya, Turkey, pp. 1–13.
- Özer, N., 2011. Turkey loses 1.4 billion tons of soil each year. *Hürriyet Daily News*. <<http://www.hurriyetdailynews.com/n.php?n=0107114705742-2011-01-07>> (accessed 26.05.11).
- Özkesim, U., Özkesim, S., 2003. A participatory approach to ecosystem conservation: fuzzy cognitive maps and stakeholder group analysis in Uluabat Lake, Turkey. *Environ. Manage.* 31, 518–531.
- Özgenç, M., 2011. Bal ormanları kurarak dünya lideri olacağız. *Hürriyet*. January 8, 2011. <<http://www.hurriyet.com.tr/ankara/16710572.asp?gid=140>> (accessed 13.02.11) (in Turkish).
- Özhatay, E., 1986. Some endemic species of Sandras Dağı (C2 Muğla) in Southwest Turkey. In: V. Optima Meeting Abstr. Posters: 76. İstanbul, Turkey.
- Özhatay, N., Kültür, S., Aksoy, N., 1994. Check-list of additional taxa to the supplement flora of Turkey. *Turk. J. Bot.* 18, 497–514.
- Özhatay, N., Byfield, A., Atay, S., 2010. Important Plant Areas of Turkey. WWF Turkey Press, İstanbul, Turkey.
- Özhatay, F.N., Kültür, S., Gürdal, M.B., 2011. Check-list of additional taxa to the supplement Flora of Turkey V. *Turk. J. Bot.* 35, 1–36.
- Özkan, H., Brandolini, A., Schäfer-Pregl, R., Salamini, F., 2002. AFLP analysis of a collection of tetraploid wheats indicates the origin of emmer and hard wheat domestication in southeast Turkey. *Mol. Biol. Evol.* 19, 1797–1801.
- Özkurt, Ş.Ö., Sözen, M., Yiğit, N., Kandemir, İ., Çolak, R., Gharkheloo, M.M., Çolak, E., 2007. Taxonomic status of the genus *Spermophilus* (Mammalia: Rodentia) in Turkey and Iran with description of a new species. *Zootaxa* 1529, 1–15.
- Öztürk, B., Öztürk, A.A., 1996. On the biology of the Turkish straits system. *J. Bull. Inst. Oceanogr. Spec. Issue* 17, 205–221.
- Özyurt, N., Bayarı, C.S., Doğdu, M.Ş., Arıkan, A., 2001. Akkuyu Körfezi (Mersin) deniz suyunun fiziksel ve kimyasal özelliklerini etkileyen süreçler. *Yerbilimleri* 24, 113–126 (in Turkish).
- Paula, S., Arianooutsou, M., Kazanis, D., Tavsanoglu, Ç., Lloret, F., Buhk, C., Ojeda, F., Luna, B., Moreno, J.M., Rodrigo, A., Espelta, J.M., Palacio, S., Fernández-Santos, B., Fernandes, P.M., Pausas, J.G., 2009. Fire-related traits for plant species of the Mediterranean Basin. *Ecology* 90, 1420.
- Pausas, J.G., Llovet, J., Rodrigo, A., Vallejo, R., 2008. Are wildfires a disaster in the Mediterranean basin? – A review. *Int. J. Wildland Fire* 17, 713–723.
- PECBMS (Pan-European Common Bird Monitoring Scheme). Trends of common birds in Europe, 2011 update. <<http://www.ebcc.info/index.php?ID=457>> (accessed 28.08.11).
- Radikal, 2011a. 'Protected sites under threat by law', say NGOs. *Hürriyet Daily News*. <<http://www.hurriyetdailynews.com/n.php?n=8216protected-sites-under-threat-by-law8217-say-ngos-2011-08-23>> (accessed 24.08.11).
- Radikal, 2011b. Turkish village turned into ghost town by spread of arsenic. *Hürriyet Daily News*. <<http://www.hurriyetdailynews.com/n.php?n=8216constructing-a-new-dam-is-not-a-permanent-precaution8217-2011-05-09>> (accessed 26.05.11).
- Reed, J.M., Leng, M.J., Ryan, S., Black, S., Altınışa, S., Griffiths, H.I., 2008. Recent habitat degradation in karstic Lake Uluabat, western Turkey: a coupled limnological–palaeolimnological approach. *Biol. Conserv.* 141, 2765–2783.
- Reeves, R.D., Adıgüzel, N., 2004. Rare plants and nickel accumulators from Turkish serpentine soils, with special reference to *Centaurea* species. *Turk. J. Bot.* 28, 147–153.
- Republic of Turkey, 2010. Maden Kanununda ve Bazı Kanunlarda Değişiklik Yapılmasına Dair Kanun 5995. Resmî Gazete 27621. <<http://www.resmigazete.gov.tr/eskiler/2010/06/20100624-1.htm>> (accessed 27.01.11) (in Turkish).
- Riservato, E., Boudot, J.-P., Ferreira, S., Jović, M., Kalkman, V.J., Schneider, W., Samraoui, B., Cuttelod, A., 2009. The Status and Distribution of Dragonflies of the Mediterranean Basin. <<http://data.iucn.org/dbtw-wpd/edocs/2009-030.pdf>> (accessed 13.02.11).
- Roberts, N., Rosen, A., 2009. Diversity and complexity in early farming communities of southwest Asia: new insights into the economic and environmental basis of Neolithic Çatalhöyük. *Curr. Anthro.* 50, 393–402.
- Sala, E., Kızılkaya, Z., Yıldırım, D., Ballesteros, E., 2011. Alien marine fishes deplete algal biomass in the eastern Mediterranean. *PLoS One* 6, e17356.
- Sarıkaya, M.A., Bishop, P.M., 2010. Space-based assessments of the ice cap on Mount Ağrı, Eastern Turkey. *Associations of American Geographers Annual Meeting, Program Abstracts*, 31922.
- Schaller, G., O'Brien, T., 2005. A Preliminary Survey of the Asiatic Cheetah and Its Prey in the I.R. of Iran: Report to WCS, DOE and UNDP-GEF. Wildlife Conservation Society, New York.
- Şekercioğlu, C.H., 2006. A birder's guide to Turkey. *Living Bird* 26 (1), 14–23.
- Şekercioğlu, C.H., 2010. Ecosystem functions and services. In: Sodhi, N.S., Ehrlich, P.R. (Eds.), *Conservation Biology for All*. Oxford University Press, Oxford, pp. 45–72.
- Şekercioğlu, C.H., 2011. Sarıkamış-Posof Yaban Hayatı Koridoru. Unpublished report. February 2011 (in Turkish).
- Sezic, E., 2002. Turkish orchids and Salep. *Acta Pharm. Turcica* 44, 151–157.
- Smith, K.G., Darwall, W.R.T. (Eds.), 2006. *The Status and Distribution of Freshwater Fish Endemic to the Mediterranean Basin*. IUCN, Gland, Switzerland, and Cambridge, UK.
- State Planning Organization of Turkey (SPO), 2007. Forestry: special expertise commission report. In: 9th Development Plan of Turkey (2007–2013), Ankara, Turkey.
- Şan, Ö., 2009. Doğu Karadeniz, HES Sarmalı Altında. <<http://www.gazetevice.net/Haber/3426.html>> (accessed 13.02.11) (in Turkish).

- Şenerdem, E.D., 2011a. Experts slam AKP plans to add two new cities to İstanbul. *Hürriyet Daily News*. <<http://www.hurriyetdailynews.com/n.php?n=plans-to-add-two-new-cities-to-istanbul-unsustainable-experts-say-2011-04-21>> (accessed May April 28, 2011).
- Şenerdem, E.D., 2011b. Turkish ministry opposes Greenpeace on fishing regulations. *Hürriyet Daily News*. <<http://www.hurriyetdailynews.com/n.php?n=expert-contradicted-data-by-ministry-on-fishing-regulations-2011-02-04>> (accessed 24.05.11).
- Tabiat Kanunu İzleme Girişimi (TKIG), 2011. Tabiatı ve biyolojik çeşitliliği koruma kanun tasarisının maddeler bazında değerlendirilmesi ve öneriler metni. Ankara. (Report on the Draft Act on Nature and Biodiversity Conservation, in Turkish).
- Tamer, E., Karaman, B., Çopur, O., 2006. A traditional Turkish beverage. *Food Rev. Int.* 22, 43–50.
- Tan, G., 2009. Yarasasızlaşma. Atlas. <<http://www.kesfetmekicinbak.com/doga/09350/>> (accessed 13.02.11) (in Turkish).
- Tapu ve Kadastro Genel Müdürlüğü (TKGM), 2010. 2B Özet.18 Ekim 2010 Powerpoint Sunumu. <http://www.web.tkgm.gov.tr/files/birimler/kadastro/sunumlar/2-B_Ozet_18_Ekim_2010.ppt> (accessed 15.07.11). Ankara (in Turkish).
- Taşkın, Ö., 2009. The environmental attitudes of Turkish senior high school students in the context of postmaterialism and the new environmental paradigm. *Int. J. Sci. Ed.* 31, 481–502.
- Tavşanoğlu, Ç., Gürkan, B., 2009. Post-fire regeneration of a *Pinus brutia* (Pinaceae) forest in Marmaris National Park, Turkey. *Int. J. Bot.* 5, 107–111.
- Tayanç, M., İm, U., Doğruel, M., Karaca, M., 2009. Climate change in Turkey for the last half century. *Clim. Change* 94, 483–502.
- Thirgood, J.V., 1981. Man and the Mediterranean Forest: A History of Resource Depletion. Academic Press, London.
- Thompson, J.D., 2005. Plant Evolution in the Mediterranean. Oxford University Press, New York.
- TMMOB Elektrik Mühendisleri Odası, 2011. Doğu Karadeniz Bölgesi HES Teknik Gezisi Raporu, Ankara. <http://www.emo.org.tr/genel/bizden_detay.php?kod=85992> (accessed 22.08.11) (in Turkish).
- Topçuoğlu, S., Kirbaşoğlu, Ç., Güngör, N., 2002. Heavy metals in organisms and sediments from Turkish Coast of the Black Sea, 1997–1998. *Environ. Int.* 27, 521–526.
- Turkish State Meteorological Service (TSMS, Devlet Meteoroloji Mudurlugu), 2011. Yıllık Toplam Yağış Verileri (Yearly Rainfall Data). <<http://www.dmi.gov.tr/veridegerlendirme/yillik-toplam-yagis-verileri.aspx>> (accessed 07.07.11) (in Turkish).
- TUIK (Turkey Statistical Institute), 2011. Seragazi emisyon envanteri, 2009. <<http://www.tuik.gov.tr/PreHaberBultenleri.do?id=8537>> (accessed 07.07.11) (in Turkish).
- Turan, N., 1984. Türkiye'nin Av ve Yaban Hayvanları, Memeliler. Ongun Kardeşler Matbaacılık Sanayi, Ankara (in Turkish).
- Turkish Water Assembly (TWA), 2011. HEPP's, Dams and the Status of Nature in Turkey. Report <<http://english.turkiyemesclisi.net/index.html>> (accessed 08.07.11).
- Türker, M.F., 2003. Sürdürülebilir Orman Kaynakları Yönetimi ile Orman Sınırları Dışına Arazi Çıkarma Uygulamaları Arasındaki Etkileşim: Mevcut Durum, Yaşanan Darboğazlar ve Çözüm Önerileri, Orman Kanununun 2/B Maddesinin Uygulanması ve Değerlendirilmesindeki Sorunlar Paneli 13.03.2003, Ankara, Turkey (in Turkish).
- Türkmen, N., Düzenli, A., 2005. Changes in floristic composition of *Quercus coccifera macchia* after fire in the Çukurova region (Turkey). *Ann. Bot. Fen.* 42, 453–460.
- Türkozan, O., Yılmaz, C., 2008. Loggerhead turtles, *Caretta caretta*, at Dalyan Beach, Turkey: nesting activity (2004–2005) and 19-year abundance trend (1987–2005). *Chelonian Conserv. Biol.* 7, 178–187.
- United Nations Development Programme (UNDP) Turkey, 2009. Strengthening Protected Area Network of Turkey: Catalyzing Sustainability of Marine and Coastal Protected Areas. <<http://www.undp.org.tr/Gozlem2.aspx?WebSayfa-No=2193>> (accessed 17.01.11).
- Uras, A., 2006. Kıyı ve Denizler. In: Eken, G., Bozdoğan, M., İsfendiyoğlu, S., Kılıç, D.T., Lise, Y. (Eds.), Türkiye'nin Önemli Doğa Alanları. Doğa Derneği, Ankara, Turkey, pp. 44–46 (in Turkish).
- van den Berg, A.B., Bekir, S., Kniff, P., The Sound Approach, 2010. Rediscovery, biology, vocalisations and taxonomy of fish owls in Turkey. *Dutch Bird.* 32, 287–298.
- Vural, M., Adıgüzel, N., 2006. Bozkırlar. In: Eken, G., Bozdoğan, M., İsfendiyoğlu, S., Kılıç, D.T., Lise, Y. (Eds.), Türkiye'nin Önemli Doğa Alanları. Doğa Derneği, Ankara, Turkey, pp. 28–30 (in Turkish).
- Willcox, G.H., 1974. A history of deforestation as indicated by charcoal analysis of four sites in Eastern Anatolia. *Anat. Stud.* 24, 117–133.
- Wilson, D.E., Reeder, D.M. (Eds.), 2005. Mammal Species of the World: A Taxonomic and Geographic Reference, third ed. Johns Hopkins University Press, Baltimore.
- Wood, L.J., 2007. MPA Global: A Database of the World's Marine Protected Areas. Sea Around Us Project, UNEP-WCMC & WWF. <www.mpaglobal.org> (accessed 13.02.11).
- World Bank, 2011. Gross domestic product 2010, PPP. World Development Indicators Database. <http://siteresources.worldbank.org/DATASSTATISTICS/Resources/GDP_PPP.pdf> (accessed 06.07.11).
- Yale Center for Environmental Law and Policy, 2010. Yale Environmental Performance Index. <<http://epi.yale.edu/Home>> (accessed 13.08.11).
- Yazgan, N., 2011. Doğa ve milli park gibi tüm alanları yok edecek kararlar. <<http://www.hayvansevergazetesi.com/yazar.asp?yaziID=173>> (accessed 10.02.11) (in Turkish).
- Yezdani, İ., 2011. Environmental group threatens campaign over villas in southern Turkey. *Hürriyet Daily News*. <<http://www.hurriyetdailynews.com/n.php?n=plans-to-build-villas-in-patara-to-become-an-international-environmental-issue-2011-05-20>> (accessed 24.05.11).
- Yılmaz, K., 1997. Ecological diversity of the Eastern Mediterranean region of Turkey and its conservation. *Biodivers. Conserv.* 7, 87–96.
- Yılmaz, H., Karahan, F., 2003. Eko-turizm yaklaşımlarında flora turizmi: Palandöken Dağlarının potansiyeli. I. Ulusal Erciyes Sempozyumu, Bildiriler Kitabı, pp. 94–95 (in Turkish).
- Yokeş, M.B., 2009. Additions to the knowledge of Opsithobranchia from Turkey. *Triton* 20, 5–19.
- Yokeş, M.B., Galil, B.S., 2006a. New records of alien decapods (Crustacea) from the Mediterranean coast of Turkey, with a description of a new palaemonid species. *Zoosystema* 28, 747–755.
- Yokeş, M.B., Galil, B.S., 2006b. Touchdown – first record of *Percnon gibbesi* (H. Milne Edwards, 1853) (Crustacea: Decapoda: Grapsidae) from the Levantine coast. *Aquat. Inv.* 1, 130–132.
- Yokeş, M.B., Meriç, E., 2004. Expanded populations of *Amphistegina lobifera* from the southwestern coast of Turkey. In: 4th Intl. Congr. Env. Micropaleol. Microbiol. Meiobenthol., pp. 232–233.
- Yörek, N., Aydın, H., Uğule, I., Doğan, Y., 2008. An investigation on students' perceptions of biodiversity. *Nat. Mont.* 7, 175–184.
- Zenetos, A., Meriç, E., Verlaque, M., Boudouresque, C.F., Giangrande, A., Çınar, M.E., Bilecenoğlu, M., 2008. Additions to the checklist of marine alien biota in the Mediterranean with special emphasis on Foraminifera. *Med. Mar. Sci.* 9, 119–165.
- Zeydanlı, U., 2001. Southern Anatolian montane conifer and deciduous forests. World Wildlife Fund, Bern. <http://www.worldwildlife.org/wildworld/profiles/terrestrial/pa/pa1220_full.html> (accessed 16.01.11).