First comprehensive assessment of the conservation status of the flora of the Çukurova Deltas, southern Turkey

Halil Çakan, K. Tuluhan Yilmaz and Atabay Düzenli

Abstract The Çukurova Deltas on the southern coast of Turkey, with their high biodiversity, are one of the most important wetland and RAMSAR sites in the eastern Mediterranean basin. The total native flora comprises 600 plant taxa, including many endemic and threatened taxa. In an examination of this flora, 62 taxa (31 endemic and 31 rare taxa for Turkey) were categorized as having restricted distributions and being under threat of extinction. To assess the conservation status of the threatened flora, the IUCN Red List categories and criteria were applied at both a regional and global scale. The distribution of threatened flora in the study area was analysed in relation to four principle habitats: sand dunes (mobile or fixed) and sandy beaches (with 64.5% of all taxa), salt flats and salt water marshes (16.1%), river banks and fresh water marshes (9.7%), and field margins and roadsides (9.7%). Sand dunes and sandy beaches were identified as the most threatened habitats, being both sensitive to disturbance and heavily affected by humans. This Red Data List is a first step towards the recognition of conservation problems in the Çukurova Deltas and the need for more effective conservation of their flora.

Keywords Çukurova Deltas, IUCN categories, RAMSAR site, sand dunes, southern Turkey, threatened flora, wetland.

This paper contains supplementary material that can only be found online at http://journals.cambridge.org

Introduction

The Mediterranean basin is a major centre of plant diversity, with 10% of the world's higher plants occurring in 1.6% of the earth's land surface (Médail & Quézel, 1997). However, the high degree of human disturbance of the vegetation, both historical and current, has transformed much of the native vegetation into secondary or subseral communities (Heywood, 1995). As a result of habitat fragmentation many of the plant species occur in small, poorly dispersed populations and face extinction or severe loss of genetic diversity (Olff & Ritchie, 2002).

One important Mediterranean habitat that has been affected in this way is the coastal dunes. In the Mediterranean and elsewhere the mobility of sand dunes has often conflicted with human interests, and dune forests have often been cleared and dune fields temporarily cultivated or overgrazed by sheep or goats (Van Der Meulen & Udode-Hoes, 1996). Along the Spanish and French Mediterranean coasts and Italian mainland coast 75–80% of the coastal dunes have been destroyed by tourism, urbanization and industry (Doody, 1991).

During the 20th century there was a loss of *c*. 30% (360 km^2) of coastal dunes along the Turkish coastline due to afforestation, agriculture and tourism activities (Tucker & Evans, 1997). Degradation continues due to the development of both agriculture and tourism; for example, 46% of the coastal dunes around the Seyhan River estuary were transformed into agricultural fields between 1921 and 1996 (Kapur *et al*., 1999). In addition, following the construction of the Aslantaş dam on the Ceyhan River in 1984, the Çukurova Deltas in southern Turkey have been affected by a 60% decrease in transported sediment (Bal & Demirkol, 1999).

Serious coastal erosion due to recreational activities has been reported for all European countries, including Turkey (Van Der Meulen & Salman, 1996), resulting in the loss of fragile dune systems caused by wind erosion. Mobile dunes have in some cases been stabilized by pine and acacia plantations, and afforestation with exotic tree species is continuing, especially in Turkey. Approximately 70% of the extensive Akyatan dune system in the Çukurova Deltas has been lost to agriculture (3,200 ha) and afforestation (3,500 ha) (Yilmaz, 2002). Another afforestation project is threatening the adjacent dune systems and vegetation at Yumurtalik (Van Der Meulen & Salman, 1996).

Because of these pressures on the Çukurova Deltas there is an urgent need for detailed information on the

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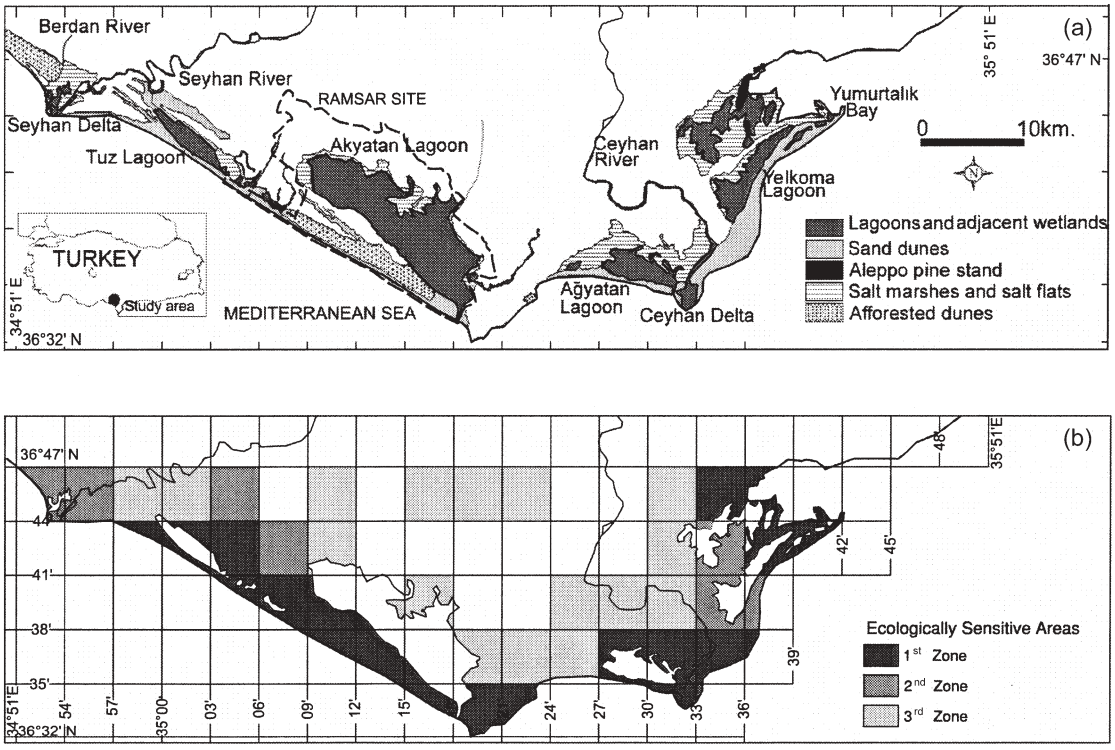

Fig. 1 (a) The distribution of habitat types within the Çukurova Deltas (the inset map indicates the position of the Deltas within Turkey), and (b) the three zones of ecologically sensitive areas (see text for details).

diversity and conservation status of the plant species of the area. Red Data Lists can play a crucial role by focusing attention on species in need of conservation action (Balanca *et al.*, 1998; Broughton & McAdam, 2002). The only published Red Data Lists available for the Deltas are at an international (Walter & Gillet, 1998; IUCN, 2003) and national (Ekim *et al.*, 1989; Ekim *et al.*, 2000) scale, and these provide little information on the threatened plant species of the Deltas because of the lack of detailed floristic studies of this ecosystem. Here we provide the first comprehensive regional assessment, using the 2001 Red List categories and criteria (IUCN, 2001), of the conservation status of the flora of the Çukurova Deltas, and outline the conservation measures required for the protection of this flora.

Study area

The Çukurova Deltas are located in the south-east of the Anatolian peninsula on a wide alluvial coastal plain of 7,000 km^2 formed by the Seyhan, Ceyhan and Berdan rivers. These rivers originate from the Taurus Mountains and flow into the Mediterranean Sea (Yilmaz, 2002). The Çukurova Deltas is one of the most extensive coastal ecosystems in the eastern Mediterranean and includes three major ecosystems: freshwater (rivers, former river beds, small inland lakes, and oxbows), coastal and saltwater ecosystems (sandy beaches, mobile and fixed sand dunes, salt marshes, salt flats, and lagoons), and agroecosystems (Fig. 1a). These support four main vegetation types (Çakan *et al.*, 2003): sand dune vegetation, salt marsh vegetation, stream bank and fresh water vegetation, and ruderal vegetation of field margins and roadsides. Three separate sites are currently managed: a Wildlife Reserve (the Seyhan River, Tuz Lagoon and Akyatan Lagoon), a Nature Protection Area (Yumurtalik pine grove) and a RAMSAR wetlands site (Akyatan Lagoon and adjacent areas).

Methods

Data were obtained from flora and vegetation surveys conducted during 1999–2001 (Çakan *et al.*, 2003), herbarium specimens and the available literature (Davis, 1965–1988; Ekim *et al.*, 1989; Ekim *et al.*, 2000; Çakan & Zielinski, 2004), and field surveys carried out during March-August 2002 to map threatened plant taxa, estimate plant population sizes and examine threat factors.

The area was divided into 184 grid squares of 2.5 * 2.5 km and the plant taxa were surveyed in all habitat types in each square. For the evaluation of threat

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Table 1 Occurrence of the 58 threatened plant taxa and 4 endemic taxa categorized as Least Concern (see Appendix) in the four main habitats of the Çukurova Deltas.

Habitats	Red List category*							Total taxa (%)	Endemic taxa (%)
	EX	CR	EN	VU	NT (LR:nt)	LC (LR:lc)	DD		
Sand dunes & sandy beaches	5	11	5	7	3	3	6	40 (64.5)	20 (32.2)
Salt flats & salt water marshes	1	4	1	1	1	1	1	10 (16.1)	4 (6.5)
River banks & fresh waters marshes	0	3	1	1	1	0	0	6 (9.7)	3 (4.8)
Field margins & roadsides	0	0	1	4	1	0	0	6 (9.7)	4 (6.5)
Total (regional scale)	6	18	8	13	6	4	7	62 (100.0)	31 (50.0)
Total (global scale)	2	9	5	8	3	4	0	31 (50.0)	31 (50.0)

*EX, Extinct; CR, Critically Endangered; EN, Endangered; VU, Vulnerable; NT, Near Threatened; LC, Least Concern; LR:nt, Lower Risk: near threatened; LR:lc, Lower Risk: least concern; DD, Data Deficient. LR:nt and LR:lc are categories in version 2.3 of the Red List categories and criteria (IUCN, 1994), and were replaced by NT and LC, respectively, in version 3.1 (IUCN, 2001).

categories, disturbance risks were assessed based on land use activities such as agriculture and sand mining. The population size of each threatened taxon was estimated by counting the number of individuals in one 10 * 10 m quadrat in each of the grid squares, and extrapolating to the entire area. Based on our surveys we defined 11 different threats, and determined the number of plant taxa threatened in each case.

At the national scale the Turkish Endemic Plants Project of 1995–1998 determined the status and distribution of the endemic and rare Turkish plant taxa. This information was used to re-evaluate an earlier Turkish Red Data List (Ekim *et al*., 1989) and produce a new List (Ekim *et al*., 2000) using the 1994 Red List categories and criteria (IUCN, 1994); this List only evaluated the global status of the Turkish flora. Using our field observations, the detected threats and our estimates of population sizes, we assigned an IUCN Red List category to each taxon using version 3.1 of the Red List categories and criteria (IUCN, 2001). Although these categories and criteria were designed for application at the global scale we used them, with reference to Gärdenfors (2001), at the regional scale of the Çukurova Deltas.

The distributions of the threatened plant taxa were mapped to identify ecologically sensitive zones in the Deltas, with the number of threatened taxa in each 2.5 * 2.5 km grid square used to determine the approximate boundaries of each zone. For mapping these zones four adjacent squares were combined to produce a 5 * 5 km grid. Three zones were thus identified for conservation priorities (Zone 1 containing 11–15 threatened taxa, Zone 2 with 6–10 threatened taxa, and Zone 3 with 1–5 threatened taxa). Unless otherwise stated, nomenclature follows Davis (1965–1988).

Results

The flora of the Çukurova Deltas includes 58 threatened or extinct taxa, *c*. 10% of its total flora (Appendix). Four taxa that are categorized globally as Least Concern (i.e. not on the Red List) are also included in Table 1 and the Appendix because they are endemic to Turkey. Six taxa are regionally Extinct, two globally Extinct, and 39 are threatened (Critically Endangered, Endangered or Vulnerable) at a regional scale (Table 1). Sixty-five per cent (40 taxa) of the threatened taxa occur on mobile or stabilized sand dunes and on sandy beaches (Table 1). Farming and changing agricultural practices are threatening the greatest number of taxa in the Deltas, followed by the effects of small populations and restricted habitats, recreational activities, and inappropriate forestry practices (Table 2).

Two plant taxa originally described as endemic to the Çukurova Deltas (prostrate trefail *Trigonella raphanina*, last collected in 1855, and sand milkvitch *Astragalus subuliferus*, last collected in 1859) were previously categorized as Data Deficient (Ekim *et al*., 2000). Because our surveys during the last 10 years have failed to find these taxa, we have categorized them as both regionally and globally Extinct (Appendix). Four rare taxa (tiny leaved pondweed *Althenia filiformis*, compound flowered pea *Argyrolobium uniflorum*, tongue milkvitch *Astragalus epiglottis* and sand fenugreek *Factorovskya aschersoniana*) were categorized as regionally Extinct (Appendix).

Although the main distribution area of four endemic taxa (sand alkanet *Alkanna pinardii*, multi-rayed thorow wax *Bupleurum polyactis*, Zohary's throw wax *B. zoharii*, and blue flax *Linum anisocalyx*) is the Çukurova Deltas and adjacent areas, we did not record these taxa in the Deltas during 4 years of field surveys. We have therefore categorized them as Data Deficient for the Çukurova Deltas, but their global threat category was left unchanged (Appendix).

A total of 18 taxa are Critically Endangered regionally, five of which are endemic to Turkey and four to the Deltas (Table 1, Appendix). Eight taxa are regionally Endangered, five of which are endemic to Turkey. Thirteen taxa are regionally Vulnerable, five of which are

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Table 2 The number of plant taxa in each Red List category affected by the 11 identified threats (see text for details) in the Çukurova Deltas.

	Red List category*							
Threats	EX (6)	CR (18)	EN (8)	VU (13)	NT (6)	LC (4)	DD (7)	Total (62)
1. Farming (changes in agricultural practices)	6	16	8	11	6	4	4	55
2. Small populations and restricted habitats	6	18	5	8	3		6	46
3. Recreational activities (tourism)	5	13	7	7	5	2	5	44
4. Inappropriate forestry practices (plantation on dunes)	5	9	6	9	1	2	4	36
5. Sand mining (for agriculture and construction)	5	8	3	7	3	2	3	31
6. Land pollution (domestic/agricultural)	4	11	5	6	1	1	3	31
7. Overgrazing	5	6		3	1	2	3	20
8. Wetland desiccation and water pollution	2	6	2	3	1	1	1	16
9. Harvesting of plant material		3	1	1	2	1		8
10. Clear-cutting (to open beach or for fuel)		1	1	1		1		4
11. Fire		1	2			1		4

*Abbreviations as Table 1

endemic to Turkey and three to the Deltas. Six taxa are Near Threatened, three of which are endemic to Turkey. The estimated population sizes of 15 threatened plant taxa are <500 individuals. Five of these are endemic to Turkey and four to the Deltas (Appendix).

The three zones of ecologically sensitive areas are indicated in Fig. 1b. The habitats of Zone 1 (with 11–15 threatened taxa) largely consist of sand dunes and salt marshes under pressure from intensive human activities, and this zone is the priority area for conservation of the threatened flora. Zone 2 (6–10 taxa) and Zone 3 (1–5 taxa) are also important, however, as they contain a significant number of threatened taxa.

Discussion

This study highlights the need for a revision of the Turkish Red List of threatened species, using version 3.1 of the Red List categories and criteria (IUCN, 2001), at both national and regional scales. In an international context the conservation of the endemic species of the Çukurova Deltas is of greatest importance, and should be the focus of priority action. Thirty-one plant taxa (5% of the total native flora) are endemic to Turkey, 12 of which are mainly found in the Çukurova Deltas and adjacent coastal areas (Appendix). Sand dune and other sandy habitats are particularly important for most of these taxa, but these habitat types are being destroyed by agriculture, wood plantation, sand mining and recreational activities. In addition, 64.5 % of the threatened flora was recorded from these fragile and sensitive habitats.

Although a significant proportion of the Çukurova Deltas has been declared a RAMSAR site (Akyatan Lagoon), Wildlife Reserve (Tuz Lagoon) and Nature Protection Area (Yumurtalik Lagoon) and the area has been included on the list of Important Plant Areas by WWF (Özhatay *et al.*, 2003), a number of plant taxa, including endemics, are being threatened by several factors because there are no measures in place for plant conservation in the area. Most of the Critically Endangered taxa are affected by the combination of 7–8 types of threat, the Endangered taxa by 4–5 types of threat and the Vulnerable taxa by 3–4 types of threat (Table 2). Without measures to mitigate the effects of these threats some of the most threatened endemic species, especially those with relatively small populations (e.g. elegant aroid *Biarum eximium*, salt trefoil *Trigonella halophila*, sand campion *Silene pompeipolitana*, hairy salt cedar *Tamarix duezenlii*, sand bromegrass *Bromus psammophilus* and slender foxtail *Alopecurus myosuroides* var. *latialatus*) will most likely become extinct within the next 10 years.

A major hindrance to the conservation of the flora of the Çukurova Deltas has previously been the lack of detailed baseline data for the area. This need has now begun to be addressed by both the present study and that of Çakan *et al*. (2003), and the improvement of the existing regional herbarium at Çukurova University, Adana. In addition, the establishment of the Botanical Garden in Çukurova University will help to develop ex-situ conservation of the threatened coastal flora. Based on our work we recommend that the following measures are required for the conservation of the flora of the Deltas: (1) an integrated conservation scheme for the whole area of the Deltas rather than for individual protected areas separately, (2) recognition and special protection for ecologically sensitive areas, (3) regular monitoring of the most threatened species, (4) recovery programmes that include the establishment of new populations of the most seriously threatened taxa in areas where threats are low, (5) control of human impacts, particularly through the development of sustainable agriculture and ecologically sensitive tourism, (6) maintenance of the hydrological regime and monitoring of water pollution, (7) halting of sand extraction and the planting of exotic trees on

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sand dunes, and (8) cultivation of the most threatened endemic taxa. Implementation of these recommended measures are officially the responsibility of the Turkish Ministry of Forestry and Environment. Realistically, however, implementation will require technical support from universities and other research institutions, funds from both national and international sources, and contributions from local NGOs. The latter will, in particular, help to increase public awareness and stakeholder participation.

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Appendix

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Biographical sketches

Halil Çakan's research is focused on plant ecology and taxonomy, with particular interests in Mediterranean ecosystems and the vegetation and flora of wetland and delta ecosystems.

K. Tuluhan Yilmaz is investigating human influences on coastal ecosystems. He formerly directed a national research project on the relations between bird life and plant communities in the coastal areas of eastern Mediterranean Turkey.

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