

Ecology and Conservation of Three Globally Threatened Waterfowl Species Breeding in Tunisian Wetlands: The Ferruginous Duck, Marbled Teal and White-Headed Duck

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Wetland features and landscape-scale variables

Based on a literature review, we identified and measured 8 environmental variables related to wetland features and landscape composition (Table 1). These variables are known to influence waterbird communities. To measure all the distances (Table 1 and 2), we used ESRI Imagery (Esri.com), available in QGIS V3.4.2-Madeira as a Base Map. This imagery provides a high level of detail and the pictures are easy to manipulate in the GIS platform. We chose Universal Transverse Mercator (UTM) zone 32 N based on UTM grid zones on a projected world map using the World Geodetic System WGS84 ellipsoid. For the determination of wetland size and perimeter (Table 1 and 2), we outlined each wetland as polygon using aerial imagery and then their area and perimeter were computed. Descriptive statistics of the measured environmental variables in the 40 studied wetlands are shown in Table 2.

Table 1: Descriptions of the eight-landscape metrics that were computed for each wetland site

Landscape metric	Abbreviation	Units	Description
Wetland area	WA	km ²	Area covered by the wetland
Wetland perimeter	WP	km	distance around wetland
Distance to house	DNH	km	Distance to nearest house
Distance to urban center	DNVU	km	Distance to nearest urban center
Distance to paved road	DNPR	km	Distance to the nearest paved road

Distance to the nearest coast	DNC	km	Distance to the Mediterranean coastline
Distance to agriculture area	DNAA	km	Distance to the nearest agriculture area
Distance to wetland	DW	km	Distance to the nearest wetland

Table 2: Descriptive data of wetlands features, and landscape composition recorded in the 40 selected wetlands.

Site	Latitude (X)	Longitude (Y)	WA	WP	DH	DUC	DPR	DNC	DAA	DW
Joumine	36°58'44.39"N	9°36'18.82"E	1.8	11	1.4	8.71	1.48	34.22	0.34	9.6
Sejnane	37°10'45.08"N	9°27'51.87"E	5.2	18	2.27	24.43	3.82	10.44	6.92	11.32
Melah	37° 4'35.64"N	9°26'48.87"E	0.68	9.1	1.65	9.27	2.09	20.24	0.21	9.72
Ghezala	37° 3'11.29"N	9°32'24.01"E	0.44	3.3	0.66	2.57	0.88	24.5	0.37	9.24
Sidi Soltane	36°52'11.5"N	9°33'29.0"E	0.17	2.6	2.4	13.41	1.24	44.9	0.23	5.2
Oued Ettine	36°51'56.03"N	9°37'15.84"E	0.88	4.2	0.74	19.39	0.38	48.14	0.79	5.2
Ghar ElMelh	37° 8'26.38"N	10°10'41.37"E	35	25	2.59	2.68	2.5	2.41	3.05	23.4
Sidi Abdelmonem	36°51'30.82"N	10°56'5.59"E	0.16	2.4	1.08	8.74	1.2	11.27	0.3	6.09
Mornaguia	36°46'34.78"N	10° 1'50.20"E	0.76	4.4	1.12	2.58	0.59	22.79	0.44	2.42
Dam of Mlaâbi	36°49'29.05"N	10°59'24.82"E	0.05	0.89	0.49	4.84	0.61	4.93	0.33	6.09
Lake Tunis	36°47'37.70"N	10°13'54.54"E	9.2	30	0.88	4.4	1.11	5.42	10.12	5.8
Sebkhet Sedjoumi	36°45'47.16"N	10° 9'1.36"E	21	22	2.26	5.72	1.99	12.41	2.13	5.9
Lagoon Soliman	36°43'40.38"N	10°29'47.79"E	3.3	15	1.9	2.25	1.9	1.62	1.12	21.91
Lagoon Tazarka	36°31'39.41"N	10°50'22.64"E	0.91	6	0.36	1.17	0.35	0.37	0.25	6.35
Lagoon of Korba	36°36'42.77"N	10°53'17.01"E	3.2	18	0.71	4.74	0.36	0.32	0.36	6.35
Dam of Lebna	36°44'21.55"N	10°54'52.84"E	0.93	7.7	0.93	3.86	1.91	5.19	0.34	9.42
Dam of Al Masri	36°31'51.24"N	10°29'12.09"E	0.4	4.4	0.52	2.5	0.71	17.28	0.4	13.83
Halk el Menzel	35°58'13.24"N	10°27'26.23"E	0.32	6.7	0.19	1.38	0.17	7.61	0.06	5.74
Laabid	36°49'1.64"N	10°42'8.26"E	0.28	3.2	1.29	18.97	1.17	6.1	0.15	11.89
Dam of El khatf	36°50'38.45"N	11° 1'58.71"E	0.54	3	0.64	3.9	0.73	3.89	0.37	4.32
Dam Hmira/ Khairat	36° 9'3.80"N	10°12'57.08"E	0.24	2	1.86	14.8	0.46	22.48	0.3	8.26
Dam Takrouna	36° 8'40.48"N	10°18'34.82"E	0.02	0.61	0.52	4.89	1.7	14.22	0.18	8.26
Hill lake Boulabousse	36,242532	10,180937	0.05	1.7	0.2	18.07	1.17	26.85	0.16	10.38
Dam of Oued Rmal	36,349398	10,345004	0.5	2.9	1.63	9.19	0.96	13.44	0.88	12.79

Sebkhet sidi khelifa	36,236051	10,456328	1.7	5.8	3.78	5.3	2.29	1.45	2.69	13.62
Oued EL Kebir	36°51'59.32"N	8°43'22.34"E	0.99	6.6	0.27	3.19	0.33	10.53	0.38	2.76
El Oglâ	36°11'11.99"N	10° 4'53.59"E	0.27	2.5	0.43	24.06	0.6	34.55	0.35	12.63
Khmiss	35°43'32.77"N	10°47'46.94"E	3.2	12	3.02	4.56	0.94	3.05	2.1	2.74
Dam of El Houareb	35,568073	9,74002	2.3	7.5	2.78	34.6	1.7	85.35	1.95	20.88
Goubellat	36°34'58.32"N	9°48'10.76"E	0.09	1.3	1.94	17.97	4.65	49.39	1.3	29.9
Sidi Djedidi	36°25'11.79"N	10°27'19.40"E	0.34	3.2	0.25	9.53	0.33	9.71	0.57	12.79
Gdir EL Goulla	36°46'59.63"N	10° 3'35.86" E	0.22	2.2	0.54	3.86	0.49	20.83	0.81	2.42
Chiba	36°42'6.95"N	10°46'16.24"E	0.01	0.53	0.41	8.33	0.37	14.54	0.36	13.26
Sidi Saad	35°22'11.52"N	9°40'52.58"E	7.5	23	3.52	7.31	2.75	100.99	2.48	21.05
Borj kastile	33°42'4.53"N	10°56'21.52"E	0.12	1.5	1.74	5.48	0.5	0.39	1.85	0.39
Douz Laâla	33°28'19.93"N	8°58'46.17"E	0.03	0.95	2.08	2.74	0.34	116.94	0.22	2.56
Snam	33,469688	8,954093	0.1	2.6	3.42	4.6	0.17	118.47	0.18	2.56
Ghidma	33,431699	8,795167	0.13	1.9	1.31	11.39	0.69	134.58	0.27	15.31
Sebkhet Nouaïel	33,536186	8,778982	0	0	3.23	20.94	2.43	131.12	3.12	7.76
Blidatte	33°33'18.46"N	8°51'39.01"E	0.24	2.4	3.02	3.36	2.64	121.87	0.56	12.04