























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Results of the eighteenth winter waterbird census in Libya in 2022

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Abstract

Background: Libyan wetlands are diverse; the coastline of Libya, in particular, has different kinds of wetlands, such as salt marshes, bays, lakes, lagoons, and islands. These varieties in habitats provide good shelters and foraging sites for migratory birds during their journeys between Eurasia and Africa. Since the beginning of the Libyan winter census of waterbirds International waterbirds census (Libya IWC) in 2005, which continued regularly until 2012, it has had relatively the same performance in the number of covered sites. However, since 2013, due to the security situation that Libya has experienced due to wars and conflict, which negatively affected the quality of the IWC in Libya, the number of sites has dramatically decreased, reaching only six locations during the middle of the previous decade.

Aim: The IWC 2022 aimed to count the birds along the Libyan coast from January 10 to 29.

Methods: The census activities were conducted from dawn to dusk during the study period by using high-quality Telescopes, binoculars, and digital cameras for the documentation. Point transects method was used to cover the sites.

Results: The results of this year showed that a total of 64 sites were covered, and 68 species of waterbirds were counted, with an abundance of 61,850 individuals. During the census period, a total of 52 non-waterbird species found in Wetlands were recorded, and the number of individuals was 14,836 birds. A total of 18 threatened species were observed during this survey, 12 of them are mentioned in the International Union for Conservation of Nature Red List, and nine species are mentioned in the regional activities center of specially protected areas annex II as threatened in the Mediterranean, where the species; *Larus audouinii* (Payraudeau, 1826), *Larus genei* (Breme, 1839), and *Puffinus yelkouan* (Acerbi, 1827) are mentioned in both of them.

Conclusion: The lack of the number of ornithologists and bird watchers is still one of the factors affecting the quality of the IWC in Libya, as well as lack of funding remains an important factor that plays a major role in the success of the waterbirds census.

Keywords: International waterbird census, Sites, Threatened species, Libya.

Introduction

Libyan wetlands are diverse, from desert oases, fresh and saltwater springs, salt marshes, coastal lagoons, artificial reservoirs, and dams. In general, the majorities of wetlands in Libya are shallow salt marshes, dry or semi-dry most of the year, and sometimes connected to the sea (Sobkha) (Smart *et al.*, 2006; EGA-RAC/

SPA, 2012). The coastline of Libya, in particular, has different kinds of wetlands, such as salt marshes, bays, lakes, lagoons, and islands (Defos du Rau *et al.*, 2003). These varieties in habitats provide good shelters and foraging sites for migratory birds during their journey from Europe and Asia to Africa and their journey back returns. Furthermore, some of these sites provide staging and nesting grounds for some species.

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However, with its dry climate, Libya is perceived as having relatively few wetlands and waterbirds. It is also, in terms of biodiversity one of the least known among Mediterranean countries, despite the published reports and papers (Azafzaf *et al.*, 2005, 2006; Smart *et al.*, 2006; Etayeb *et al.*, 2007, 2012; EGA-RAC/SPA, 2012; Bourass *et al.*, 2013).

The winter census of waterbirds in Libya began in 2005; it has continued regularly during January of each year in the framework of the International Waterbirds Census (IWC).

The IWC in Libya was conducted by local specialists and some ornithologists from outside the country (Tunisia, Italy, France, and the United Kingdom); this team worked from 2005 to 2011 under the supervision of the Environment General Authority (currently the Libyan Ministry of Environment) in cooperation with the Regional activities Center of Specially Protected Areas (RAC/SPA) and the Agreement on the Conservation of African-Eurasian migratory waterbirds, in coordination with Wetlands International. The first outputs of this cooperation were issued in two reports on wintering waterbirds in Libya (Azafzaf *et al.*, 2005, 2006). Then these results were published in a scientific paper (Smart *et al.*, 2006). Moreover, the census of wintering waterbirds in Libya continued until 2010, when the Atlas of wintering waterbirds of Libya was published (EGA-RAC/SPA, 2012). Then the results of the 2011 survey were published; it was the last year covering all the sites in Libya, where the total number was 84 (Bourass *et al.*, 2013).

Libya has experienced widespread security, which strongly affected the IWC. In 2012, about half of the sites were covered than in the previous year (Etayeb *et al.*, 2012). In 2013, coordinated waterbird counts between North African countries noticed a limited coverage of the sites where 10 important wetlands were skipped due to security situations (Sayoud *et al.*, 2017). From the year 2013 until 2021, the waterbirds census activities have continued were conducted by a team from the Libyan society of birds (LSB) with support from Mediterranean waterbird network in collaboration with Bisida Society and Bado Society in Zwara city, the Libyan Organization for Conservation of Nature (LOCN) and the Environment General Authority; despite the obstacles, security problems and unstable country situation that negatively affected the program. Consequently, the number of sites was at most 34; the least was only six sites around Tripoli in 2015. Although there was a slight improvement in the following years until 2021, this improvement did not lead to reaching the number of surveyed sites during the period from 2005 to 2011. However, the diversity and abundance of waterbirds and non-waterbirds were recorded; the results were undoubtedly affected by the inconvenient circumstances experienced by the winter census for birds in Libya (Table 1).

This paper aims to present the results of the 18th IWC in Libya, which was conducted in January 2022 along the Libyan coastline under the supervision of the LSB in collaboration with the Libyan Ministry of Environment, National Research Center for Tropical and Transboundary Diseases and NGOs (LOCN, Bisida and Alhaya Organization for Protection of Wildlife and Marine Organisms).

Material and Methods

The winter census of waterbirds in Libya for 2022 was conducted from 10 to 29 January. The team covered all wetlands and waterbirds sites along the Libyan coast from Ras Jdair in the west to Tobruk in the east (Fig. 1). The census usually starts from early morning until evening. Sometimes to maintain the time, the team was split into two groups to cover the sites located at the same range and to avoid repeated counting of the same birds. The census was carried out using six binoculars, nine telescopes, and digital cameras for documentation. In addition, the point transects method (standing at a specific site and counting birds) was used to cover the areas (Volpato *et al.*, 2009).

To examine the population trend of waterbirds wintering in Libya from 2005 to 2022, the living planet index (LPI) was used. The use of LPI was started in 1997 by the World Wide Fund for Nature to investigate the changes in global biodiversity over time, especially for measuring the average trends of vertebrate populations (Loh *et al.*, 2005). In this paper, the Chain method was used to calculate the index, where the logarithm of the ratio of the population of each pair of years was calculated using the formula:

$$d_t = \log(N_t/N_{t-1})$$

Where N_t = population size and t = years (time). The specific values of d_t were generated for n_t as:

$$n_t$$

$$dt = \sum_{i=1}^n d_{it}$$

$$n_t$$

Finally, the index for waterbird populations in Libyan wetlands in a standard year t was calculated as:

$$d_t$$

$$I_t = I_{t-1} 10$$

Results

The results of the winter survey of birds for 2022 showed that the total number of birds counted was 76,686 individuals, and the diversity of species reached 120 for the aquatic and non-aquatic birds. The abundance of waterbirds was 61,850 individuals belonging to 68 species classified under 18 families (Table 2). The number of species has varied among the

Table 1. Results of IWC in Libya from 2005 to 2021.

Year	Waterbirds	Waterbird sp.	Non-waterbirds	Non-waterbird sp.	Covered sites	Period
2005	29,996	79	30,160	74	65	3–17 Jan.
2006	51,698	85	146,621	60	56	19–31 Jan.
2007	39,303	92	39,130	69	43	3–15 Feb.
2008	53,632	79	13,378	64	50	20–31 Jan.
2009	40,369	65	13,047	55	49	26 Jan – 7 Feb.
2010	51,652	86	60,000	60	94	24 Jan – 3 Feb.
2011	34,842	81	506,155	67	84	29 Jan – 13 Feb.
2012	29,258	66	2,110	27	42	3 Jan – 1 Feb.
2013	5,308	46	0	0	16	19 Jan – 9 Feb.
2014	7,761	58	0	0	12	1–12 Jan.
2015	1,930	37	90	8	6	20–24 Jan.
2016	5,040	47	544	15	10	2–7 Jan.
2017	10,488	64	830	25	29	15–22 Jan.
2018	24,815	54	751,420	23	34	11–31 Jan.
2019	25,480	63	1,872	22	32	10–30 Jan.
2020	14,205	46	6,104	19	12	9–25 Jan.
2021	17,091	60	2,002,622	36	32	14–31 Jan.

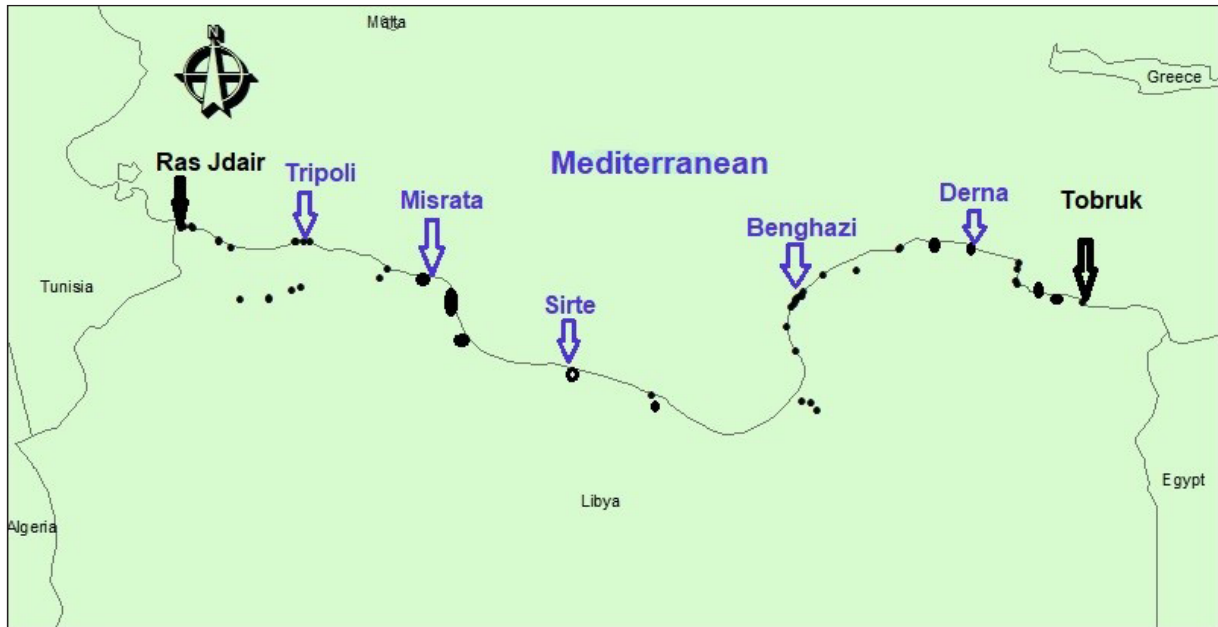


Fig. 1. Covered sites during the IWC 2022.

Table 2. Waterbirds and non-waterbirds were recorded in Jan. 2022 in Libya.

Family	No.	Common name	Binomial name	Count
Anatidae	1	Common shelduck	<i>Tadorna tadorna</i> (Linnaeus, 1758)	176
	2	Common pochard	<i>Aythya ferina</i> (Linnaeus, 1758)	5
	3	Ferruginous duck	<i>Aythya nyroca</i> (Güldenstadt, 1770)	60
	4	Red-breasted merganser	<i>Mergus serrator</i> (Linnaeus, 1758)	3
	5	Gadwall	<i>Mareca strepera</i> (Linnaeus, 1758)	3
	6	Northern shoveler	<i>Spatula clypeata</i> (Linnaeus, 1758)	231
	7	Mallard	<i>Anas platyrhynchos</i> (Linnaeus, 1758)	2
	8	Northern pintail	<i>Anas acuta</i> (Linnaeus, 1758)	5
	9	Garganey	<i>Spatula querquedula</i> (Linnaeus, 1758)	1
	10	Eurasian teal	<i>Anas crecca</i> (Linnaeus, 1758)	95
	11	Marbled teal	<i>Marmaronetta angustirostris</i> (Ménétrés, 1832)	8
Procellariidae	12	Yelkouan shearwater	<i>Puffinus yelkouan</i> (Acerbi, 1827)	3
Podicipedidae	13	Little grebe	<i>Tachybaptus ruficollis</i> (Pallas, 1764)	148
	14	Great crested grebe	<i>Podiceps cristatus</i> (Linnaeus, 1758)	103
	15	Black-necked grebe	<i>Podiceps nigricollis</i> (Brehm, 1831)	98
Phoenicopteridae	16	Greater flamingo	<i>Phoenicopterus roseus</i> (Pallas, 1811)	352
Ciconiidae	17	White stork	<i>Ciconia ciconia</i> (Linnaeus, 1758)	35
Threskiornithidae	18	Glossy ibis	<i>Plegadis falcinellus</i> (Linnaeus, 1766)	75
	19	Eurasian spoonbill	<i>Platalea leucorodia</i> (Linnaeus, 1758)	30
Ardeidae	20	Squacco heron	<i>Ardeola ralloides</i> (Scopoli, 1769)	1
	21	Cattle egret	<i>Bubulcus ibis</i> (Linnaeus, 1758)	3,705
	22	Little egret	<i>Egretta garzetta</i> (Linnaeus, 1766)	137
	23	Great white egret	<i>Ardea alba</i> (Linnaeus, 1758)	27
	24	Grey heron	<i>Ardea cinerea</i> (Linnaeus, 1758)	118
Sulidae	25	Northern gannet	<i>Morus bassanus</i> (Linnaeus, 1758)	41

Phalacrocoracidae	26	Great cormorant	<i>Phalacrocorax carbo</i> (Linnaeus, 1758)	1,139
	27	European shag	<i>Gulosus aristotelis</i> (Linnaeus, 1761)	8
Rallidae	28	Common moorhen	<i>Gallinula chloropus</i> (Linnaeus, 1758)	46
	29	Common coot	<i>Fulica atra</i> (Linnaeus, 1758)	151
Gruidae	30	Common crane	<i>Grus grus</i> (Linnaeus, 1758)	2
Haematopodidae	31	Eurasian oystercatcher	<i>Haematopus ostralegus</i> (Linnaeus, 1758)	34
Recurvirostridae	32	Black-winged stilt	<i>Himantopus himantopus</i> (Linnaeus, 1758)	91
	33	Little ringed plover	<i>Charadrius dubius</i> (Scopoli, 1786)	6
Charadriidae	34	Common ringed plover	<i>Charadrius hiaticula</i> (Linnaeus, 1758)	52
	35	Kentish plover	<i>Charadrius alexandrinus</i> (Linnaeus, 1758)	592
	36	Eurasian golden plover	<i>Pluvialis apricaria</i> (Linnaeus, 1758)	52
	37	Grey plover	<i>Pluvialis squatarola</i> (Linnaeus, 1758)	49
Scolopacidae	38	Sanderling	<i>Calidris alba</i> (Pallas, 1764)	20
	39	Little stint	<i>Calidris minuta</i> (Leisler, 1812)	224
	40	Temminck's stint	<i>Calidris temminckii</i> (Leisler, 1812)	3
	41	Curlew sandpiper	<i>Calidris ferruginea</i> (Pontoppidan, 1763)	7
	42	Dunlin	<i>Calidris alpina</i> (Linnaeus, 1758)	1,618
	43	Ruff	<i>Calidris pugnax</i> (Linnaeus, 1758)	34
	44	Common snipe	<i>Gallinago gallinago</i> (Linnaeus, 1758)	16
	45	Bar-tailed godwit	<i>Limosa lapponica</i> (Linnaeus, 1758)	1
	46	Eurasian curlew	<i>Numenius arquata</i> (Linnaeus, 1758)	16
	47	Common sandpiper	<i>Actitis hypoleucos</i> (Linnaeus, 1758)	23
	48	Green sandpiper	<i>Tringa ochropus</i> (Linnaeus, 1758)	16
	49	Spotted redshank	<i>Tringa erythropus</i> (Pallas, 1764)	4
	50	Common greenshank	<i>Tringa nebularia</i> (Gunnerus, 1767)	6
	51	Marsh sandpiper	<i>Tringa stagnatilis</i> (Bechstein, 1803)	6
52	Wood sandpiper	<i>Tringa glareola</i> (Linnaeus, 1758)	6	
53	Common redshank	<i>Tringa totanus</i> (Linnaeus, 1758)	148	
54	Ruddy turnstone	<i>Arenaria interpres</i> (Linnaeus, 1758)	15	
Laridae	55	Slender-billed gull	<i>Chroicocephalus genei</i> (Breme, 1839)	2,169
	56	Black-headed gull	<i>Chroicocephalus ridibundus</i> (Linnaeus, 1766)	24,194
	57	Little gull	<i>Hydrocoloeus minutus</i> (Pallas, 1776)	46
	58	Mediterranean gull	<i>Ichthyaeus melanocephalus</i> (Temminck, 1820)	5,026
	59	Audouin's gull	<i>Ichthyaeus audouinii</i> (Payraudeau, 1826)	21
	60	Lesser black-backed gull	<i>Larus fuscus</i> (Linnaeus, 1758)	9,059
	61	Yellow-legged gull	<i>Larus michahellis</i> (Naumann, 1840)	10,897
	62	Great black-backed gull	<i>Larus marinus</i> (Linnaeus, 1758)	3
	63	Caspian tern	<i>Hydroprogne caspia</i> (Pallas, 1770)	66
	64	Black tern	<i>Chlidonias niger</i> (Linnaeus, 1758)	5
65	Sandwich tern	<i>Thalasseus sandvicensis</i> (Latham, 1787)	502	
66	Lesser crested tern	<i>Thalasseus bengalensis</i> (Lesson, 1831)	7	
Stercorariidae	67	Parasitic jaeger (Arctic Skua)	<i>Stercorarius parasiticus</i> (Linnaeus, 1758)	2
Alcedinidae	68	Common kingfisher	<i>Alcedo atthis</i> (Linnaeus, 1758)	6

Continued

Phasianidae	69	Barbary partridge	<i>Alectoris Barbara</i> (Bonnaterre, 1791)	2
	70	Black kite	<i>Milvus migrans</i> (Boddaert, 1783)	1
	71	Western marsh-harrier	<i>Circus aeruginosus</i> (Linnaeus, 1758)	26
Accipitridae	72	Hen harrier	<i>Circus cyaneus</i> (Linnaeus, 1766)	1
	73	Pallid harrier	<i>Circus macrourus</i> (Gmelin, 1770)	1
	74	Long-legged buzzard	<i>Buteo rufinus</i> (Cretzschmar, 1829)	3
Burhinidae	75	Eurasian stone-curlew	<i>Burhinus oediconemus</i> (Linnaeus, 1758)	5
Columbidae	76	European turtle dove	<i>Streptopelia turtur</i> (Linnaeus, 1758)	2
	77	Laughing dove	<i>Spilopelia senegalensis</i> (Linnaeus, 1766)	50
Tytonidae	78	Barn owl	<i>Tyto alba</i> (Scopoli, 1769)	1
	79	Little owl	<i>Athene noctua</i> (Scopoli, 1769)	11
Strigidae	80	Pharaoh eagle-owl	<i>Bubo ascalaphus</i> (Savigny, 1809)	1
Apodidae	81	Common swift	<i>Apus apus</i> (Linnaeus, 1758)	188
Upupidae	82	Common hoopoe	<i>Upupa epops</i> (Linnaeus, 1758)	22
Falconidae	83	Common kestrel	<i>Falco tinnunculus</i> (Linnaeus, 1758)	6
Malaconotidae	84	Black-crowned tchagra	<i>Tchagra senegalus</i> (Linnaeus, 1766)	1
Laniidae	85	Southern grey shrike	<i>Lanius meridionalis</i> (Temminck, 1820)	51
Corvidae	86	Common raven	<i>Corvus corax</i> (Linnaeus, 1758)	7
	87	Greater hoopoe-lark	<i>Alaemon alaudipes</i> (Desfontaines, 1789)	5
Alaudidae	88	Crested lark	<i>Galerida cristata</i> (Linnaeus, 1758)	104
	89	Thekla's lark	<i>Galerida theklae</i> (Brehm, 1857)	1
	90	Eurasian skylark	<i>Alauda arvensis</i> (Linnaeus, 1758)	18
Hirundinidae	91	Barn swallow	<i>Hirundo rustica</i> (Linnaeus, 1758)	3
	92	Northern house martin	<i>Delichon urbicum</i> (Linnaeus, 1758)	10
Phylloscopidae	93	Common chiffchaff	<i>Phylloscopus collybita</i> (Vieillot, 1817)	389
Acrocephalidae	94	Great reed-warbler	<i>Acrocephalus arundinaceus</i> (Linnaeus, 1758)	1
Leiothrichidae	95	Fulvous babbler	<i>Turdoides fulva</i> (Desfontaines, 1789)	16
	96	Spectacled warbler	<i>Curruca conspicillata</i> (Temminck, 1820)	2
Sylviidae	97	Sardinian warbler	<i>Curruca melanocephala</i> (Gmelin, 1789)	15
	98	Eurasian blackcap	<i>Sylvia atricapilla</i> (Linnaeus, 1758)	1
Sturnidae	99	Common starling	<i>Sturnus vulgaris</i> (Linnaeus, 1758)	12,740
Turdidae	100	Common blackbird	<i>Turdus merula</i> (Linnaeus, 1758)	5
	101	Song thrush	<i>Turdus philomelos</i> (Brehm, 1831)	1
	102	Spotted flycatcher	<i>Muscicapa striata</i> (Pallas, 1764)	1
	103	European robin	<i>Erithacus rubecula</i> (Linnaeus, 1758)	20
	104	Bluethroat	<i>Luscinia svecica</i> (Linnaeus, 1758)	2
	105	Black redstart	<i>Phoenicurus ochruros</i> (Gmelin, 1774)	15
Muscicapidae	106	Moussier's redstart	<i>Phoenicurus moussieri</i> (Olphe-Galliard, 1852)	1
	107	Whinchat	<i>Saxicola rubetra</i> (Linnaeus, 1758)	1
	108	Common stonechat	<i>Saxicola torquatus</i> (Linnaeus, 1766)	115
	109	Desert wheatear	<i>Oenanthe deserti</i> (Temminck, 1829)	8
	110	Mourning wheatear	<i>Oenanthe lugens</i> (Lichtenstein, 1823)	5

	111	White-crowned wheatear	<i>Oenanthe leucopyga</i> (Brehm, 1855)	5
Muscicapidae	112	Black wheatear	<i>Oenanthe leucura</i> (Gmelin, 1789)	22
	113	Blue rock thrush	<i>Monticola solitaries</i> (Linnaeus, 1758)	1
Passeridae	114	House sparrow	<i>Passer domesticus</i> (Linnaeus, 1758)	53
	115	Spanish sparrow	<i>Passer hispaniolensis</i> (Temminck, 1820)	438
	116	White wagtail	<i>Motacilla alba</i> (Linnaeus, 1758)	225
Motacillidae	117	Meadow pipit	<i>Anthus pratensis</i> (Linnaeus, 1758)	66
	118	Red-throated pipit	<i>Anthus cervinus</i> (Pallas, 1811)	2
Fringillidae	119	European serin	<i>Serinus serinus</i> (Linnaeus, 1766)	121
Emberizidae	120	Corn bunting	<i>Emberiza calandra</i> (Linnaeus, 1758)	45

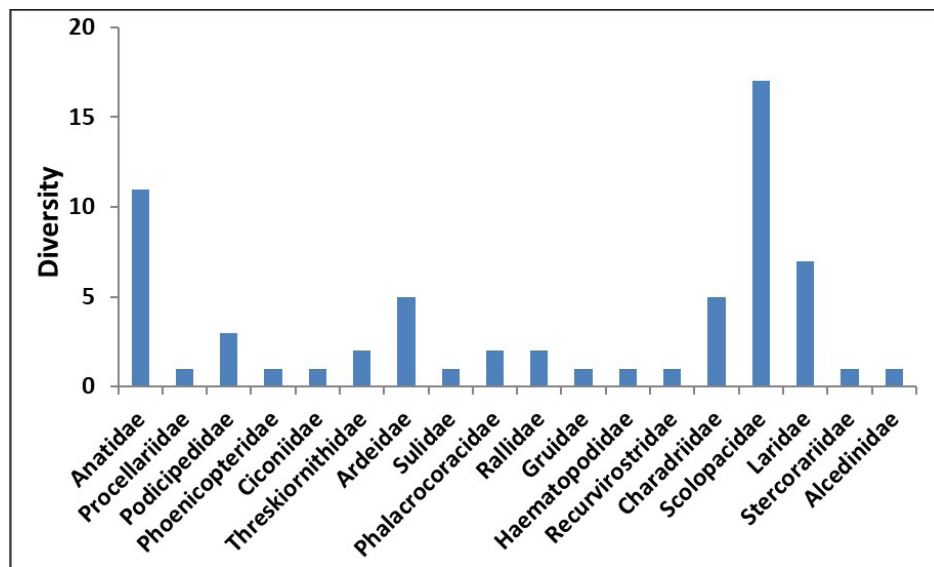


Fig. 2. Diversity of bird families during the IWC 2022 in Libya.

families (1–17), where the family Scolopacidae is the most diverse, followed by the family Anatidae with 11 species. There are nine families represented by only one species each (Fig. 2). The abundance of waterbirds among the families was significantly varied, where the most considerable abundance was for the family Laridae (51,412) with a percentage of approximately 85%, while in some families, the number did not exceed one or two individuals. In terms of the diversity of species among the sites, it ranged from 0 to 27, where the largest assortment was in Farwa, and the highest abundance was in Sabkhat Qanfudhah with a total of 35,169 individuals (Table 3).

The abundance of non-waterbirds was 14,836 individuals belonging to 52 species out of 25 families, the highest diversity was in the family Muscicapidae, represented by 12 species, and the abundance of those species was 474 individuals. The largest abundance of non-waterbird species was 12,740 for the family Sturnidae, although it has represented by only one species: Common Starling *Sturnus vulgaris* (Linnaeus, 1758) (Table 2).

The diverse species of non-waterbirds varied between sites (0–17), with the highest diversity being in the Tawergha region and in terms of abundance, which was 3,012, while a total of 10 sites with no records of non-waterbirds (Table 3).

Using the LPI Chain method revealed that the population index of the wintering water birds in Libya in 2022 has increased by up to more than 100%. The period from 2005 to 2009 showed a fluctuation of rising between 50% and 100%, while, for the period from 2013 to 2021, the index showed a dramatic decrease of 25% to 100%, particularly in the year 2015 (Fig. 3). This survey observed a total of 18 endangered (Threatened) bird species; 16 are aquatic, and 2 are non-aquatic birds. This classification is depending on the International Union for Conservation of Nature (IUCN Red-list) and the Annex II of the (RAC/SPA-MAP/UNEP). Moreover, six of them are evaluated as threatened species, the other six species are near threatened, and the vulnerable, endangered species are six (Table 4). Those species have been recorded in 79.6% of sites ($n = 64$).

Table 3. Number of birds in the covered sites during the IWC 2022 in Libya.

No	Site name	WB diversity	WB abundance	NWB diversity	NWB abundance	Threatened sp.
1	Ras jdeir	10	92	6	18	3
2	Farwah Abokammash coast	23	3,452	3	61	3
3	Farwah	27	1,652	1	2	8
4	Sabkhet Almanqoub	5	125	2	15	2
5	Zwarah Harbour	7	598	0	0	2
6	Sabkhet Mellita	3	15	3	11	0
7	Wadi Kaam dam	21	342	11	49	4
8	Kahaf Dakhil	7	819	9	25	1
9	Zliten Sewage Treatment Plant	8	249	4	66	1
10	Zliten Harbour	10	371	0	0	4
11	Ain Kaam	8	70	6	26	1
12	Alkhoms harbour	7	132	1	2	2
13	Alkrarem	1	25	12	2,485	0
14	Misrata's industrial area	1	11	3	1,451	0
15	Misrata harbour	5	89	0	0	2
16	Qaser Ahmed	13	849	16	283	1
17	Zraiqh port	15	435	9	236	6
18	Misrata treatment plant	15	906	8	779	4
19	Wadi Saso	13	57	15	308	1
20	Tawergha	1	1	17	3,012	0
21	Al-Heesha	22	413	9	43	3
22	Sirt harbour	10	180	1	1	4
23	Sultan	2	2	0	0	1
24	Abumariem	6	85	1	20	3
25	Derna coast	6	154	1	1	2
26	Wadi Alkhabta	3	13	7	49	1
27	Wadi Alhamsa	5	25	9	82	0
28	Um hafain	15	785	5	60	2
29	Sabkhat at Tamimi	7	55	6	57	2
30	Ras Attin	7	117	1	12	5
31	Alqsebaia	7	126	2	2	3
32	Ain Alghazala	3	36	1	2	1
33	Tobruk harbour	4	192	0	0	3
34	Khalij al Bumbah	7	193	0	0	0
35	Ain Ashaghigha	2	30	2	3	0
36	Ain Azargha	0	0	2	153	0
37	Al Marj	2	535	0	0	0
38	Sabkhat Julyanah	15	2,879	7	341	3
39	Sabkhat Nairuz	1	21	0	0	1
40	Sabkhat al Nakhil	5	23	2	3	3
41	Sabkhat Qaminis	6	150	1	30	3
42	Sabkhat Qanfudhah	11	35,169	4	1,516	3
43	Ayn Zayyanah	7	550	6	2,508	2

44	Bou Dzira	6	1,626	1	1	0
45	Ras Almengar	6	79	2	17	3
46	Sabkhat al Thama	16	1,255	5	34	3
47	Assabri beach	6	154	3	5	3
48	Tebesti lake	10	52	2	401	2
49	Sabkhat Karkurah	6	221	3	8	2
50	Sabkhat al Burayqah	2	15	5	58	2
51	Algardabia reservoir	4	24	1	150	0
52	Al-Washka	10	1,345	2	3	4
53	Wadi Turghat	6	10	9	46	1
54	Annjeela sewage	11	945	10	32	2
55	Wadi Al-mjenin dam	15	96	4	57	3
56	Wadi Ghan dam	4	20	2	5	0
57	Ain Taghneet	0	0	6	18	0
58	Al-Mallaha	8	98	3	10	2
59	Tajoura coast	9	140	6	11	3
60	Tajoura port	5	124	0	0	2
61	Tripoli coast	11	246	3	64	3
62	Tripoli harbour	7	978	0	0	3
63	Al Haqabah Sewage Treatment Plant	8	295	10	203	2
64	Qergarish	21	764	1	1	6

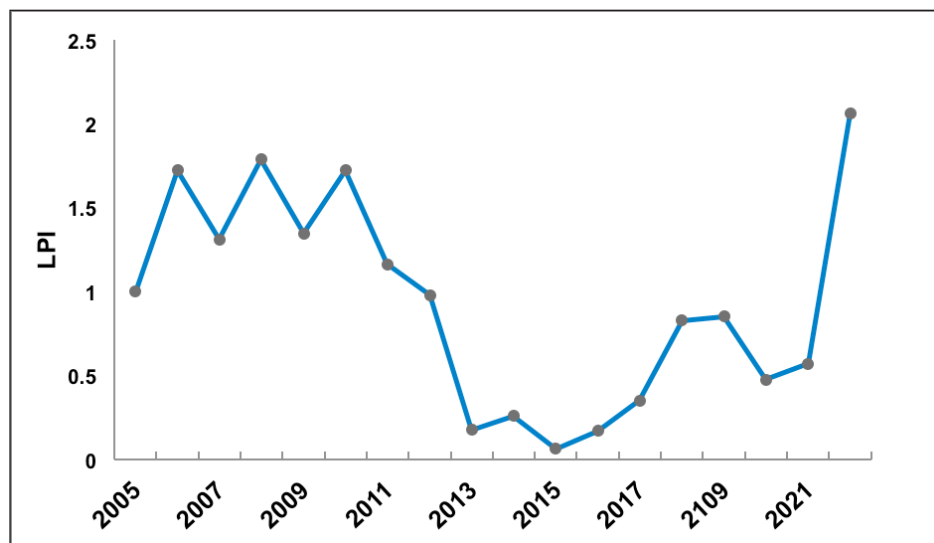


Fig. 3. LPI of wintering water birds in Libya 2005–2022.

Discussion

The results of IWC 2022 in Libya are generally reasonable compared to the previous years (2013–2021), but they can be compared with the results of the beginning of the survey in Libya during the years from 2005 to 2012 (Azafzaf *et al.*, 2005, 2006; Smart *et al.*, 2006; Etayeb *et al.*, 2007; Hamza *et al.*, 2008; EGA-RAC/SPA, 2012). The main reason for the improvement

is related to the number of covered sites in which the census is conducted, as it decreased significantly during the years 2013–2021, with a total of six sites in 2015, while in 2010, the number of covered sites reached 94 (EGA-RAC/SPA, 2012).

The highest abundance of waterbirds in 2008 was 53,632 (Hamza *et al.*, 2008), and the highest diversity was 92 in 2007 (Etayeb *et al.*, 2007), compared to

Table 4. Threatened species recorded during the IWC 2022 in Libya.

	Species	Common name	No.	No. of sites	Status	Source
1.	<i>Larus audouinii</i> (Payraudeau, 1826)	Audouin's gull	21	9	VU, T	* & **
2.	<i>Larus genei</i> (Breme, 1839)	Slender billed gull	2,169	32	VU, T	* & **
3.	<i>Larus melanocephalus</i> (Temminck, 1820)	Mediterranean gull	5,026	20	T	**
4.	<i>Thalasseus bengalensis</i> (Lesson, 1831)	Lesser crested tern	7	1	T	**
5.	<i>Sterna sandvicensis</i> (Latham, 1878)	Sandwich tern	502	21	T	**
6.	<i>Charadrius alexandrinus</i> (Linnaeus, 1758)	Kentish plover	592	20	T	**
7.	<i>Gulosus aristotelis</i> (Linnaeus, 1761)	European shag	8	2	T	**
8.	<i>Phoenicopterus roseus</i> (Pallas, 1811)	Greater flamingo	352	6	T	**
9.	<i>Puffinus yelkouan</i> (Acerbi, 1827)	Levantine shearwater	3	2	VU, T	* & **
10.	<i>Aythya ferina</i> (Linnaeus, 1758)	Common pochard	5	1	VU	*
11.	<i>Aythya nyroca</i> (<i>Güldenstädt</i> , 1770)	Ferruginous duck	60	5	NT	*
12.	<i>Marmaronetta angustirostris</i> (Ménétries, 1832)	Marbled teal	8	3	VU	*
13.	<i>Numenius arquata</i> (Linnaeus, 1758)	Eurasian curlew	16	6	NT	*
14.	<i>Calidris ferruginea</i> (Pontoppidan, 1763)	Curlew sandpiper	7	4	NT	*
15.	<i>Haematopus ostralegus</i> (Linnaeus, 1758)	Eurasian oystercatcher	34	2	NT	*
16.	<i>Limosa lapponica</i> (Linnaeus, 1758)	Bar-tailed godwit	1	1	NT	*
17.	<i>Circus macrourus</i> (Gmelin, 1770)	Pallid harrier	1	1	NT	*
18.	<i>Streptopelia turtur</i> (Linnaeus, 1758)	European turtle dove	2	1	VU	*

VU= vulnerable, T= Threatened, NT= Near threatened, * = IUCN Redlist & ** = Annex II (RAC/SPA).

the results of IWC 2022, where 68 species were recorded with the abundance of 61,850 birds, this indicated good improvement in term of diversity and abundance of species, as well as, the LPI emphasized this improvement in 2022, where it was increased up to more than 100% from the point of starting in 2005. However, under normal circumstances, Libya is considered less diverse and abundant of birds compared to its neighboring countries such as Tunisia and Egypt (Smart *et al.*, 2006), through which major migration routes pass, as the first route passes along the Nile River and the other one passes through Italy and Sicily to Tunisia (Berthold, 2001).

Although the family Scolopacidae was represented by the highest diversity (17 species), followed by the Anatidae family with 11 species, in terms of abundance, the family Laridae was the highest, represented by seven species, including gull species which are marine birds, and the covered sites are along the coastline. Moreover, the important factor that explains the abundance of gulls in large numbers is the presence of dumping grounds in some sabkha; this attracts high numbers of gulls that reach tens of thousands because these species are mainly scavengers and prefer the putrescible-waste landfills (Belant, 1997). One of the most important areas where there are many gulls is Sabkhat Qanfudhah, the largest dumps in the Benghazi region. The number of Black-headed gull *Chroicocephalus ridibundus* exceeded 15,000, and more than 9,000 individuals of the yellow-legged gull *Larus michahellis* were recorded. However, the diversity and abundance of bird species are usually related to habitat type and preference factors (Jones, 2001).

Recording and observing the globally threatened species is one of four criteria used by the global network of important bird areas (IBAs) and the IUCN to identify the importance of the sites for biodiversity in general and birds in particular (BirdLife International, 2014; IUCN, 2016).

This study recorded a total of 18 threatened species with varying numbers in 51 sites out of 64. These records give importance to the sites where threatened species were recorded. Moreover, such recordings support decision-makers in declaring protected areas in addition to other reasons or purposes for protection. However, recording one endangered species is sufficient to give the area importance and be a priority for protection (Day *et al.*, 2012; Stolton *et al.*, 2013).

Regarding sites, depending on the registered threatened species, Farwa is considered the most important site as an IBA and marine protected area (MPA); indeed, it has been declared as MPA by the resolution of the Minister of Agriculture, Animal and Marine No. 22 of 2009. Ain Alghazala also was declared as MPA in 2011, although this study found only one threatened species. This finding is considered supportive of the protection decision, in addition to the presence of other important species of fish recorded in the area. Overall, this study

strongly recommends that the rest of the sites listed in the present study should be protected and managed, as well as implementing a comprehensive study to address the other biodiversity components.

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References

- Azafzaf, H., Baccetti, N., Defos du Rau, P., Dlensi, H., Essghaier, M.F., Etayeb, K., Hamza, A. and Smart, M. 2005. Report on an ornithological survey in Libya from 3 to 17 January 2005 (Unpublished report). Tunis, Tunisia: Regional Activities Centre/Special Protected Areas (MAP/UNEP), Environment General Authority, Libya, and African-Eurasian Waterbird Agreement (UNEP/AEWA).
- Azafzaf, H., Baccetti, N., Defos du Rau, P., Dlensi, H., Essghaier, M.F., Etayeb, K., Hamza, A. and Smart, M. 2006. Report on an Ornithological Survey in Libya from 19 to 31 January 2006. Cyclostyled report to the Regional Activity Centre/Special protected Areas (MAP/UNEP), Environment General Agency, Libya and to the African-Eurasian Waterbird Agreement (UNEP/AEWA).
- Belant, J.L. 1997. Gulls in urban environments: landscape-level management to reduce conflict. *Landscape Urban. Plan.* 38, 245–258.
- Berthold, P. 2001. Bird migration, a general survey, 2nd ed. Oxford, UK: Oxford University Press, p: 253.
- BirdLife International. 2014. Important bird and biodiversity areas: a global network for conserving nature and benefiting people. Cambridge, UK: BirdLife International.
- Bourass, E., Baccetti, N., Bashimam, W., Berbash, A., Bou Zainen, M., De Faveri, A., Galidan, A., Saied, A.M., Yahia, J. and Zenatello, M. 2013. Results of the seventh winter waterbird census in Libya, January-February 2011. *Bull. Afr. Bird. Club.* 20, 20–26.
- Day, J., Dudley, N., Hockings, M., Holmes, G., Laffoley, D., Stolton S. and Wells, S. 2012. Guidelines for applying the IUCN protected area management categories to marine protected areas. Gland, Switzerland: IUCN, p: 36.
- Defos du Rau, P., Essghaier, M.F.A. and Etayeb, K. 2003. Inventaire préliminaire des zones humides cotières de Libya. *Faune. Sauvage. (ONCFS).* 259, 44–48.

- EGA-RAC/SPA Waterbird Census Team. 2012. Atlas of wintering waterbirds of Libya, 2005-2010. Ben Arous, Tunisia: Imprimerie COTIM.
- Etayeb, K.S., Berbash, A., Bashimam, W., Bouzainen, M., Galidana, A., Saied, M., Yahia, J. and Bourass, E. 2015. Results of the eighth winter waterbird census in Libya in January 2012. *Biodiver. J.* 6(1), 245–252.
- Etayeb, K.S., Essghaier, M.F., Hamza, A., Smart, M., Azafzaf, H., Defos du Rau, P. and Dlensi, H. 2007. Report on an ornithological survey in Libya from 3 to 15 February 2007. EGA-AEWA-RAC/SPA-MAP-UNEP, p: 46.
- Hamza, A., Saied, A., Bourass, E., Yahya, J., Smart, M., Baccetti, N., Defos, P., Dlensi, H. and Azafzaf, H. 2008. Final report on a fourth winter ornithological survey in Libya, 20-31 January 2008. EGA-AEWA-RAC/SPA-MAP-UNEP, p: 31.
- IUCN. 2016. A global standard for the identification of key biodiversity areas, version 1.0, 1st ed. Gland, Switzerland: IUCN.
- Jones, J. 2001. Habitat selection studies in avian ecology: a critical review. *The Auk.* 118(2), 557–562.
- Loh, J., Green, R.E., Ricketts, T., Lamoreux, J., Jenkins, M., Kapos, V. and Randers, J. 2005. The living planet index: using species population time series to track trends in biodiversity. *Philos. Trans. R. Soc. B.* 360, 289–295.
- Sayoud, M.S., Salhi, H., Chalabi, B., Allali, A., Dakki, M., Qninba, A., El-Agbani, M.A., Azafzaf, H., Feltrup-Azafzaf, C., Dlensi, H., Hamouda, N., Abdel Latif Ibrahim, W., Asran, H., Abu Elnoor, A., Ibrahim, H., Etayeb, K., Bouras, E., Bashaimam, W., Berbash, A., Deschamps, C., Mondain-Monval, J.Y., Brochet, A.L., Véran, S. and Defos du Rau, P. 2017. The first coordinated trans-North African mid-winter waterbird census: the contribution of the international waterbird census to the conservation of waterbirds and wetlands at a biogeographical level. *Biol. Conserv.* 206, 11–20.
- Smart, M., Essghaier, M.F., Etayeb, K., Hamza, A., Azafzaf, H., Baccetti, N. and Defos Du Rau, P. 2006. Wetlands and wintering waterbirds in Libya, January 2005 and 2006. *Wildfowl. Wetl. Trust.* 56, 172–191.
- Stolton, S., Shadie, P. and Dudley, N. 2013. IUCN WCPA best practice guidance on recognising protected areas and assigning management categories and governance types, best practice protected area guidelines series no. 21. Gland, Switzerland: IUCN, p: 143.
- Volpato, G.H., Lopes, E.V., Mendonça, L.B., Boçon, R., Bisheimer, M.V., Serafini, P.P. and Anjos, L.D. 2009. The use of the point count method for bird survey in the Atlantic forest. *Zoologia* 26(1), 74–78.