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VARIATIONS IN THE DIURNAL WINTERING WATERBIRDS COUNTS IN RELATION TO CENSUS TIME IN THE ANZALI WETLAND, SOUTHWEST CASPIAN SEA (IRAN)

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Abstract. In order to find variations in the number of waterbirds species between the morning and at the afternoon counts, a study has been done once every two weeks on non-hunting days from October 1999 to early April 2000 at Selkeh and Espand within the Anzali wetland complex, a habitat for wintering and passage migrant waterbirds in the south Caspian Sea. In general, most species had not higher numbers neither in the morning nor in the afternoon throughout the study period, except for Common Moorhen and Great Cormorant. Apart from Northern Pintail, other members of Anatidae, the most important family in these wetlands had a similarity of over 0.85 at Selkeh while at Espand the highest similarity of Anatidae species was seen for Mute Swan (0.98) and the lowest for Greylag Goose (0.55). Horn's similarity index of total waterbirds between the morning and afternoon showed a similarity of 0.98 for Selkeh and 0.97 for Espand. Paired Samples *t*-test performed separately for all dates showed no significant difference between the total waterbirds population between the morning and afternoon counts ($p > 0.05$). There was no difference between Horn's similarity calculated for the population of all waterbirds and selected common birds at Espand or at Selkeh ($p > 0.05$). Spearman Correlartion test showed a significant correlation between total waterbirds population and species number with waterlevel at Selkeh and Espand ($p < 0.05$). The test also showed a significant correlation between total waterbirds species number and population with the humidity at Espand only ($p < 0.05$). Regarding the main use of wetlands by waterbirds during the daytime presence of the waterbirds throughout the study period, grebes and Rallidae species, especially Eurasian Coot were observed feeding at these wetlands while Anatidae species and cormorants were using the study sites as their roost.

Key words: Caspian Sea, method, count, similarity, waterbirds, number.

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Связь результатов дневных зимних учетов гидрофильных птиц со временем учета в Энзели, юго-запад Каспийского моря (Иран). - А. Халеджизаде. - Беркут. 19 (1-2). 2010. - Лагуна Энзели находится на юго-западном побережье Каспийского моря, относится к IBA и рамсарским водно-болотным угодьям. Это одно из важных мест гнездования, зимовки и остановки на пролете водоплавающих и околоводных птиц. С юга к ней примыкают участки с мелководьями и лугами Селке и Эспанд (севернее г. Решт), на которых и велись исследования. С целью изучения влияния времени учета на его результаты с октября 1999 г. до апреля 2000 г. проводились регулярные учеты зимующих гидрофильных птиц. Для большинства видов показатели учетов в утренние и вечерние часы оказались сходными. В целом достоверных различий между численностью птиц, учитывавшихся в разное время, не обнаружено. Отмечена корреляция количества видов и общей численности птиц с уровнем воды на обоих участках, а на участке Эспанд – также с влажностью воздуха.

INTRODUCTION

In the past, many diurnal waterbird surveys have been done around the world (e.g. Evans, 2008). Most of the times, the researches have been done during the daylight hours and rarely nocturnal ones (e.g. Anonymous, 2007). However waterbird counts indicated different results around the world, sometimes comparison of waterbird counts revealed interesting results. For example, Anderson & Smith (1999) found that the counts during nocturnal were 10.5 times higher than diurnal counts. It is obvious that counts in different times of the day and in different habitats give various results for different waterbirds taxa.

As mentioned by Anderson & Smith (1999), if the main purpose is to evaluate effectiveness of wetland management for waterfowl, then monitoring of nocturnal and diurnal use is essential. The waterbirds exhibited either a circadian (most waders, except

Common Sandpipers (*Actitis hypoleucos*) and Turnstones (*Arenaria interpres*)) or a diurnal foraging activity pattern (herons and terns), with no purely nocturnal species. Some species fed throughout the day, others showed peak foraging at various times of the day (Ntiamoa-Baidu et al., 1998).

Of the specific species, for example, Tamisier (1976) analysed daily activity for Greater White-fronted Geese (*Anser albifrons*) and Shimada (2002) for Common Teal (*Anas crecca*) and Northern Pintail (*A. acuta*). Houhamdi & Samraoui (2008) studied diurnal and nocturnal behavior of Ferruginous Duck (*Aythya nyroca*), Davis et al. (1989) analysed diurnal time-activity budgets for Lesser Snow Geese (*Anser caerulescens*), and Meissner & Remisiewicz (2008) surveyed daily arrival and departure patterns for Ruddy Shelduck (*Tadorna ferruginea*), Northern Pintail and Mallard (*Anas platyrhynchos*).

The present study was carried out on one of the most important wetland resorts for waterbirds in the south Caspian Sea on the Eurasian-East African Flyway (Newton, 2008). The Anzali wetland and its satellite wetlands such as Siahkesheem and Selkeh are extremely important for a wide variety of breeding, passage and wintering waterbirds, and support huge concentrations of wintering ducks, geese, swans and coots. The Anzali Mordab supports an extremely diverse wetland fauna and flora (Scott, 1995).

Although RSPB (1998) guided monitoring methods for many species, including the best time of the day to study a specific species, literature review revealed less information about daytime counts for waterbirds spanning the whole period of the wintering season. Therefore, because of the lack of information, this study focused on comparison of waterbird numbers between the morning and afternoon counts.

STUDY AREA

The Anzali wetland complex is situated in the south Caspian lowlands in Gilan Province in northwestern Iran. The Anzali wetland, some 15,000 ha, is one of 105 IBAs (Evans, 1994) and 22 Ramsar sites (a total area of 1,481,147 ha) in Iran (Ramsar Convention, 2000). Anzali (IBA IR016) was designated as a Ramsar Site on 23.06.1975. South of the main Anzali lagoon, Selkeh Wildlife Refuge (37°23′ N, 49°27′ E, 77.3 ha) and the Espand wetland (37°24′ N, 49°19′ E, 45 ha) comprise shallow freshwater lagoons and marshes with adjacent flood meadows (Evans, 1994). The study covered the open waters of the two wetlands. Maximum water depth of both areas is 120 cm, and salinity varies between 0.38 and 0.61 mhos/cm (Khaleghizadeh, 2007). The Sowmaea-Sara DOE Office ensures that both study sites are fully protected from hunting, but waterbird hunting is permitted in adjacent areas on certain days of the week. Two sites were selected because of their easy access and close proximity to one another, Selkeh and Espand being 11 km apart and some 19 and 30 km, respectively, north of the city of Rasht (Khaleghizadeh, 2007).

MATERIAL AND METHODS

Field observations

The present study was carried out in two areas of this Ramsar site (Selkeh and Espand) to monitor variations in the numbers of waterbird species and population in relation to morning and afternoon counts over a six-month period spanning the winter of 1999/2000. Observations of waterbirds were carried out approximately once every two weeks from early October 1999 to early April 2000 both in the morning (7^{00}–11^{00}) and the afternoon (15^{00}–17^{00}). At Espand sector 8, I obtained the best viewpoint by climbing the DOE radio aerial near the Game Guard Station. The optics were Berkut 15×50 binoculars. Counts were done on 14 occasions on days when hunting was forbidden in adjacent areas (Sundays to Tuesdays) – Iranian Environmental Law allows hunting of waterbirds only on Wednesdays, Thursdays and Fridays (Laws..., 1997). Counts on Saturdays were avoided because of

Table 1

Weather conditions and water levels at study areas
Погодные условия и уровни воды на исследуемых участках

Selkeh		**3 Oct**	**18 Oct**	**31 Oct**	**16 Nov**	**29 Nov**	**14 Dec**	**27 Dec**	**10 Jan**	**8 Feb**	**14 Feb**		**1 Mar**	**14 Mar**	**26 Mar**	**5 Apr**
Time	AM	6^{00}	7^{10}	7^{12}	7^{13}	8^{03}	8^{00}	9^{40}	9^{23}	9^{35}	9^{55}		9^{40}	10^{45}	10^{40}	13^{00}
	PM	16^{00}	16^{30}	15^{40}	12^{50}	14^{20}	15^{00}	14^{35}	15^{03}	14^{57}	15^{14}		15^{15}	15^{40}	15^{45}	15^{20}
Temp. air	AM			12	22	8.5	15	16	11	17	7.5		6	15	7.5	20
	PM			13			12		11.5	12	7.5		6	12.5	8.5	20
Humidity (%)	AM	52	57	53	65	52	66	47	35	35	83		57	42	44	68
	PM	35	55	50	22	33	60	53	57	25	58		67	39	46	66
Weather condition*	AM	C	SC	SR	S	SC	CSR	SC	SCW	S	WSR		CWR	C	SC	CW
	PM	S	SR	SR	S	SC	S	SC	SCW	SW	CR		CWR	S	C	S
Water level (cm)		80	76	67	81	76	88	86	81	73	76		55	29	61	83
Espand		**5 Oct**	**17 Oct**	**1 Nov**	**15 Nov**	**30 Nov**	**13 Dec**	**28 Dec**	**9 Jan**	**7 Feb**	**15 Feb**	**20 Feb**	**28 Feb**	**15 Mar**	**25 Mar**	**6 Apr**
Time	AM	7^{00}	7^{30}	8^{30}	8^{50}	9^{00}	9^{30}	9^{30}	9^{40}	8^{20}	10^{20}	10^{50}	7^{00}	9^{55}	11^{25}	10^{30}
	PM	16^{00}	16^{25}	17^{10}	15^{25}	15^{00}	15^{30}	15^{30}	15^{45}	15^{45}	15^{45}	15^{40}	15^{10}	15^{30}	15^{30}	15^{25}
Temp. air	AM			10	15.5	10	14	17	17	5.5	10.5	20	7.5	11	6.5	20.5
	PM			10.5		10.5	13	21	9	5.5	14	13	7.5	6	7.5	23.5
Humidity (%)	AM	23	68	74	20	62	52	50	54	78	50	20	52	42	50	40
	PM	22	68	51	55	71	58	20	57	74	58	41	59	57	29	35
Weather condition*	AM	SC	R	WR	S	WR	C	SC	SC	WR	S	S	CW	CW	R	S
	PM	SC	RW	SC	S	WR	C	SC	SC	R	S	S	RW	CWR	R	S
Water level (cm)		80	89	64	65	68	83	84	86	86	85	?	86	70	71	65

* S – sunny, C – cloudy, W – windy, R – rain.

possible knock-on effects of Friday's hunting. During the field observations, some factors such as air and water temperature, water level and the humidity were registered (Table 1) in order to find any correlation between waterbird species numbers and populations with the environmental factors measured.

Data analysis

This study mainly focused on the five groups of common waterbirds: resident, autumn migrants, early arriving winter visitors, winter visitors, late arriving winter visitors and spring migrants (Khaleghizadeh, Behrouzi-Rad, 2004). Their numbers were counted more

Table 2

Results of counts at Selkeh (morning/afternoon)

Результаты учетов на участке Селке (утро/вечер)

Species	3.10	18.10	31.10	16.11	29.11	14.12	27.12	10.01	8.02	14.02	1.03	14.03	26.03	5.04	No. of cases	Horn's Similarity
Tachybaptus ruficollis	12/4	0/2	9/27	1/1	3/0	0	1/0	0	0	0	0	0	0	0	**6**	**0.75**
Pelecanus onocrotalus	0	0	0	0	0	0	2/2	12/13	11/15	11/13	3/10	9/8	3/3	0	**7**	**0.98**
Phalacrocorax carbo	0	0	0	0/2	10/0	73/0	43/5	18/7	10/22	22/22	31/56	18/11	4/5	34/0	**11**	**0.65**
Ph. pygmeus	26/19	31/4	21/12	27/8	64/24	17/6	10/10	5/3	8/6	10/10	13/7	8/15	19/31	0/2	**14**	**0.93**
Ardea cinerea	16/16	36/17	6/4	4/8	2/9	3/4	6/0	0/2	1/5	3/3	1/2	2/3	8/4	3/3	**14**	**0.88**
Casmerodius albus	11/11	7/1	1/2	3/3	11/18	2/4	1/0	0/2	0/1	0/1	3/2	5/7	2/0	1/3	**14**	**0.87**
Egretta garzetta	11/22	3/40	3/183	10/24	4/4	1/2	2/0	0/2	0	0/1	0/1	4/6	0/1	12/8	**13**	**0.67**
Cygnus olor	0	0	0	0	1/1	108/0	99/66	36/37	9/7	19/6	8/7	10/12	8/11	6/6	**10**	**0.81**
C. cygnus	0	0	0	2/8	24/11	140/0	164/182	49/71	313/249	130/5	36/86	5/4	0/2	7/3	**11**	**0.83**
Anser anser	0	0	0	169/186	778/795	899/941	579/677	794/803	819/1228	402/110	0/12	6/0	62/77	40/58	**11**	**0.98**
Anas penelope	0	0	0	1/1	25/0	0	+39/0	59/163	132/360	105/134	18/19	19/0	0/15	8/8	**10**	**0.85**
A. strepera	0	3/0	12/12	70/70	592/1315	738/1080	+131/675	505/520	77/74	30/258	38/46	81/4	131/60	13/8	**13**	**0.93**
A. crecca	0	0	0	+450/ +776	5625/ 3843	3628/ 3870	4045/ 3264	4632/ 4380	2924/ 4632	4446/ 4160	1330/ 2157	546/ 315	680/ 505	15/ 25	**11**	**0.98**
A. acuta	0/85	3/76	0/2	0	0/2	8/8	+17/33	28/40	23/12	18/0	0/8	29/28	27/0	0/5	**13**	**0.57**
A. querquedula	2846/ 3794	1983/ 2152	368/ 311	0	0	0	0	0	0	0	0	0	400/ 340	151/ 165	**5**	**1.00**
A. clypeata	0	0	0	510/+53	558/67	665/340	+110/200	990/990	321/367	290/0	240/0	31/30	250/195	109/138	**11**	**0.85**
Aythya ferina	0/2	9/11	2/4	9/47	245/237	65/124	17/75	38/0	23/62	0/4	0	0	0	0	**10**	**0.89**
Gallinula chloropus	10/0	7/0	17/14	0	0	0	1/0	0	0	0	0	0	0	0	**4**	**0.73**
Porphyrio porphyrio	39/15	15/7	2/3	0/11	3/2	8/12	12/4	10/0	1/7	10/7	10/9	4/6	0	0	**12**	**0.81**
Fulica atra	380/724	1153/1361	869/891	3645/2491	1322/0	1764/2295	1150/0	0	0	0	10/10	22/29	23/24	16/16	**11**	**0.86**
Recurvirostra avosetta	0	0/4	0	27/0	10/1	58/55	109/0	104/105	131/125	130/105	60/41	2/58	0	0	**10**	**0.83**
Vanellus vanellus	0	0	4/1	41/37	57/36	140/120	324/344	15/0	0	0	0	0	0	0	**6**	**0.98**
Tringa totanus	0/41	7/11	0	0	2/0	33/12	170/121	109/91	44/93	30/0	0	0	0	70/65	**9**	**0.89**
T. stagnatilis	0	0/170	0	0	0	392/130	198/262	0	45/0	0	0	0	0	32/0	**5**	**0.72**
Larus ridibundus	0	0	0	0	0	0	0	85/1	0	0	0	0/1	20/0	214/86	**4**	**0.87**
L. minutus	0	0	0	0	0	0	0	0	0	0	82/64	570/95	115/390	0	**3**	**0.72**
Total no. of species in AM	17	17	14	26	25	27	30	23	22	20	19	21	20	22		
Total no. of species in PM	18	16	17	24	22	24	20	20	25	20	21	18	19	21		
Total no. of waterbirds in AM	3392	3570	1318	5043	9397	8799	7256	7520	4912	5684	1893	1381	1775	988		
Total no. of waterbirds in PM	4779	3875	1472	4896	6394	9062	5939	7236	7299	4906	2548	643	1668	665		
Paired samples *t*-test	0.173	0.412	0.425	0.932	0.211	0.752	0.284	0.334	0.181	0.174	0.453	0.172	0.760	0.169		
No. of all species in equation	22	24	19	31	30	32	32	26	29	24	25	23	26	25		
Horn's Similarity for all sp.	0.98	0.92	0.93	0.87	0.88	0.96	0.87	0.98	0.98	0.93	0.91	0.85	0.93	0.87		
No. of selected sp. in equation	12	15	13	18	20	20	23	20	19	18	18	20	18	18		
Horn's Similarity for sel. sp.	0.98	0.96	0.94	0.94	0.89	0.96	0.87	0.99	0.99	0.93	0.92	0.86	0.93	0.91		

than 50 individuals during the present study, in addition to a few resident bird species less than 50 individuals. Regarding the common birds defined, at Selkeh 26 species of waterbirds and in Espand 17 species were considered for the comparison of bird numbers of selected species between the morning and afternoon counts. The numbers of each species are given in Tables 2–3.

Data analyses were done in SPSS 16 software using *t*-test paired samples to test the significance of correlation between the morning and afternoon counts for species separately for all the census dates. Spearman's Correlation test was used to find correlation between the number of measured factors such as temperature and changes in the waterlevel with total waterbirds species number and population of all waterbirds species.

To quantify and compare the similarity and difference between the counts in the morning and afternoon Horn's similarity index (between 0 and 1) was also perfomed both for total and selected waterbirds species in Ecological Methodology software (Krebs, 2001). The similarity was also used for similarity of the counts of each species between the morning and afternoon. Finally, the values of Horn's similarity of all waterbirds species compared with selected species using *t*-test paired samples.

RESULTS

Waterbird species numbers

In general, most species had not higher numbers neither in the morning nor in the afternoon throughout the study period; however, at Selkeh the number of Common Moorhen (*Gallinula chloropus*) in the mornings was usually more than the afternoons (Table 2). This situation was similary seen at Espand; the only exception was the number of Great Cormorants (*Phalacrocorax carbo*) where its number usually was more in the afternoon (Table 3).

As for Selkeh, Horn's similarity index showed the highest similarity of counts between the mornings and afternoons for Garganey (*Anas querquedula*) (1.0) whereas the lowest similarity was for Northern Pintail. Great Cormorant and Little Egret (*Egretta garzetta*) also showed low similarity of 0.65 and 0.67, respectively. High similarity of two daytime counts over the study period was seen for the following species: White Pelican (*Pelecanus onocrotalus*), Pygmy Cormorant (*Phalacrocorax pygmeus*), Greylag Goose (*Anser anser*), Common Teal, Northern Lapwing (*Vanellus vanellus*) all above 0.9. This index for the species: Little Grebe (*Tachybaptus ruficollis*), Common Moorhen, Marsh Sandpiper (*Tringa stagnatilis*) and Little Gull (*Larus minutus*) was calculated between 0.70 and 0.80 and for the remaining species ranging 0.80–0.89.

And for Espnad, however, there was a wider range of similarities between the morning and afternoon counts representating by Mute Swan (*Cygnus olor*) with the highest amount of 0.98 and Pygmy Cormorant the lowest amount of 0.15, and then Little Egret (0.18). Gadwall (*Anas streprea*), Common Teal, Whooper Swan (*Cygnus cygnus*), Eurasian Coot, Mallard, Grey Heron (*Ardea cinerea*), Little Grebe and Northern Lapwing showed higher similarity of 0.84–0.96; and the remaining species showed lower similarity of between 0.55 and 0.75.

Little Grebe showed high similarity of 0.75 and 0.85 between the morning and afternoon counts at the two sites (Tables 2–3). The number of White Pelican, a late wintering species at Selkeh, was also similar between the morning and afternoon counts (similarity of 0.98; Table 2). Except for Northern Pintail, other members of the family Anatidae had a similarity of over 0.85 at Selkeh. At Espand the highest similarity was seen for Mute Swan (0.98) while the lowest similarity was for Greylag Goose (0.55). However, the similarity for Whooper Swan, Gadwall and Mallard were high at this wetland.

During the present study, the number of Purple Swamphens at Selkeh (a suitable habitat for this species, maximum 39 individuals)

Table 3

Results of counts at Espand (morning/afternoon)

Результаты учетов на участке Эспанд (утро/вечер)

Species	5.10	17.10	1.11	15.11	30.11	13.12	28.12	9.01	7.02	15.02	20.02	28.02	15.03	25.03	6.04	No. of cases	Horn's Similarity
Tachybaptus ruficollis	0	0	0	3/3	1/1	1/2	1/0	0	0/1	2/0	2/3	2/0	1/1	4/3	0	**9**	**0.85**
Phalacrocorax carbo	0	0/79	0/210	1/1	5/1	13/2	13/1	12/12	9/76	37/225	18/709	16/752	15/11	3/0	0	**12**	**0.58**
Ph. pygmeus	6/78	155/0	90/0	1/217	15/3	1/2	0	19/0	0	1/0	5/1	2/1	1/6	14/4	19/4	**12**	**0.15**
Ardea cinerea	3/2	15/34	1/0	1/1	1/1	0/1	2/0	1/0	1/0	1/1	0	2/0	0	1/4	6/6	**12**	**0.84**
Casmerodius albus	1/3	3/20	0	0	0	1/0	2/0	1/0	0	1/0	1/1	3/1	1/0	1/0	1/0	**10**	**0.56**
Egretta garzetta	4/0	0/8	0	0	0/1	1/2	1/0	5/0	0	0	0/1	1/1	0/1	0	0	**9**	**0.18**
Cygnus olor	0	0	0	0	7/0	133/133	112/152	87/127	0	0	0	0	0	0	0	**4**	**0.98**
C. cygnus	0	0	0	0	0	0	9/27	61/48	0	0	0	0	0	0	0	**2**	**0.95**
Anser anser	0	0	0	0	0/14	0	17/0	13/51	0	0	0	0	0	0	0	**3**	**0.55**
Anas strepera	0	0	0	0	48/48	106/36	51/64	126/126	7/21	76/70	58/63	25/42	0	0	0	**7**	**0.96**
A. crecca	0	0	0	957/ 1166	2349 /87	2603/ 2685	3461/ 2283	4100/ 4636	5120/ 5360	3672/ 2310	3230/ 3766	4852/ 2654	220/ 845	50/ 125	0	**10**	**0.95**
A. platyrhynchos	0	0	0	2/0	22/22	2/0	12/2	43/1	13/6	44/8	40/20	23/23	0	0	0	**8**	**0.85**
A. querquedula	0/22	44/0	302/56	0	0	0	0	0	0	0	0	0	0	2/0	22/30	**5**	**0.75**
Porphyrio porphyrio	7/11	3/0	7/0	0/1	0	0	0	0	0	0	0	0	0	0	0	**4**	**0.61**
Fulica atra	0	0	15/11	609/ 653	580/ 580	703/ 1203	43/ 605	620/ 905	27/ 76	115/ 86	139/ 52	121/ 88	136/ 136	45/ 64	2/3	**12**	**0.94**
Vanellus vanellus	0	0	0	0	0	260/323	471/335	0/96	45/95	530/165	106/0	43/0	0	0	0	**6**	**0.84**
Larus minutus	0	0	0	0	0	0	0	0	0	0	0	0	0/95	165/65	0	**2**	**0.61**
Total No. of species in AM	6	6	8	9	12	14	14	13	9	15	13	13	7	13	7		
Total No. of species in PM	7	6	4	9	14	11	8	10	8	9	13	8	8	7	6		
Total No. of waterbirds in AM	22	222	429	1574	3035	3834	4201	5089	5231	4498	3607	5093	377	304	53		
Total No. of waterbirds in PM	111	146	287	2043	768	4391	3469	6005	5636	2867	4625	3562	1096	271	45		
Paired samples *t*-test	0.266	0.701	0.695	0.658	0.333	0.295	0.595	0.144	0.122	0.264	0.284	0.531	0.277	0.807	0.671		
Total No. of species in equation	8	9	10	10	15	15	15	15	12	17	13	14	10	13	8		
Horn's similarity for total sp.	0.53	0.17	0.36	0.95	0.68	0.99	0.92	0.98	0.99	0.99	0.92	0.88	0.90	0.86	0.88		
No. of selected sp. in equation	6	8	9	9	12	13	13	13	8	11	10	8	9	5	6		
Horn's similarity for selected sp.	0.67	0.17	0.36	0.95	0.68	0.99	0.92	0.98	0.99	0.90	0.92	0.90	0.87	0.90	0.67		

in the morning was usually more than the afternoon while at Espand this species was occurred (maximum 11) only by mid-November. Horn's similarity index for this species was 0.81 at Selkeh and 0.61 at Espand.

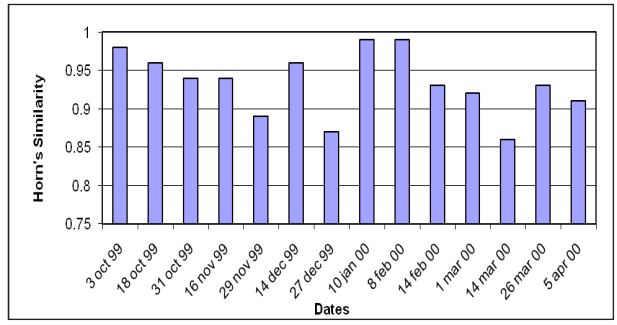

Fig. 1. Trend of Horn's similarity index at Selkeh during October 1999 – early April 2000.
Рис. 1. Изменения индекса сходства Хорна на участке Селке в октябре 1999 г. – начале апреля 2000 г.

Total waterbird numbers

The total waterbird species numbers reached their highest levels at Selkeh in the morning on 29 November with 9,397 individuals and in the afternoon on 9 February with 10,255 individuals (Table 2). At Espand, this sitation took place in the morning on 7 February with 5,231 individuals and in the afternoon on 9 January with 6,005 individuals (Table 3).

At Selkeh, the total waterbird numbers in the morning were considerably more than the afternoon on the following days: 29 November, 27 December, 14 February, 14 March and 5 April while on the following days was the reverse (total waterbird numbers in the afternoon was considerably more than the morning): 3 October, 8 February and 26 March (Table 2).

At Espand, the total waterbird numbers in the morning were considerably more than the afternoon on the following days: 17 October, 1 November, 30 November, 28 December, 15 February and 28 February while on the following days in the afternoon more waterbird numbers were counted than the morning: 5 October, 15 November, 9 January, 7 February, 20 February and 15 March (Table 3).

Horn's similarity index of total waterbirds between the morning and afternoon showed a similarity of 0.98 for Selkeh and 0.97 for Espand. The trend of this index for Selkeh and Espand are shown in Figures 1–2. At Selkeh this similarity started at 0.98, then, it decreased slightly and continued with some fluctuations; the highest amount on 10 January and 8 February and the lowest on 14 March. At Espand, however, there were more fluctuations in Horn's similarity index, ranging from 0.17 (on 17 October) to 0.99 (on 13 December and 7 February).

Paired samples *t*-test separately done for all dates showed no significant difference between the total waterbirds population between the morning and afternoon counts on none of the census dates in both sites ($p > 0.05$). There was no difference between Horn's similarity calculated for the population of all waterbirds and selected common birds at Espand ($p = 0.65$) or at Selkeh ($p = 0.18$).

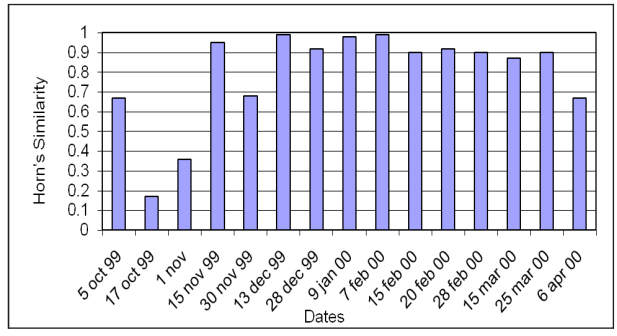

Fig. 2. Trend of Horn's similarity index at Espand during October 1999 – early April 2000.
Рис. 2. Изменения индекса сходства Хорна на участке Эспанд в октябре 1999 г. – начале апреля 2000 г.

Effect of measured factors on waterbirds

Spearman correlartion test showed only significant correlation between total waterbirds population with waterlevel at Espand in the afternoon ($r = 0.633$, $N = 15$, $p < 0.05$) but it is no significant with the measured factors at Selkeh ($p > 0.05$). The Spearman correlation test also showed a significant correlation between total waterbirds species number and waterlevel in the morning at Selkeh ($r = 0.634$, $N = 14$) but both the morning ($r = 0.588$, $N = 15$) and afternoon ($r = 0.691$, $N = 15$) at Espand ($p < 0.05$).

DISCUSSION

In the present study the highest waterbird species number at Selkeh was 30 on 27 December and at Espand 15 on 15 February. This is a general phenomenon in the context of main wintering waterbirds in the south Caspian Sea whose species and population start to rise from mid-November and usually peaks in December and January, and then decrease by early March (see e.g. Khaleghizadeh, Behrouzi-Rad, 2004).

The daytime is spent on two main activities, feeding and roosting (Ntiamoa-Baidu et al., 1998). Like Bridgman (1998), during the present study most species spent much of their time resting. In this regard, most waterbirds except for Rallidae and Podicipedidae used the habitats as resting habitat during daytime rather than as feeding ground (our observations). Resident Rallidae species were using the Anzali Wetland both as feeding and resting grounds, in addition to wintering grebes. Anatidae species were usually resting during the present study. Similarly, Houhamdi and Samraoui (2008) indicated sleeping as the main diurnal activity whereas feeding dominated during the night. This is supported by a nocturnal waterbird survey conducted on a moonlight night at Espand that showed waterbird assemblages were partly in the water's edge and emergent vegetation, but the rest had moved out of this wetland at sundown.

Diurnal feeding representated by Eurasian Coots in the present study, peaked at the start of the wintering period, supported by greater population size in autumn (Tables 2–3), exhibited a marked seasonal decline (see also Bridgman, 1998; Houhamdi, Samraqui 2008). The movement of Eurasian Coots away from Selkeh in late December and from Espand in late January is thought to be due to the depletion of their food resources (submerged plants), the birds having to move elsewhere in the Anzali complex for the remainder of the winter. However, Bridgman (1998) found no seasonal differences in feeding for cormorants and grebes. Similarly, grebes and cormorants were using Selkeh and Espand for feeding throughout the study period.

For waterbirds, at least the results reflect that some wintering sites are being used as the first preferred habitats (like Selkeh) than other sites as the second preffered habitats (like Espand), interpreting the first habitats as more suitable for waterbirds (Khaleghizadeh, Behrouzi-Rad, 2004). In this regard, many factors, in particular area size, waterlevel and aquatic plants affect the distribution, density and population of waterbirds, in addition to adjacent environment conditions (van der Have et al., 2002, Khaleghizadeh, Behrouzi-Rad, 2004; Khaleghizadeh, 2007). In this study, Little Egret had a similarity of 0.67 at Selkeh while it had a low similarity of 0.18 at Espand, indicating more changing habitat of Espand (due to waterlevel fluctuations and more changes in water depth) compared with Selkeh. Great White Egret showed a similar pattern (similarity of 0.87 at Selkeh and 0.56 at Espand). However, Grey Heron, the other members of Ardeidae showed less difference between the morning and afternoon counts at both areas.

Among the Anatidae species, Northern Pintail showed the lowest similarity index at Selkeh (0.57), demonstrating Selkeh as less favorite habitat for this species. Selkeh is of crucial importance as a staging area for Garganey, a passage migrant through the south Caspian region (Khaleghizadeh, Behrouzi-Rad, 2004),

whose similarity index was very high (1.0) in this wetland but in a short period of early autumn and late winter. Common Teal, the most abundant winter visitor and using these wetlands as resting, showed a high similarity index between the morning and afternoon counts in both sites (0.95 and 0.98).

Nearly all waterfowl have at least two components to their winter habitat – roost and a feeding area – and they generally make regular flights between them (Owen, Black, 1990). Ducks and waders are largely nocturnal during the winter (McNeil 1991; Masero, Pérez-Hurtado, 2001). The data from the Old Bird acoustic study suggests that there is gull activity over the Big Galloo Island, New York, all night long, but that it increases substantially toward the dusk and dawn (Evans, 2009). Flight was most prominent around dawn (Houhamdi, Samraqui, 2008). During field observations in the morning counts, flocks of geese and swans were seen being arrived these wetlands, indicating these larger Anatidae were using adjacent feeding grounds by later hours of the morning in comparison to the ducks – however some individuals of geese and swans were also seen feeding during the daylight hours, in particular at Selkeh.

Waterbirds often alternate between distinct habitats every day, exploiting large water bodies as diurnal roosts and dispersing to small surrounding wetlands as nocturnal feeding areas (Tamisier, 1976; Mouritsen, 1994; Cox, Afton, 1997; Dodd, Colwell, 1998; Guillemain et al., 2002; Kloskowski et al., 2009). Flight direction and passage rates were sometimes clearly caused by the location of the daily food source (e.g. Evans (2008) showed for Ring-billed Gull (*Larus delawarensis*)). During the field observations of the present study, passage rates of cormorants (although it is not quatified) were higher across the northeastern end of Espand (a similar pattern pointed out by Evans (2008)) where the cormorants spread around the Anzali wetland and ponds for exploiting fish resources and return to the roost in the afternoon. Similarly, in Selkeh, members of Anatidae were seen arriving from the northeast corner of this wetland where adjacent ricefields are considered to be the feeding grounds of these species.

Low similarity index of 0.15 and 0.58 for Pygmy and Great Cormorants, respectively, at Espand (Table 3) indicates a significant difference between the morning and afternoon count at this wetland, whereas the index for the two species at Selkeh was calculated as 0.93 and 0.65, respectively (Table 2). Espand is a roosting site for some waterbirds species, in particular Great and Pygmy Cormorants (1,500 Great Cormorants were roosting at Espand from mid-autumn to mid-winter and the number of Pygmy Cormorants peaked at 217 on 15 November). Espand lies within a large protected area (Siahkesheem), and there is little hunting within the immediate vicinity. The protection of these habitats is probably the reason for making roosting sites.The number of Great Cormorants at Espand usually was more in the afternoon when flocks of the two cormorant species were arriving Espand, they firstly sit on the open water in the western corner of this wetland as landing site, then gathered on the nearby *Alnus glutinosa* and *Populus* sp. trees.

And finally, correlartion test showed that among the environmental factors only waterlevel had significant relathionship with total waterbirds population and species number. Therefore, the sensitivity of waterbirds to waterlevel fluctuations suggests urgent need to manage the wetland habitats by means of the control of waterlevel in the south Caspian Sea in order to conserve the waterbird populations. Meanwhile some comprehensive research are needed to find effects of this factor on waterbirds species along the south Caspian Sea wetlands.

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