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Preference of the White-headed Duck *Oxyura leucocephala* for wastewater reservoirs in the Judean Plain, Israel

EZRA HADAD[1] AND CHAIM MOYAL[2]

The White-headed Duck *Oxyura leucocephala*, which bred in Israel until the 1960s, began to winter there from the 1980s onwards. Numbers soon became significant, reaching 2605 in 2007 (25% of the world population). The origin of the wintering birds is not certain, but may encompass in part the populations that once wintered in Turkish locations, although the present winter population in Turkey may be comprised of an increasing proportion of birds displaced from former Russian and Kazakh breeding grounds by agriculture, the displacement possibly leading to new migration routes. Since the 1980s, overshoots from the Turkish wintering population would have found Israel increasingly congenial because the national reservoir construction policy created waterbodies that housed expanding plant and invertebrate communities. The annual series of winter counts suggest that White-headed Duck males and females display differential migration, a phenomenon not previously documented. Immatures are difficult to distinguish from females, and so improved discrimination would better document the extent of this behaviour, which if confirmed, would have implications for the species' conservation strategy. However, if females and males were found to be in equal proportions in winter in Israel, the unlikely corollary is that the sheer numbers of immatures present suggest high productivity levels never before recorded.

[1]Supervisor, Israel Nature and Natural Parks Authority, [2]International Center for the Study of Bird Migration, Latrun, Israel. [2]e-mail lh_m@zahav.net.il
Translation by Peter Geffen, Avner Cohen and Jonathan Meyrav

INTRODUCTION

The White-headed Duck *Oxyura leucocephala*, one of the rarest ducks in the world today and listed in the IUCN Red List of Threatened Species as endangered, winters in Israel in growing numbers in the Judean Plain at treated waste water reservoirs and in the Jezreel Valley at the Tishlovet and Kishon reservoirs. These reservoirs have been surveyed regularly since the 1980s. The results of these counts are described in this paper. The head markings, relatively large beak and upright stiff tail make the species, an active diving-duck, easy to identify. Its distribution of disparate populations extends over much of the Palearctic from Spain to Mongolia, western China and south to India. Its eastern Asian distribution is much more discontinuous. The White-headed Duck no longer breeds in Italy, France, Hungary, Albania, the former Yugoslavia, Greece, Israel and Egypt, having become extinct from the early 20th century onwards (Green & Anstey 1992), and it appears extinct in Ukraine (Burfield & van Bommel 2004). From the 1930s onwards, its world population decreased from 100 000 to an estimate of only 10 000 (Green & Hunter 1996, Stattersfield & Capper 2000). The counts in Israel from 1990 to 2002 suggest that the species exhibits differential migration, at least in this part of its wintering range, behaviour not previously recorded. Much remains to be discovered about the migration strategy of the species (Li & Mundkur 2003).

HABITAT REQUIREMENTS AND PREFERENCES

General

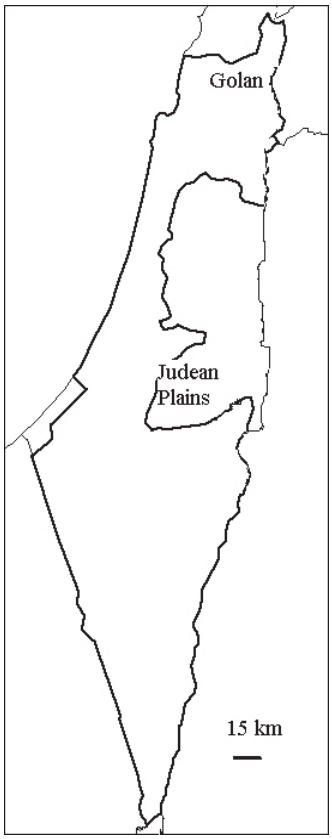
The preferred habitat of the White-headed Duck is shallow waterways of between 0.5 and 3m depth, as found in arid areas. The nests are situated in dense vegetation at the waters edge, in reed and papyrus beds. Many of the nesting habitats are temporary or

seasonal, which apparently causes significant population movement and fluctuations in numbers, some of them natural (Cramp & Simmons 1977). The White-headed Duck is dependent on water more than most other duck species, being more awkward out of water and agile in it, a function of the legs being so near the tail. Studies in central Asia have shown that the White-headed Duck is found in deeper and larger water bodies in the winter, and feeds in fresh water reservoirs with less dense and extensive vegetation (Anstey 1989). However, most of the White-headed Ducks that winter in Israel do so in wastewater or treated-water reservoirs, and less often in salt or fresh waterbodies. The reasons for this require further study.

A diving duck, the species feeds mostly nocturnally, but we have observed daytime feeding in Israel. The winter flocks are large and feed together separately from other duck species in the same water body. Studies in Pakistan and in the vicinity show that the diet of young and adult ducks consists mainly of Chironimid (midge) larvae (Sanchez *et al* 2000). Green *et al* (1993) state that the presence of such larvae drives the species' choice of habitats. The White-headed Duck also feeds on rotting floating vegetation and a variety of seeds, such as papyrus *Cyperus papyrus*, melilot *Melilotus sulcatus*, water lilies *Nymphaea alba*, slender naiad *Najas major*, as well as aquatic insects, such as Corixidae (water boatmen) found in the Judean Plain reservoirs, molluscs and other invertebrates and plants.

Habitat use and species' history in Israel

In summary, Henry Baker Tristram (1884) indicated that 'the White-headed Duck may be seen throughout the year in the Sea of Galilee and the Hula, apparently nests in the Hula, but definitely not in the Sea of Galilee'. Meinertzhagen (1930) stated it "apparently nests in the Hula and may be sighted all the year". Israel Aharoni (1923), the first Jewish zoologist in the then Palestine Mandate, described its status thus: "the White-headed Duck is resident in our land and is found in lakes in the Galilee". Shimon Bodenheimer (1953) wrote: "the White-headed Duck has completely disappeared". Up to 1960, there were no sightings of or data recorded on the species in Israel, except as Haim Merom noted (1960), that two specimens were in Israeli scientific collections, one dated 26 December 1953 in the University of Tel Aviv and the other, in the Haifa Biological Institute, collected on 9 November 1955 from the Kfar Masaryk pools. During the 1960s and early 1970s there were isolated sightings in northern Israel, the largest number being 26 in 1978 (Shirihai 1996, Paz 1986). The number of White-headed Duck sightings rose steadily during the 1980s, from 11 to 80 being seen from 1980 to 1984. The rate of increase paralleled the building of reservoirs in the Jezreel valley, where, during the 1984/85 winter, 180 were counted and another 22 were seen in the Ma'agan Michael pools (Shirihai 1996, Paz 1986). The continued rise in numbers produced 395 in the 1988/89 winter in the Jezreel valley (Shirihai 1996) and a few dozen individuals in the Hula and other northern waterbodies, some 500 in total. A literature survey showed that formerly, the White-headed



Map 1. General locations of wintering concentrations in Israel of White-headed Duck *Oxyura leucocephala*.

Duck was a common breeder in Israel, the then population apparently being stable, as were other southern populations at the time, such as those in Spain and Morocco. However, there is no reference in the literature to numbers increasing in winter, which suggests that the extent of winter visitors to Israel might not have been significant. Because the species' migration routes are still not known, partly because there had been so little ringing in the past, a comprehensive ringing programme for the White-headed Duck in the region would be a useful method of contributing vital data about its migration routes and phenology.

The White-headed Duck remains a fairly scarce winter visitor, although it has occurred in large numbers in two areas: one, comprising Tishlovet and Kfar Baruk reservoirs, is in northern Israel, split by the Kishon river, northwest of Afula and was established in 1981 – they have some exposed muddy pools, excellent for shorebirds – and the other is in central Israel in the Judean Plain and consists of waste treatment reservoirs built from the early 1980s onwards. Recently, a new and relatively large concentration was found near Ramle ('Matash Ayalon') in the Nesher cement factory reservoir, constructed in 1984 but not surveyed until the 2003/4 winter. In the 2004/5 winter, 1481 individuals were counted in Israel, the then highest-ever total, 980 at the Kishon reservoirs and 501 at the Judean Plains reservoirs, but in the 2006/7 winter, the total rose to 2605 (25% of the maximum world population – see Burfield & van Bommel 2004), the respective sub-totals being 1457 and 1148.

As has been found in all climates, swamp and lake drainage in Israel has had an adverse effect on a wide range of plants and animals. Amongst the most important drained swamps were the Hula Swamp, the Kbe'ra Swamps, the coastal swamps and lastly the swamps of the Jordan Valley and the Central Valleys. The driving factors for swamp drainage were the increased demand for river water for agriculture and for drinking water, thus accelerating the complete elimination of swamps in Israel. These changes had considerable knock-on effects on wet habitats in the area. Many populations of animals and plants, including some endemic to Israel, either declined sharply or became extinct. It is likely that this change was the proximate cause of the extinction of White-headed Duck as a breeding species in Israel, although the lack of timely studies means that there is no direct evidence, but the disappearance of all suitable breeding habitat is a common cause of extinction worldwide. It is also possible that at that time, breeding had already ceased because of other factors. For example, in the mid-1930s, small fish farms were being built, and these added to the demand for water. However, the construction in the 1970s of large water reservoirs, mainly in the Golan Heights, by the National Water Authority, began to provide potential replacement habitats, a trend followed in the 1980s by the establishment of large pools for effluent that would be treated for use in agriculture. As these reservoirs matured, areas of habitat suitable for a wide range of waterbirds developed, as shown by the systematic counts at these locations since then.

POPULATION THREATS

General

The main threats to the White-headed Duck population in regions of Russia and Kazakhstan derive from land use change (drainage of wetlands for agriculture and other development) and increased use of water resources (for irrigation, industry and human consumption) – increased disturbance at favourite haunts also forms a threat. However, the circumstances are exacerbated by increasing aridity over much of the species' range (Anstey 1989), probably due to climate change, a process of continuous habitat reduction. Increased irrigation also increases the frequency of waterbodies

drying up completely. The species' occurrence has been dropping steadily in various areas (Anstey & Moser 1990). In recent years, considerable effort in Spain and in Turkey has been expended to establish artificial reservoirs as one way of helping declining White-headed Duck populations. The western population in Iberia is estimated at around 1000 birds (Burfield & van Bommel 2004), but this total is a remarkable increase from the estimated 22 individuals surviving in the wild in the 1970s, and the trend in Spain seems to be continuing. This success came after a determined and costly effort by the Spanish Government and conservationists. The reasons for the original decline include the drying up of lakes, such as in Andalusia, where about 60% have dried up completely (Amat & Sanchez 1982). The breeding population in Turkey may be as high as 250 pairs (much lower than in the past), but the wintering population is estimated to be between 3000 and 12 000 individuals (Burfield & van Bommel 2004), which suggests a sizeable outward migration from, perhaps, Russia. Overshoots from this movement could explain the increase in the species' numbers in Israel in winter.

Another threat to the White-headed Duck population comes from the escapes of the North American Ruddy Duck *O. jamaicensis* from collections, mostly in the UK, where it was first introduced in the 1930s, although escapes from Slimbridge began to thrive during the 1950s. By the 1990s, a proportion had redeveloped a migratory impulse and birds began to appear in winter in continental Europe, with little ecological impact until males reaching Spain began to interbreed with White-headed Duck females. Ruddy Duck is far more aggressive than its congener in its mating behaviour and so hybrids began to appear in numbers. The hybrids retained the dominant behaviour of Ruddy Duck and out-competed the resident White-headed Duck males for breeding territories and for females. Although second- and third-generation crosses possessed reduced fertility, the males could still out-compete White-headed Duck males, whose productivity in affected areas reduced sharply. Spanish (and to a surprising extent, French) authorities have operated effective culling programmes of Ruddy Duck and hybrids, but the risk remains because of limited culling in UK, where Ruddy Duck remains a popular species. Ruddy Duck and hybrids have been recorded in North Africa, Ukraine, Turkey and Israel.

Another invasive species that contributes to the decrease in White-headed Duck numbers is carp *Cyprinus carpio*, which when overstocked, competes successfully for submergent vegetation. The eradication of the carp population from lakes in the Cordobá region in Spain brought about a consequent increase of breeding White-headed Duck pairs (Martí 1993). Hunting is another contributory factor implicated in the decline of White-headed Duck, because unlike its congener, which is wary and shy in human presence, it is easy to locate and shoot. Many countries in which it breeds or winters do not enforce any protection laws, if these exist, and in any case many who go shooting make little distinction between species. In waters that are heavily shot over, contamination through ingestion of lead shot has added to the mortality rate. Lastly, human consumption of the species' eggs in its former breeding range in France, Italy, the former Yugoslavia and Egypt may well have been the main reason for its local extinction (Green & Anstey 1992)

The White-headed Duck tends to avoid flying to escape danger, preferring to escape by diving and swimming to concealment (Roberts 1991) but like most ducks its flight is direct and fast. The species is additionally vulnerable because it is one of the few ducks that has a double moult strategy – one moult occurs at the onset of winter and the other immediately after the breeding season.

Specific to Israel

The present combination of a series of drought years and over-extraction from the Judean plains reservoirs is a threat to the wintering White-headed Ducks and to many other waterbirds. Water usage has increased since 1990, not least because quotas for agriculture have not been set relative to the reserves available. Hunting pressure during winter is exacerbated by unrestricted access to some reservoirs, and although hunting White-headed Duck is prohibited in Israel, the species often is shot while it is flying in mixed duck flocks – in the 2002 winter, EH (own notes) found lead shot in two White-headed Ducks killed at the Hulda/Mishmar-David reservoir. However, some reservoirs in the Soreq Valley are in the process of becoming protected areas, which should help increase the variety and number of birds using them.

Pesticide pollution of water (*eg* from Permethrin), we believe, is affecting adversely the diet of White-headed Ducks. Certainly, anti-mosquito pesticides appear to have damaged ecological systems in the reservoirs. In 2005, the Ministry of the Environment permitted pesticide use in the Soreq reservoirs, after which a mass mortality occurred of fish, insects and other aquatic fauna (Amram Tsabari & Ezra Hadad pers obs). Without a full scientific analysis, causation cannot be proven, but in our opinion, it is highly likely that this type of pesticide is having severe adverse effects on the sensitive ecological balance in such aquatic habitats. The use of other agricultural pesticides and artificial fertilizers in fields around the reservoirs and in their basins probably has led to concentrations in the waterbodies, the sediments, the plants and the food-chains, either as, or in the manner of nitrate run-off, a well-known cause of ecological damage world-wide. The introduction of a variety of fish species, like mosquito fish *Gambusia affinis* to clean vegetation and to reduce mosquito larvae and other aquatic insects may also have unknown, but possibly adverse effects on the availability of the duck's food sources. Various studies in Pakistan and Afghanistan (Chaudhry 1992) showed that the introduction of such as carp sp affected the ecological balance, as evidenced by a reduction in local fish species, vegetation and other organisms.

Ruddy Duck is not a problem in Israel, the one confirmed record in 1983 at the Yesodot reservoir possibly being a local escape. A winter 2004 report of 2 individuals on the Eastern Ram-On reservoir remains unconfirmed. No *Oxyura* hybrids have been recorded in Israel to date.

THE SURVEY AREA AND WHITE-HEADED DUCK DISPERSION

The survey area lies at 70-150m asl and has a mean annual rainfall of 450mm. It comprises a plateau scattered with low hills and many fields of cotton, wheat, sunflower, corn, chickpea and watermelon interspersed with vineyards and orchards. The Soreq, the largest river locally, possesses the area's typical rich riverine vegetation community, consisting primarily of cane *Phragmites australis*, tamarisk *Tamarix nilotica* and blackberry *Rubus sanctus*. The area's main reservoirs are near the settlements of Hulda, Revadim, Kfar-Menahem and Ramle. Excluding the Ramle-Na'an section, the survey area includes 23 treated waste-water reservoirs, the majority of which were built in the early 1980s to cope also with flood water (Since 1986, 150 such reservoirs have been built nationally). Raw sewage is first purified and left in oxidization pools before release to the main reservoirs, whose winter accumulation is used mainly agriculturally during summer. The two sewage treatment works opened along the Soreq River in 1999 and 2000 west of Jerusalem and at Beit-Shemesh respectively have improved the quality of the river water dramatically, a likely associative cause for the increase in wintering White-headed Duck numbers since. From 1995 to 2007, the Hulda/Mishmar-David and the Tzuba-Shoresh reservoirs held on average some 47%

of the total numbers in Israel. However, the White-headed Duck does disperse on occasion to one distant (Nesher-Ramle) and five nearby reservoirs, probably because of hunting pressure at Hulda/Mishmar-David and possible because of over-extraction at Hulda, following an increase in farming land locally (mainly during 2006).

Summary of winter counts in the reservoirs of the Judean plain

Until the 1980-81 winter, White-headed Duck was not recorded in the Judean Plain reservoirs, which then were few in number. During the reservoir building programme in the early 1980s, the species began to frequent the area in winter, numbers growing as more reservoirs were filled. Numbers remained quite low up to the 1988-89 winter, typically between 1 and 7 individuals being recorded per observation. In the 1989-1990 numbers reached 38, mainly at the Hulda/Mishmar David reservoir, but in the next two years peaked at 101 and 450 respectively at Hulda/Mishmar David. Between the 1993-1994 and 1999-2000 winters, there was a drastic decrease, the minimum being six and the maximum 60 (**Table 1**). Numbers increased in the winter of 2000-2001 to 140, which was the start of a steady increase to 501 in the winter of 2004-2005 and to 1148 in the winter of 2006-2007. Numbers gradually increased in parallel in other parts of the country. **Table 2** shows the typical temporal pattern of White-headed Ducks in winter in Israel, from late October to early April, the peak being in January. Certain reservoirs in the Judean Plains complex, particularly Hulda/Mishmar David and Zuba/Shoresh (**Table 3**), held some 66% of the White-headed Ducks (and similar proportions of other duck species present in large numbers), probably for two main reasons – they are large and their biotopes are better suited for Anatidae. Of the six reservoirs in that complex with the highest counts, five are within 1km of each other.

Of the White-headed Ducks counted up to 2005 in the Judean Plain region, 89% were juveniles or females (the distinction between juveniles and females being too difficult for certainty at range) and 11% adult males (**Table 4**), and although the overall percentage ratios had changed slightly by 2007 to 79:17, the imbalance remained. We cannot asses the actual proportion of adult females to males, but it is likely that females outnumbered males by some margin. Amongst duck species, it is not uncommon for adult males and females to adopt different migration strategies. The assumption is that it enables males to work out their dominance hierarchy to a degree before departing on the return migration, the most dominant being able to have first choice of breeding territory by arriving earliest, weather conditions on the breeding grounds permitting. We cannot assume as yet that the males wintering in Israel come from the same populations as the wintering females, but even if they do, we do not know where the 'other' males winter. However, if we assume that the actual proportion of wintering adult males and females is 1:1, then up to 2005 78% of the wintering population in Israel consisted of juvenile birds, approximately 7 per breeding pair, if all pairs successfully raised broods; the brood failure rate, like many duck species, is likely to be high and so 7 juveniles per pair is very unlikely, given the general decline of the species across so much of its extensive breeding distribution. Therefore, although we assume that the White-headed Duck population wintering in Israel exhibits differential migration to an as yet unknown degree (**Table 4**), we acknowledge that this phenomenon has not previously been documented for this species (Baz Hughes, Simon Delany pers comm to the editor, see also Li & Mundkur 2003). Assuming equal proportions of males and females for the 2007 figures still requires more than four young per pair surviving to reach the wintering grounds. An additional obscuring factor is that juveniles may also adopt different migration patterns from adult birds. Should differential migration be proved an established and not a transient behaviour, then the International Single Species Action Plan of the Conservation of Migratory Species (CMS) and the Agreement on the Conservation of African-Eurasian Migratory Waterbirds (AEWA) (Hughes *et al* 2006) may have to be revised.

Our thesis is that the wintering population of White-headed Ducks in Israel cannot truly represent the breeding populations to which the individuals belong. Furthermore, the origin of the wintering population in Israel may yet be shown to include a proportion of birds from the Central Asian breeding grounds, described by Li & Mundkur (2003).

Comparison of numbers in the two main wintering concentrations in Israel

Table 1 consists of the numbers of White-headed Ducks observed at the Kishon complex reservoirs and the reservoirs of the Judean plains between the years 1990-2007 (excluding the Nesher- Ramle reservoir which was surveyed only from winter 2003-2004). **Table 1** shows that the average number of ducks per count (16 counts) at the Judean plains reservoirs was 160 individuals, compared to 553 individuals (10 counts in 16 years) at the Kishon complex of reservoirs. In 1992 the Judean plains reservoirs area held nearly half of White-headed Duck seen in Israel that year (48.6%).

Table 1. Count maxima of White-headed Ducks per reservoir complex from 1990-2007. (NC = No Count)

Year (winter's end) ▶																		
Location ▼	**90**	**91**	**92**	**93**	**94**	**95**	**96**	**97**	**98**	**99**	**00**	**01**	**02**	**03**	**04**	**05**	**06**	**07**
Judean Plains	38	101	450	220	22	60	30	6	35	25	58	140	190	227	452	501	659	1148
Kishon Complex	NC	410	475	NC	430	NC	580	NC	NC	NC	440	568	854	409	385	980	832	1457
Totals ▶	**38**	**511**	**925**	**220**	**452**	**60**	**610**	**6**	**35**	**25**	**498**	**708**	**1044**	**636**	**837**	**1481**	**1491**	**2605**

Table 2. Typical pattern of build-up and dispersal of White-headed Ducks in winter in Israel (1990-2005).

Month	**Average/year**	**Month**	**Average/year**	**Month**	**Average/year**
October	12	January	239	March	39
November	89	February	135	April	2
December	105				

Table 3. Numbers of White-headed Ducks per reservoir from 1990-2007 in the Judean plains

Year (winter's end) ▶																		
Reservoir ▼	**90**	**91**	**92**	**93**	**94**	**95**	**96**	**97**	**98**	**99**	**00**	**01**	**02**	**03**	**04**	**05**	**06**	**07**
Hulda /Mishmar David	36	69	250	146	22	60	0	6	85	5	30	120	80	186	180	245	45	200
Revadim-east	0	32	0	0	0	0	3	0	0	0	0	0	50	13	60	5	30	53
Zuba /Shoresh	0	0	168	74	0	0	27	0	30	20	16	20	35	8	29	8	130	300
Hafetz-Haim	0	0	0	0	0	0	0	0	0	0	0	0	0	20	20	5	102	62
Yesodot	0	0	11	0	0	0	0	0	0	0	0	0	0	0	5	20	33	67
Nachshon	0	0	21	0	0	0	0	0	0	0	12	0	0	0	0	0	0	280
Kfar-Menachem	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	0
Anot	0	0	0	0	0	0	0	0	0	0	0	0	25	0	0	0	0	0
Mishan	0	0	0	0	0	0	0	0	0	0	0	0	0	0	58	70	52	39
Zohar	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	12	0	0
Nesher-Ramle	-	-	-	-	-	-	-	-	-	-	-	-	-	-	100	136	257	147
Year Totals	**2**	**101**	**450**	**220**	**22**	**60**	**30**	**6**	**35**	**25**	**58**	**140**	**190**	**227**	**452**	**501**	**659**	**1148**

Table 4. Relative numbers of females and juveniles to males in the Judean Plains Reservoirs from 1990-2007

Year	**♀+ juv**	**♂**	**Year**	**♀+ juv**	**♂**	**Year**	**♀+ juv**	**♂**
1990	**37**	**1**	1996	**5**	**25**	2002	**158**	**32**
1991	**90**	**11**	1997	**6**	**0**	2003	**202**	**25**
1992	**424**	**26**	1998	**23**	**12**	2004	**428**	**32**
1993	**200**	**20**	1999	**15**	**10**	2005	**435**	**66**
1994	**22**	**0**	2000	**47**	**11**	2006	**571**	**88**
1995	**45**	**15**	2001	**132**	**8**	2007	**1035**	**113**

In 2007, the 1148 White-headed Ducks counted at the Judean plains reservoirs (by then the Nesher Ramle Reservoir had been added) comprised nearly 44% of all White-headed Ducks seen in Israel, but that same year was a record for the Kishon complex and immediate surrounds, which held 1457 ducks (almost all of the remaining 66%). From 2000-2007 there was a gradual rise in numbers of wintering White-headed Duck in the Judean plains area, but at the Kishon complex, numbers fluctuated, two major surges being were noted in the winters of 2002 and 2005. In the three counts done in the 1994-2000 period, the Kishon reservoirs often held substantially more ducks than the Judean plains complex. There is no satisfactory explanation as to why so few White-headed Ducks wintered in the Judean plains during that period.

CONCLUSIONS

The White-headed Duck begins to arrive in its breeding range by the end of March and leaves the northernernmost limits from the middle of October onwards. At present, there are no data on the origins of the White-headed Duck wintering in Israel. Tagging or ringing birds in the breeding grounds might help provide this information, but equally, similar actions with the wintering birds in Israel could be of great assistance to observers on the breeding grounds. The wintering concentrations observed throughout the years were limited to sewage treatment reservoirs, namely the Kishon complex of reservoirs and the water treatment reservoirs of the Judean plains, the biotopes thus created being attractive to the species, providing us with clues as to the White-headed Ducks' distinct preferences in choosing wintering sites. Relatively high numbers of White-headed Duck were first noted in the winter of 1984-85, just about the same time that most of Israel's water treatment reservoirs were being constructed.

A large surge in numbers of wintering White-headed Duck in Israel occurred in the early 1990s. In those years there was a dramatic decline in the number of White-headed Duck wintering at Burdur Golu lake in Turkey, from a sizeable 11 000 individuals in 1991, to only 1300 birds in 1996 (Green *et al* 1993, Stattersfield & Capper 2000). It is therefore possible that part of the Turkish wintering population continued south during those years and chose to winter in Israel, and also other countries in the region, like Syria, where in 2005, 700 White-headed Duck were observed. Although there may have been some recovery in wintering numbers in Turkey (Burfield & van Bommel 2004), the apparent extension of the outward migration route to Israel seems to have become established. Initial reports from December 2006 were of a total of 2150 birds, but this rose to 2605. It is likely that the main reason that White-headed Ducks are site-faithful to water treatment reservoirs is that these provide an abundance of suitable and accessible food, such as the insect and arthropod communities and adequate decaying plant material (*Melilot* sp). These reservoirs have no fish as competitors for the ducks' food, which remains in good supply until they depart. In neighboring fishponds, such as those adjacent to the Revadim and Kefar-menachem reservoirs, no White-headed Ducks were observed.

The large numbers of White-headed Ducks now wintering in Israel (and in Syria) make these populations of great importance for the conservation of the species' world population. So far, this importance has not been translated into action, because the authorities in charge of the reservoirs, not being aware of the circumstances, do not manage the reservoirs in ways that necessarily support this natural treasure. Although it would help, as a first stage, if the reservoirs were declared hunting-free zones, we still need to research many aspects to construct a sound understanding of the processes at work. It is entirely possible that relatively little effort could improve the quality of its wintering sites for the White-headed Duck in Israel. In particular, we

need to establish practical ways of improving conditions in the reservoirs so that the species' winter diet can be confirmed and better supported, and to better understand the migration patterns of the duck's age-classes, through such as ringing and satellite monitoring. Lastly, we need to improve the discrimination of adult females from immatures (Taej Mundkur pers comm to the editor) so that we can better document the phenomenon of differential migration, which could be a key factor in refining our understanding of the species' migration strategy. Success can come only through collaboration with all the agencies involved.

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