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Faculté des Sciences de la Nature, de la Vie et Sciences de la Terre et de l´Univers
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Evaluation of the ornithological value of El Eulma Wetlands complex

Présentée par : Madame **BOUCHIBI Nacéra**

Soutenu devant le jury :

Menai R.	M.C.A.	Président	Université de Guelma
Samraoui B.	Pr	Rapporteur	Université de Guelma
Chakri K.	M.C.A.	Examinatrice	Université d' Annaba
Si Bachir A.	Pr	Examinateur	Université de Batna
Boulkssaim M.	M.C.A.	Examinateur	Université d'Oum El ouaghi

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Introduction

Wetlands are recognized as one of the most important ecosystems in the world. They are one of the most productive ecosystems and support various biotic communities including diverse plants and animals that are adapted to shallow and often dynamic water regimes (Lee *et al*., 2006). Previous studies confirmed the importance of Algerian wetlands for avian biodiversity in providing key wintering sites, staging areas and breeding habitats (Samraoui and Samraoui, 2008a). One geomorphologic element characterizing the north east of Algeria is the Hauts Plateaux that dominate the coastal plains of the north. These Hauts Plateaux covering huge surface, mainly from Setif to Oum El Bouaghi wilaya include the Oum El Bouaghi salt lakes complex and the El Eulma wetlands complex. Our knowledge on these Hauts Plateaux remains highly insufficient due to the rarity of multi-disciplinal studies (ecology, climatology, hydrology, geology, sociology, etc.

Information acquired about the distribution, abundance and evolution of bird populations have permitted, especially in Europe, to draw up lists of more or less rare, endangered or threatened birds. Taking in consideration the regression and the widespread alteration of wetlands, waterbirds occupy an important place in such inventories (De Beaufort, 1983). A multiple species approach can provide new ecological and behavioral insights (McKinney, 1973) relative to non breeding waterfowl ecology, and studies longer than one year are necessary to determine the influence of annual effects on various aspects of wintering waterfowl behavior (Turnbull and Baldassarre, 1987).

The wintering ecology of Northern Shoveler *Anas clypeata* and Mallard *Anas platyrhynchos* was documented in Europe (France) (Guillemain *et al*., 2000a, 2000b, 2002b) and in North America (Jorde *et al.* , 1983, 1984), yet little is known regarding their wintering ecology in North Africa except few sporadic counts carried out in the past (Neithammer, 1963; Etchécopar, 1964; Burnier, 1979; Ledant *et al.*, 1981; Isemman and Mouali, 2000; Anonymous 2004; Samraoui and Samraoui, 2008a).

A lack of local ornithologists and a vast arid country have presented challenges to the assessment of the true status of the Greater Flamingo *Phoenicopterus roseus* in Algeria, which has led researchers to underestimate the role of Algerian wetlands for the Greater Flamingo Mediterranean metapopulation. Over the last eight years (2003-2010), the Greater Flamingo has made a total of 17 nesting attempts in Algeria, resulting in four successful breeding at two distinct sites (Samraoui *et al*., 2006b, 2009, 2010). Identifying and monitoring all breeding sites may allow data on lifetime reproductive success to be collected from banded individuals and provide a clearer picture of the life history of the Greater Flamingo (Samaroui *et al*., 2006b).

In order to highlight the ornithological value of El Eulma wetlands complex in the eastern Hauts plateaux northeast, Algeria, this study was carried out over the years 2007-2010 to investigate the following objectives:

1. Ecology of Northern Shoveler *Anas clypeata*: the status, the spatiotemporal distribution, habitat use and the diurnal activity time budgets.
2. Ecology of Mallard *Anas platyrhynchos*: the status, the spatiotemporal distribution, habitat use and the diurnal activity time budgets.
3. Ecology of Greater Flamingo *Phoenicopterus roseus*: the status, the spatiotemporal distribution and the breeding survey through artificial nests construction.

Chapter 1. Biodiversity and Wetlands

1. 1. Biodiversity

Biodiversity is the one of the greater wealth of the planet, and nevertheless less recognized as such (Wilson, 1988). **Biological diversity means the full range of variety and variability within and among living organisms and the ecological complexes in which they occur, and encompasses ecosystem or community diversity, species diversity, and genetic diversity.** These three forms of diversity form a graduation, ranging from smallest to largest, from the individual until habitat or ecosystem (Claude, 1992). **Genetic diversity** is the combination of different genes found within a population of a single species, and the pattern of variation found within different populations of the same species. **Species diversity** is the variety and abundance of different types of organisms which inhabit an area. **Ecosystem diversity** encompasses the variety of habitats that occur within a region, or the mosaic of patches found within a landscape (Dajoz, 2008).

1.1. 1. Role and importance of biodiversity

Biodiversity plays an important role in maintaining the structure, the stability and the functioning of the ecosystem in particular their productivity. This design dates back to the mid-nineteenth century was confirmed at the end of the twentieth century by experiments conducted on large surfaces and in several countries. Maintaining a high level of biodiversity is essential for the maintenance of all services provided by ecosystems. The loss of biodiversity has important consequences for the functioning and stability of ecosystems. For example, the disappearance of insect pollinators that are threatened by intensive use of pesticides will be a disaster for agriculture. The depletion of sea otters on the coast of North America, the virtual disappearance of prairie dogs in Yellowstone Park, are examples among others (Christian and Jean Claude, 2001).

For all humans, biodiversity plays a significant economic role. It provides plants and animals consumed for food. It provides also many plants

used in industry which are the source of many molecules that have high medical importance. These molecules are derived either from terrestrial plants or insects, or marine invertebrates. Many organisms that could provide useful molecules are still unknown (Dajoz, 2008).

1.2. Wetlands

The term wetland includes a variety of terrestrial, coastal and marine biotopes that share a number of characteristics. Over fifty different definitions are used to clarify what it meant really, the wider is that of the Ramsar Convention (1971) which defines wetlands as" expanses of march, fen, peat bog or natural or artificial water, permanent or temporary, where water is stagnant or current, fresh, brackish or salty, including area of marine water where depth at low tide does not exceed six meters" (Fustec and Lefeuvre, 2000).

Wetlands are the earth's most important freshwater resource and are also the most threatened. They perform manifold functions in the maintenance of the ecological balance of a region. Being dynamic ecosystems, they are continually undergoing natural changes due to infilling with sediments and nutrients, subsidence and droughts etc. They sustain all life and perform some useful functions in the maintenance of overall balance of nature. Unsustainable uses of underground water and in the catchment areas have contributed to the decline of quality and quantity of wetlands. Hence, it is imperative to focus on the preservation of these endangered habitats to achieve ecological sustainability (zulfiqar, 2005).

Moreover, wetlands are recognized as one of the most important ecosystems in the world. They are one of the most productive ecosystems and support various biotic communities including diverse plants and animals that are adapted to shallow and often dynamic water regimes. Wetlands are vital habitats for many waterbird species and loss of these habitats generally increases waterbirds competitive interaction between individuals, mortality rate

and severe consequences of their populations (Lee *et al*., 2006). Therefore loss of wetlands has significantly increased the importance of those that remain to wetland-dependant organisms such as waterbirds (Taft *et al*., 2002).

However, many wetlands around the world are slowly diminishing or under threat (Davis and Hirji, 2003), despite growing public demand for wildfowl conservation and ratification of the Ramsar Conservation by many countries (Guillemain *et al*., 2002a). There are few exact figures available on the extent of wetlands loss worldwide, although experts estimated that half of the world's wetlands have disappeared since 1990 (Munro and Holgate, 1991; Davis and Hirji, 2003).

Fortunately, wetland restoration is carried out all around the world for different purposes such as habitat and species enhancement, water quality improvement, and environmental protection (Mitsch and Gosselink, 1993). A number of restoration projects are focused on the goal of attracting diverse and abundant waterbird communities by providing a diversity of foraging habitats (Reid, 1993).

1.2.1. Restoration of Ecosystems

The ecology of restoration is a recent discipline that aims to restore, where it is still possible, the ecosystem in a state similar or identical to the one they had before their degradation. These companies, which take place in many countries, concern three areas (Dajoz, 2008).

The first is the restoration of habitats and landscapes. This restoration involves diverse ecosystems among which the abandoned industrial areas and polluted by a variety of products; herbaceous formations degraded by agriculture or by drainage as the water meadows or calcareous grasslands; aquatic environments, lakes and rivers; forests; land of mountains. This restoration can obviously take place only if the causes of degradation have disappeared. It uses techniques known as "ecological engineering".

The second area of restoration consists of reintroducing into the habitat where they had been exterminated, certain animal species or reinforces small populations threatened by extinction.

The third area of the restoration is the eradication of invasive species that were very harmful to local fauna and flora, especially in the islands. Among the species in the eradication are the rats that destroy bird populations in the island (Dajoz, 2008).

1.2.2. Interest and Value of wetlands birds

1.2.2.1. Interest of waterbirds as bioindicators

Waterbirds can provide indications on wetland characteristics at different level of biological organization. At the individual level, searching for toxic substances in tissues is particularly interesting that the birds are at the end of food chain. It can contribute in estimating ecosystem contamination degrees. Thus, many studies have identified heavy metals all along trophic chains until the birds. The level of contamination of Flamingos and ducks with lead, in Camargue for example, is revelator of high hunting pressure compared to other European wetlands (Pain, 1992). Through their abundance, their biomass and their breeding success, easily identified comparatively with other animal groups, waterbirds populations provide information on wetlands biological productivity. The more widespread, Grey Heron and Coot, have local populations which differ sharply according to trophic availability of habitat (Roché, 1993). Several opportunistic and very mobile species (Waders, Anatidae) react quickly to changes of their habitat. They are bioindicator of ecological conditions alterations usable to detect wetland modifications (Fustec and Lefeuvre, 2000).

1.2.2.2. Waterbirds and Wetlands Conservation

The assessment of the value of wetland fauna is done from the degree of rarity, at regional, national or international, species they host. Information acquired about the distribution, abundance and evolution of bird populations have permitted, especially in Europe, to draw up lists of more or less rare, endangered or threatened birds. Taking in consideration the regression and the

widespread alteration of wetlands, waterbirds occupy an important place in such inventories (De Beaufort, 1983).

Waterbirds have raised awareness in many areas, functions and value of wetlands. Dependent species more restricted to providing them a variety of roles, they are now simple indicators of wetland quality and preserve that heritage as such. Their populations and their communities appear suited to reveal the ecological imbalances of our planet (Fustec and Lefeuvre, 2000).

1.2.2.3. Possible factors affecting distribution of wintering waterbirds

Waterbirds exploitation is a studied issue because of its economic importance. For ornithologist, these birds have a measurable value (Bibby, 2002). The saving of these populations presents major benefits for the national patrimony (Pinet 1993 in Mathetvet and Mesléard, 2002). In order to allow their durable exploitation, demographic tendencies (count and distribution) of these populations of waterbirds must be preciesely surveyed (Pirot *et al.,* 1989).

The majority of waterbirds are migratory species and have two distribution areas (reproduction and wintering areas) related by migratory phases (Evans *et al*., 1984; Alerstam, 1990).

It is known that before leaving for immigration, birds termed « reproducteur sur capital » such as Geese (Meijer and Drent, 1999), should store energetic reserves that will be used in their flight (Nisbet *et al.*, 1963 in Alerstam, 1990). But it was found that these reserves were, also, essential to start breeding where food resources were not always available at arrival in breeding site (Raveling, 1978, 1979). It was also found that the second type of birds termed « reproducteur sur revenue » such as Ducks (Meijer and Drent, 1999) uses winter to prepare their breeding by pair formation and not to store energy reserves for breeding (Hepp and Hair, 1983). Therefore wintering season considered as a functional link in waterbirds 'breeding (Tamisier, 2001).

In order to exploit these species durably, it is mandatory to understand the group of factors that influence the spatial distribution and the abundance of

waterbirds in wintering quarters. Two factors may explain the preceded parameters: global and local factors.

1.2.2.3.1. The global factors

After the end of the breeding period and the post nuptial migration, waterbirds gather in thousands or tens of thousands on a large space of wetlands called wintering quarters that occupy for many months, from August to March (Tamisier, 2001). These sites are subjected to global phenomenon affecting currently our planet such as climatic changes and natural habitat loss, which are susceptible to influence the abundance and distribution of waterbirds.

Climatic changes

Birds' migration can be summarized in being in the right place on the right time« être au bon endroit au bon moment » (Coppack and Both, 2002). Waterbirds are adapted to use in an optimal manner the available resources on breeding sites and to avoid winter rigors by moving towards more soft regions where resources are available and sufficient (Alerstam, 1990). However, the right place « le bon endroit » is changeable by geologic times' scale. The migratory behaviour of birds should be flexible in order to adapt to global climatic changes (Coppack and Both, 2002). Currently, under climate influence, more and more environmental quick changes are shown, affecting in particular the habitats (Stenseth *et al.*, 2002). For instance, a 3°C variation in average monthly temperature corresponds to isotherms modification clause to 300-400 Km in latitude or 500 m of altitude. With temperature elevation, some habitats are thus modified, leading to a change in species distributions (Hughes, 2000). However, knowing the consequences of these modifications on abundance and distribution of these birds is difficult because within the year they change locations where the climate may develop into different directions which will prohibit adequate adaptation (Coppack and Both, 2002). Long distance migratory birds are affected by climatic changes, some are even facing decline in their populations (Robbins *et al.*, 1989), and since spring migration is triggered by endogenous factors that are not related to breeding sites'

climate. These will lead to time difference between arrival date on these sites and abundance surge in food sources linked in turn to temperatures (Both and visser, 2001).

Natural habitat loss

Wetland regression associated with agricultural, industrial, and urban zones is a global phenomenon that causes an important problem for waterbirds frequenting these zones (Sutherland, 1998). Their abundance and distribution depend on the quality, distribution and availability of these habitats (Dehorter and Tamisier, 1996). Three types of habitat losses linked to the use of these sites by birds were defined: wetlands conversion to another use such as agriculture, wetlands degradation by pollution and disturbance by human activity (Van Vessem *et al.*, 1992). Therefore global factors seem to have an effect on distribution and abundance of waterbirds on wintering quarters.

1.2.2.3.2. The Local factors

At the local scale, waterbirds have types of main requirement that determine their choice for a wintering site (Tamisier and Dehorter, 1999). The first is trophic type; the energy acquired within feeding behaviour governs the entire biological cycle of the bird. A part of it fulfils its immediate needs for maintenance and growth, and the other part is stored for future needs such as migration or breeding (Ankey *et al*., 1991).

Second type of requirement is the spatial resources. The waterbirds need during their wintering to have an access to sites where they can carry out their comfort activities (swimming, preening, sleeping) and feeding, in security without being disturbed (Evans and Day, 2001).

Local wetlands characteristics

The factors linked to the physical nature of marshes are susceptible to influence the abundance and the distribution of waterbirds on wintering

quarters because they determine the selection of habitat at local level (Allouche *et al.*, 1989; Sanders, 1999).

The surface of marshes is a main factor because waterbirds gather on large water stretches (Tamisier, 1976; Pirot *et al.*, 1984). These gregarism is considered as a response to predation pressure (Tamisier, 1972a).

Characteristics linked to water are also very important. Fluctuations of water levels determine the availability and accessibility of food (Clausen, 2000). It also determines the presence of resting sites (Green and Robins, 1993; Guillemain *et al*., 2000c). The flooding duration and salinity of marshes are also variable elements that determine the composition of submerged macrophytes communities (Grillas, 1990). These vegetations are the main source of food for numerous waterbirds that feeds on grains, stems, leaves and bulbs (Dervieux and Tamisier, 1987).

Chapter 2. Biology of Anatidae and Greater Flamingo

2.1. Anatidae

2.1.1. Systematic

The taxonomic division of the Anatidae is rather complex and has been much disputed and revised. Most of the controversy is centered around the partition into subfamilies and tribes, whereas there is much more agreement on the total number of species and the taxonomic status of the different forms. In the conventional view, the family is arranged into three subfamilies, Anseranatinae (primitive Magpie Goose), Anserinae (swans and geese), Anatinae (ducks) (Del Hoyo *et al*., 1992; Kear, 2005).

The Anatinae, with eight tribes and 113 species, is the largest of the three subfamilies. Within the Anatinae, the shelducks and sheldgeese, which form the tribe Tardonini, show the closest affinities with the true geese of the Anserini, some species showing intermediate characters and certainly looking quite goose-like. The tribe Anatini (dabbling ducks) is the largest of the family, with 41 species, 38 of them belonging to the large, broad-based genus *Anas*, which includes many of the most abundant duck species in the world (Del Hoyo *et al*., 1992).The taxonomy of studied species is as follows:

Northern Shoveler
Kingdom: Animalia
Phylum: Chordata
Class: Aves
Order: Anseriformes
Family: Anatidae
Subfamily: Anatinae
Genus: Anas
Species: *A. clypeata*
Mallard
Kingdom: Animalia
Phylum: Chordata
Class: Aves
Order: Anseriformes
Family: Anatidae
Subfamily: Anatinae
Genus: Anas
Species: *A. platyrhynchos*

2.1.2. Morphology

The neck is relatively long in all species, particularly so in swans and geese but also in some ducks, and the head is generally small. The bill is broad and conical, with serrated lamellae in the interior, which are particularly well developed in plankton filtering species, or along the cutting edges, especially in fish-eating species. The bill may present a conspicuous knob-like projection in some species, with the noteworthy example of the Comb Duck; this knob may be horny or fleshy, temporary or permanent and may appear in males only or in both sexes, and in general it attains its fullest expression in males during the breeding season. In many species, the bill color, particularly of the male, is also brightest at the onset of the breeding season.

The wings are relatively short and pointed, and are very strong. Gaining or maintaining momentum in the air requires continuous, fast beating of the wings for such heavy birds with wing-loading. For this reason, the wing muscles are necessarily large and well developed; they are deeply inserted on the highly keeled sternum and help give wildfowl their broad-breasted appearance (Del Hoyo *et al*., 1992; Kear, 2005).

Ducks have a thick covering of feathers for insulation, which is particularly necessary for birds that are usually on the water. The feathers must always be in good condition in order to maintain their waterproofing effects, and birds spend many hours daily in the care of feathers. The oil-gland is feathered, and is highly developed in this family (Del Hoyo *et al*., 1992; Kear, 2005; Pyle, 2005).

Most characteristic of the subfamily Anatinae is a high degree of sexual dimorphism, and, except in very few cases, adult male and female plumages are readily distinguishable in the field. In the tribes Anatini, Tardonini, Merganettini and Cairinini, each species has its own distinctive speculum. This is a brightly colored patch on the secondaries, which is generally metallic green, bronze or blue, often bordered by black or white bars, and sometimes with a white trailing edge. Both sexes and all ages exhibit the same pattern, which is peculiar to the species.

In the Anatinae, juvenile plumage closely resembles that of the adult female, and in some cases they are nearly indistinguishable (Del Hoyo *et al*., 1992; Pyle 2005). Adult male plumage is normally acquired at one to three years old. Another distinctive

mechanism that affects many species in this subfamily is the adoption of an “eclipse” plumage. Although males keep their breeding plumage during the best part of the year, towards the end of the summer they typically undergo a complete body moult, during which they shed the brilliantly colored feathers, temporarily assuming a much duller aspect, whereby they closely resemble the females. This eclipse plumage is worn by adult males for a period of a few weeks, until the new flight-feathers are grown, so that during the winter, when sexual activity starts off again, they are really to exhibit their striking patterns of color (Del Hoyo *et al*., 1992; Pyle 2005).

Only birds of the more terrestrial groups, such as shelducks and dabbling ducks, can take off without a previous run along the water, or directly from land. Coming down from the air can be almost agile species, including some shelducks and dabbling ducks, can alight directly on the land.

It is well known that wildfowl are good swimmers and, without exception, they are quite at home on the water. All species are capable of diving under water, although some only do in cases of extreme danger (Del Hoyo *et al*., 1992).

2.1.3. Habitat

Ducks are clearly linked to predominantly aquatic environments, and each species shows a preference for a certain kind of habitat, including lakes, marches, streams, ponds or reservoirs. A series of factors such as the depth and quality of the water, the presence and the nature of emergent or edging vegetation, the maintenance of a minimum water level throughout the year, the bottom material and the presence of a particular kind of food, generally decide whether or not a given water body can maintain a population of a particular wildfowl species.

In general, the dabbling ducks belonging mostly to the tribe Anatini require much shallower waters than the diving ducks of the Aythyini, Mergini and Oxyurini. In conjunction with this, they also prefer more gently sloping land with some vegetation around it where they can build a nest or seek refuge in case of danger, and tend to occur on smaller water bodies than those preferred by diving ducks (Del Hoyo *et al*., 1992).

Man's daily requirement of large volumes of fresh water and the difficulties involved in storing it have resulted in the construction of many dams and reservoirs and extensive networks of canals. Many of these have been occupied by various species of wildfowl and have now become regularly used habitat (Del Hoyo *et al*., 1992; Kear, 2005).

2.1.4. General habits

Ducks are well known for their strong gregarious tendencies. They frequently gather together in flocks, which vary in size from a few dozen or less to several hundred thousand birds, depending largely on species composition, time of year and locality. The range of activities that are habitually performed socially includes feeding, roosting and loafing, either on water or on the ground, and moving about, for instance during migration. A significant proportion of sexual activity is also carried out socially in most species, mainly during the early stages, and activities such as pair formation, courtship display and so on often take place in groups. However, most species disperse afterwards in order to nest in solitary pairs or loose groups with little interaction between neighboring pairs (Del Hoyo *et al*., 1992).

The advantages of flocking are obvious in that it reduces the risk of predation and also facilitates the process of finding food. The individual in the flock may obtain food more easily by watching and closely following conspecifics that have been successful, instead of having to spend hours searching on its own. Equally, if a predator attacks the flock, it is less likely to be successful than when attacking an individual bird. It is essential for a flock of birds to maintain its cohesion (Del Hoyo *et al*., 1992; Kear, 2005).

Due to their mostly aquatic habits, wildfowl require a thick coat of feathers that will insulate them against heat loss, but will not become soaked (Pyle 2005). In order to maintain their plumage in good condition, they have to spend a great deal of time and care in the daily maintenance of feathers. Wildfowl dedicate many hours to feather repair and preening, using the bill and coating the plumage with an oily substance produced by the enlarged uropygial gland, situated at the base of the tail. It is the combination of these two actions that gives wildfowl plumage its perfect waterproofing (Del Hoyo *et al.,* 1992; Kear, 2005).

Many species are partly nocturnal in their feeding habits, and they may carry out a number of other activities at night (Tamisier and Dehorter, 1999; Paulus, 1988), for instance several species perform an important part of their courtship display at night. For this reason, they have little time for sleep while it is dark, so they commonly roost in the middle of the day (Del Hoyo *et al*., 1992).

Most species roost communally on the water or where undisturbed on small islets or on the shore. When sleeping on the water, a bird tucks its bill under its wing feathers. When resting on land, birds often stand on one leg. A few birds always remain alert in a roosting flock, ready at the first sign of any possible danger to signal it to the rest of the group (Del Hoyo *et al*., 1992; Tamisier and Dehorter, 1999).

2.1.5. Voice

In all species of the Anatidae, there are some sounds directly related to particular displays or to sexual activity. In many cases, the adoption of an aggressive posture is accompanied by distinctive calls that tend to be loud and far-carrying. These or other similar calls are in signaling the defended territory, often in association with a display indicating ownership of the territory. A variety of calls are made during the many stages of courtship, and at the moment of copulation. These are generally low-pitched notes and are distinctive in each species, so that they help to prevent interbreeding among closely related species (Del Hoyo *et al*., 1992).

Dabbling ducks are not among the noisiest of all wildfowl, and many species remain relatively silent outside the breeding season. As in other groups of wildfowl, there is a fair degree of sexual variation in the voices of many of the *Anas* ducks, and it is the females that tend to be more vociferous. They have a loud, grating voice and produce a characteristic descending series of quacking notes, typically demonstrated by the Mallard, but shared by most other members of the genus, with variable intensity and length. Males' calls are generally either a short, high-pitched, multisyllabic whistle, which is most distinctive in the wigeons, or a soft, rough note, like those made by the Common Teal, Mallard and Northern Pintail. A few species have added most distinctive calls to their vocabulary and use these particularly during their courtship displays, as they contribute to prevent interbreeding (Del Hoyo *et al*., 1992).

2.1.6. Food and Feeding

The diversity of the wildfowl is reflected in a wide variety of diets. The availability of food in each area is, of course, fundamental, but such aspects as the proportion of plant and animal matter and the methods of obtaining it are generally consistent with the taxonomic groupings of species (kear, 2005).

There are some purely vegetarian and other purely carnivorous species, but vegetarian diets predominate among fully-grown birds. In contrast, young chicks of most species feed mainly on small animal prey items for a certain period. This is favored by the relative facility with which animal food is digested, in comparison with vegetable items, and by the increased abundance and availability of aquatic insects, mollusks and crustaceans during the period immediately after the chicks have hatched (Del Hoyo *et al*., 1992).

Wildfowl have several methods of foraging, the most important of which are surface-feeding, or dabbling, diving and grazing. In addition, they sometimes wade, probe with the bill, filter mud, upend, sieve the bottom debris, chase fish, reach for below grasses, chase small animals, and so on (Del Hoyo, 1992; Kear, 2005). The distinction between the dabbling ducks and the diving ducks has been based more on taxonomic divisions than ecological differences. The Anatini normally feed by dabbling at the surface, whereas the Aythyini are commonly regarded as diving foragers, so these tribes have often been labeled respectively the "dabbling" and "diving" ducks (Del Hoyo *et al*., 1992).

The daily pattern of foraging activity among wildfowl also varies according to species, season, general area, particular site, type of food and feeding method (Del Hoyo *et al*., 1992; Kear, 2005). Some species are mostly nocturnal, particularly in winter or when feeding in rice fields. The majority, though, are more crepuscular, feeding during the first hours of the morning, from dawn to just sunrise, and during the hours immediately prior to nightfall (Tamisier and Dehorter, 1999; Guillemain, 2000b); moonlit nights often prompt an increase in activity. Predators also play a role in determining a bird's pattern of daily activity (Paulus 1988). The Common Schelduck is a highly specialized predator on the salt water snail *Hydrobia.* Such food is obtained on land by probing with the bill or in shallow water, where the birds

dabble, wade and upend. Inland foragers normally choose to be most active around twilight or in complete darkness, and they generally loaf during the day (Del Hoyo *et al*., 1992; Kear, 2005).

The dabbling ducks include a large number of species, each of which has its own strange structural adaptations, ecological requirements, diet and foraging methods; despite the relative uniformity, a few species are quite distinctive. The shovelers, with bills specially designed for filter-feeding, collect most of their small planktonic food from the water surface, often feeding co-operatively, swimming in small circles to bring up small food particles and filtering the mud in one another's wake (Del Hoyo *et al.,* 1992; Tamisier and Dehorter, 1999; Kear, 2005). Although some species eat almost exclusively vegetarian, or less often carnivorous, most dabbling ducks have mixed diets consisting mainly of seeds, grain, green parts of aquatic plants and herbs, as well as a wide variety of tadpoles, small fish and aquatic invertebrates, including insects, mollusks and crustaceans (Cramp and Simmons, 1980; Tamisier and Dehorter, 1999; Kear, 2005).

Wildfowl diet very enormously between habitats, seasons, species, age and sex, and even between and within individual birds (Baldassarre and Bolen, 1994). The feeding behavior of dabbling ducks often shows a marked season shift, with feeding occurring at greater depths during the nonbreeding/wintering period than during the breeding season; that is that dabbling ducks immerse their head and neck more often, while in the breeding season they feed more at the surface (DuBowy 1988 in Kear, 2005), probably in response to changes in the distribution of food items. During the breeding season, feeding is concentrated on invertebrates that are found at or close to the surface, whereas in winter, feeding is concentrated at greater depths (Kear, 2005).

2.1.7. Breeding

In almost all species of wildfowl, birds attempt breeding only once a year, during the most favorable period. This is in particularly true in regions with marked seasons, where the availability of both suitable habitat and food is more or less predictable (Del Hoyo *et al*., 1992; Kear, 2005).

In most of the ducks of the Anatinae a new pair formed each year, so that the link is broken each season, usually just after egg-laying. In most species, while birds are

still in their winter flocks, each selects a new partner and the new pair travels to the breeding grounds together, so that when they reach the nesting area they are already paired, thus saving time. Only in a few cases, particularly among eiders and some other sea ducks, do birds pair up again with the same mate in successive years (Del Hoyo *et al*., 1992).

In contrast with most ducks species, in which the male takes little or no part in the incubation or chick rearing, male birds of the species with permanent pair bonds generally have an active role in the breeding responsibilities, sitting on the eggs, when the female goes out to feed during incubation, guarding her while she incubates, accompanying the young, defending the territory necessary to provide enough food for all the family, and so on (Del Hoyo *et al*., 1992; Kear, 2005).

In many species, social interactions leading to the selection of a mate take place in groups, commonly in the winter flocks. It is generally the female that starts displaying amidst several already receptive males. She commonly performs a "Head-nodding" movement while swimming in circles around several males, and adopting a very flat position that is typical of dabbling ducks. The males respond by adopting an "Uptilted" posture, in which the head is retracted, the plumage bristled up and the whole body stretched out, and at the climax of this movement, the bird shakes its plumage vigorously. Then it bends its neck well forward and produces a loud whistle followed by a sound, as it recovers its original position. Displays between paired birds affect only the two birds involved, although they may be performed in front of other birds (Del Hoyo *et a*l., 1992).

Males play an important role in the feeding efficiency of their mates, as they defend their feeding territories, and guard them as they forage. This is essential if the female is to build up reserves for the considerable efforts involved in nest building and especially egg-making. Incubation is carried out almost exclusively by the female (Afton, 1979; Del Hoyo *et al*., 1992).

The young hatch with their eyes open and can stand up, move about or swim almost immediately after they have dried out. However, until they are one or two days old their mobility tends still to be limited and they do not usually get lost far from the nest. They have a natural tendency to follow their mother, or both parents, and they

immediately become attached to the parental contact call. Thus the parent bird may lead them to new feeding or staging areas across fields, roads or whatever. Young wildfowl, led normally by the female alone, or by both parents, are capable of gathering food for themselves immediately they can swim. The role of the parent bird in the foraging of the chicks is based on a rather passive attitude, and consists mainly of leading the young birds to areas with plenty of food, where it stays alert and guards them from predators (Del Hoyo *et al*., 1992; Kear, 2005).

In some species, the young of several broods are brought together in a large aggregation, or crèche, under the attendance of a few adults. This strategy occurs for flamingos, is particularly common among shelducks and is thought to improve the chances of survival of the chicks, by concentrating them in the best feeding areas and by diminishing the individual risk of predation. It is also thought to have advantages for the females, as most of them are freed from breeding duties and can start moulting earlier in the season, so as to be ready for migration sooner (Del Hoyo *et al*., 1992).

Most duck species are sexually mature at about one year old, so they are capable of successful breeding in their second summer. There have been many studies of the average chick production of different species of wildfowl in different parts of the world. Obviously, the results fluctuate greatly from one species to another, and within the same species between areas. In general, those pairs that attempt breeding, sometimes a small fraction of the total population, obtain medium to high overall hatching success, often 60-80% or higher in normal years. However, the number of surviving chicks decreases gradually as the season advances, as many are lost to predators or in bad weather, so that only fairly small proportions reach fledging. In most species, 40-60% of the young that hatch die before they are fully-grown (Del Hoyo *et al*., 1992).

2.1.8. Relationship with Man

The close relationship of wildfowl with man is undoubtedly connected with the fact that both are numerous and widespread, occurring in almost every corner of the world. Ducks have been domesticated in Europe, Asia, Africa and America, they have been farmed for meet, egg and down, they have been hunted and killed in many ways, and they have been kept in collections and have become naturalized in places far from their

original ranges. These days, they are significantly affected by the conservation effort being invested in wetlands habitats worldwide, but they often come into conflict with agriculture too. The first species of wildfowl to be domesticated was probably the Mallard that is the direct ancestor of almost all the current breeds of domestic ducks (Del Hoyo *et al*., 1992).

2.1.9. Status and Conservation

Although five species and three subspecies of wildfowl are considered to have become vanished in modern times and some 16 existing species are currently considered to be threatened on a global scale, the status of the Anatidae in general is a good deal more satisfactory than that of many other families of sizeable birds (Del Hoyo *et al*., 1992).This is particularly encouraging given the high levels of exploitation that wildfowl have traditionally suffered, and indicates that effective protection might be achieved with simpler measures than those required for many other birds. Many species have successful populations of millions and occur on a great number of sites in different geographical regions (Del Hoyo *et al*., 1992).

Despite all those negative factors, wildfowl have their future guaranteed as long as their habitats are preserved and, where possible, re-established. The present rate of wetland drainage is the most urgent threat to their survival throughout the world. The "recovery" of land for agricultural purposes, the destruction of coastal lagoons to improve the attractiveness of an area for tourists, and the use of lakes and rivers for leisure purposes are factors that reduce the abundance and diversity of wildfowl, so protection of all appropriate sites worldwide is essential (Del Hoyo *et al*., 1992).

2.2. Biology and Ecology of Greater Flamingo

Flamingos are waterbirds extremely gregarious, rather cautious, and rarely allowing getting closer to it and it grazes in shallow water to feed on. This waterbird frequented coastal water and shallow lakes, especially those with high concentrations of alkali salts probably because this type of environment has enough plankton (insects, miniscule crustaceans and plants). These birds owe their color to small crustaceans that are basis of their diet. These birds, very dependent on this specific aliment, breed only when the resource is sufficiently abundant (Bond, 1996).

2.2.1. Systematic

There are five species of Flamingos in the world. The first two live in Hauts Plateaux lakes of Andes and South America (*Phoenicoparrs andinus* and *Phoenicoparrus chilensis*); the third is found in warm region between Madagascar, Ceylon and the Galapagos islands (*Phoenicopterus ruber ruber*); the fourth lives in Southern Europe and Africa (*Phoenicopterus ruber roseus*); the fifth is the small flamingo (*Phoenicopterus minor*) (Johnson, 1992). The taxonomy of studied species is as follows:

Kingdom: Animalia
Phylum: Chordata
Class: Aves
Order: Phoenicopteriformes
Family: Phoenicopteridae
Genus: Phoenicopterus
Species: *P. roseus*

2.2.2. Flamingo Morphology

Flamingo has specificities such as the shape of the bill and the very special way of its feeding. It can live in areas over-salted due to a gland that evacuate the salt through nostrils. Moreover, it is one of rare species in raising their chicks in a “crèche”. Flamingos are birds that feed by filtering water and their diet are composed of small invertebrates such as insects and crustaceans found in the shallow water or brackish wetlands. The most consumed species belongs to the genus *Artemia* (Britton *et al.* 1986; Johnson 1997).

Flamingos are long lived; the maximum recorded age is 40 years in the wild and 60 year in captivity (Johnson, 2000). Sexual dimorphism is pronounced, and the size and weight of males are on average 20% larger than those of females (Johnson *et al*, 1993). They are monogamous seasonal, with high rates of partner change (98.3%) from breeding season to the next (Cézilly *et al*. 1995). Reproduction is often irregular, including favorite sites (Johnson, 1997), mainly because of fluctuations in water level which is a characteristic of the tropics and subtropics zones (Del Hoyo *et al*. 1992).

This bird is a real curiosity about avifauna with a silhouette and unique coloring. Flamingos are birds of great size, with maximum wingspan of 187 cm, and maximum

total length of 207 cm. The male larger than the female weighs 4.5kg; while the female 2kg. The bird has a body entirely pale pink, pink webbed feet long, curved bill with short black tip. In flight, the characteristic shape is very elongated (stretched legs and neck), wings will then be visible. The primary and secondary flight feathers are entirely black with bright pink cover tending towards white. Immature (juveniles or sub adults) are not colored: the legs are dark, neck and white underside and the top marked with brown. The pink color appears during 4 to 7 years where the intensity is at its maximum (Johnson, 1983). The bird has a fairly deep and raucous cry similar to the bugler geese (Johnson, 1992; Nicolai, 1985).

2.2.3. Flamingo Habitat

The flamingo is a coastal bird related to brackish waters and its preferred habitat consists of lagoons and coastal ponds. It frequents the salt waters of Garaets and Sebkhets (Johnson, 1992; Nicolai, 1985).

2.2.4. Greater Flamingo population in Algeria

The Greater Flamingo *Phoenicopterus roseus* is an emblematic species of wetlands and was probably present in lagoons and salt lakes since thousands of years (Allen, 1956). It is one of the commonest species that are able to use freshwater as well as brackish and even saline habitats (Samraoui and Samraoui, 2008a).

Previous record (A. Johnson in Isemann and Moali, 2000) reported the presence of Greater Flamingo *Phoenocopterus Rosus* in different locations (Hauts Plateaux, Boughzoul, Oran region, Sahran Chotts) in Algeria all around the year particularly between September and March-April. Previous census carried out in Algeria provide a mean of 6000 individuals in January 1995 and 1996 (Rose, 1995 and Delany *et al*., 1999). In the Hauts Plateaux, the number varied between hundreds and several thousand where 1000 on October 1977 at ouled Zaoui (Ezzmoul), 5000 on 2-3 December 1971 at Garaet El Taref and 1900 on 1 st February 1992 at Sebkhet Bazer (El Eulma) individuals were counted (Isemann and Moali, 2000). The survey of "Direction Génerale des Forets" in the Hauts Plateaux provided sporadic and non regular counts where the highest numbers were recorded at Chott tinsilt 1450 in 2003, 5425 at Ank el Djemel in 2004, 36 at Sebkhet El Hamiet in 2000, 61 at S. Bazer in 1999 and 1345 at Chott El Beidha in 2000 (Anonymous, 2004). In a recent study

Samraoui and Samraoui (2008a) reported the presence of the species over Numedia and the Hauts Plateaux. Ouldjaoui (2010) carried out a regular census at Oum El Bouaghi wetlands complex and reported a maximal number between 18150 and 59135 counted over three year census (2003-2005). The widespread distribution Greater Flamingo across the Hauts Plateaux can be partly explained by the nature of the wetland habitats which predominate (Samraoui and Samraoui, 2008a).

Despite the fact that Greater Flamingo population in North Africa is a part of a larger regional metapopulation spread over the western Mediterranean basin (Johnson 1983, 1997), very little is known about the role of North African wetlands in Metapopulation processes that may be essential for survival of the species between this region and the rest of the Mediterranean (Samraoui *et al*., 2006b). Thus, our study is a contribution to a fair estimation of Greater Flamingo population, at least in part, in Algeria.

2.2.5. Breeding ecology of Greater Flamingo in Algeria

The reduced number of breeding sites throughout the world (less than 30) for all species altogether of Greater Flamingo arise a challenge for conservation of this taxon a symbol of wetlands (Conway 2000). This verdict is of course applied on Greater Flamingo *Phoenicopterus roseus*. The breeding of the latter in North Africa was since several decades a "Frustrante" (Lavaude, 1924). Despite intense investigations, the number of breeding sites remains few minor.

Despite Remarkable advances have been made during the past decades for comprehending the breeding biology of the Greater Flamingo in Mediterranean Europe (Allen, 1956; Brown, 1959; Johnson, 1983, 1997, 2000; Rendon Martos *et al.*, 1991; Rendon Martos, 1996) little is known about it in Algeria.

The Breeding occurred many times in Morocco, in Daya Iriki (Panause, 1958; Robin, 1966; 1968). Unfortunately this Moroccan colony disappeared after Dam construction on Oued Dra that feeds the Daya (Johnson, 1979).

In Tunisia, the breeding was noted sporadically in some salt lakes like Tunis Lake(Johnston, 1881 in Allen, 1956), Chott Djerid (Domergue1951-1952; Castan, 1960); Fedjadj (Kahl, 1975), El Hani, El Djemet Sidi Mansour (Johnson, 1997).

In Algeria, the delay in discovering the breeding Greater Flamingo can be probably explained by the vastness of the country (2 382000 km^2) and by its potential sites. The difficult access to salt lakes and their irregular water impoundment have always inhibited the breeding study in Algeria (Gautier, 1928) or elsewhere (Brown, 1959). Until the year 2000, the breeding of the species was not yet confirmed (Isenmann and Moali, 2000).

During the year 2003 and 2004, Saheb *et al* (2006) located, through a systematic survey of salt lakes of the Hauts Plateaux, a breeding site, Gareat Ezzemoul, where the Greater Flamingo attempted unsuccessfully to breed for the past two years. The failure was attributed to many causes among which human disturbance.

The year 2003 was characterized by observation of thousands of waterbirds within the Oum El Bouaghi Wetlands complex, intensification of courtship and copulation between April and June, the finding of few abandoned eggs at two sites with the observation of 60 chicks. In March 2004, 60 nests and 7 eggs were discovered on an islet of Gareat Ezzemoul where trustful riparian witness confirmed the interruption of the breeding in 2003 due to human intrusion.

In 2004, almost 8500 waterbirds occupied the islet on June 7^{th} in an attempt for breeding that was confirmed by the observation by several courtships and copulations. Later on, the islet was deserted due to human intrusion. A total of 276 nests were discovered and 226 eggs were counted and their weight and measurement were taken. Moreover, the study reported that laying period of Greater Flamingo in Algeria is delayed compared to that in Europe (February to May in Fuente de Piedra, Spain Rendon Martos *et al.*, 1991; mid-April to May/June (in Camargue, south France) (Cézilly *et al.*, 1995).

The first recorded reproduction occurred in 2005 on a natural islet of Garaet Ezzemoul, a seasonal salt lake near the town of Ain M'lila in the Hauts Plateaux. This successful breeding occurred by at least 5 379 breeding pairs. Egg laying started relatively late (mid-May) and breeding success was estimated by 92% and about 5 000 fledged chicks. Ring viewing indicated that the breeding population was made up in part of adults born in Spain, France and Sardinia supporting evidence of a

metapopulation of nomadic birds breeding and wintering across the Mediterranean Basin (Samraoui *et al.*, 2006a).

The year 2006, as a favorable wet year and with establishment of protective procedures to secure the safety of the breeding colony, the Greater Flamingo managed to breed at Garaet Ezzemoul and an estimated 4,750 pairs bred producing an estimated 3,750 fledged chicks and achieving a breeding success of 79%. Egg-laying begun in May like that of 2005 i.e. much later than in Europe (Johnson, 1983; Rendón Martos *et al*., 1991). Incubation of eggs and chicks lasted till mid-July with many late-breeding birds reusing vacated nest (Boulkhssaïm *et al.,* 2006).

In 2008, Samraoui *et al* (2008b) summarized by reporting that Greater Flamingo made at least ten breeding attempts between 2003-2008 in three different salt lakes: Ezzemoul and S. Bazer in the Hauts Plateaux, and El Goléa in the Sahara. Where only two attempts were successful (Ezzemoul 2005 and 2006). Nesting attempts failed at Ezzmoul during 2007 and 2008 due to drought where in 2008, Greater Flamingos abandoned the islet after laying 400 eggs.

At El Goléa, in the Sahara, the Greater Flamingos also attempted to breed in 2007 (17 nests were discovered) and in 2008 (46 nests were counted). Egg removal by nomadic herders, probably for their own use, disrupted the breeding attempt in the incubation stage.

At Sebkhet Bazer, in El Eulma wetland complex, the Greater Flamingos attempted to breed in three consecutive years (2007, 2008 and 2009). The colony was built at the edge of the salt lake and was highly vulnerable to human disturbance (egg poachers) and terrestrial predators (feral dogs, foxes, jackals and wild boars) that might have led to nesting failure a total of 60 , 55 and 12 nests were discovered in 2007 , 2008 and 2009, respectively. The incubation start reported to be mid May in 2008 and late May in 2009. The place of breeding during 2007 and 2008 was localized at 100 m from the shore which facilitate human and animal intrusion (Samraoui *et al.*, 2010).

After two failed nesting attempts in 2007 and 2008, the Greater Flamingo managed to breed successfully at El Goléa in March-April, 2009, in the heart of the Algerian Sahara. A total of 70 pairs nested and 23 chicks fledged. This was the second

Algerian site to host a Greater Flamingo breeding colony after the first recorded reproduction at Ezzemoul in 2005. Two of the breeding birds at El Goléa were ringed at Ezzemoul in 2006, suggesting that the establishment of the new colony may owe much to the successful reproduction of the older and larger colony located in the Algerian Hauts Plateaux. Eight chicks were banded as part of a study focused on factors influencing dispersal and recruitment of Flamingos in the region (Khelifa *et al.*, 2009).

The third successful breeding event was recorded at Ezzmoul in 2009 where an estimated 10 000-12 000 pairs nested but only 6069 nests were counted after the breeding was over. The number of chicks estimated to be in excess of 6 000. A total of 637 chicks were banded and standard measurements were collected before all the chicks were released (Boulkhssaïm *et al.*, 2009).Through the period of study (2003-2009) a total of more than 21000 bands were recorded which revealed the diverse origin (Portugal, Spain, France, Italy, Turkey and Algeria) of wintering or breeding Greater Flamingo in Algeria (Samraoui *et al.,* 2010).

Chapter 3. Description of study sites

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3.1. Generalities on the Hauts Plateaux of the Algerian East

One geomorphologic element characterizing the north east of Algeria is the Hauts Plateaux that dominate the coastal plains of the north. These Hauts Plateaux covering huge surface, mainly from Setif to Oum El- Bouaghi wilaya, undergo a semi arid climate. It is a large region on the south of Constantine containing twenty wetlands of very ecologic and economic importance (Jacobs and Ochando, 1979). Our knowledge on these Hauts Plateaux remains highly insufficient due to the rarity of multi-disciplinal studies (Ecology, Climatology, Hydrology, Geology, Sociology, etc). The region constitutes a wide corridor dominated by two mountain chains:
Aures massive to the south and the chains of Constantine Mountains to the north. The main feature of the local pouring basins is the endoreism that results in many Sebkhets (salt lakes) occupying the center of these plains. The majority of these are wide, shallow salt lakes that remain poorly known but that have recently been investigated (Samraoui *et al*., 2006b; Boulekhssaim *et al*., 2006; Samraoui and Samraoui, 2008a).

The wetland complex of EL Eulma is part of this huge complex and is bordered by two Wilayas Jijel and Bejaia in the north and Batna and M'sila in the south. It is bordered from the East by Wilaya Mila and from the West by Wilaya Bordj bou Arreridj. In locality designations, the words Sebkhet (salt lake), oued (wadi) are abbreviated to 'S' and 'O', respectively. The main water bodies found within this complex are in mean altitude of 900 m (Figure 1a, c).

The most spacious wetlands are: Garaet Taref, Garaet Guelif, Garaet Ank Djemel, Garaet Zemoul, Chott El Beidha and Chott El Frain. Most of them remain hard to have access to due to striking lack of road infrastructure (Figure 1b). The major wetland zones are:

3.1.1. Garaet Tarf

Administratively, Garaet Tarf belongs to the Wilaya and Daira of Oum El-Bouaghi, municipality of Ain Zitoune. The site is 14 Km far from the wilaya and can be accessed to by the national road linking Oum El- Bouaghi to Khenchela or by the national road linking Ain El Beïda to Khenchela. On the hydrologic level, the site is

mainly fed by rain waters forwarded by Oued Boulefreiss, Oued Maarouf, Oued Remila, and Oued Gueiss. The overflowing of these wadis results in big volume of clay and mud, a favourable milieu for Plovers. This water stretch is the biggest wetland in the region covering a surface of 25500ha. Its water is salty, 75.6 ms/cm with a pH 8.2, less deep, and fluctuates depending on precipitations. The water stretch dry up in the summer and is deprived of vegetation all around with the exception of *Salicornia*, *Artemisia* and *Atriplex* that cover the wetland. Garaet Tarf, like all wetlands of the region, shelter each year very diversified aquatic avifauna constituted mainly of Common Shelduck, Greater Flamingo, Common Crane, surface Ducks and Plovers (Metzmatcher, 1976). The site was classified by Ramsar convention as a site of International importance on December 15th 2005.

The south part of Garaet Tarf characterized by many depressions that overflow and appear as water stretches (water stretches satellites).

3.1.2. Garaet Guelif

Garaet Guelif belongs to the Oum El- Bouaghi Wilaya, municipality of Aïn Zitoune. The site is located at 12 Km to south of Oum El- Bouaghi, and it is accessible through the road linking Oum El- Bouaghi and Khenchela or through the road linking Oum El- Bouaghi and Boughrara Saoudi. It is mainly fed by Oued Tallizerdane, Oued Houassi, and Oued Ourleiss. The water level is about 40 to 50 cm during heavily rainy years. Its water is salty 152 ms/cm with a pH 7.86. The site dries up in the summer due to intense evaporation. Garaet Guelif shelters each year many waterbirds where the most common species are the Common Shelduck, Greater Flamingo, surface Ducks and Plovers. Starting from March, we meet a very large number of Avocets, Black Winged Stilts, Slender-billed Gulls, and of Gull-Billed Terns. Cereal culture occupies the largest part surrounding the site, whereas, the left is colonized by *Atriplex halimus* and *Salicornia fructicosa.* The ornithological richness of site notably by the Greater Flamingo, the Common Shelduck, the Eurasian Wigeon, and the Northern Shoveler provide the site the status of International importance since it receives more than 1% of Mediterranean population of these species.

3.1.3. Garaet Ank Djmel

Administratively, the site belongs to Oum El- Bouaghi Wilaya, Daïra of Aïn Fakroun, and municipality of Boughrara Saoudi. The site, to the east, is attached to Garaet Guelif and considered as the second large water stretch of the region in surface. Its water is, also, salty and featured by heavy seasonal rains. From the hydrologic point of view, the site is mainly fed by Oued Tallizerdane and Oued Berrou. Very diversified aquatic avifauna frequents the site and the most abundant species are Greater Flamingo *Phoenocopterus roseus*, the Common Shelduck *Tadorna tadorna*, the Common Crane *Grus grus* and other Anatidea species. Garaet Ank Djemel was classified on 2004 as a Wetland of an International importance because it holds more than 1% of Mediterranean population of two species: Greater Flamingo and Common Shelduck.

3.1.4. Garaet El Maghsel

Administratively, the site belongs to Oum El- Bouaghi Wilaya, Daïra of Aïn Fakroun, and minicipality of Boughrara Saoudi. .It is an endoroeic depression of 125 ha with salty water. The site is colonized by a halophile vegetation and enclosed between a sequence of mountain chains composed of El Maghsel to the west, the mountain chain of Oum Kechrid to the north and Ank Djmel Djebel to the east and to the south east.

3.1.5. Garaet Boucif (Ogla Touila)

The site has a surface equal to 170 ha and is located near the national road linking Oum El- Bouaghi to Khenchela. Administratively, it belongs to the Daïra of Oum El- Bouaghi, municipality of Aïn Zitoun. The Sebkhet is located in the plain Medfoun, at the base of Tarf Djebel. The water stretch is surrounded by durum wheat fields and frequented, especially in high raininess years, by a large number of waterbirds such as the Common Shelduck, Northern Pintail, and the Plovers.

3.1.6. Chott El Maleh

It is a water stretch satellite of Garaet Tarf with a surface of about 875 ha. Situated at 35° 35. 49.00 'North, 7° 03.49.3'East at 902 m in altitude. Chott El Maleh is composed of four units located to the south of Garaet Tarf. Its brackish water lays only within rainy years and it is fed mainly by Oued Maarouf and Oued Remila waters. The site contains two types of Vegetation Sea Club-rush (*Scirpus maritimus*) and Reed (*Phragmites australis*) where the first species is the dominante in the four units. The site is favourable for many species of waterbirds where the Coots, the Northern Shovelers, and the Eurasian Wigeons are the most abundant. Not only the site is used for wintering but, also, for breeding during rainy seasons.

3.1.7. Sebkhet Gemot

Sebkhet Gemot is only a continuity of Garaet Tarf and it is a small water stretch with a surface of 10 ha providing, with its vegetation composed of *Tamarix* and its appropriate water depth, an adequate milieu for aquatic avifauna notably the Ardeidea, the Rallidea, the Ducks, and the Plovers.

3.1.8. Garaet Timerganine

Situated at 35° 39′ 56 ″ North and 06° 57′ 02″ East at altitude equal to 843 m, this endoreic Garaet is fed mainly by rain fall and by Oued Boulefreiss, originated from the massive of Aures mountains, that overflows the different basins of G. Timerganine. It is characterized with its relatively important water depth in the region and with a surface approximating 700 ha. This is brackish fresh water stretch has a conductivity of 2.01 ms/cm and pH 8.54. The site can be accessible through the national road linking Oum El- Bouaghi to Khenchela.

Timerganine Garaet is located at 25 km to the south of Oum El- Bouaghi and it is bordered at the north by Aïn Zitoun municipality and at the south by Remila plain. Administratively, it belongs to the wilaya of Oum El- Bouaghi, municipality of Aïn Zitoun. The site featured by its dense vegetation, mainly composed of *Eleocharis palustris*, *Scirpus maritimus*, *Scirpus triqueter*, and *Phragmites australis*, and by its water depth serve as an ideal milieu for wintering and breeding of many waterbirds

notably the Anatidea and the Rallidea, particularly Coots (Samraoui and Samraoui, 2007).

3.1.9. Chott Tinsilt

The site is located on the territory of the Wilaya of Oum El- Bouaghi, Daïra de Souk Naamane, and Minicipality Ouled Zouaï. It is at 17 km to the south of Ain M'lila on the national road N° 3 linking Ain M'lila to Batna. Its flooded surface inondable is 1000 ha. The Chott is fed by rain waters coming from Oued Zerhaib. Its water is brackish with a mild conductivity, 38ms/cm, an alkaline pH 8.05, and a depth that never exceed 50 cm. The Chott is surrounded by a humid meadow covered with herbaceous vegetation represented by two families, the Chenopodiacea and the Aizonacea. Moreover, the site is, also, a wintering milieu for different species notably the Anatidea, the Greater Flamingo, and the Plovers. It is classified as a wetland of an International importance, Ramsar site on December 15th 2004.

3.1.10. Sebkhet Ezzemoul

The Sebkhet or Garaet Ezzemoul is located to the East of Chott Tinsilt 35°53′ North and 06°33′ East, it is separated from the latter by the national road N° 3 linking Constantine to Batna. A Part of this Sebkhet is exploited for salt extraction. It only becomes filled with water when the seasons are heavily rainy. Its surface is 4 600 ha, and it is usually dry during summer .This drought may bypass the two month–period. It holds invertebrates such as *Artemia tunisiana* and *Branchinella spinosa* which seem to tolerate the salinity more than 151g/l NaCl (Samraoui *et al.,* 2006a). The site holds, also, an important ornithological richness (Samraoui *et al.*, 2006b) where the most abundant species is the Common Shelduck *Tadorna tadona* (Morgan, 1982; Boulkhssaïm *et al.,* 2006).

3.1.11. Sebkhet Djendli

It is Located at 35° 43′ North and 06° 32′ East, with an altitude of 825m. The surface of it is 200 ha. Its water is salty (29g/l NaCl) and rich with *Branchinectella media* and with Gasteropoda (Samraoui *et al*., 2006a). The site dries up in the summer

for at least a short period. More than 8000 Ducks were counted in winter in the site where the most frequent waterbird is the Common Shelduck *Tadorna tadorna* (Morgan, 1982), the Great Flamingo and, also, Ducks' surface. Sebkhet Djendli is situated surrounded by three mountain chains: Djebel Bou Arif to the south, Djebel Toumbait and Tafrout to the north and to the west. To the east, the sebkhet Djendli open on the plains of Boulhilet and Chemora. It is a water stretch of a surface 3 700 ha, fed mainly by water rains (Morgan, 1982).

3.1.12. Sebkhet Tazougart

Sebkhet Tazougart (35 ° 23.777'N, 7 ° 19.920'E) is a brackish stretched lake, divided into many sequence of units, where two of them, the main ones, are known under the names: Sebkhet Ouled Amara and Sebkhet Ouled M'barek, which are fed by Oued Ounrhal. Many species of waterbirds were counted during winter where those of higher numbers are Anatidae particularly Eurasian Wigeon, Northern Shoveler, Northern Pintail, Common Pochard, and Common Shelduck. Rallidea, particularly, Coots were, also, counted in very high numbers in winters.

3.1.13. The plain of Remila

During High raininess years, we could observe the formation of a lot of temporal ponds with variable surfaces that are important at least in the whole plain of Remila (wilaya of Khenchela). The plain is usually used for cereal culture. These formed ponds shelter many waterbirds among which surface Ducks and Plovers.

3.1.14. Garaet Boulhilate

G. Boulhilate (35°44.699'N, 6°47.431'E) is a freshwater pond of 290 ha fed mainly by O.Boulhilate and rainfall. It is surrounded by a belt of *Tamarix gallica* and it is easily accessed through WR 26 linking Ain Kercha and Boulhilate.

3.1.15. Sebkhet Bazer

Sebkhet Bazer (35°63'N, 5°41'E) is a permanent salt lake (4,379 ha) in the region, fed by rainfall and by the seasonal streams, Oued El Guitoune, Oued Djermane

and mainly by Oued El Mellah which is permanent (houses and industrial sewages). The site is located near El Eulma town (Figure 2). It is bordered at the West by Djebel Baraou, at the East by Mechtet Nouasser, at the North by Merdjet Ech-Chtout and at the south by Koudiat Gueltet Ed Debba. The site is localized at the south of two urban areas El Mellah village and Bazer Municipality. S. Bazer is distant from Chott El Beidha by 11.5 km and by 29 km from S. El Hamiet. It contains aquatic vegetations which are composed mainly of *Thypha angustifolia*, *Juncus maritimus*, *Atriplex glauca*, *Maribium* sp, *Salicornia fructiasa*, *Ranunculus* sp and other undetermined species.

Many waterbirds frequent the site among which Ducks *Anas* sp, Common Shelducks, Greater Flamingos, Avocets, Black Winget Stilts, *Grus grus* and Greylag Goose *Anser anser*. The site is used by riparians for sheepherding and growing cereals. The ornithological richness of site notably by the Greater Flamingo, the Common Shelduck, Ducks provided the site the status of International importance in 2004 because it receives more than 1% of Mediterranean population of these species (Anonymous 2004) and was included as an important Birding Area (IBA) (Samraoui and Samraoui, 2008a).

3.1.16. Sebkhet El Hamiet

Sebkhet El Hamiet (35°55'N, 5°33'E) is a temporary salt lake is composed of a Sebkhet (1400 ha) and a humid meadow (200 ha) on its surround (Figure 1c). Water level is changeable according to seasons and years. Administratively, the site belongs to Wilaya of Setif and it is bordered at the North by Ain El-Hadjar town and Mechtet Ouled Mefla, at the South by Merdjet El Hamiet and Mechtet Lekhtatla, at the West by Maadhet El Hamiet and at the East by the road linking Ain Azel to El Eulma. The site contains different type of halophyte vegetations such as *Juncus maritimus*, *Atriplex glauca*, *Limonium delicatum*, *Salsola vermiculata*, and *Suaeda fruticosa*. The site is favorable for many species of waterbirds (Flamingos, Ducks *Anas* sp, Black Winget Stilts, Avocets, plovers) where the Common Shelduck is the most abundant. The socio-economic activities of the site include sheepherding, Cattle and Poultry breeding and growing vegetables. It was classified as a wetland of an International importance because it holds more than 1% of Mediterranean population of two species: Greater

Flamingo and Common Shelduck (Anonymous 2004) but not yet included as IBA due to insufficient sampling (Samraoui and Samraoui, 2008a).

3.1.17. Chott El Beidha

Chott El Beidha (35°35'N, 5°48'E) is a 12,223 ha temporary salt lake that is composed by a sebkhet (90%) fed mainly by rainfall and a humid permanent meadow (10%) covered by halophyte vegetation. The site is located in the South of Hammam Soukhna municipality (Figure 1c). The largest part of the site, situated in the North, belongs administratively to Wilaya of Setif and the other part, situated in the South of M'sila municipality, belongs administratively to Wilaya of Batna. The humid weadow featured by its diversified vegetation mainly composed of *Halocnemum strobilaceum*, *Arthrocnemum indicum*, *Atriplex glauca* and other undetermined species. The site is frequented, especially in high rainy years, by a large number of waterbirds such as Common Shelducks, Greater Flamingos, Ducks *Anas* sp, Black Winged Stilts, *Grus grus* and Avocets. The site was classified by Ramsar convention as a site of International importance because it shelters more than 1% of Mediterranean population of two species: Greater Flamingo and Common Shelduck (Anonymous 2004).Yet it is not included as an IBA due to drought or degradation (Samraoui and Samraoui, 2008a).

3.1.18. Chott El Frain

Chott El Frain (35°59'29"N, 5°46'65"E): This 16,750 ha temporary salt lake is accessible through National road 77 and departmental road 64 (Figure 1c). It is bordered by Ain Azel town to the south and Ain Lahdjer town to the west. It is fed mainly by rainfall (Anonymous 2004). The site dried up over the three year study period which disable us to carry out neither counting nor activity time budget.

3.2. Geography and hydrology

The wetland complex of the north east Algeria is located on a plain surrounded by hills and by Plateaux. To the south these sites are bordered by Aures mountainous chain. The oriental border is formed by F'kirina, village, Boutoukhma (1349 m), Fedjidjet, and Amamet El-Kebir (1337m) moutains. Sidi Rghis (1635m) mountains and a whole sequence of mountains coming through Ain Fakroun till Constantine

border them to the north, however, towards the western side, these sites open towards other wetlands that reach Setif i.e. Chott El Beidha, Sebkhet Bazer, Chott El Frain and Sebkhet El Hamiet. The hydrographical system of the region depends heavily on meteorological conditions (Anonymous, 2004).

3.3. Climatology

The climate is a Mediterranean type over the entire northern fringe that includes the littoral and the Tellian Atlas (Hot and dry summers, humid and cool winters), a semi-arid climate on the Hauts Plateaux in the country center, and desert climate once the Atlas saharian is crossed. The region belongs to semi-arid bioclimatic stage with a cold winter characterized by a cold continental climate, rainy in winter and hot, dry in summer where the dominating winds are of South-West, West and North-West (Sirocco). The rain is torrential and irregular. The annual pluviometry varies between 300 mm and 350 mm. The annual minimal and maximal temperature varies, respectively from 6.9 to 8.6°C and 20.6 to 21.4°C (Anonymous, 2004).

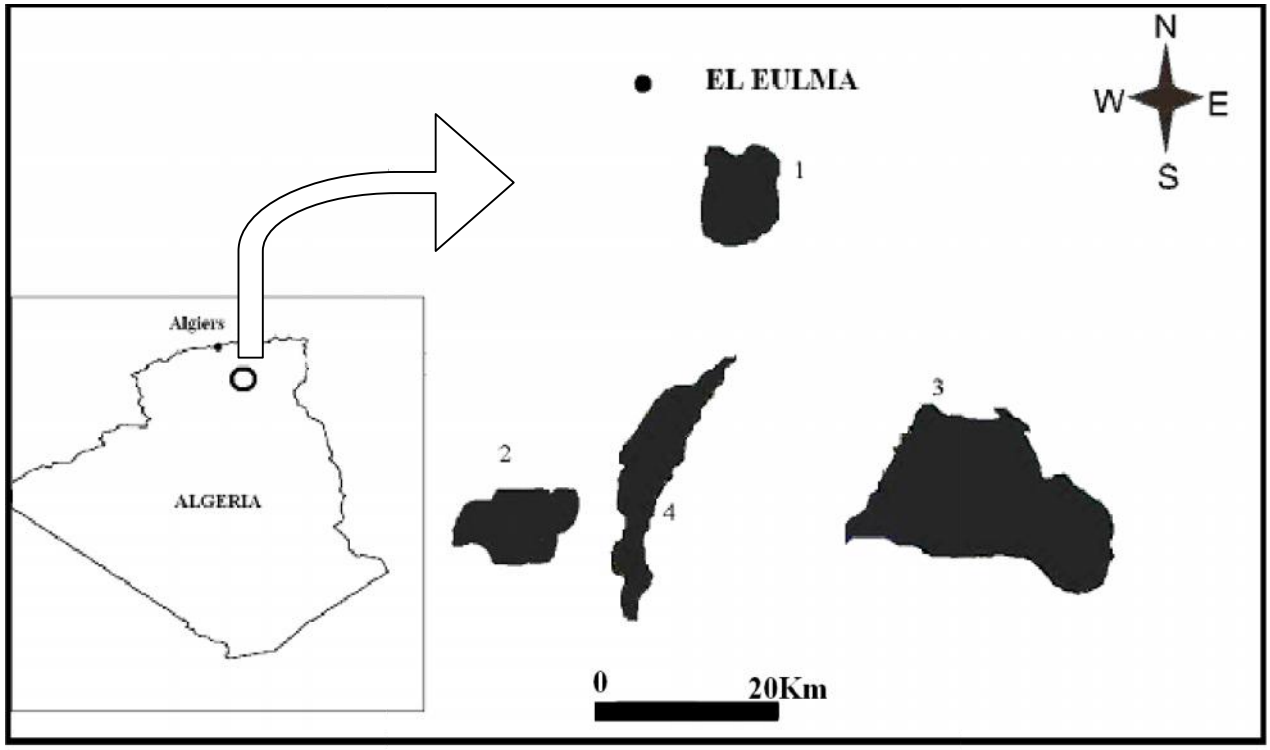


Figure1a. Map of the wetlands complex of EL Eulma, in the Algerian Hauts Plateaux, Site locations are: 1 = S.Bazer, 2 = S.El Hamiet, 3 = Chott El Beidha, 4 = Chott El Frain.

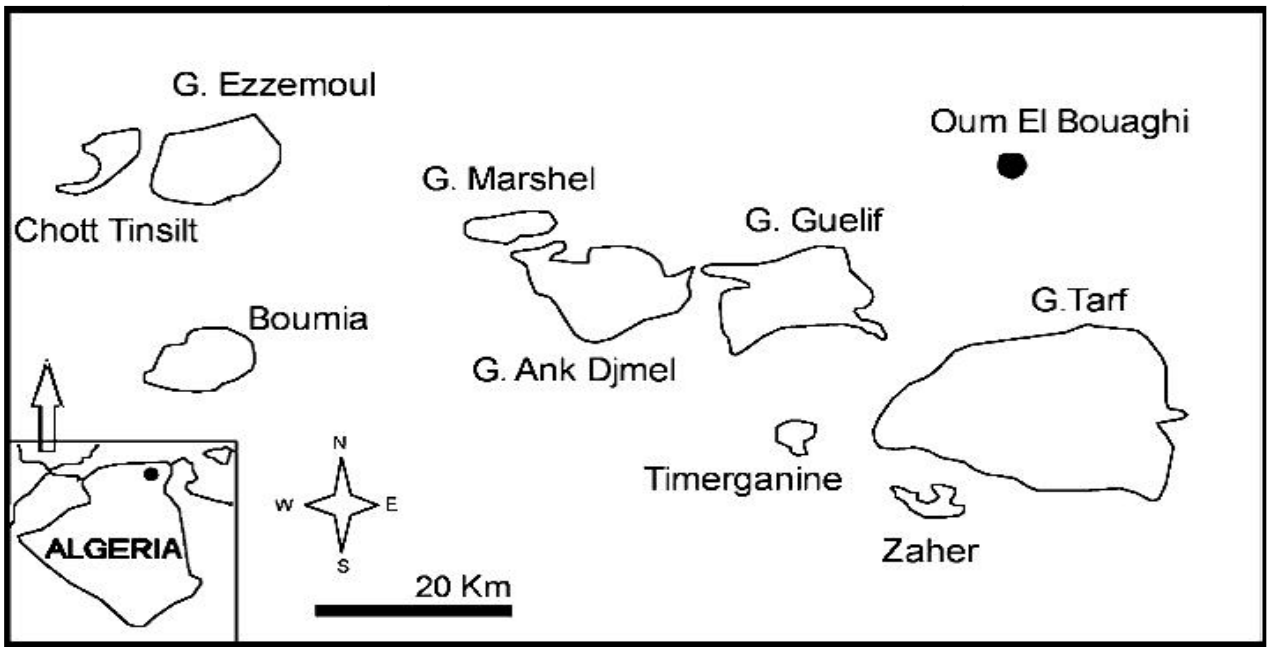


Figure1b. Map of Algeria (inset) with the Oum El Bouaghi wetlands complex located in the eastern Hauts Plateaux.

Figure 1c. Satellite picture illustrating study sites: Sebkhet Bazer, Sebkhet El Hamiet, Chott El Beidha and Chott El Frain.

Figure 2. Satellite close picture depicting S. Bazer fed permanently by Oued El Mellah.

Chapter 4. Material and Methods

4. Material and Methods

4.1. Northern Shoveler

Twice-monthly counts were carried out from September 2007 to July 2010 using an x20-60 telescope. Individual birds were counted when the numbers present were small. When more than 200 birds were present, an estimation of the population size was achieved by dividing the flock into small equal parts and counting the number of blocks. To reduce the risk of recording the same birds twice, counts were made from a single counting position for each site, taking into account topography and bird concentration (Tamisier and Dehorter, 1999).

Time budgets were monitored at twice-monthly intervals, starting from December 2008 to March 2009 and from October 2009 to March 2010, using scan sampling (Altmann 1974). All scans lasted 8h (with a scan carried out every half hour between 08:00h and 16:00h), with a total of 192 h devoted to these observations (56 h, 80h at S. Bazer in winter 2008/09 and 2009/10, respectively; 56 h at S. El Hamiet within winter 2008/09).

Behaviour was divided into nine activities: feeding, swimming, preening, resting, sleeping, flying, agonistic behaviour, walking and courtship. Feeding was additionally divided into surface feeding, dabbling, upending and grazing.

Statistics and Analysis

The hourly data were analyzed in two ways. Firstly, the whole data set was inspected to determine the mean percentage time spent by Northern Shoveler in each activity for the whole winter season. Secondly, the data were re-analyzed to determine the mean percentage time allocated to different activities during the eight diurnal hours of observation that was divided between 8:00 AM and 4:00 PM. Standard errors are indicated as (± SE).

4.2. Mallard

Twice-monthly counts were carried out from September 2007 to July 2010 using an x20-60 telescope using the same method used for the Northern Shoveler ((Tamisier and Dehorter, 1999).

Time budgets were monitored at twice-monthly intervals, starting from October 2009 to March 2010, using scan sampling (Altmann 1974). All scans lasted 8h (with a scan carried out every half hour between 08:00h and 16:00h), with a total of 88 h devoted to these observations.

Behaviour was divided into ten activities: feeding, swimming, preening, resting, sleeping, flying, agonistic behaviour, walking, loafing and courtship. Feeding was additionally divided into surface feeding, dabbling, upending and grazing.

Statistics and Analysis

The hourly data set were analyzed to determine the mean percentage time spent by Mallard in each activity for the whole winter season. Standard errors are indicated as (± SE).

The maximum water depth never exceeded 30 cm at both study sites during the year 2008/2009. During the year 2009/2010 the maximum water depth did not exceeded 18 cm and the minimum was 6 cm at S. Bazer; however S. El Hamiet dried out.

4.3. Greater Flamingo

In order to study the spatiotemporal distribution of Greater Flamingo population, half monthly counts were carried out from September 2007 to March 2011. To monitor accurately the evolution of possible breeding population at the wetlands complex, counts were performed on a weekly basis during breeding period that starts in Mid April to early June (Samraoui *et al*, 2010) in the Hauts Plateaux using a x20-60 telescope. Birds were counted using the above mentioned method (Tamisier and Dehorter, 1999).

Between April and August 2010, S. Bazer as a Greater Flamingo nesting site in Algeria, where nesting attempts had been confirmed in the past (Samraoui *et al.* 2010), was monitored and observations were made every few days until display and nest building was initiated. Thereafter, a vigil was kept daily to provide physical protection against human disturbance. The colonies were monitored from the shores using a telescope.

The following materials were used during the study period:

- Telescope x20-60 Optolyth
- A field guide to the birds
- Notebook for recording data and observations
- Technical sheets
- Water suit
- Profound meter
- Spades
- Buckets
- Scrapers
- Shells of chicken eggs
- Digital camera

Chapter 5. Results and Discussion

5. Results and Discussion

5.1. Results

5.1.1. Northern Shoveler

5.1.1.1. Northern Shoveler population

The wetlands complex of EL Eulma began to be occupied by Northern Shoveler in the second week of September/early October, and this number increased gradually to reach a maximum, when water is available, at early November/early December before decreasing progressively (Figure 3a). Fewer than 300 birds remained at the end of March and just a few dozens were present at early April.

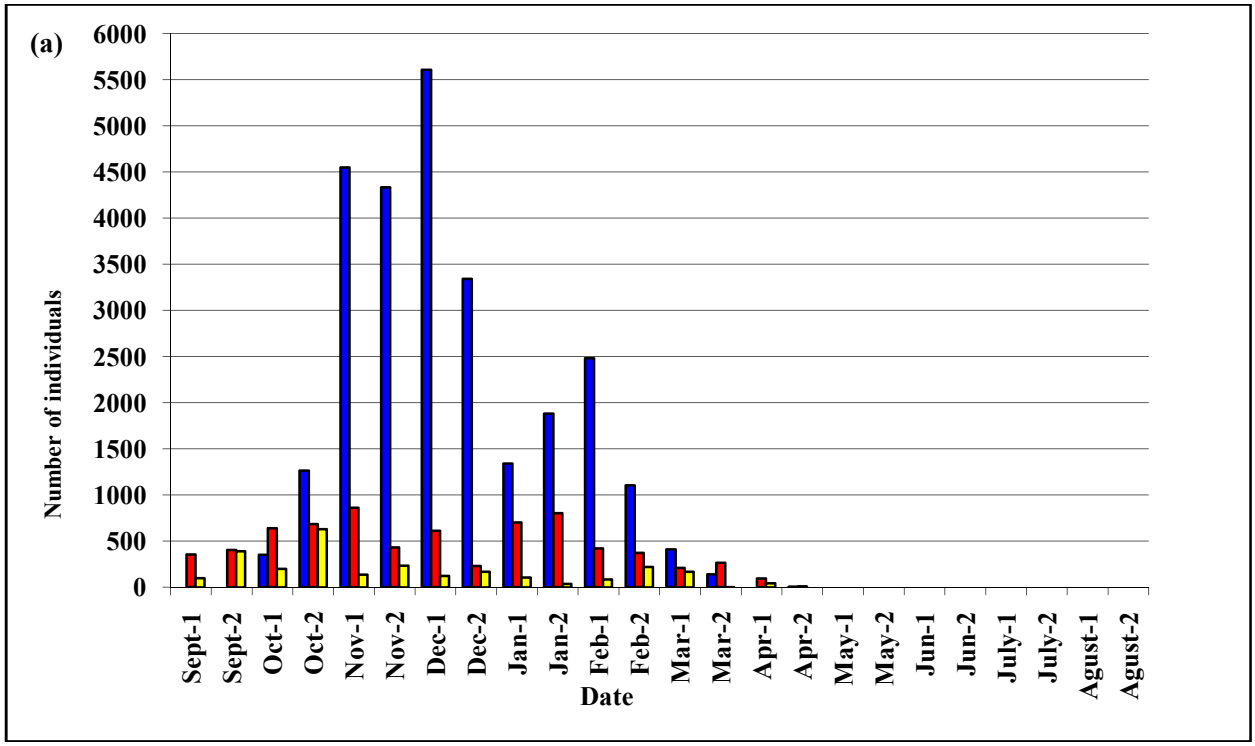
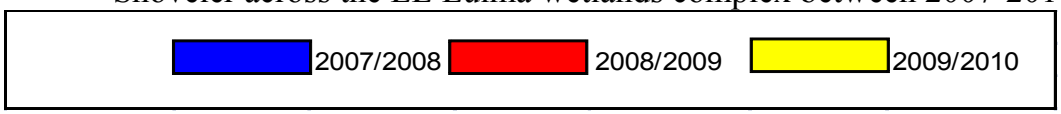


Figure 3 a. Maximum numbers recorded during twice-monthly counts of Northern Shoveler across the EL Eulma wetlands complex between 2007-2010.



Three year-census of Northern Shoveler within the wetland complex of El Eulma showed fluctuations and a sharp decline in numbers at two study sites namely, Chott El Beidha and S. El Hamiet with maximum winter counts recorded in late November and in late December 2007, 2610 and 4650, respectively (Table 1 and Figure 3b, c). This decline was coincided with the quick drying up of Chott El Beidha

and with a slow drying up of S. El Hamiet over the year 2008/09; however the year 2009/10 was characterized by a total drying up, which resulted in a massive Northern Shoveler desertion. Only S. Bazer permanently fed by O. El Mellah showed to be occupied by the waterbird over 2007/10 where fluctuations in Northern Shoveler counts were recorded in early winter (September–October) and mid winter (November–December); whereas, the numbers in late winter and early spring (January-March) remained fairly stable ranging between 170 and 220 individuals (Figure 3d). The maximum counts of Northern Shoveler recorded in mid March 2008, early December 2008 and late October 2009 (190, 500, 630, respectively) increased by two folds within the years 2008 and 2009 (Table1).

Table 1. Maximum counts of Northern Shoveler in each main site (M. C. S) with date of sampling at EL Eulma wetland complex.

Site	Winter	M.C.S	Date of M.C.S
S. Bazer	2007/08	190	16/03/2008
S. El Hamiet	2007/08	4650	26/12/2007
Chott el Beidha	2007/08	2610	22/11/2007
S. Bazer	2008/09	500	02/12/2008
S. El Hamiet	2008/09	600	31/01/2009
Chott el Beidha	2008/09	500	12/11/2008
S. Bazer	2009/10	630	26/10/2009
S. El Hamiet	2009/10	Dry	
Chott el Beidha	2009/10	Dry	

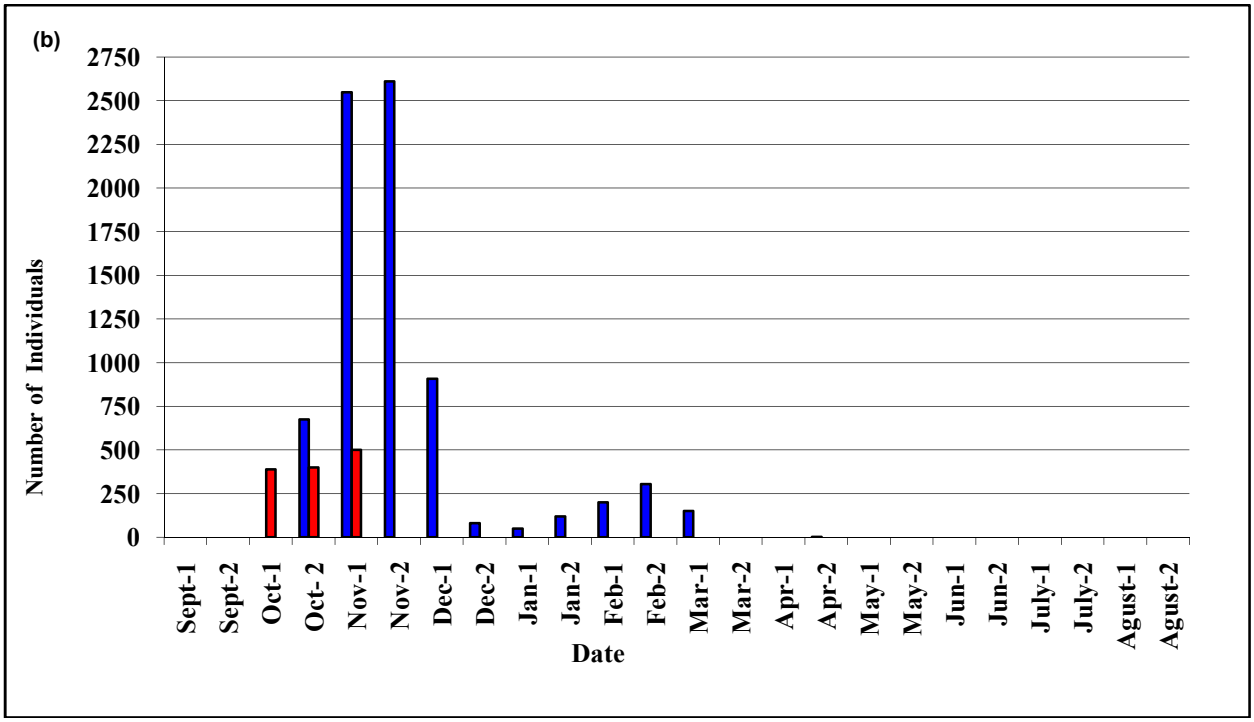


Figure 3 b. Half monthly counts of Northern Shoveler at Chott El Beidha during 2007-2010.

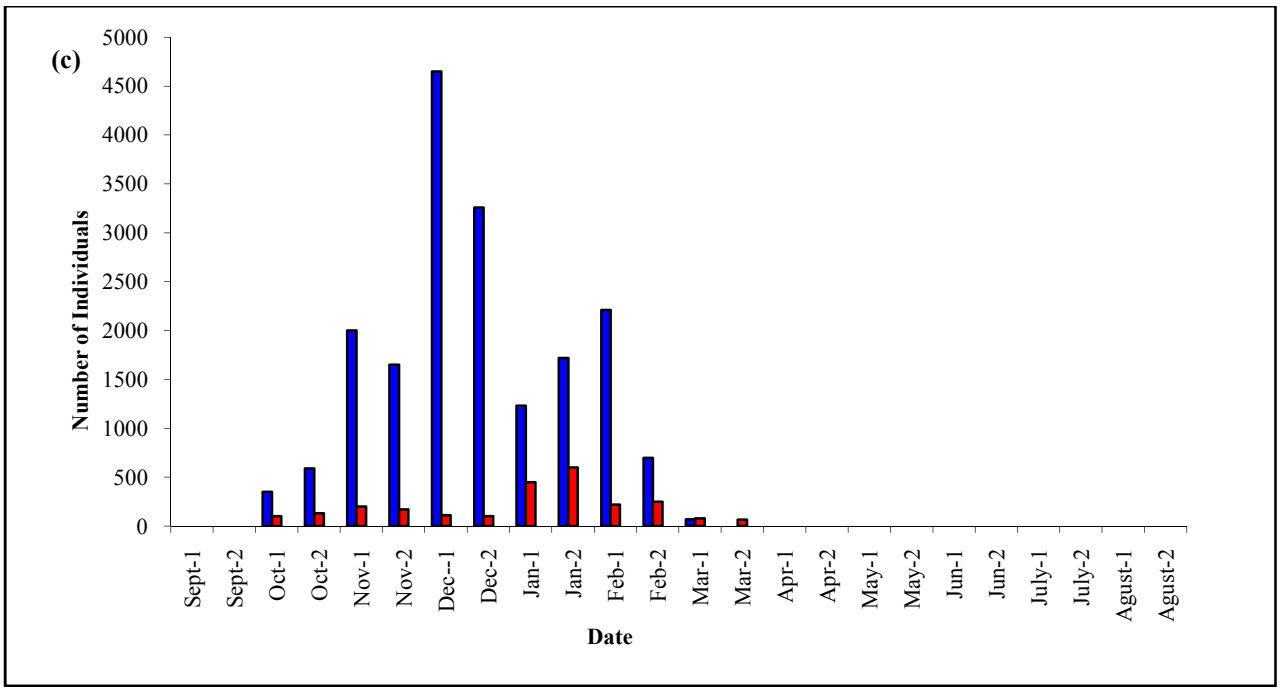


Figure 3 c. Half monthly counts of Northern Shoveler at S.El Hamiet during 2007-2010

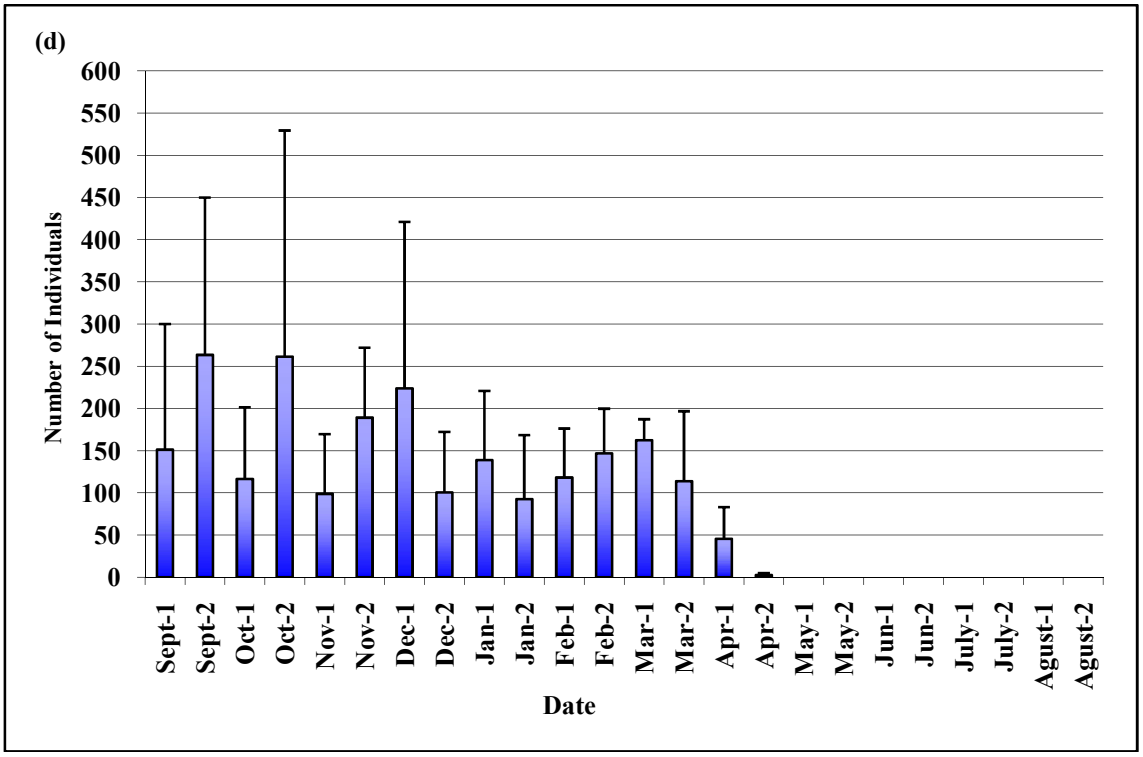


Figure 3 d. Mean counts of Northern Shoveler at S. Bazer during 2007-2010. Vertical lines are standard errors.

Northern Shoveler population during activity time budget at S. Bazer and S. El Hamiet fluctuated and ranged between 38-360 and 59-600 individuals, respectively (Figure 4). Unexpectedly, the whole birds left S. Bazer in the second week of March 2010 to elsewhere which disallow us from carrying on the activity time budget during this period.

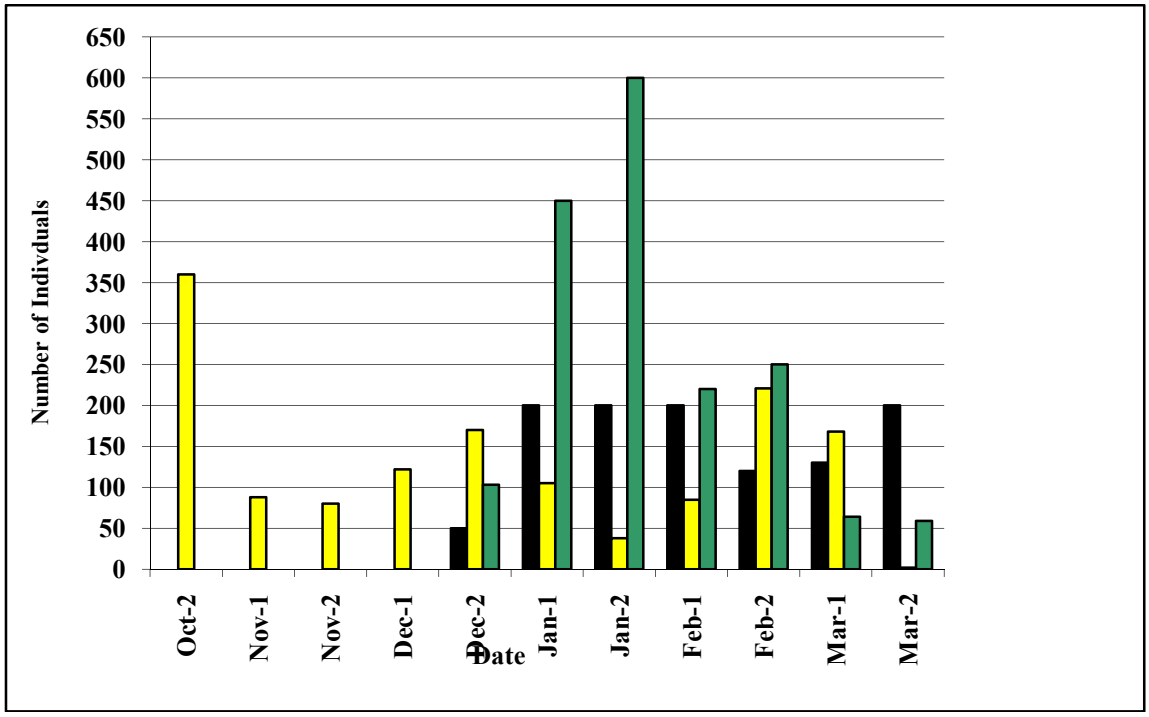


Figure 4. Counts of Northern Shoveler during activity time budget at S. Bazer over winter 2008/09 and 2009/10 and at S. El Hamiet over winter 2008/09.

5.1.1.2. Time Budget

The diurnal activity time budgets recorded for Northern Shoveler throughout the two sites indicate that sleeping was the dominant diurnal activity at S. Bazer where birds devoted almost 1/2 to 3/4 of their mean time spent sleeping (47 % in 2008/09, 68 % in 2009/10). Sleeping was, however, the second diurnal activity at S. El Hamiet with a mean value of ~37% of the time allocated (Table 2, Figure 5 a, b, c).

Table 2. Mean percentage of time spent by Northern Shoveler on different activities at S. Bazer and S. El Hamiet.

Activity (%)	S. Bazer (2008/09)	S. El Hamiet (2008/09)	S. Bazer (2009/10)
Feeding	30,07 (±11,79)	44,59 (±12,93)	17,28 (±10,31)
Swimming	12,86 (± 5,18)	9,68 (± 5,12)	3,40 (±3,87)
Preening	3,75 (± 0,82)	1,86 (± 0,72)	4,49 (±1,21)
Resting	3,14 (±1,73)	5,51 (± 4,23)	4,69 (±2,65)
Sleeping	47,46 (± 9,89)	36,62 (± 13,13)	68,27 (± 10,59)
Flying	0,78 (± 0,90)	1,72 (±1,47)	0,54 (± 0,52)
Agonistic behaviour	0,07 (± 0,08)	0,00	0,06 (±0,09)
Walking	1,87 (± 1,50)	0,02 (± 0,04)	1,19 (±0,59)
Courtship	0,00	0,00	0,08 (±0,14)

Feeding was the second diurnal activity at S. Bazer with differences in mean time allocated to it between years (30% in 2008/09 and 17% in 2009/10; Table 2, Figure 5 a, c). At S. El Hamiet, time devoted to feeding was higher than that recorded at S. Bazer (44%, Table 2, Figure 5 b).

Seasonal changes in mean time apportioned to sleeping showed slight fluctuations paralleled with increases in time spent feeding at S. Bazer with highest mean values of ~64 % in 2008/09 and ~83% in 2009/10 recorded in late December. At S. El Hamiet, a similar highest mean value of ~63% was recorded later (in early February as opposed to late December). However, time spent sleeping declined sharply in late January 2008/09 coinciding with high wind during field work and an increase in feeding activity (Figure 5 a, b, c).

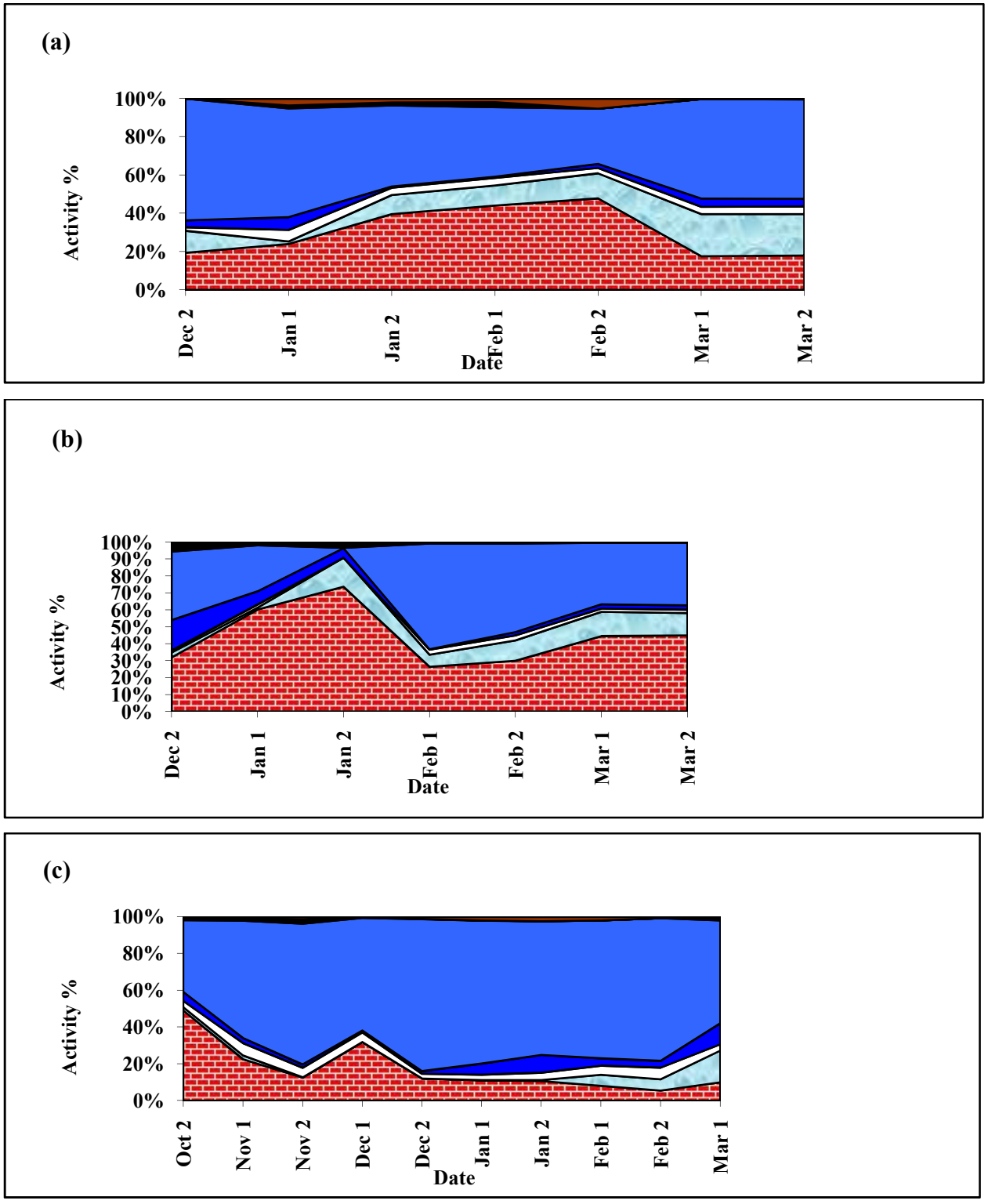


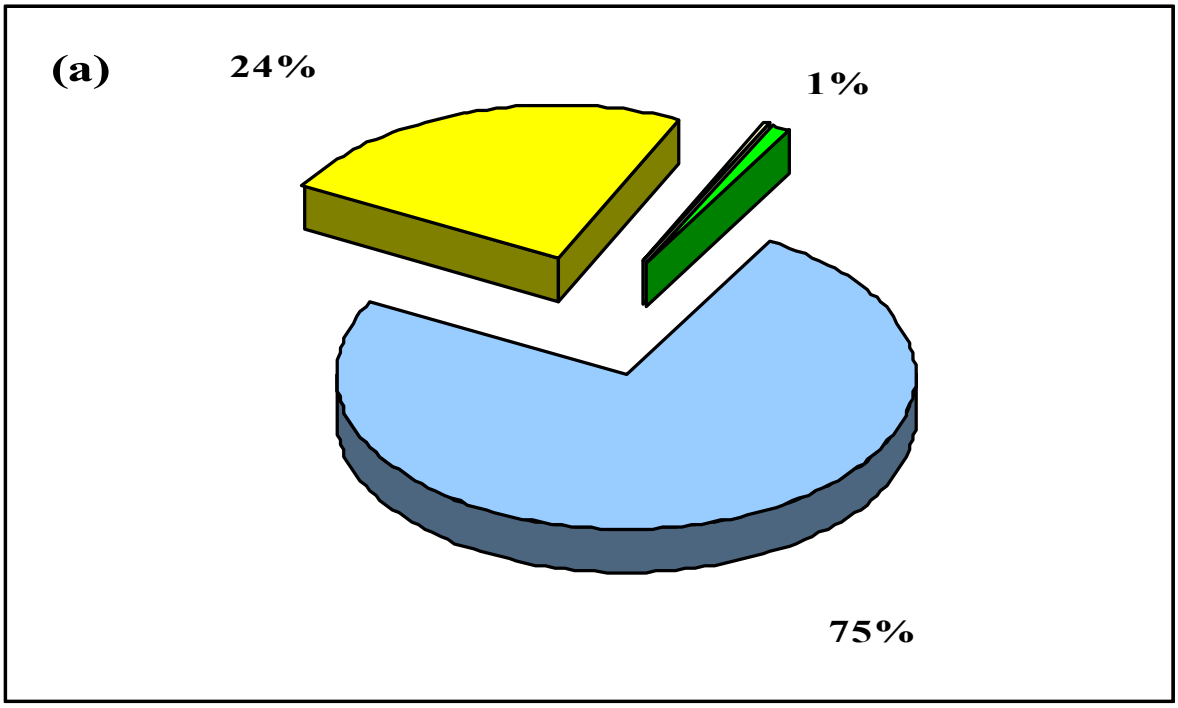
Figure 5. Mean Percentage of time spent by Northern Shoveler on different activities at (a) S. Bazer (2008/09), (b) S. El Hamiet (2008/09) and (c) S. Bazer (2009/10).

The seasonal changes in diurnal time spent feeding at S. Bazer exhibited different pattern between years with similar high mean values of~ 48% during late winter 2008/09 and early winter 2009/10. Two marked declines in time allocated to feeding were recorded, the first in early spring with a mean value of~18% (March 2009) when birds devoted more time to sleeping and the second in late mid winter to early spring (2009/10) with a mean value of less than 12% which was paralleled with an increase in sleeping and resting activity of Northern Shoveler (Figure 5a,c).The second decline coincided with a cold weather and very low rainfall that led to a dramatic drop in water level. At S. El Hamiet, the seasonal changes in diurnal time spent feeding over winter 2008/09 exhibited a similar pattern to that revealed at S. Bazer over the same period with a high mean value of ~74%. A decline of ~ 28% of diurnal time was recorded earlier (February as opposed to March at S. Bazer) which corresponded with a period of wintry weather when birds devoted more time to sleeping (Figure 5 b).

Feeding, as the second major activity, was accomplished in three ways: surface feeding, the principal method, dabbling, and to a lesser extent grazing. Surface feeding dominated other feeding methods during the year 2008/09 with different high mean values of 75% at S. Bazer compared to a mean value of 93 % at S. El Hamiet.
Mean percentage time allocated by Northern Shoveler to dabbling in shallow waters and on the shores at both sites differed between sites and years with a mean value of 24% (2008/09) that raised to 61% (2009/10) at S. Bazer compared to only 6% (2008/09) at S. El Hamiet (Figure 6 a, c, e).

Seasonal alterations in foraging strategies used by Northern Shoveler reflect fluctuations in water levels. Surface feeding, and to lesser extent dabbling, was used in a similar pattern, with fewer fluctuations in late winter, during the course of winter

2008/09 at both sites. As water retreated over 2009/10, Surface feeding use decreased sharply from a mean value of ~35% during early winter to only ~2% in mid winter when birds switched gradually to dabbling method with a high mean value of ~ 28%.



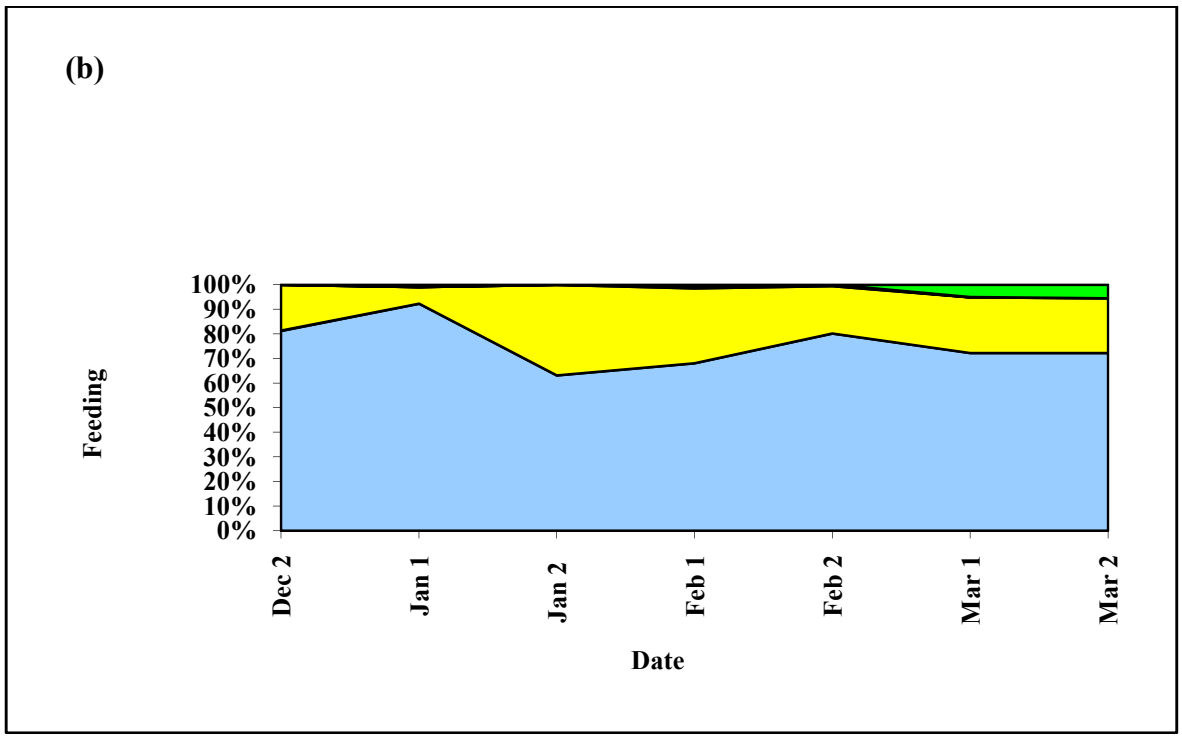


Figure 6 a, b. (a) Mean percentage of time allocated to three distinct ways of feeding by Northern Shoveler at S. Bazer over winter 2008/09.
(b) Seasonal evolution of different feeding types used by Northern Shoveler at S. Bazer over winter 2008/09.

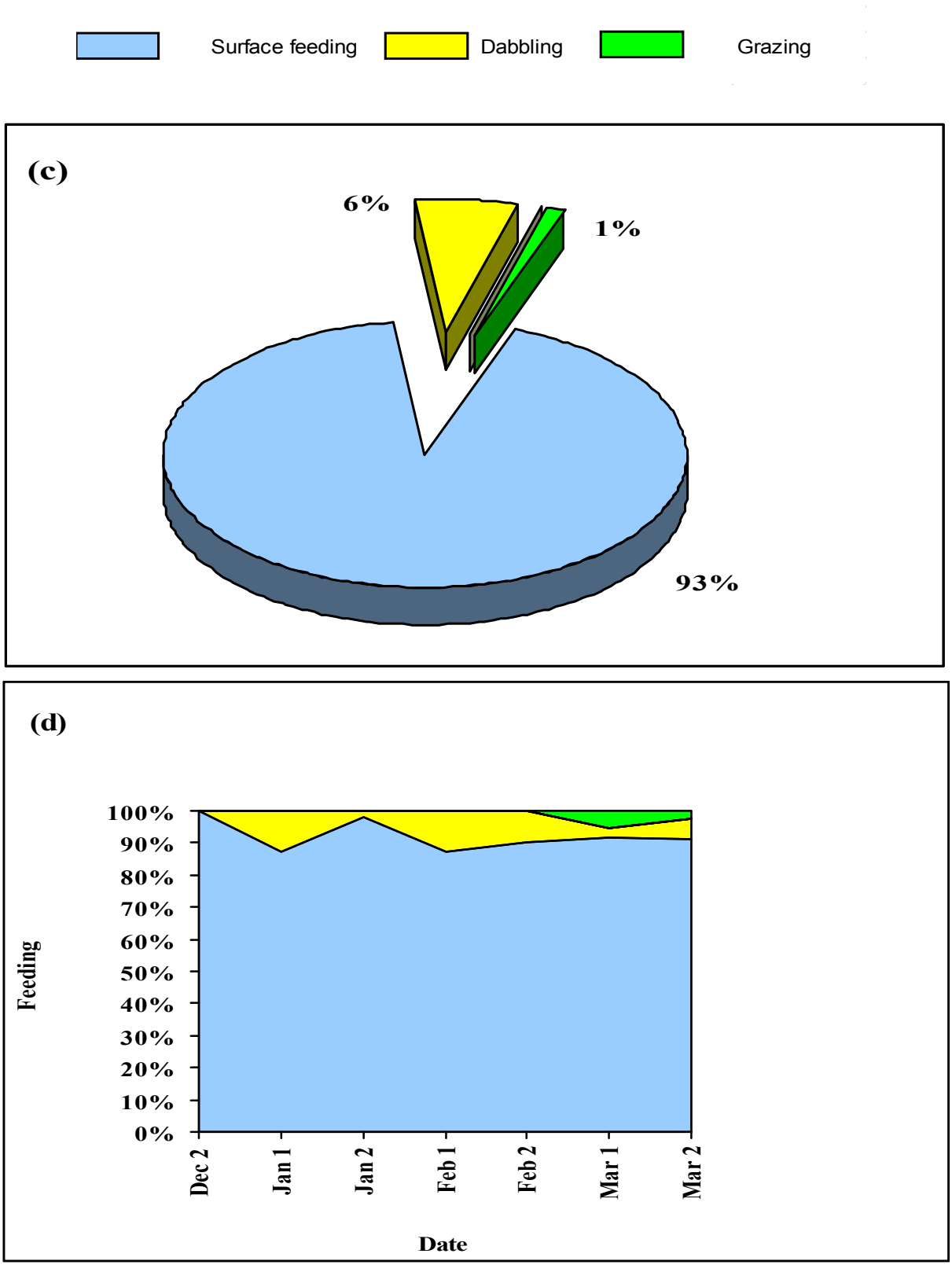


Figure 6 c, d. (c) Mean percentage of time allocated to three distinct ways of feeding by Northern Shoveler at S. El Hamiet over winter 2008/09.
(d) Seasonal evolution of different feeding types used by Northern Shoveler at S. El Hamiet over winter 2008/09.

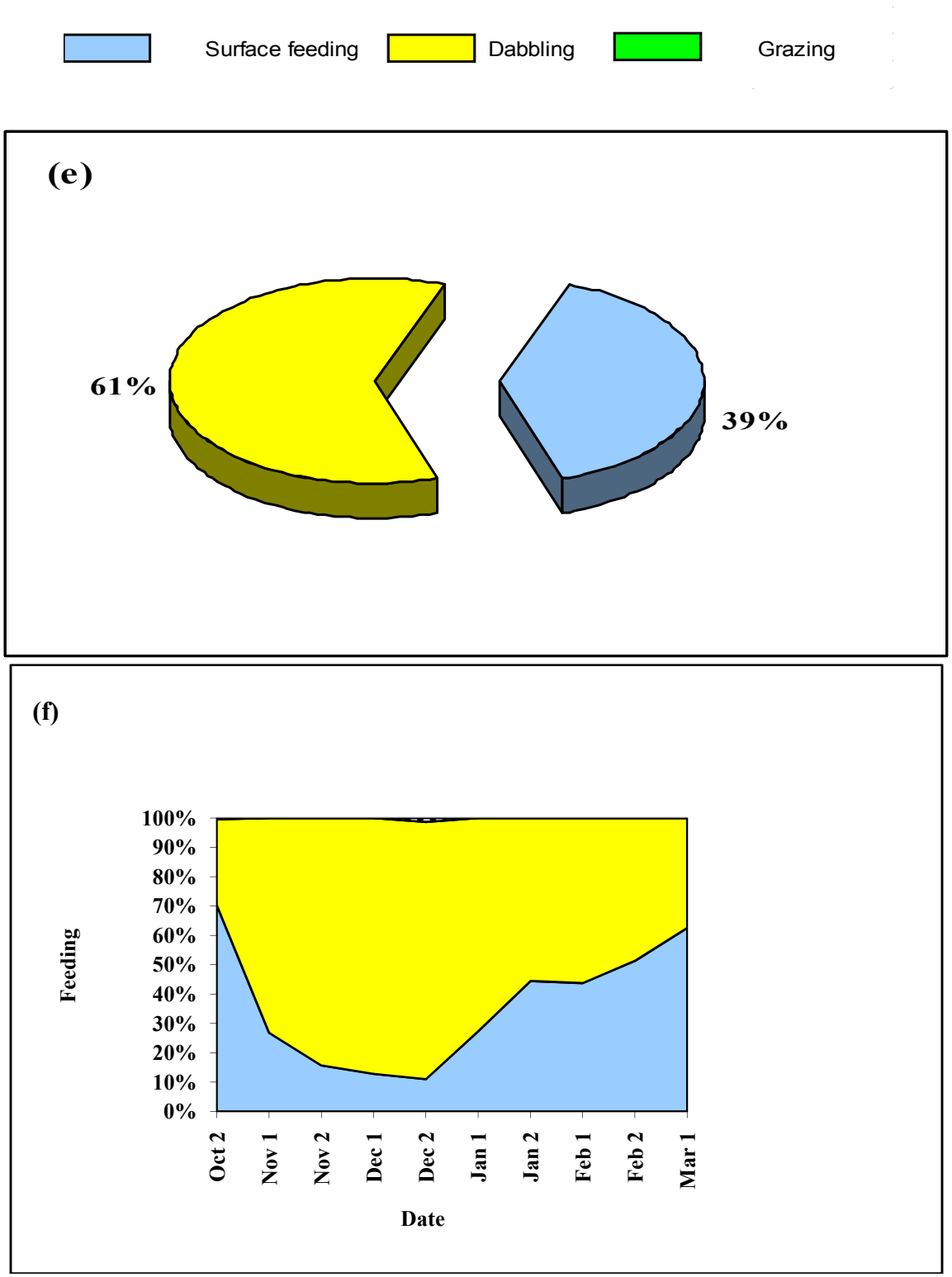
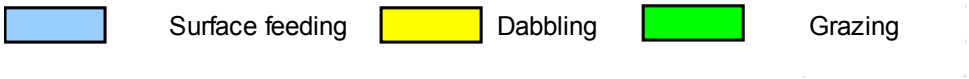


Figure 6 e, f. (e) Mean percentage of time allocated to three distinct ways of feeding by Northern Shoveler at S. Bazer over winter 2009/2010.
(f) Seasonal evolution of different feeding types used by Northern Shoveler at S. Bazer over winter 2009/2010.



From late winter, both foraging strategies were used interchangeably corresponding with rain spells within that period (Figure 6 b, d, f). Grazing method started to be used mainly within early spring with a mean value of less than 3 % (2008/09) at both sites.

Mean time spent swimming showed similarities between sites and differences between years where a mean value of less than 13% was recorded in 2008/09 at both sites; whereas, only ~4% was recorded at S. Bazer in 2009/10 (Table2). Swimming behaviour was displayed almost all over winter season 2008/09 at both sites, but only on early spring 2009/10 at S. Bazer. The highest values were recorded between January and March (Figure 5 a, b, c).

Northern Shoveler spent a much smaller proportion of their diurnal time resting (less than 6 %; Table 2). The highest values were recorded in January 2008/09 and March 2009/10 at S. Bazer, and in December 2008/09 at S. El Hamiet (Figure 5 a, b, c).

Preening as a comfort activity had a quite low mean time spent (less than 5%, Table 2) at both sites during 2008/09 and 2009/10. The values recorded at S. Bazer were higher by at least two times than that recorded at S. El Hamiet. Seasonal alterations showed quite similar patterns between the two sites with highest values recorded in late winter in 2008/09 and in mid winter in 2009/10 (Figure 5 a, b, c).

Flying was observed rarely (< 2%) over the wintering seasons and was watched only after a disturbance caused by herders, dogs or by aerial predators usually Marsh Buzzard *Circus aeruginosus* on few occasions. However, presence of the latter was common at S. Bazer rather at S. El Hamiet (Table 2; Figure 5 a, b, c).

Walking as one way of locomotion on the shores, Northern Shoveler displayed walking behaviour with a minor mean time spent (< 2%) merely at S. Bazer where the highest values (5% in 2008/09 and 2% in 2009/10) were recorded in late winter (Table 2; Figure 5 a, b, c). This coincided with the start of emerging vegetations on the shores that were used mainly for resting. At S. El Hamiet, walking was rarely observed.

Agonistic behaviour was observed rarely either interspecies or intraspecies (often with other Anatidae). As the species is not known to breed in North Africa but only a wintering waterbird; Courtship, unfortunately, could not be assessed clearly during the day hours of our observation at both sites where sleeping couples were accounted only for sleeping behaviour (Table 2). Nevertheless, few formed couples were observed during late winter at S. Bazer in 2009/10.

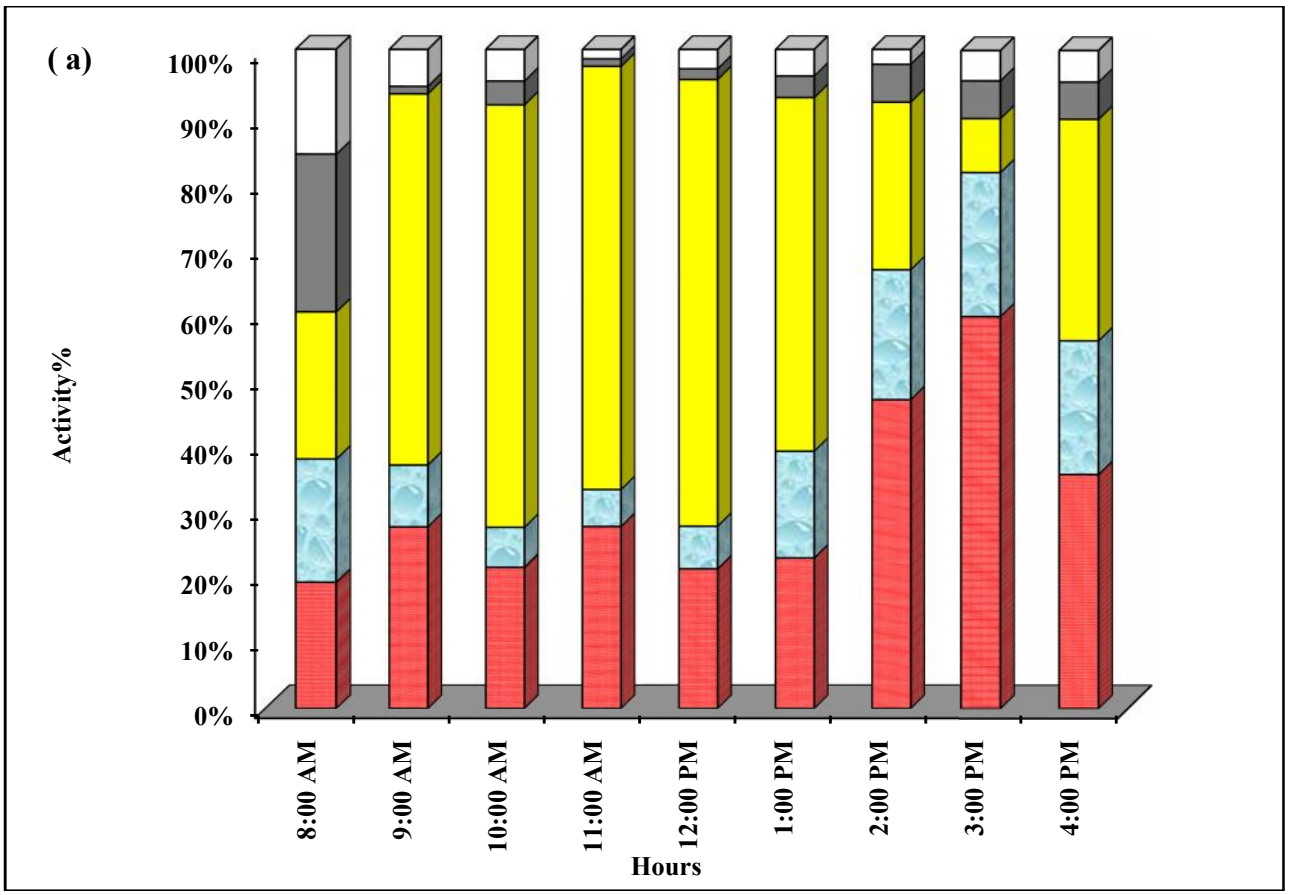
Diurnal mean percentage time within eight hours observation on Shoveler behaviour devoted to feeding showed highest values (57% in 2008/09; 39 % in 2009/10 at S. Bazer and 76% at S. El Hamiet in 2008/09) were recorded at 3:00 PM, 4:00PM, and 2:00 PM, respectively. The diurnal pattern showed an increase in feeding within edge hours of winter observation (8:00 AM and 4:00PM) at S. Bazer (in 2009/10) and at S. El Hamiet (in 2008/09); however, this pattern was partially altered at S. Bazer over winter 2008/09 where feeding rate increases were higher in afternoon (Figure 7 a, b, c).

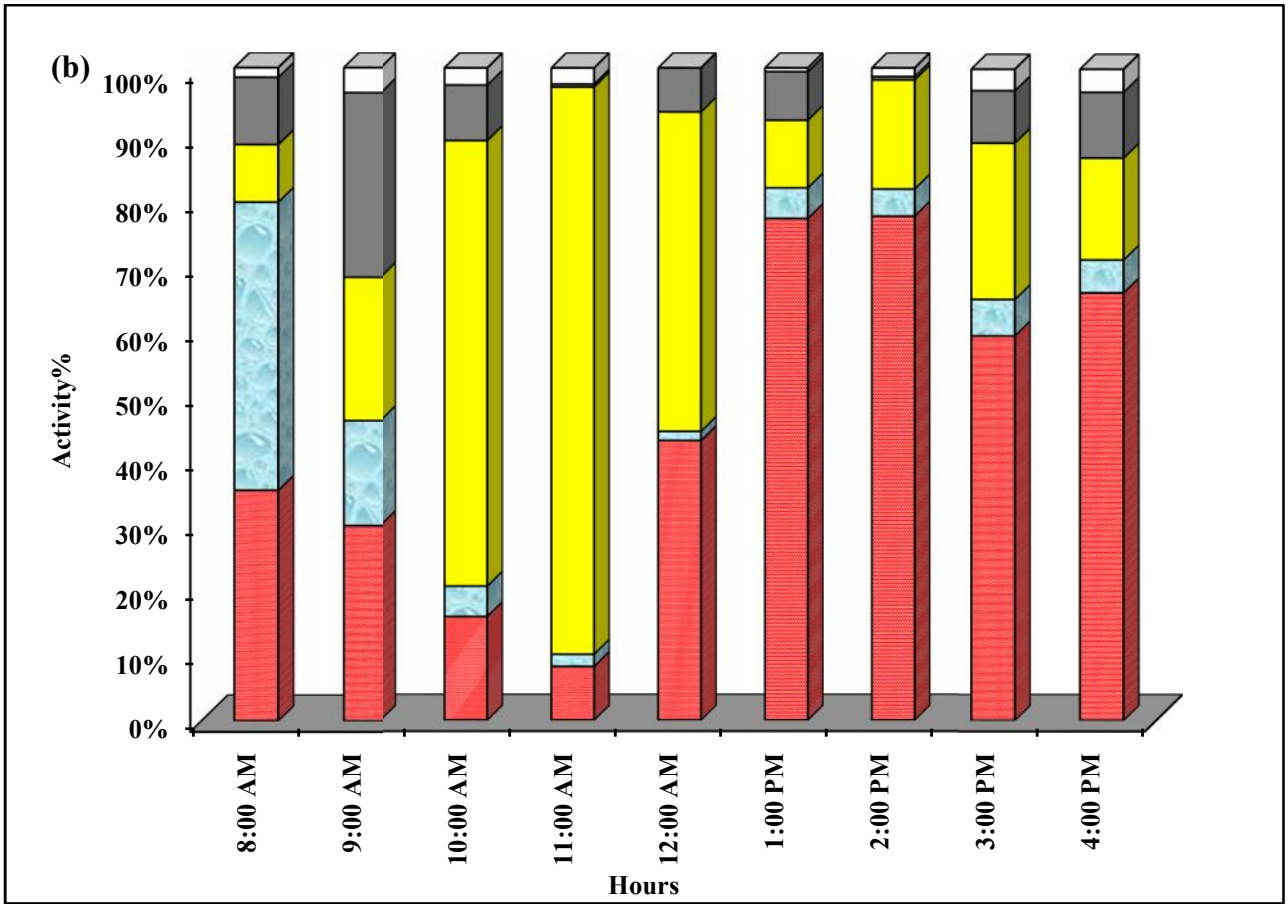
Diurnal behaviour for Sleeping displayed highest values (66% in 2008/09, 90% in 2009/10 at S. Bazer and 86% at S. El Hamiet in 2008/09) recorded at mid day (between 11:00 AM and 12:00 AM). The decline in mean percentage time allocated to sleeping was, however, paralleled by opposite increases in feeding activity of the species (Figure 7 a, b, c).

Moreover, the highest values of mean percentage time devoted to resting were quite similar at both sites within the year 2008/09 (ranged between 20 % and 27%), but in 2009/10 the highest recorded value was only 11 % at S. Bazer. The resting behaviour was exhibited throughout daylight observation (Figure 7 a, b, c).

In addition, swimming activity was displayed within the eight hours observation with highest values recorded at different part of the day at S. Bazer (21% at 3:00 PM

in 2008/09 and 7% at 9:00 AM in 2009/10). At S. El Hamiet, the highest value (44% in 2008/09) was recorded at 8:00 AM. The diurnal pattern for swimming exhibited an elevation in early morning followed by a decline in mid day, as paralleled with an increase in sleeping, then after another increase in swimming follows at S. Bazer during




(b)
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
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Activity%
8:00 AM
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1:00 PM
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Hours

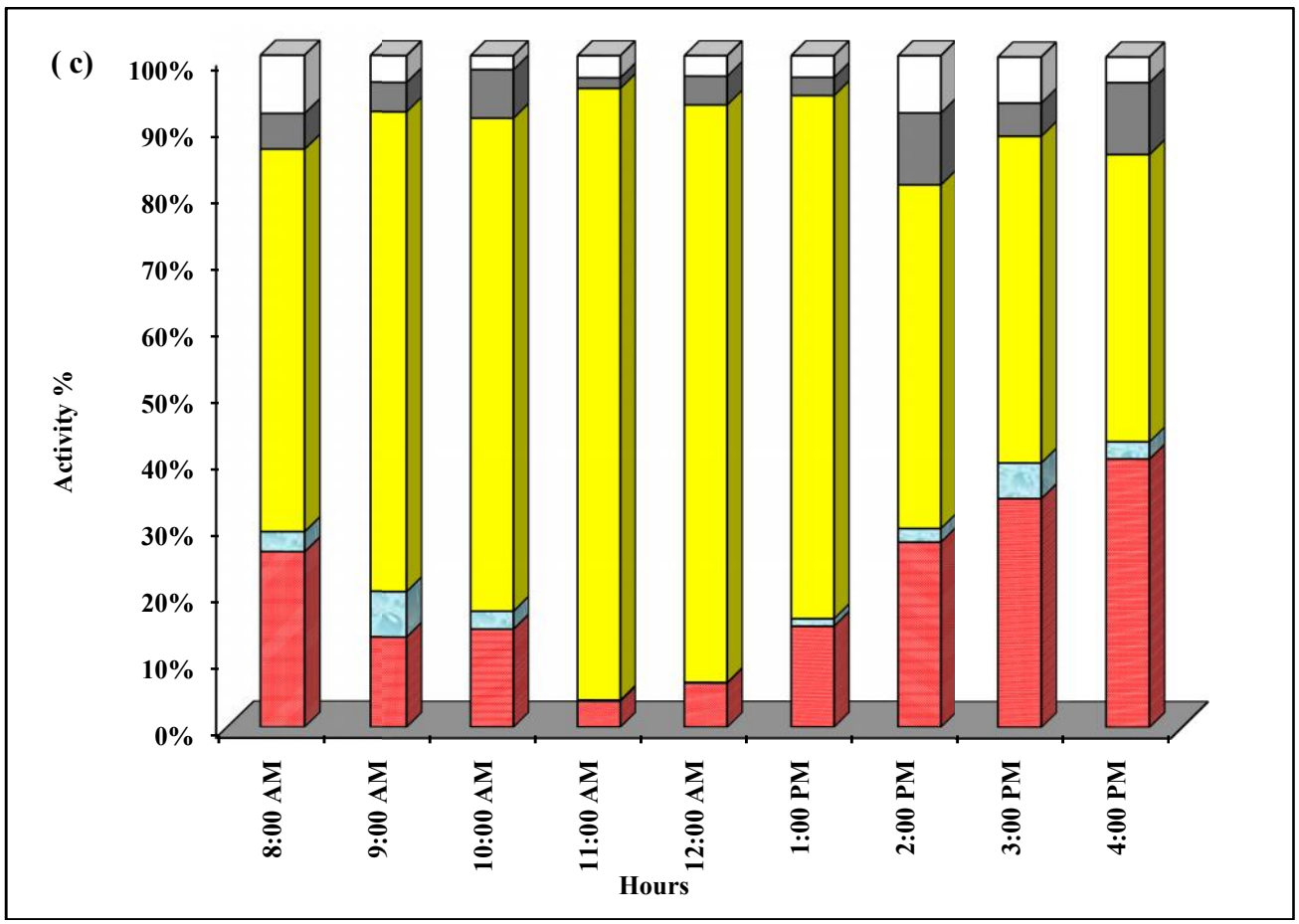


Figure 7. Mean percentage time spent feeding, swimming, sleeping, resting and preening expressed in hours by Northern Shoveler over winter season at (a) S. Bazer during 2008/09, (b) at S. El Hamiet during 2008/09 and (c) at S. Bazer during 2009/10.

afternoon. At S. El Hamiet, the mid day decline remained, however, for the whole afternoon (Figure 7 a, b, c).

Preening as a comfort behaviour recorded within the eight hours observation showed to be used all over the daylight hours with highest values that did not exceed 14% at both sites in two year study (Figure 7 a, b, c).

Hourly mean percentage time allocated by birds to different feeding strategies showed that surface feeding was the preferably utilized foraging method followed by dabbling. Both strategies were used interchangeably during daylight observation hours at both sites within winter 2008/09 with few fluctuations in diurnal pattern recorded at

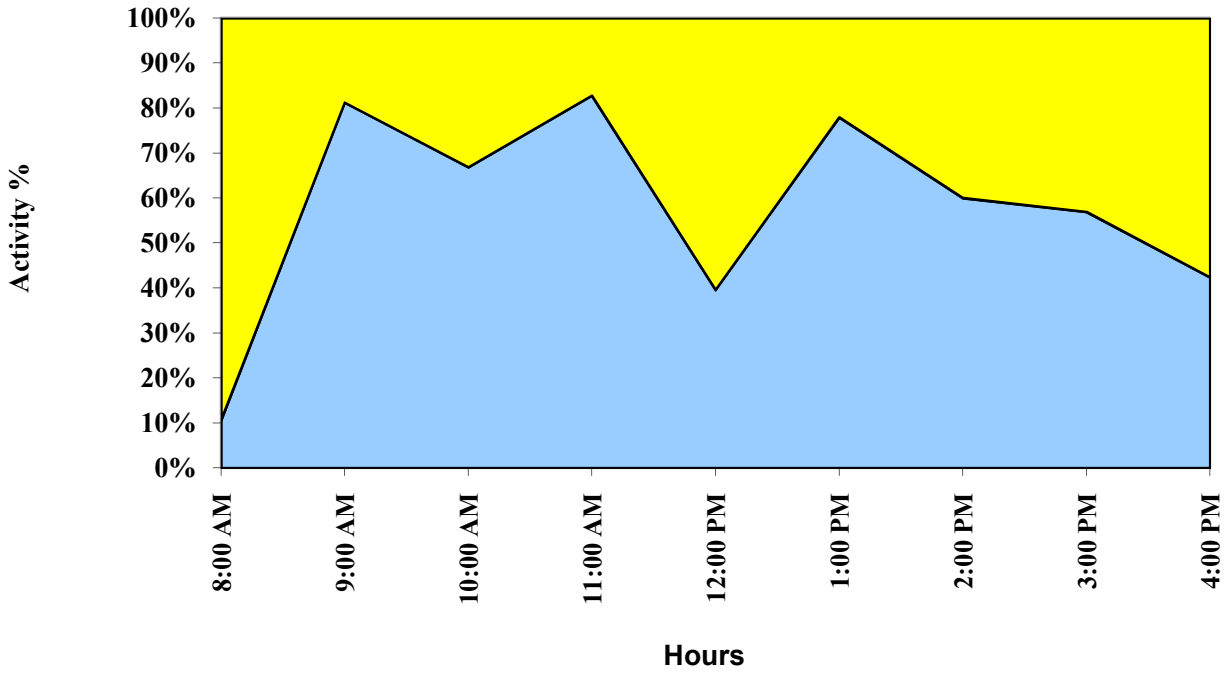
S. Bazer. A sequencing in dominance of foraging methods showed the prevalence of surface feeding in the morning up to a value of 95% at 10:00 AM followed by dabbling strategy from 11:00 AM with a value of 76% to late afternoon in 2009/10 at S. Bazer (Figure 8 a, b, c).

Comparison of average time allocated to different activities within eight hours of day observations shows that the two main activities which are feeding and sleeping were quite similar between sites and different between years (Table 3).

Table 3. Mean time devoted (Td) by Northern Shoveler to different activities during eight hours daylight observation at study sites over winter season 2008/09 and 2009/10.

Activity	**S. Bazer 2008/ 09 Td(hr)/ 8hrs**	**S. Bazer 2009/ 10 Td(hr)/ 8hrs**	**S. El Hamiet 2008/ 09 Td(hr)/ 8hrs**
Feeding	2,41	1,38	3,57
Swimming	1,03	0,27	0,77
Preening	0,30	0,36	0,15
Resting	0,25	0,38	0,44
Sleeping	3,80	5,46	2,93
Flying	0,06	0,04	0,14
Agonistic behaviour	0,01	0,00	0,00
Walking	0,15	0,10	0,00
Courtship	0,00	0,01	0,00

(a)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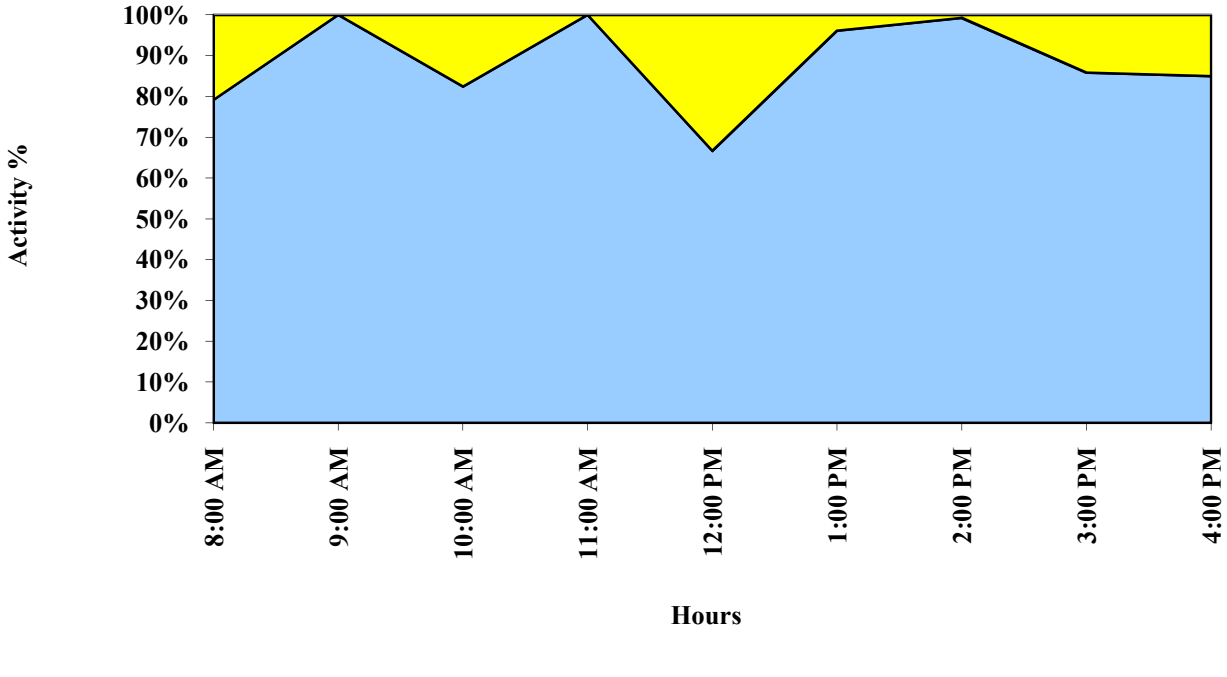
(b)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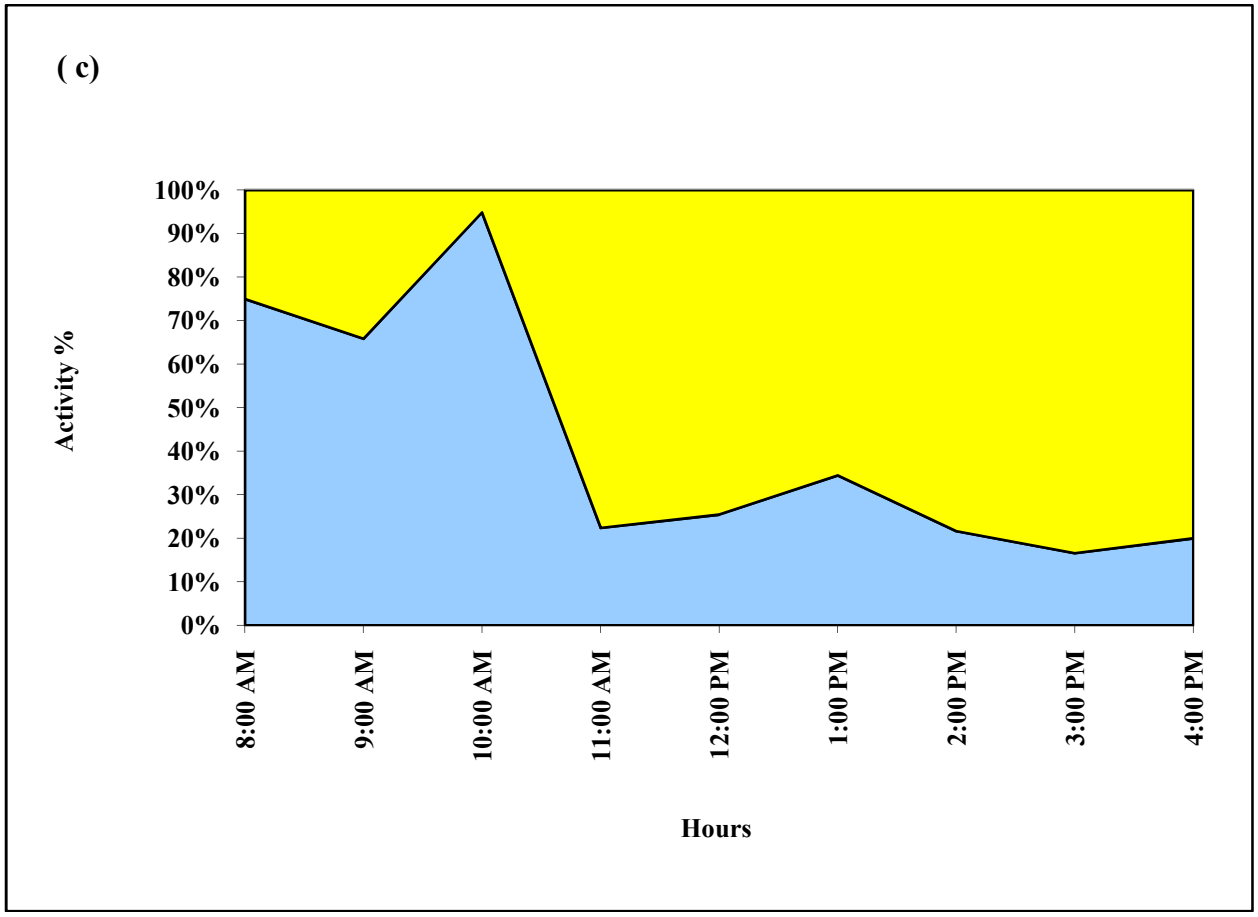
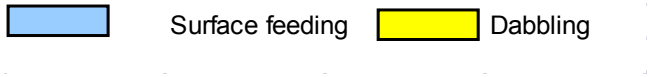


Figure 8. Diurnal evolution of surface feeding and dabbling strategy used by Northern Shoveler at (a) S. Bazer over winter season 2008/09, (b) S. El Hamiet over winter season 2008/09 and (c) at S. Bazer over winter season 2009/10.



5.1.2. Mallard

5.1.2.1. Mallard status

The three year survey revealed that El Eulma wetlands complex shelter Mallard *Anas platyrhynchos* during winter and breeding season. Sebkhet Bazer showed to be the most frequented site by Mallard where it begins to occupy the site in the first week of September where the mean records increases gradually to reach a maximum in late October (mean value > 700) (Figure 9a) which coincided with new arrival of waterbirds at the site, then after a gradual decline occurs in mid winter (November–December) where the waterbirds might have moved elsewhere. A partial recovery in mean numbers occurs in n late winter. However, the population remains fairly stable within spring time at mean values that range between 200-300 individuals. This corresponds with breeding season of the Mallard. The latter remains all over the breeding season at the site until late June where few (<20) individuals were present (Figure 9a).

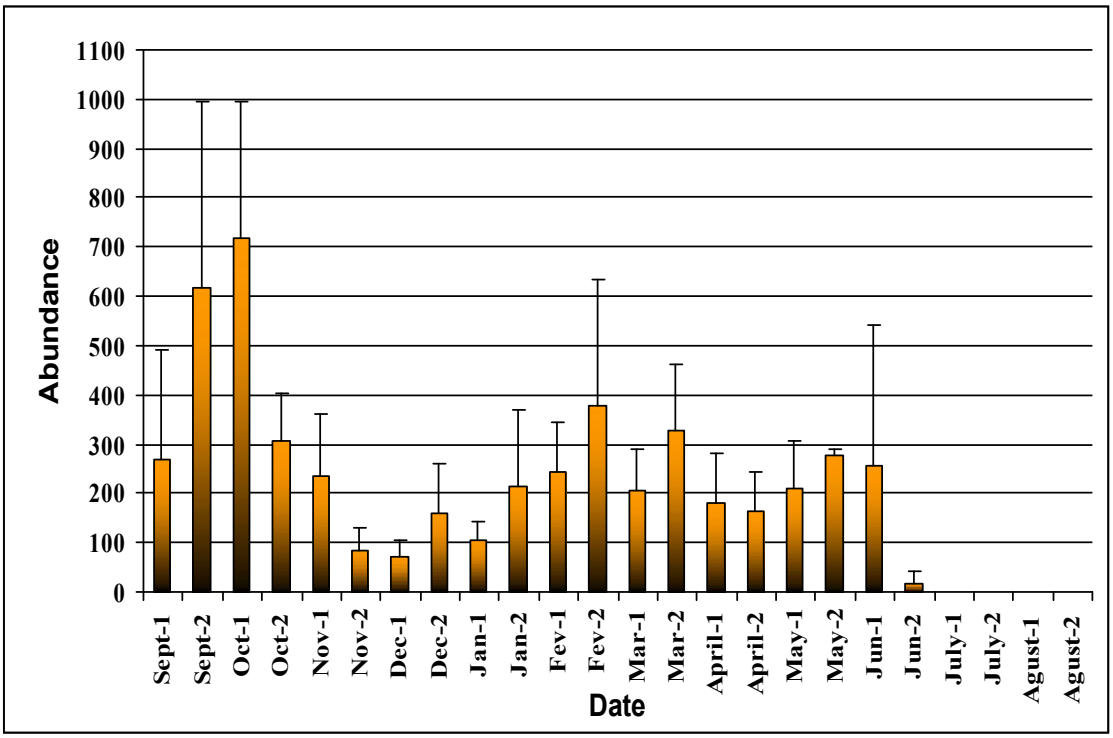


Figure 9 a. Half monthly mean counts of Mallard at S. Bazer for three year periods: 2007-2010. Vertical lines are standard errors.

As opposed to the regular presence of Mallard at S. Bazer permanently fed by O. El Mellah, S. El Hamiet and Chott Beidha exhibited, sharp fluctuations and a decline in numbers with different maximal winter counts recorded in early and late November 2007 at Chott El Beidha and S. El Hamiet, respectively (Table 4). Due to low rain falls during the years 2008-2010, both site dried out which led to a long-term abandonment by waterbirds to elsewhere. Then after waterbirds were counted only twice during September/October at Chott El Beidha where the number ranged between 300-500, which corresponds usually with arrival time of wintering waterfowl at study sites (Figure 9 b, c).

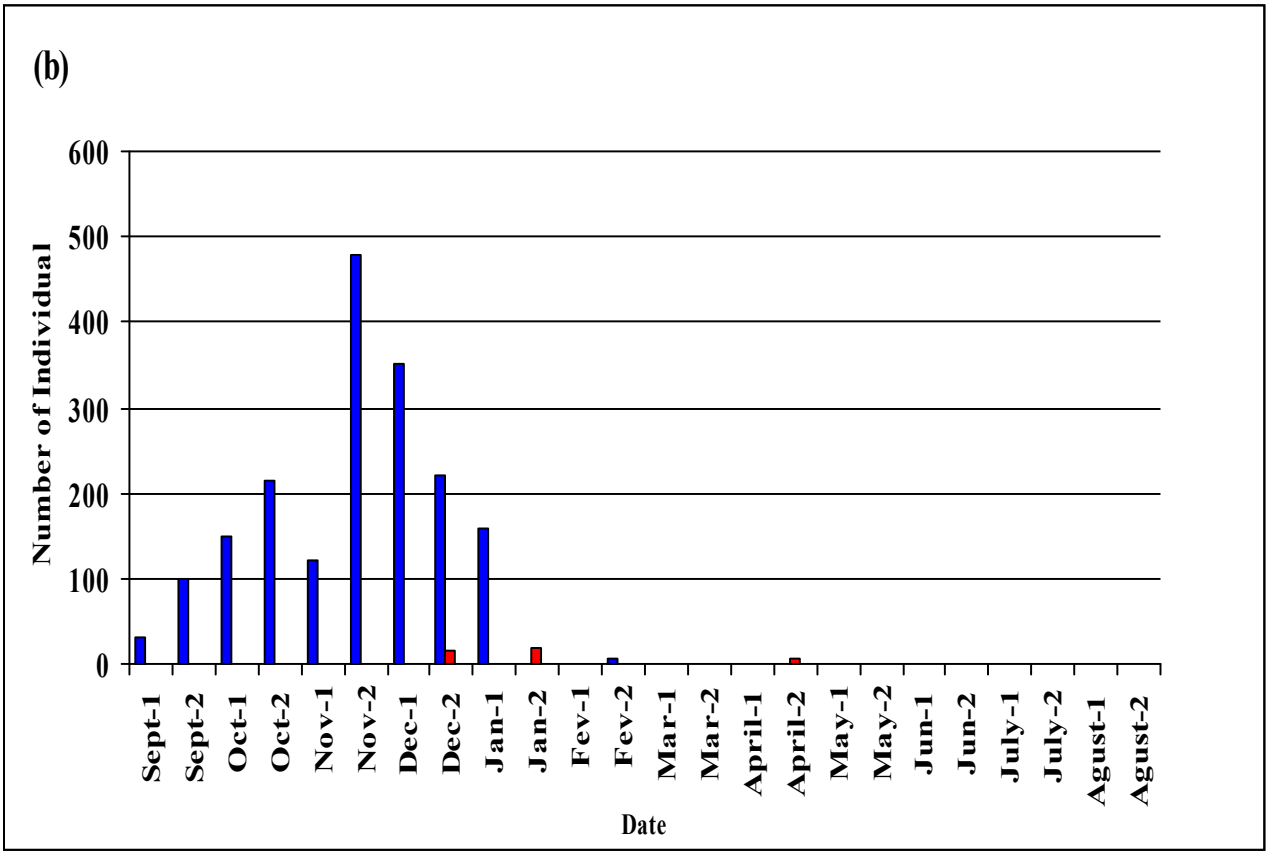


Figure 9 b. Half monthly counts of Mallard at S. El Hamiet during the year 2007-2010.

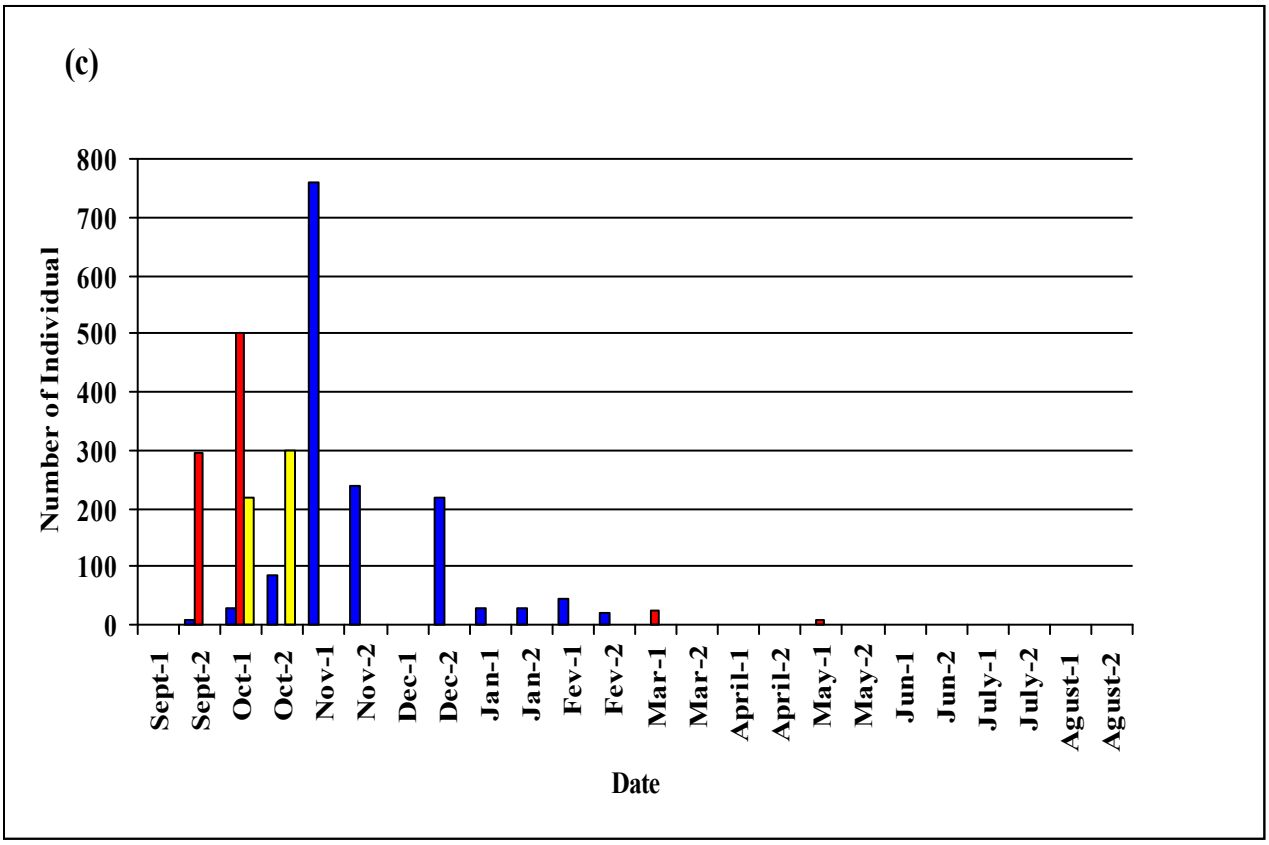


Figure 9 c. Half monthly counts of Mallard at Chott El Beidha during the year 2007-2010.

The maximal counts recorded within 2007-2010 were quite similar in numbers and in date of sampling at S. Bazer which reflects the carrying capacity of the site that is not far from Oued El Mellah that is another near habitat (2Km) known for sheltering many waterfowls; whereas, it declined by 24-160 times over the 2007-2010 at S. El Hamiet; and 1.5- 2.5 over the same period at Chott El Beidha (Table 4).

Table 4. Maximum counts of Mallard in each main site (M. C. S) with date of sampling at El Eulma wetlands complex.

Site	Winter	M.C.S	Date of M.C.S
Sebkhet Bazer	2007-2008	800	03/10/2007
	2008-2009	802	26/09/2008
	2009-2010	1050	03/10/2009
Sebkhet El Hamiet	2007-2008	479	22/11/2007
	2008-2009	20	31/01/2009
	2009-2010	3	03/10/2009
Chott el Beidha	2007-2008	758	07/11/2007
	2008-2009	500	09/10/2008
	2009-2010	300	27/10/2009

Mallard population during activity time budget at S. Bazer fluctuated and ranged between 32-400 individuals (Figure 9 d). The lowest number were recorded in late November (32 individuals) while the progressive increase in numbers in March corresponds with approaching breeding season.

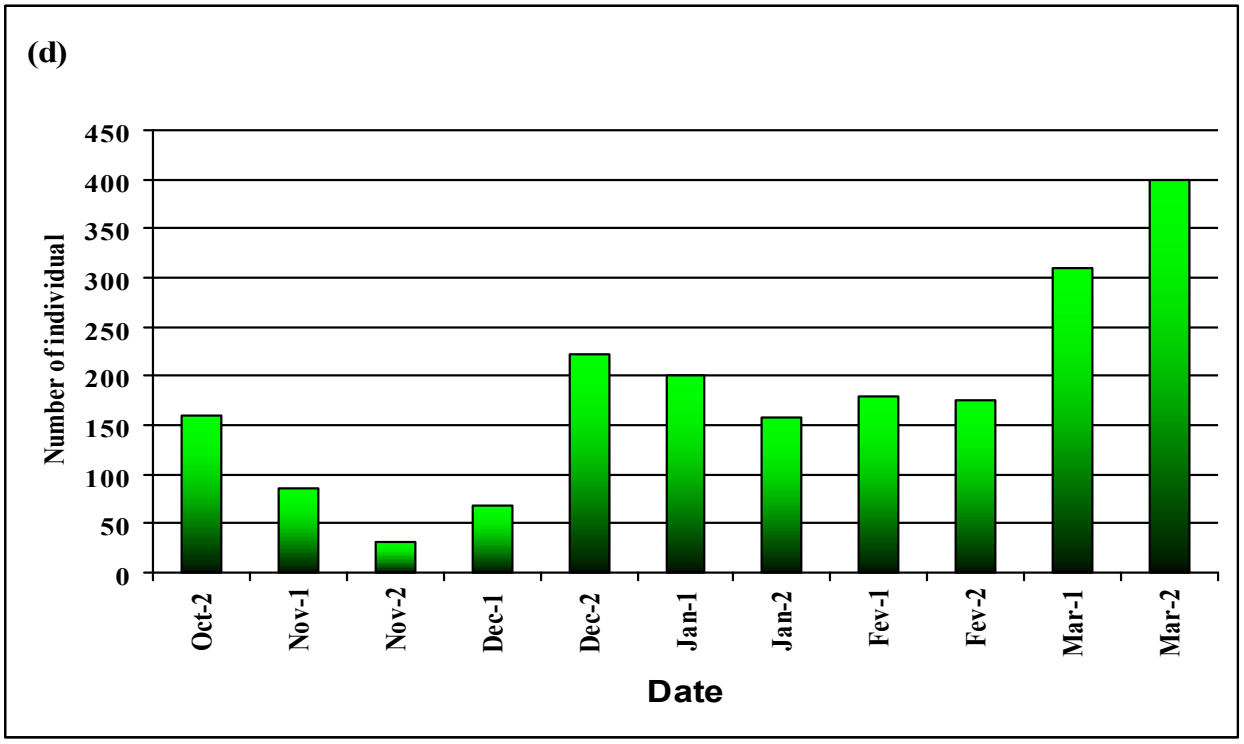


Figure 9 d. Counts of Mallard within diurnal activity time budget over winter season 2009/2010.

5.1.2.2. Mallard activity Time Budget

The diurnal activity time budgets recorded for Mallard within S. Bazer indicate that sleeping was the dominant diurnal activity where birds devote more than 4/5 (85.18%) of their mean time spent sleeping (Figure 10).

Mallard allocated less than 5 % on comfort activities where the mean percentage time devoted to resting, swimming and preening was 4.23%, 4.21% and only 1.33%, respectively. As the waterbird is nocturnal, the mean time spent feeding was only 3.19% (Figure 10). Locomotion was scarce (1.03%) and used only when waterbird moves on the shores. As the study site was rarely subjected to human disturbance or to other possible predator such as dogs, flying exhibited a mean percentage time less than 1%. Courtship, loafing and agonistic behaviours were rarely observed during our diurnal survey and had less than 1% of the mean time allocated diurnally (Figure 10).

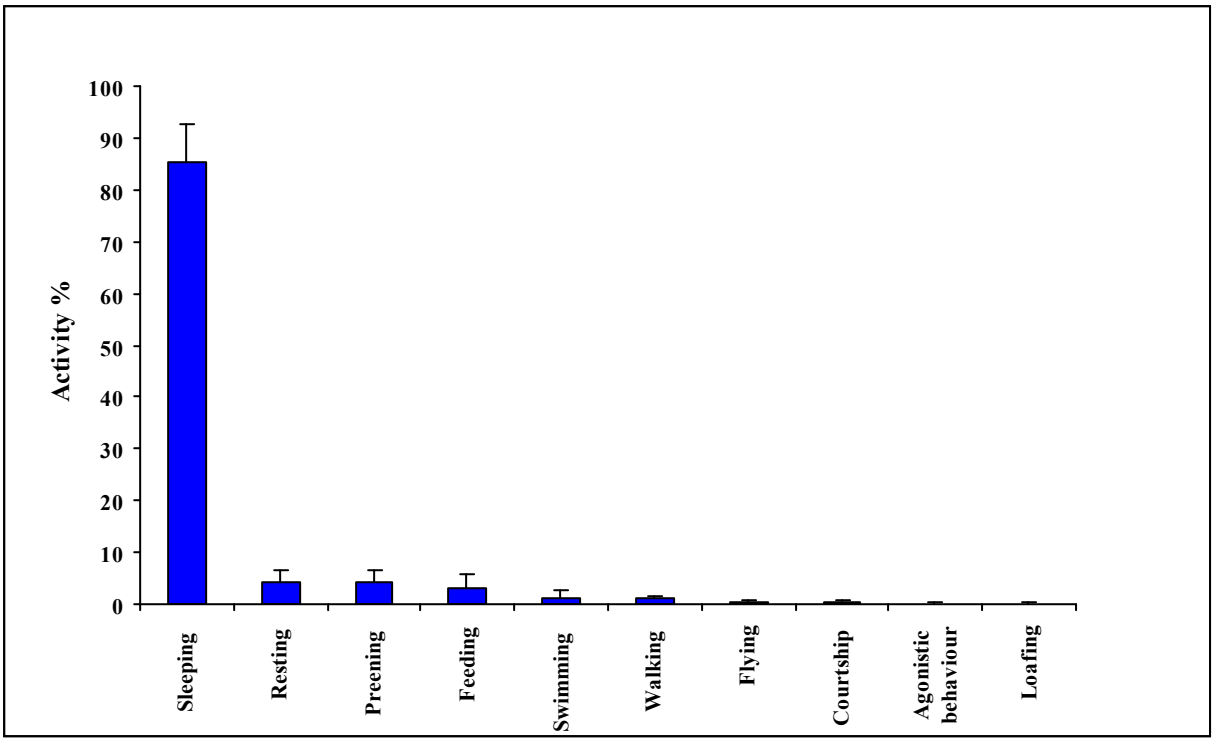


Figure 10. Mean percentage of time spent on different diurnal activities by Mallard at S. Bazer during winter season 2009/2010.

Seasonal changes in mean time apportioned to sleeping showed minor fluctuations paralleled with increase in time spent feeding on early winter with mean percentage time value of ~ 82% which coincided with waterbirds arrival at site .The highest value for sleeping was recorded in mid winter (early December, 94.85%) and the lowest value was recorded in early spring (late March, ~ 71%) that corresponds with breeding season start (Figure 11).

The seasonal changes in diurnal time spent feeding at S. Bazer exhibited a slight elevation in early winter with a value of 6%, then after feeding behaviour declined sharply within mid winter where the lowest values (0%) were recorded in late November and early December when birds allocated more time to sleeping. Not until early spring where the Mallard showed a restoration in diurnal feeding activity with values above 7% (Figure 11).

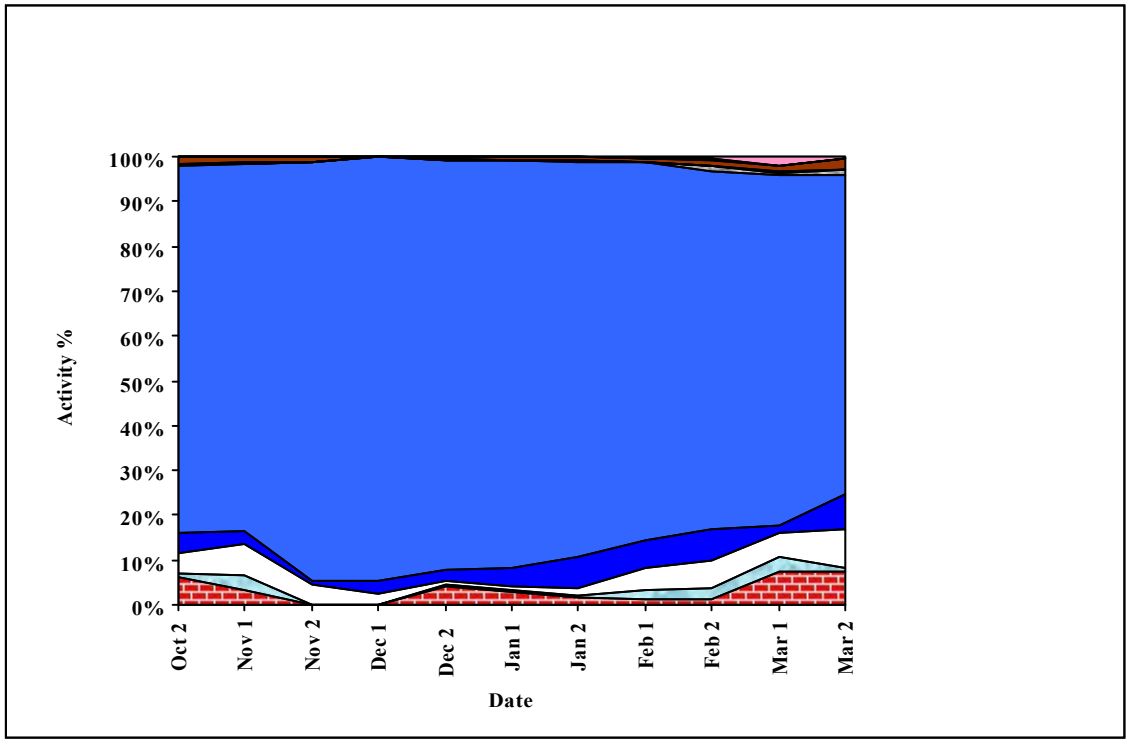


Figure 11. Seasonal evolution in mean percentage time spent in different diurnal activities by Mallard at S. Bazer during winter season 2009/2010.

Feeding, as the second major activity, was accomplished in three ways: dabbling, the principal foraging method, surface feeding, and to a lesser extent grazing. Dabbling dominated other feeding methods by more than two times with a high value representing 59% compared to surface feeding in shallow waters that had a value 24% and grazing on the shores with a value of 17% as another alternative foraging method used by Mallard (Figure 12). Mallard as granivorous duck was seen in cereal field foraging in early winter, sowing period, and in late winter early spring. Upending as another feeding strategy used commonly for feeding in deep water was not observed due to the lack of depth during the study period.

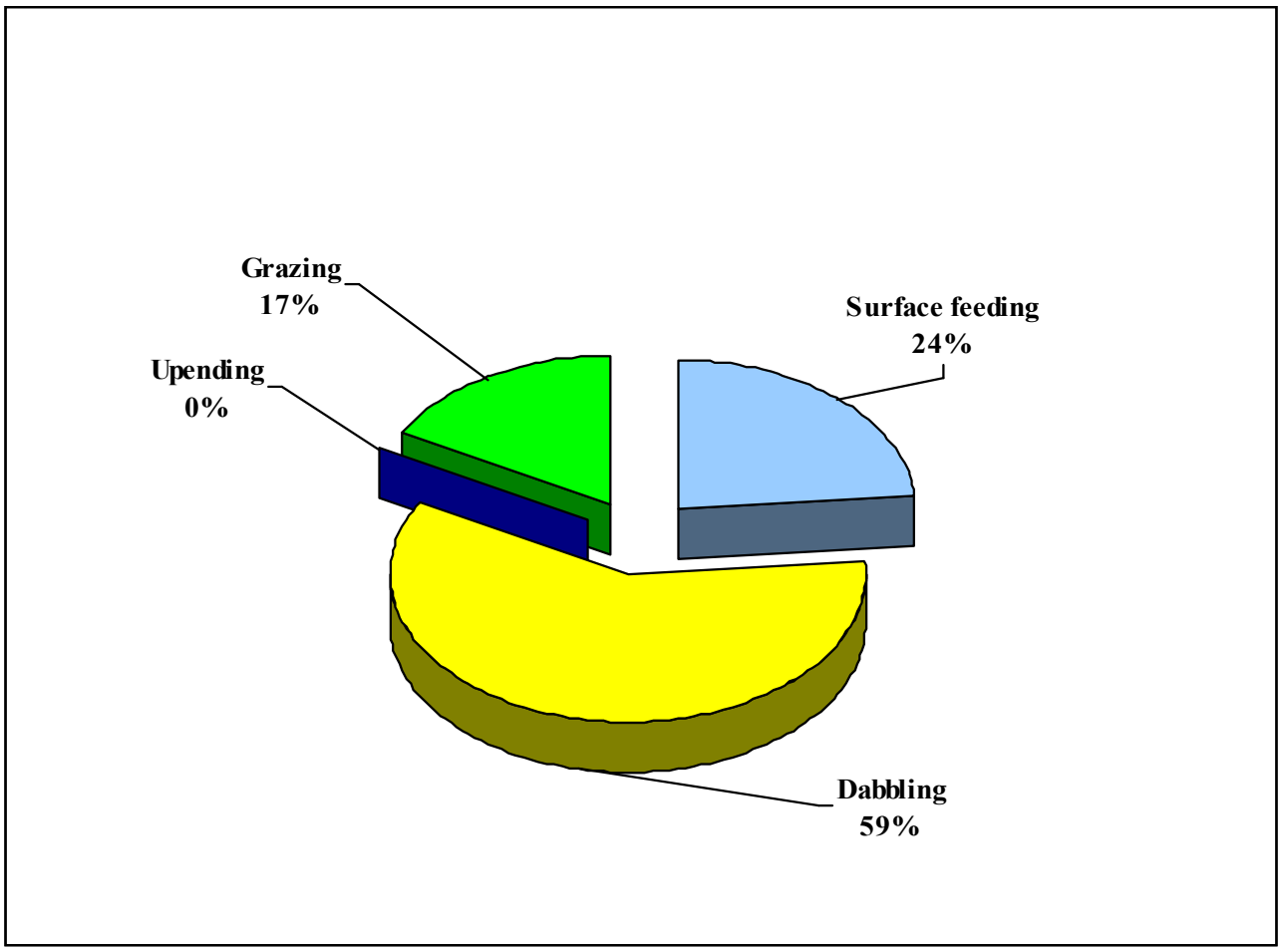


Figure 12. Mean percentage of total time spent feeding during eight hour observations using different feeding strategies by Mallard at S. Bazer over winter season 2009/2010.

Comparison of average time allocated to different activities within eight hours of daylight observations shows that the main activity was sleeping and accounts for 6.81 hr, followed by resting with a value 0.34 hr, whereas; preening and feeding account for 0.34 hr and 0.26 hr, respectively (Table 5).

Table 5. Mean time devoted by Mallard to different activities during eight hours daylight observation at Bazer over winter season 2009/2010.

Behaviour	Time devoted (hr)
Sleeping	6,81
Resting	0,34
Preening	0,34
Feeding	0,26
Swimming	0,11
Walking	0,08
Flying	0,03
Courtship	0,02
Agonistic behaviour	0,01
Loafing	0,00

5.1.3. Greater Flamingo

5.1.3.1. Greater Flamingo population Census

Over the three year study period (2007-2010), S. Bazer showed to be occupied by Greater Flamingos mainly during the autumn (September to October), spring and summer (from March to August) (Figure 13 a, b, c) with numbers that vary between 4-4500 in 2007/2008, 6-6750 in 2008/2009, 10-9010 in 2009/2010 and 2-4150 in 2010-March 2011.

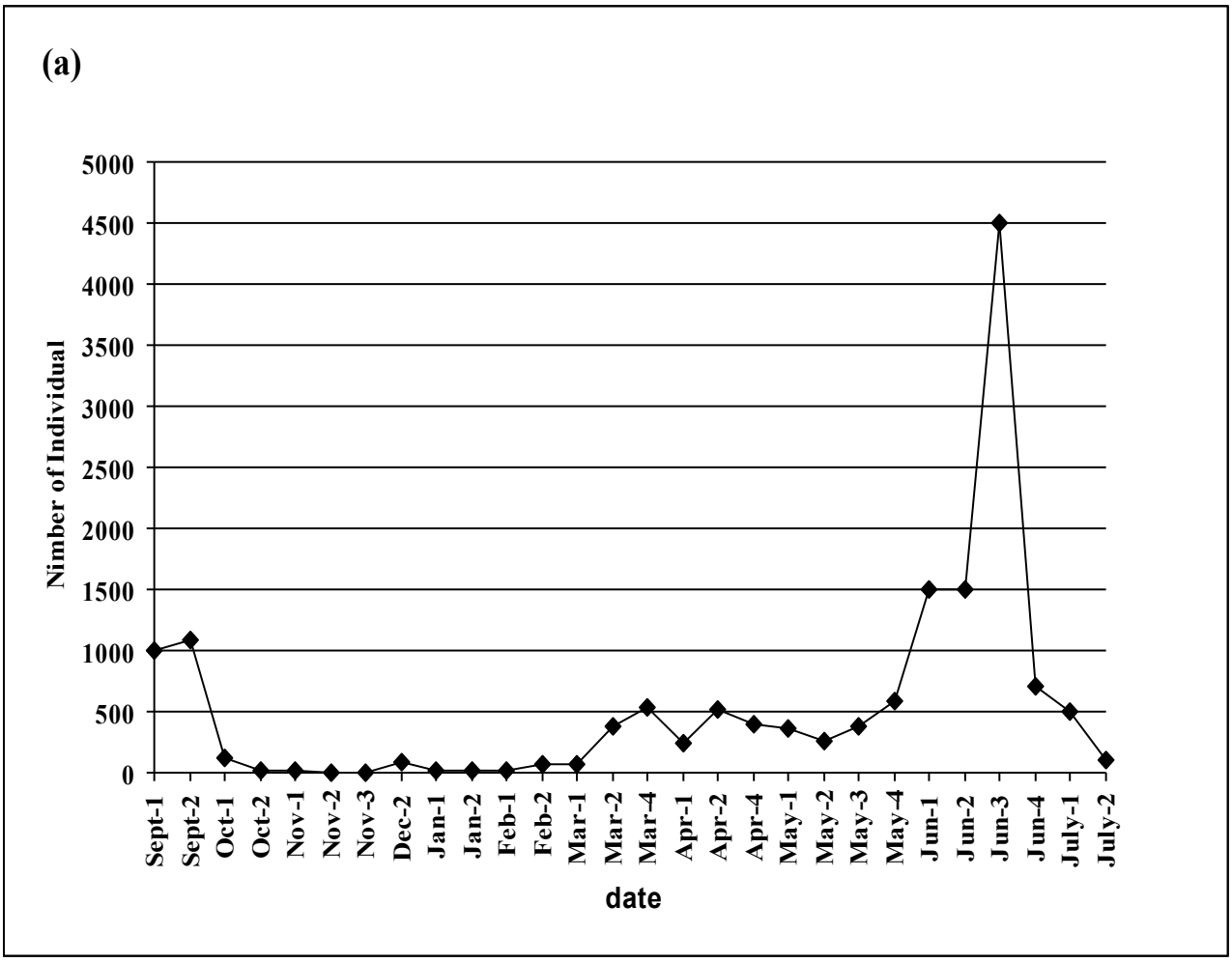


Figure 13 a. Counts of Greater Flamingo at S. Bazer during 2007/2008.

For the year 2007/2008, the results reveal that Greater Flamingo population start to occupy the site in September with a number of 1000 individuals, then a sharp decline was recorded till early spring where a fairly stable population of about 500 was recorded. From early June, the population surged and reached a maximum number of

4500 individuals (Figure 13a, Table 6).Then after, a sharp decline followed till the end of July.

The spatiotemporal distribution patterns of Greater Flamingo in 2008/2009 and 2009/2010 were similar to that recorded in 2007/2008. The highest surges of 6750 and 9010 individuals were recorded in early June and September 2009 (Figure 13b, c; Table 6).

Table 6. Maximum counts of Greater Flamingo in each main site (M.C.S) with date of sampling at El Eulma wetlands complex

Site	Year	M.C.S	Date of M.C.S
S.Bazer	2007/2008	4500	18/06/2008
S.El hamiet	2007/2008	1312	27/10/2007
Chott El Beidha	2007/2008	1150	22/11/2007
Chott El Frain	2007/2008	12	27/10/2007
S.Bazer	2008/2009	6750	06/06/2009
S.El hamiet	2008/2009	110	02/12/2008
Chott El Beidha	2008/2009	80	17/04/2009
Chott El Frain	2008/2009	dry	
S.Bazer	2009/2010	9010	02/09/2009
S.El hamiet	2009/2010	dry	
Chott El Beidha	2009/2010	dry	
Chott El Frain	2009/2010	dry	

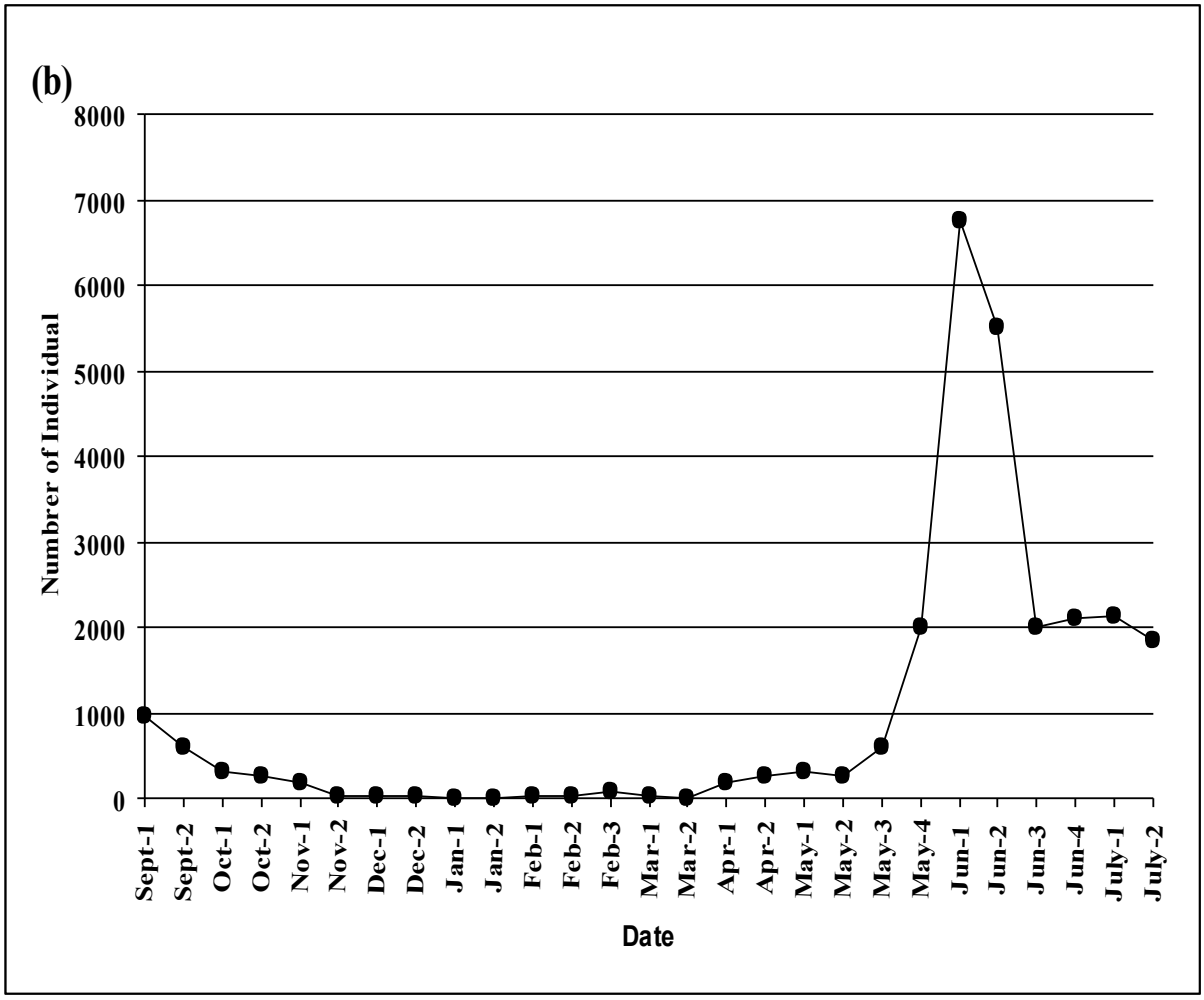


Figure 13 b. Counts of Greater Flamingo at S. Bazer during 2008/2009.

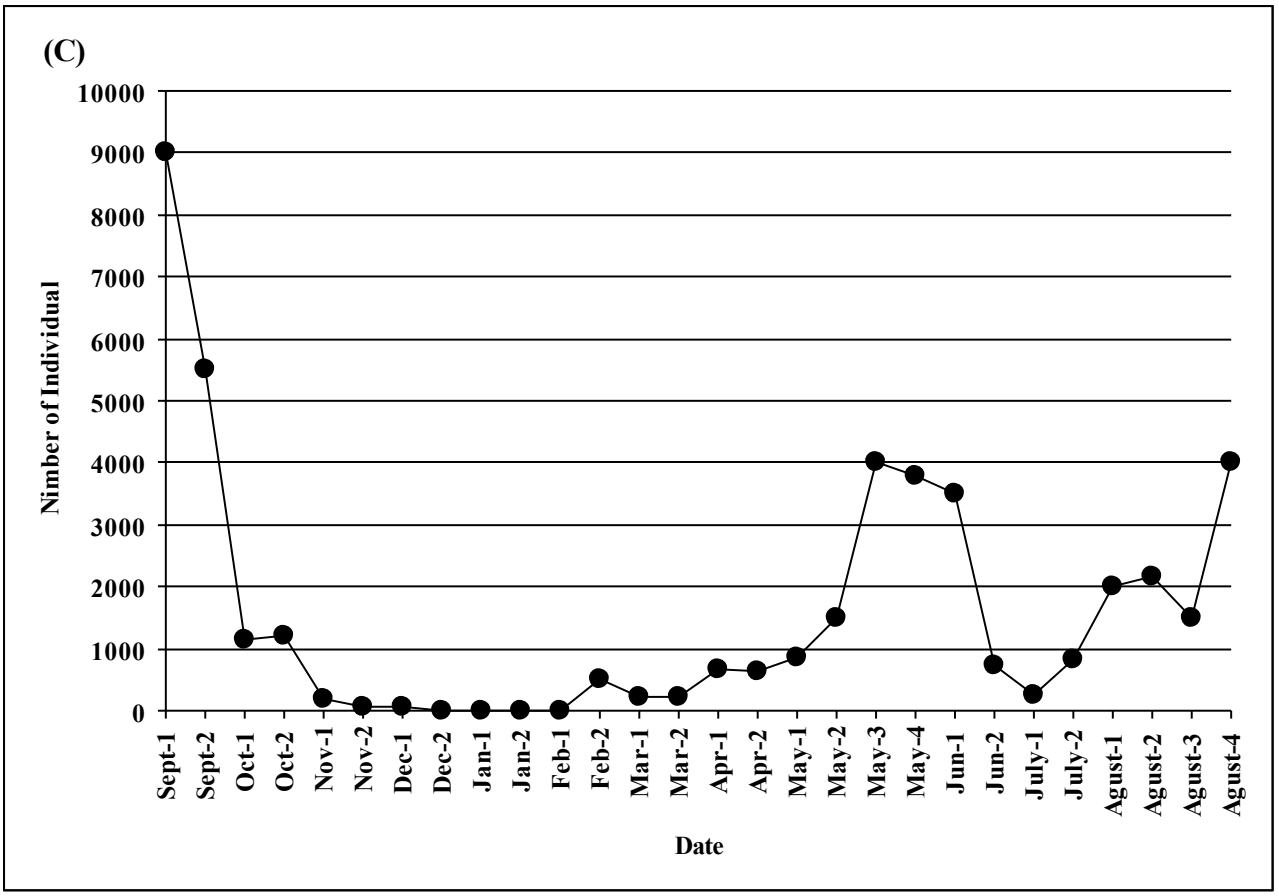


Figure 13 c. Counts of Greater Flamingo at S. Bazer during 2009/2010.

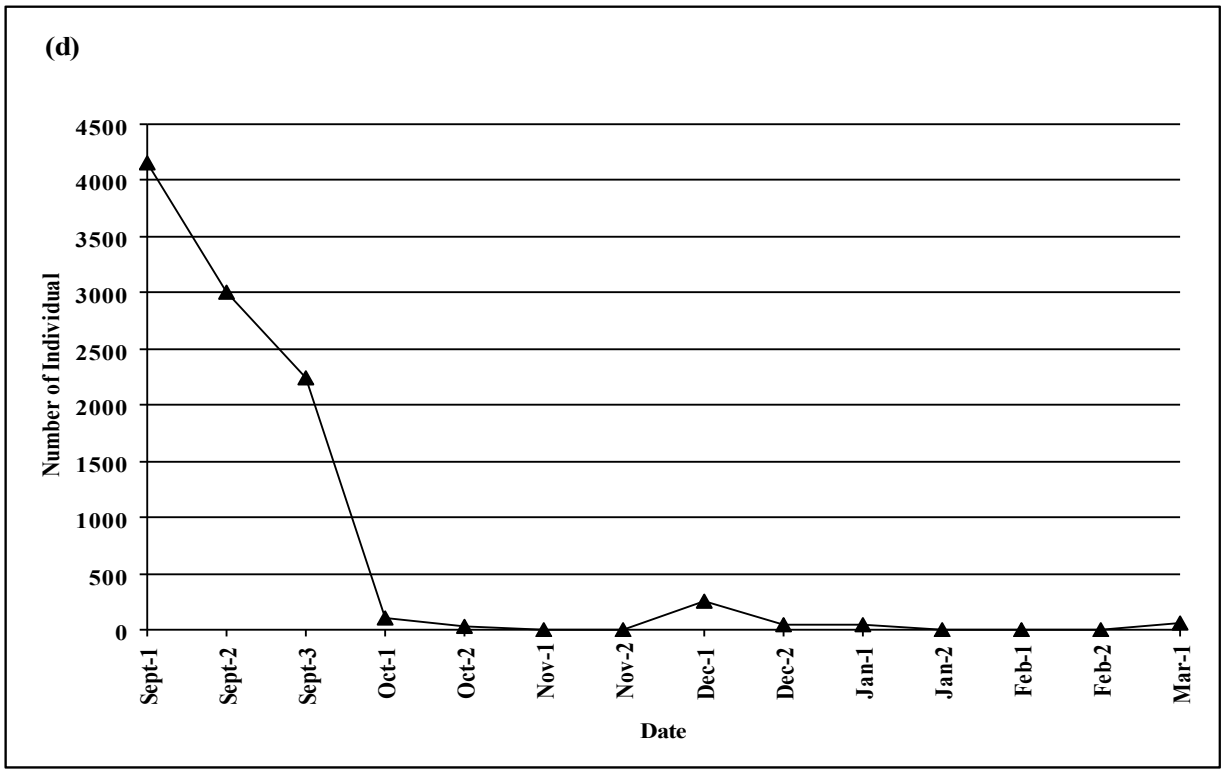


Figure 13 d. Counts of Greater Flamingo at S. Bazer during 2010/ March 2011.

During the autumn and winter of the year 2010/2011, Greater Flamingo counts reached their maximal counts in 06th September 2010 with 4150 individuals , then as expected the numbers declined sharply over all winter season (Figure 13 d).

It is worth noting that S. Bazer has not ever dried up totally because it is fed on a regular basis by Oued El Mellah and rain fall where water levels increase and may reach above 30 cm in rainy years. Despite the fact that water levels diminished up to 2 cm in early summer during the year 2009/2010 Greater Flamingos remained at site.

S. El Hamiet, however, appeared to be occupied mainly in autumn and winter and exhibited fluctuations in numbers where the highest number recorded was in October 2008 (1312 individuals) during 2007/2008 followed by a sharp decline to few dozens in early winter and less than 200 individuals in early spring (Figure 13e, Table 6).The number did not exceed 100 individuals within 2008/2009.

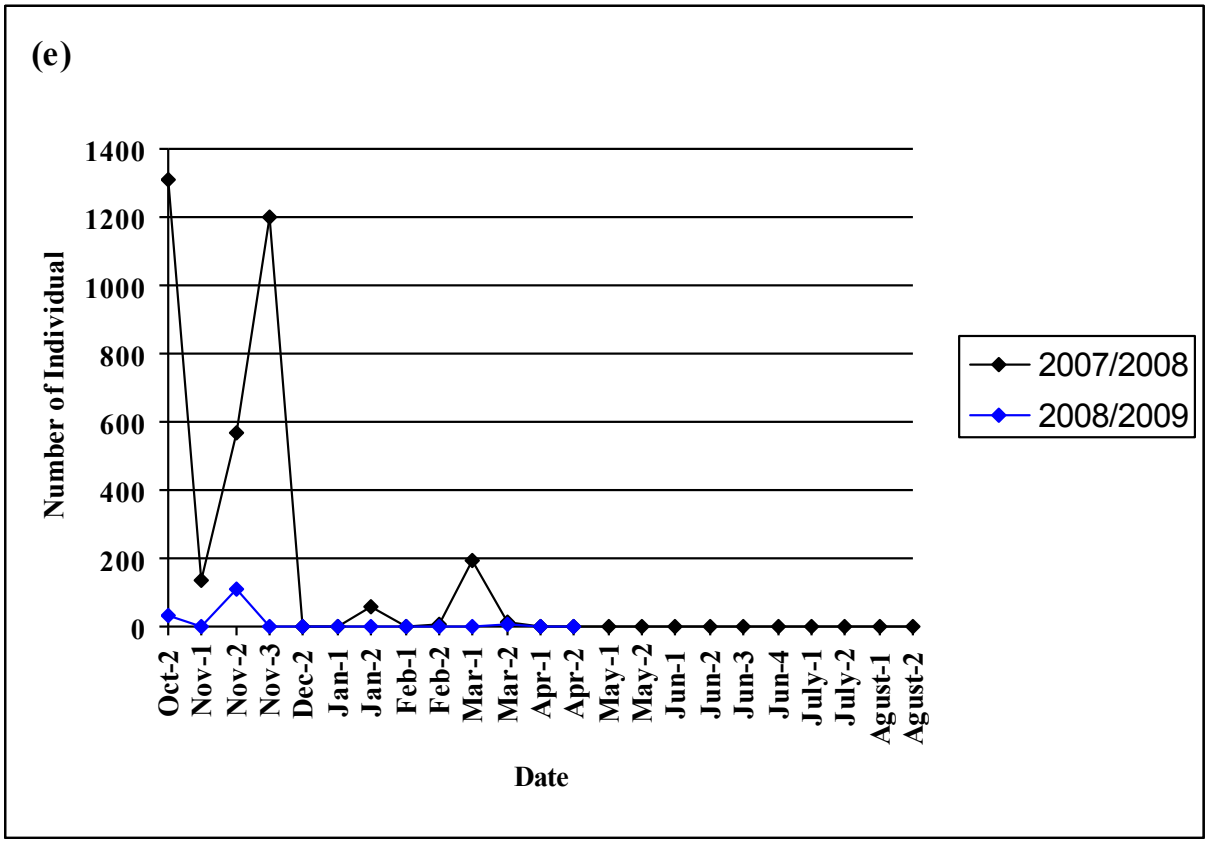


Figure 13 e. Counts of Greater Flamingo at S. El Hamiet during 2007/2008 and 2008/2009.

Chott El Beidha in turn, sheltered Great Flamingo during 2007/2008 over autumn, winter and spring season where the highest number, 1150 individuals, was recorded in mid winter (Figure 13f, Table 6). The site dried up within the years 2008/2009 and 2009/2010 which led to a total desertion of birds to elsewhere.

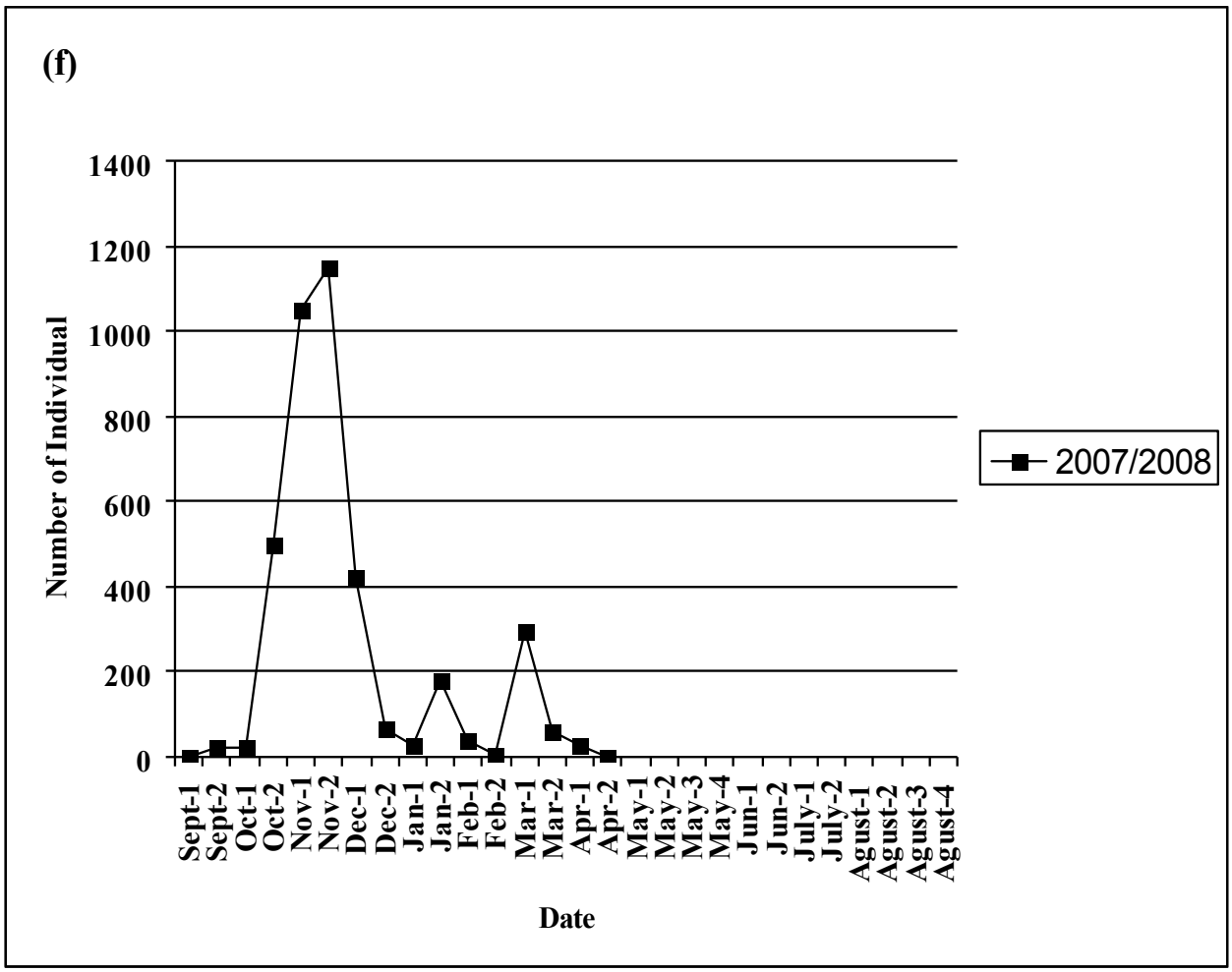


Figure 13 f. Counts of Greater Flamingo at Chott El Beidha during 2007/08.

Table 6 illustrates the Maximum counts of Greater Flamingo in each main site (M.C.S) with date of sampling at El Eulma wetland complex. S. Bazer was the most attractive site during the three year study period and showed a carrying capacity that by passed the other two sites by 3-4 times in 2007/2008 and 61-84 times in 2008/2009.

5.1.3.2. Breeding attempts of Greater Flamingo at S. Bazer

The region of El Eulma like that of Oum El Bouaghi (Ezzemoul) is also located in the eastern Hauts Plateaux. There was little rain in 2010 and the salt lake of S. Bazer was holding a thin sheet (2 cm) of water at the end of April with most Greater Flamingos foraging around the main affluent which feeds the site with sewage water. On 1 May, a team of 10 people, made up of students and researchers worked for over 6 hours to build a total of 100 artificial nests using mud, buckets and spades to give them the shape of a natural nest (Figure 14 a, c). These nests were on average 12 cm high and 30 cm wide, and were located close to the shore in an area where, in the past, the Greater Flamingo nested unsuccessfully (Figure 14b). Chiken egg shells were scattered across these newly built nests to give them added attraction. Between May and July, the number of flamingos fluctuated between 258 and 3500 but no nesting was recorded. On 9 August, 2000 Flamingos were present with 62 birds aligned along a line of nests about 250 m long. A total of four nests were being used by incubating Greater Flamingos, and over the next two days, this number rose steadily to 47 and 64 with a total of 2200 flamingos present on the site (Figure 15 a). On 12 August, there were still a few birds incubating early in the morning but by midday, the colony was deserted. Inspection of the colony, a few days later, revealed a total of 300 nests but with no sign of eggs (Figure 15 b, c). Footprints were found close to the deserted nests

.

Figure 14 a. Building artificial nests at Sebkhet Bazer.

Figure 14 b. Artificial nests built at Sebkhet Bazer.

Figure 14 c. A close view to one of the built nests.

Figure 15 a. Nesting attempt by a colony of Greater Flamingo at Sebkhet Bazer, in 2010.

Figure 15 b. View of the deserted colony at Sebkhet Bazer in 2010.

Figure 15 c. A closer view of few deserted nests at Sebkhet Bazer.

5.2. Discussion

5.2.1. Northern Shoveler

This study indicates for the first time the importance of wetland complex of El Eulma as one of the main wintering quarter for Northern Shoveler (*Anas Clypeata*) like many other waterfowls in the eastern Algerian Hauts Plateaux (Saheb *et al*., 2006; Samraoui *et al*., 2006b; Boulekhssaïm *et al*., 2006; Baaziz and Samraoui, 2008; Samraoui and Samraoui, 2008a). Moreover, it illustrates its status, spatiotemporal distribution and diurnal activity time budget.

Even though early studies reported the presence of the Shoveler as a winter visitor and trans Saharan migratory from August-September to March -April waterbird in North Africa (Heim de Balsac and Mayaud 1962; Etchecopar and Hüe 1964), no regular census of the species was carried out in Algeria at all sites during winter seasons.

Sporadic winter counts in the past produced an estimated Algerian population total of 6000 to 10000 individuals with a major concentration in Oranie (Jacobs and Ochando 1979). Subsequently, Rose (1995) reported in January 1995 survey a count of 13000-16000 Shoveler. It was also noted in hundreds (500-800) in the Saharan oases lakes such as Touggourt, Ourgla, and observed at Golea (Ledant *et al*., 1981). In the Eastern Hauts Plateaux which involves 20 wetlands, 500 individuals were counted at Sebkhet Djendli on 24 December 1991 (Chown and Linsley in Isenmann and Moali 2000). Another report indicated 3000 individuals at S. Bazer in 2004 (Anonymous 2004).

In a recent survey undertaken of 100 major wetlands across ten distinct regions of Algeria Samraoui and Samraoui, (2008a) have reported the species as a highly dispersed wetland bird over 47 wetlands and frequents different habitats ranging from freshwater, brackish and even saline ones. Across the Hauts Plateaux, numerous salt lakes (Timerganine, Chott Tinsilt, Chott el Hodna and S. Bazer) held flocks of several thousands migrant ducks such as Shoveler (Samraoui and Samraoui, 2008a).

The phenology of the Shoveler at study sites support Ledant *et al* (1981) observations in Numidia where they reported that first winter visitors arrive in the

second half of September, reach bulkiness between October and early December and begin their departure in February/March and ends in early May at Lac des oiseaux.

Our systematic survey over three-year period at the wetland complex of El Eulma as a part of the huge Hauts Plateaux is a contribution to the evaluation of the Shoveler population and identification of the highly frequented sites and their carrying capacity. In fact ducks were shown to concentrate on ponds of intermediate invertebrates' richness and intermediate size suggesting that pond size as well as food abundance affect their distribution (Guillemain *et al*., 2000b).

Moreover, it appeared that the gradual decline in Shoveler population over the three-year study period can be explained non-exclusively by the unfavorable climatic conditions over the last two years that coincided with the study, characterized by drying up of most wintering sites resulting in mass desertion by Shoveler.

Food shortage has also been reported to be responsible for the gradual abandonment of sites by Shoveler (Guillemain *et al*., 2000a). As S. Bazer did not dry up within the study period winters, it was the most attractive site for Shoveler over the three year study period probably due to (1) its permanent affluent which feeds the site with sewage water and important food stock (Allouche, 1988) or (2) high abundance of aquatic invertebrates, especially zooplankton (Pirot and Pont, 1987). Yet, these assumptions require further investigations.

Possible reasons for the differences in selecting habitats within the Complex are (1) adequate water depth and quality (Allouche, 1988), (2) vegetation nature of the surface and march and the type of food available that was found to influence the presence, in a given site, of specific species according to their needs (Verhoeven, 1980; Britton and Podlejski, 1981; Del Hoyo *et al*., 1992). Thus, the results suggest that El Eulma wetland complex is one of the main wintering quarters in Algeria for Shoveler.

An early study carried out on time budget during breeding season in Canada (Afton, 1979) showed that Shovelers spent most of their daylight hours feeding during spring arrival, prelaying, laying and incubation period. A subsequent study carried out in North Carolina, USA reported a value of 59% for diurnal feeding (Hepp, 1982 in Paulus, 1988). Pirot and Pont (1987) carried out a study in Camargue, South France

on diurnal and nocturnal time budget over two periods in winter season and revealed a mean of 53% of the time spent feeding. The diurnal mean time spent feeding was 5% and 12% in late November (mid winter) and in late February (late winter), respectively. Our data exploit diurnal observations and thus can only provide a partial overview of the time budget of wintering Northern Shoveler. The means % time allocated to foraging behaviour, 17% (in 2009/10) to 30- 45% (in 2008/09), were higher when compared to the European one and near to the American one and differed between sites and study years (Guillemain *et al.,* 2000b).

The possible reasons for discrepancies with the Camargue studies is (1) the larger necessity for local ducks to restore reserves after the Mediterranean crossing where energy depletion is more intense (Houhamdi and Samraoui, 2001), (2) also, dabbling ducks are generally known as nocturnal feeder, but may expand their foraging time into daylight hours if they have high energy requirement (Tamisier, 1972b; Guillemain *et al.*, 2002a), (3) lower food availability was reported to led Shoveler to compensate for poor feeding conditions at night by increasing diurnal foraging activities (Guillemain *et al*., 2000a, b), (4) a lower feeding efficiency, larger energy expenditure, or building important lipid reserves to meet spatial occupation constraint on breeding sites and energy demand for breeding (Allouche, 1988). However, data should be interpreted with caution as two different habitats are involved because foraging behaviour of Shoveler change over the day differs between sites and across weeks at some sites (Guillemain *et al*., 2000a). It has also been reported that less hunting pressure and disturbance encourage waterfowl for daily use of preferred wetlands (Paulus, 1988).

The seasonal pattern of feeding displayed by Shoveler during the present study appear to be partially consistent with the usual trend exhibited by wintering waterfowl with a peak in feeding activity in Autumn followed by a decline in winter and an increase in feeding corresponding to the premigratory ' fattening' period of early spring (Paulus 1988; Tamisier and Dehorter 1999). Moreover, the seasonal trends in time budget of non breeding waterfowl are closely related to food availability and quality and to energy requirement of individuals (Miller, 1985). The decline in feeding in early spring 2008/09 can be explained non exclusively by the fact that reserves were

accumulated during previous months on the same site or on neighboring sites (Allouche, 1988; King and Murphy, 1985), a second possible reason is to lower energy expenditure given the approach of the reproductive season that requires more energy to be spent (Irwin and O'Halloran, 1997). A third possible reason is due to their relatively small body size, Shovelers must acquire fat stores needed for migration and breeding later in the season and /or elsewhere by feeding on high prey densities at higher temperature (Afton, 1979; Pirot and Pont, 1987). Furthermore, the timing and the amount of rainfall may vary significantly and unpredictably from year to year in the Algerian Hauts Plateaux and this, in turn, may influence food availability. Water depth has been shown to constraint access to food resources and depth required for foraging varies widely among species of waterbirds (Lee *et al*., 2006). Thus, the dramatic decline in water depth at study site in 2009/10 along with cold and high wind conditions appeared to depress feeding activity (Paulus, 1988; Boulkhssaim *et al*., 2006). Besides, the adoption of lowering feeding activity has been reported as an adaptive physiologic character of Shoveler to limited resources conditions (Pirot and Pont, 1987) and to environmental conditions of wintering process (Allouche, 1988).

Thus, the Hauts Plateaux appear to be a wintering quarter distinct from European ones where Shoveler population developed a particular strategy which is the most adequate for responding efficiently to the specific habitat constraints.

A Previous studies in Europe documented very well the feeding strategy of Shoveler (Pirot and Pont, 1987) where mainly head and neck foraging method is used with a value of 57% of time spent. Yet our results exhibited higher values (75%-93%) for surface feeding and support previous reports on the flexibility in foraging behaviour in dabbling ducks through the easily shift to dabbling which may reflects (1) the opportunistic nature of waterfowl (Cramp and Simmons, 1980) and (2) differences in depth profiles, trophic resources between sites and /or years (Thomas, 1982; Põysã, 1986; Stephens and Krebs, 1986; Tamsier and Dehorter, 1999). Although seasonal change in water depth was measured, Shoveler appears to relay more heavily on dabbling feeding as water receded.

The data on hourly percentage time spent feeding are consistent with those of Tamisier and Dehorter (1999) where they reported that diurnal feeding is concentrated

on edge hours for S.El Hamiet and S. Bazer only over winter 2009/10. The increase in feeding activity of Shoveler in the afternoons can be explained at least in part by the humans disturbances exerted on the sites or to other unknown factors. Moreover, the nature of habitat and riparian activities such as herding (mainly sheep and dogs) appeared to be factors influencing foraging behaviour (Baaziz and Samraoui, 2008) where we recorded the critical time range for herders presence is generally in first mid day. This factor might have led Shoveler to switch its forging strategy from surface feeding to dabbling.

Furthermore, the present data support data reported elsewhere (Tamisier and Dehorter, 1999) and point to a distinct pattern of behaviour dominated, along with feeding, by sleeping throughout the wintering period.

Unfortunately, the model of "functional unit system" (Tamisier, 1974, 1985) was not investigated in the present study due to field constraints, but we do believe that S. El Hamiet and S.Bazer played a dual role of a resting and a feeding area for the year 2008/09; yet the latter site played a resting role area because ducks were observed to commute to a nearby wetland " Oued El Mellah" that was about 2 km far from S. Bazer (Pers.observ).

In as much as the present study is limited by the lack of data on food resources and weather effect; further studies are needed to highlight the relationship between habitat, trophic resources, weather and behaviour at the Haut Plateaux wetland Complex.

5.2.2. Mallard

This study indicates for the first time the importance of wetlands complex of El Eulma as one of the main wintering quarters for Mallard *Anas platyrhynchos* like many other waterfowls in the eastern Hauts Plateaux in Algeria (Saheb *et al*., 2006; Samraoui *et al*., 2006b; Boulekhssaïm *et al*., 2006; Baaziz and Samraoui, 2008; Samraoui and Samraoui, 2008a). Moreover, it illustrates its status, spatiotemporal distribution and diurnal activity time budget.

Early studies reported that European Mallard overwinter in Algeria between October and April in Tell where sporadic winter counts in the past produced an estimated Algerian population total of 1600-9200 individuals counted during 1972-1994. At Lack Oubeira, 3000-5000 counted on 17 Juanuary1992 (Chown and Linsley in Isenmann and Moali, 2000). The species was also recorded in the Sahara: 30-40 individuals in Juanuary 1976 at Djamaa, Ghardaia and even Tassili and Ahagar (Neithammer, 1963).

In the eastern Hauts Plateaux which involves 20 wetlands, 100 and 102 individuals were counted at Sebkhet Bazer on 1990 and 2000, respectively and 63 at Chott El Beidha in 1999 (Anonymous 2004). In a recent survey undertaken of 100 major wetlands across ten distinct regions of Algeria, Samraoui and Samraoui, (2008a) have reported the species as a highly dispersed wetland bird over 47 wetlands and frequents different habitats ranging from freshwater, brackish and even saline ones. Across the Hauts Plateaux, numerous salt lakes (Timerganine, Chott Tinsilt, Chott el Hodna and S. Bazer) held flocks of several thousand migrant ducks. Moreover the Authors reported that Mallard is a widespread breeding species in 10 over 53 wetlands mainly in Fetzara, Lac Tonga, Mekhada, Bouderssa and Tinsilt.

Despite the above data, no regular census of the Mallard was carried out in Algeria at all sites during winter seasons so far. Thus, the present study is at least a contribution to a fair estimation of Mallard population in the Hauts Plateaux northeast Algeria.

Furthermore, the phenology of Mallard at study sites strengthens previous observations (Chown and Linsley in Isenmann and Moali, 2000) and indicates through our a three year regular survey that the first winter visitors arrive in early September,

reach a bulkiness between late September and early October, disperse in mid winter and occupy the sites during breeding season till early summer. In Fact S. Bazer as an important birding area (IBA) (Samraoui and Samraoui, 2008a) shelters the species either for wintering or breeding where many couples were seen with their broods swimming (pers obs).

Moreover, the present study indicates stability in Mallard population frequenting mainly S. Bazer over the three year observations. This regular recurrence can be explained, at least in part, by: (1) the fact that Mallard winters in shallow waters where optimal depth varies between 20 to 40cm (Heitmeyer, 1985 cited in Allen, 1987, Tamisier and Dehorter, 1999); (2) Ducks, were also shown to concentrate on ponds of intermediate invertebrates' richness and intermediate size suggesting that pond size as well as food abundance affect their distribution (Guillemain *et al*., 2000b). The fact that S. Bazer did not dry up completely within the study period winters, hence, it was the most attractive site for Mallard probably due to its permanent affluent which feeds the site with sewage water and important food stock, yet, this assumption require further investigation.

The differences in preferring habitats within our study sites might be due to an adequate water depth and quality (Allouche, 1988), the type of food available that was found to influence the presence, in a given site, of specific species according to their needs (Verhoeven, 1980; Britton and Podlejski, 1981; Del Hoyo *et al*., 1992).

Thus, the results suggest that El Eulma wetlands complex, as a part of the huge Hauts Plateaux, is one of the main wintering (and breeding) quarters in Algeria for Mallard.

Since Mallard is generally a nocturnal species (Guillemain *et al*., 2002b) depending on tactile food selection (Tamisier and Dehorter, 1999), our data exploit diurnal observations and thus can only provide a partial overview of the activity time budget during winter at S. Bazer. Sleeping was the dominant behaviour within the wintering period. An early investigation carried out in North America by Turnbull and Baldassarre (1987) showed that resting was the major diurnal activity with a mean percentage time ranging from 39% to 54% that was less than the mean time allocated

to resting and sleeping (89%) at S. Bazer. This discrepancy might be due to the geographical variations or to other unknown factors.

Feeding ecology of wintering granivorous dabbling ducks *Anas* spp has been intensively studied in Camargue, South France where the birds feed very little by day (<10%) and at night fly far from roosts to a variety of feeding habitats e.g. freshwater marshes and rice fields (Tamisier, 1976). Guillemain *et al*., (2002b) indicated mean values of 4-22% allocated to feeding at daylight hours for different habitats in France. These findings are in accordance with our results on mean time spent feeding (3.19%).

In winter, Mallards feed primarily on seeds but also on invertebrates associated with leaf debris and wetlands, agricultural grains, and to a limited extent, leaves, buds, stems, rootlets, and tubers (Goodman and Fisher, 1962; Heitmeyer, 1985, cited in Allen, 1987).

S. Bazer located in Hauts Plateaux where the main agricultural activities depends on cereals: Durum wheat, Common wheat and Barley may offers a good opportunity for Mallard to high energy food sources that can increase efficiency and minimize feeding time of Mallard. This reduced feeding time may allows additional time for other activities such as sleeping and resting, yet this assumption require further studies on body composition and diet analysis at our study sites. In fact, Mallards were shown to spent less time in feeding because they participated in evening feeding flights to flooded cornfields on the refuge (Baldassarre and Bolen, 1984 in Turnbull and Baldassarre 1987).

The seasonal pattern of feeding displayed by Mallards during the present study appear not to be consistent with the usual trend exhibited by wintering waterfowls with a peak in feeding activity in Autumn followed by a decline in winter and an increase in feeding corresponding to the premigratory ' fattening' period of early spring (Paulus 1988; Tamisier and Dehorter 1999).

The reasons for such an inconsistency are unclear, but regrettably information on the nocturnal behaviour of Mallards is at present lacking. Moreover, the seasonal trends in time budget of non breeding waterfowl are closely related to food availability and quality and to energy requirement of individuals (Miller, 1985).

Waterfowls foraging strategies varies across the winter period (Tamisier, 1995). The dominance of dabbling over other feeding strategies by Mallard at S. Bazer confirms previous observation where they reported that ducks use a wide range of methods, and show great flexibility in foraging behaviour (Thomas, 1982) which may reflects (1) the opportunistic nature of waterfowl (Cramp and Simmons, 1980) and (2) differences in depth profiles, trophic resources between sites and /or years (Thomas, 1982; Põysã, 1986; Stephens and Krebs, 1986; Tamisier and Dehorter, 1999).

Unfortunately, the model of "functional unit system" (Tamisier, 1974, 1985) was not investigated in the present study due to field constraints, but we do believe that S. Bazer played a role of resting (daylight roost) area for the year 2009/2010 because few Mallard flocks were observed to commute to a nearby wetland " Oued El Mellah" that was about 2 km far from S. Bazer (Pers. observ).

In so far as the present study is limited by the lack of data on nocturnal activity time budget, food resources and body composition; further studies are needed to highlight the relationship between these factors and behaviour at the Haut Plateaux wetlands Complex.

5.2.3. Greater Flamingo

The obtained results indicated clearly that El Eulma wetlands complex, as part of the huge Hauts Plateaux northeast Algeria, is one of the important wetlands zones in sheltering, wintering and aestivating population of Greater Flamingo (Samraoui *et al*., 2009) and a breeding ground, within the huge wetlands complex in the Hauts Plateaux northeast, Algeria (Samraoui *et al*., 2006b; Ouldjaoui, 2010). The discrepancies in frequentation among sites can be explained non exclusively by (1) the water level fluctuations during the study period where it was reported that temperature elevation and increase in water evaporation (drying up) lead to a decline in numbers of waterbirds in a given site (Ouldjaoui, 2010) and (2) the availability of trophic resources where it was reported that nesting site of Greater Flamingo in Algeria and adjacent sites used for feeding hold three species of Crustaceans branchiopods *Artemia salina*, *Branchinella spinosa* and *Branchinetella media* and one insect species dipetera *Ephydra* sp (Samraoui *et al*., 2006a). Yet, the latter assumption needs further investigation at our Study sites. The higher number of Greater Flamingo counted during spring and summer season at S. Bazer confirm previous studies (Samraoui and Samraoui, 2008a; Ouldjaoui, 2010) in Algeria, where it was reported that Greater Flamingo frequented selected sites starting from breeding period that extends from March to August (Samraoui *et al*., 2010). Moreover, the large number of greater Flamingo clearly indicates the role of North African wetlands acting as source area to maintain the Mediterranean metapopulation of Greater Flamingos (Samraoui *et al*., 2006 b).

S. Bazer has long been considered as a stopover and wintering quarter for migratory birds (Samaroui and Samraoui, 2008a) is the third breeding site after Ezzmoul in the Oum El Bouaghi wetlands complex and El Golea in the Algerian Sahara.

At Sebkhet Bazer, the Greater Flamingos attempted to breed in three consecutive years (2007, 2008 and 2009). The colony was built at the edge of the salt lake and was highly vulnerable to human disturbance (egg poachers) and terrestrial predators (feral dogs, foxes, jackals and wild boars) that might have led to nesting failure. A Total of 60, 55 and 12 nests were discovered in 2007, 2008 and 2009,

respectively. The incubation start reported to be mid May in 2008 and late May in 2009. The place of breeding during 2007 and 2008 was localized at 100 m from the shores which facilitate human and animal intrusion (Samraoui *et al*., 2010).

Despite being unsuccessful at breeding in 2010, the Greater Flamingo seemed to have expanded its nesting range across Algeria with breeding attempts at three known nesting sites, Ezzemoul, S. Bazer and El Goléa (Bouzid *et al*., 2009). These breeding attempts, undertaken at an unusually late period, may be due to young, inexperienced birds "learning the trade" and they may only succeed on rare occasions.

Colonial waterbirds are known to require social stimulation to initiate and achieve successful breeding. Following the use of decoys and vocalisation playbacks as successful management tools in recovery programs of waterbird breeding colonies (Podolsky and Kress, 1989; Crozier and Gawlik, 2003), similar techniques including increase of flock size (Stevens, 1991), use of large mirrors to provide extra stimuli (Pickering and Duverge, 1992), and use of a combination of decoys, vocalization playbacks and artificial nests (O'Connell-Rodwell *et al*., 2004) have been successfully tried on various species of Flamingos both in captivity and in the wild.

Different management techniques like predator control, crop protection or the maintenance or provision of breeding islands have also been used successfully in the past in efforts to conserve the Greater Flamingo (Johnson and Cézilli, 2007). The use of artificial nests was first used in zoos to stimulate Greater Flamingos to breed (Kear and Duplaix-Hall, 1975) and the technique has been successfully replicated in the wild. For example, at Etang du Fangassier in the Camargue region of France, a mixture of nests built using mud-filled buckets and real nests transplanted from a nearby dyke was placed on an artificial island, which became the principal breeding site in France (Johnson, 1976). A modified technique of molding nests and scrapping mud to create depressions between the mounds was similarly successful at Fuente de Piedra, Spain with the nests containing scattered shells of chicken eggs being particularly attractive to Flamingos (Rendon Martos and Johnson, 1996). If hydrological conditions remain the key factors that control the reproduction of the Greater Flamingo, active management may lead to successful breeding at S. Bazer and the colonization of new sites in North Africa. Our first attempt at stimulating Greater

Flamingos to breed at S. Bazer was promising; it remains to be seen whether it will succeed in the long run.

Conclusion

Firstly, The current study carried out within three year period (2007-2010) on the wintering ecology of Northern Shoveler *Anas clypeata* and Mallard *Anas platyrhynchos* is original in North Africa. It indicates for the first time the importance of wetlands complex of El Eulma as one of the main wintering quarters for the studied species like many other waterfowls in the eastern Hauts Plateaux in Algeria (Saheb *et al*., 2006; Samraoui *et al*., 2006b; Boulekhssaïm *et al*., 2006; Baaziz and Samraoui, 2008; Samraoui and Samraoui, 2008a). Moreover, it illustrates the status, spatiotemporal distribution and diurnal activity time budgets of both surface ducks mentioned above and describes their habitat use.

Regular census of Northern Shoveler and Mallard carried out in the current study represents a contribution to a fair estimation of their population in the Hauts Plateaux northeast Algeria. S. Bazer as an important birding area (IBA) (Samraoui and Samraoui, 2008a) not only shelters Northern Shoveler and Mallard for wintering but also for breeding of the latter.

The phenology of the Shoveler at study sites support Ledant *et al* (1981) observations in Numidia where they reported that first winter visitors arrive in the second half of September, reach bulkiness between October and early December and begin their departure in February/March and ends in early May. S. Bazer was the most attractive habitat for Shoveler over the three year study period.

The means percentage time allocated to foraging behaviour, 17% (in 2009/10) to 30- 45% (in 2008/09), were higher when compared to the European one and near to the American one and differed between sites and study years (Guillemain *et al*., 2000b).

The seasonal pattern of feeding displayed by Shoveler during the present study appear to be partially consistent with the usual trend exhibited by wintering waterfowl with a peak in feeding activity in Autumn followed by a decline in winter and an increase in feeding corresponding to the premigratory ' fattening' period of early spring (Paulus 1988; Tamisier and Dehorter 1999). Thus, the Hauts Plateaux appear to be a

wintering quarter distinct from European ones where Shoveler population developed a particular strategy which is the most adequate for responding efficiently to the specific habitat constraints.

our results exhibited higher values (75%-93%) for surface feeding and support previous reports on the flexibility in foraging behaviour in dabbling ducks through the easily shift to dabbling as water receded.

The data on hourly percentage time spent feeding are consistent with those of Tamisier and Dehorter (1999) where they reported that diurnal feeding is concentrated on edge hours for S.El Hamiet and S. Bazer only over winter 2009/10.

Sleeping behaviour was the second main diurnal activity after feeding in winter that corresponds with previous data reported in Europe (Tamisier and Dehorter, 1999).

Furthermore, the phenology of Mallard at study sites strengthens previous observations (Chown and Linsley in Isenmann and Moali, 2000) and indicates that the first winter visitors arrive in early September, reach a large size between late September and early October, disperse in mid winter and occupy the sites during breeding season till early summer. Mallard population frequenting mainly S. Bazer exhibited stability over the three year observations and a high attraction to this site.

The dominant behaviour of the diurnal activity time budget of Mallard was sleeping and resting and accounts for 89% of the time spent within the wintering period.

Results on mean percentage time spent feeding (3%) by Mallard were similar to that of Camargue, South France. The dominance of dabbling over other feeding strategies by Mallard at S. Bazer confirms previous observation and show a great flexibility in foraging behaviour (Thomas, 1982).

Secondly, The obtained results indicated clearly that El Eulma wetlands complex, as part of the huge Hauts Plateaux northeast, Algeria, is one of the important wetlands zones in sheltering, wintering and aestivating population of Greater Flamingo (Samraoui *et al*., 2009) and a breeding ground, within the huge wetlands complex in the Hauts Plateaux northeast, Algeria (Samraoui *et al*., 2006b; Ouldjaoui, 2010).

The higher number of Greater Flamingo counted during spring and summer seasons at S.Bazer confirm previous studies (Samraoui and Samraoui, 2008a;

Ouldjaoui, 2010) in Algeria. The large number of Greater Flamingo clearly indicates the role of North African wetlands acting as source area to maintain the Mediterranean metapopulation of Greater Flamingos (Samraoui *et al*., 2006 b).

S. Bazer has long been considered as a stopover and wintering quarter for migratory birds (Samaroui and Samraoui, 2008a) is the third breeding site after Ezzmoul in the Oum El Bouaghi wetlands complex and El Golea in the Algerian Sahara.

The use of artificial nests for the first time in North Africa to encourage breeding at S. Bazer seemed to induce Greater Flamingo to built 300 new nests and started an attempt at incubation in the middle of the dried salt lake before deserting the colony in mid August 2010.

At last, our study on the ecology of Northern Shoveler, Mallard and Greater Flamingo emphasizes the ornithological values of the wetlands Complex of El Eulma and suggests the urgent need for better management and protection of these valuable wetlands from continuous deterioration.

Summary

The ecology of two dabbling ducks: Northern Shoveler *Anas clypeata* and Mallard *Anas platyrhynchos* and Greater Flamingo *Phoenicopterus roseus* were investigated at El Eulma wetlands complex in the eastern Hauts plateaux northeast, Algeria during the period 2007-2010.

Fluctuations and a sharp decline were recorded in the number of Northern Shoveler population at two study sites. S.Bazer, however, showed to be the most frequented site over the study period. The maximal counts increased by two fold within 2008 and 2009. Analysis of diurnal time budgets showed that sleeping was the dominant diurnal activity at S.Bazer where birds devoted almost 1/2 to 3/4 of their mean percentage time spent to sleeping (47 % in 2008/09, 68 % in 2009/10). Sleeping was, however, the second diurnal activity at S.El Hamiet with a mean value of less than 1/2 of the time allocated. The seasonal evolution in mean percentage time apportioned to sleeping showed slight fluctuations at both study sites with a domination of sleeping at S. Bazer over winter 2009/10, while feeding exhibited a similarity between sites and a difference in pattern between years. Feeding was accomplished in three ways: surface feeding, dabbling and grazing with flexibility in using the former and the second foraging methods**.** Swimming showed similarities between sites and differences between years with mean values < 13%. Resting, preening and locomotion accounted for < 6%; whereas, flying, agonistic behaviour and courtship were rare. Hourly data analysis showed that time spent feeding was concentrated on edge hours with some alterations. Feeding and sleeping as two main activities were quite similar between sites and unlike between years when expressed in hours.

The phenology of Mallard indicates that the first winter visitors arrive in early September, reach a large size between late September and early October, disperse in mid winter and occupy the sites during breeding season till early summer. Mallard population frequenting mainly S. Bazer exhibited stability over the three year observations and a high attraction to this site.The dominant behaviour of the diurnal activity time budget of Mallard was sleeping and resting and accounts for 89% of the diurnal time spent within the wintering period. Results on mean percentage time spent feeding (3%) by Mallard were similar to that of Camargue, South France. Mallard shows a great flexibility in foraging methods with dominance of dabbling.

The results indicated clearly that El Eulma wetlands complex is one of the important wetlands zones in sheltering, wintering and aestivating population of Greater Flamingo and a breeding ground. The higher number of Greater Flamingo counted during spring and summer seasons at S.Bazer over 2007-2010 confirm previous studies in Algeria. S. Bazer considered as a stopover and wintering quarter for migratory birds is the third breeding site after Ezzmoul in the Oum El Bouaghi wetlands complex and El Golea in the Algerian Sahara. The use of artificial nests to encourage breeding at S. Bazer seemed to induce Greater Flamingo to built 300 new nests and started an attempt at incubation in the middle of the dried salt lake before deserting the colony in mid August 2010.

Thus the present study emphasizes the ornithological values of the wetlands Complex of El Eulma and suggests the urgent need for better management and protection of these valuable wetlands from continuous deterioration.

Résumé

L'écologie de deux canards de surface : le Souchet *Anas clypeata* and le canard colvert *Anas platyrhynchos* et du flamant rose *Phoenicopterus roseus* a été étudiée dans les zones humides du complex d'El Eulma, Hauts Plateaux North Est de l'Algérie durant la période 2007-2010.

Les résultats montrent des fluctuations et un déclin aigu dans la population du Souchet dans les deux sites d'études. S. Bazer, cependant, a montré d'être le site le plus fréquenté au cours de la période d'étude. Les nombres maximaux augmentés de deux fois durant l'année 2008/2009. L'analyse des budgets temps diurnes a montré que le sommeil était l'activité dominante diurne à S. Bazer où les oiseaux consacré presque 1 / 2 - 3 / 4 de leur temps au sommeil (47% en 2008/09, 68% en 2009/10). Le sommeil était, cependant, la deuxième activité diurne à S. El Hamiet avec une valeur moyenne de moins de 1 / 2 du temps alloué. L'évolution saisonnière dans le pourcentage moyen du temps dévoué au sommeil montre de légères fluctuations dans les deux sites d'étude avec une domination du sommeil à S. Bazer durant l'hiver 2009/10, tandis que l'alimentation a montré une similitude entre les sites et une différence de profil entre les années. L'alimentation a été accomplie de trois façons: alimentation en surface, barbotage et alimentation a bord avec une flexibilité dans l'utilisation de la première et la seconde méthode de recherche de nourriture. La nage a montré des similitudes entre les sites et des différences entre les années avec des valeurs moyennes de moins de 13%. Le repos, la toilette et la locomotion représentaient moins de 6%, tandis que, le vol, le comportement agonistique et la parade nuptiale ont été rares. L'analyse des données à l'heure a montré que le temps consacré à l'alimentation a été concentré sur les heures extrêmes (début et fin de journée) avec quelques modifications. L'alimentation et le sommeil comme deux activités principales étaient assez semblables entre les sites et différentes entre les années lorsqu'elles sont exprimées en heures.

La phénologie du canard colvert indique que les premiers visiteurs arrivent au début de Septembre, atteindre une grande taille entre la fin de Septembre et au début Octobre, dispersent dans milieu de l'hiver et occupent les sites au cours de la saison de reproduction jusqu'au début de l'été. La Population du Canard colvert fréquentant principalement S. Bazer montrent une stabilité au cours des trois années d'observations et une forte attraction pour ce site. Le comportement dominant du budget de temps diurne a été le sommeil et le repos représentant 89% du temps diurne alloué durant la saison d'hivernage. Les résultats du pourcentage moyen du temps alloué à l'alimentation (3%) par le canard colvert était similaire à celui de la Camargue, Sud de la France. Le canard colvert a montré une grande flexibilité dans les méthodes de recherche de nourriture avec une dominance du barbotage.

Les résultats indiquent clairement que les zones humides du complexe d'El Eulma est l'une des zones humides importantes dans l'abri, l'hivernage et l'estivation de la population du Flamant Rose et aussi lieu de reproduction. Le plus grand nombre du Flamant Rose compté pendant les saisons de printemps et d'étés à S. Bazer durant la période 2007-2010 confirment les études antérieures en Algérie. S. Bazer considéré comme une escale et un quartier d'hivernage pour les oiseaux migrateurs est le troisième site de reproduction après Ezzmoul dans le complexe des zones humides d'Oum El Bouaghi et El Golea dans le Sahara algérien. L'utilisation de nids artificiels pour encourager la reproduction à S. Bazer semblait induire le Flamant Rose à construire 300 nouveaux nids et a commencé une tentative d'incubation au milieu du lac salé à sec avant de déserter la colonie dans le mi- août 2010.

Ainsi, la présente étude accentué sur les valeurs ornithologiques des zones humides du complexe d'El Eulma et suggère la nécessité urgente d'une meilleure gestion et protection de ces zones humides précieuses de la détérioration continu.

المـلخــص

تمت دراسة ايكولوجية نوعين من بط السطح هما : البط الجراف *Anas clypeata* و البط ذو العنق الأخضر *Anas platyrhynchos* و طائر النحام *Phoenicopterus roseus* في المناطق الرطبة لمركب العلمة في الهضاب العليا للشرق الجزائري خلال ثلاث سنوات2007- 2010.

أظهرت الدراسة اضطرابات و انخفاض حاد في أعداد عشيرة الجراف في موقعي الدراسة، بينما أظهرت سبخة بازر على انها الموقع الأكثر إقبالا للطيور أثناء فترة الدراسة . ارتفعت الأعداد القصوى بمعدل مرتين خلال سنة 2008 و 2009، كما أظهر تحليل ميزانية النشاط النهاري أن النوم هو الغالب في سبخة بازر حيث كرست الطيور ما يقارب ½-¾ من متوسط نسبة الوقت الممضى في النوم (47%في2008-2009 و 68%في 2009-2010)، بينما كان الوقت المكرس للنوم كنشاط ثاني نهاري في سبخة الحاميات بمعدل أقل من نصف الوقت الممضى.

كما أظهر التطور الفصلي تغيرات طفيفة في موقعي الدراسة لمتوسط نسبة الوقت الممضى في النوم مع غالبية النوم في سبخة بازر خلال شتاء 2010/2009 . كما أظهرت التغذية تشابه ما بين مواقع الدراسة و اختلاف في نمط التغذية ما بين السنوات .

استخدمت في التغذية ثلاث طرق هي : تغذية على السطح ، التجريف و الرعي بمرونة في إستعمال الطريقة الاولى و الثانية، كما أظهرت السباحة تشابه مابين المواقع واختلافات مابين السنوات بمعدل اقل من 13%. بينما لم تتجاوز نسب الوقت الممضى لكل من الراحة، التنظيف و الحركة 6%. كان السلوك العدواني، و الطيران، و التودد نادري الملاحظة.

أظهر تحليل للنتائج الساعية أن الوقت المستهلك في التغذية مركز خلال الساعات الطرفية للنهار مع بعض التغيرات الطفيفة كما كانت التغذية و النوم (النشاطين النهارين الأساسين) متشابهين إلى حد ما فيما بين المواقع و مختلفين فيما بين السنوات .

كما أشارت فينولوجية البط ذو العنق الأخضر أن وصول الزوار الأوائل كان في بداية سبتمبر حيث يزداد عددهم ما بين نهاية سبتمبر و بداية أكتوبر و يتبعه تفريق في منتصف الشتاء ثم إعادة حجز للمواقع خلال فصل التكاثر حتى بداية الصيف.

أظهرت عشيرة البط ذو العنق الأخضر المترددة على سبخة بازر انجذاب عالي للموقع خلال ثلاث سنوات الدراسة.

كان النشاط النهاري الغالب لهذا البط هو النوم والراحة واللذان قدرا ب 89% من الوقت النهاري الممضى خلال فترة التشتية بينما لم يمثل ذلك للتغذية سوى3 % و هذا ما يدعم النتائج المحصل عليها سابقا في الكمارج- جنوب فرنسا. بالإضافة أظهر هذا البط مرونة كبيرة في استعمال وسائل البحث عن الغذاء مع غالبية إستعمال طريقة التجريف.

كما أشارت النتائج بوضوح أن مركب المناطق الرطبة للعلمة هو احد أهم المناطق الرطبة في الحماية و التشتية و التصييف لعشيرة النحام، إضافة لكونها أرضية للتكاثر . تؤكد أعداد النحام العالية التي تم جردها خلال فصول الربيع و الصيف في سبخة بازر دراسات الجرد السابقة في الجزائر.

تعتبر سبخة بازر ليس فقط مكان توقف و حي تشتية للطيور المهاجرة ولكن الموقع الثالث لتكاثر طائر النحام و ذلك بعد سبخة الزمول في مركب المناطق الرطبة لأم البواقي والمنيعة في الصحراء الجزائرية.

كما أدى استعمال الأعشاش الاصطناعية إلى حث تكاثر طائر النحام في سبخة بازر حيث قام هذا الاخير ببناء 300عش جديد مع محاولة بداية التحضين في وسط البحيرة المالحة الجافة، ثم تلى ذلك إخلاء المستعمرة في منتصف اوت2010 .

لهذا فان هذه الدراسة تؤكد على القيمة الاورنيثولوجية للمناطق الرطبة لمركب العلمة و تقترح ضرورة القيام بتدبير الحماية الأفضل لهذه المناطق الرطبة الثمينة ضد التدهور.

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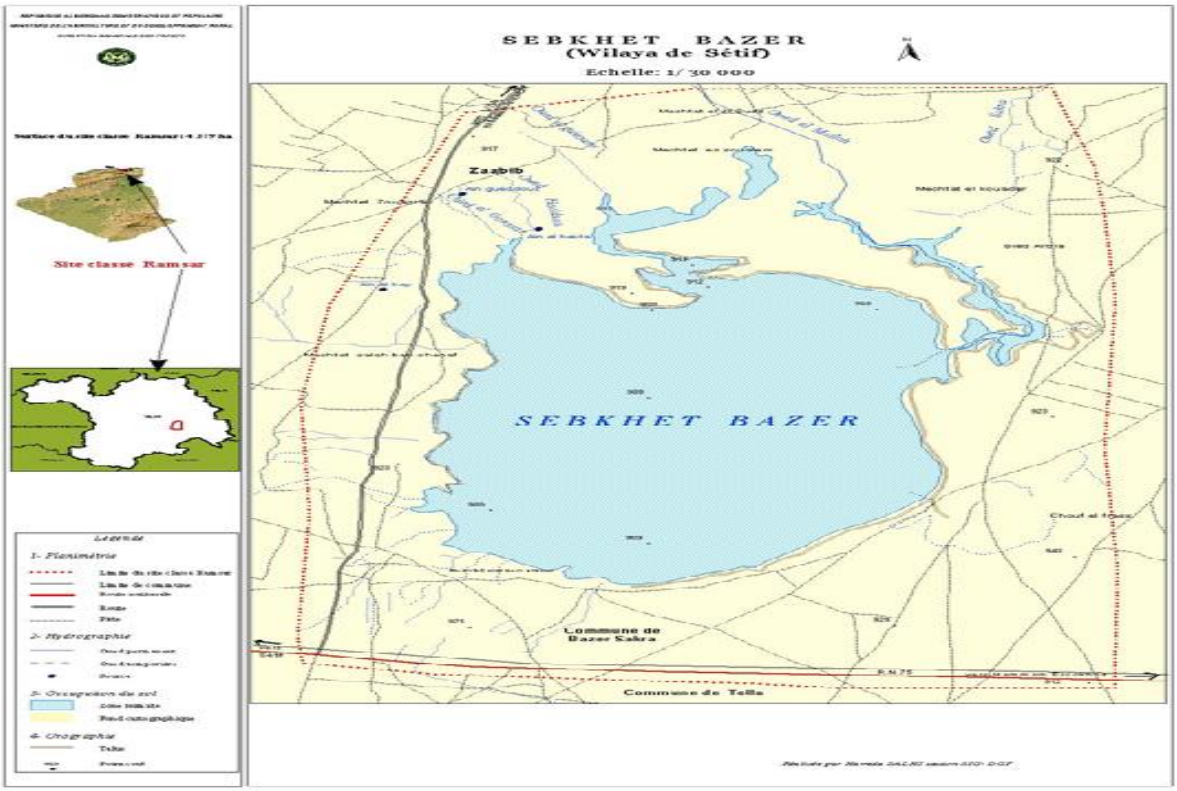
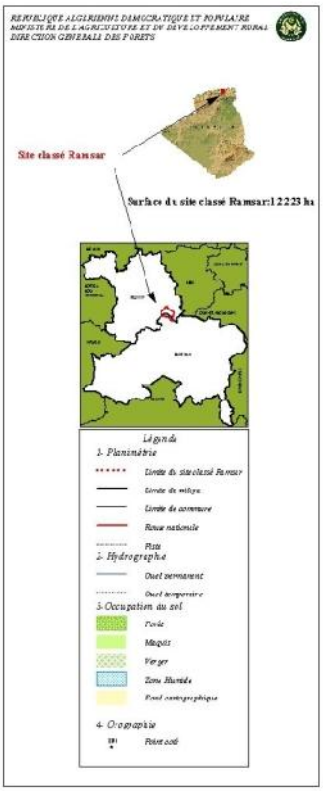
Annex

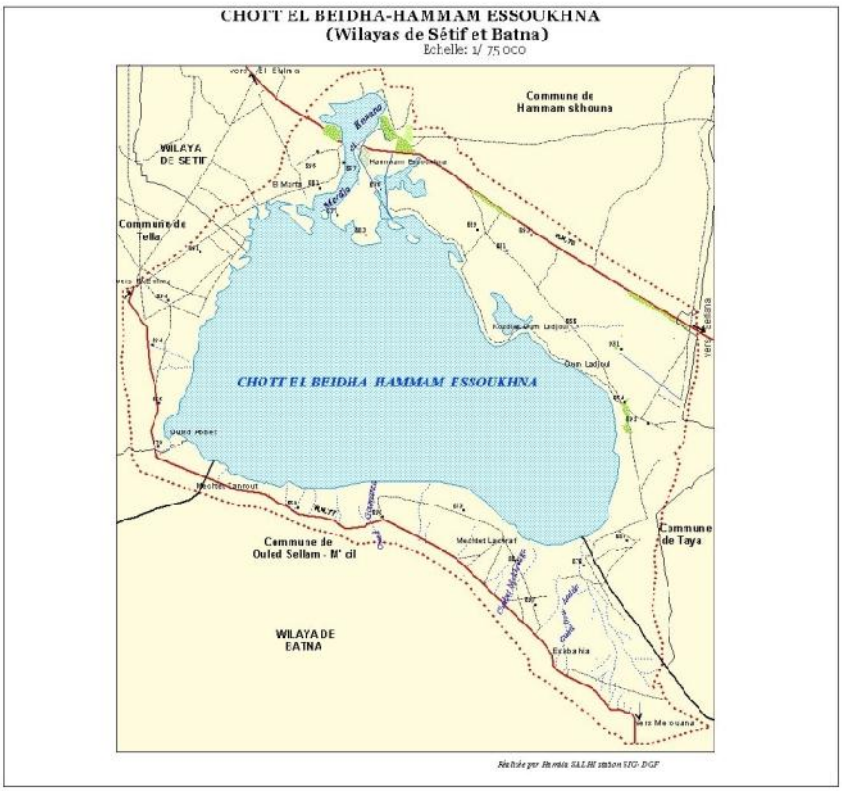

SEBKHET BAZER
(Wilaya de Sétif)
Echelle: 1/ 30 000
Site classé Ramsar
SEBKHET BAZER
Zaabib
Commune de Bazer Sakra
Commune de Talla
R.N.75

SEBKHET EL HAMIET

WILAYA DE SETIF

Projet financé par le W.W.F. International
Living Waters Program


REPUBLIQUE ALGERIENNE DEMOCRATIQUE ET POPULAIRE
MINISTERE DE L'AGRICULTURE ET DU DEVELOPPEMENT RURAL
DIRECTION GENERALE DES FORETS
Site classé Ramsar
Surface du site classé Ramsar: 12223 ha
Légende
1- Planimétrie
Limite du site classé Ramsar
Limite de wilaya
Limite de commune
Route nationale
Piste
2- Hydrographie
Oued permanent
Oued temporaire
3- Occupation du sol
Forêt
Maquis
Verger
Zone Humide
Fond cartographique
4- Orographie
Point coté


CHOTT EL BEIDHA-HAMMAM ESSOUKHNA
(Wilayas de Sétif et Batna)
Echelle: 1/ 75 000
Commune de Hammam sthouna
WILAYA DE SETIF
Commune de Tella
CHOTT EL BEIDHA HAMMAM ESSOUKHNA
Commune de Ouled Sellam - M' cil
Commune de Taya
WILAYA DE BATNA
Réalisé par Hamza SALHI station SIG- DGF

English, French, Latin name of Waterbirds (Isenmann and Moali, 2000)

English name	French name	Latin name
▪ Gadwall	C.Chipeau	*Anas strepera*
▪ Mallard	C.Colvert	*Anas platyrhynchos*
▪ Northern Pintail	C.Pilet	*Anas acuta*
▪ Eurasian Wigeon	C.Sifleur	*Anas penelope*
▪ Northern Shoveler	C.Souchet	*Anas clypeata*
▪ White-Headed Duck	Erismature a T.B	*Oxyura leucocephala*
▪ Common Pochard	Fuligule milouin	*Aythya ferina*
▪ Tufted Duck	Fuligule morillon	*Aythya fuligula*
▪ Ferruginous Duck	Fuligule nyroca	*Aythya nyroca*
▪ Garganey	Sarcelle d'été	*Anas querquedula*
▪ Common Teal	Sarcelle d'hiver	*Anas crecca*
▪ Marbled Duck	Sarcelle marbrée	*Marmaronetta angustirostris*
▪ Greylag Goose	Oie cendré	*Anser anser*
▪ Common Shelduck	Tadorne de Belon	*Tadorna tadorna*
▪ Ruddy Shelduck	Tadorne casarca	*Tadorna Ferruginea*
▪ Black Winget Stilt	Echasse blanche	*Himantopus himantopus*
▪ Common Crane	Grue cendrée	*Grus grus*
▪ Avocet	Avocette	*Recuvirostra*
▪ Plovers	Gravelot	
▪ Waders	Limicoles (Gravelots, Becasseaux, Chevaliers etc….)	