

## Research Article

# Current Population Status and Activity Pattern of Lesser Flamingos (*Phoeniconaias minor*) and Greater Flamingo (*Phoenicopterus roseus*) in Abijata-Shalla Lakes National Park (ASLNP), Ethiopia

**Tewodros Kumssa and Afework Bekele**

Department of Zoological Sciences, Addis Ababa University, P.O. Box 1176, Addis Ababa, Ethiopia

Correspondence should be addressed to Tewodros Kumssa; [tewodroskk@gmail.com](mailto:tewodroskk@gmail.com)

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A study of the population status, habitat preference, and activity pattern of nonbreeding flamingos was carried out in Lakes Abijata, Shalla, and Chitu, part of the Great Rift Valley, Ethiopia, from 2011 to 2013. The current population status and habitat preference of flamingos in the area are still poorly known. Likewise, data on diurnal and seasonal activity pattern of the species are scarce and this leads to the misunderstanding of how Flamingos use local wetlands throughout the different seasons. Data regarding population size and activity pattern were gathered during the wet and dry seasons. Point-count method was used to estimate the population size. Behaviors were recorded using scan sampling techniques. A total of 53671 individuals representing two species of flamingo were counted during both wet and dry seasons from the three lakes. There were more flamingos during the dry season than the wet season in Lake Abijata contrary to Lakes Shalla and Chitu during the wet season. Lesser flamingos (*Phoeniconaias minor*) were the most abundant species comprising 95.39%, while Greater Flamingos (*Phoenicopterus roseus*) accounted for 4.61% of the total population. Lake Abijata is the major stronghold of Lesser Flamingos in the area. There was significant variation in the mean number of both species during the wet and dry season in the different study sites of the lake, respectively. The species were known to use varied habitats within the lakes. The Lesser Flamingo mainly preferred the shoreline and mudflat areas of the lakes. However, Greater Flamingo on several occasions showed preference to offshore area of the lakes. Seasonal average flock sizes were not similar between the species. There was a strong relationship between time allocated to each activity and time of day. Feeding activity varied among daylight hours and was higher in the evening (76.5%) and late morning (74.56%) and least during midday (54%). Some variations in activity breakdown were observed between time blocks and season. Conservation efforts in the park should include the wild flora and fauna not only of the land but also of the aquatic systems. The information in this study will be very useful for the future management of the species in the area.

## 1. Introduction

The hundreds of thousands of flamingos congregating on the African Rift Valley Lakes is one of the truly spectacular sights of the natural world [1]. Sub-Saharan Africa and India are known for their flamingos but the largest flocks occur not only in the East Africa Rift Valley, particularly in the central section at Lakes Bogoria, Elmenteita, Nakuru, and Magadi in Kenya and Natron and Manyara in Tanzania but also at Lakes Rudolf and Abijata in Ethiopia [2, 3]

and Lakes Chitu and Shalla of Ethiopia. Additionally, a few thousand individuals occur on Ugandan crater lakes [4], while smaller populations are present in southern Africa (55,000–60,000), West Africa (Mauritania/Senegal) (15,000–25,000) and 400,000 individuals occur in the Rann of Kachchh in northwest India [4, 5].

Flamingos are one of the most easily recognizable birds, with their long necks and legs, unusual bill shape, and their plumage ranging from pale pink to red or orange with black primary and secondary wing feathers [6]. The amount of

pink coloration, noticeable particularly on the head and neck, varies greatly amongst individuals, not in relation to age (some birds have a very pink head when otherwise still in immature plumage) but possibly according to diet and an individual's capacity to assimilate carotenes for pigmentation [7]. Lesser flamingos have a highly specialized and fine filter, diet consisting almost entirely of microscopic cyanobacteria and benthic diatoms [8]. However, the Greater Flamingos that occur in the same habitat as the lesser ones (but with lesser density) are generalists consuming copepods, mollusks, annelid worms, small fish, seeds, brine shrimps (*Artemisia* spp.), and other small planktonic and benthic animals in addition to algae [9].

Of the six species of flamingos in the world, two occur in Africa: the Lesser Flamingo (*Phoeniconaias minor*) and the Greater Flamingo (*Phoenicopterus roseus*) [10]. These species overlap in distribution and habitats, occurring mainly in large alkaline or saline lakes, salt pans, and estuaries [11]. Both species are very gregarious and frequently occur in large numbers [12]. The two species mingle freely where they occur, usually at feeding and breeding sites. The Lesser Flamingo is the smallest in size and more numerous in number than the Greater Flamingo one [4]. Both flamingo species are irregular nomadic or partially migratory nomadic and inhabit areas with high seasonal fluctuation in conditions and resources, with a great physical and chemical heterogeneity and geomorphology [13]. Their abundance is associated with variations of water characteristics like conductivity, diversity, and availability of potential food items, alkalinity changes [14], breeding migrations, fresh water requirements and predation pressure [15].

About 60% of the Greater Flamingo population is located in the Mediterranean region [16]. They occur in lower numbers in Africa. In Eastern Africa, they make up about 1% of the average number of flamingo aggregations [17]. This species has a very large range, the population trend appears to be increasing, and the population size is very large and hence does not approach the thresholds for vulnerable. So the species is evaluated as of least concern [5].

Greater Flamingos born in France, Spain, and Italy have been observed to breed at other colonies in the Mediterranean and in West Africa, often moving to a third colony thereafter [18]. It has been suggested that the Mediterranean colonies could function as a metapopulation [18]. Following sustained conservation effort undertaken at the two most important breeding colonies in the western Mediterranean (Camargue in France and Fuente de Piedra in Spain), the Greater Flamingo successfully expanded its range in southern Europe and in North and West Africa [19]. Movements between southern Europe and North Africa have long been known [9], and North Africa has generally been considered to be an important wintering ground for Greater Flamingos and a "nursery" for immature flamingos from Europe [20].

However, the Lesser Flamingos are classified by IUCN as being near threatened, due to its dependence on a limited number of unprotected breeding sites, declining of population, and quality of habitat. It is known to breed in only five sites, two in southern Africa (Makgadikgadi Pans in Botswana and Etosha Pan in Namibia), one in

east Africa (Lake Natron), and two in India (Zinzuwadia and Purabcheria Salt Pans), and on an artificial island at Kamfers Dam in South Africa. Of these breeding sites, only Etosha Pan and the two sites in India are officially protected [21]. More than 75% of breeding individuals are concentrated at only one site (Lake Natron, Tanzania) [22]. A narrow range of breeding conditions is required that occur irregularly resulting in a declining population. An irregular episode of mortality involves tens and sometimes hundreds of thousands of birds in East African Rift Valley Lakes [23]. Africa's flamingo populations are not isolated, and flamingos migrate between the Soda lakes of East Africa and the Etosha and Makgadikgadi Pans in southern Africa [10]. Therefore, flamingo conservation should stretch across many political boundaries, and threats to all key habitats need to be considered in an attempt to conserve the African flamingos.

Abijata-Shalla Lake National Park (ASLNP) in Ethiopia is established primarily to conserve the diverse bird life of the area [24]. A great number of bird species seen in these lakes are seasonal migrants; thus the area remains major place of attraction to bird watchers [25]. The Park supports one of the largest African colonies of flamingos and Great White Pelicans (*Pelecanus onocrotalus*). In addition, a high species richness of mammals, the hot springs, and scenery of the lakes all occur in the protected area [26]. The Park is a candidate wetland of international importance under the Ramsar Convention [24].

Little research has been conducted on the diversity and ecology of avian species in Ethiopia [27]. For instance, the status of the flamingo in Ethiopia has not been well known and the current population status and habitat preference of flamingos in the area are poorly known. Likewise, data on diurnal and seasonal activity pattern of the species are scarce and this leads to the misunderstanding of how flamingos use local wetlands during the different seasons. The present study gives data on the population status of the two species, habitat preference, and their activity pattern in the Park.

## 2. Materials and Methods

**2.1. The Study Area.** Abijata-Shalla Lakes region was established as a National Park by the Ethiopian Wildlife Conservation Organization in 1970 with the aim of conserving the biodiversity of the spectacular number of aquatic birds [28]. The park is known as Abijata-Shalla Lakes National Park (ASLNP), deriving its name from the two Lakes Abijata and Shalla [24]. ASLNP is one of Ethiopia's National Parks, located in the Great Rift Valley comprising three lakes: Abijata, Shalla, and Chitu (Figure 1). The site lies between the 7°15'–7°45'N and 38°30'–38°45'E, at about 207 km south of Addis Ababa. ASLNP comprises two types of ecosystems, namely, the water part and land together covering a total area of 887 km<sup>2</sup> of which 405 km<sup>2</sup> is land area while 482 km<sup>2</sup> is water body [29].

Among the three saline lakes in the National Park, Lake Shalla is the deepest (266 m deep) and covering an area of 370 km<sup>2</sup> and Abijata is the shallowest (<7 m deep) and covering an area of 180 km<sup>2</sup> [30]. Lake Chitu is the smallest covering an area of 0.8 km<sup>2</sup> and a maximum depth of 21 m

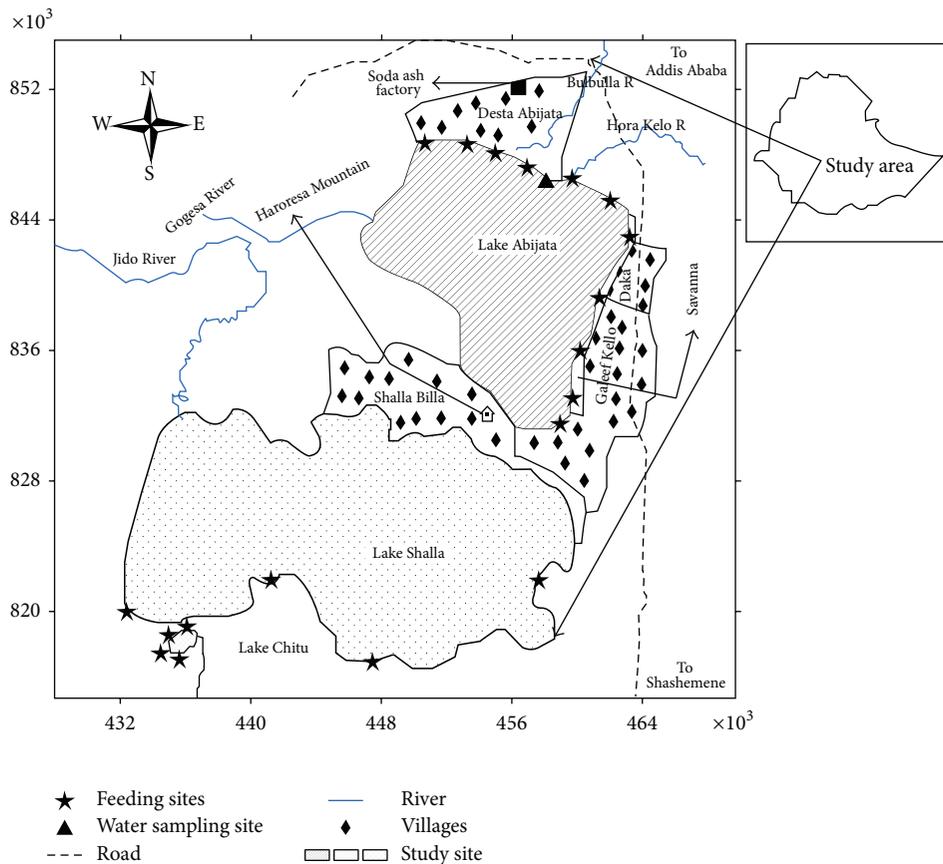


FIGURE 1: Map of the study area with study sites.

and is highly saline. Due to its location in a rainfall deficit area of the Rift Valley, ASLNP receives an annual rainfall ranging between 500 and 700 mm and the mean monthly temperature varies from 18.5°C to 24.6°C with mean annual temperature of 21°C [29]. The habitat surrounding the lakes in the park is generally dominated with tree species of *Acacia* and open scrub rocky slopes [29]. A total of 453 bird species have been recorded in the park [31]. The park has 6 endemic species to Ethiopia [28] and holds at least 144 and 292 water-associated and terrestrial bird species, respectively [29].

The study was carried out from 2011 to 2013. A total of 28 surveys were conducted throughout the study period on foot. Fourteen were performed during the rainy season (June to September) and the remaining fourteen during the dry seasons (November to May). Surveys of the three lake areas were conducted seasonally to identify and count the presence of individuals of both flamingo species. During the terrestrial surveys, depending on the size and shape of the wetland, 5 or more survey points per lake (in total 36 points) were taken and systematically all individual flamingos were recorded by direct count using telescopes (W30x or W22x), binoculars (10 × 42), and manual counters. Point-count method was conducted at four locations for 20 minutes in a point using direct observation through binoculars and telescopes [32]. The mean distance between observers and focal birds was

45 m. For a given wetland, the same census points were used during each subsequent survey as adopted by [33]. The size of the census area varied from point to point. The limits of subareas were determined beforehand and, in order to avoid double counts, moved to the next point as rapidly as possible without disturbing the birds. Habitat preference of the bird species is recorded by the observer each time birds were detected. For this purpose, onshore, mudflat and offshore categories were used.

At the time of census, reference points were established to enable flock identification when counting to avoid repetitions [34]. Flocks were defined as groups of flamingos in which the nearest-bird distance averaged <25 m, and where no bird was >50 m from the nearest flock member as adopted by Bildstein et al. [35]. For larger number of birds (>4,000 birds), poor visibility, or both, we counted birds in estimated groups (that is, 10, 100 [32]). Each count was done by at least two people, and the average was used as the estimated abundance. The census was conducted by 10 to 16 people recording the data together according to the size of the site and bird settlement. Multi-lake censuses were conducted over short periods of time at the same time.

To minimize disturbance during counting, silent movement followed by 3 to 5 minutes of waiting period was allowed to settle down from any disturbance [32]. Census data were

TABLE 1: Number of Lesser and Greater Flamingos on lakes censused from 2011 to 2013.

Site	Species with season								Mean $\pm$ SE	
	2011-2012				2012-2013					
	Wet		Dry		Wet		Dry		L	G
	L	G	L	G	L	G	L	G	L	G
<i>Abijata Lake</i>										
Bulbulla and Hora Kelo rivers inlet	9200	278	29700	847	15535	534	22173	464	19152 $\pm$ 19.6	530.75 $\pm$ 11.7
Gogesa River	345	11	2956	245	482	18	1115	92	1224.5 $\pm$ 9.5	91.5 $\pm$ 4.2
Savanna	652	—	3516	—	1130	—	2448	—	1936.5 $\pm$ 12.6	—
Haroresa mountain	71	—	441	—	168	—	186	—	216.5 $\pm$ 8.2	—
Fresh artificial pond of soda ash factory	634	—	2325	—	413	—	1678	14	1262.5 $\pm$ 14.2	3.5 $\pm$ 0.3
<b>Total</b>	<b>10902</b>	<b>289</b>	<b>38938</b>	<b>1092</b>	<b>17728</b>	<b>552</b>	<b>27600</b>	<b>570</b>	<b>23792 <math>\pm</math> 15</b>	<b>625.75 <math>\pm</math> 11</b>
<i>Lake Shalla</i>	16300	1008	7200	906	19058	3819	6267	548	12206.25 $\pm$ 4.3	1570.25 $\pm$ 9.3
<i>Lake Chitu</i>	17812	189	13153	313	18513	493	11312	123	15197.5 $\pm$ 9.6	279.5 $\pm$ 5.1
<b>Total</b>	<b>45014</b>	<b>1486</b>	<b>59291</b>	<b>2311</b>	<b>55299</b>	<b>4864</b>	<b>45179</b>	<b>1241</b>	<b>51195.75 <math>\pm</math> 13.4</b>	<b>2475.5 <math>\pm</math> 7</b>

L: Lesser Flamingo; G: Greater Flamingo.

collected twice a day, morning (6:30–10:00 a.m.) and late afternoon (10:00 to 6:00 p.m.). These were the periods when most avian species were most active [36].

Various activity patterns of nonbreeding flamingos were recorded during dry and wet seasons of each year at Lake Abijata. Behavioral observations were conducted randomly in two distinct points where flamingos were most numerous. Observations were made using binoculars, at least 35 m from the birds to avoid interference. Since no breeding was observed in the lakes, behaviors associated with the breeding period, such as courting, copulation, and incubation, were not observed. Behaviors were recorded using scan sampling techniques [37] because flock activities of flamingos often are synchronized [38]. Sampling was conducted on three randomly selected days per week with each day divided into four equal time blocks of (1) early morning (06:00–09:00 hr), (2) late morning (09:00–12:00 hr), (3) midday (12:00–14:00), and (4) late afternoon/evening (15:00–18:00) as adopted by Lehner [39]. Data were collected from September 10–14, 2011 (on 4 separate days), October 20–23, 2011 (on 3 days), February 21–27, 2012 (on 6 days), August 12–18, 2012 (on 6 days), March 17–21, 2013 (on 5 days), and May 27–29, 2013 (on 2 days). A total of 303 h of observation was carried out during the hours from 06:00 to 18:00. Each individual of flock was observed for 2 min (focal animal analysis) as used by Altman [37]. The time spent in different activities was calculated and from these values the percentage time spent for each activity during different times on the day was estimated. The activities are divided into five categories as follows:

- (i) feeding: stand feeding and walk feeding (feeding was defined as a flamingo holding its head down with the beak either partially or totally submerged),
- (ii) moving (walking, swimming, and flight),
- (iii) resting (standing, sleep, and grooming),
- (iv) preening (feather shaking, wing flapping, tail shaking, and bath),
- (v) alert (alarm) [38].

To analyze the data Stata version 12 software was used. ANOVA and chi-square test were performed to find out statistically significant difference among various variables. Behavior data were analyzed with a Kruskal-Wallis test, a nonparametric test.

### 3. Result

*3.1. Population and Habitat Preference of Flamingo.* A total of 53671 individuals representing two species of birds were counted during both wet and dry seasons from the three lakes. Lesser Flamingos were the most abundant comprising 95.39%, while Greater Flamingos comprised 4.61%. These constituted 50.32% of the total species during the dry season and 49.68% during the wet season count. There were more flamingos during the dry season than the wet season in Lake Abijata ( $\chi^2 = 10.31$ ,  $df = 1$ ,  $P < 0.05$ ). The wet season count significantly outnumbered the dry season count in Lake Shalla ( $\chi^2 = 34.15$ ,  $df = 1$ ,  $P < 0.05$ ) and Lake Chitu ( $\chi^2 = 3.76$ ,  $df = 1$ ,  $P < 0.05$ ). The difference was also significant between lakes ( $\chi^2 = 24.83$ ,  $df = 2$ ,  $P < 0.05$ ) (Table 1).

From the total population, Lake Abijata harbors 46.47% and 25.28% Lesser and Greater Flamingos, respectively, and Lake Shalla supports 23.84% lesser and 63.43% Greater Flamingo, whereas Lake Chitu supports 29.68% and 11.29% of Lesser and Greater flamingos, respectively. Lake Abijata is the major stronghold of Lesser Flamingos in the area. There was significant variation in the mean number of Lesser Flamingo ( $F_{4,101} = 110.42$ ,  $P < 0.005$ ) and Greater Flamingo ( $F_{4,101} = 130.16$ ,  $P < 0.005$ ) during the wet and dry season in the different study sites of the lake, respectively. For both species, the highest record was obtained during the dry season in Bulbulla and Hora Kelo rivers inlet site and the lowest was in Haroresa mountain site for Lesser Flamingo and Savanna and Haroresa mountain sites for Greater Flamingo as represented in Table 1.

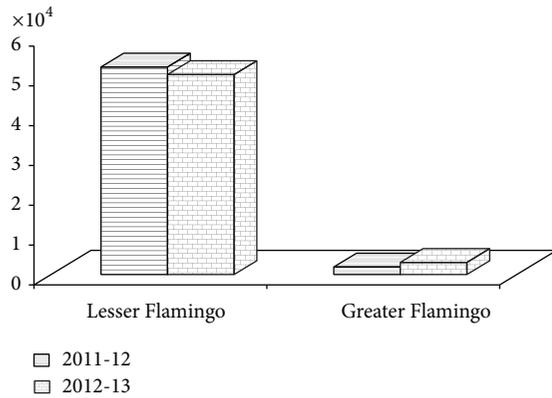


FIGURE 2: Mean number of Lesser and Greater Flamingos from 2011 to 2013 on the whole study sites.

There was no significant difference in the mean number of Lesser Flamingos of the two-year period on the three lakes ( $\chi^2 = 1.13$ ,  $df = 1$ ,  $P > 0.05$ ). However, the count of Greater Flamingo showed a significant variation among years ( $\chi^2 = 0.36$ ,  $df = 1$ ,  $P < 0.05$ ) (Figure 2). The highest record of Lesser Flamingo was obtained during 2011-2012 year count, while, for Greater Flamingo, the highest record was during 2012-2013 count.

The largest average flock size was for the Lesser Flamingos (10,000 birds) and for Greater Flamingos (14 birds). Lesser Flamingo flocks consisted of greater than 500 birds that are very common and flocks of less than 20 birds that are rare. Seasonal average flock sizes were not similar between the species (Table 2). Flock sizes were the largest during the wet season for both species and were significantly different across seasons, for Lesser Flamingos ( $\chi^2 = 4.14$ ,  $df = 1$ ,  $P < 0.05$ ) and for Greater Flamingos ( $\chi^2 = 1.11$ ,  $df = 1$ ,  $P < 0.05$ ).

Flamingos were observed in various parts of the lakes during the day. At Lake Abijata, birds were mainly observed along the northwest of the lake during early morning. During the late afternoon, they flew in flocks to the northeastern side and continue feeding during the course of the day. At night, most birds roost back in the northwest side of the lake. Lesser Flamingos were more frequent in shallow area of the lakes and mudflats, occasionally preferring man-made solar salt concentration ponds of Soda ash factories. Lesser Flamingos in Lake Chitu were most of the time concentrated on the southern and western side of the lake shore in relation to human disturbance.

The relative use of the different habitats by flamingo was statistically significant ( $F_{4,63} = 18.49$ ,  $P < 0.005$ ) as indicated in Figure 3. Lesser Flamingo showed a very high (65.91%) utilization on the shore line. This utilization of habitat by the Lesser Flamingo was very different from the habitat preference of Greater Flamingo (59.76%) which utilized offshore area of the lakes.

3.2. Activity Patterns. The data from Table 3 are used to show different activities of nonbreeding Lesser Flamingo. There was a strong relationship between time allocated to

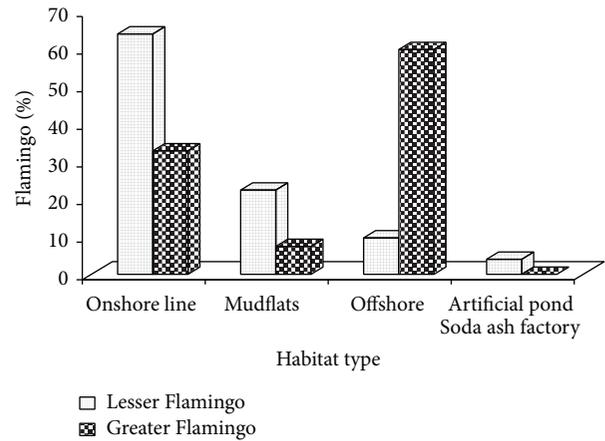


FIGURE 3: Percentage of flamingos observed at different habitat types.

TABLE 2: Group size of lesser and greater flamingos in the lakes.

Species	Season	Groups	Group size range	Mean group size
Lesser flamingo	Dry	52	2-4400	2100
	Wet	112	2-10,000	7300
Greater flamingo	Dry	26	2-18	15
	Wet	15	2-34	27

each activity and time of day. Feeding activity varied among daylight hours and was higher in the evening (76.5%) and late morning (74.56%) than least during midday (54%). The peaks in moving were similar to the peaks in feeding during all the time blocks of a day and preening and resting were higher during the midday.

Percent time spent in all activity differed significantly except alerting. On average, 68.35% of the bird day time was spent in feeding. Feeding occurred all hours but there was a reduction in feeding activity between 1200 and 1500 hours. Percent time spent in feeding, resting, and preening differed significantly based on seasons (Table 4). Lesser Flamingos fed least during the dry season (62.33%) and most during the wet season (77.91%). Preening activities occurred more during the wet season than the dry season. Alerting and moving showed insignificant variation in season. Resting activity varied between time of day and season. It always peaked during midday and the dry season.

#### 4. Discussion

Flamingos typically are the most prominent and important consumers in the lakes. The largest concentration of flamingo was 24,417 in Lake Abijata. However, drastic and sudden fluctuations in number can occur and there is a very marked exchange between the lakes. There were more flamingos during the dry season than the wet season in Lake Abijata and contrary to Lakes Shalla and Chitu during the wet season. Despite the observed fluctuations, the total flamingo population of the area remained relatively stable, suggesting that

TABLE 3: Percentage of time spent (mean  $\pm$  SD) on different activities by nonbreeding lesser flamingos based on time of day.

Activity	Time of the day (hours)				<i>H</i>	<i>P</i>
	0600–0900	0900–1200	1200–1500	1500–1800		
Feeding	68.33 $\pm$ 7.21	74.56 $\pm$ 4.2	54 $\pm$ 3.2	76.5 $\pm$ 4.5	51.12	0.000*
Moving	6.5 $\pm$ 5.11	7.17 $\pm$ 1.43	3.95 $\pm$ 0.21	10.67 $\pm$ 0.6	78.13	0.000*
Resting	8.83 $\pm$ 2.3	2.1 $\pm$ 0.3	20.55 $\pm$ 1.4	3.83 $\pm$ 0.2	42.11	0.000*
Preening	10.01 $\pm$ 3.4	8.67 $\pm$ 2.03	17.5 $\pm$ 2.1	2.33 $\pm$ 1.3	28.34	0.000*
Alerting	6.33 $\pm$ 1.62	7.5 $\pm$ 0.72	4 $\pm$ 0.78	6.67 $\pm$ 0.4	16.47	0.34

\*Differ significantly (Kruskal-Wallis test,  $P < 0.05$ ) between time blocks.

TABLE 4: Percentage of time spent (mean  $\pm$  SD) on different activities by nonbreeding lesser flamingos based on seasons.

Activity	Season		<i>H</i>	<i>P</i>
	Dry	Wet		
Feeding	62.33 $\pm$ 3.1	77.91 $\pm$ 2.4	37.23	0.000*
Moving	5.27 $\pm$ 2.3	7.11 $\pm$ 1.4	7.21	0.121
Resting	18.74 $\pm$ 1.7	1.27 $\pm$ 0.4	22.3	0.000*
Preening	5.36 $\pm$ 0.6	10.90 $\pm$ 2.2	27.12	0.000*
Alerting	8.3 $\pm$ 1.3	2.81 $\pm$ 0.3	3.45	0.141

\*Differ significantly (Kruskal-Wallis test,  $P < 0.05$ ) between seasons.

the flamingos responded to the effect of seasonal variation by moving between lakes. This aspect of behavior makes flamingos nonresident in any one saline lake, moving and exploiting various nearby lakes as their home range [40]. A seasonal pattern of abundance was observed which was positively correlated with weather and water level quality has been shown for many species of flamingos [41]. The algal food resources are not stable and decline from time to time [42]. Hence, any lake that provides food in suitable quality and quantity makes a valuable contribution to the survival of these birds. Therefore, seasonal abundance of diet might be the primary cause for the difference in the number of individuals within and among lakes. Diet abundance within lakes is associated with variations of water characteristics like conductivity and salinity [43].

The relative difference in the number of flamingos in Lake Abijata sites might be due to the difference in quantity of their diet among sites. In particular, differences in concentration of flamingos at the rivers inlet sites might be due to the concentration of algae as a result of fresh water nutrients provided by the rivers for algal growth and access to use the fresh water to drink. Vareschi [14] and Tuite [41] stated a striking characteristic of flamingos to strong fluctuations on Rift Valley Soda Lakes. Variations could also be caused by availability of fresh water [44].

The Greater Flamingos which occur at low density in the same habitat with the Lesser Flamingo are mostly found (63%) in Lake Shalla. This might be related to the feeding habit of the birds. Greater Flamingos are generalists consuming copepods, mollusks, and other small planktonic and benthic animals in addition to algae [4]. Greater Flamingos feed mainly on invertebrates which they filter from water or mud over a large range of habitats [45]. Shalla has poor phytoplankton and yet supports dense number of benthic organisms [46].

Flamingos are gregarious birds and form very large feeding groups. They form large foraging flocks, which can be interpreted as a consequence of the high patchiness of food distribution. On several occasions, Greater Flamingos showed preference to offshore area of the lakes. In contrast, Lesser Flamingo mainly preferred the shoreline and mudflat of the lakes. This preference for shallow water bodies may be related to the species' foraging behavior, characterized by feeding on small diatoms and *Spirulina* near the lake banks. Lesser Flamingos require shallow eutrophic wetlands and waterbodies which are more saline than those used by the Greater Flamingos, because it feeds mainly blue-green algae that bloom under these conditions [47]. During the wet season, Lesser Flamingos at Lake Abijata were observed in mudflat habitat where diatoms may be plentiful [48].

Feeding usually was the major activity of flamingo, probably because of the small size of their prey items that flamingos are forced to spend more time on feeding than on other forms of behavior. More feeding activity of flamingo in the late afternoon may reflect their need to obtain energy for overnight energetic requirements. The general pattern of flamingo feeding in different regions worldwide is that they fed mainly during morning and late afternoon to early evening and roosted during the midday [35]. The rate of resting was the highest in the middle of the day, between 012:00 and 15:00. Probably, the main purpose of this rest is to avoid the heat of the day to conserve water loss. Flamingos spend more time in feeding activities during the wet than dry seasons. There are several possible explanations. It is their breeding season which necessitates an increase in forage intake regardless of the ambient conditions. However, the main effect was the decline of availability of their diet in the area (Lake Abijata) during wet season [48]. Preening showed a significant variation with season and time of a day (high during midday and low during late afternoon). It plays an important role in deparasitisation and feather adjustment [49]. Similar to preening, moving showed marked seasonal and time of day changes. Individuals spent more time moving in the afternoon partly because a fraction of the population left the site to go to another one after having taken the required food intake and also disturbance by raptors (African fish eagle) occurs mainly in the afternoon.

## 5. Conclusion

Seasonal and annual fluctuations are observed in the total number of birds counted. Such changes in flamingo counts

at individual lakes may indicate changes in the importance of each of these Soda lakes both within years and between years. The distribution and abundance of flamingos are related to food supply. Thus, changes in the numbers of flamingos at a particular lake during the year and between years may reflect fluctuations in the availability of food supply and may at least in part be a result of anthropogenic activities. Conservation efforts in the park should include not only the wild flora and fauna not only of the land but also of the aquatic systems because both places represent one integrated system. Presently, there is no effective protection of flamingo feeding areas or enforcement of laws protecting the bird. Ethiopian Wildlife Conservation Authority should take a more positive position action to protect flamingos.

### Conflict of Interests

The authors declare that there is no conflict of interests regarding the publication of this paper.

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