Journal of Animal & Plant Sciences, 34(1): 2024, Page: 145-156
ISSN (print): 1018-7081; ISSN (online): 2309-8694
https://doi.org/10.36899/JAPS.2024.1.0703

POPULATION MONITORING AND MAJOR THREATS TO DEMOISELLE CRANE (*GRUS VIRGO)* AT LASBELA COAST, BALOCHISTAN, PAKISTAN

S. Qayum[1], M. A. Kalhoro[1*], A. Hakeem[1], M. Dashti[2], Atiq-ur-Rehman[1] and M. Shafi[1]

[1]Faculty of Marine Sciences, Lasbela University of Agriculture, Water and Marine Sciences. Uthal, Pakistan
[2]Balochistan Wildlife and Forest Department (Ten Billion Trees Tsunami Program), Government of Balochistan, Pakistan
[*]Corresponding author: muhsanabbasi@yahoo.com

ABSTRACT

The Demoiselle Crane (*Grus virgo*) is one of the most threatened bird species in the world as it is indicated as "Least Concern" under the IUCN and Bird Life International category. To evaluate the current status and threats to *G. virgo* from Lasbela coast, two field stations were selected i. e, Siranda lake and Sonmiani area. Data were based on daily observation monitored during February, March, April, September, October, November, and December during 2020-2021. The line transit method and questionnaire-interview based survey was used to estimate the bird population and threats to birds population. Total of 322,143 numbers of cranes were observed in which 142700 in autumn and 179443 during spring season. Area wise distribution of cranes were detected at 271701 from Sarinda lake while, 50442 cranes were observed from Sonmiani area. It was also noted that during autumn overall 136850 cranes were observed in flying mode while 5850 were observed at resting stage, however in Spring 167330 were in flying and 12113 were at resting. Overall, high population was observed during spring season at 55.7% while population during autumn was observed at 44.29%. It was also noted that during present study the percentage of flying cranes are higher than the resting cranes and higher numbers were observed from Sarinda lake compared to Sonmiani area. This maybe because the Sarinda lake is far from city area so cranes prefer to rest compare to Sonmiani area. The hunting information was collected from local community, government agencies and personal visits at local areas. It was noted that total of 116 numbers of cranes were hunted during the study period from which 74 cranes were hunted using gunshot and 42 cranes were caught alive. Most of the hunting cranes were operated during March. We may assume that these sites (study area) are short term stay for these guest birds. However, due to certain reasons it may also be noted that flying cranes are higher than the resting cranes which shows that these sites also indicate the threats to the cranes. It may also suggest that hunting must be prohibited and Sarinda lake should be declared as Ramsar site for the conservation of migratory birds.

Key words: Sarinda lake, Siberian crane, Endangered, Hunting, Lasbela, Pakistan

Published first online November 12, 2023 Published final January 20, 2024

INTRODUCTION

Migratory birds are defined as the birds moving from one place to another even on each side of the world depending on season. Most of the wetlands on earth planet have fame for migratory birds. The migratory birds evade over inter space hundreds of kilometers in search for better ecological conditions, feeding, breeding, good habitat and elevating their offspring (Meine and George 1996). Some cranes migrate from north breeding locations to south wintering foundations in the summer, while others breed in the far south of Africa and migrate to northern wintering foundations in the winter or migrate straight to enjoy the coastal temperatures (Meine and George 1996). In the summer, other birds fly higher (toward mountains), while in the winter, they migrate to lower elevations, such as the "Rann of Kachchh," where the desert meets the Sea. Migratory birds like flamingo with their flashing pink plumage, arrive in thousands to ramp nest mounds from the salty mud and exalt their young ones in Rann of Kachchh region (Jiang *et al*., 2014).

The *Grus virgo* belongs to family "*Gruidae* is generally known as Demoiselle Crane and locally known as "Koonjh", under threat of extinction. The *G. virgo* is one of the most endangered bird species in the world as it is indicated as "Least Concern" under the IUCN and BirdLife International category (Meine and George 1996; De-Lima *et al*., 2011). Every year, almost all Siberian cranes move about 5000 kilometres between their breeding habitats in northern Russia and their wintering homes in southern China (Qian *et al.,* 2009). So far, their breeding sites in northern Russia have remained mostly unaffected. The *G. virgo* is threatened by abasement and habitat loss. In accretion, they migrate over tedious distances meanwhile facing hunting pressure and crossing Himalayas. Extensive conservation struggles are animated, but preferred

expectation is given to protect the greater migration corridor in west Asia by the assistance of crossed countries. When cranes (*Gruidae*) use wetlands, grasslands or agriculture area as per stopover sites, they make biannual migration (Archibald *et al.*, 1983; Meine and George 1996). Cranes are endangered species when they migrate from south Asia to south -eastern and northern China to central China and Japan without protective stopover. Habitat loss and abjection on their migrating, staging, and wintering sites in China are huge risks to Siberian cranes. Anthropogenic activities such as hydraulic engineering and wetland reclamation for fisheries and agriculture are causing habitat destruction and endangering the crane population (Hou *et al.,* 2006). Meanwhile, human activities have a negative impact on foraging, breeding, and resting places during migration (Smyth *et al.,* 2010). Because this species of mammoth wetland wading bird has a particular preference for their habitats (Chen *et al.,* 2011), it prefers to wade and forage on tubers of immersed aquatic macrophyte, such as water saturated soil or shallow water, it is also vulnerable to morphological changes in the environment (Wu *et al*., 2009).

Pakistan has a suitable environmental weather conditions especially in winter season for the many migratory bird species. Cranes stop at different locations in Pakistan like few areas in Balochista in which Lasbela coast is one of the most attractive places for migratory birds, Khyber Pakhtunkhwa and also Indus River areas of Sindh where they found suitable location, they stopover and move forward to the Indian sub-continent. During the winter season most of Pakistan wetlands attract a large number of migratory birds. It primarily serves as a migratory bird route through central Asia. Water birds arriving from Siberia use wetlands from the northern mountains to the southern coast as a stopover (Gemeda *et al*., 2016). Around one million birds are estimated to migrate along international migratory bird route number 4 over a distance of about 2800 miles (4500 km). In Pakistan, the number of species stopping at water reservoirs has decreased dramatically. Houbara bustards, Cranes, Teals, Pintails, Mallards, Geese, Spoon bills, Waders, and Pelicans are among the major bird species that migrate from Siberia to Pakistani territory (Kumar and Arvind, 2016). Pakistan is located on the largest Siberian cranes central flyway. However, Siberian crane historically flyway similar to Eurasian cranes and other water birds. They flutter over the Indus River valley via using different avenues in Balochistan province including Quetta, Zhob, Loralai, Noshki, Chagai, Kharan, Lasbela for migration. Cranes also found from south part of Pakistan and mostly observed on Indus River connecting to Taunsa Barrage and D.I Khan and small areas associated with Indus River etc (like Zhob, Luni, Kashu and Kurram) gliding through the districts of Zhob, D.I Khan Bannu and Parachinar, respectively (Ahmed, 1991). Limited research has been conducted on crane population from different locations of Pakistan like Zhob Balochistan and Kyber Pakhtunkhwa (Kozma *et al*., 1995; Khan, 2004; Khan *et al*., 2010, 2011; Perveen and Khan, 2010; Perveen, 2012). Siberian cranes have a gateway from Pakistan to the different locations to India. Most of these collected data are reports of insights by residents and crane hunters meanwhile they were camping along the river and the only perception by a professional biologist (Ahmed, 1991). None of them have been observed conceited assurance except the perception by hunters who killed a Siberian crane at the Zhob river in March 1987 and prolonged its head and legs are indication that it was a Siberian crane (Wijnen *et al.,* 1995). The most symbolist wetlands along these flyways are the Taunsa Barrage reservoir in Punjab province and Thanedarwala in Khyber Pakhtunkhwa province.

Based on our knowledge limited work has been done on the population monitoring of *G. virgo* from Lasebla coast and no literature available for Sonmiani, and Sarinda lake which is also wetland area. Sonmiani area is also called Miani-Hor receives freshwater from small rivers in result creates mangrove forest ecosystem which provide shelter for fisheries as well as many native and migratory birds. However, Sarinda wetland area also called lake is large freshwater reservoirs which creates suitable environment for many living organisms and also attracts migratory birds and provide food and shelter for short term stay. Current study is not only regarding population monitoring but also identify the threats to the *G. virgo* species from Lasebla coast (Sonmiani, and Sarinda lake), Balochistan. Based on present findings, wildlife conservation department will be guided to take precautions to work on the conservation for this species in Pakistan.

MATERIALS AND METHODS

Study area: To evaluate the status of *G. virgo* along Lasbela coast, two sites were selected i.e Siranda lake (25º 32 N 66º36E) and Sonmiani area (25º 25 N 66º35E) (Figure 1, 2, 3). Data based on daily observations poured from February, March, and April, 2020 during arrival season from Siberia to September, October, November, and December 2021 during the departure season from Pakistani areas towards Siberia. Khurkhera is small town situated near winder city (Sarinda lake) along the coastal area of Sonmiani (Daam) (26◦03′N, 66◦44′E), it is 10 km away from north to winder and 40 km South to Uthal, district Lasbela. The area is separated from the neighbouring Sonmiani bay by a vast sandy peninsula, which is home to various low-lying islands, massive mangrove swamps, and intertidal mudflats. The MianiHor gets its water from a few seasonal streams that rise in the highlands of eastern Balochistan to the north and empties into Sonmiani bay via a huge waterway at its eastern end.

Fig.1 Pakistan coastline showing study area Sonmiani (25º 25 N 66º35E) and Sarinda lake (25º 32 N 66º36E) study area (source; Google earth)

Fig 2. Demoiselle Crane (*G.virgo*) observation during resting and traces from Sarinda lake and Sonmiani beach, A)MianiHor near Shahjamal during March 12-2020, B) Sarinda lake during Feb 28, 2020 by author; C) Sarinda lake during Oct 19, 2021, Courtesy by: Mr. Adil Rathor; D) Sonmiani creek area during 19 Nov, 2021 by scholar

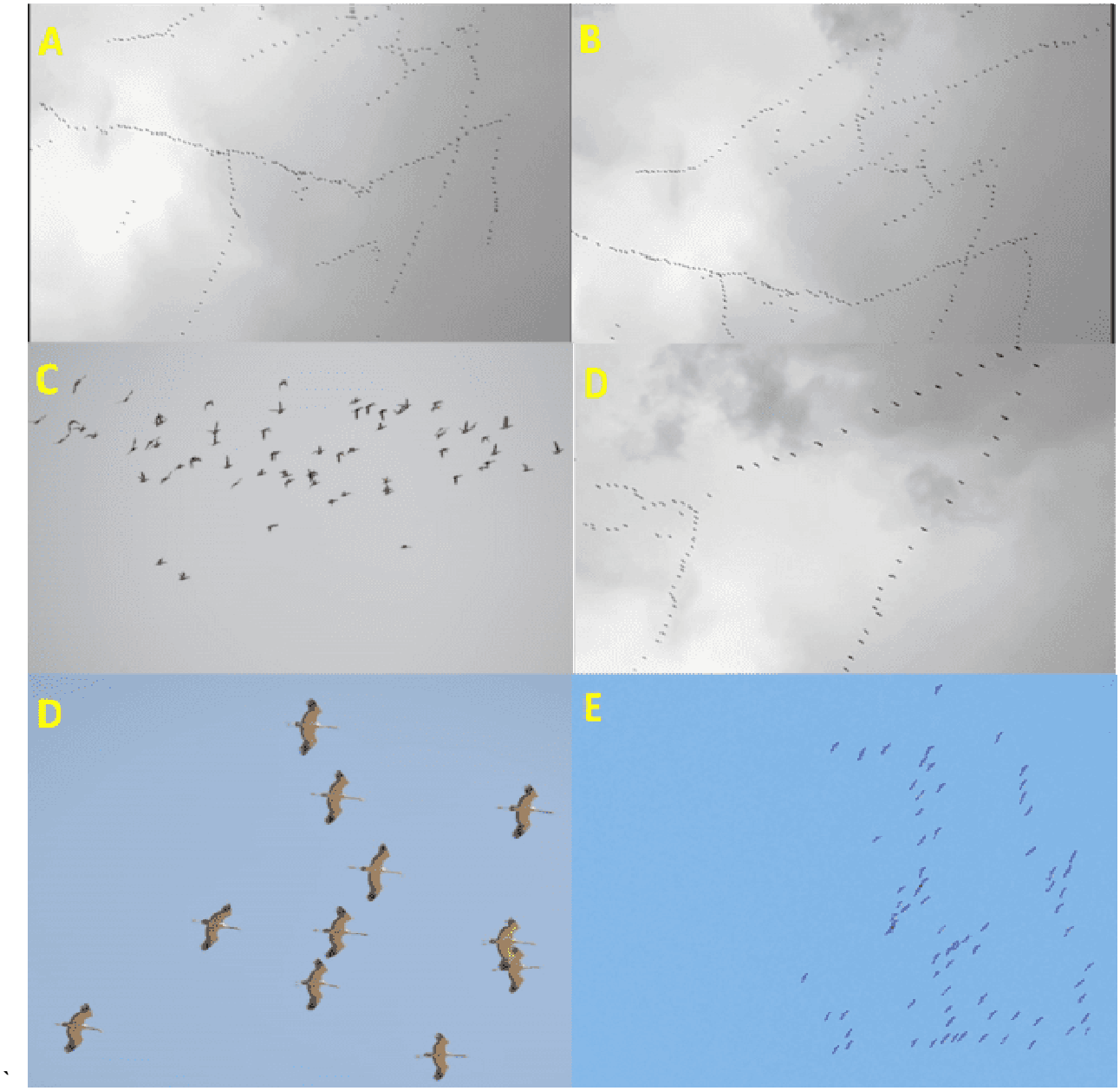

Fig. 3. Crane (*G.virgo*) observation during flying mood from Sarinda lake and Sonmiani area; A) MianiHor during Oct 19, 2021, Courtesy by: Mr. Adil Rathor; B) MianiHor V-shaped flying on Dec 12, 2021 by author; C) Sarinda lake on Dec 12, 2021 by author; D & E) MianiHor during 14 Dec, 2021, Courtesy by: Mr. Adil Rathore

Sampling Strategies: The weekly observations were divided into morning and evening timing and flying and resting on monthly and seasonal basis from study area. The observations were based on visual and photographic collection. During the winter season, birds were seemed at their most active times of the day, which is early morning (6:00 to 10:00 AM) and late afternoon (16:30 to 19:00) starts from March 2020 throughout up to December 2021 timeframe.

Line transect sampling is a non-model sampling; it helps the distribution of an organism changes across an area. Tape measure promote to mark out the line which we want to study, the next step was counting the organisms along the line, either by counting the ones touching the line or using quadrats placed at regular intervals. Line transect method was used for movement observation of migratory birds at Sarinda lake at Khurkhera and nearby wetlands top over sites. An observer travel along a defined line of a specific length, counting the number of birds, nests, or

other pertinent things such as burrows, droppings, and tracks (Buckland *et al.,* 1993). The presence or absence of species at each marked point was recorded, or the species touching the line will be reported along the entire length of the line (continuous sampling). Social survey was carried out for hunting and threats information was collected during field visits based on questionnaire from local community, hunters from other areas, NGOs and Government agencies.

RESULTS AND DISCUSSION

Population of Grus virgo in the spring season: During spring season population monitoring of *G. virgo* were observed from February to April 2020. This is usually the arrival time for the migratory birds from different regions of Siberia towards Pakistan and Indian Territory. Overall, 179,443 numbers of cranes were observed during spring season, from which 167,330 were in flying mode, while 12113 cranes were at resting during these months. The overall area wise population distribution of cranes was analysed like from Sarinda lake in morning as flying and resting stage at 32990 (±19.71) and 6251 (±51.6) respectively, while in evening 74200 (±44.34) and 3400 (±28) respectively during March. However, from Sonmiani the flying and resting cranes were observed at 4750 (±2.83) and 500 (±4.12) respectively in morning, while, 28800 (±17.2) and 192 (±1.58) respectively, in evening during March. The observation of flying and resting from Sarinda lake in morning and evening was observed at 200 (±0.11) and 16000 (±9.56) respectively, while no any resting bird was observed in morning and evening from Sarinda lake during April. It was also noted that there were 5300 (±3.16) number of flying cranes were observed in evening from Sonmiani, however there was no any observation was noticed during April. The observation of flying and resting during February in morning was 1950 (±1.16) and 1020 (±8.42) respectively, while in evening 3140 (±1.87) and 750 (±6.19) respectively was found (Table 1, Figure 4). Overall observation of flying cranes was found higher at 93% while, 7% was observed at resting during spring season from study area.

Table 1. Total distribution of Demoiselle Crane during spring (2020) season

Months	Flying	Resting	Flying (±SE)	Resting (±SE)
March Siranda morning	32990	6251	19.715	51.605
March Siranda evening	74200	3400	44.343	28.069
March Sonmiani morning	4750	500	2.838	4.127
March Sonmiani evening	28800	192	17.211	1.585
April Siranda moning	200	0	0.119	0
April Siranda evening	16000	0	9.561	0
April Sonmiani morning	0	0	0	0
April Sonmiani evening	5300	0	3.167	0
February Siranda morning	1950	1020	1.165	8.421
February Siranda evening	3140	750	1.876	6.192
Total	167330	12113	-	-

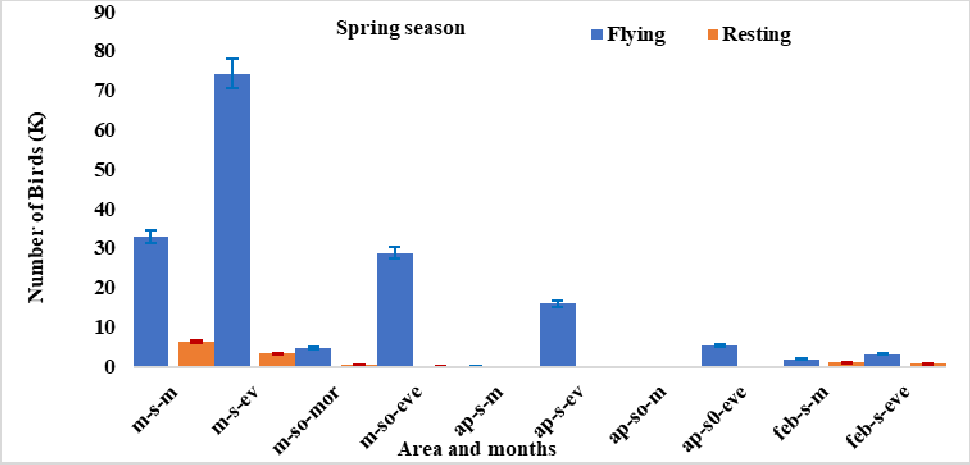

Fig 4. Flying and resting birds distribution of cranes in the spring season

Grus virgo Population during Autumn Season: Overall population of cranes during autumn was distributed from September to December 2021. Autumn season is the time for departure of those migratory birds through Pakistan territory, where guest birds stay at their suitable areas for resting and feeding purpose. Total of 142,700 numbers of flying and resting cranes were detected in autumn season in which 136850 were flying mode and 5850 were at resting from study area. The area and month wise distribution were observed during September in morning the flying and resting birds were at 6300 (±4.6) and 2250 (±38.46) respectively from Sarinda, while only flying cranes at 17850 (±13) in evening were observed. However, in October the flying and resting cranes were observed at 19950 (±14.57) and 400 (±6.87) respectively in morning, and only flying cranes at 30500 were detected in evening time from Sarinda lake. Whereas, during October from Sonmiani in morning and evening there was only flying cranes were observed at 5650 and 5250 respectively. The morning and evening observation of flying and resting cranes from Sarinda were at 12300 (±8.98), 1450 (±24.78) and 27400 (±20), 800 (±13.67) respectively, during November. The morning observation from Sarinda of flying at 7150 (±5.22) while no resting bird was detected, however, in evening 4500 (±3.2) and 950 (±16.23) flying and resting respectively were observed during December. During present observation in autumn season, it was observed that 96% of flying and only 4% were observed at resting stage from study area (Table 2, Figure 5).

Overall Population from Sonmiani and Sarinda Lake: Study on monitoring of *G. virgo* was conducted during autumn and spring from Sarinda and Sonmiani area. Total of 322,143 numbers of cranes were observed in which 142,700 in autumn and 179,443 during spring season. Area wise distribution of cranes were detected at 271,701 from Sarinda area while, 50442 cranes were observed from Sonmiani area (Table 3). It was also noted that during autumn overall 136,850 cranes were observed in flying mode while 5850 were observed at resting stage, however in Spring 167,330 were in flying and 12113 were at resting (Figure 4, Table 1). By and large, high populace was seen during spring season at 55.7% while populace during pre-winter was seen at 44.29%. The low level of populace demonstrates that the appearance cranes populace is lower than the take-off crane during spring season. This peculiarity shows that Pakistani region is appropriate for the favorable places for Siberian cranes.

Table 2. Total distribution of Demoiselle Crane during autumn (2021) season.

Season	Flying	Resting	Flying (±SE)	Resting (±SE)
Sept Sarinda Morning	6300	2250	4.603	38.461
Sept Sarinda Evening	17850	0	13.043	0
Oct Sarinda Morning	19950	400	14.578	6.837
Oct Sarinda Evening	30500	0	22.287	0
Oct Sonmiani morning	5650	0	4.128	0
Oct Sonmiani evening	5250	0	3.836	0
Nov Sarinda Morning	12300	1450	8.987	24.786
Nov Sarinda Evening	27400	800	20.021	13.675
Dec Sarinda Morning	7150	0	5.225	0
Dec Sarinda Evening	4500	950	3.288	16.239
Total	136850	5850		

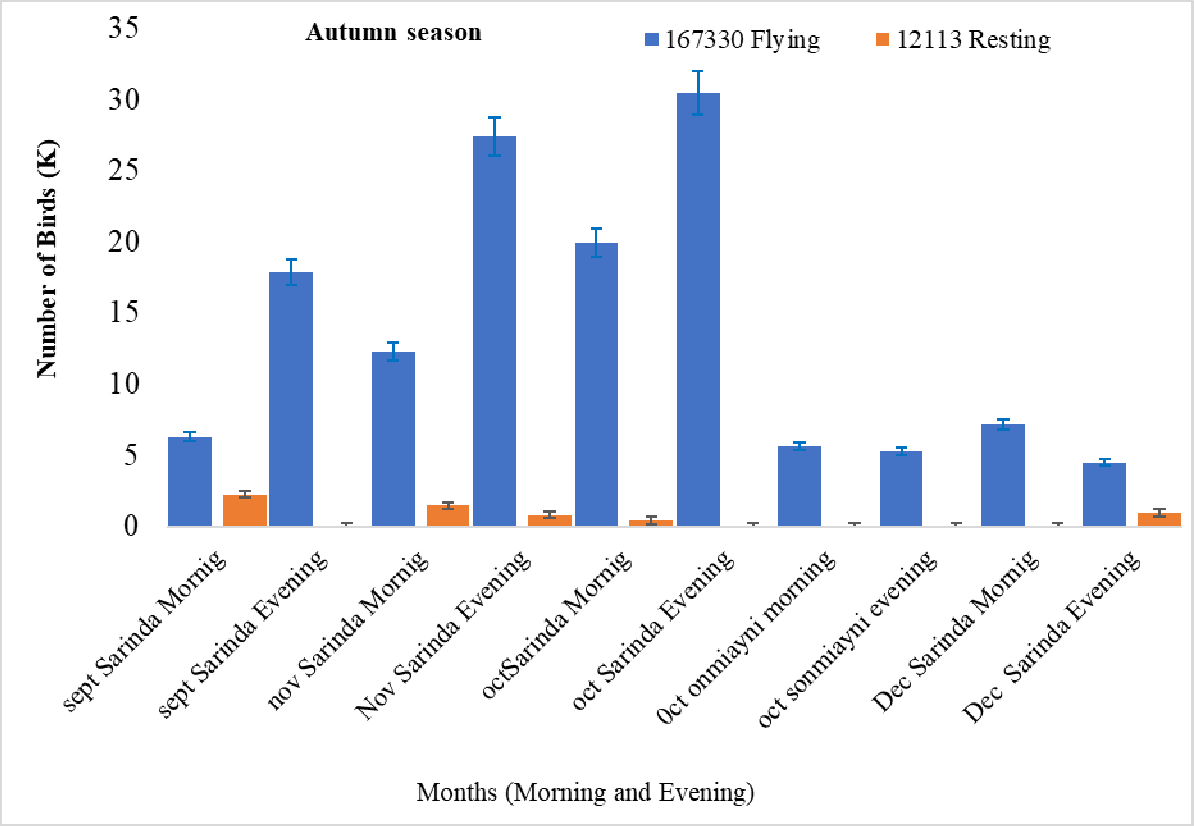

Fig 5. Flying and resting birds distribution during different months in morning and evening sessions of cranes in the autumn season

Table 3. Total seasonal distribution from study area in flying and resting mode

S.No	Area	Number	Season	Flying	Resting	Total
1.	Sonmiani	50442	Autumn	136,850	5850	142,700
2.	Sarinda	271,701	Spring	167,330	12113	179,443
	Total	322,143	Total	304,180	17,963	322,143

Table 4. Distribution from study area during flying and resting.

S.No	Area	Flying	Resting	Total
1.	Sonmiani	49750	692	50442
2.	Sarinda lake	254430	17271	271701
	Total	304,180	17,963	322,143

It is likewise noticed that during present findings the level of flying cranes are higher than the resting cranes. During spring 93% were found in flying mode while 95% were observed during autumn season, remaining were at resting mode from study area. Siberian cranes are a lot of sensitive and smart to recognize danger around the area and can screen the state of propensities. So, we might expect that these destinations (Sonmiani and Sarinda area) are transient stay for these visitor birds and prefer to use as fly zone. This peculiarity likewise shows that cranes also travel to Sindh province along Indus Delta region and other wetland areas and further to Indian region wetland areas.

Hunting and Threats from Study Area (Sonmiani and Sarinda): The data was collected during personal visits and information gathered from local community, government and non-government agencies. It was found that the basic reason for hunting and trapping was just a recreational activity for the hunters. Most of the hunters considered that it is a symbol of pride and honor, so they hunt and also keep alive as a pet. The only domestic use of crane species noticed in the area was its occasional use as a food. Economic incentives gained from the hunting and commercial trade was negligible. Normally alive cranes are also gifted to their friends.

The infrequent hunting use of gunfire was reported from the study area. Live capturing and shooting cause a serious damage to the population to the crane species across its resting stages in Lasbela. Total of 116 numbers of cranes were hunted during the study period from which 74 cranes were hunted using gunshot and 42 were caught alive. The highest number of hunting cranes 60 by gunshot and 25 captured alive in March which show that 73.2% hunting was operated during March. During October it was also noticed that 15 cranes were captured alive (Figure 7). During present study it was observed that hunting is the major threat to the migratory birds around the area. However, climate change, alteration in mangrove forests due to climate change and manmade is a major threat to habitat deterioration is a major threat to the migratory birds.

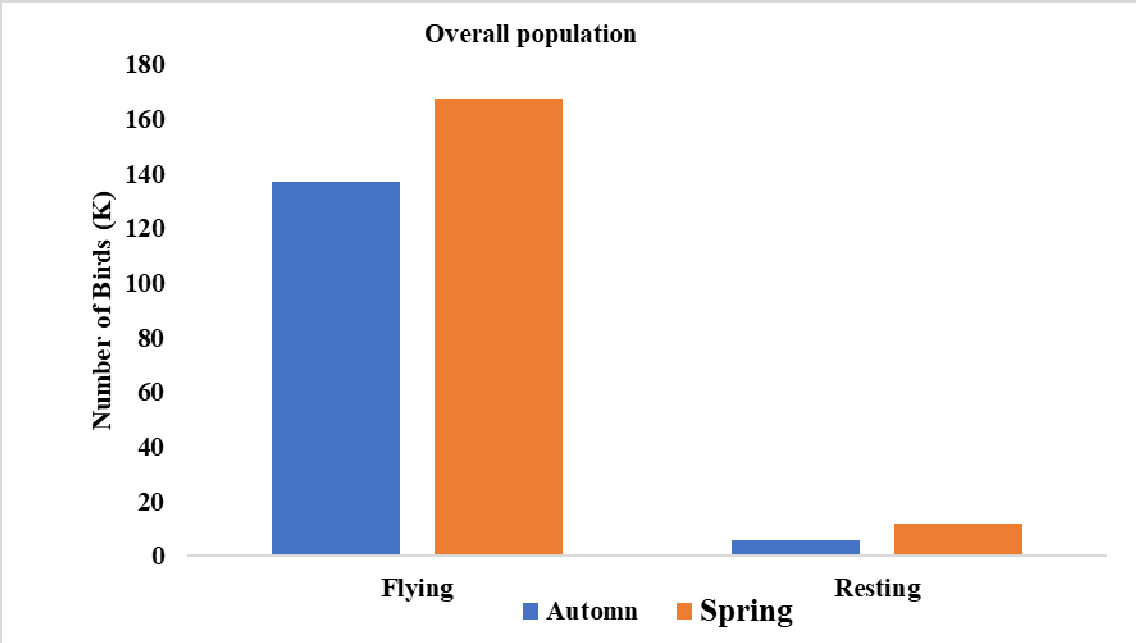

Fig 6. Overall population of cranes in autumn and spring season at flying and resting behaviour

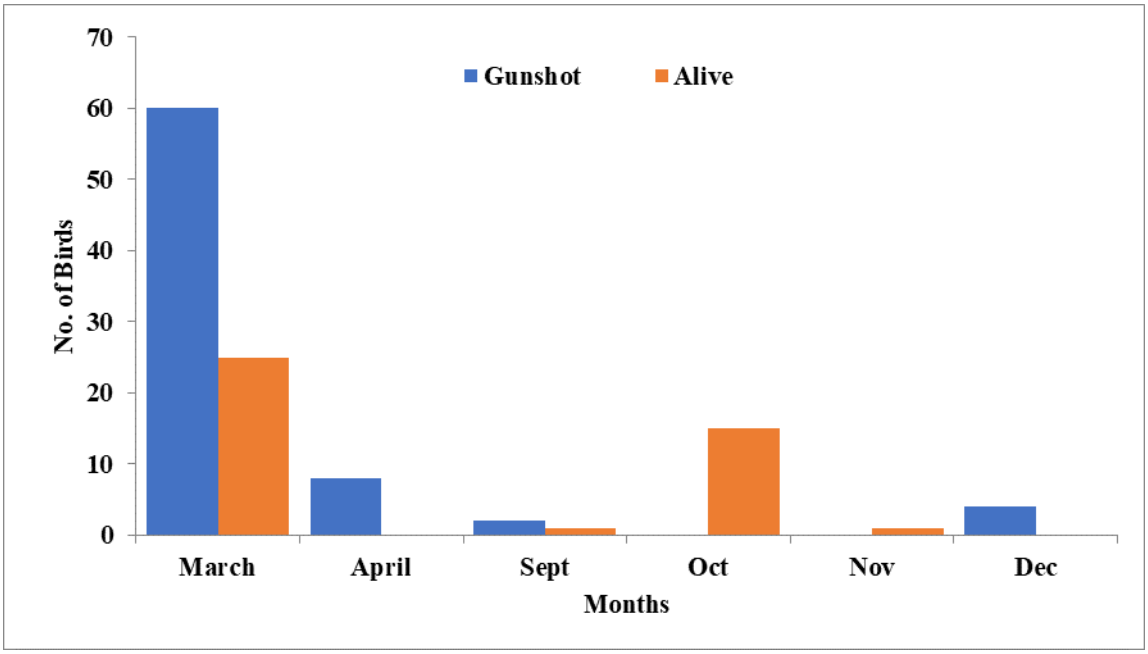

Fig.7.Hunting method ratio used in the study area during 2020-2021

Fig. 8. Catching of live crane and hunting using instruments methods from study area. A & B) Hunting; C) live trapping using instrument.

DISCUSSION

The population monitoring and major threats to *G. virgo* crane were studied from Sarinda lake also called wetland area and Sonmiani area (MianiHor) during present study. Total of 322,143 numbers of cranes were observed in which 142,700 were in autumn and 179443 during spring season (Table 4). Area wise distribution of cranes were detected at 271,701 from Sarinda lake while, 50,442 cranes were observed from Sonmiani area. It was also noted that during autumn overall 136,850 cranes were observed in flying mode while, 5850 were observed at resting stage, however in spring 167,330 were in flying and 12,113 were at resting mode (Figure 4. Table 1). It is also noted that the higher number of populations was observed during spring season at 55.7% while 44.29% were observed during pre-winter season.

Grus virgo is very attractive with long neck legs and life span and lift the human spirit compare to the other animals. Migratory species are recognized to perform some of the most arduous endurance feats in the animal kingdom. Despite the fact that majority of species migrate across different regions, oceans, and hemispheres, most are unable to provide services in all of them. Migrants' survival and reproduction are highly reliant on properly placed breeding and feeding locations (Murray *et al*., 2018). Seasonal resource availability does, in fact, constrain many species in terms of time and space. For the vast majority of migratory bird species, Pakistan is an ideal wintering and breeding destination for many bird species. These migratory birds have need large food and space requirements, and the natural ecology provides plenty of trees, plantations, and grasses to meet them. However, anthropogenic activities and overhunting of Cranes, Dalmatian Pelicans, Black-headed Ibis, Painted Storks, Geese, Coots, and Ducks resulted in a significant decrease in their numbers in a specific area.

Warm waters in Pakistan marshes have long provided a haven for millions of birds migrating from Siberia to avoid the cold. However, due to many environmental variables and hunting by local and foreign residents in the area, the number of migrating birds has been steadily declining. Crane hunting is more enjoyable than anything else in district Lasbela, Balochistan. The early personnel were well aware of several risks to cranes (Siewertsen *et al*., 2009). As the number of hunters increases year after year in result the catching or shooting ratio of cranes increases. Habitat deterioration is the second major danger to crane migration. Cranes' habitat and migration routes are heavily polluted by untreated sewage from home and industrial sources. In addition to agricultural growth, river canalizations, deforestation, and road construction are eliminating many of the breeding wetlands that support more than a quarter of the crane population (Weis *et al.*, 2006). The fact that risks to crane populations are always increasing is frightening, as there is no effective conservation on a broad scale. Cranes suffer the most serious risks in Asia and Sub-Saharan Africa, high human populations, intense land usage, and economic development that is sometimes poorly integrated with environmental preservation (James and Mirande, 2013).

The hunting information was collected from local community, government agencies and personal visits at local areas. It was noted that total of 116 numbers of cranes were hunted during the study period from which 74 cranes were hunted using gunshot and 42 cranes were caught alive. Local people also used vocalize instruments to catch live cranes to use as pet animal or sold to other cities for earnings (Figure 8). This vocalized instrument used to generate cranes voices/sound to attract and get attention to other cranes to stay and stop that area because cranes like to stay and fly in groups and people hide traps to capture the live cranes.

Based on our knowledge there is no any recent material available regarding the status of migratory birds specially crane from study area (Lasbela coast). However, population assessment of cranes were estimated from district Zhob and estimated that during autumn 4710 number of cranes were observed, while 35688 numbers of cranes were observed during spring season (Khan *et al*., 2011). Total number of cranes during autumn and spring were 5960 and 38340 respectively, which indicates that the crane migration was much higher during spring season which also similar to present study (Khan *et al*., 2011). During present study it was observed that high number of crane population were found at flying mode compare to resting mode which is similar to previous studies and higher numbers were observed during evening time conducted from Zhob district by Khan *et al.* (2011). The total crane population from D.I Khan-Pannu and Parachiinar route and Zhob were 35000-50000 in spring season (Ahmad and Jan, 1995). It was also studied that 7000 cranes were passed from Lakki and Bannu districts of Khyber Pakhtunkhwa during autumn and spring season of 2008-2009 (Perveen and Khan, 2010; Khan *et al*., 2010). However, about 5000 cranes which could be 10-15% of total migratory birds were hunted either by captured or by gunshot in single season (Kozma *et al*., 1995). Overall, observations indicates that the higher number of cranes migrate from Lasbela area compared to Zhob of other areas of Balochistan. This phenomenon indicates that this species prefers to migrate along the coast and far from city area. It was also observed that Lasbela coast is also suitable region for the flying and resting for the migratory birds. Sonmiani is also rich in mangrove ecosystem which may also attract birds and provide shelter and food for short term stay for migratory birds. During present study it was observed that high population were observed from Sarinda lake/wetland area compared to Sonmiani area it maybe because urbanization and more human interference activities at Sonmiani. Cranes are very much sensitive and clever to detect the threats around the area and can monitor

the habitat situation. Sarinda lake is far from city area which provides more shelter and peaceful environment for the resting for the migratory birds. However, urbanization and loss of mangroves trees affects the crane population from study area.

Beside other issues hunting is a major factor of decreasing migratory birds in western as well as in Asia (Landon *et al*., 2009). Data during 2001 reveals that more than 4500 crane were capture live and 100 were captured by gunshot in Pakistan (Khan, 2004). It was also observed that overall crane habitat is shrinking rapidly which directly impact on the decrease in crane population (Rehman *et al*., 2022). It was also observed that threats to the crane population were continuously increasing because of no effective approaches for the conservation of cranes (Perveen, 2012).

Conclusions: Present study was focused on monitoring population status and major threats to *G. virgo* from Lasbela coast (Sarinda lake/wetland area and Sonmiani) Balochistan, Pakistan. High population was observed at Sarinda lake compare to Sonmiani area maybe because it is a bit far from city area and less human activities. Flying ratio (55.7%) was higher than resting birds (44.29%) which indicates that many factors influence on the resting stage from this area.

Acknowledgements: The authors are highly indebted to the worthy Vice Chancellor Prof. Dr. Dost Muhammad Baloch, Lasbela University of Agriculture Water and Marine Sciences. Authors also like to thank Dr. Muhammad Aslam, Dean Faculty of Marine Sciences and Mr. Adil Anwar Rathore (Lab Attendant) Research Centre at Damb for their technical support and help in data collection. Authors are also thankful to Forest and Wildlife Department, Government of Pakistan. The present work supported by Forest and Wildlife Department, Government of Balochistan under the Ten Billion Trees Tsunami Program, No.968-72, dated 08-06-2020, Project Director Conservator of Forest, Quetta, Balochistan, Pakistan.

Statement of conflict of interest: The authors declare that there is no conflict of interests regarding the publication of this article.

REFERENCES

Ahmad, A. and A. Jan (1995). Crane research and protection in Europe. Halle-Wittenberg: Martin-Luther Universität, pp. 337-352.

Ahmed, M. (1991). *A model to determine benefits obtainable from the management of riverine fisheries of Bangladesh* (728): ICLARM Tech. Rep. 28, 133 p. ISSN 01 15-5547 ISBN 971-8709-08-8

Archibald, C. P., D. Fournier and B. M. Leaman (1983). Reconstruction of stock history and development of rehabilitation strategies for Pacific Ocean perch in Queen Charlotte Sound, Canada. North American J. Fisheries Management, 3(3): 283-294. https://doi.org/10.1577/1548-8659(1983)3<283:ROSHAD>2.0.CO;2

Buckland, S.T., D.R. Anderson, K.P. Burnham and J.L. Laake (1993). *Distance Sampling: Estimating Abundance of Biological Populations*. Chapman and Hall, London. 446pp

Chen, H, Y. Qin, Q. Zhang, W. Jiang, L. Tang, J. Liu and Q. He (2011). Lactoferrin modified doxorubicin-loaded procationic liposomes for the treatment of gliomas. European J. Pharmaceutical Sci., 44(1-2): 164-173. https://doi.org/10.1016/j.ejps.2011.07.007

De-Lima, R. F, J.P. Bird and J. Barlow (2011). Research effort allocation and the conservation of restricted-range island bird species. Biological Conservation, 144(1), 627-632. https://doi.org/10.1016/j.biocon.2010.10.021

Gemeda, D.O, M.A. Abebayehu, D.H. Feyessa, A.D. Sima and M.G. Tariku (2016). Community knowledge, attitude and practice towards black crowned crane (*Balearica pavonina* L.) conservation in Chora Boter district of Jimma Zone, Ethiopia. J. Ecology and the Natural Environment.8: 40-48. DOI: 10.5897/JENE2015.0549

James, H and C. Mirande (2013). A global overview of cranes: status, threats and conservation priorities. Avian Research.4: 189-209. Doi:10.5122/cbirds.2013.0025

Hou, M.T. K, G.K.W. Huang, J.Y. Huang, K.M. Liao, R. Chen and J.L.A. Yeh (2006). Extending displacements of comb drive actuators by adding secondary comb electrodes. J. Micromechanics and Microengineering, 16(4): 684-691. DOI:10.1088/0960-1317/16/4/003

Jiang, F., S. Qi, F. Liao, M. Ding and Y. Wang (2014). Vulnerability of Siberian Crane habitat to water level in Poyang Lake wetland, China. GI Science & Remote Sensing, 51(6): 662-676. https://doi.org/10.1080/15481603.2014.978126

Khan, A. (2004). Habitat status and hunting pressure on migratory cranes in Pakistan and assessment of Abi-I-Estada in Afghanistan with proposed conservation plans for selected wetlands. University MSc dissertation, University of Wisconsin, Madison. 428 pp.

Khan, K. M, N. Ambreen, U.R. Mughal, S. Jalil, S. Perveen, M. I. Choudhary (2010). 3-Formylchromones: Potential anti-inflammatory agents. European J. Med. Chemistry, 45: 4058-4064. https://doi.org/10.1016/j.ejmech.2010.05.065

Khan, S. B., M. Faisal, M.M. Rahman and A. Jamal (2011). Exploration of CeO2 nanoparticles as a Chemi-

sensor and photo-catalyst for environmental applications. Science of the total Environment, 409:2987-2992. https://doi.org/10.1016/j.scitotenv.2011.04.019

Kozma, R., S. Ahmed, A. Best and L Lim (1995). The Ras-related protein Cdc42Hs and bradykinin promote formation of peripheral actin micro spikes and filopodia in Swiss 3T3 fibroblasts. Molecular and Cellular Biology.15: 1942-1952. DOI: 10.1128/MCB.15.4.1942

Kumar, K. and Arvind. (2016). India's energy security and pipeline politic. Int. Res. J. Management Sociology and Humanity.7: 25-30. ISSN 2277 – 9809: https://d1wqtxts1xzle7.cloudfront.net/53160144/4622

Landon, M.B., C.Y. Spong, E.Thom, M.W. Carpenter, S.M. Ramin, B. Casey, R.J. Wapner, M.W. Varner, D.J. Rouse, Jr. J.M. Thorp and A. Sciscione (2009). A multicenter, randomized trial of treatment for mild gestational diabetes. New England J. Medicine, 361(14):1339-1348. DOI:10.1056/NEJMoa0902430

Meine, C., and G. W. Archibald (Eds) (1996). The Cranes: - Status Survey and Conservation Action Plan. IUCN, Gland, Switzerland, and Cambridge, U.K. 294pp; Copyright: © 1996 International Union for Conservation of Nature and Natural Resources

Murray, N.J., P.P. Marra, R.A. Fuller, R.S. Clemens, K. Dhanjal-Adams, K.B. Gosbell, C.J. Hassell, T. Iwamura, D. Melville, C.D. Minton and A.C. Riegen (2018). The large-scale drivers of population decline in a long-distance migratory shorebird. Ecography, 41(6): 867-876. doi: 10.1111/ecog.02957

Perveen, F. (2012). Biological status of captive crane in southern districts of northern Pakistan. J. Life Science.6: 296-300. https://d1wqtxts1xzle7.cloudfront.net/46526388/JLS_201

Perveen, F. and H.U. Khan (2010). Pressure from hunting on crane species in southern districts of northern Pakistan. Chinese Birds, 1(4):244-250. http://dx.doi.org/10.5122/cbirds.2010.0021.

Qian, F., H. Wu, L. Gao, H. Zhang, F. Li, X. Zhong and G. Zheng (2009). Migration routes and stopover sites of Black-necked Cranes determined by satellite tracking. J. Field Ornithology, 80(1): 19-26. https://doi.org/10.1111/j.1557-9263.2009.00201.x

Rehman, J.U., S. Alamb, S. Khalilc, M. Hussaina, M. Iqbald, K.A. Khane, M. Sabirb, A.Akhtarf, G. Razag, A.Hussaina and U. Habibaa (2022). Major threats and habitat use status of Demoiselle crane (*Anthropoides virgo*), in district Bannu, Pakistan. Brazilian J. Biology, 82:1-7, e242636 | https://doi.org/10.1590/1519-6984.242636

Siewertsen, R., H. Neumann, B. Buchheim-Stehn, R. Herges, C. Nather, F. Renth and F. Temps (2009). Highly efficient reversible Z− E photoisomerization of a bridged azobenzene with visible light through resolved S1 ($n\pi^*$) absorption bands. J. American Chemical Society, *131*(43): 15594-15595. https://doi.org/10.1021/ja906547d

Smyth, V., H. Jewhurst, D. Wilkinson, B. Adair, A. Gordon and D. Todd (2010). Development and evaluation of real-time TaqMan® RT-PCR assays for the detection of avian nephritis virus and chicken astrovirus in chickens. Avian Pathology, *39*(6), 467-474. https://doi.org/10.1080/03079457.2010.516387

Weis, D., B. Kieffer, C. Maerschalk, J. Barling, J. De-Jong, G.A. Williams, D. Hanano, W. Pretorius, N. Mattielli, J.S. Scoates and A. Goolaerts (2006). High-precision isotopic characterization of USGS reference materials by TIMS and MC-ICP-MS. Geochemistry, Geophysics, Geosystems, 7(8). https://doi.org/10.1029/2006GC001283

Wijnen, J., H. Vasen, P.M. Khan, F.H. Menko, H. van-der-Klift, C. van-Leeuwen, M. van-den-Broek, I. van-Leeuwen-Cornelisse, F. Nagengast, A. Meijers-Heijboer and D. Lindhout (1995). Seven new mutations in hMSH2, an HNPCC gene, identified by denaturing gradient-gel electrophoresis. American J. Human Genetics, 56(5):1060-1066. 0002-9297/95/5605-0006

Wu, G. (2009). Amino acids: metabolism, functions, and nutrition. Amino Acids, 37(1): 1-17. DOI:10.1007/s00726-0090269-0 .