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Trends in counts of Columbiformes at Shakpak Pass, Kazakhstan

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Abstract. *Berdikulov BT, Frolov IG, Gavrilov AE, Tashimova AT, Zaripova SKH. 2023. Trends in counts of Columbiformes at Shakpak Pass, Kazakhstan. Biodiversitas 24: 4661-4667.* This study aims to determine the trends in counts of Columbiformes (pigeons and doves) at Shakpak Pass in Western Tien Shan (southern Kazakhstan). The analysis is based on long-term ringing data collected from 1966 to 2023, encompassing eight pigeon and dove species. The results reveal notable trends in the counts of Columbiformes over time, which can reflect changes in population sizes. Different species show different numbers in counts among different seasons. The Rock Dove population, predominantly non-migratory, displays no pronounced trend. The Stock Dove population has experienced a decline in recent years, yet it remains consistent throughout the entire research period. Counts of the Woodpigeon demonstrate an increasing trend during autumn migration, whereas the Yellow-eyed Pigeon exhibits a noteworthy decrease in both spring and autumn migrations. The Oriental Turtle Dove appears abundant during both spring and autumn migrations, with its count data exhibiting fluctuations devoid of any significant trend. The Laughing Dove is considered rare at Shakpak Pass, which makes determining a clear trend challenging; however, a negative trend is noted in autumn. Counts of the Turtle Dove have markedly decreased in both spring and autumn migrations, resulting in the species being nearly absent at Shakpak Pass since 2005. Regarding the Collared Dove, a non-migratory species, its abundance at Shakpak Pass is also limited. These findings provide valuable insights into the population trends of Columbiformes in Kazakhstan and highlight the importance of long-term monitoring and conservation efforts for these species.

Keywords: Columbiformes, long-term study, pigeons, trends in counts, population trends, ringing data, Shakpak Pass

INTRODUCTION

Columbiformes are widely distributed across various habitats worldwide, and their population sizes vary considerably across species and geographic ranges. In recent years, concerns have emerged regarding the population trends of certain Columbiformes species, as they face numerous threats, including habitat loss, hunting, disease, and the introduction of invasive species (del Hoyo et al. 2020; BirdLife International 2022). As of 2022, out of the 330 Columbiformes species assessed by the IUCN, 89 (27%) are categorized as threatened with extinction (IUCN, 2022). Endangered pigeon species suffer from insufficient research attention. Remarkably, only 10 species (approximately 3% of all species) have been the focus of 77% of research articles published since 1966 (Cambrone et al. 2023).

The fauna of Kazakhstan historically has included two genera of the order Columbiformes: *Columba* and *Streptopelia* (Dolgushin 1962). These genera comprise a total of eight species: the Rock Dove (*C. livia*), the Stock Dove (*C. oenas*), the Woodpigeon *(C. palumbus*), the Yellow-eyed Pigeon (*C. eversmanni*), the Oriental Turtle Dove *(S. orientalis)*, the Laughing Dove *(S. senegalensis)*, the Turtle Dove (*S. turtur*), the Collared Dove (*S. decaocto*) (Gavrilov 2005). Two more species, the Hill Pigeon (*C. rupestris*) and the Snow Pigeon (*C. leuconota*), have recently been identified in the Western Tien Shan region (Chalikova 2010). Of these 10 species, the Yellow-eyed Pigeon and the Turtle Dove are classified as vulnerable. The Yellow-eyed Pigeon is listed in both the Kazakhstan Red Book and the IUCN's listings (BirdLife International 2022) and mentioned in a field guide (Ryabitsev 2019a, 2019b).

While studies focusing on specific aspects of pigeon species' biology and distribution are valuable, they do not provide definitive evidence regarding the overall trend of pigeon populations in Kazakhstan. Consequently, shifting our attention towards long-term population trends is crucial to developing a more comprehensive understanding of these species' populations (Petras and Vrezec 2021; Lawrence 2022).

The objective of this study is to determine trends in counts of the Columbiformes order at Shakpak Pass, situated in the Western Tien Shan (Tanirtau) mountains in southern Kazakhstan. Count trends have often been used as an index of population trends (Briedis and Keišs 2016). We utilized ringing data to estimate the population trend of migrating birds, as the number of birds captured by stationary traps typically correlates with their relative abundance in nature (Gavrilov 2014). By analyzing ringing data collected over several decades, this study aims to provide insight into changes in population size, distribution, and migratory patterns of *Columbiformes* in

the region. Understanding the long-term population trends of *Columbiformes* at Shakpak Pass can contribute to local conservation efforts and broader research and conservation initiatives focused on migratory bird species.

MATERIALS AND METHODS

Study area

Shakpak Pass is important for bird migration and population trends, representing the narrowest point between the Talas Alatau (Western Tian Shan) and Karatau ridges, Kazakhstan (42.517° N, 70.633° E, altitude 1000-1200 m asl.).

Data availability

All birds were captured using three stationary traps of the "Heligoland" type. It is important to note that not all three traps were consistently maintained throughout all years and seasons, so we adjusted the number of captured birds for each trap separately to account for differences in capturing efforts over the study period. Individuals caught in mist nets were excluded from the trend analysis due to these traps' undefined length and working time.

Data analysis

The original data represents calendar dates and the number of birds captured on each respective day. Due to variations in the capturing periods across different observation seasons and years, resulting in varying active days for each trap, separate analyses were conducted to determine the captured bird count. To comprehend the distinct contribution of each trap to capturing the desired species, we computed an attractiveness coefficient that gauged the allure of each trap for each specific species. These attractiveness coefficients were computed for each species independently. The average number of captured birds per day was then calculated upon acquiring the count of days when all traps were operational. Therefore, the calculated values were adjusted using the attractiveness coefficients to account for the varying preferences of different species concerning migration behavior and trap locations. This adjustment yielded the final count of captured birds per trap per day.

For assessing trends in pigeon count data, the Mann-Kendall test was employed. The null hypothesis assumes no trend in the time series data, while the alternative hypothesis aims to detect both positive and negative trends. The direction of the trend is determined by the sign of the Tau parameter, which quantifies the number of pairs of data points in the time series that have concordant (both increasing or decreasing) or discordant (one increasing while the other decreasing) relationships. After calculating the variance of Tau and the Z-score, the p-value is determined using a standard normal distribution. A significance threshold of $p \leq 0.05$ is applied to reject the null hypothesis and conclude the presence of a significant trend in the data. All statistical analyses used the R programming language version 4.2.3 (R Core Team, 2023). Therefore, to determine the daily abundance of captured birds within each trap, the data underwent processing using a script primarily reliant on the Tidyverse (Wickham et al. 2019) and Lubridate (Grolemund and Wickham 2011) packages. These packages were chosen for their efficacy in managing data spanning different observation years. Furthermore, the calculations considered the number of days each trap remained active. Following the computation of abundance for each individual trap, the data were consolidated into a single variable. The Mann-Kendall test, facilitated by the Kendall package (McLeod and Xu 2018), was subsequently employed to identify potential trends within the time-series data (Hamed 1998; Haig 2019). Notably, this analysis was conducted individually for each species encompassed within this research.

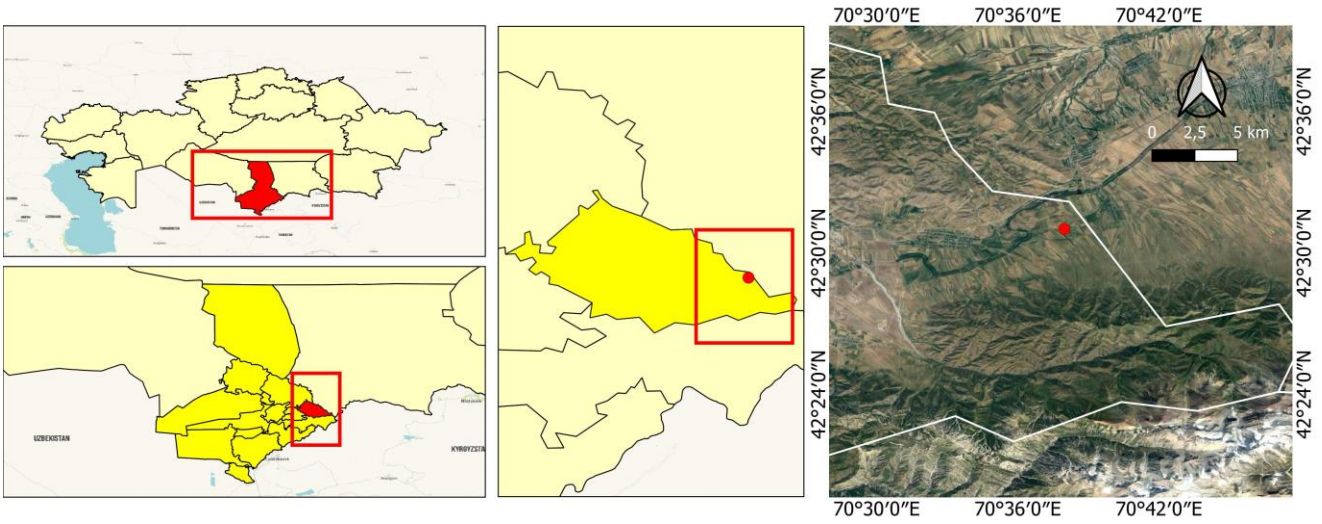

Figure 1. Location of Shakpak Pass in Western Tien Shan, Kazakhstan

RESULTS AND DISCUSSION

During 1966-2023 (including only the spring season in 2023), a total of 20,805 pigeon and dove individuals were captured and ringed in Kazakhstan in the foothills of the Western Tien Shan at the Shakpak Pass, accounting for over 1.24% of the total number of birds captured there.

Our analysis has revealed several noteworthy population trends in Columbiformes over time, providing valuable insights into the changing abundance of these species in the study area. Detailed results are presented in Table 1.

The "spring" season corresponds to the migration period from day 90 to day 160 within a given year. Conversely, the "autumn" season represents the migration phase between day 230 and day 310 of the year. The results of the Mann-Kendall test furnish insights into the strength of the trend (tau), which is accompanied by a positive or negative sign, along with its corresponding significance level (p). Notably, significant p-values are denoted by an asterisk (*). Information was gathered for 43 spring and 55 autumn seasons throughout the data collection process. The column labeled "Years of captures, n" provides a count of the years during which the species was captured. A summarizing row, designated "Kazakhstan trend description," is included. It's important to note that the trend might remain undefined due to a low p-value obtained from the Mann-Kendall test and/or a small sample size. A substantial sample size is recommended for a robust analysis, ideally surpassing 30 captured birds. The column "IUCN trend and status" presents the global trend and status of the species following the IUCN Red List (2022).

Genus *Columba*

Columba livia (Rock Doves)

The count of captured Rock Doves (*Columba livia*) has shown a statistically significant rise during the spring migration, but there is no such pattern in the autumn (see Figure 1.A-B). However, it is important to consider that the captured birds during this time might include individuals foraging in nearby fields, potentially influencing the observed increase. Additionally, accurately assessing the distribution of migration Rock Doves is challenging due to the presence of feral pigeons resulting from domestication and releases. Feral pigeons can be found both within and outside their natural range, posing difficulties distinguishing between wild and feral individuals. It is worth emphasizing that conducting further long-term observations would be valuable for monitoring changes in the Rock Dove population over time.

In Kazakhstan, Rock Doves primarily breed in the mountains and foothills of the country's southern, eastern, and southeastern regions. However, the specific population that migrates through the Shakpak Pass is not yet clearly understood. Further research is needed to determine the origin and characteristics of the Rock Dove population that utilizes this migration route.

Columba oenas (Stock Dove)

The population of Stock Dove (*Columba oenas*) did not exhibit a significant increasing or decreasing trend throughout our observations (see Figure 1.C-D). However, it is noteworthy that between 1985 and 2000, a relatively high number of Stock Doves was observed during autumn migration, indicating specific dispersal patterns of the species during that time. Subsequently, from 2000 to 2022, a notable decline in the counts of Stock Doves migrating through the Shakpak Pass can be observed. It is important to highlight that the lower abundance of Stock Doves during the initial years of the study period (1966-1983) contributes to the apparent increasing trend observed in the early years, followed by a peak in population and subsequent decline in recent years. While the trend analysis for the entire study period does not reveal statistical significance, there is clear evidence of a decline in the population of Stock Doves in recent years.

Table 1. Trends in captured birds from the order Columbiformes at Shakpak Pass from 1966 to 2023.

Species name	Season	Mann-Kendall test		Birds, n	Years of captures, n	Kazakhstan trend description	IUCN trend and status
		tau	p				
Rock Dove	Spring	0,43	0,00*	48	8	Increasing	Decreasing,
(*Columba livia*)	Autumn	0,09	0,38	102	26	No trend (in sign. P-value)	LC
Stock Dove	Spring	-0,10	0,42	37	9	Not defined (small sample size)	Increasing,
(*C. oenas*)	Autumn	-0,14	0,13	9738	49	No trend (in sign. P-value)	LC
Woodpigeon	Spring	0,31	0,01*	3	3	Not defined (small sample size)	Increasing,
(*C. palumbus*)	Autumn	0,24	0,01*	198	35	Increasing	LC
Yellow-eyed Pigeon	Spring	-0,36	0,00*	259	19	Decreasing	Decreasing,
(*C. eversmanni*)	Autumn	-0,57	0,00*	1005	39	Decreasing	VU
Oriental Turtle Dove	Spring	-0,09	0,41	3881	42	No trend (in sign. P-value)	Stable,
(*Streptopelia orientalis*)	Autumn	-0,14	0,12	4083	51	No trend (in sign. P-value)	LC
Laughing Dove	Spring	-0,24	0,04*	19	14	Not defined (small sample size)	Stable,
(*S. senegalensis*)	Autumn	-0,27	0,01*	47	20	Decreasing	LC
Turtle Dove	Spring	-0,36	0,00*	1043	32	Decreasing	Decreasing,
(*S. turtur*)	Autumn	-0,39	0,00*	322	35	Decreasing	VU
Collared Dove	Spring	0,28	0,02*	12	5	Not defined (small sample size)	Increasing,
(*S. decaocto*)	Utumn	0,06	0,63	8	3	Not defined (small sample size)	LC

The Stock Dove breeds in the Ural Valley, along with various northern and southeastern Kazakhstan locations. During migration, it has a wide distribution across the country. Our recapture data indicates that the Siberian population of this species commonly migrates through the Shakpak Pass. Therefore, the population trends described above may serve as an indicator of the state of this specific population.

Columba palumbus (Woodpigeon)

The Woodpigeon (*C. palumbus*) exhibited a positive trend during autumn migration (see Figure 2.E-F). Although the overall population of this species is relatively low, it has been captured almost every year in recent times (1991-2021). In contrast, from 1966 to 1990, it was captured only in 10 out of the 25 years of observation.

The Woodpigeon is predominantly found in the Ural Valley, specifically from Atyrau, and in forested areas along the Kurum. It also breeds in select locations in Northern Kazakhstan, including Naurzum, the Kokshetau forests, and near Karagandy. During the summer, the species can be observed in the Pavlodar region and the Irtysh and Ulba valleys. During migration, it is distributed across the western half of Kazakhstan, extending eastward to Korgalzhyn and the middle Syrdarya valley. On occasion, the Woodpigeon winters in the Irtysh Valley near Oskemen.

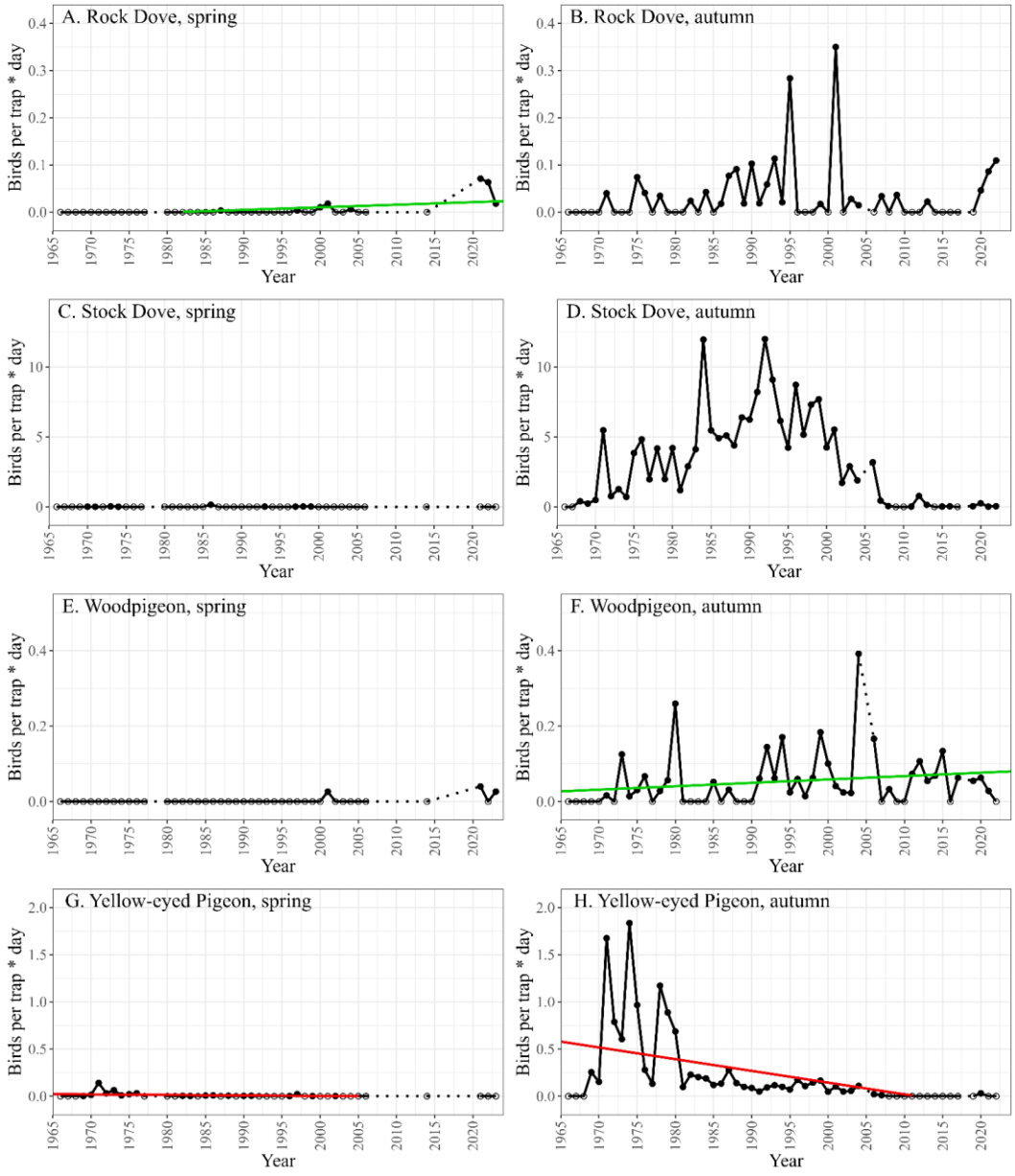

Figure 1. Abundance trends of the *Columba* genus at Shakpak Pass. Statistically significant positive and negative trends in counts are represented by green and red lines, respectively

Columba eversmanni (Yellow-eyed Pigeon)

The Yellow-eyed Pigeon (*C. eversmanni*) population has experienced a significant decline during spring and autumn migrations (see Figure 1G-H). Since 2006, only a few individuals have been captured during the autumn migration, while this species was relatively abundant, particularly in 1970-1980. The Yellow-eyed Pigeon breeds and migrates through Southern and Southeastern Kazakhstan, ranging north to the lower reaches of the Syr Darya and Ili valleys, the Southern Balkhash region, and the Zaisan basins. Conservation efforts for the Yellow-eyed Pigeon in its breeding areas should prioritize identifying and protecting critical habitats. This can be achieved through the establishment of protected areas and the implementation of sustainable land-use practices. Monitoring their migration patterns can provide valuable information for conservation initiatives, helping identify additional measures necessary to safeguard the species.

Genus *Streptopelia*

Streptopelia orientalis (Oriental Turtle Dove)

The population of the Oriental Turtle Dove (*Streptopelia orientalis*) at Shakpak Pass has exhibited stable population numbers throughout the years of observation (see Figure 2A-B). There are no significant trends in the population of Oriental Turtle Doves during both the spring and autumn migrations. While some interannual dynamics may occur within the population, the overall trend remains stable.

The Oriental Turtle Dove breeds in northern Kazakhstan and the mountainous areas of the eastern and southeastern regions of the country. It is frequently observed during migration to the east of the Turgai depression. These specific breeding and migratory patterns contribute to the presence of Oriental Turtle Doves in the study area of Shakpak Pass during their seasonal movements.

Streptopelia senegalensis (Laughing Dove)

The Laughing Dove (*S. senegalensis*) exhibits a low occurrence at Shakpak Pass, making it challenging to determine its population trend or absence (see Figure 2.C-D). However, there is a negative trend for this species during autumn migration. This species is a resident bird in many areas, and relying solely on migration data through the Pass may not provide a comprehensive indicator of its population dynamics. Therefore, it is important to complement migration data with other methods, such as population surveys and habitat assessments, to fully understand the Laughing Dove's population trends and conservation requirements.

In recent years, the Laughing Dove has shown an expansion in its range and has become increasingly common in Kazakhstan's southern and eastern regions. It demonstrates adaptability to various environments, including villages and cities, and is often found in areas with one-story buildings. During the breeding season, the species tends to form pairs that nest close to each other. These behavioral characteristics and distribution patterns contribute to the species' ecological niche and population dynamics. Further research and monitoring efforts are necessary to gain deeper insights into the Laughing Dove's population trends and conservation status in different regions of Kazakhstan.

Streptopelia turtur (Turtle Dove)

The Turtle Dove (*S. turtur*) populations have shown a significant decline during both the spring and autumn migrations at Shakpak Pass (see Figure 2.E-F). While the Turtle Dove has never been numerous at Shakpak Pass, the recent absence of this species has made the negative population trends particularly noteworthy among the Columbiformes species in this location.

The Turtle Dove is known to breed across most of Kazakhstan, except for the northern regions and waterless deserts. Its breeding distribution encompasses a wide range of habitats within the country. The observed decline in the Turtle Dove population at Shakpak Pass may reflect larger population dynamics occurring at a regional or global scale.

Streptopelia decaocto (Collared Dove)

The Collared Dove (*S. decaocto*) exhibits a non-migratory behavior and is characterized by a relatively low number of individuals at Shakpak Pass (see Figure 2.G-H). Consequently, using migration data through the Pass alone does not provide sufficient information to determine population trends or the absence thereof for this species.

The Collared Dove breeds in various regions, including the Ural Valley, north of the Aktobe and Kostanay regions. It can also be found in the mountains and foothills from Tashkent to Altai, extending further along the Irtysh valley to Pavlodar. During autumn, this species is often observed near grain elevators, farms, zoos, and other areas that offer an abundant food supply. Additionally, small flocks of Collared Doves may occasionally fly to nearby mowed fields for feeding purposes.

During winter, the Collared Dove faces a critical period as it heavily relies on human support due to the limited availability of natural food sources. Providing supplementary food during this time is essential for their survival.

Discussion

The results of this research support the trends identified by the International Union for Conservation of Nature (IUCN) for the Yellow-eyed Pigeon and Turtle Dove, indicating a decline in their populations. The data used in the analysis suggest that these species have become extremely rare at Shakpak since the 2000s. However, it is important to note that the observed decline may be attributed to changes in migration routes and patterns, leading the species to migrate through alternative flyways. Therefore, it is necessary to consider the possibility that the decline in counts is not indicative of an actual decrease in overall population size but rather a shift in migration behavior.

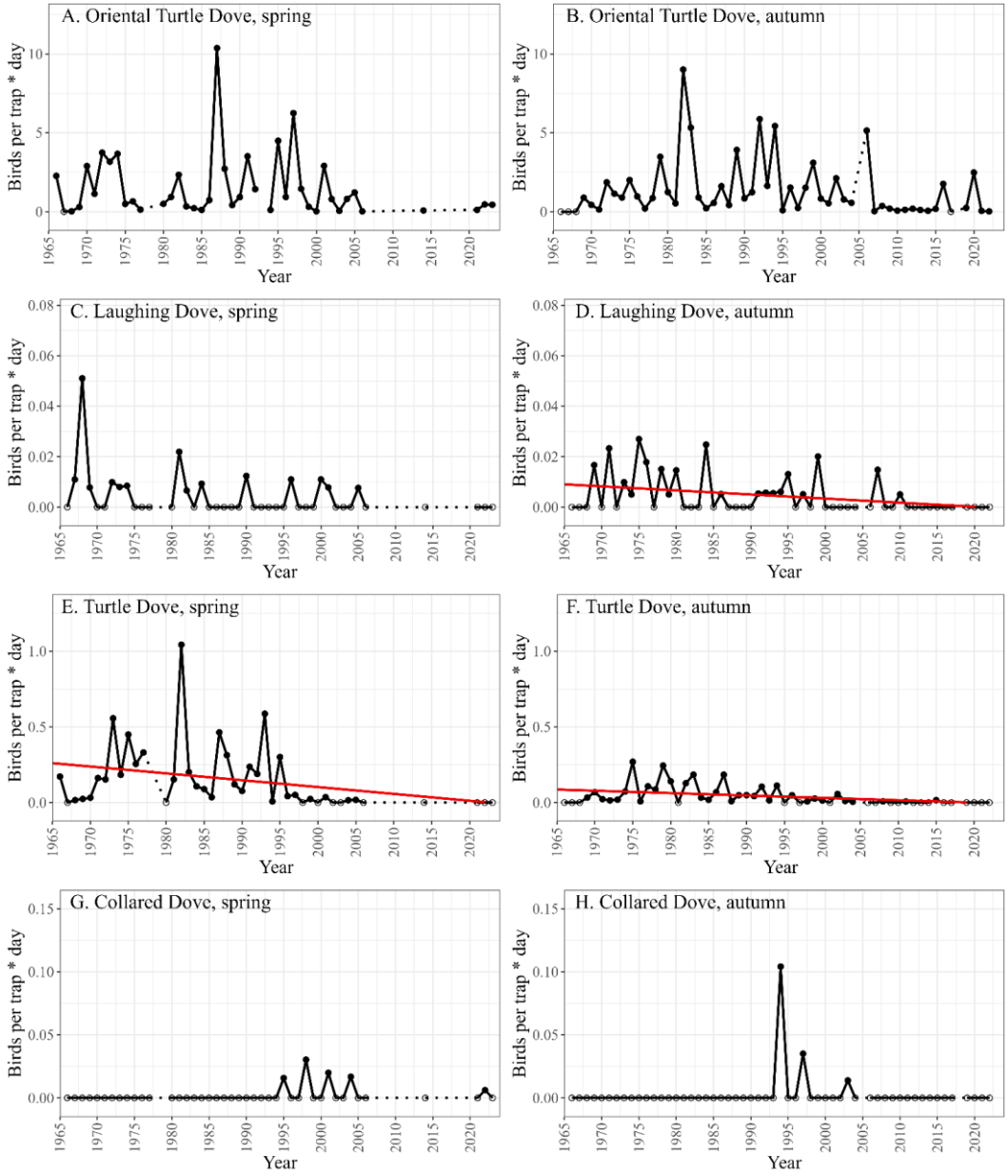

Figure 2. Abundance trends of the *Streptopelia* genus at Shakpak Pass. Statistically significant negative trends in counts are represented by red lines

Regarding the Laughing Dove, it is interesting to note that despite being classified as "least concern" by the IUCN, the species shows a negative trend in captures at Shakpak in autumn. This suggests that local populations of Laughing Doves in this specific area may be facing certain challenges or undergoing changes that are not reflected in their global conservation status. Further research and monitoring are necessary to understand better the factors driving this region's negative trend.

Woodpigeon count data have shown an increasing trend during the autumn migration, suggesting a positive change in their numbers. Conversely, both Yellow-eyed Pigeon and Turtle Dove populations have experienced significant declines during spring and autumn migrations. These declines emphasize the need for conservation efforts to protect these species and their habitats.

The low number of ringed birds at Shakpak Pass has made it challenging to determine significant population trends for the Laughing Dove and Collared Dove. These species are considered residents, and their population dynamics may differ from migratory species. Identifying population changes in Rock Doves is complicated due to the prevalence of domesticated doves and the limited number of ringed birds. However, it is presumed that Rock Doves are relatively stable in Kazakhstan.

It is important to interpret the trends in counts observed in this study with caution, as they are based on the data available from the Shakpak Pass only and may not represent the entire population dynamics of these species

across their entire range. Future research efforts should aim to gather more comprehensive data, including information on habitat use, breeding success, and population connectivity, to understand better the factors influencing the population trends and conservation needs of these species in Kazakhstan.

Shakpak Pass in Kazakhstan is an important observation site for studying various species of doves and pigeons. The data collected over the years have revealed both increasing and decreasing trends in counts among different species. Continued monitoring of the population trends of these pigeon species is essential to understand the factors influencing their abundance and conservation status. The data collected over the years have provided valuable insights into Kazakhstan's population trends and abundance of Columbiformes. These findings can inform future conservation efforts and contribute to our overall understanding of avian populations in the region.

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