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SHIFTS IN AVIAN COMMUNITY STRUCTURE IN ONE OF THE GORGES OF THE AKSU-ZHABAGYLY NATURE RESERVE

This article examines changes in bird community structure in Taldybulak Gorge (Aksu-Zhabagly Nature Reserve) from 1996 to 2025. To maximise comparability, we analyse 11 seasons restricted to the last week of June (1996–2000, 2002, 2004, 2006, 2008, 2012, 2025). Counts were conducted along a fixed route, in morning hours only, by the same observer. Over this period, 34 species were recorded; a core of just 12 species formed the resident community, whereas others bred irregularly or appeared during post-breeding foraging movements. The latter occasionally dominated for short intervals (e.g., *Sturnus roseus*). Both species richness (8–19 per day) and total abundance varied strongly across years (12.3–198.8 ind./h) and even across successive days. The processes observed were largely natural; however, even minor human disturbance influenced them, as evidenced by marked declines since the early 21st century in the Black-headed Penduline Tit (*Remiz coronatus*) and the White-throated Dipper (*Cinclus cinclus*), coincident with increased tourist traffic.

Keywords: Aksu-Zhabagly Nature Reserve, Taldybulak Gorge, avifauna, bird community structure, recreational disturbance, phenology.

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Ақсу-Жабағылы мемлекеттік табиғи қорығының бір шатқалындағы құстар қауымдастығы құрылымының өзгерісі

Бұл мақалада Ақсу-Жабағылы қорығының Талдыбұлақ шатқалындағы құс қауымдастығы құрылымының 1996–2025 ж. аралығындағы өзгерістері зерттеледі. Нәтижелер 11 жыл бойы маусым айының соңғы аптасында жүргізілген санақ деректеріне негізделді (1996–2000, 2002, 2004, 2006, 2008, 2012 және 2025). Құстарды санау тұрақты маршрут бойымен, тек таңертеңгі уақытта, бір санақшымен жүргізілді. Аталған кезеңде құстың 34 түрі тіркелді; олардың ішінен небәрі 12 түр орнитофаунаның тұрақты «өзегін» құрады, ал қалғандары жыл сайын ұяламайтын немесе қорек үшін қоныс аудару кезеңінде ғана кездесетін түрлер болды. Кейбір құстар, мысалы алаторғай *Sturnus roseus* соңғы кезде, қыстың кей мезгілдерінде үлесі артып отырды. Құстардың түр аулуандығы (8–19) ғана емес, саны да (12.3–198.8 дарак/сағ) әр жылда да, бір маусым ішінде де айтарлықтай құбылып отырды. Бақыланған өзгерістер негізінен табиғи сипатта болды, дегенмен адам ықпалының аздаған артуы да байқалды. Мысалы, ХХІ ғ. басынан бері қарабас құркылтай (*Remiz coronatus*) мен кәдімгі сушылқараның (*Cinclus cinclus*) саны туристер ағынының көбеюімен қатар едәуір азайғаны байқалды.

Түйін сөздер: Ақсу-Жабағылы қорығы, Талдыбұлақ шатқалы, авифауна, құстар қауымдастығының құрылымы, рекреациялық әсер, фенология.

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Изменение структуры населения птиц в одном из ущелий заповедника Аксу-Жабагылы

В статье рассмотрены вопросы изменения структуры населения птиц в ущелье Талдыбулак (заповедник Аксу-Жабагылы) с 1996 по 2025 г. Для чистоты эксперимента взята последняя неделя июня за 11 лет наблюдений (1996–2000, 2002, 2004, 2006, 2008, 2012 и 2025 гг.). При этом учеты птиц проводились на постоянном маршруте, только в утренние часы и силами одного и того же учетчика. За этот период встречено 34 вида птиц, из которых основу населения составили только 12, а другие гнездились не ежегодно или появлялись в период кормовых кочевок. Последние иногда на короткий промежуток времени составляли основу населения (*Sturnus roseus*). Как видовой состав (от 8 до 19), так и численность птиц была не постоянна и изменчива как по годам (от 12.3 до 198.8 ос./ч), так и в течение нескольких дней. Все прослеженные процессы имели естественное происхождение. Однако даже малейшее вмешательство человека влияло на их ход, что прослежено на черноголовом ремезе (*Remiz coronatus*) и обыкновенной оляпке (*Cinclus cinclus*), которые с начала XXI в. существенно сократили свою численность, связанную с возросшим потоком туристов.

Ключевые слова: Заповедник Аксу-Жабагылы, ущелье Талдыбулак, авифауна, структура птичьего сообщества, рекреационное воздействие, фенология.

Introduction

Protected areas are central to biodiversity conservation, but they are not static systems. Bird communities in reserves still respond to weather variability, species interactions and broader environmental change; detecting those signals reliably requires long-term, standardized monitoring. Birds are especially useful for this purpose because their populations are relatively easy to survey and they respond quickly to environmental change (Fraix-das et al., 2020; Lindenmayer et al., 2022). Long-term projects elsewhere show what such monitoring can reveal, for example, climate and habitat shifts have been linked to reduced fitness in cavity-nesting songbirds (Riggio et al., 2023).

Aksu-Zhabagyly State Nature Reserve in the Western Tien Shan, established in 1926 as the first reserve in Kazakhstan (BirdLife International, 2025), will celebrate its centenary in 2026. Over the past century its area has expanded more than four-fold, from 29,712 ha at the time of foundation to 131,934 ha today, as additional gorges were incorporated. The reserve is now recognized as a regional biodiversity hotspot, supporting about 247 recorded bird species and 130 confirmed breeders (Kovshar, 2016). Its long history of strict protection and diverse avifauna make it an ideal model system for studying long-term dynamics in bird community structure.

At the same time, many protected areas, including Aksu-Zhabagyly, have experienced grow-

ing tourist visitation (Akbar et al., 2020). Even low levels of recreation may reduce breeding success and local abundance in sensitive birds if not carefully managed. A global review found that almost 90% of studies reported negative effects of non-motorized recreation such as hiking and wildlife watching (Steven et al., 2011). Local studies confirm these tendencies: in Aksu-Zhabagyly, the penduline tit (*Remiz pendulinus*) has been proposed as an indicator of anthropogenic pressure along ecological trails (Chalikova, 2004), while other field studies show that species richness and abundance decline along heavily used routes, particularly in open habitats (Wolf et al., 2013). Understanding whether changes in bird communities within strictly protected reserves reflect natural turnover or subtle anthropogenic impacts is therefore an important applied question. Long-term data from undisturbed systems show that bird communities can fluctuate considerably between years, yet retain a stable core composition over decades (Wesołowski et al., 2022; Berdikulov et al., 2023).

The first ornithological studies in the Western Tien Shan are associated with D. N. Kashkarov and A. P. Korovin. In 1922–1923 they surveyed the Talas Alatau and joined an expedition organized by the Central Asian Museum, which led to the establishment of the Aksu-Zhabagyly Nature Reserve (Kashkarov & Korovin, 1926). Since then, bird observations in the region have been conducted regularly initially as faunistic inventories and, from the 1980s onward, as long-term monitoring.

Our aim was to analyse the breeding-season bird community of Taldybulak Gorge under conditions of limited human activity, using standardized morning transect counts conducted on astronomically comparable dates (last week of June) across 11 survey years (1996-2025). Our objectives were (1) to determine species composition and the occurrence status of birds during this late-June window; (2) to identify the species that form the community core across years and quantify dominance and subdominance; and (3) to diagnose the drivers of interannual change in community structure and in the abundances of individual species.

Methods of research

Study area

Taldybulak Gorge is located in the lower mountain belt of the Talas Alatau and has been part of Aksu-Zhabagly State Nature Reserve since 1946. Human influence has been limited: periodic horse grazing in the lower gorge, planting of cultivated trees (apricot, almond, cherry, poplar and *black locust*) in the 1950s, and the development of tourism since the 1960s, which became widespread in the early 21st century (Akbar et al., 2020). The gorge lies on the northern slope of the Talas Alatau, 3 km from the reserve headquarters in Zhabagly village. The gorge opens onto a foothill valley. The gorge is

narrow: the lower section runs south–north, then in its middle part it forks into an eastern branch carrying the Taldybulak River and a dry western branch. The river rises from springs; below the gorge its flow is partly diverted into an irrigation canal, with the remainder spreading as small streams across the foothill valley. Elevation ranges from 1210 m at the entrance to 1930 m at the pass.

Riparian vegetation along the river is dominated by *Salix tenuijulis*, mixed with *Berberis oblonga*, *Rosa beggeriana*, *Rosa fedtschenkoana*, *Rosa kakanica*, *Lonicera nummulariifolia*, *Lonicera stenantha*, *Lonicera tianschanica*, *Crataegus turkesstanica*, *Padellus mahaleb*, *Cerasus erythrocarpa*, *Spiraea hypericifolia*, *Juniperus seravschanica*, *Juniperus semiglobosa*, and *Malus sieversii*, which forms small groves upstream. The slopes are dry and stony, with rocky outcrops and scattered shrubs (rose, almond, honeysuckle, cherry) and trees (juniper, hawthorn, apple).

Bird surveys

Bird counts were conducted along a fixed 3.5 km trail following the Taldybulak River from the gorge entrance (42°24'56.1" N, 70°28'17.1" E; 1210 m) to the point where the path leaves the riverbed for the southern slope (42°23'56.0" N, 70°27'35.3" E; 1530 m) (Figure 1).

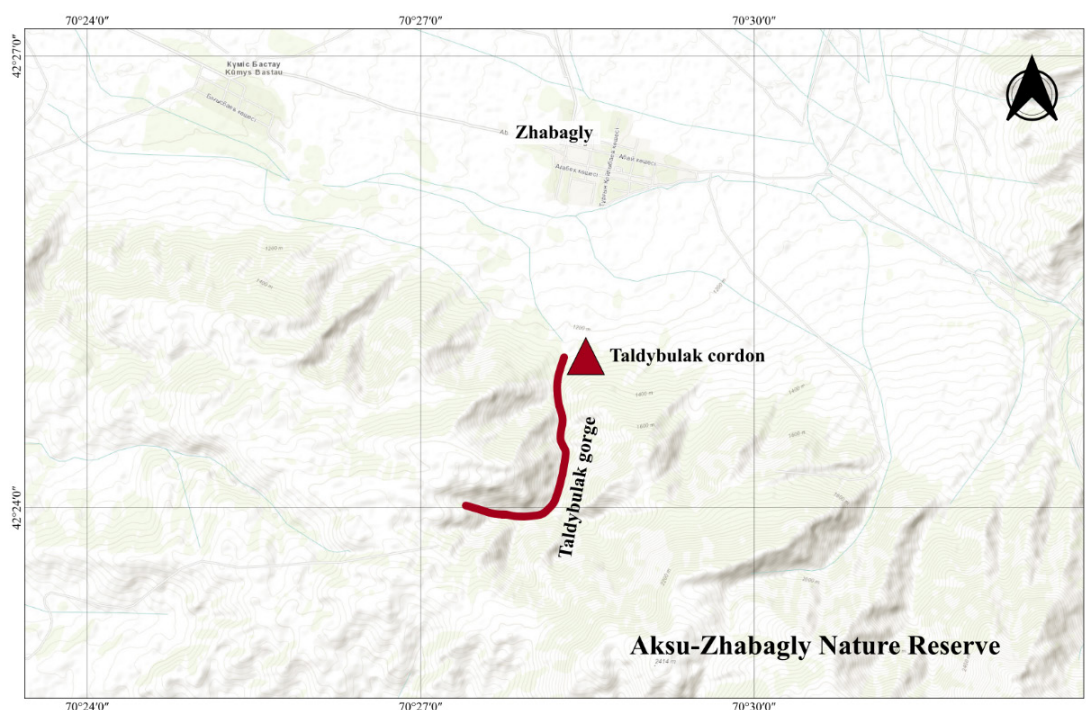


Figure 1 – Survey route map of bird counts in Taldybulak Gorge

Observations were carried out exclusively in the early morning, starting at 07:00, by the same observer throughout the study. The total observation effort exceeded 28 hours. Abundance was expressed as the number of individuals recorded per hour (ind./h) (Chalikova, 2007). Because surveys were restricted to a fixed route and time of day, the values represent relative rather than absolute densities (Morelli et al., 2022).

Birds are mobile throughout the year, but earlier surveys in Taldybulak Gorge (1994–2012) confirmed that the breeding season is the only period when most species remain tied to a territory. Its length varies from about one month in small passerines to up to five months in large raptors. To ensure comparability, all counts used here were conducted in the last week of June. At this time breeding is ending for most species, males continue to sing, and fledglings remain near natal areas, while large-scale movements have not yet begun.

Comparative analysis was based on 11 survey years: 1996 (26 June), 1997 (25 June), 1998 (24 June), 1999 (29 June), 2000 (27 and 30 June), 2002 (25 and 28 June), 2004 (23 June), 2006 (29 June), 2008 (25 June), 2012 (27 June), and 2025 (30 June).

Data analysis

Species lists and abundance indices were compiled for each survey year. To characterize community structure, species were grouped as: (i) *core species* (recorded in ≥ 7 of 11 years), (ii) *occasional species* (2–6 years), and (iii) *rare visitors* (single records). Relative abundance was calculated as each species' share of all individuals counted across years. Species contributing $>10\%$ were classified as dominants, and 3–10% as subdominants.

Rosy Starling (*Pastor roseus*) counts were excluded from these calculations because post-breeding flocks (e.g. hundreds of birds in late June 2000) would otherwise distort dominance estimates. Species richness, total abundance (ind./h), and field notes on breeding evidence were summarized for each survey. No formal trend tests were applied due to the limited number of years; instead, patterns were assessed by comparing early vs. later periods.

The census route was mapped in QGIS. Data were analysed in R. Abundance

Results and discussion

Species richness and composition

Across 13 late-June surveys in 1996–2025, we recorded a cumulative 34 species in Taldybulak Gorge (Table 1). Species richness per count varied

widely, from 8 species in 1998 to 19 in 2002 (Fig. 2). Turnover between years was high: only a subset of species appeared consistently, while many were intermittent. Based on detections in ≥ 7 of 11 years, 11 species form the core breeding assemblage of the gorge in late June: Eurasian Magpie *Pica pica*, Black-headed Penduline Tit *Remiz coronatus*, Blue Whistling-Thrush *Myophonus caeruleus*, White-capped Bunting *Emberiza stewarti*, White-throated Dipper *Cinclus cinclus*, Common Nightingale *Luscinia megarhynchos*, Common Blackbird *Turdus merula*, Yellow-breasted Tit *Parus flavipes*, Woodpigeon *Columba palumbus*, Red-headed Bunting *Emberiza bruniceps*, Oriental Turtle-Dove *Streptopelia orientalis*. Most showed territorial behaviour and/or breeding evidence in multiple years. The **remaining 23 species** were less regular.

Nine species occurred **once** across all late-June counts (single-year records). Most are species that breed in other habitats of the gorge and enter its lower, valley-bottom section sporadically or during foraging. Thus, the Golden Eagle (*Aquila chrysaetos*) observed in June 1999 has bred on nearby cliffs since 1965 (records for 1980, 1987, 1990–1992, 1999, 2004, and 2007). The Common Pheasant (*Phasianus colchicus*) was first noted in the gorge in November 2002, and in the following year bred in the foothills immediately adjacent to the gorge entrance, which it visits periodically; a bird was again observed there on 27.06.2012. The European Bee-eater (*Merops apiaster*) does not breed inside the gorge properly and previously appeared there only during autumn passage from 31 July (2008) to 11 September (2003). In 2025, however, two pairs selected an eroded riverbank at the mouth of the gorge for nesting; a pair was recorded there on 27.06.2025. The Lesser Grey Shrike (*Lanius minor*) breeds periodically and in small numbers in deciduous and juniper woodlands (records for 1983, 1989, 1992, 1994–1998, 2000–2001, 2004–2007), so its detection on 25.06.1997 is unsurprising. The Carrion Crow (*Corvus corone*) began to colonise the Talas Alatau actively in the 1980s, although from the 1930s it bred only sporadically as isolated pairs in juniper forests of a few gorges (Shulpin, 1953; Kovshar, 1966). Since the late twentieth century it has become common near people, whom it previously avoided. At the Taldybulak cordon it bred in 1994–1996, in 2000, and annually since 2004; no nests have been found inside the gorge itself, although the lower section is visited regularly (e.g., 27.06.2025). Hume's Leaf Warbler (*Phylloscopus humei*) and the Rufous-naped Tit (*Parus rufonuchalis*) breed as scattered pairs in juniper woodland and descend to the ripar-

ian strip to forage, as noted in late June 2002 and 2004. The Turkestan (Bukhara) Tit (*Parus bokharensis*) has bred annually in the cordon area since 1994; late June corresponds to more wide-ranging post-breeding movements, which we observed

on 27.06.2025 (two flocks of 7 and 5 birds). The Eastern Rock Nuthatch (*Sitta tephronota*) favours cliffs in the dry branch of the gorge and is only rarely encountered on the rock faces along the river (29.06.1999).

Table 1 – Bird community structure in late-June surveys (astronomically comparable dates) in Taldybulak Gorge (excluding Rosy Starling).

No.	Species	Proportion in the community by year (%)												Occurrence across 13 counts (%)
		1996	1997	1998	1999	2000*	2002*	2004	2005	2008*	2012	2025*	Total*	
1	<i>Accipiter nisus</i>	0	0	0	0	0	0	0	0	0	5.6	1.5	0.6	15.4
2	<i>Aquila chrysaetos</i>	0	0	0	2.1	0	0	0	0	0	0	0	0.2	7.7
3	<i>Falco subbuteo</i>	0	0	0	0	0	2.2	3.0	0	5.0	2.8	0	0.9	38.5
4	<i>Alectoris chukar</i>	0	0	0	0	4.2	0	0	0	0	0	2.9	1.1	15.4
5	<i>Phasianus colchicus</i>	0	0	0	0	0	0	0	0	0	2.8	0	0.2	7.7
6	<i>Columba palumbus</i>	6.9	4.8	0	2.1	3.1	9.9	6.1	0	5.0	0	5.9	4.6	69.2
7	<i>Streptopelia orientalis</i>	0	0	0	0	2.1	3.3	0	2.6	5.0	8.3	11.8	3.4	53.8
8	<i>Merops apiaster</i>	0	0	0	0	0	0	0	0	0	0	2.9	0.4	7.7
9	<i>Motacilla cinerea</i>	3.4	2.4	0	4.2	0	0	0	0	0	0	0	0.8	23.1
10	<i>Lanius minor</i>	0	2.4	0	0	0	0	0	0	0	0	0	0.2	7.7
11	<i>Oriolus oriolus</i>	6.9	0	0	0	0	2.2	6.1	0	0	0	0	1.1	23.1
12	<i>Sturnus roseus</i>	0	0	0	0	91.3	35.5	0	0	71.4	0	4.23	67.7	46.2
13	<i>Acridotheres tristis</i>	10.3	0	3.8	0	6.3	3.3	6.1	5.3	0	0	0	3.2	46.2
14	<i>Pica pica</i>	31.0	21.4	42.3	27.1	9.4	11	3.0	5.3	10.0	0	2.9	12.9	92.3
15	<i>Corvus corone</i>	0	0	0	0	0	0	0	0	0	0	1.5	0.2	7.7
16	<i>Cinclus cinclus</i>	3.4	14.3	19.2	6.3	8.3	5.5	3.0	0	0	5.6	0	5.9	76.9
17	<i>Sylvia communis</i>	0	0	3.8	4.2	1.0	2.2	0	0	0	5.6	0	1.5	46.2
18	<i>Sylvia althaea</i>	0	0	0	0	3.1	0	3.0	2.6	10.0	5.6	2.9	2.1	46.2
19	<i>Phylloscopus humei</i>	0	0	0	0	0	1.1	0	0	0	0	0	0.2	7.7
20	<i>Terpsiphone paradisi</i>	0	0	0	0	2.1	2.2	0	7.9	5.0	0	2.9	1.9	38.5
21	<i>Luscinia megarhynchos</i>	0	2.4	3.8	8.3	3.1	3.3	12.1	5.3	10.0	5.6	10.3	5.5	92.3
22	<i>Turdus merula</i>	0	2.4	0	0	2.1	3.3	9.1	2.6	5.0	16.7	13.2	4.9	69.2
23	<i>Turdus viscivorus</i>	0	11.9	0	0	5.2	0	6.1	2.6	0	0	0	2.5	30.8
24	<i>Myophonus caeruleus</i>	13.8	16.7	0	12.5	10.4	3.3	6.1	28.9	15.0	16.7	7.4	10.8	92.3
25	<i>Remiz coronatus</i>	10.3	14.3	15.4	20.8	14.6	26.4	18.2	18.4	0	0	1.5	14.2	84.6
24	<i>Parus rufonuchalis</i>	0	0	0	0	0	0	6.1	0	0	0	0	0.4	7.7
26	<i>Parus flavipectus</i>	3.4	0	0	2.1	10.4	6.6	3.0	0	0	0	8.8	4.7	53.8
27	<i>Parus bokharensis</i>	0	0	0	0	0	0	0	0	0	0	17.6	2.3	7.7
29	<i>Sitta tephronota</i>	0	0	0	2.1	0	0	0	0	0	0	0	0.2	7.7
30	<i>Carduelis caniceps</i>	3.4	0	7.7	0	0	1.1	0	5.3	0	0	1.5	1.3	38.5
31	<i>Carpodacus erythrinus</i>	0	0	3.8	0	0	0	3.0	0	0	0	0	0.4	15.4
32	<i>Emberiza stewarti</i>	6.9	0	0	4.2	9.4	6.6	6.1	13.2	25.0	11.1	4.4	7.2	76.9
33	<i>Emberiza cia</i>	0	0	0	0	1.0	0	0	0	0	2.8	0	0.4	15.4
34	<i>Emberiza bruniceps</i>	0	7.1	0	4.2	4.2	6.6	0	0	5.0	11.1	0	3.8	61.2
Individuals per hour (ind./h)		23.2	28.0	18.4	19.2	198.9	31.3	26.4	18.2	56.0	12.3	18.9	41.1	
Total bird species		11	11	8	13	19	19	16	15	12	13	18	34	

A further four species were detected only twice in the late-June surveys. The Eurasian Sparrowhawk (*Accipiter nisus*) was first confirmed breeding in the Talas Alatau in 1960 (Kovshar, 1966) and in Taldybulak Gorge in 1994. It subsequently nested in various apple groves in the middle section of the gorge in 1997, 1998, 2001, 2005-2008, 2011, 2012, and 2025. Because hatching typically occurs in late June, adults are extremely secretive and are rarely detected **during surveys along the lower slope of the gorge** (e.g., 2012 and 2025); only inspection of nests reliably confirms breeding. The Chukar (*Alectoris chukar*) and the Rock Bunting (*Emberiza cia*) favour dry, rocky slopes. The former descends to the river only to drink recorded on our counts in 2000 and 2025 – whereas the latter's song is often audible on the gorge floor when a pair's territory boundary runs along the lower slope (2000 and 2012). The Common Rosefinch (*Carpodacus erythrinus*) is a regular breeder in high-mountain prostrate juniper scrub and, only at peak abundance, nests in small numbers in the upper belt of juniper forest. Situated in the lower montane belt, Taldybulak experiences earlier ripening of shrub berries than the high mountains, which attracts rosefinches to descend for feeding (records in 1998 and 2004). The species remains regularly present here from late July through August.

The Grey Wagtail (*Motacilla cinerea*) and the Eurasian Golden Oriole (*Oriolus oriolus*) were each recorded on three late-June counts (1996, 1997, 1999; and 1996, 2002, 2004, respectively), whereas the Mistle Thrush (*Turdus viscivorus*) was noted on four (1997, 2000, 2004, 2006). Although the wagtail is typically tied to running water and nests on gravel bars, suitable sites are lacking along the Taldybulak itself. Only at the gorge bifurcation does the shallow channel widen to expose small patches of cobble and gravel; however, water levels there are unstable and periodically inundate these substrates, often during nest building. The species has attempted to nest at this spot in most years (exceptions: 1998, 2000, 2002, 2010, 2014, 2015, 2025), yet since 1984 no nestlings, fledglings, or broods have been recorded; thus late-June detections likely reflect failed breeding. The Eurasian Golden Oriole breeds as isolated pairs in the gorge's tugai (riparian) woodland in most years (except 1998, 2009, 2014, 2015, 2025) and is usually detected by male song, which declines rapidly once fledglings appear, typically by late June.

Species recorded 4-5 times breed irregularly in the gorge, and this is reflected in their detections. The Common Whitethroat (*Sylvia communis*) and

Hume's Whitethroat (*Sylvia althaea*) place nests in shrubs on the slopes, descending to the river only to forage. The former was not recorded in late-June counts in 2003, 2006, 2009, and 2025; the latter was absent in 2001, 2002, 2007, and 2009. The Asian Paradise-Flycatcher (*Terpsiphone paradisi*) the first time nested in various apple groves within the gorge in 1980 (Ivashchenko, 1982), and later 1983-1985, 1994, 2000-2002, 2005, 2008, 2010, 2012, and 2025. The Grey-crowned Goldfinch (*Carduelis caniceps*) bred in tugai (riparian) woodland in 1995, 1997-1999, 2002, 2004, 2006, and 2025, and more often in the planted groves at the Taldybulak cordon, from which birds regularly entered the gorge to forage. The Eurasian Hobby (*Falco subbuteo*) and the Common Myna (*Acridotheres tristis*) also breed near the cordon; the former hunts throughout the gorge, whereas the latter rarely penetrates beyond its lower section. The Rosy Starling (*Sturnus roseus*) shifts its nesting sites annually and has bred within Taldybulak only once, in 1926 (Shulpin, 1953). Nevertheless, from late June onward it often appears in the gorge during post-breeding foraging movements. It was noted in 2000, 2002, 2008, and 2025; on 27 and 30 June 2000 the counts ranged from about 600 individuals to as few as two per survey. Because on such days Rosy Starlings can be up to 6.2-fold more numerous than all other birds combined, we excluded this species from calculations of community structure.

Dominant and subdominant species

Based on the eleven late-June surveys, three species qualified as dominants (share >10% of all individuals, *Rosy Starling* excluded): the Black-headed Penduline Tit (14.2%), the Eurasian Magpie (12.9%), and the Blue Whistling-Thrush (10.8%).

The Black-headed penduline tit historically the most abundant species in the late 1990s, however, retained this status only until the mid-2000s: it was not detected in late June 2008 and 2012, and in 2025 accounted for just 1.5% of all individuals. A marked decline during the breeding season was already noted in 2004, when none of five nests found in mid-June survived to early July, a pattern attributed to increasing tourist pressure and the removal of nests irrespective of contents or accessibility (Chalikova, 2004). In 2025 we likewise found no nests; two decades on, the species has shifted from dominant to scarce. The Eurasian Magpie typically nests in deciduous plantings in the lower parts of gorge but forages widely throughout; in late June it often forms the bulk of the community (from 0.0% in 2012 to

42.3% in 1998). This reflects a threefold drop in breeding-season abundance from the late 20th to the early 21st century (2.7 to 0.8 ind./h). An even larger, sixfold difference is evident for late-June counts (6.4 ind./h in 1996-1999 vs. 1.1 ind./h in 2000-2025), and the species lost dominant status in 2000, 2004, 2006, 2012, and 2025. The Blue Whistling-Thrush,

with one to three breeding pairs along the river, also fell below the dominance threshold in 1998, 2002, 2006, and 2025. In individual years, other species reached dominant levels: the Turkestan Tit in 2025, the Mistle Thrush in 1997, the Common Tit Myna in 1996, and Hume's Whitethroat in 2008 when broods were present.

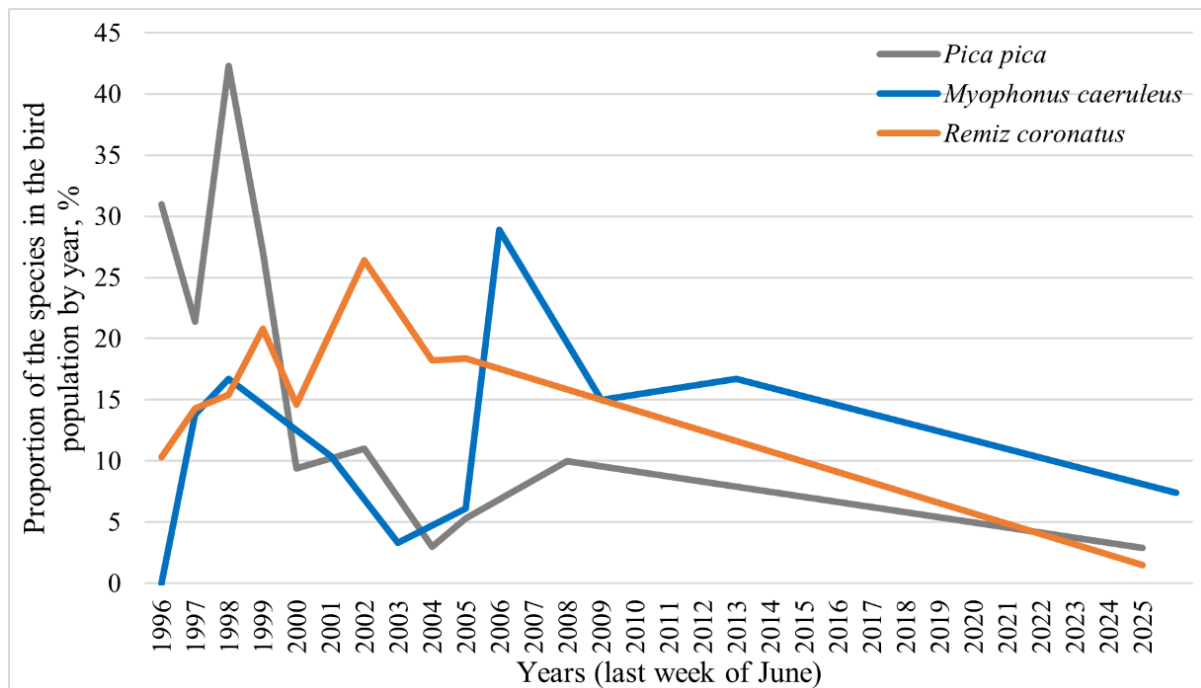


Figure 2 – Dominant bird species in Taldybulak Gorge

(The plot shows individual late-June survey days (not annual aggregates); values correspond to specific survey dates)

Eight additional species were classified as sub-dominants (3.0-9.9%). **White-capped Bunting** (*Emberiza stewarti*) breeds around rocky sections of the gorge and is typically detected by song. It reached dominant status in late June of 2006, 2008, and 2012, but was not recorded in 1997 or 1998. Notably, those two years had the lowest breeding-season densities for this species since 1994 (0.5 and 0.1 ind./h; mean 0.8 ind./h), and both its breeding-season and late-June densities in the 1990s (0.5 and 0.6 ind./h) were lower than in the 21st century (1.0 and 1.8 ind./h).

The **White-throated Dipper** occurs year-round on the river but is not always recorded on counts. Unlike *E. stewarti*, its breeding-season abundance was higher before 2004 than after (means 2.8 vs 0.6 ind./h). It ranked as a dominant in late June 1997 and 1998 (14.3% and 19.2%), yet was not detected in 2006, 2008, or 2025. These fluctuations likely re-

fect tourist pressure: one of the two traditional nest sites, situated at a shallow pedestrian crossing, was repeatedly destroyed in 1999–2005, after which the pair no longer bred there.

Participation of the **Common Nightingale** in the community likewise varied. It was dominant in late June 2004, 2008, and 2025, merely common in 1997, and absent from the 1996 count. Its late-June abundance also fluctuated (up to 2.7 ind./h in 2004; mean 1.1 ind./h).

The **Common Blackbird** was irregularly recorded before 2000 (not detected in 1996, 1998, 1999), but its share of the community increased thereafter (from 2.1% in 2000 to 16.7% in 2012). Peak late-June densities (2.0, 2.1, and 2.4 ind./h; overall mean 0.9 ind./h) occurred in 2004, 2012, and 2025.

The **Yellow-breasted Tit** was likewise irregular in late June (absent in 1997, 1998, 2006, 2008,

2012), as family groups wander at this time. Encountering one such flock in 2000 elevated its status to dominant (10.6%).

The **Woodpigeon** was absent from late-June counts in 1998, 2006, and 2012, but in 2002 approached dominance (9.9%).

The **Red-headed Bunting** more often breeds in shrublands on the eastern and southern slopes and seldom descends into the riparian thickets (not de-

tected in 1996, 2004, 2006, 2025); in summer 1998 it was absent from the gorge entirely. In other years its share ranged from 4.2% (1999, 2000) to 11.1% (2012).

The **Oriental Turtle-Dove** breeds regularly and becomes numerous along the riparian corridor once berries and fruits ripen. However, in late June prior to 2000 and again in 2004 it was not recorded on the counts (though later in the season it was abundant).

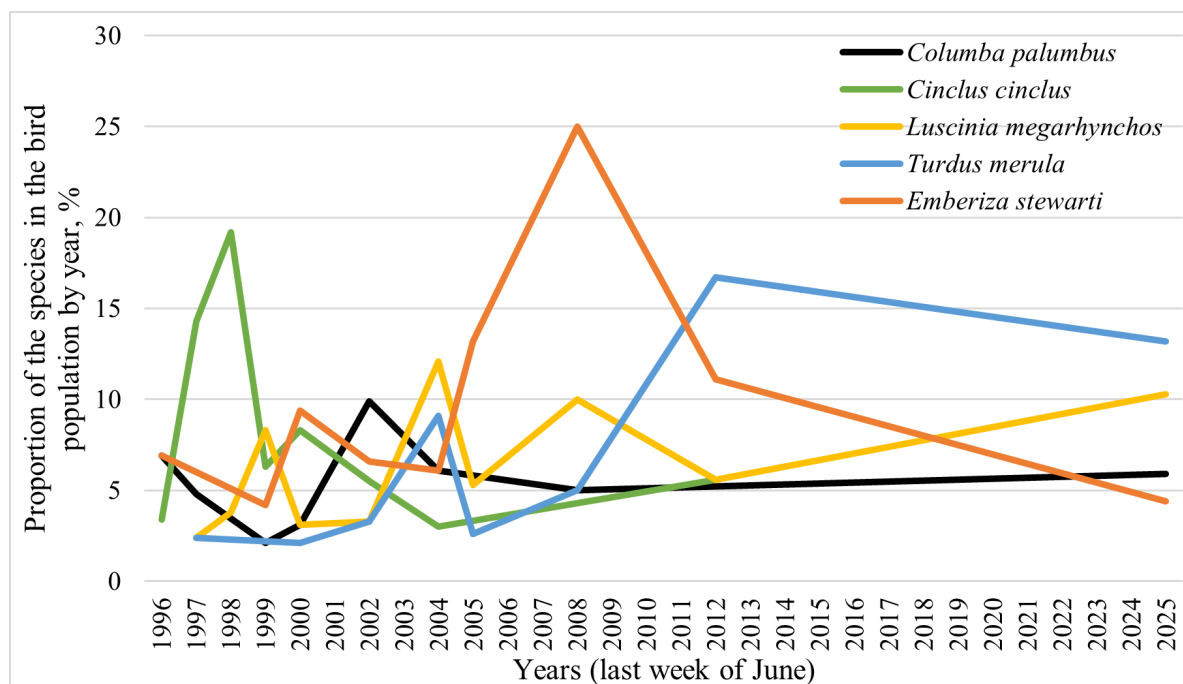


Figure 3 – Some subdominant bird species of Taldybulak Gorge.

(The plot shows individual late-June survey days (not annual aggregates); values correspond to specific survey dates)

Abundance dynamics

Total abundance (individuals per hour) varied far more than species richness. If all birds are included, counts ranged from 12.3 ind./h (2012) to 199.8 ind./h (2000); the latter was inflated by a large Rosy Starling flock. Excluding Rosy Starling, late-June examples were 21.1 ind./h (2000) and 36.0 ind./h (2008), with an overall mean of 40.6 ind./h across years. Short-term differences were pronounced even within the same year: 27.06.2000 = 378.5 ind./h vs 30.06.2000 = 21.1 ind./h; in 2002 the two counts were 28.8 and 36.0 ind./h. No linear trend was evident; however, aside from irruptive events, late 2010/2025 tended to have somewhat lower encounter rates than late 1990s.

Two site-faithful species declined as visitor traffic along the main trail increased: the Black-headed

Penduline Tit and the White-throated Dipper. The dipper abandoned its traditional nest at the shallow crossing and was detected less often thereafter. By contrast, several previously underrepresented species increased during 2012-2025: the Common Blackbird and the Oriental Turtle-Dove became more numerous, likely tracking high fruit crops in some years. The Carrion Crow established breeding near the cordon and now visits the lower gorge regularly.

Natural variability in a protected system

Our long-term surveys in Aksu-Zhabagyly Reserve demonstrate that bird communities in a protected mountain environment are highly dynamic. Species composition and abundances showed strong temporal fluctuations, consistent with findings from

other intact forests such as Białowieża, where long-term cycles occur despite a stable species pool (Wesołowski et al., 2022). Such results emphasize that variability is a normal feature of undisturbed systems and provide an essential baseline for distinguishing natural shifts from anthropogenic impacts.

In Taldybulak Gorge, many changes reflect natural processes such as nomadism, food-driven irruptions, or source-sink exchanges with nearby habitats. However, some trends point to human influence. Declines of Penduline Tit and White-throated Dipper coincided with increased tourist activity and nest disturbance along the trail. Similar effects of recreation have been reported elsewhere, where even low visitor pressure reduced breeding success or shifted communities toward disturbance-tolerant species (Kangas et al., 2008). This indicates the need for management actions such as keeping visitors on paths, restricting group size, or placing barriers near sensitive nesting sites. At the same time, late-June increases in Common Blackbird and Oriental Turtle-Dove are best explained by year-to-year variation in fruit crops. Both species leave the gorge for winter, and their early-summer abundance tracks spring flowering and the subsequent fruit set of wild shrubs and trees. These patterns show how climate (via spring phenology and fruiting), natural dynamics, and human presence together shape long-term community change (Alba & Chamberlain, 2025; Jonas et al., 2025).

Conclusion

Thirteen late-June survey days across 11 years (1996–2025) recorded 34 species in Taldybulak Gorge, with per-day richness ranging from 8 to 19 and marked variation in abundance. Community

composition showed a stable core of regular breeders and high turnover at the margins, with no clear directional change at the assemblage level once irruptive Rosy Starling flocks were excluded. Three taxa reached long-term dominance (Black-headed Penduline Tit, Eurasian Magpie, Blue Whistling-Thrush), but the penduline tit declined from dominant to scarce by 2025, and the White-throated Dipper also decreased after the loss or disturbance of a traditional nest site at a shallow crossing. In contrast, Common Blackbird and Oriental Turtle-Dove increased in late June, tracking interannual variation in fruit crops. These species-specific responses indicate that natural variability (phenology, food availability) and localized recreation jointly shape community structure. Site-focused management around the marked path and the shallow crossing should be sufficient for sensitive nests. Brief annual notes on fruiting would help explain fluctuations. We recommend maintaining and expanding long-term monitoring programs in protected areas. Continued standardized late-June counts on an annual cycle would provide continuity; while adding autonomous acoustic recorders, trail cameras, simple visitor tallies, and basic weather and phenology notes could improve attribution of change and allow evaluation of management effectiveness over time.

Gratitude, conflict of interest

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