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Zoological Research

Assessing the Hazard Grade of Birdstrike in Spring at Baita Airport，Hohhot

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Abstract：Between March and May 2005，bird communities in four sample plots at Baita Airport were studied using strips methods in Hohhot，Inner Mongolia．A total of 59 species belonging to 10 orders and 26 families were recorded．Based on the principles of avian community ecology，the community parameters were discussed，including the comparative importance value，distribution coefficient，density and probability of interactive encounter．By analyzing these indices，combined with their flight behaviors at the airport and its neighbourhood，we identified bird species that have the potential to threaten flight security at Baita Airport；The results showed that the 23 bird species including magpie and red falcon are the most hazard to flight security and the eight bird species including sparrow Hawk and Greenfinch are the hazard．Furthermore，we assessed the bird species＇different hazard grades to flight security．

Key words：Birdstrike；Hazard grade；Hohhot；Baita airport

呼和浩特白塔机场春季鸟类的鸟击危险等级评估

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摘要：2005 年 3—5 月采用样带法对呼和浩特白塔机场 4 个样区的鸟类进行了调查，共记录到鸟类 59 种，隶属于 10 目 26 科。通过分析春季鸟类群落中各鸟种的相对重要值、分布系数、密度和种间相遇概率等群落特征参数，结合鸟类在机场及周边地区的活动行为等综合因素确定影响飞机飞行安全的危险鸟类。其结果表明：构成飞行安全威胁有两类：喜鹊和红隼等 23 种鸟类为最危险的鸟类，雀鹰和金翅雀等 8 种鸟类为较危险的鸟类。

关键词：鸟击；危险等级；呼和浩特；白塔机场
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Birdstrike has been a problem since nine years after planes were first manufactured in the early 20th century，causing severe damage to passengers and possessions．Nowadays，as a potential danger to flight security，these incidents call for greater global attention to the effects of birdstrike．Over the last hundred years，scientists have changed their focus from increasing plane function to withstand birdstrike to ecological investigations on birds，prompting renewed global effort to reduce birdstrike．Recently，much progress has been achieved in all airports and related institutions around the world（Fang et al，2002；Li et al，2001；Wang et al，1999；Yang et al，1998）．In order to control the hazard of potential birdstrike at Baita Air-

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port, Hohhot, we started an ecological investigation of birds in a cone area between 2004 and 2005. The study aimed to assess the species, number, ecological distribution and daily activities of birds to generate an integrated method of avoiding birdstrike. Furthermore, identifying the bird species in different seasons will help staff to avoid and control birdstrike on a daily basis. This paper identifies bird species and their activities and habitats in spring in order to classify the hazard grade in this season to flight security.

1 Method

1.1 Natural environment

Baita Airport is located in the marginal zone between urban and rural areas within the Saihan district, seven kilometers east of Hohhot municipal Government. The central area of the airport is located at 110°49′24″E latitude, 40°51′06″N longitude and 1 077 m above sea level. The airport has a slight gradient and is higher in the north and lower in the south. The center of the runway is 5.6 km from Wanbu Huayanjing Tower (Baita Tower). This area belongs to the middle temperate continental climate zone, the average daily temperature is 6.8℃ and the daily temperature variation is approximately 10℃. The annual average rainfall is 361.9 mm, evaporation is 1 839 mm, wind speed is 1.8 m/s, and the maximum depth of frozen earth is 1.6 m.

1.2 Habitat features and settings of sample strips

1.2.1 Habitat features Four sample areas (A, B, C, D) were classified according to the landscape, vegetation type and distance to the flight area. The sketch map (Fig. 1) was drawn to indicate the four sample areas (A, B, C, D). Section A is the airfield area and is mainly covered with grass. It contains five different identified bird habitats. A construction refuse dump full of grasses is approximately 100 m to the north of the eastern tip of the runway. There is a sewage disposal facility at the northwest tip of the parking area, where a sewage puddle approximately 500 m^2 is formed in spring. The floral community in Section A mainly consists of annual grasses, like *Pennisetum centrasiaticum*, *Setaria viridis*, *Artemisia scoparia*, *Potentilla tanacetifolia*, *Potentilla tanacetifolia*, *Medicago sativ*. Wood plants, such as *Picea wilsonii*, *Pinus tabulaeformis*, *Sabina chinensis* and *Platycladus orientalis* are mainly distributed near the Air Traffic Control headquaters and Fire Department areas.

Section B is in the north of the office area and vegetation is mainly coniferous and broadleaf forest, including species such as *Larix principis-rupprechtii*, *Pinus sylvestris* var. *mongolica*, *Juniperus rigida*, *Populus* × *Canadensis* and *Prunus davidiana*. Scrub species, like *Sorbaria sorbifolia* and *Prunus triloba* are distributed among them, of which the dominant species are *Lespedeza davurica* and *Heteropappus altaicus*. There is approximately 0.5 ha of manufactured lawn, covering 40% of this area. This section includes three different identified habitats.

Section C lies in a inner level area except Sections A and B. It contains seven bird habitats. This Section overlaps agricultural farmland and villages and is covered with artificial forest (such as *Populus simonii*, *Populus alba* var. *pyramidalis* and pine), a few scrub species (such as *Rosa rugosa*) and agricultural crops. The dominant plant species are *Chloris virgata* and *Heteropappus altaicus*.

Section D is the area between inner level and cone area. Except for large patches of village and farmland, water bodies, such as rivers, ponds and ditches, are dominant in this area. The terrestrial vegetation is similar with that in Section C, while the plants in the wetland are predominantly *Phragmites australis*, and the plants near the water bank include *Echinochloa crus-galli*, *Polygonum lapathifolium* and *Achnatherum splendens*. Section D contains 10 different identified bird habitats.

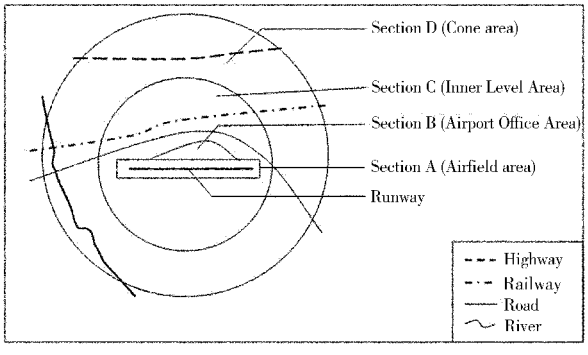

Fig. 1 A sketch map of sample areas at Baita airport

1.2.2 Settings of sample strips The 25 different bird habitats in the four sample sections (5, 3, 7 and 10 habitats respectively) were identified and 6, 3, 39 and 32 sample strips were established in the sites respectively (total sample strips = 80). The investigation lasted three months. Investigations strip were repeated three times a month in Sections A and B but only once each in Sections C and D.

1.3 Investigation method

Birds were investigated according to the sample strip method (Zheng, 1995) and the species and number of all birds seen within 50 m of both sides of a central line were recorded using 10 × 50 binoculars. Species was identified by combing the flight behavior and birdcalls. Unidentified birds were photographed using a digital camera and identified using *A Field Guide to the Birds of China* (Yan, 1999).

1.4 Statistical method

Bird density, distribution, probability of interactive encounter and the comparative importance values (Luan et al, 2004) were measured. The potential hazard to flight security was based on this evidence.

The density was calculated using $D = N/2LW$, of which, N is the number of birds in the sample strip, L is the length and W is the width of one side of the sample strip. The distribution coeffient (Hou et al, 2001) was calculated according to $ADC = (n/N + m/M) \times 100\%$, in which, n is the number of sample strips and m is number of habitats where a bird occurs. N is the total number of strips in the investigation and M is the total number of vegetation types investigated. According to variable distribution coefficients, birds are grouped into three distribution types: wide distribution (nearly 100%), middle distribution (25%–100%) and narrow distribution (below 25%). The probability of interactive encounter (Ding et al, 1989) was calculated according to $PIE = \sum(ni/N) \times [(N - ni)/(N - 1)]$, in which, ni is the number of bird i, and N is the total number of birds. The comparative importance values expresses the relative position and role of a certain species within the community (Li et al, 2000), which is an important index for identifying the hazard grade of birds at the airport. Importance values were calculated according to IV = (comparative number + comparative time + comparative dimension + comparative weight)/4, where; comparative number = (number of individual birds of a species/the largest number of individual birds of any species) × 100; comparative time = (number of investigations for a bird species/total number of investigations) × 100; comparative dimension = (total number of sample strips which a bird was observed on/total number of sample strips) × 100; comparative weight = (estimated weight of all birds of a single species/the largest weight of all birds of any species) × 100. The bird weight was estimated according to Zhao (1995, 2001). The average weight of male and female birds was the final bird weight; $IV \geqslant 25$ was defined as the most important bird, $15 \leqslant IV < 25$ as highly important birds, $5 \leqslant IV < 15$ as less important birds, and $IV < 5$ as the least important birds within the community.

2 Results and analysis

2.1 The composition of bird species in the community

In spring, a total of 59 species and 32 576 individuals, belonging to 10 orders and 26 families were recorded in the sampling area of the airport. Of these species, 20 are residents, accounting for 33.9% of species, 24 are summer migrants, accounting for 40.7% of species, five are winter migrants, accounting for 8.5% of species and 10 are visitors, accounting for 16.9% of species. The seasons, statistics, densities, importance values, distribution coefficients and probabilities of interactive encounter are shown in Tab. 1.

The distribution coeffients across the habitats (Tab. 1), showed that in spring there were two widely distributed species, *Pica pica* and *Passer montanus*, accounting for 3.4% of the total number of species. There were also 15 mid-distribution species, including *Falco tinnunculus* and *Perdix dauuricae*, accounting for 25.4% of species, and 42 narrow distribution species, including *Accipiter nisus* and *Falco amurensis*, accounting for 71.2% of species. Therefore, the narrowly distributed birds are the main birds at the airport. The average density of birds in spring was 16.6 / ha. The highest density species are *Corvus dauuricus*, *Corvus corone* and *Passer montanus* with densities of 11.3, 1.55 and 1.28/ha respectively. The overall probability of interactive encounter was 0.516 and the highest probability of interactive encounter was 0.217 for jackdaws.

2.2 The identification of the hazard grade of birds

According to Tab. 1, 15 species, including *Falco tinnunculus* and *Perdix dauuricae*, were classified as the most important species, 12 are highly important species, including *Accipiter nisus* and *Falco amurensis*, 20 are less important, including *Coturnix japonica* and *Charadrius veredus* and 12 are the least important bird species, including *Charadrius dubius* and *Apus apus*. According to the importance values combined with the distribution, density, probability of interactive encounter, group behavior, whether they fly around the

Tab. 1 The composition and hazard grade of the avian community of Baita Airport in spring

Species	Distribution	Quantity	Number of individuals	Density	Transect Quantity	Number of Habitats Observed in	Importance Values	Distribution Coefficient (%)	Probability of Interactive Encounter
1. *Accipiter nisus* ***	P	1	1	0.0005	1	1	18.659	5.25	0.00003
2. *Falco tinnunculus* ****	R	12	12	0.0061	10	9	38.446	48.50	0.00037
3. *Falco amurensis* ****	S	3	2	0.0015	2	2	16.359	10.50	0.00009
4. *Falco subbuteo* ****	S	4	2	0.0020	2	1	18.345	6.50	0.00012
5. *Perdix dauuricae* ****	R	54	13	0.0276	8	6	41.972	34.00	0.00165
6. *Coturnix japonica* ***	R	1	1	0.0005	1	1	8.625	5.25	0.00003
7. *Phasianus colchicus* ****	R	20	7	0.0102	7	6	112.412	32.75	0.00061
8. *Vanellus cinereus* ****	S	7	5	0.0036	3	3	29.255	15.75	0.00021
9. *Charadrius dubius* **	S	2	1	0.0010	1	1	4.837	5.25	0.00006
10. *Charadrius veredus* ****	P	18	1	0.0092	1	1	8.659	5.25	0.00055
11. *Tringa ochropus* ****	P	1	1	0.0005	1	1	8.816	5.25	0.00003
12. *Actitis hypoleucos* ****	S	4	2	0.0020	2	1	7.820	6.50	0.00012
13. *Sterna hirundo* **	S	12	2	0.0061	2	1	12.607	6.50	0.00037
14. *Columba* sp. ****	R	388	45	0.1980	28	12	82.204	83.00	0.01177
15. *Streptopelia orientalis* **	R	7	3	0.0036	3	2	25.977	11.75	0.00021
16. *Streptopelia decaocto* ****	R	188	46	0.0959	30	13	76.985	89.50	0.00574
17. *Streptopelia chinensis* **	R	9	5	0.0046	3	4	20.083	19.75	0.00028
18. *Athene noctua* ****	R	1	1	0.0005	1	1	13.801	5.25	0.00003
19. *Apus apus* ***	S	7	1	0.0036	1	1	4.796	5.25	0.00021
20. *Alcedo atthis* *	S	1	1	0.0005	1	1	4.215	5.25	0.00003
21. *Upupa epops* ****	S	47	25	0.0240	19	9	42.661	59.75	0.00144
22. *Jynx torquilla* *	S	1	1	0.0005	1	1	4.811	5.25	0.00003
23. *Picoides major* **	R	35	22	0.0179	19	9	41.023	59.75	0.00107
24. *Picus canus* **	R	4	3	0.0020	3	2	16.675	11.75	0.00012
25. *Calandrella cinerea* ***	S	17	4	0.0087	3	2	7.976	11.75	0.00052
26. *Galerida cristata* **	R	1	1	0.0005	1	1	5.216	5.25	0.00003
27. *Alauda arvensis* ****	S	50	8	0.0255	3	3	10.890	15.75	0.00153
28. *Hirundo rustica* ****	S	75	10	0.0383	9	5	18.203	31.25	0.00230
29. *Motacilla alba* ***	S	32	14	0.0163	12	11	24.226	59.00	0.00098
30. *Motacilla citreola* **	S	4	1	0.0020	1	1	3.568	5.25	0.00012
31. *Motacilla cinerea* *	S	4	2	0.0020	2	2	5.051	10.50	0.00012
32. *Anthus richardi* ****	S	24	3	0.0122	3	3	7.562	15.75	0.00074
33. *Anthus godlewskii* ****	S	111	6	0.0566	6	5	12.808	27.50	0.00340
34. *Anthus hodgsoni* **	S	192	10	0.0980	10	5	20.299	32.50	0.00586
35. *Anthus spinoletta* **	P	13	1	0.0066	1	1	3.694	5.25	0.00040
36. *Lanius sphenocercus* ****	R	5	3	0.0026	2	2	18.135	10.50	0.00015
37. *Sturnia cineraceus* ***	S	92	24	0.0469	19	9	43.631	59.75	0.00282
38. *Pica pica* ****	R	1065	111	0.5434	63	21	159.270	162.75	0.03162
39. *Corvus dauuricus* ****	R	22192	17	11.3224	15	11	146.618	62.75	0.21716
40. *Corvus corone* ****	R	3029	7	1.5454	7	5	66.874	28.75	0.08434
41. *Corvus macrorhynchos* ****	R	2002	2	1.0214	2	1	57.131	6.50	0.05768
42. *Prunella montanella* **	W	4	2	0.0020	1	1	3.780	5.25	0.00012
43. *Luscinia svecicus* *	P	1	1	0.0005	1	1	3.192	5.25	0.00003
44. *Phoenicurus auroreus* **	S	6	6	0.0031	6	5	12.058	27.50	0.00018
45. *Saxicola torquata* **	S	22	2	0.0112	2	2	5.111	10.50	0.00067
46. *Oenanthe pleschanka* **	S	15	5	0.0077	3	2	7.839	11.75	0.00046
47. *Turdus ruficollis* *	W	4	2	0.0020	2	2	11.059	10.50	0.00012
48. *Turdus eunomus* **	W	13	5	0.0066	5	4	15.038	22.25	0.00040
49. *Ficedula parva* **	P	27	7	0.0138	6	3	12.182	19.50	0.00083
50. *Phylloscopus fuscatus* *	S	2	1	0.0010	1	1	2.536	5.25	0.00006
51. *Parus major* **	R	10	3	0.0051	2	2	5.296	10.50	0.00031

（Tab. 1　continued）

Species	Distribution	Quantity	Number of individuals	Density	Transect Quantity	Number of Habitats Observed in	Importance Values	Distribution Coefficient (%)	Probability of Interactive Encounter
52. *Passer montanus* ****	R	2500	82	1.2755	45	17	111.071	124.25	0.07086
53. *Fringilla coelebs* **	P	1	1	0.0005	1	1	3.597	5.25	0.00003
54. *Fringilla montifringilla* **	W	5	3	0.0026	2	2	6.034	10.50	0.00015
55. *Carpodacus erythrinus* **	P	24	2	0.0122	2	2	5.631	10.50	0.00074
56. *Carduelis sinica* ***	R	92	15	0.0469	8	8	19.623	42.00	0.00282
57. *Emberiza yessoensis* **	P	2	1	0.0010	1	1	3.186	5.25	0.00006
58. *Emberiza pusilla* ***	W	112	9	0.0571	9	5	17.550	31.25	0.00343
59. *Emberiza spodocephala* **	P	1	1	0.0005	1	1	3.403	5.25	0.00003
Total (59 species)		32576		16.6204					0.51628

* are the least hazardous species; ** are the less hazardous species; *** are the highly hazardous species; **** are the most hazardous species
R: species of residents; S: species of summer breeders; W: species of winter species; P: species of transient migrants.

runway, their flying height, the distance of their activities to the flight area and so on, the 59 species were classified as the most hazardous, hazardous, less hazardous and least hazardous according to its rank.

3 Discussion

3.1 The distribution of bird species influencing flight security

Fourteen species from each of the resident group and the summer migrant group respectively fall into the two highest hazard groups (most hazardous and hazardous birds), accounting for 90.3% of bird species in these groups. Three species from each of the winter migrants and the visitors account for the remaining 9.7%. Therefore, the species which are the highest potential hazards to flight security, are mainly residents and summer migrants.

3.2 Evaluation of the potential hazard to flight security at different hazard grades

The most hazardous birds, with importance values over 25, include: raptors which fly fast and have a wide activity scope; crows and small finchs which fly in large flocks; cooers and pigeons which fly across the runway; quails and chickens which live on both sides of the runway; and small snipes which inhabit the water areas. These birds often inhabit Section A and often transverse or fly above the runway, close to the flight route. The biological features of raptors influence their hazard grade; as they fly at high elevation, are active in a wide area and feed mainly on mice and small birds, the hot air current above the runway can support their flight and save them energy. In addition quarries on both sides of these fields provide ideal foraging habitat and therefore, the flight area becomes a preferred present site. Meanwhile, crows, quails and small finchs fly in large flocks across the runway in spring. At times there can be more than 10 000 crows at the site, which are more dangerous than raptors as planes can not avoid them easily. The power of the impact of a group of crows is greater than that of a single raptor. Quails are common birds in the flight area. They forage on the ground close to the runway during dawn and dusk, and display scattered flight when scared. Therefore they may be drawn into the engine of the plane by the currents generated by the engine. Small snipes are always in the water areas around the flight area. They usually land in flocks when they spot water. The water from the sewage factory has formed a shining water surface to the north of the runway, which attracts birds which have flown for long distances and need to rest to renew their energy. They can easily encounter landing or airborne planes while descending or flying around the runway when disturbed.

The eight hazardous-grade raptor species are distributed far away from the inner level area and seldom fly into the flight area. Their flight routes overlap with the ascending and descending route of the planes, which poses a potential threat to the airplane. Compared these species with the most hazardous species that often fly within the airfield area, they are less dangerous, and are thus defined as hazardous birds.

There are 28 bird species that are less or least hazardous. Their activities are focused in the cone area and within the inner level area, far away from the flight route. They pose little hazard to aircraft and have not been discussed here.

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