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RESEARCH ARTICLE

Analysis of bird mortality caused by transport incidents In flight safety management

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We discussed some approaches to increase the effectiveness of flight safety measures in airports through monitoring and analyze the occurrence of birds near highways (which we believed have similar attraction factors for the birds). We revealed definite similar patterns as for bird occurrence in the airfields and near the highways. We also monitor the dynamics of birds' annual mortality and species composition of dead birds, which also had similar trends. This information could contribute to data analysis of the ornithological situation near the roads to the flight safety system.
Keywords: birds' mortality; road bird incidents; bird danger; bird strikes; flight safety; aviation ornithology

Introduction

The expansion of technogenic areas and anthropogenic influence contributes to the strong conflict between techno and natural environment at the border zones. These conflicts more typical for the areas of local manmade objects integrated into the natural habitats (country plots, agricultural farms, etc.), as well as along extensive linear manmade structures (Kukhta, 2013), such as power lines and roads. We consider that relatively low technogenic transformation of such manmade areas is typical (in comparison with the urban environment), which has practically zero effect on the native animal species.

At the same time, the technogenic influence introduced into the system is used by animals for their own purposes, for example, various types of summer houses (toilets, barns, fences, residential buildings, etc.) provide additional nesting areas for different species of birds (Novikov, 2006), and feeding resources, like waste (Kukhta, 2014). Roads are used by birds to collect forage objects (thrown out of motor vehicles or killed by the cars), while bushy vegetation growing on the edges of roads, and road embankments attract birds for nesting (Banik, 2009). Power lines are used as perches by the birds of prey and other birds (Karev, 2009). Thus, the frontier technogenic territories are characterized by minimal technogenic pressure, providing animals with a number of new conditions they can use to their advantage (Rezanov, 2005).

The problem of interaction between these two environments caused the high mortality of animals used elements of the techno environment (Kukhta, 2012; Salnikov, 2013) and sometimes act in opposite way as danger factors to the humans (Saltykov, 2003). We believe that such incidents often occur in highways, where a high vehicle speed usually causes serious mechanical damage to mid-sized and large animals (even caused death of people and animals). In this context, the role of birds is minimal due to bird weight and car speed limit - even the large birds can not cause serious damage to the vehicle.

The situation can be different in high-speed roads (Formula 1 racer Alan Stacey died on the 24th lap when a bird crashed into his helmet in June 19, 1960). The bird hazards becomes more relevant in the world of sports with high speeds and extremely lightweight materials. Every year we have the breakdowns on the racetracks and other incidents caused by the birds.

The problem of bird danger in aviation is even more relevant. Every year we recorded hundreds of aircraft collisions with the birds (hereinafter named as BASH). Nevertheless, due to high speeds and extremely demanding attitude to the technical condition of aircraft significant part of the collisions ends with a forced landing, technical inspection, or sometimes with serious damage. These accidents caused multimillion-dollar losses annually (IKAO, Ilyichev, 2007)

The majority of BASH occur in the process of takeoff and landing, so, according to the analysis of collisions of the Armed Forces with wild animals, conducted by the International Civil Aviation Organization, the probability of bird strikes is less than 5% (according to Ministry of Transport, International..., Civil Aviation Organization, Electronic Bulletin, Analysis of collisions with wild animals (IBIS) for 2008-2015 years. 12.05.2017) due to the great intensity of bird flights in the surface layer of 0-300 m (Kolesnikov, 2008). One of the problems connected to ornithological safety in airports is the problem of bird identification (Ryzhov, 2013). To take effective measures aimed for the BASH prevention it is necessary to carry out the targeted management against the certain species. At the airport, the identification of these species is based on the analysis of bird

surveys. However, not all common species can be dangerous to the vehicles, and some rare species can cause the BASH, especially if an incident occurred outside the airport. Moreover, in many cases, the remains of a bird brought down by an airplane are could not be identified and often in Inspection Acts of the Armed Forces after the BASH you can find such the definition "sublimated biological substance". That is all you can know about this bird. Meanwhile, we can suggest certain seasonal trend and get significant data for the analysis from the similarity between the bird mortality resulted from a collision with motor vehicle and airplane rather than from “sublimated substance” information.

We also know that the analysis of bird strike data reveals trends useful for airport administrations in identifying hazardous areas that should be covered by a well-organized bird control program. Bird collision statistics can also be used to determine the time of year or a day when the bird control is extremely important (IKAO, Doc 9137-AN/898). Based on this premise, we can extrapolate the data on bird highway mortality to the territory of airfield and the takeoff runway, which allows managing and controlling certain species and groups of birds, thereby increasing the effectiveness of airport safety.

Materials and methods

We analyzed the data on bird mortality on the roads and airports located in the southeastern zone of Western Siberia. We collected the data from May to September in 2016-2018 because in this area the majority of BASHs falls on the summer months.

Tomsk airport and a 25 km (one-way) highway connecting the airport with the city were used as a model site in our study. In addition, we analyzed the data on the BASHs, which occurred in other airports in the region, as well as data from the Archive materials of the investigations of industrial incidents (hereinafter III), as well as finds of dead birds on the roads of Tomsk, Novosibirsk, and Kemerovo regions.

We carried out the bird counts at the airport by direct visual observations en route at least 2 times a week, while estimated the number of birds on the route, species composition, flight height, bird activity (feeding, flying, flying, singing, etc.). We identified the species and probable death reason for the dead birds on the takeoff runway or near it and also the weather and seasonal conditions.

We counted the birds along the road "Tomsk - Airport - Tomsk" during a bike ride, on dry days 1-3 times a week (depending on the weather), at 6:00 am towards the airport and after 16:00 towards the city. At the end of the trip, we noted the most common bird species and their behavior in the road transect. We identified the species of dead birds, the sex and age if possible. We also determined the reasons of bird mortality. The usage of a bicycle to observe the dead birds and evaluate the ornithological situation along highways has a number of advantages (Slater, 1994). We also think that driving by car we have less chances and worse overview, resulting in underestimation of dead animals. In particular, the crushed and unrolled remains of small birds by wheels of motor vehicles cannot be visible when observing them from a car (Figure 1).

We obtained episodic information about the downed birds on other parts of the roads of Tomsk and neighboring regions by car surveys and the method of population survey. The share of this sample is insignificant; we registered only 9 birds of large and medium size.

Figure 1. The remains of a male chaffinch (Fringílla coelebs L.) shot down by a car, detected during the bicycle counting and invisible from the vehicle.

During three years of observations, we carried out 39 cycling surveys of 1950 km of the countryside road and registered 104 dead birds. On the territory of Tomsk airport, we made 170 bird surveys and analyzed 5,616 individuals close to an takeoff runway. More than 1000 cases of BASHs from the III database, which occurred with Russian airplanes were analyzed, in particular, we analyzed 18 bird strikes in the airports of southeastern part of Western Siberia.

Results and discussion

BASH in the Russian Federation are recorded monthly throughout the year (Fig. 2). According to official data from the Federal Air Transport Agency and the Archive of Incident Investigations and Industrial Accidents (AIIIA), the largest number of BASH is observed in summer when the probability increasing by 17 times (an average of 119 BASHs in July) compared to winter months (at least 7 strikes).

Figure 2. The average annual distribution of bird strikes (the graph is based on the analysis of daily information, AIIIA)

The annual dynamics of bird strikes throughout the year reflects the general tendency of the birds to stay in the territories of airports. In the airports of Western Siberia in winter there is a minimum number of birds, which are represented mainly by small passerines (Passeriformes). Large birds (owls (Strigiformes), corvids (Corvidae), buzzards (Buteoninae) occur only occasionally at this time, usually we counted 1–3 individuals. The summer period, on the contrary characterized by a surge in bird activity due to feeding flights, as well as their numbers associated with the nesting period.
An analysis of the dynamics of change in finds of downed birds outside the road area and cases of MTPs showed a similarity between the trends of these two graphs (Fig. 3) from May to August.

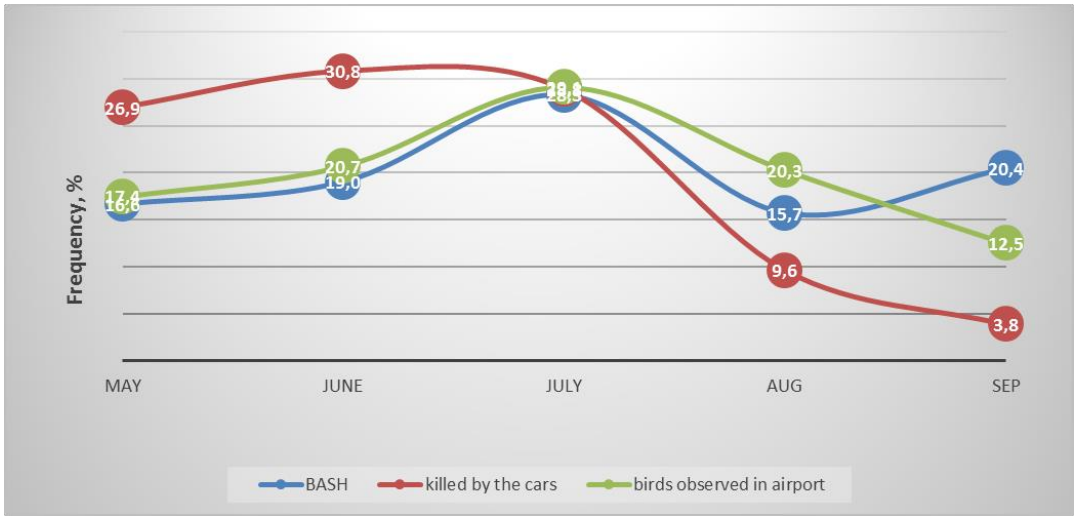

Figure 3. The relative distribution of BASH and death of birds caused by vehicles in summer period vs the summer dynamics of birds' presence in Tomsk airport.

The divergence of schedules from September is due to geography (during this period, the BASH most often occurs in the European and Southern part of Russia). Birds migrating to the south provide BASH outbreak (for Russia as a whole) in September and the first half of October. In regions with cold temperatures, which includes the Siberian region, the occurrence of birds significantly decreases after the autumn, and there are no autumn peaks of BASH (just some cases were reported). A similar trend in birds' presence in the airfield is generally typical for West-Siberian airports. The overall decline in birds' number is also reflected in a significant decrease in birds killed on the roads (see Fig. 3). Thus, the curve of bird road death accurately reflects the BASH trend in this and adjacent regions, showing an increase in bird death in the first half of summer, followed by subsequent decrease.

What is the reason for the similar dynamics of bird death? The answer to this question can be obtained by analyzing the behavior of birds and the fluctuations in species diversity, both on the airfields and near the roads.

In May, migratory processes in western Siberia end, with the result that the total number of species increases. Most of these species belong to small passerines (warblers (Phylloscopidae), warblers (Sylviidae), etc.) and are not dangerous for airplanes. Since the second half of May, the frequency of chaffinch and oatmeal prevails along the roads, which asphalt coating attracts for boron feed. These same species of birds prevail among the dead. Beginning in the second half of May, the occurrence of dead blackbirds increases. The thrush of the grass soldier (Turdus pilaris L.) feeds in wet places along the roadsides, so they can form fodder here, from a few birds to dozens of individuals. Obviously, increased motor activity, in particular the intersection of the roadway, is the cause of the death of these birds under the wheels of vehicles. On the territory of the airport, chaffinch and oatmeal near the runway is practically not found, because The runway is separated from the forest, where they live in a vast meadow area. However, at the airport, these birds can be found feeding along an unpaved service road, (passing near groves) where they do not pose a danger to the aircraft. A different situation on the airfield is observed with thrushes (Turdidae). These birds feed on the meadow part of the airfield, in particular, in the immediate vicinity of the runway. The feeding activity of thrushes is accompanied by their high motor activity (during this period the birds move intensively, mostly at a low altitude, from 0 to 10 meters). The size and weight of the thrush are small, but the schooling movement... These birds pose a risk to the sun. When in May mainly the adult blackbirds die on the roads (up to May 20 the occurrence rate of adult dead birds was 100%), then in June the adult blackbirds found only 30%, young individuals dominated among the dead, while the total number of downed thrushes increased. Obviously the death of the young is due to lack of experience and lack of understanding of the danger. From this position, the stay of young birds near the runway is especially dangerous for aircraft. In June 2016, a carcass of a young thrush was found at the runway, which died as a result of a tangled jet from a scattering aircraft. A number of birds found on the road also died not as a result of direct contact with a motor vehicle, but as a result of the influence of a wake.

From the second half of June, corvids (european magpie (Pica pica L.), hooded crow (Corvus cornix L.) begin to concentrate along the roads, including young birds, most often in groups of 3-10 birds. In a short time you can find downed birds, which are young individuals. With the beginning of the concentration of corvidae birds along highways, the beginning of a more mass concentration of corvidae birds (for the Tomsk region - the Hooded Crow) on the meadow part of the airfield where they feed is connected. The increase in the proportion of young birds in the flock during this period adversely affects the position of ornithological safety. The size and weight of even the young crows are such that this bird may well harm the aircraft, therefore, in the initial period of concentration of corvids on the airfield, enhanced preventive measures should be taken to ensure ornithological safety. An indicator of the need to prepare for these measures can serve as a noticeable increase in the occurrence of corvids along roads.

During July, the death of birds on the road gradually decreases, since Most of the bird species during this period end up feeding the chicks, and the chicks acquire the necessary experience of avoiding hazards, therefore the death is mostly random. Significant fodder concentrations of birds along the road (with the exception of corvids) were not observed during this period.

Figure 4. Young birds of prey killed by vehicles: black kite (Milvus migrans) and marsh owl (Asio flammeus).

We observed the initial moment of birds on the roads in second half of July and in August, when we registered the owls (Asio flammeus Pont., Asio otus L., Strix uralensis Pall.) and black kites (Milvus migrans Bodd.). Dead birds were mostly the young individuals who were not able to identify the danger.

Birds of prey could be very dangerous at airplane strikes because of their weight-size characteristics. In addition, hunting bird of prey (especially young) targeting the object and often could not evaluate the danger from transport. Our results proved the great share of young birds killed on the road. We also monitored black kites behavior when they rush for food objects on the road and ignored approaching vehicles.

We observed an increase of predatory birds' number from the third decade of July in the area of airport "Tomsk"; on the same time birds quantity still high at the highways until the third decade of August then their number gradually decreases. Predators are predominantly close to the runway and takeoff runway, looking for prey on them from heights more than 100 meters and from small heights (0-10 meters). The latter makes their stay at the airport especially dangerous. Young black kites and kestrels (Falco tinnunculus L.) could cause serious hazard in late July - early August.

Figure 5. The remains of a young kestrel (Falco tinnunculus) trapped in the engine of the flying aircraft.

Owls die on the roads mainly in the darkness; according to our observations, the bird sits on the road and looks at the car headlights until the last moment. A similar situation was typical in bird behavior with respect to the landing/taking-off aircraft, when the landing headlight switched on. In 2011, we recorded BASH when a marsh owl, disoriented by the light of a landing plane, hit the side of an aircraft moving along the takeoff runway at a minimum speed.

The number of passerines registered on the roads decreases in August, which is associated with a decrease in the intensity of general bird flights partly due to the adult molting. However, the number of the wagtail (Motacilla alba L.), increases along the roads from the second half of the month because it feed here by killed insects. In the same period, we registered strong increase in killed wagtails (Kukhta, 2012). Insects, and other small invertebrates flying over the roadway attract the swallows, which can be found on the sections of the road passing through open habitats (meadow or field). The takeoff runway, surrounded by a vast meadow area also represents a suitable area for these birds. In August, when the young swallows leave the nests, their occurrence on the airfield increases by an average of 30 percent or more (compared to June). These birds often cross and fly along the takeoff runway at low altitudes (0-10 m) in flocks of 3-15 individuals. This phenomenon contribute to an increase in BASH numbers (we registered this at the airport, namely in August).

We should like to consider the pigeon (Columba livia Gmel.) mortality on the highway. The great number of such cases occur on the urban of rural roads. The death of pigeons because of a collision with the cars is observed throughout the year with peaks in the places of forage accumulations, which pigeons arrange near the colonies located in the attics. The colonial way of pigeons, their size and weight as well as the high level of tolerance towards human danger consider these birds to the category of hazardous species. We reported several cases of pigeon colliding with a car moving at a speed of less than 20 km/h and two cases of collision with a cyclist during the observation period. We suggested the management measures against the pigeon-induced BASHs, which should include elimination their colonies near the airport, maintaining the grass stand in the meadow area of the airfield not lower than 20-25 cm during the summer period (according to section 4.2.2 89).

Conclusions

We can extrapolate the results from the Tomsk region and the Tomsk Airport to almost all the airports within the Russian Federation.

We made a comparison of the death of birds on the roads and during bird strikes and found an analogy between them regards the species composition. In particular, we estimate that there is common annual and seasonal dynamics, the species composition of dangerous species in different annual periods for the area of Tomsk region. We consider these data to be of great practical importance, allowing to determine the present and future ornithological situation near the paved run by data on the occurrence and death of birds along the adjunct road. Considering the fact that the length of roads in Russia is much larger than the length of the paved runways, bearing in mind that the airport operating personnel is forced to reach the work site by road, such approach can contribute significantly to the information on the ornithological situation near the paved runway. The annual tracking of the bird occurrence and dynamics along highways allows us to focus on management implications to reduce number of birds that are relevant in a given season. Nevertheless, the data on the occurrence and death of birds along the roads are only auxiliary, complementing and expanding the entire picture of the ornithological situation that we evaluate from direct bird surveys in the airfield.

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