

Threats and Preventive Methods to Avoid Bird Strikes at the Deblin Military Airfield, Poland

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Abstract—The paper presents results of the project conducted in Poland devoted to study on bird strikes at military airfields. The main aim of this project was to develop methods of aircraft protection against threats from birds. The studies were carried out using two methods. One by transect and the other one by selected sector scanning. During the research, it was recorded, that 104 species of birds in the number about of 36000 were observed. The most frequent ones were starling *Sturnus vulgaris* (31.0%), jackdaw *Corvus monedula* (18.3%), rook *Corvus frugilegus* (15.9 %), lapwing *Vanellus vanellus* (6.2%). Moreover, it was found, that starlings constituted the most serious threat. It resulted from their relatively high attendance at the runway (about 300 individuals). Possible repellent techniques concerning of the Deblin military airfield were discussed. The analysis of the birds' concentration depending on the altitude, part of the day, year, part of the airfield constituted a base to work out critical flight phase and appropriate procedures to prevent bird strikes.

Keywords—Airport, bird strikes, flight safety, preventive methods.

I. INTRODUCTION

FLIGHT safety problem is of utmost importance in aviation operations [1]. The conclusions from research analyses performed so far point out to the fact that one of the factors having an adverse effect on flight safety is a bird strike hazard, particularly at aerodromes and in their vicinity [14]. Despite the implementation of various means and methods in order to minimize the bird strike possibility, it becomes apparent that such measures do not bring expected results [8]. An example of that is the well-known crash landing, which was, fortunately, successful, of an USAir 1549 Airbus in the Hudson River, following a multiple bird strike with a flock of Canada geese *Branta canadensis*. Therefore, the problem of bird strike prevention is still open and it requires the continuation of research studies. This article includes the research outcomes and the final conclusions of the independent research project, conducted in 2007-2010: "Hazards to Aircraft and Bird Strike Protection Methods in the Context of the Ornithological Situation at the Military Airport in Deblin" No N305 – O/0007/32 funded by the Ministry of Science and Higher Education [5].

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II. PROJECT CHARACTERISTIC

The main objective of the project was to develop methods of protecting aircraft in terms of flight safety hazards caused by breeding, non-breeding and migratory birds. The authors of the project predict that developed recommendations will significantly enrich the existing airport security prevention against potential bird strikes and, what it involves, will have a positive impact on flight safety. It is expected that the conclusions and preventive recommendations resulting from the execution of the project will make a significant contribution not only to safety management in aviation but they will also enrich our knowledge of ornithology and ecology. As a research area, the authors of the project selected the military airport in Deblin, as statistics at that airport record more of such events than at other military airports in Poland [5]-[10].

The following research hypotheses were verified:

- The military airport in Deblin due to the open landscape and the layout of vegetation (bushes, trees, herbaceous vegetation) is an important breeding area for birds, which poses a direct risk of bird strikes.
- Habitat conditions between the perimeter of the airport and the surrounding areas are favorable for the settling of birds which use those areas as nesting grounds and feeding or resting sites during migrations.
- There are key points which "attract" birds at the airport and in its vicinity, and thereby increase their number and the diversity of bird species.

The project team carried out the following research objectives:

- 1) Habitat preferences were determined relating to the activity of birds directly at the airport. Carrying out that objective allowed for the determination of the points most relevant to the activity of particular bird species. The studies allowed for the identification of the forms of birds' daily activity (time management, feeding, resting, etc.) at the airport. The effects of observation for the particular species were confronted with a map of vegetation.
- 2) Habitat preferences were determined relating to the activity of birds in the close vicinity of the airport. The so-called "hot spots" were inventoried around the airport, i.e. the locations that are attractive to birds, outside the airport, for example, colonies of rooks and other birds, reservoirs and water courses, legal and illegal dumping termination of the extent to which the environment is a reservoir of birds, manifesting their activity at the airport.
- 3) The map of vegetation at the airport was made together with the analysis of the existing methods of vegetation

management. Attainment of the objective allowed for the determination of the birds' habitat preferences.

- 4) Critical phases of aircraft flight were identified in the context of the birds' activity in the maneuvering area and in the vicinity of the airport.

Identification of the most dangerous aircraft flight phases, in comparison with the map of birds' activity, allowed for drawing conclusions to be used for the development of preventive procedures for pilots and airport management [4]-[7]. Moreover, tests were performed related to the assessment of the current state of knowledge of air force personnel, concerning both the behavior of birds, and also the rational use of bird control methods, as well as preventive activities in use at military airports. As a result of the attainment of the above mentioned objectives, conclusions and recommendations were formulated concerning management of the vegetation cover on the surface of the airport [8]. Methods of reducing bird activity at the airport and in its surroundings were also developed, which, after minor modifications, can be a model for other military airports. In addition, based on the outcome of the research, proposals of preventive procedures for airport authorities and management, pilots, and air traffic services were developed in order to minimize the possibility of bird strikes.

III. RESEARCH METHODS

Based on the prepared map and field studies, various elements of the airport and its surroundings within a radius of several kilometers were analyzed in terms of the feasibility and usefulness of observations of bird activity, birdlife studies, and the inventory of vegetation in the study area. Following the analysis, the airport and its vicinity were divided into more than ten parts (sectors), to which the attributes relevant to the further research were assigned. The size of bird populations and their distribution were determined by transect and scanning methods. Transect method consisted in counting birds along designated transects in different types of plant communities. In addition to birds, mammals, as well as traces of their activity – burrows and molehills – were also recorded. Checks were performed in favorable weather conditions – on days without precipitation or strong wind, and with good visibility. Checks were performed in the morning, 2-3 hours after sunrise, or in the evening, 4-5 hours prior to sunset. The duration of a single check was approximately 3-4 hours, and the total duration of checks of the open part of the airport was 75 hours and 45 minutes. Within each month 2-3 checks were performed [3]. In scanning method critical zones of the runway were observed from two focal points. The critical zones of the runway were discretely observed from a specially used platform and the roof of the Faculty of Aviation Air Force Academy's building. Scans used an angle from 120° to 60° from both sides of the observer. A 60× telescope was used for scans.

On the basis of geographical coordinates, ranges of different types of vegetation were determined qualifying it to the following categories: low herbaceous vegetation, tall herbaceous vegetation, shrubs, trees, built-up areas [12].

Records were made of all hazards observed during the inspection and they were documented photographically. To illustrate the distribution of the most important feeding locations of birds, illustrations were made depicting locations of the highest concentration of birds at the airport.

IV. RESULTS

A. Ornithological Situation Assessment

In the studies conducted at the open part of the airport in Deblin in 2007-2009, 36,187 birds from 104 species were found (23.7% of all birds found in Poland) [3], the most numerous of which were: European starling (blackbird) – 11,198 (31.0%), Eurasian jackdaw – 6,638 (18.3%), rook – 5,751 (15.9%), lapwing – 2,237 (6.2%), skylark – 1,674 (4.6%), domestic pigeon – 1,476 (4.1%), other species 7,213 (19.9%).

The presented data point out to the fact that population changes of the most common species, i.e. blackbird, rook, and jackdaw were dynamic. European starling was the most abundant species occurring in the open part of the airport in Deblin. With regard to this species, three peaks of population size were observed in the following periods: late March-April (approximately 550 individuals), July-August (approximately 1,400 individuals), and September (approximately 900 individuals). The second most numerous species was the Eurasian jackdaw (18.3% of all identified birds), and its highest concentration, both in the open and in the built-up areas of the airport, was observed in the second half of February and in April, as well as in the second half of November. This species of the Corvid family (*Corvidae*) was the third (15.9% of all identified birds) in terms of the size in the open area of the airport. With regard to that species, three peaks of population size may be observed. The first occurred in mid-January, the second in mid-February and the third in mid-October.

Lapwings were observed at the airport from the second third of February to the first third of October. That species was represented by 2,237 individuals (6.2%). The highest numbers were found during the fall migration, from the last third of August to the first third of September, when more than 200 birds were found [5]. Every day, 200 to 1,800 birds were present in the airport throughout the day, frequently on the runway or just next to it.

B. Risks and Critical Flight Phases in the Context of Bird Distribution at the Airport in Deblin

On the basis of the number of birds observed at the airport in Deblin, threat levels and periods of their occurrence were categorized as follows (Fig. 1):

- low level threat <400 birds;
- medium level threat - 400-800 birds;
- high level threat - 800-1,200 birds;
- very high level threat >1,200 birds.

Fig. 1 shows that the period of very high threat level is in the summer months, i.e. the period of the greatest intensity of air operations. Moreover, low level threats (fewer than 400

individuals) have been omitted because such situations occurred very sporadically, in only a few individual observations. In the light of the behavioral research, the most serious threat to air traffic at the military airfield in Deblin is posed by European starlings (blackbirds). This results from their high presence frequency in the observations, and forming large flocks (60-300 individuals) [3].

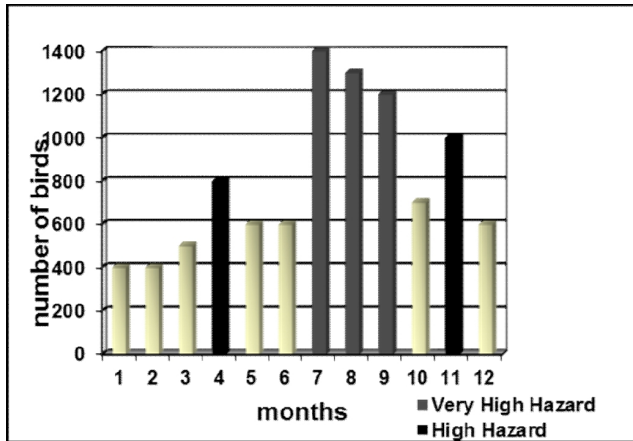


Fig. 1 The distribution of hazards according to the number of birds at the airport in Deblin in each month

A very important aspect of bird distribution for the determination of the critical flight phases is the distribution of altitude, and the image showing the location of bird concentration. A preliminary analysis shows that a very high-level threat is posed by birds during departures to the North-West, because their concentration was observed at altitudes of 5-50 m on the runway extended centerline. An aircraft taking off at the location of bird concentration is in the climb phase 50 m (15-100 m, depending on the type). Another location of bird concentration, which intersects the trajectories of aircraft, is the area located on the south side of the runway. At that location aircraft execute a landing maneuver related to aerodrome traffic circuit. Therefore, efforts should be focused on the use of all methods aiming at eliminating bird population from that area. Furthermore, a significant portion of the bird concentration locations is in the estuary of the river Wieprz to the Vistula, where the aerodrome traffic circuit operations are performed. In conclusion, on the basis of studies conducted, the following phases of flight are critical:

- Departure from runway 30, due to the concentration of birds on the runway extended centerline, especially during mowing the grass, in April, summer, and early fall (see study results).
- Performing the overhead approach maneuver for landing course 298°, at an altitude of less than 200 m.
- Approach to runway 12 (course 118°).
- Setting up helicopter departure heading for approximately 200° (southerly direction) below 200 m

V. RECOMMENDATIONS, PROCEDURES, AND PREVENTIVE MEASURES AIMING AT MINIMIZING THE RISK OF BIRD STRIKES AT THE DEBLIN AIRPORT

Before drawing final conclusions and developing recommendations relating to ways of reducing the population size and activity of birds at the airport in Deblin, as well as recommendations for the management of vegetation cover, currently implemented risk reduction methods were assessed. At the Deblin airport, the issue of managing the risks concerning bird strikes was neglected, regardless of the fact that that airport, along with the airport in Modlin, belonged to national leaders in terms of bird strike incidents. It was only an aircraft collision with a white stork in 1999 that resulted in an increased interest in the problem, which has been monitored since then. As time went, this resulted in the application of specific preventive measures. The basic bird control methods, used at the airport in Deblin include:

- landing light;
- gas cannon;
- acoustic device imitating the voices of the birds of prey;
- falcon (since fall 2008).

Taking into account the results of surveys conducted among pilots in Deblin, and the observations made by the project team, it is not possible to conclude that landing light switched on during the daytime deters birds. In most cases, the sound of an aircraft taking off will cause escape responses in birds, so it is difficult to assess what impact on such behavior has the switched on landing light. Therefore, during the observations at the airport, attention was focused on an evaluation of two bird control methods reducing the risk of bird strikes. The first method involved the use of a stun cannon that used pressurized gas from a cylinder. The other method was the falconry. Moreover, despite the fact that the airport was equipped with acoustic devices imitating the voices of birds of prey, the use of such devices was not noted.

A. Recommended Preventive Measures for Airport Authorities to Reduce the Population of Birds and Other Wildlife at the Airport in Deblin

In light of the studies conducted within the scope of the research project, it is recommended to make changes to hitherto applied ways and methods of limiting the presence of birds at the airport and to introduce new bird control methods.

1. Gas cannon – change of the application method.
2. Acoustic devices – change of the application method.
3. Falconer – introduction of a work plan taking into account the ornithological situation for a given period of time and the nature of air operations for the day.

Recommended new methods:

1. Introduction of vegetation cover management at the airport.
2. Pyrotechnician's activity.
3. Taxidermy decoys.
4. Blocking access to hunting perches.
5. Blocking nesting sites.
6. Reducing food resources.

Some recommended methods are described below [5].

1. Gas Cannon Application

In the case of gas cannon the necessity of locating it in the south-western end of the airport was recognized correctly. That was due to the fact that it was there where the population of birds, mainly belonging to the Corvid family (*Corvidae*) such as rooks and Eurasian jackdaws, was the largest. However, the manner in which the cannon was used was highly unsatisfactory and, most of all, ineffective. A good example may be the years 2008-2009, when in the course of the field work (observations from the roof of the Aviation Department building, and transect counting) the use of cannons during flights was observed on more than ten different occasions. However, on only one occasion was the cannon used in the central part of the runway. No change of its location resulted in the habituation (getting used to it) in birds [7]. The symptom of the lack of fear in jackdaws and rooks was the fact that they were feeding very close to the cannon despite shots being fired. In some cases, birds were seen sitting on the cannon's housing, when the cannon was not in use. The cannon did not fulfill its deterrent function, and its use had only a formal character. Therefore, the proposed improvement is to increase the mobility of the gas cannons. They should work in areas where they have not been used before. The cannon could, for example, disperse the Passeriformes perching on rose bushes in the south-western part of the airport. Its use should be reinforced with the sessions of falconer's and pyrotechnician's activity. Cannons can also be spot-used against birds that persistently use certain hunting perches. Despite the large presence of corvids at the western end of the airport, it seems necessary to abandon frequent use of cannons there and to use pyrotechnics instead.

2. Falconry

Despite numerous advantages, some disadvantages of falconry have also been observed. Those disadvantages do not change the very high assessment of its effectiveness. It was, however, limited by weather conditions such as mists and strong wind. Tamed birds of prey encountered noticeable difficulty in dispersing flocks of gulls [13]. Gulls appeared very rarely at the airport; however, they posed an extremely serious threat to aircraft. It is interesting and vital, that despite the fact of the use of falconry a bird strike took place, it was very dangerous because a gull hit in the engine inlet, so the engine could stop working [5]. Fig. 2 depicts this bird strike. Similar difficulties occurred with regard to white storks. Trained falcons and hawks did affect high-flying Corvids moving to collective nighttime roosting places in the fall and winter. The falcons also remained helpless in the face of flocks of graylag geese, bean geese, swans, cormorants, or herons and cranes. Moreover, in order to improve the efficiency, the falconer ought to develop a plan of daily activities that would take into account the current ornithological situation, information from pilots, and the nature of the planned flights [5], [10], [11].

Table I shows the recommended bird control methods appropriate with regard to the dominant bird species at the airport in Deblin. It is important to take into account the

selection of the method depending on the bird species. Therefore, the above-mentioned principles ought to be taken into consideration in the planning of preventive activities.

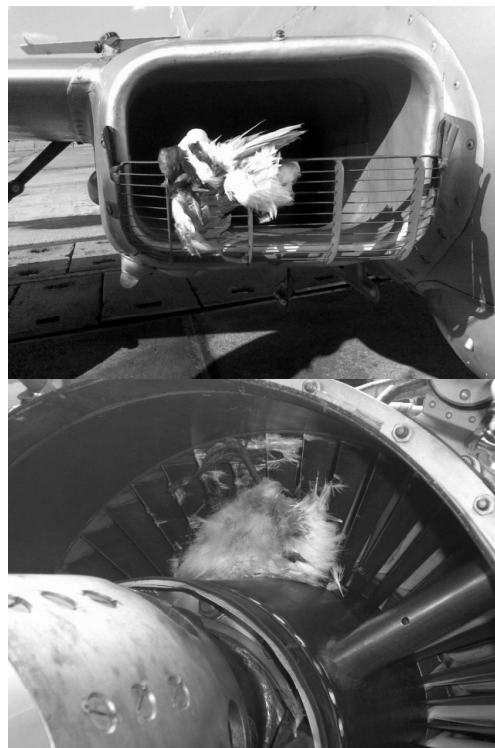


Fig. 2 Bird strike to jet trainer aircraft - TS-11 Iskra

TABLE I
POPULATION MANAGEMENT TECHNIQUES OF BIRD SPECIES AT THE DEBLIN
AIRPORT [5]

| Species | Bird population management techniques | | | | | |
|---|---------------------------------------|---|---|---|---|---|
| | P | S | Z | S | O | L |
| White stork <i>Ciconia ciconia</i> | + | | | | | + |
| Marsh harrier <i>Circus aeruginosus</i> | + | | | | | |
| Hen harrier <i>Circus cyaneus</i> | + | | | | | |
| Montagu's harrier <i>Circus pygargus</i> | + | + | | | | |
| Common buzzard <i>Buteo buteo</i> | + | | | + | | |
| Rough-legged buzzard <i>Buteo lagopus</i> | + | | | + | | |
| Common kestrel <i>Falco tinnunculus</i> | + | + | | | + | |
| Northern lapwing <i>Vanellus vanellus</i> | + | + | | | | + |
| Herring gull <i>Larus argentatus</i> | + | + | + | + | | + |
| Common gull <i>Larus canus</i> | + | + | + | + | | + |
| Black-headed gull <i>Larus ridibundus</i> | + | + | + | + | | + |
| White-winged tern <i>Chlidonias leucopterus</i> | | + | | | | |
| Common swift <i>Apus apus</i> | | | | | + | + |
| Eurasian skylark <i>Alauda arvensis</i> | + | | | | | |
| Barn swallow <i>Hirundo rustica</i> | | | | | | + |
| House martin <i>Delichon urbicum</i> | | | | | + | + |
| Eurasian jackdaw <i>Corvus monedula</i> | + | + | + | + | + | |
| Rook <i>Corvus frugilegus</i> | + | + | + | + | + | |
| European starling <i>Sturnus vulgaris</i> | + | + | | | | + |

P - "tall grass policy";

S - falconry;

Z - securing waste disposal sites;

S - bird spike systems;

O - limiting access to nesting sites;

L - limiting access to waters and muddy areas.

Ornithological observations carried out within the framework of the project allow for the proposal, in addition to application of current bird control methods, of several other techniques to manage the presence of birds, which should increasingly reduce the population of birds at the airport. One of such techniques is the introduction of a new type of vegetation cover management at the airport.

3. Introduction of Vegetation Cover Management at the Airport

Forming vegetation cover at the airport aims to reduce its attractiveness to birds – by reducing food base, the availability of water, shelter, nesting sites, gathering in flocks. Vegetation can be used directly by birds that are threatening the flight safety or it can contribute to increasing the population of invertebrates and small mammals which are used as food by insectivorous birds and birds of prey. The activities associated with the formation of the vegetation cover can go in two directions: modeling vegetation of certain height, or creating appropriate species composition.

Field studies show that species numerically dominant at the airport responded particularly intensively to extensive grass-mowing. Mowing the grass is a typical agro-technical procedure. In order to eliminate the factor which is attracting birds, based on field research, the project authors propose various scenarios of taking a number of preventive measures within the area on both sides of the runway. The most radical proposal is to maintain a grass height of 15 cm on both sides of the runway [2], [4], [7]. It should typically be mowed 5 times a year, starting from mid-May (during flowering) until early October. Maintaining grass height of 15 cm has no equivalent in the agricultural practice, and is tantamount to regular trimming the tops of plants, to remove their growth cones [6]. Unfortunately, this proposal involves expenditures (equipment and labor costs). However, the one-time investments will protect the airport for many years.

4. Taxidermy Decoys

Although Deblin airport is populated by a single pair of adult foxes, and also visited by individuals from beyond its perimeter, the impact of the predators on birds such as: lapwings, Corvids and starlings that are dominant at the airport is insufficient. The impact the foxes have on: lapwings, starlings, gulls, and Corvids should be intensified. In order to do so, taxidermy fox decoys should be placed in the critical areas of the runway [7]. Minimum four fox decoys should be used.

Taxidermy decoys should be set on platforms that guarantee their mobility and changing their position by the wind. Such an arrangement prevents habituation by birds.

5. Blocking Access to Hunting Perches

Hunting perches used by birds of prey, which are located at the airport, especially those near the runway, pose a definite problem. They are used by birds for resting or hunting. Bird spikes should be used in order to reduce the attractiveness of these areas for selected species of birds. The spikes should be

attached to hunting perches attractive to birds of prey [4]-[5]-[7].

First of all, bird spikes should be attached to elements of the airport infrastructure, which are located adjacent to the runway. Such elements are: signs marking critical runway areas, runway edge lights, navigation lights and photocells. The presence of birds in these areas is extremely undesirable. Bird spikes should also be used in ILS localizer infrastructure, TACAN beacons, antennas, containers, tall lamps at the main apron, radio masts, flags and metal signs used for marking the edges of the grass runway.

6. Blocking Nesting Sites

Buildings adjacent to the runway provide numerous nesting sites for birds. The use of these sites should be prevented by blocking access to them. This may be done, however, only after the breeding season. This principle should be strictly followed, because blocking access to nesting sites (nests) during the breeding season is against the law. Blocking access to potential nesting sites for kestrels and jackdaws may be related to the renovation work on the buildings adjacent to the runway, carried out in the fall and winter [7].

7. Reducing Food Resources

Food resources attract birds to the airport. In the period of distinct depletion of food resources (fall and winter), shrubs abundant in fruits are extremely attractive for passerine birds. Limiting their presence can be achieved by means of controlled burning of, among others, a large area covered with withered rugosa roses in the south-eastern part of the airport, at the eastern end of the runway. Controlled burning will prevent the reconstruction of the indicated plant's population. Grubbing-up alone may prove ineffective with regard to that species.

Reduction of food resources attracting birds, mainly Corvids, will be helped by energy loss prevention in the vicinity of the buildings, where the heat emitted by underground installations warms the ground, which attracts birds. Putting insulation on piping will not only prevent energy loss, which is associated with a reduction of the operational costs of the facility, but will also prevent the warming of the ground, which will definitely make feeding Corvids and starlings stop gathering there.

Airport perimeter fence requires repair, which will help to reduce the extent of presence of mammals (including roe deer) at the airport. Individuals which are present at the airport should simply be captured, which has already been done successfully in other facilities in Poland, for example, in Balice [3], [4], [7].

Because of the identified cases of bird feeding (in at least 2-3 points of the airport, including at the entrance gate into the military installation), plaques prohibiting bird feeding should be posted in the interests of flight safety. Such plaques shall be situated on the Vistula River, where bird feeding by locals has been noted. Feeding roe deer present at the airport is unacceptable.

B. Recommendations for Air Operation Management

A major issue during the planning and execution of air operations is the threat level to be taken into consideration depending on the time of year, time of day, and concentration of birds.

Field studies have shown that there is

- a threat period resulting from increased presence of all birds. The periods of particularly high presence of birds, and, hence, a higher risk of collision proved to be the following: from the last third of March to the second third of April (inclusive), from the last third of July to the last third of September, the last third of October to the first third of November.
- a threat period resulting from increased presence of Corvids in the fall and winter: Risks arising in the fall and winter from the flocks of Corvids flying from the airport area to their overnight roosting sites located at the estuary of the river Wieprz to the Vistula. Observations show that most of those flights occur between approximately 2 p.m. and sunset.

The following preventive measures are recommended throughout the year, and particularly in the above-mentioned periods:

1. Intensify bird control activities in order to reduce the presence of birds at the airport, in the areas particularly affecting the critical flight phases. Patrol plan should be prepared on the basis of the current ornithological situation at the airport, current observations and information from pilots.
2. Reduction of Terminal Maneuvering Area (TMA) operations (traffic pattern, low altitude flights, attacking ground targets over the airport) should be considered.
3. When conducting TMA operations, the pilots should take into account the bird concentration chart.
4. The pre-flight briefing should be attended by the person responsible for the bird control actions for that day, who should present the current ornithological situation, predicted concentrations of birds, and the patrol plan. Crews conducting flights should intensify the observation of bird concentration sites and take into account the possibility of a potential bird strike.
5. In the fall and winter, from mid-September to mid-March, starting from 2 p.m. until sunset, flight below 300 meters should be limited in the area to the southwest of the airport extending to the estuary of the river Wieprz to the Vistula. Moreover, depending on the time of bird flights (from approximately 2 p.m.), departing to the east should be periodically limited. In case of necessity to perform such operations, each departure should be preceded by bird control actions. These measures should also take into account the information provided by the crews, who should enhance the observation of bird activity.
6. Pilots should be kept warned of birds observed. Therefore, the patrol should be equipped with means of communication allowing for the exchange of information between the patrol, the duty officer (pilot) and the tower controller.

7. The tower should suspend takeoffs and landings if birds appear in the takeoff and approach area. Air operations may be resumed when the bird strike threat has abated.
8. Pilots should participate in a training related to the risk of aircraft collisions with birds and other wildlife at least once a year, and officer cadets should complete such a training before the commencement of practical air training. The course content should include:
 - fundamentals of ornithology;
 - ways of identifying bird species typical of airports at a basic level, using available national literature (keys for identifying birds);
 - behavior of occurring bird species;
 - basic types of bird control techniques;
 - effects of aircraft collisions with birds and other wildlife;
 - events occurring at the airport due to aircraft collisions with birds and other wildlife;
 - ornithological situation of the airport;
 - critical phases of flight depending on the seasonal and diurnal cycle of birds;
 - risk management system concerning collisions with birds and other wildlife, currently in use at the airport;
 - principles of cooperation between flight personnel and the team managing the risk of aircraft collisions with birds and other wildlife;
 - procedures in the event of danger caused by birds and other wildlife, including incident reporting procedures.

VI. CONCLUSION

The results of research conducted within the scope of the project and the experience of other airports indicate the need for a risk management team at the air base level to deal with the issue of aircraft collisions with birds and other wildlife [4]-[7]-[9]. As seen from practice, the situation at military airports varies widely. Depending on the importance of the airport, the type of aircraft, etc., the problems of bird presence at the airport is dealt with mostly by designated persons, for whom it is an extra duty. The actions of these persons are frequently not coordinated. In recent years, some military airports have employed a falconer, who mainly deals with bird control during air operations. However, at many airports, there is no such person, and preventive measures are limited to the passive use of a gas cannon, and switching on landing lights by departing and arriving aircraft. Furthermore, the problem of bird strike avoidance belongs to primary duties of flight safety inspectors. Given these circumstances, it seems justified to clearly determine the composition of the risk management team for aircraft collisions with birds and other wildlife.

The team should include representatives of the airbase as the managing body of the airport, representatives of the flight crews and technical personnel from the aviation unit stationed at the airport, as well as the persons responsible for bird control during air operations (falconer, if any, pyrotechnician, and other persons trained in bird control) [4]-[7]. The team should have defined tasks, competences and responsibilities. Depending on the degree of bird strike risk and the types of aircraft, the team may be permanent or ad hoc. In some cases,

only certain persons in the team may be employed on a permanent basis. The team should be chaired by a flight safety inspector, or - more frequently - a competent civilian employee occupying the position specially created to this end. Team members should receive appropriate training. It is proposed that in this case postgraduate, or equivalent, courses should be conducted at the Polish Air Force Academy in Deblin and the University of Life Sciences in Lublin. Currently, the personnel responsible for preventing bird strikes undergo only an ad hoc instruction course. Each team member should have at least the following knowledge and skills:

- fundamentals of ornithology;
- ability to identify bird species typical of airports at a basic level, using available national literature (keys for identifying birds);
- behavior of occurring bird species;
- knowledge of basic risk management techniques concerning bird strikes;
- basic knowledge comprising issues of airport infrastructure, rules and regulations of air traffic, aviation technology;
- awareness of the ornithological situation at the airport. Personnel responsible for preventive measures during air operations should have additional skills:
 - monitoring ornithological situation during air operations;
 - planning the patrol with regard to planned air operations;
 - selection of bird control techniques depending on the current ornithological situation at the airport, and the type of air operations;
 - effective use of bird control techniques;
 - preparation of a report from the patrol;
 - cooperation with the relevant ATC service personnel (tower controller, duty officer (pilot), others).

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