Birdstrike Risk Index (BRI2): a new approach to the wildlife strike risk assessment

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INTRODUCTION

Among the methods to estimate wildlife strike hazard published in ISI journals [1,2,3,4], some use an economic perspective [1,4], while others use data collected on a national level [2]. The major problem with these approaches is that they may not reflect the characteristics of each individual airport, making comparisons between airports difficult. Moreover it often happens that the wildlife strike data available are incomplete because records from pilots may lack species information or carcasses may be lost [5]. Thus, there is a general need for a standardized method that is easy to apply and statistically robust. It must be taken also into account that often different wildlife monitoring programs are run at airports, therefore the risk assessment tool should work with different time series of data.

A method that takes into account the ecological characteristics of the bird communities present in the airport area, together with the local history of wildlife strikes, their effects on flight and the number of aircraft movements is presented here.

The main achievement is a site-specific analysis that avoids flattening wildlife strike events on a large scale while maintaining comparable airport risk assessments.

MATERIALS AND METHODS

DATA COLLECTION

Wildlife presence data, collected by professional ornithologists or professionally trained airport ground staff (Bird Control Units) on an hourly basis during daylight or every 2-3 hours per day where provided for eight Italian international aiports representative of the 37 present in Italy in terms of air traffic. The average daily abundance for each species was used for the computation of the wildlife strike risk index.

The aircraft movement data for each airport (in terms of flight numbers per month comprising both landings and takeoffs) were provided directly by the airport management authority. The airports were subdivided into 3 classes according to the yearly averaged Total Flight Number (TFN) registered in period 2003-2010 (**Table 1**): class 1: small-scale airport 1<TFN<50,000; class 2: medium-scale airport 50,001<TFN<99,999; class 3: large-scale airport TFN>100,000.

The wildlife strike data were provided from the Italian CAA (ENAC) for the years 2006-2010 while strike data of the period prior to 2006 were provided directly from each airport authority. A summary of the wildlife abundance and strike data used in the present paper for each airport is reported in **Table 1**.

Airport	Airport class	Wildlife data availability (years)	Wildlife strike data availability (years)
A	1	2007-2008	2006-2010
B	1	2009	2006-2010
C	1	2007-2010	2006-2010
D	1	2008-2009	2006-2010
E	1	2010	2006-2010
F	2	2007, 2009-2010	2004, 2006-2010
G	2	2006-2010	2006-2010
H	3	2007, 2009-2010	2006-2010

Table 1. List of investigated airports (ID letter), with the specific traffic size class, and the available time series extension for wildlife observations and strikes data.

BRI2 INDEX

In order to determine the BRI2 (Birdstrike Risk Index ver. 2), 17 functional groups of species have been created according to their ecological patterns (habitat and diet), body size and social behaviour (flocking vs. non-flocking species) (**Table 2**)

ID group	Species group	Some examples
1	Grebes and divers	*Tachybaptus ruficollis, Gavia immer*
2	Cormorant, pelicans, swans and geese	*Phalacrocorax carbo, Cignus olor, Anser anser*
3	Herons, storks, flamingoes	*Ardea cinerea, Casmerodius albus*
4	Ducks, pheasants, rallids	*Anas platyrhynchos, Phasianus colchicus*
5	Birds of prey - large	*Buteo buteo, Circus aeruginosus*
6	Birds of prey - small	*Falco subbuteo, Falco tinnunculus*
7	Seabirds - large	*Larus michahellis, Larus argentatus*
8	Seabirds - small	*Chroicocephalus ridibundus, Sterna hirundo*
9	Waders	*Charadrius alexandrinus, Tringa totanus*
10	Doves	*Columba livia, Streptopelia decaocto*
11	Owls	*Athene noctua, Tyto alba*
12	Swifts and swallows	*Apus apus, Hirundo rustica*
13	Corvids	*Corvus cornix, Corvus monedula*
14	Non-flocking passerines and bats	*Motacilla alba, Turdus merula, Nyctalus noctula*
15	Flocking passerines	*Sturnus vulgaris*
16	Small mammals (<10 kg)	*Vulpes vulpes*
17	Large mammals (>10 kg)	*Dama dama*

Table 2. Distribution of wildlife species among different groups, based on species-specific ecological patterns (habitat, diet), body size, and social behaviour (flocking vs. non flocking species).

Then the following set of equations was calculated :

$$1:\ GF_i = \overline{W}_i \cdot Ag_i \cdot \frac{BS_i}{TFN} \cdot EOF_i^{95} \qquad 2:\ GSR_i = \frac{GF_i}{\sum_{i=1,N} GF_i} \cdot DB_i \qquad 3:\ BRI2 = \left(\frac{\sum_{i=1,N} GSR_i \cdot DF}{TFN} \right)$$

which represent, respectively, the historical risk associated to a species, or Group Factor (GF_i), the actual Group Specific Risk (GSR_i), and the second version of the index (BRI2).

In Eq. 1-3, *i* indicates a species group (see **Table 2**), *N* is the group total, *W* the average weight of the ith group, *Ag* the group specific aggregation index, *BS* is the mean value of impacts recorded per year, *TFN* is the mean value of flights per year and *TFN* its monthly average. DB_i represents the mean daily number of birds of the ith group, and *DF* is the mean daily flight traffic calculated on a monthly basis. EOF^{95}_i is the 95th percentile of the EOF (Effect On Flight). EOF was defined according to the possible effects, from no effect to airplane damage beyond reparability, according to the 5 level ranking proposed in **Table 3**.

EOF Value	Category	Description
1	None	None
2	Minor	Delay
3	Substantial	Precautionary landing, aborted take-off
4	Serious	Engine(s) shutdown, forced landing, vision obscured
5	Catastrophic	Damage sustained makes it inadvisable to restore aircraft

Table 3. Categories of the Effect On Flight (EOF) provoked by wildlife strike events.

RESULTS

The results obtained from the application of BRI2 to the eight investigated airports are depicted in **Figure 1**.

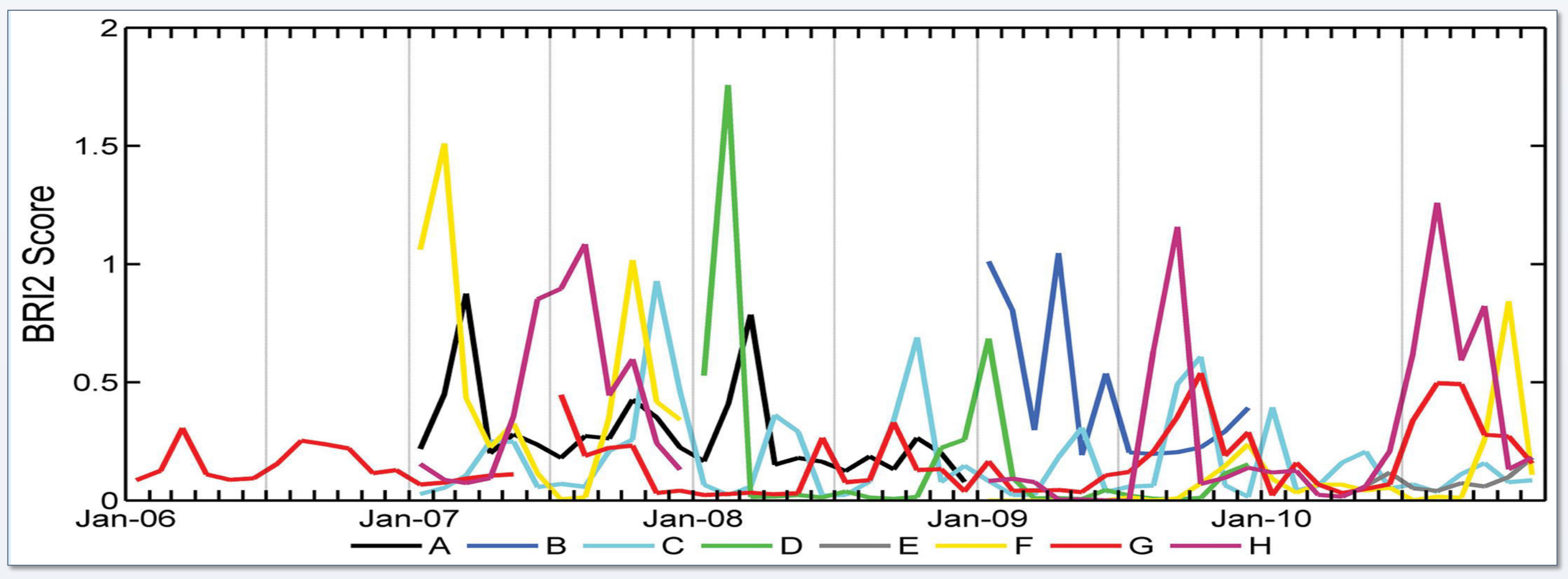

Figure 1. BRI2 scores for the eight investigated Italian airports in the period 2006-2010.

As expected, each airport presents different seasonal trends due to differences in wildlife community composition and their site-specific strike history. For example in airport G the seasonal trend with higher values in late summer is attributable to the first autumn migration movements which are associated to the large presence of hazardous groups 6, 7, and 12 (juveniles of kestrels, gulls and migratory species), while airport F shows higher BRI2 scores during the cold seasons, because of the foraging movements of the starlings (group 15) from the city to the surrounding cropland areas.

Among the 8 investigated airports, the highest wildlife strike risk is associated to the airport D, which belongs to the air traffic class 1. Such a result can be easily explained by considering that the wildlife strike risk history associated to the group of waders (mainly *Vanellus vanellus*) is significantly higher than all the others groups, having a EOF_{95} equal to 2 and an aggregation index of 30 individuals.

The analysis of BRI2 scores degradation due to the presence of an increasing number of undetermined values in the wildlife strike reporting lead to encouraging results.

It was possible to accept up to a 20% reduction of the strikes dataset for the airport G, before the BRI2 trend significantly degraded, as a consequence of a poor reliability of the Group Factor.

DISCUSSION

In all airports studied in the present work, apart from airport D, no significant correlations were found between the increase in air traffic and the number of wildlife strike events. This indicates that the variation in the number of wildlife strike events do not reflect the sole increase of air traffic trend. It is therefore important to investigate the ecological and behavioural characteristics of wildlife communities present in airport areas.

A key aspect of the proposed index is the possibility to compare the risk level associated with wildlife presence, even if differences exist among site communities and surrounding environment information are missing. In particular, direct environmental information are neglected in the computation of BRI2, since they are assumed to be triggered by the local wildlife community composition.

Wildlife communities are extremely dynamic. In Italy *Sturnus vulgaris* populations increased dramatically and migrate or are resident depending on the latitude [6], assembling in larger flocks in southern Italy. The variability shown by this species is only an example of what can be expressed by a whole community at the local level. Therefore, a "risk coefficient" calculated on a national (or international) scale would flatten a species' hazardousness at the local level, preventing a site-specific risk assessment [1,2].

The results obtained by applying the BRI2 algorithm on 8 Italian airports with an homogeneous distribution of air traffic characteristics are encouraging and allow a comparison between different airport sizes thus providing a site-specific evaluation of the wildlife strike risk. To our opinion BRI2 application renders comparison between different size-class airports possible even if wildlife monitoring data are non-homogenously collected and without the need to incorporate environmental characteristics information. However, a proper and complete monitoring program should be implemented to reasonably rely on the BRI2 scores.

Our results show that there are different wildlife strike risk level trends for each airport (**Figure 1**). These trends can be explained at a site-specific level by the seasonal variation in local wildlife communities, thus allowing site-specific management planning.

Finally, the index was conceived as a tool capable of describing an airport specific wildlife strike risk, based upon historical trend of wildlife observations, in order to identify critical periods during the year. Therefore, the index is not meant to be a prognostic index since bird distribution throughout the years is unlikely predictable although it can be applied to assess specific theoretical risk scenarios.

The BRI2 algorithm was adopted as a standard by ENAC in order to perform a wildlife risk assessment (ENAC Advisory Circular APT-01B) at a national level.

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