BEYOND FALCONRY BETWEEN TRADITION AND MODERNITY: A NEW DEVICE FOR BIRD STRIKE HAZARD PREVENTION AT AIRPORTS

Dr. Valter Battistoni (1)**, Dr. Alessandro Montemaggiori** (2), **Dr. Paolo Iori** (3),

(1) BC & T – Birdstrike Consulting and Training – *Former Chairman of Bird Strike Committee Italy*- Via Su Furraghe A, 9 07040 Olmedo (Italy) Ph. & Fax +39 079 902316 - E-mail: battvtr@tiscali.it
(2) Ornithologist, ICAO and Italian Civil Aviation Authority's Bird Strike Expert - Via Federico Tozzi, 9 - 00137 Roma (Italy) - E-mail: alessandro.montemaggiori@poste.it
(3) Project Designer of "Falco Robot GBRS" model - Frazione Calvenzano, via Bottega n. 33/d Vergato (BO), Italy – Ph. +39 0534 22244 - E-mail: info@birdraptor.com

ABSTRACT

Most accredited studies in Italy and all over the world emphasize the problems related to traditional falconry used as a means against bird hazard at airports.
Some negative features of using falcons are the impossibility to be employed during some periods of the year and adverse weather conditions, unforeseen animal behaviour, their biological needs, the tight dependency on the falconer and the limited employment over the day.
Above all, high costs play a key role due to the value of the animals, to their training, to the number of birds necessary to be effectively operated on a medium/large size airport and finally to the employment features.
The attempts to use remote-controlled model aircrafts instead of real falcons proved to be unsuccessful because of the habituation effect it produced on other birds, that are certainly harassed by the device, but do not recognize it as a natural bird of prey, whose hunting area must be avoided.
So it is the frightening effect that is missing, upon which also other dispersal methods are based, such as distress calls or predator effigies.
The use of full scale bird of prey accurate reproductions, engine powered and fully remote-controlled, seems to have reached the goal to match the natural predator effectiveness with employment flexibility, cost reduction and mass production.

1. BACKGROUND

The use of traditional falconry to prevent bird strikes at airports

Trained falcons or hawks have been used with encouraging results at several airports in Europe and North America in attempts to reduce bird hazards to aircraft (Erickson et al. 1990). The first reported use of falcons to disperse birds was at an airbase in Scotland in the late 1940s (Wright 1963, Blokpoel 1976). The use of such predators is undoubtedly effective in dispersing birds, however falconry is still rarely used on a large scale for bird control at airports because of a series of requirements and limitations.

First of all one or more trained and licensed falconers and assistants, together with a certain number of certified animals, are needed (depending on the extent of the area to be protected and the number and kind of pest birds present). Although obtaining raptors to be trained has become much easier today, due to captive breeding techniques, special care must be provided for their feeding, training and housing, and the cost of such aspects can be very high. At Rome’s Fiumicino International Airport a cost assessment was made during the 90’s for protecting the whole airfield (more than 1,500 hectares) with trained falcons and hawks in order to prevent bird strikes; the final estimate resulted in more than one million USD per year, and the idea was soon abandoned.

Moreover falcons and hawks are not effective in dispersing all hazardous birds in all conditions: they are ineffective with very large pest birds (e.g. herons), cannot be flown at night, when moulting, during strong winds, or in rain or fog (Solman 1966, Brough 1968, Burger 1983). They are not easily manageable and sometimes refuse to fly, especially if already fed. Several raptors are required to ensure that one is available to fly when needed (Solman 1973). Occasional losses occur, especially if the same raptors are used for prolonged periods at the same site and become familiar with the surrounding area.
Compared to other commonly used bird-hazing frightening methods, the use of falconry as an employed technique is insignificant and this is unlikely to change in the near future (Erickson et al. 1990). An analysis of strike data at JFK New York International Airport pointed out that the adopted falconry programs had little effect on strike rates (Dolbeer et al. 2003)

The use of falconry as a bird-hazing technique has received considerable attention over the last decades, especially for its use at airports to prevent potential bird/aircraft strikes. Because of its human-interest appeal, the technique’s description always catches the attention of the media, thus giving a false perception of its actual use.
In 2005 the Italian Parliament was nearly promulgating a law to indiscriminately adopt falconry at all airports, in order to prevent bird strike risks. The bill was soon abandoned as the Parliament was informed by the Italian Bird Strike Committee about the real efficacy and the costs of this methodology.

Finally, although promising results have been achieved, falconry’s limitations have prevented it from becoming a practical and commonly used technique. With few exceptions, it required other bird-frightening techniques to be used in connection to be effective (Erickson et al. 1990).

The International Bird Strike Committee (2006) pointed out that the use of falconry should be regarded as one tool amongst many that the bird controller may use, and its employment alone is not an adequate substitute for other bird management techniques.

In Italy the National Bird Strike Committee similarly assesses that the use of falconry can be effective, depending on the ornithological situation of a specific airport, but that it must be considered as one of the possible techniques, among all others, that can be adopted to prevent bird strike hazard at airports.

2. THE "FALCO ROBOT GBRS": AN INNOVATIVE METHOD

The use of remote-controlled model aircrafts in shape of birds of prey: historical view

The use of "fake" flying predators in order to disperse "true" birds from airports and bring under control the bird strike phenomenon is a development of the idea of using traditional radio-controlled model aircrafts powered by small two-stroke engines.
It had been already suggested by several scientific researchers, either as mocks tied to captive balloons (Conover, 1983; De Fusco & Nagy, 1983; Harris, 1980; Inglis, 1980) or as painted flying forms (Saul, 1967).
These studies were based upon previous researches (Lorenz 1939, Tinbergen 1948), and then have been confirmed by others (Canty & Gould 1995, Burns & Wardrop 2001, etc.) supporting the statement that just the shape of a flying bird of prey has a horrific effect in itself.
Some experimental studies, proving the effectiveness of flying mocks in shape of birds of prey, were conducted at Vancouver airport (Ward 1975; Solman, 1981). In that case it resulted that birds behaved as if they were in the presence of a true bird of prey, while the use of a traditional model aircraft did not achieve the same results. The best results were achieved mostly on European Starlings *(Sturnus vulgaris),* Kildeer (*Charadrius vociferous)*, ducks, Canadian Geese (*Branta canadensis*) and on Gulls *(Larus* spp.), the last being actually among the most problematic species related with bird strike phenomenon.
On the contrary, falcon-shaped model aircrafts called "Ornithopters" achieved poor results. They actually proved to have clear limits: they flap their wings continually, differently from true falcons that do it very seldom in nature. Moreover such a mechanical effort requires a lot of energy and consequently causes scarce endurance. They cannot fly dynamically (i.e. without engine) as wings are the only propelling power. To handle them it's not easy, they do not sustain strong winds and cannot fly at relatively high altitudes.

The "FALCO ROBOT GBRS" (Gregarious Birds Removal System)

The FALCO ROBOT GBRS has been designed aiming at the goal of dispersing birds in a rapid, controlled, non lethal way when they may cause problems, mostly at airports, and to produce a long lasting clearance of birds in that area. It was actually observed that artificial *stimuli*, mostly those static and repetitive so far employed in bird scaring and dispersing, in variable time-lapses drove birds to habituation and to a lack of response, therefore becoming ineffective.

The idea of using a 'natural looking' false predator originated from the hunch of its inventor (Dr. Paolo Iori, co-author of this paper) to take into account the deep

ethological reasons of birds' innate raptor fear. He spent years studying and getting information on falconry, bird behaviour, and bird strike problems, together with aerodrome safety procedures, in order to produce a device which could be suitable for being used without problems inside airfields.
The result of his effort is a remote-controlled flying robot which perfectly resumes in its shape a natural predator. While flying, the robot replicates the natural hunting methods of a specific raptor, and the way it is operated is one of the main reasons why the device is so efficient in deeply scaring the target birds.

The system is composed of: one or more model aircrafts "FALCO ROBOT GBRS", a remote controller (set on authorized radio frequencies) and a small maintenance kit

The model (Figure 1 and 2) can be assembled and disassembled very easily, and this feature makes transport and garaging easier.

Fig. 1 and 2. The model in action.

It can be operated either for tactical purposes (immediate and complete bird dispersal) or strategic purposes (maintaining an area clear when no birds are present).
It can be seen by birds even from long distances, especially when it flies at high altitudes, and therefore its flight zone is perceived as dangerous so birds don't get near.
The same effect is strengthened by distress calls of birds that hastily leave the area.
Materials used are light and robust composite mixtures while the propulsion is granted by a little electric brushless engine powered by rechargeable batteries. Having reached a certain altitude, the engine can be switched off and the model flies dynamically as a glider always remaining under the operator control.
It practically flies in all-weather conditions, apart from extreme ones that would affect even the normal airport operations.

Preliminary flight tests

The definitive flight attitude of "FALCO ROBOT GBRS" has been achieved through many flight tests that allowed in the same time to verify the device effectiveness in removing birds from a certain site.

Following are in brief the main tests performed (Table 1).

- Rastignano (BO), Italy - 22.05.1998;
- Landfill of Novellara (RE), Italy - 17.01.2001;
- Landfill of Novellara (RE), Italy - 13.06.2001;
- Guastalla "Canale Fiuna" (MN) Italy - 16.06.2002;
- Villa Cavazzoli (RE), Italy - 13.04.2004;
- Landfill of Novellara (RE), Italy - 18.01.2005;
- Altedo (BO) Italia - 15.03.2006;
- Landfill of Novellara (RE), Italy - 14.06.2006 (*);
- Genoa Airport 'C.Colombo', Italy - 22.06.2007 (*);
- Genoa Airport 'C.Colombo', Italy - 11.09.2007;
- Rome Fiumicino Airport 'L. da Vinci', Italy - 17.09.2007;
- Palma de Mallorca, Basurero Central, Spain - 17.01.2008;
- Bergamo Airport 'Orio al Serio', Italy - 27.03.08;
- Madrid Airport 'Quatrovientos', Spain - 29.02.2008;
- Warton, BAE System Airfield, UK - 03.04.2008;
- Cagliari Airport 'Elmas', Italy - 22.06.2008;
- Gibraltar Airport, UK - 13.07.08;
- Rome Fiumicino Airport 'L. da Vinci', Italy - 19.06/20.07.08;
- Tarragona, Puerto, Spain - 25.07.08;
- Barranquilla Airport, Colombia – 25/26.08.08;
- Bogotà Airport, Colombia - 27.08.08.

(*) *Dr. V.Battistoni, co-author of this paper, attended this flight test as Chair of Bird Strike Committee Italy at that time, in order to make a report to the Aviation Authority on the new device effectiveness.*

Tab. I: List of places and dates of "FALCO ROBOT GBRS" preliminary flight tests

Early "on the field" model experiments were conducted using various shapes of birds of prey: the first to be used in a chronological order were:

a) a generic bird of prey model, 60 cm. X 50 cm. coloured in white (no colours)
b) a Peregrine *(Falco peregrinus*) model, coloured and in full scale
c) a Goshhawk (*Accipiter gentilis*) model, not coloured and in full scale
d) a Goshhawk model, coloured and slightly bigger than in nature (still in use). (Figure 1)

Results obtained during these first flights were:

- with "a" model the results were very discordant and never repeatable;
- The "b" model was too small to be seen from long distances by the operator and proved to be instable in flight: therefore it could not be used for long term studies. Furthermore big birds (e.g.Herons – *Ardea cinerea)* seemed not to react to it;
- With "c" model the results were substantially good;
- But only with natural colours and a little increase in dimensions – "d" model – current satisfactory results have been achieved.

The biggest problem that emerged was that the model shape should have been as similar as possible to the original bird of prey; this caused some turbulence problems mostly in the primaries wing feathers.

These problems have been successfully solved thanks to computer calculations and in the smoke gallery. Also constructing materials have changed since the beginning. The first prototypes were all made by balsa wood and aluminium. Now the current industrial model is made by special expanded mixtures and carbon fibres

The improved aerodynamics joined with lightness also solved the problem of battery duration: the model may fly dynamically – engine switched off – for many minutes (up to thirty), but full endurance was never needed for dispersing birds.

In brief, the above mentioned tests allowed to ascertain the absolute tactical effectiveness of the “FALCO ROBOT GBRS” prototype, that in all circumstances removed the present birds; the tests also allowed to assess the reactive behaviours of some species, and some individuals in particular, that sometimes counterattacked and fought with the “fake” predator, permitting a safe escape to other birds.
This was really important in planning removal strategies: for example, sometimes it may be more useful to let the bird go after the model, avoiding fights, in order to clear immediately some crowded air traffic path.

The model has been tested facing several bird species and its tactical effect, i.e. an immediate bird dispersal, proved to be at the maximum on Yellow-legged Gulls (*Larus michahellis),* European Starlings *(Sturnus vulgaris),* Hooded Crows *(Corvus cornix)* and other species (e.g. Lapwing – *Vanellus vanellus*, Feral Pigeon – *Columba livia,* etc.).

Operative aspects within airport contexts

The scientific literature reports some supposed disadvantages and objections, that may be called historic, to the use of radio-controlled model aircrafts, in particular those mentioned by Bishop et al. (2003) concerning the supposed limited employment in adverse weather conditions: in several tests conducted in hostile environment the “FALCO ROBOT GBRS” proved to remain under total operator control with a wind up to 25/27 kts, it does not suffer from rain and the only limit seems to be the lack of visibility, as the operator might lose sight of the model; generally speaking a RVR (Runway Visual Range) of 500 mt. is sufficient for maintaining the model under visual control.

Another limit (Harris & Davis, 1998) would regard the supposed incapability to direct the bird escape: on the contrary, this is one of the device fortes. “FALCO ROBOT GBRS” is perfectly able to direct towards a wanted direction even great flocks of birds, in particular Yellow-legged Gulls.
Electric engines powered by batteries also removed the problem (Harris & Davis, 1998) to have suitable areas for refuelling (the battery can be replaced in about 30 seconds) and for take-offs and landings (only a 30 meters plain surface is needed for landings)

Some more recent remarks can be added to the “historic” objections; one of the most problematic issues found during the several tests was the availability of a trained operator, ready to respond to the intervention requests and after the site owners authorization (airports, landfills, ponds etc…). Actually the first part of the experimentation was handled by only one operator, who was also the first prototype improver, then followed by two others.
At the early stages the device effectiveness was greatly depending on the operator’s skill in handling the model.

The sudden success of the system, with several intervention and experimentation requests from all over the world, further highlighted this problem and requested more and more professional operators and a training school. The problem appears to be common to other dispersal and scaring systems where the human component is dominant (e.g. use of trained dogs).

Now Bird Raptor Internacional SL (the model manufacturer) announces to have set up a training programme for operators, based upon a theoretical and practical course, and a “flight-simulator” software for the flight training.
This, together with an improved handiness of latest industrial models, should solve the problems of operator availability and somehow of reducing general operating costs.

Another problematic issue concerns the relationship between “FALCO ROBOT GBRS” and the Air Traffic Control (ATC).
During some tests conducted at airports, some reluctances and perplexities came to light from ATC operators, who limited the model flight duration.

The controller unconsciously treats the model aircraft like an air traffic and requires for it the same separations imposed to airplanes; furthermore the model operator is not in a direct radio contact with the Control Tower (TWR), but communicates through other airport personnel, often concerned as well as the ATC controller for the “novelty”.
It has been observed that ATC controllers paradoxically “accept” the presence of flocks of birds in the airport, dangerous for air traffic as they are out of any control, but “reject” the model aircraft, that on the contrary is completely under operator control and has a device for an immediate and vertical drop on the ground in emergency conditions. Therefore he requires restrictive procedures for it.

Other remarks concern supposed radio interferences with air navigation communications caused by the model remote control, but they have no foundation as the systems and the frequencies in use, as well as the continuous automatic frequency monitoring, are totally capable of excluding any problem of this kind.

At last the common fear that the model aircraft may escape from the operator control and cause another 9/11; these are worries that may rise a smile but that must be properly considered in order to overcome the psychological reluctances in a technically advanced, but basically conservative, aviation world.
From this point of view a better preparation of the ATC personnel will be needed, either on the bird problem in general or explaining the model features in proper briefings. On the other hand a direct two-way radio communication, with the knowledge of standard ATC phraseology, will have to be one of the service features, as well as a perfect knowledge of airport environment.
Most researchers agree on the issue that no prevention or bird removal system can be considered as “ultimate”, so that it could be used as the only one claiming to solve the problem of birds at airports. Therefore also the “FALCO ROBOT GBRS” can achieve the best tactical and strategic effects if part of a wider prevention programme, based upon an accurate naturalistic study, identifying the problematic species and the attractive factors and with the alternative use of other scaring devices, both acoustic and optical; above all the presence of a Bird Control Unit is needed, according to the IBSC best practice.

3. ROME FIUMICINO AIRPORT TESTS

Rational

During a meeting concerning bird strike problems held in Rome on 14.2.2008, Dr. John Allan, Chair of IBSC, suggested an objective and prolonged data collection regarding “FALCO ROBOT GBRS” employment in a real operative context like an international airport. Previous tests made on domestic and international airports were positive from the point of view of the device effectiveness, but too short and

influenced by the above mentioned ATC controllers attitude. In brief the model could fly only in the few minutes with no air movements, and the birds were not always present in those times in a so large number that the device capabilities could be shown.
Thanks to the cooperation of "Aeroporti di Roma spa", that runs Rome Fiumicino airport, a one month experimentation was started, focused on an area close to the 34L runway threshold (see Figure 3), where even the presence of large flocks of Yellow-legged Gulls *(Larus michaellis)* had been observed.

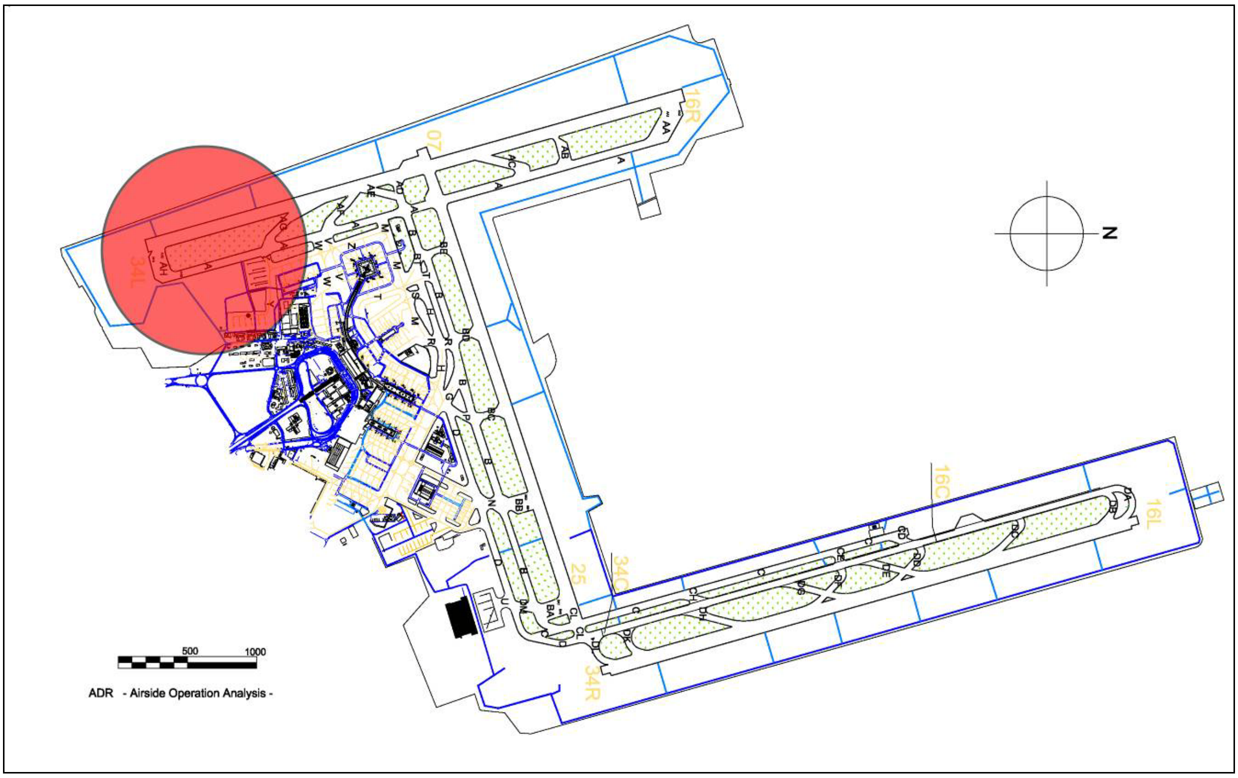

Fig. 3. The area of Rome Fiumicino airport chosen for the tests

It is interesting to observe that this area is not far from the point of the multiple impact with ingestion occurred on July 2007 to a Delta B767.
Rome Fiumicino airport is the Italian airfield where most studies and experiments on bird strike issues were conducted since 1989 (Montemaggiori, 1998, 2001, 2002, 2003), and where a long term strategy has been implemented in order to keep the bird hazard under control. Different bird-avoidance devices are used, mainly acoustic (propane gas cannons, distress call, pyros). Despite this, bird strikes are increasing (2,57/10.000 mvt in 2007) mainly due to environmental changes, air traffic growth, bird population growth (Montemaggiori, 2008). It is a strike ratio far below the "attention threshold" established by the CAA (5/10.000) but corresponding to 86 impacts in 2007.

Methods

The main experimentation goal was to ascertain and assess the bird behavioural response to "FALCO ROBOT GBRS" and the effectiveness duration.
The experiment consisted in two daily model flights *(raids),* the first one at about 7,00 a.m. and the second at 7,30 p.m. for five days a week from June 19 to July 19 2008, when the runway 34L/16R was inoperative.

Dr. A. Montemaggiori, co-author of this paper, was appointed as scientific test coordinator.

The model flight strategy was based on two kinds of actions:

- tactical (short term): the model attacks directly the birds present either in flight or on the ground;
- strategic (long term): when no birds are in the area, the model simulates the Goshhawk patrolling action above its hunting territory.

Bird reactions have been recorded on standard report forms where all data available have been collected as follows:

- bird species
- number of birds, in flight and on the ground
- time and weather conditions
- kind of reaction (total escape, partial escape, no reaction, counterattack)
- reaction time
- effectiveness duration (return times of birds to the area)

Results

Overall 42 raids have been carried out, 17 in presence of birds (almost only Yellow-legged Gulls). Every raid lasted an average time of 26 minutes, as shown in the following graphic (Figure 4).

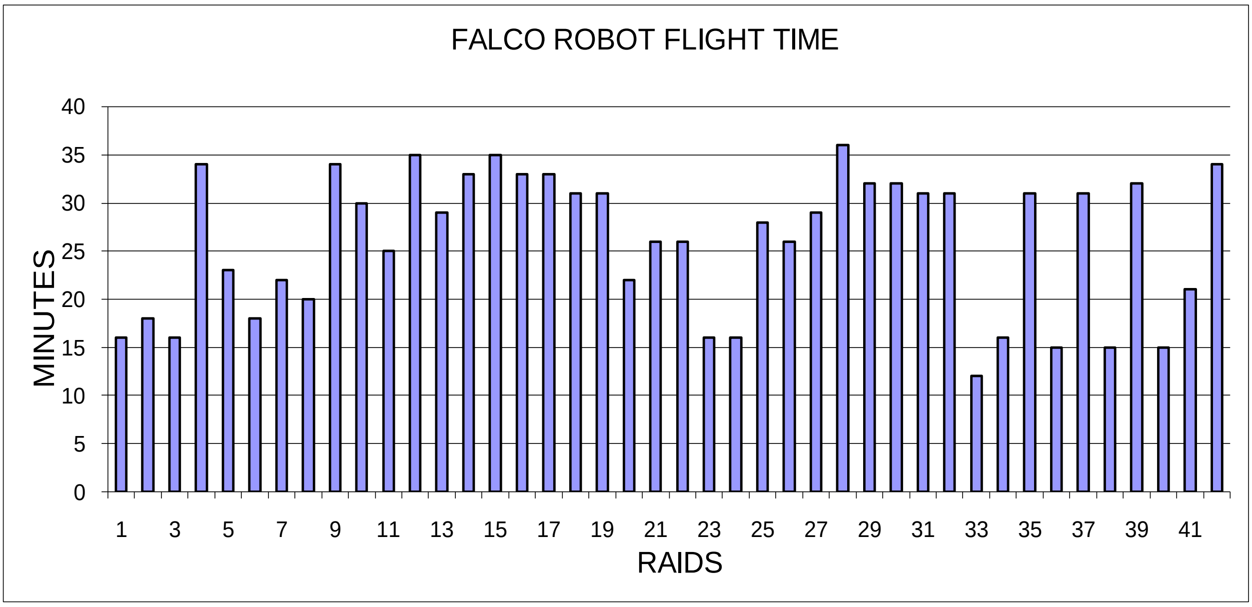

Fig. 4. Flight time for each of the 42 “FALCO ROBOT GBRS” raids carried out from 19.06 to 19.07.2008 at Rome Fiumicino airport.

Bird presence was more relevant in the late afternoon hours.

The 17 raids aiming to immediately disperse birds allowed to completely clear the area in an average time of 8 seconds, as shown below (Figure 5).

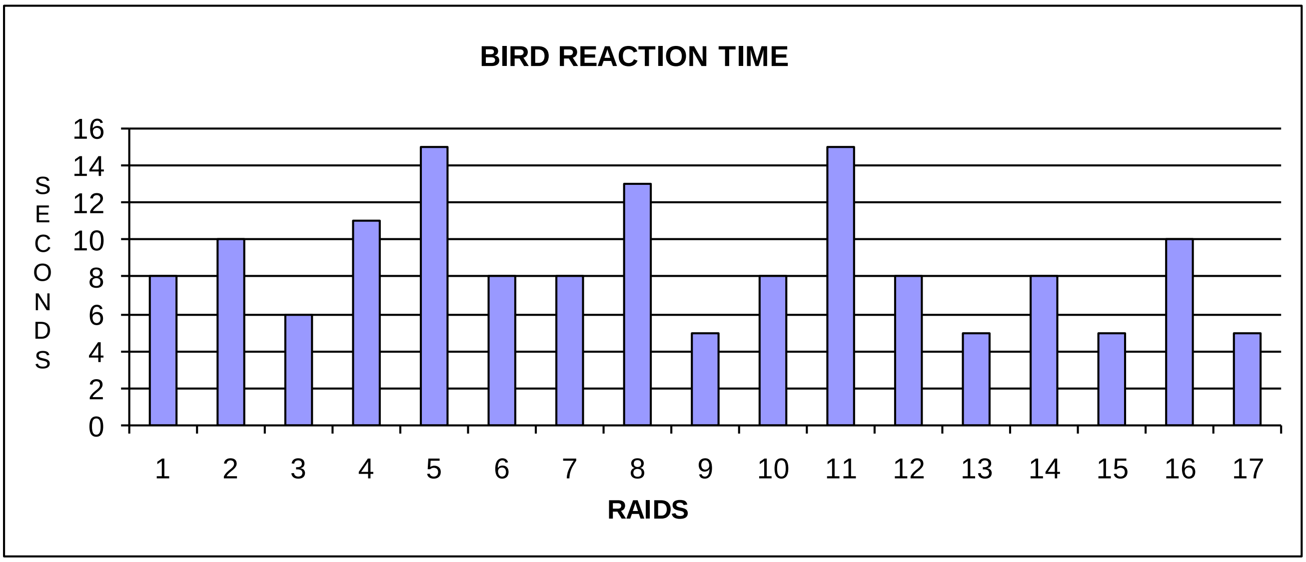

Fig. 5. Flight times needed to disperse birds for each of 17 “FALCO ROBOT GBRS” raids

After every raid, including the patrolling ones, the area resulted completely clear from birds for at least 1h 30min.
However this duration corresponds to the researchers presence *in situ*; nevertheless there are undocumented news and rumours stating that birds came back to the area only after hours and, after the evening raids, until the next morning.
The following graphic (Figure 6) shows the bird (Yellow-legged Gulls) presence reported during the 42 “FALCO ROBOT GBRS” raids.

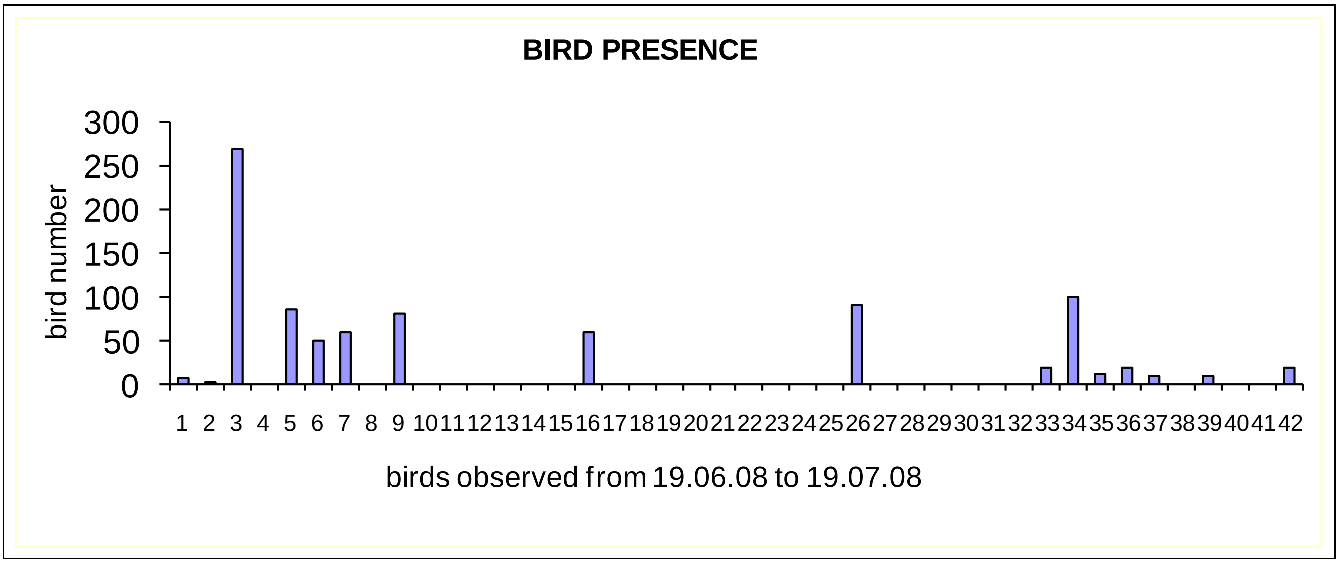

Fig. 6. Number of Yellow-legged Gulls observed during the 42 FALCO ROBOT GBRS raids

Apart from raids n. 16,26 and 34, when the bird presence may have been affected by particular weather or environmental conditions, and prudentially speaking due to the shortness of experiment, a general presence reduction seems to appear after the first days until a so called “physiological threshold”.
However this does not reach the individual critical number that leads to the well known “multiplication effect”: this happens when the number of birds in an area (normally estimated in 30/40 individuals) persuades others to come in as the area was favourable for food, rest or other reasons.

Discussion

Supposed disadvantages and objections have already been mentioned. Dropping the discussion about historic objections, regarding old devices now overcome by the new technical features of "FALCO ROBOT GBRS", the main problem related to a widespread and large scale device employment seems to be the ATC controllers reluctance; in order to grant a wide and prompt effectiveness, the model needs to fly even in presence of air traffic, approaching or taxiing on the ground.
Limiting the employment to the rare moments when there's no traffic in an international airport means to frustrate the device's potentiality and effectiveness.
Other problems, like those of operators and their training, are part of organizational and financial questions that can find an answer at an industrial level.

It's a matter of fact that "FALCO ROBOT GBRS" has an extraordinary and proven tactical effectiveness, i.e. it is capable to remove in a few seconds even a large number of birds from an area of at least 1 km. radius. Furthermore this effect endures for at least 1h 30min., and this could allow an airport to operate regularly even in critical periods due to an exceptional bird presence.

Furthermore there are reasons to believe that prolonged and repeated employment of one or more devices can make an airport unattractive to birds, so achieving also a long-term or permanent effect. This will be actually the subject for future experimentations,
In any case the effect duration is definitively much longer than any other known traditional scaring device.

No bird habituation problems, at least with the Yellow-legged Gulls, have been reported, even if the test period was relatively short; the main factors that exclude the habituation are:

- continuous changes of operative conditions;
- the possibility to change attack strategies;
- the model is recognized as an authentic predator (counterattacks just confirm that gulls perceive the model as a real bird of prey).

Another fundamental feature is its capability to steer the bird escape towards a predetermined safe direction, avoiding movements that sometimes may affect approaching or taking off airplane flight paths. This is the real "nightmare" of ATC controllers and airport managers who in all tests made the same question: "where will the birds go"?
It has been proven instead that an accurate employment strategy, similar to that used by Border Collies, allows the operator to steer the escape to safe areas; this really appears to be the "FALCO ROBOT GBRS" added value, linking immediate interventions to absolute safety.

There are also several other advantages that must be considered in the operative employment:

- the model can be ready to fly in less than 5 minutes;
- easy maintenance (all components are quickly changeable);
- versatility and flexibility;
- it is ecological: no pollution, no noise, no harm to other birds;
- easiness in transportation and garaging;
- total control: electronic systems and procedures allow to immediately and vertically drop the model in the rare event of a loss of control;
- limited cost if compared with traditional falconry

4. CONCLUSIONS

Returning to the paper title, and after the analysis and the discussions, it appears even unnecessary to present a comparison between traditional falconry and "FALCO ROBOT GBRS". Reliability, flexibility, availability, total control and proven effectiveness are the winning arms for stating that no comparison is possible and that the new device is the winner.
Modernity overcomes tradition.

"FALCO ROBOT GBRS" is doubtless an innovative and effective system against the bird hazard at airports.
Beyond its proven tactical effectiveness (bird removal), birds have been observed not to come back to the area for quite long periods.
Furthermore it has been observed that the patrolling action decreases the number of birds in the area. Therefore there are enough reasons to believe that a widespread operative employment of "FALCO ROBOT GBRS", in different environmental contexts and facing different bird species, will confirm this strategic effect.
It is clear that this statement would allow to consider the new device also as a real prevention system.

5. CITED LITERATURE

- BISHOP, J., McKAY, H., PARROTT, D., ALLAN, J. 2003. Review of international research literature regarding the effectiveness of auditory bird scaring techniques and potential alternatives. Rep. from *Central Science Laboratory for Defra, UK,* December 2003. 24-25 pp.
- BLOKPOEL, H. 1976. Bird hazards to aircraft. *Clarke, Irwin & Co*. Ltd., Canada. 235 pp.
- BROUGH, T. 1968. Recent developments in bird scaring on airfields. In: *The Problems of Birds as Pests (R.K. Murton and E.N. Wright, eds.)*. Academic press, London: 29-38.
- BURGER, J. 1983. Bird control at airports. *Environ. Conserv*. 10: 115-124.
- BURNS, J.G. & S.L. WARDROP. 2001. The veloci-raptor: a bicycle–powered model raptor for realistic predator encounter experiments. *J. Field. Ornithol.* 72: 399-403.
- CANTY, N. & J.L. GOULD. 1995. The hawk/goose experiment: sources of variability. *Anim.Behav.* 50: 1091-1095.
- CONOVER, M.R. 1983. Pole–bound hawk kites failed to protect maturing cornfields from blackbird damage. *Proc.Bird Control Seminar* 9: 85-90.
- DE FUSCO, R.P. & J.G. NAGY. 1983. Frightening devices for airfield bird control. *Bird damage. Res. Rep. 274 U.S. Fish Wildl. Serv.,* Denver Wildl Res.Cent. Colorado State Univ., Fort Collins, CO. 78p.
- DOLBEER, R.A., CHIPMAN, R.B., GOSSER, A.R. & S.C. BARRAS. 2003. Does shooting alter flight patterns of gulls: case study at John F. Kennedy international airport. *IBSC26/WP- Warsaw*, 5-9 May 2003.
- ERICKSON W.A., MARSH R.E. & T.P. SALMON. 1990. A review of falconry as a Bird-hazing technique. *Proc. 14th Vertebr. Pest Conf. (L.R. Davis and R.E. Marsh, Eds.)* Published at Univ. of Calif., Davis. 1990: 314-316.
- HARRIS, H.A.G. 1980. The blackbird problem in southern Manitoba. In *Technical and scientific papers presented at Manitoba Agronomists' Annual Conference, Winnipeg, Manitoba – Manitoba Univ.: 45-47.*
- HARRIS, R.E. & R.A. DAVIS. 1998. Evaluation of the efficacy of products and techniques for airport bird control. *Rep. from LGL ltd. King City ON, for Transport Canada* TP1329, 42-43 pp.

- IBSC (International Bird Strike Committee). 2006. Recommended Practices No. 1 - Standards For Aerodrome Bird/Wildlife Control - Issue1.
- INGLIS, I.R. 1980. Visual bird scares: an ethological approach. In *E.N.* Wright, I.R: 121-143.
- LORENZ, K. 1939. Vergleichende Verhaltenforschung. *Zool.Anz.Suppl.*,12,69-109
- MONTEMAGGIORI, A. 1998. The importance of bird monitoring at airports: the case of Fiumicino, Rome. In *IBSC 24: Proceedings and Papers, Starà Lesnà, Slovakia, 14-18 Sep. 1998*: 205-215.
- MONTEMAGGIORI, A. 2001. Airport 2001: uccelli in pista!. Atti del XI Convegno italiano di Ornitologia. *Avocetta* 25(1): 125.
- MONTEMAGGIORI, A. 2002. Il monitoraggio dei volatili in aeroporto: l'esempio di Fiumicino. *Alula* IX (1-2): 30-45.
- MONTEMAGGIORI, A. 2003. La strategia antibirdstrike adottata a Fiumicino. XII Convegno italiano di Ornitologia. Ercolano, 23-27 Sett. 2003. Tavola rotonda.
- MONTEMAGGIORI, A. 2008. Relazione Annuale Birdstrike: analisi degli impatti dovuti a volatili nell'Aeroporto di Fiumicino, anno 2007. *Adr Tech. Report*: 15 pp.
- SAUL, E.K. 1967. Birds and aircraft: a problem at Auckland's new international airport J. Roy. *Aeronautic. Soc.* 71 (677):366-367
- SOLMAN, V.E.F. 1966. Ecological control of bird hazard to aircraft. P*roc. Bird Control Seminar* 3:38-56.
- SOLMAN, V.E.F. 1973. Birds and aircraft. *Biol. Conserv*. 5:79-86.
- SOLMAN, V.E.F. 1981. Birds and Aviation. *Environ.Conserv. 8:45-52*
- TINBERGEN N. 1948. Social releasers and the experimental method required for their study" *Wilson Bull.*,60: 6-52.
- WARD, J.G. 1975. Use a falcon-shaped model aircraft to disperse birds. *Rep. From LGL ltd. For the Assoc. Comm. On Bird Hazard to Aircraft, Nat. Res. Council, Ottawa:* 9 p.
- WRIGHT, E.N. 1963. A review of bird scaring methods used on British airfields. In *Le Probleme des Oiseaux sur les Aerodromes (R. Busnel and J. Giban, eds.)*. Inst. Natl. de la Recherche Agronomique, Paris. 316: 113-119.

6. CONSULTED BIBLIOGRAPHY

- GREEN, R., CARR, W. & GREEN, M. 1968 The hawk; goose phenomenon further confirmation and a search for the releaser. *J.Psychol.* 69: 271-276.
- HIRSCH,J., LINDLEY,R.H. & TOLMAN, E.C. 1995. An experimental test of an alleged innate sign stimulus. *Journ.comp.physiol.psychol*, 48 : 278-280.
- MELZACK R., PENICK E. & BECKETT A. 1959. The problem of innate fear of the hawk shape: an experimental study with mallard ducks. *Journ. comp. physiol. psychol.* 52 : 694-698.
- PENNYCUICK C. J., FULLER M. R., OAR J. J. & KIRKPATRICK S. J. 1994. Falcon versus grouse: flight adaptations of a predator and its prey. *Journ.of avian biology* 25: 39-49.
- RYJOV, S.K. 2005. The use of goshawks against pigeons" *IBSC conference proceedings*, Athens 2005.
- SCHLEIDT , W.M. 1961 Reaktionen von Truthuhnern auf fliegende Raubvogel. *Z.Tierpsychol. 18:* 534-560.
- VENTURATO, ZILLETTI & BEANI. 1997. Reazioni a un predatore simulato-terrestre e aereo- in pernici rosse (*Alectoris rufa*) allevate in condizioni semi naturali. *Suppl. Ric. Biol. Selvaggina XXVII*: 853-859.