A NATIONAL NETWORK OF BIRD AND WEATHER RADARS IN ISRAEL - FROM VISION TO REALITY

Yossi Leshem, Dr.[1], Oded Ovadia, Maj.[2], Leonid Dinevich, Dr.[1], Oded Raz [1]

[1]Tel Aviv University, Department of Zoology, The International Center for the Study of Bird Migration, Ramat Aviv, Tel Aviv, 69978, Israel
Fax: +972-3-640-6010, Email: yleshem@post.tau.ac.il
[2] Birdstrike prevention section, Control units Head Quarter, IAF, Tel Aviv, Israel
Tel: 972-3-6067007, Fax: 972-3-6067589, Email: air91@idf.gov.il

Abstract

The Israeli Air Force (IAF), Tel Aviv University, and the Society for the Protection of Nature in Israel initiated a joint research to reduce the number of collisions of migrating birds with aircrafts. The procedures were implemented in the flight regulations of the IAF and helped reduce the collisions since 1984 by 76%, saving a national budget of 690 million dollars. As a result of the research, the IAF decided in 1990 to develop a network of weather and bird radars to provide online information to allow low flight maneuvers even during the migration seasons. In 1998, the first MRL-5 Russian Radar located at Latrun, in central Israel, was modified from an analogical to a digital system, and since 2001 started to produce online data through the Internet to the entire range of the IAF units. Since 2003, a second Enterprise Weather Radar began to be a operational in the southern part of Israel in the Negev Desert after it was updated with a Doppler unit and a Sigmet Digital System. Since 2004, a bird center began to operate at the headquarters of the IAF providing radar pictures to the entire system. The network of the ground bird watchers, complimented the migration data from the northern part of Israel for the last twenty four years. The IAF already located all the funds for the third Enterprise Radar System, which will be located in 2006 in Northern Israel. The entire country will be covered as one national system. Results from the last two migration seasons will be presented. This system will be the base to develop a regional radar system in the Middle East. Jordan and Turkish Air Forces expressed their willingness to join.

Keywords: Radar, ground observers weather, IAF, national system, regional system, bird migration

Introduction

Israel's unique location at the junction of three continents serves as one of the most important migration "bottlenecks" in the world, with close to one billion birds crossing during the cumulative autumn and spring migrations. Soaring migrants (raptors, storks, and pelicans) traveling through Israel use three principal flyways which alternately used during the spring and autumn migration seasons: (1) the Western Flyway occurs mainly along the western edge of the central mountain range; (2) the Eastern Flyway occurs mainly along the Great Rift Valley, crossing the Jordan Valley, continuing southward along the Dead Sea towards the Sinai, and (3) the Southern-Eilat Mountains Flyway (Leshem and Yom-Tov 1998). The Israeli Air Force (IAF), exploiting the same air space of migrants', has experienced numerous aircraft-bird collisions in the past. A large proportion of these collisions involved migrating birds, with soaring birds causing 74% of the severe collisions (Leshem 1992). As a mitigation effort, over the past two decades long-term monitoring of soaring birds has been conducted with a network of ground observers and radar stations, motorized-gliders, and drones, inevitably reducing the collisions by 76%, and saving the IAF 690 million dollars since 1984. Since the establishment of the International Center for the Study of Bird Migration at Latrun, an interdisciplinary

concept was developed during the last six years, combining migration research with flight-safety activities (Leshem and Yom-Tov 1996a).

Since 2004, an ongoing biological research and algorithm development of bird detection has been taking place in a cross-country online network of birds and weather radars. This research is funded by the IAF, the Fischer Institute Air-Force Association, the Ministry of Defense, and the International Center for the Study of Bird Migration in Latrun. The research has two aspects, biological and engineering. The Engineering aspect is conducted by Kosta Malsev, an M.Sc. student of Bio-Medicine Engineering. Dr. Leonid Dinevich leads the MRL-5 Russian Weather Radar program in Latrun, which was converted to a digitalized bird radar system. As part of the research, data collected by ground observers network in the northern valleys (which currently presents a substitute to the northern radar at Givat Hamore until 2006) is correlated with data obtained by the Latrun radar and the Southern Regional Control Unit radar at Mitzpe Ramon. The aim is to examine the detection abilities of the radar in comparison to the data collected by the ground observers. The important objective here is to create a real time image of the birds traveling through the Israeli air space, based on the three radars located throughout the country.

Study Area and Methods

Several factors may affect the numbers of birds counted during migration: Breeding success, survival in wintering areas, weather, observer expertise, and relative coverage of the migration front (Leshem and Yom-Tov 1996b).

During the autumn migration season the Israeli Ornithological Center activates two ground observer networks, which are sponsored by the IAF since 1983, and are located throughout northern and southern of Israel. The northern network ("the Northern Valleys") stretches from from kibbutz Tirat Tzvi on the east (close to the Jordan border), throughout the Beit Shean valley, the Harod valley and Izra'el valley, and to the Carmel range on the west. The southern network is stretched out along the west coast of the Dead Sea (during the morning), and between Kalia on the east and Mitzpe Edomim on the west, near Jerusalem (during the afternoon). The ground observers are spread out in a way that they create a front, perpendicular to the migration route (see figure 1). At the northern valleys observers watch migrating birds coming from Lebanon and Syria to the Galilee and the Golan Heights, and in the southern networks they watch birds coming from the north (the Jordan valley) and from the east (Jordan). At the north there are about 10 posts, scattered 3 km apart from each other, while in the south there are 1-2 observers occupying the counting stations. At each station there is usually only one observer.

Regular communication between the posts is maintained through the use of cellular phones and radios, and is designed to avoid double counting of the migrating birds. The observers watch flocks, count them and report immediately to the Air Force Birds Center, located at the IAF headquarters.

The counting stations are occupied from approximately one hour after sunrise, (to coincide with the departure of soaring birds from overnight roosts), until one hour before sunset. Each station is managed by a observer, who is equipped with binoculars, a telescope, and a radio device. All observers are experienced birders and trained in the identification and counting of soaring birds, enabling the comparison of daily estimates between the different stations. Each day, observers were required to complete an observational form, including the species counted, numbers, times, approximate distance from stations, and estimated altitude and direction of migrations. By comparing daily observations, and using radios to communicate with adjacent observers during periods of active migration, it is possible to eliminate double-counting (Alon D. et al, 2004).

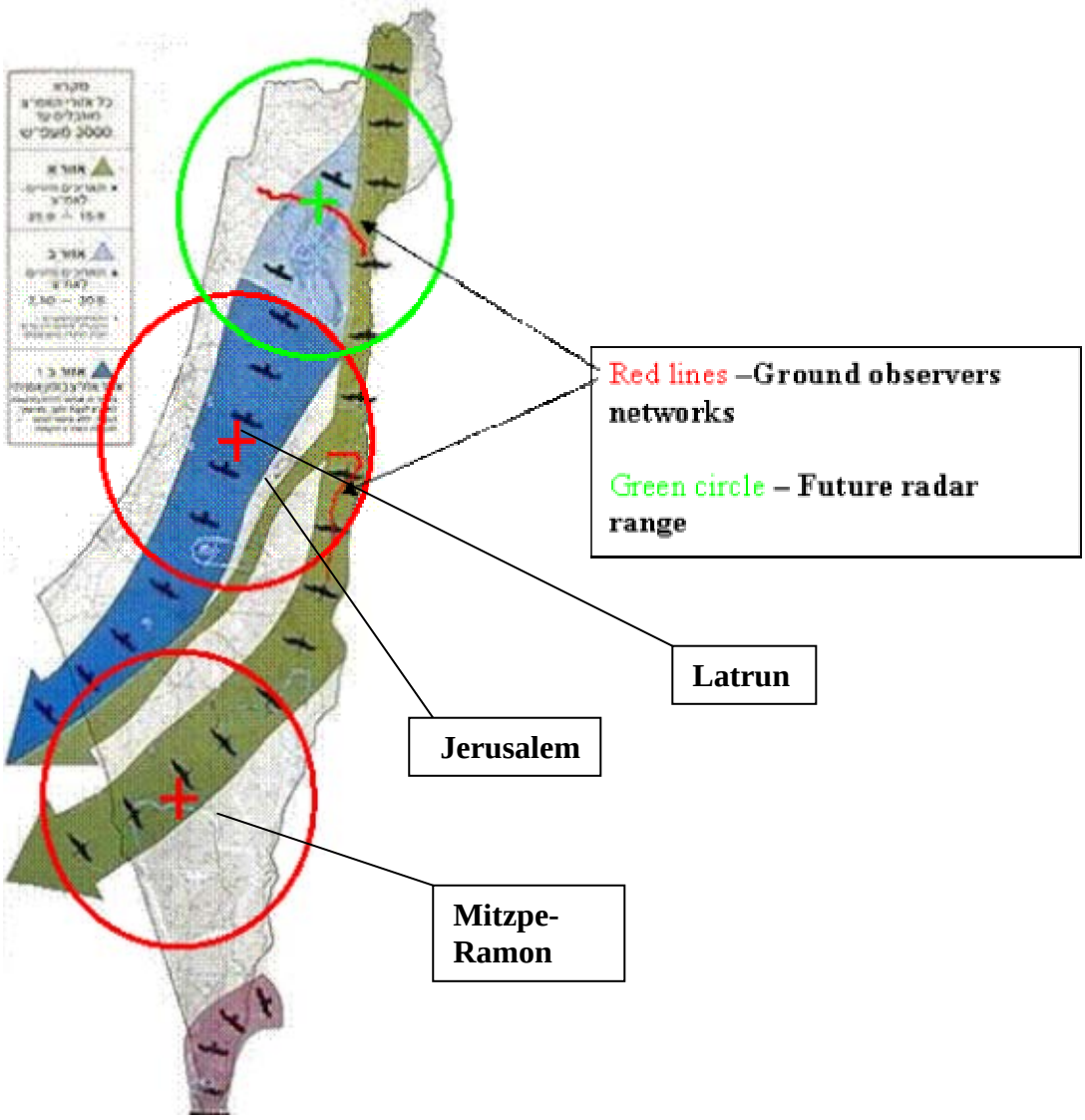

Figure 1. Locations of the ground observer networks and the future locations of radar installations in the Birds Plagued Zones maps (BPZ maps).

The Air-Force Bird Center is located inside the IAF headquarters. The Bird Center is manned by an officer and a soldier bird-watcher. They receive reports about the migrating birds from the ground observer networks, occasional observers in the field, and Air Force bases (radars of local bases, aircraft traffic control and flight units, and the two radar units at Mitzpe Ramon and Latrun, which are electronically forwarded). These reports are forwarded to the relevant Air Force bases and the Ben Gurion International Airport. Inside the Bird Center are two radar monitors: one connected to the internet and presents the Latrun radar images, and another one connected to the Ramon radar. One of the responsibilities of the Bird Center is to determine and record the daily migration intensity every 10 minutes. The use of radar has proven to be an extremely effective operational tool for issuing flight warning statements and short-term, as well as long term forecasts (Leshem 1999).

When reports from ground observers are received, the Bird Center dispatches this information to relevant air-force bases in the predicted route, to compare between the ground, field report and the one received from the radar system. Using the average species velocity, which was calculated by using a motorized glider that flew with the bird flocks and a map (Leshem and Yom-Tov 1998b). This predicted where and when will the flocks enter the air-space range of specific Air Force bases. In the meanwhile, flocks are being tracked by the Latrun radar and followed by the Ramon radar. The Bird Center runs a log book, where every report and action is documented. This log book is transferred into Microsoft Excel tables for the sake of proper analysis of all the reports. Data is divided into ground

observers reports, Latrun radar echoes, Ramon radar echoes and other reports. In addition, a flight time calculation table was created, in order to predict the appearance rate of flocks on the radar screens.

In the southern Regional Control Unit, an image of the migrating birds appears every 3 minutes on the radar screen. Each image is composed of 5 elevations of a 360 degrees radar scan (about 12 seconds each). The image presents echoes in different colors, which represent the time that passed since the scan. Thanks to a Doppler kit installed in the weather-Enterprise radar in Mitzpe Ramon, clutter disable is active and the image is much clearer. All of the data of the migration seasons is recorded in the southern Regional Control Unit and archived in Tel-Aviv University.

The two-wave MRL-5 weather radar (3cm and 10cm channels) was developed in Russia for the purpose of detection of clouds and precipitation location. It is applied for hail suppression and thunderstorm warning. The Israeli version of the MRL-5 radar is equipped with a supplementary polarization appliance, which allows to measure depolarization and differential components of the reflected signal. These parameters correspondingly define non-sphericity of the reflectors and their orientation in space-i.e., they can serve an indicator of signal radio location and a detector of bird signals against the background of atmospheric irregularities (Dinevich 2000).

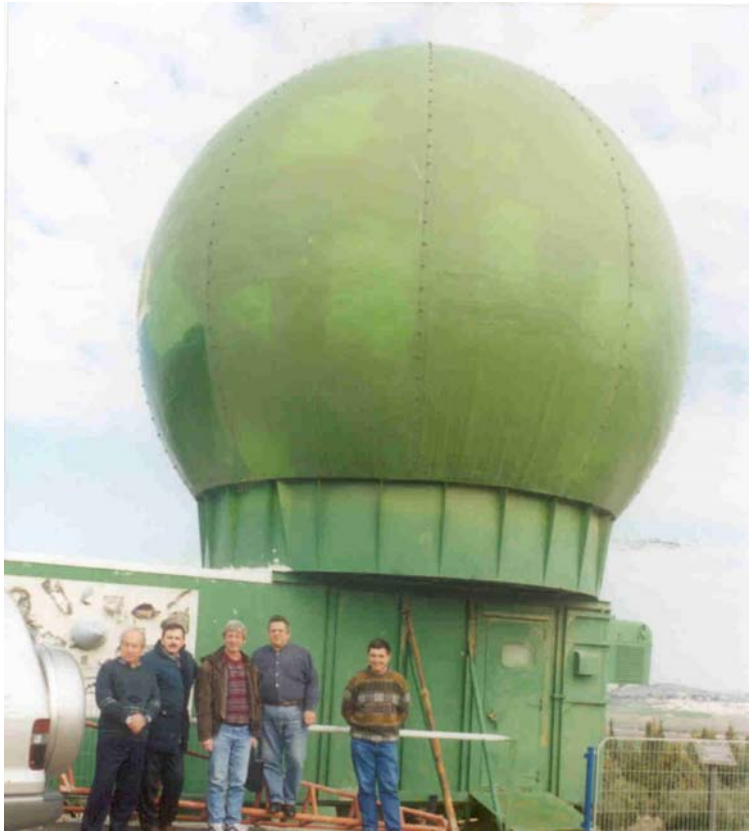

Figure 2. The team of 5 Russian scientists who immigrated to Israel standing in front of the MRL-5 radar, which they digitized and converted to a bird radar.

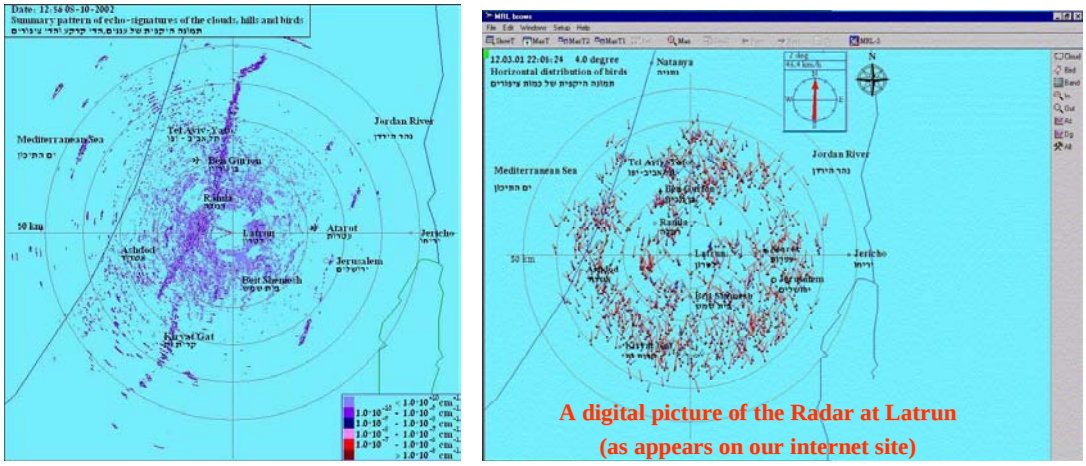

Figure 3. Left, 12 October 2002, diurnal migration, a line a 100 km-long of Lesser spotted Eagles. **Right,** 12 March 2004, nocturnal migration, on a wide front from the Mediterranean to the Judean Mountains, as depicted by the MRL-5 Russian Radar.

Since 1997, research concerning seasonal bird migrations has been conducted in Israel with the help of meteorological radar MRL-5. The radar was located at Latrun (34°98'N, 31°83'E) midway between Tel Aviv and Jerusalem, 18 Km southeast of the Ben Gurion International Airport. This location is within the boundaries of the western migratory route. Application of high potential meteorological radar on this extensive migration has allowed collection of data on nocturnal bird migration over a large territory (Dinevich L. et al, 2003). The MRL-5 effective radius is 50-60 km (altogether 100-120 km). Although a Doppler kit was not installed in this MRL-5, the software written in Israel for bird detection, by a new Russian immigrants research team, is working in a similarly to the way the radar in Mitzpe Ramon works.

During migration seasons (March-May and August-November, with a total of 7 months a year) every day between 8am and 5pm, Dr. Leonid Dinevich (the Latrun radar operator) sends a radar scan to the internet (www.birds.org.il). Each 30 minutes (or 15 minutes when migration is intense), a series of four pictures depicting the intensity of the migration are transmitted to the Internet site. Digital analysis of the images includes a directional vector and the velocity for each radar echo and its azimuth, the average of all echoes in the image (azimuth and velocity), a vertical cross-section of the height of migration layers, and distribution by migration layers of 500 meters, as well as three-dimensional pictures and weather pictures (Leshem 2001).

Figure 4. Dr. Leonid Dinevich and an IAF soldier measuring the intensity of migration at the MRL-5 Radar.

Results and Discussion

For the first time ever in Israel, we studied the soaring bird migration by combining an interrelated network of ground observers and two radars, which gave us a clear picture of soaring bird movements on a national level. The network of the ground observers located in northern Israel were calculated and analyzed as data of the third radar to be installed in 2006, and we predicted when the migrant birds should appear on the northern range of Latrun radar. In addition, we predicted when soaring birds would appear at the northern range of the southern Radar in Mitzpe Ramon.

The last two autumn migration seasons (2004 & 2005) we are analyzing and examining about 2,000 flocks correlate with our predictions in time appearance, velocity, and the height and azimuth of the flocks. Positive results will enable us to provide real-time warning systems of the locations of the flocks across the entire national network of radars, and allow the IAF to decide online how to plan their air movements within their training zones, using a half-day in advance warning system.

We predict that this will allow the IAF 40% additional low-level flights even during the 7 months of the migrations. This will also allow the IAF to decide where to conduct low level flights only in parts of the training zones where we predict that no soaring birds appears. In the IAF predicting system the Bird-Avoidance Models (BAM) will also implement the meteorological data for the region. If this proposed system will succeed we will enlarge it to a regional level.

Management Implications on a regional level

Two migration seasons (Autumn 2004 and Spring 2005) have already been recorded and they are currently being analyzed. The next step is to measure meteorological data of the migration seasons on a daily basis, and analyze the aspect of the influence of weather on migration patterns.

It has been proposed to develop a network of the same radars in neighboring countries on a regional level. Such a network will enable the Turkish Air Force during the autumn season to provide real time information to the Royal Jordanian Air-force (RJAF) and IAF, which in turn can provide the real time data to the Egyptian Air Force. During spring migration, information will be transferred from Egypt to Israel, Jordan, and Turkey (Leshem and Yom-Tov 1998).

Figure 5. A layout of the proposed radar installations throughout the Middle-East region.

Literature Cited

Alon D., B. Granit, J. Shamoun-Baranes, Y. Leshem, G. Kirwan, H. Shirihai. Soaring bird migration over northern Israel in autumn. British Birds 97:p 160-182.

Dinevich L., Y. Leshem, M. Pinsky, and A. Sterkin. 2004. Detecting birds and estimating their velocity vectors by means of MRL-5 meteorological radar. The Ring 26 (2): 35-53.

Dinevich L. 2000. Study of bird migration by means of the MRL-5 radar (primary stage). Physics and Thermodynamics 2(1): p. 94-99.

Dinevich L. 2003. Temporal characteristics of night bird migration above Central Israel–a radar study. ACTA Ornithologica 38 (2): p. 103-110.

Leshem Y. 1992. Predicting regularity of bird migration in global bottleneck areas, on daily, seasonal, and yearly scale, and its implementation in Israel Air-Force civilian flight. BSCE 21: 243-258.

Leshem Y. 1999. Developing a real time warning system in the Middle East: from vision to reality, birds and safety in the Middle East. International seminar on birds and flight safety in the middle east and Israel: p. 45-69.

Leshem Y. 2001. Migrating Birds Know No Boundaries. From regional to global perspective, Wings Over Africa, International seminar: p. 35-48.

Leshem Y., and Y. Yom-Tov. 1996a. The magnitude and timing of migration by soaring raptors, pelicans and storks over Israel. IBIS 138 (2): p. 188-203.

Leshem Y., and Y. Yom-Tov. 1996b. The use of thermals by soaring migrants. IBIS 138 (2): p. 667-674.

Leshem Y., and Y. Yom-Tov. 1998. Routes of migrating soaring birds. IBIS 140 (1): p. 41-52.