AERIAL TRACKING OF GREAT BUSTARDS (*Otis tarda*) IN SPAIN

LOCALIZACIÓN DE AVUTARDAS (*Otis tarda*) DESDE EL AIRE EN ESPAÑA

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Aerial tracking was first used in Spain in 1988 to locate Spanish Imperial Eagle (*Aquila adalberti*) young after their independence in Doñana. Two of the authors of the present paper continued to use this method to locate wintering Common Cranes (*Grus grus*) in Extremadura after marking them during their migratory staging at Gallocanta, Zaragoza province, following mainly the procedures described for aerial tracking of Whooping (*G. americana*) and Sandhill (*G. canadensis*) Cranes (Brander & Cochran, 1971; Cochran, 1972, 1980; Drewien & Bizeau, 1981; Gilmer *et al.*, 1981; Melvin & Temple, 1982). From 1992 on, aerial tracking has been used to locate Great Bustards radiomarked in the Reserve of Villafáfila and Madrid province.

The combined work of a ground team and an airborne tracking crew is necessary to recover contact with individuals that move out of land radioreceiver reach. Such recovery is specially important when continuous behavioural observations and data on social structure or habitat preferences are required.

Initially, Dornier aircraft were used, given their plane upper position and low minimal speed, what allows visualization of tracked birds. Sighting of birds from aircraft is highly useful in Cranes, but practically impossible in Great Bustards due to their tendency to fly when they detect aircraft approach. Great Bustard behaviour requires greater flight altitude to prevent the birds' take off by disturbance, which may cause the ground team not to find the individuals tracked. Therefore, most birds were located from Bonanza airplanes, which allow to reach higher altitudes.

Telemetry equipment

The equipment used for aerial tracking is the same one used in land work, that is, a TELONICS receiver (TR-2 model, provided with a TS-1 model scanner), supplied either with battery, either alcaline or NiCd, power or with power from the plane's electric system. The transmitters attached to Great Bustards were different models from trademarks TELONICS, BIOTRACK and TELEVILT.

Aerial tracking was started for Great Bustards following the procedures previously applied to eagle and crane location. We flew, Dornier E-9 aircraft, equiped with WMI three element Yagi direccional antennas to each wing strut, mounted in a similar way to that described by Gilmer *et al.* (1981). This allowed us to put both antennas in a slightly side-looking configuration (about 30 degrees from flight direction). Antenna elements were always vertically polarized.

High-wing Dornier aircraft is more suitable when visual contact with individuals is required, due to their much lower mimimal speed. In our case, however, location quickness and accuracy was more important than bird sighting. Thus, to avoid bird flying away as a consecuence of aircraft disturbance, which may prevent land contact with marked individuals, we began to fly low-wing Bonanza E-24 aircraft, much faster than the former ones. These airplanes allow to locate birds as accurately as high-wing ones and even more when combined with a GPS to obtain the birds' coordenates. In Bonanza aircraft two different antennas were simultaeously used, a three element Yagi directional

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antenna and an omnidirectional one. The former was mounted on the marginal edge of the plane's left wing, in a forward looking configuration, and the latter was attached to the ventral side of the same wing, downward ponting. We utilized a switchbox to receive signals either through one antenna at a time or through both simultaneously.

General procedures

All flights were VFR, although flight altitude was always high enough to prevent birds to fly long distances because of aircraft flying over. When searching for recently lost individuals we started aerial tracking over the spot of last ground visual contact with the bird. If no signal was detected during the approach to that point, a 2 km radius circular flight was carried out around it, at an altitud of 500-800 m above ground level, while scanning through the directional antenna. In most cases, signals were received while approach the last visual contact coordenate, at a longest distance of about 20 km. Detection distance depended on transmitter power and bird position and activity in that moment. Reported maximum reception distances refer to birds tracked during migration, with a headstart up to 160 km -4 hours flying- on a known route (Melvin, 1982).

As usually happens with directional antennas, signal quality is optimal when the antenna is pointing directly to the transmitter, and it almost disappears when pointing in a right angle side direction. Once the right direction was fixed, we flew straight towards the signal lowering flight altitude (about 1200 m a.g.l.) to increase location accuracy. The directional antenna is then selected. Since directional antenna elements are perpendicular to ground, whe our aircraft passed over the exact point in which a transmitter was located signal intensity suddenly fell, thus indicating transmitter position. The exact point was then visually spotted and, at the same time, the signal was switched to the omnidirectional antenna. Signal reception quality had to be then as good as it was when reception was switched to the directional antenna, just before flying over the exact transmitter location. To assure correct location, the plane was turned around 180 degrees to fly back over the same spot and determine its coordinates by means of a GPS. If signal intensity had not clearly fallen, a better location had then to be achieved. to do so the airplane was turned to describe a 3 or 4 km curve and spot the exact location in a direction perpendicular to the previous one. If this second localization was correct, its coordenates were determined by GPS and written down for land control.

When surveying large areas in search of long lost radiomarked Great Bustards, flight altitude was 350-450 a.g.l., scanning through both directional and omnidirectional antennas. Transect width at that altitude was between 10 and 15 km to either side of the plane, slightly less than the maximum band width of 24 km to either side reported for two side-looking antennas on high-wing aircraft (Melvin and Temple, 1987). This flight altitude is a good compromise between maximizing reception range and minimizing time required for descents to accurately locate radiomarked birds and subsequently climb again to resume searching. Some authors report maximum signal gain not being increased at altitudes greater than 300 m a.g.l. over open areas (Gilmer *et al.*, 1981), although higher flight altitudes might increase sensityvity over mountains and forest areas. Other authors indeed found an increase reception range above 300 m, which they relate to the low position of the transmitting antenna on leg band mounted radios (Melvin & temple, 1987). Transmitting antennas on Great Bustards, either on backpack or poncho mounted radios, were always upward directed. Therefore we assume that our flight altitude is high enough to receive any signal in the mentioned range, even in the case of birds lying on the ground or in slightly hilly habitats.

Benefits and handicaps of aerial tracking compared to ground tracking

Aerial tracking was used only when some indvidual could no longer be contacted with by conventional ground tracking, given the great importance of continuous contact with marked individuals to our study. High location altitude in the case of Great Bustards prevents bird visualization, for subsequent ground location is needed to continue observations. Aerial radio-monitoring is not always possible due to unfavoralbe weather conditions which caused the delay of 75% of flights.

Reception range from ground is between 10 to 20 times smaller than from aircraft. Frequently in our study, ground crew mobility was limited by the availabilty of tracks and roads when birds visited new areas unknown to observers. Land crews may be, therefore, realtively inefficient to radiotrack birds in a large and poorly known area.

Tracking Great Bustards from aircraft gives the highest probabilities to locate any lost radiomarked bird. Besides, aerial location allowed us to study the general topography of routes followed by Great Bustards in their movements. Mean distance between aerial coordenates and subsequent ground locations was only 576 m.

Quite frequently we had to lower our long-distance tracking flight altitude due to heavy interference from powerful radio sources, such as big towns, airports, etc. The only way to avoid such interferences was to change flight direction so that the plane was between the source of interference and the area to be monitored, that is, the interference source behind the directional antenna. These maneuvers increased searching time and reduced the widht of transect band.

Reasons for losing the signal

In relation to factors that may cause the loss of radio signals, the most frequent ones were transmitter type and power, as well as transmitter life. Transmitters are much more difficult to locate during the last phases of their life. This difficulty is lowered when birds are tracked from the air. Type of transmitter attachment may also affect signal quality, for the closest the antenna is to the bird's body, the worse reception gets. Antenna position is also very important for reception quality and depends mainly on the bird's activity (flying, feeding or vigilant, lying on the ground, dead upside down, dead inside a fox den; tarnsmitter thrown on the ground or buried, etc.). Geographical accidents such as hilly terrain, narrow valleys, river banks or canals, may also set a difficulty on correct localization, although it is not usually the case in the Great Bustard.

Routine in the case of not receiving a signal

When ground contact with a given transmitter is lost, it must be searched for from the air, beginning at the coordinates where it was received last time. If the bird's range previous to signal loss showed any directionality, tracking must be carried out in those areas ahead the bird's historical movements. The greater flight altidude, the greater the probability to reestablish radio contact and the longer the signal recovery distance.

Some cautions should be taken and checked periodically during the tracking flight.

1. All conexions must be correct (receiver to switchbox, switchbox to antennas, headphones to receiver).

2. Frequencies scanned must be the the right ones (move two digits up and down since transmitter glasses could in some cases slightly change its frequency).

3. The antennas must be correctly selected in switchbox.

After locating a new frequency in the scanner, signal strength may fluctuate as a consecuence of the bird's movements, often resulting in false nules and peaks. This was specially evident when birds were still far away from aircraft. Flight direction should then be changed; i.e. input through the directional antenna, until the right direction can be fixed and an accurate bearing to a true peak signal is determined.

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