TITLE STUDY STRUCTURE OF BIRD AND ECOSYSTEMS IN SPANISH AIRPORTS

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SUMMARY

THE RISK OF COLLISIONS WITH BIRDS IN AIRPORTS PRESENTS A COMPLEX PROBLEM WHICH IS OFTENTIMES DIFFICULT TO RESOLVE.

THE SPANISH AIRPORT AUTHORITY, AN AUTONOMOUS BODY WITHIN THE MINISTRY OF TRANSPORTATION, TOURISM AND COMMUNICATIONS, COMMISSIONED A STUDY LEAD BY THE TECHNICAL LABORATORIES AND THE ENVIRONMENTAL SECTION, TO DEFINE A GENERAL METHODOLOGY FOR THE STUDY OF BIRD PROBLEMS.

THE METHODOLOGY THUS ESTABLISHES, IS CURRENTLY BEING EMPLOYED IN THE AIRPORTS OF PALMA DE MALLORCA, MENORCA, IBIZA, TENERIFE/SUR, BARCELONA AND SANTANDER. THE PURPOSE OF THIS REPORT IS TO REVIEW THE MAIN FEATURES OF THE AFOREMENTIONED STUDIES AND THE METHODS APPLIED, AND TO ILLUSTRATE THE RESULTS OBTAINED DURING THE FIRST MONTH OF SAMPLING VIA SEVERAL REALLIFE EXAMPLES.

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1. INTRODUCTION

The risk of collisions with birds in airports presents a complex problem which is oftentimes difficult to resolve. The bulk of all precautionary measures applied are rarely based on in-depth knowledge of bird populations, and therefore, more often than not, merely reduce the influx of certain species. Moreover, despite the economic cost involved, many of these dissuasive measures have not fulfilled initial expectations, either because the presence of bird populations in airport zones is due to circumstances not related to the airport itself (migratory routes, feeding grounds, etc.), or because the ecosystems surrounding the airport greatly predetermine the species and population densities found.

Bearing in mind this situation, the Spanish Airport Authority, an autonomous body within the Ministry of Transportation, Tourism and Communications, commissioned a study to evaluate the status of the Vigo Airport (Northwest of Spain), with two objectives in mind: first, to define a general methodology for the study of bird populations in Spanish airports, and second, to reduce the risk of collisions. The methodology thus established is currently being employed in the airports of Palma de Mallorca, Menorca, Ibiza, Tenerife-Sur, Barcelona and Santander. The purpose of this report is (i) to review the main features of the aforementioned studies and the methods applied, and (ii) to illustrate the results obtained during the first month of sampling via several real-life examples.

2. STUDY STRUCTURE

The general framework of the study is summarized in fig. 1. First of all, an analysis of the particular features of each airport is carried out to define: siting, distribution of runways and buildings, vegetation (mainly structure), utilization, etc. Thereafter, surrounding areas which may have an impact on the bird populations in airports are then identified: resting spots, feeding grounds, breeding areas, and roosting places. This information is then used as a basis for sample design. Sampling takes place throughout the year on a monthly basis.

Samples have been classified under six separate headings, according to the different methodologies selected:

- Stable bird populations in the ecosystems in and around the airport site,
- Bird flows,
- Birds located on runways,
- Birds from outside areas which affect the airport,
- Roosting grounds,
- Additional information (dead specimens and data gathered prior to the study).

Since sampling of bird populations takes place year round, and the characteristics of air traffic in each particular airport are identified, two important features may be defined upon completion of the sampling campaign. First, numerical population evolution and behaviour can be determined and the influence of certain outside conditioning factors viewed, and second, specific risk patterns can be evaluated as a function of: density, weight, flight patterns, flock size, etc.

Finally, safety measures designed to reduce these risks are proposed, i.e. modification of vegetation around the air-

FIGURE 1

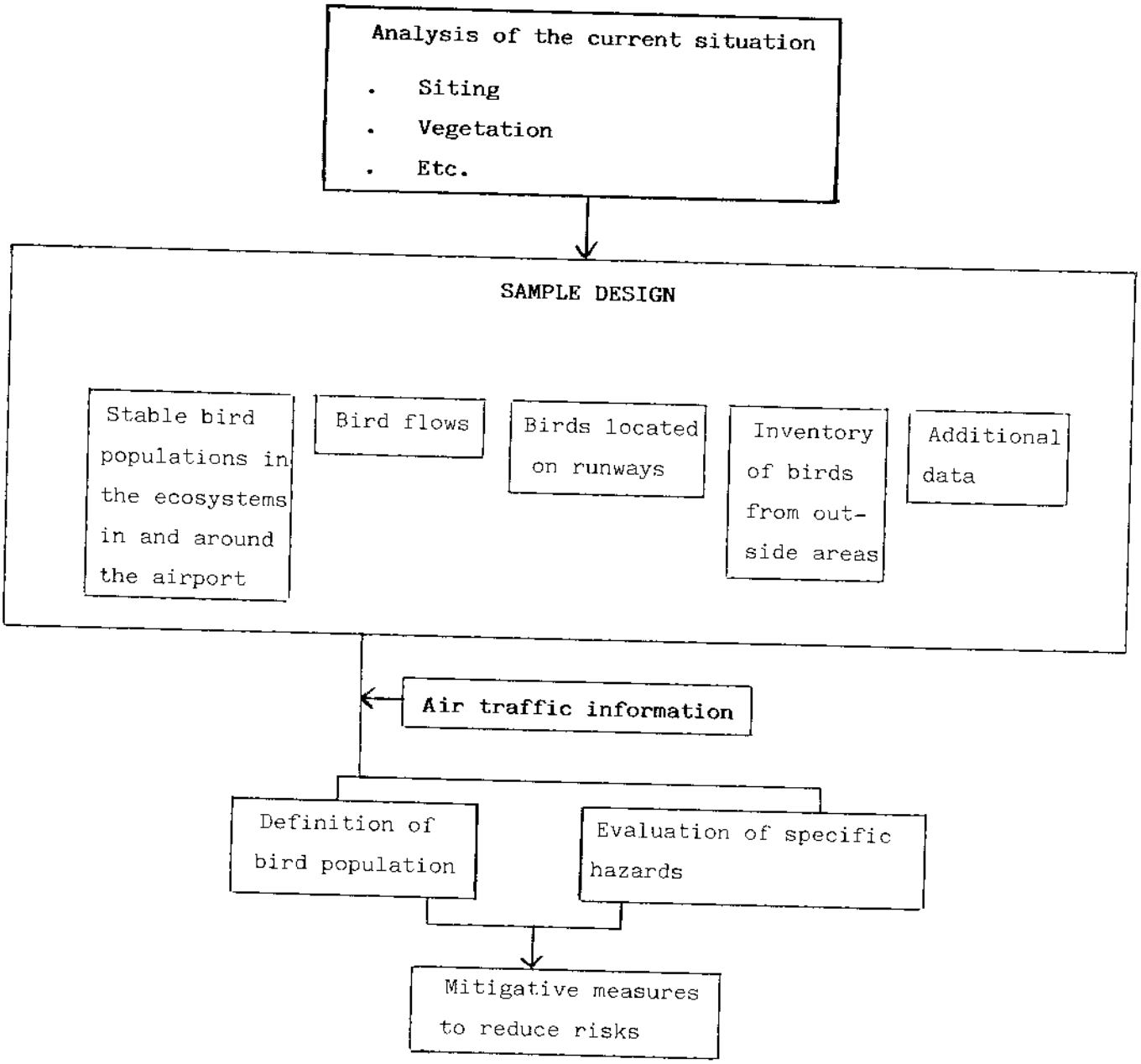


Fig. 1. General survey structure

port, dissuasive practices (different types of equipment, creation of alternative homing grounds, removal or remodeling of certain external sites, etc.).

The airport survey is currently in its fourth month of sampling, and accordingly, the data presented herein is as of yet incomplete and cannot offer definitive findings. The following highlights the methods employed for each type of sampling campaign, and offers a preliminary overview of some results.

3. STABLE BIRD POPULATIONS IN THE ECOSYSTEMS IN AND AROUND THE AIRPORT

As the heading itself suggests, this category includes populations stabilized in the ecosystems in and around the airport. As far as their potential menace of collision, these birds do not appear to present excessive risks, but that is not to say that they are harmless. Indeed, certain species could imperil air traffic due to their size and population densities, i.e. Vanellus vanellus or Pluvialis apricaria. In some airports, both have settled on airport premises and may form flocks of hundreds of individuals, cross runways at low altitudes and thereby create a potential air traffic hazard. Moreover, by recording the species living within a given vegetation structure, plans may be drawn up to introduce vegetation which will bear smaller sized birds, provided that no other safety factors are endangered.

The sampling method foreseen for this category of birds is that described by Järvinen and Väisänen (1977), which consists of a line transect where populations located within the boundaries of the main belt (50 meters - 25 meters on each side of the observer) are differentiated from those of the survey belt. Main belt observations allow for the determination of comparable specific densities and seasonal fluctuations. The drawback to this method is that the sample is always quite small, especially with low density populations. Therefore, many species, of potential interest in terms of size, are often overlooked. Survey belt sampling, on the other hand, provides additional information, since the sample size is logically larger. Due to differences in interspecific and temporary detectability, the results are not strictly comparable between species and months, but they do give a general idea of numbers of scarce bird species.

Line transects have been drawn up for each vegetation unit in the airport zone, attempting to assure that each

line transect follows the runway pattern as closely as possible. The length of each line transect will vary according to the amplitude of the ecosystem in question. Sampling along these line transects allows for calculation of the following values and indices:

- Sample number: numbered successively from 1 to n (number of samples actually taken). Its sole purpose is to enable identification of each sample on the table.
- Line transect: This is identified by an alphanumeric code (for example, M1, M2, etc.) for each type of vegetation and airport.
- Sample date/s.
- Time observation begins and ends: in solar time.
- Specific density: expressed in number of contacts with a given species/10 hectares in the main belt and number of contacts/km. in the survey belt.
- Total contacts: total number of contacts per sample in the main belt and survey belt.
- Total density: total number of contacts/10 hectares per sample and total number of contacts/km. inventoried.
- Diversity: this parameter provides a good estimate of the population "maturity" and is calculated using the data obtained in the main belt as per the following equation:

$$H' = -\sum P_i \lg_2 P_i$$

where P_i is the frequency of species i. This parameter depends directly on two components; the number of species present and their relative proportions. Maximum values are obtained for a given number of species when all are present in the same proportions. In bird communities, this value varies from 0 (none) to 4.

- Total biomass: this is the sum of specific biomasses multiplied by their densities within the main belt and is expressed in gr./hectare.
- Remarks: Miscellaneous data which could affect sampling results, such as climatology, passage of different species, etc.

To illustrate this methodology, three different informative tools are included: (i) the map of vegetation in and around the Palma de Mallorca airport with line transects (M1, M2, etc. - see fig. 2), (ii) a table summarizing the results obtained in the main belt for the month of February, and (iii) a graph of the evolution of biomass/10 hectares during the first months of the sampling campaign.

4. BIRD FLOWS

This heading encompasses all birds flying over the airport on a daily basis. At higher frequencies and lower flying heights, these flows constitute a potential risk factor.

Bird flows are estimated via direct observations from fixed points (code A1, A2, etc. - see fig. 2) for a period of 20 minutes. The total number of 20 minute observations will vary according to the specific point and its importance vis-a-vis the airport in terms of the number of birds overflying it. During this observation period, all birds larger or equal to a blackbird are recorded, provided that the flow is large enough (flocks of more than 3 individuals or continuous passage). Large species are always recorded. Data gathered on each flock includes the following:

- Observation point,
- Time observation begins and time when the flock is actually observed (solar time),
- Number of individuals of each species,
- Direction of entry and exit, broken down into 8 classes: N, NE, E, SE, S, SW, W and NW,
- Approximate flying height,
- Remarks: climatology, ethology, etc.

Table 2 demonstrates the results obtained during the month of February in the Santander Airport and figure 4 summarizes in graph form the major bird flows observed during that same period.

5. BIRDS LOCATED ON RUNWAYS AND SURROUNDING AREAS

In certain airports, this is perhaps the most problematic group, given its specific behaviour. This is due to three factors: first, the bird itself is generally equal to or larger in size than a Pluvialis apricaria (over 200 gr.), second, its behaviour vis-a-vis aircraft is dangerous, since it may take flight during airplane take-offs and landings, and finally, they normally locate themselves on the end of runways.

Sampling is carried out on two different days, with a minimum of three observations performed per day: one in the morning, one at mid-day and the other in the afternoon. The methodology consists of walking through the airport zone and recording the following information for each flock located within the area:

- Flock number,
- Observation time (solar time),
- Location according to a map drawn to 500 x 200 m. grid size,
- Area on the runway where the bird alights,
- Number of individuals and species in the flock.

To illustrate this category, a listing of birds identified at the Menorca Airport (table 3) has been included, along with a graph mapping their distribution (figure 5).

6. ROOSTING PLACES

Although the size of birds roosting within the airports surveyed is not excessive (most were starlings, approximately 80 gr.), when these birds form large flocks (several thousand) they can become a nuisance if they must cross runways to enter their roosting place.

All roosting areas are inventoried in their entirety once a month. The information recorded on each area is reflected in a table containing the following points:

- Date,
- Observation time (solar time),
- Species and number of individuals present,
- Direction of entry or exit, broken down into 8 classes: N, NE, E, SE, S, SW, W, and NW,
- Remarks: climatology, ethology, etc.

Table 4 shows the information collected on starling roosting grounds within the Barcelona Airport.

7. OUTSIDE AREAS

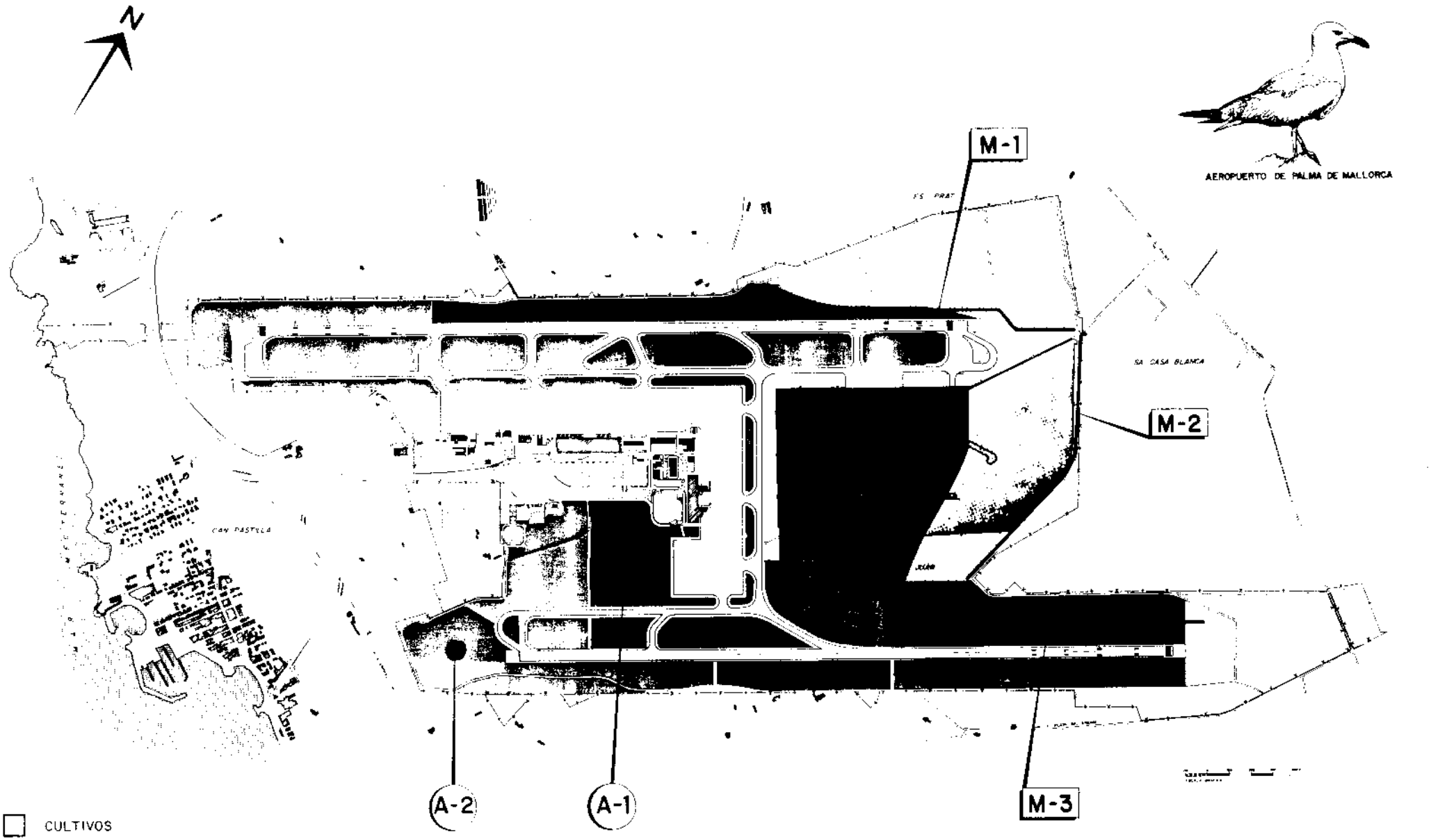
It is useful to study these areas since the direction of many bird flows can be conditioned by the presence or absence of a certain focus of attraction such as, rubbish dumps, dams, etc. A monthly inventory of the following information is compiled:

- Observation date,
- Observation time (solar time),
- Estimated coverage of the sample,
- Species and numbers observed.

Figure 6 lists a number of external sites around the Tenerife-Sur Airport. These include a dam (E1), a landfill (E2) and fish drying beds (E3). The presence of these zones can help to explain the bulk of all Herring and Lesser black-backed gull (Larus argentatus and L. fuscus) flows around this airport.

8. ADDITIONAL INFORMATION

Apart from these systematic observations, a series of additional elements are studied, i.e., the airport management plans, the identification of dead birds found around or on the airport grounds, records and sightings of collisions, etc. This information is of vital interest for the comparison and interpretation of data collected for the purpose of this survey.



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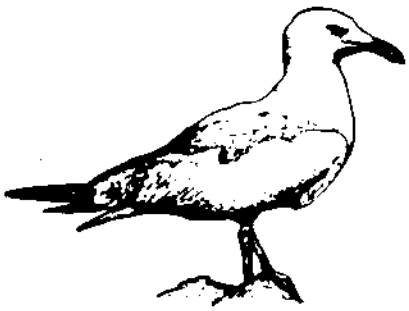
VEGETACION Y UBICACION DE
LOS ITINERARIOS Y PUNTOS DE MUESTREO. FIG.- 2



AEROPUERTO DE PALMA DE MALLORCA

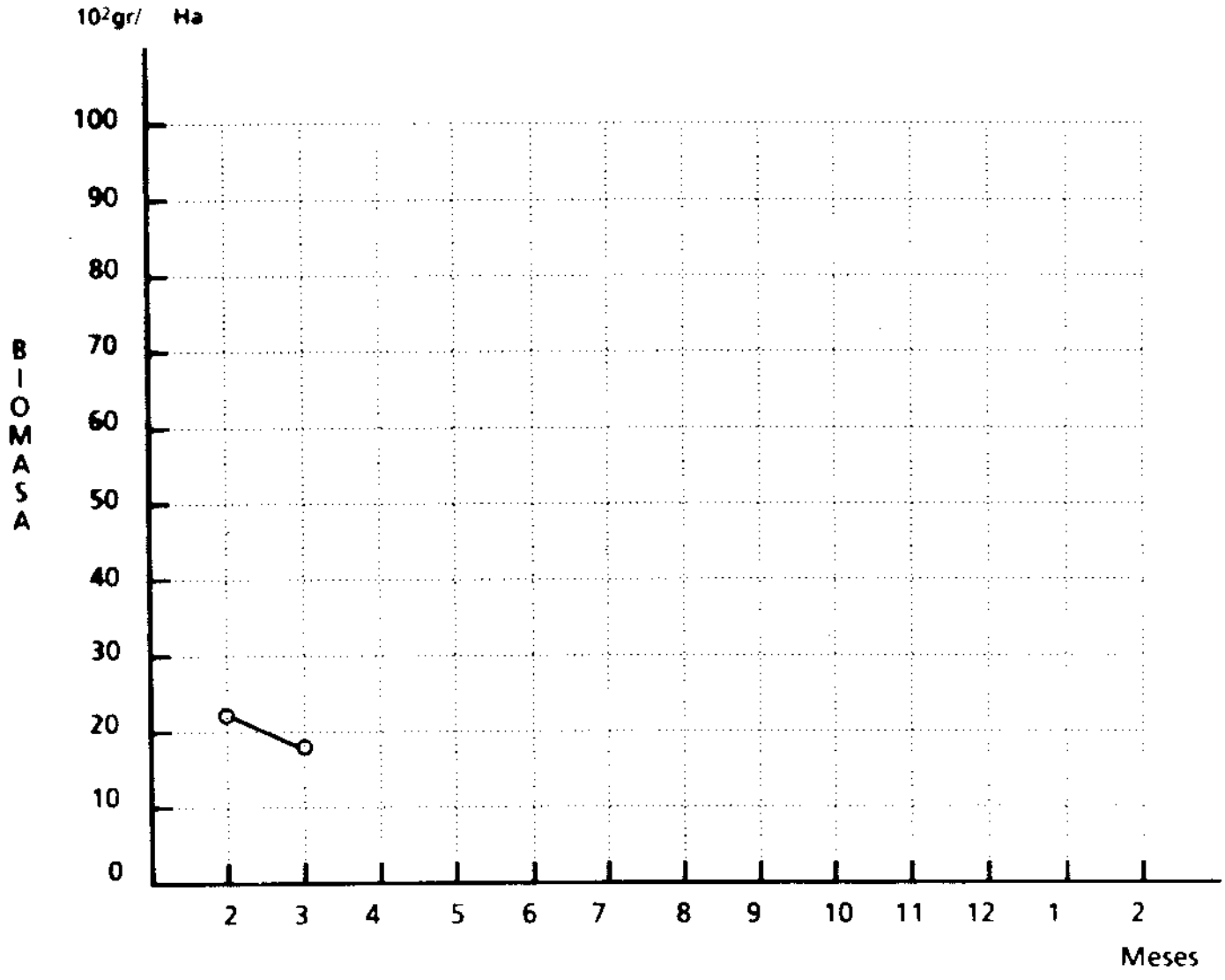
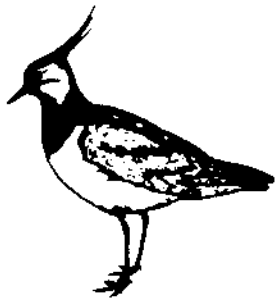


Fig 3

MES : FEBRERO

FIG. 4 FLUJOS PREFERENTES



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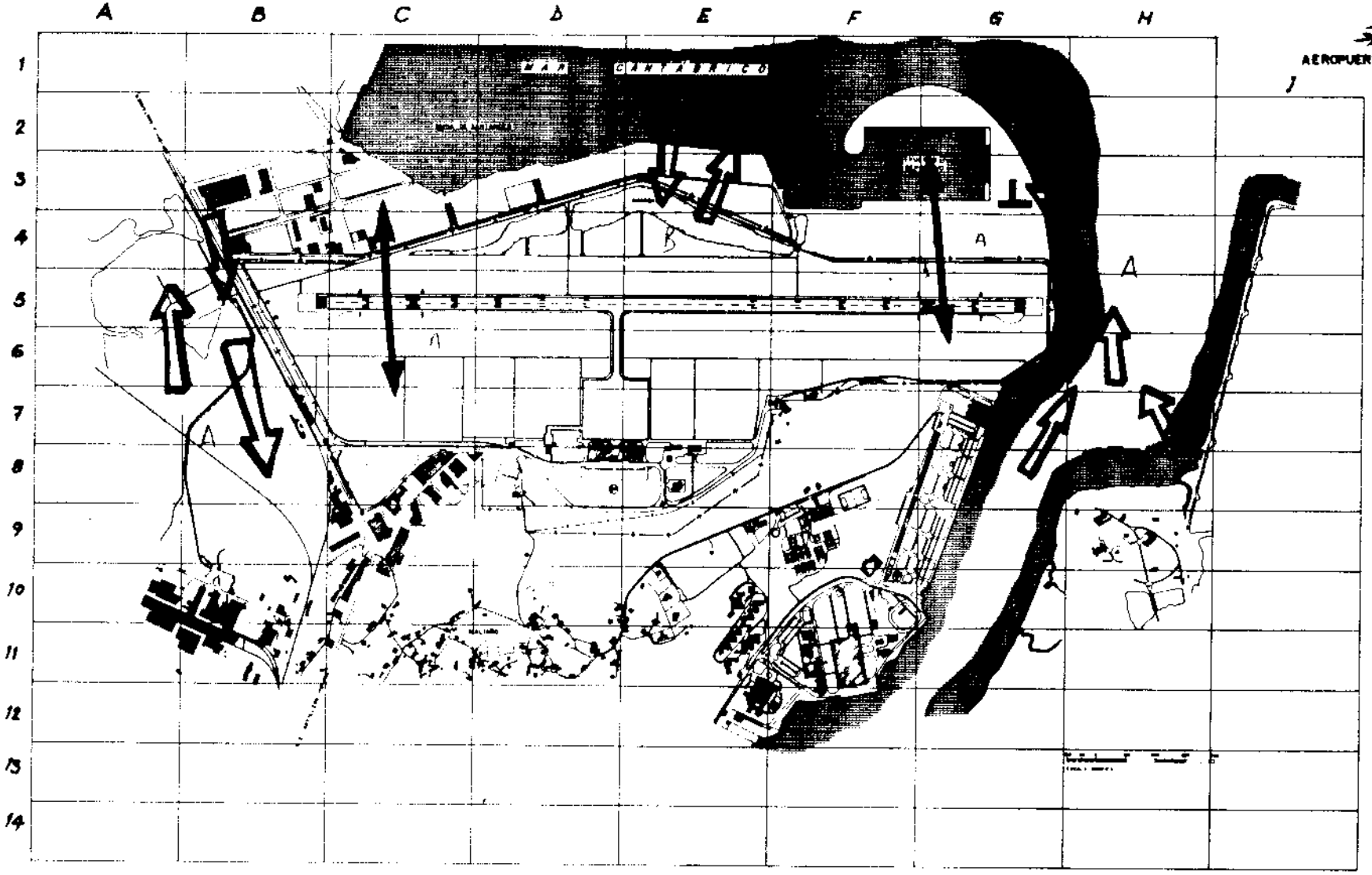
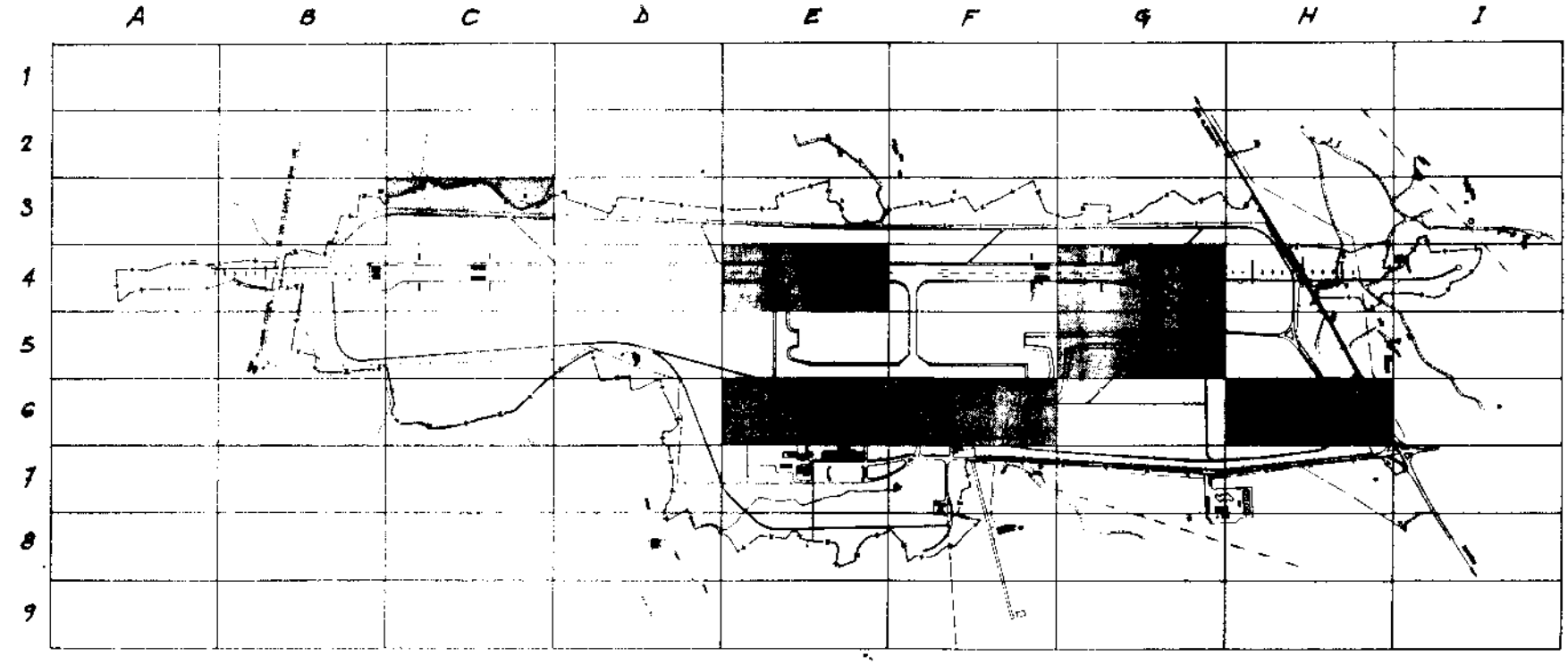


MES: FEBRERO

FIG. 5 LOCALIZACION DE BANDOS POSADOS

AEROPUERTO DE MENORCA



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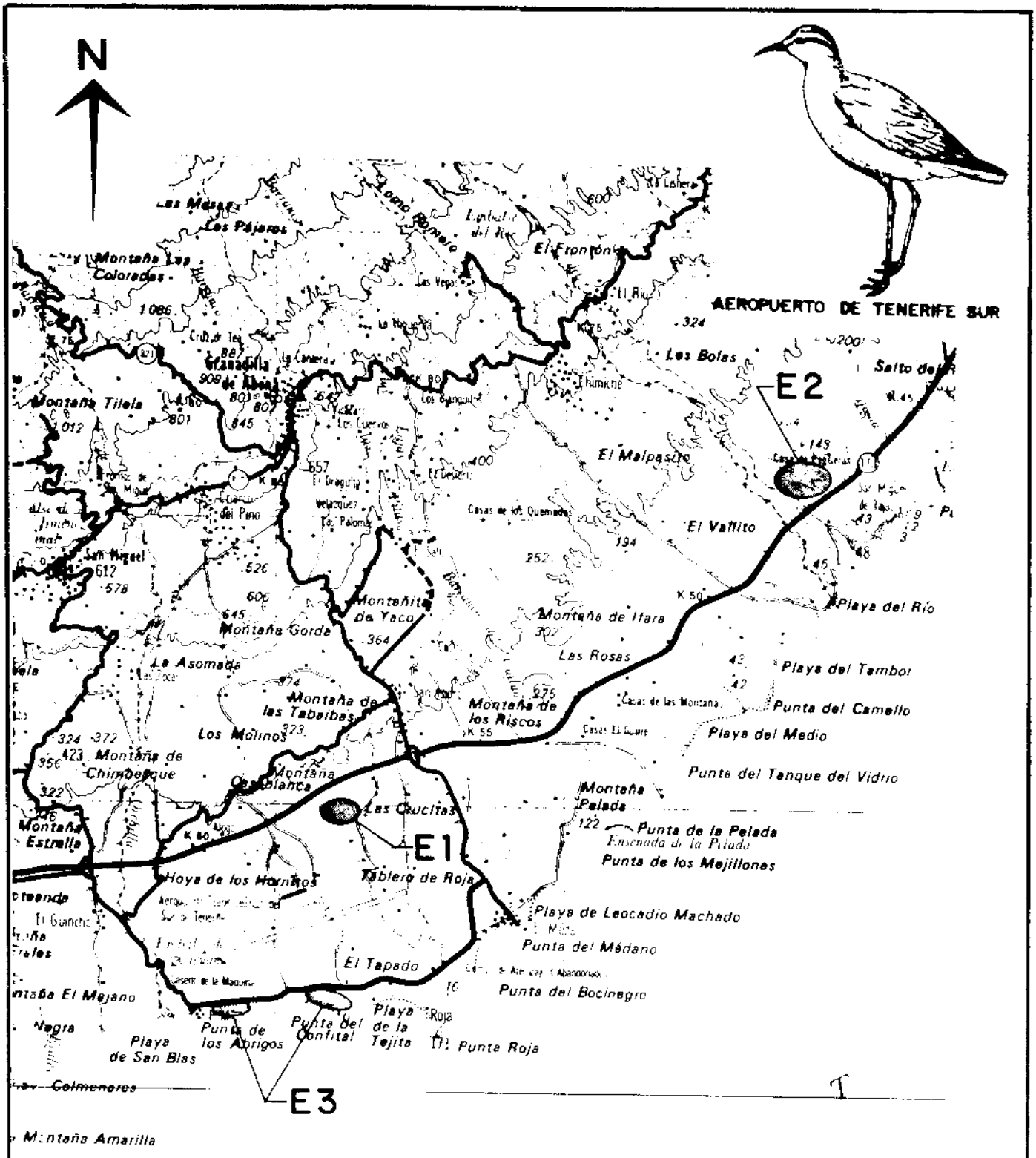

FIG. **6** LOCALIZACION DE LAS AREAS EXTERNAS

TABLE 1

AEROPUERTO DE:PALMA DE MALLORCA FECHA(Año,mes):8602
DATOS DENTRO DE BANDA.RESULTADO DE LOS TAXIADOS(Contactos/10Ha.)

NUMERO DEL MUESTREO.	01	02	03	04	05	06
CODIGO DEL ITINERARIO	M1	M2	M3	M1	M2	M3
FECHA (Ano,mes,dia)	860208	860208	860208	860211	860211	860211
HORA COMIENZO MUESTREO(GMT)	0727	0800	0903	0740	0815	0851
HORA FINAL MUESTREO(GMT). . .	0800	0845	0940	0815	0844	0917

COD.	ESPECIE	01	02	03	04	05	06
110	CERNICALO VULGAR	—	—	—	—	—	—
114	PERDIZ ROJA	—	—	—	—	—	2.00
136	AVEFRIA	—	—	2.00	—	2.80	—
138	CHORLITO DORADO COMUN	—	—	—	—	—	—
150	ARCHIBEBE COMUN	—	—	—	—	—	—
159	AGACHADIZA COMUN	—	—	28.00	—	—	8.00
175	ALCARAVAN	—	—	36.00	44.44	—	188.00
185	GAVIOTA ARGENTEA	—	—	—	—	—	—
243	ABUBILLA	1.34	1.40	—	1.34	2.80	—
257	ALONDRA COMUN	22.89	14.04	32.00	39.05	—	52.00
271	MOSQUITERO COMUN	—	—	—	2.69	—	—
275	BUITRON	8.08	5.61	—	8.08	2.80	6.00
280	CURRUCA CABECINEGRA	2.69	9.83	10.00	—	4.21	8.00
301	PETIRROJO	—	—	—	—	1.40	2.00
303	COLIRROJO TIZON	—	1.40	—	—	—	—
305	TARABILLA COMUN	14.81	16.85	2.00	17.50	15.44	14.00
315	ZORZAL COMUN	—	35.11	24.00	1.34	25.28	16.00
318	MIRLO COMUN	—	—	—	—	1.40	2.00
323	BISBITA COMUN	9.42	25.28	2.00	4.04	1.40	—
330	LAVANDERA BLANCA	—	—	—	—	1.40	2.00
350	TRIGUERO	6.73	11.23	—	4.04	—	—
361	JILGUERO	—	—	—	—	—	—
363	PARDILLO COMUN	6.73	—	12.00	4.04	5.61	2.00
367	VERDECILLO	—	—	—	—	—	—
375	GORRION COMUN	1.34	15.44	—	—	28.08	—
998	COLUMBA Sp.	—	—	—	—	—	—

TOTAL CONTACTOS D.B	55.00	97.00	74.00	94.00	66.00	151.00
DENSIDAD TOTAL(Contactos/10Ha)	74.07	136.23	148.00	126.59	92.69	302.00
DIVERSIDAD	2.72	2.91	2.66	2.43	2.73	1.92
BIOMASA TOTAL (Gramos/Ha.)	188.48	493.23	2160.7	2118.5	402.03	8523.7

OBSERVACIONES
MUESTREO 1 :BUENA TEMPERATURA.NUBES Y CLAROS.VIENTO LIGERO
MUESTREO 2 :BUENA TEMPERATURA.NUBES Y CLAROS.VIENTO LIGERO.LLOVIZNA.
MUESTREO 3 :BUENA TEMPERATURA.NUBES Y CLAROS.SIN VIENTO
MUESTREO 4 :DESPEJADO.SOLEADO.SIN VIENTO.HELADA NOCTURNA
MUESTREO 5 :DESPEJADO.SOLEADO.SIN VIENTO.HELADA NOCTURNA
MUESTREO 6 :DESPEJADO.SOLEADO.SIN VIENTO.HELADA NOCTURNA

Tabla 1
Resultados de los itinerarios en la banda principal.

TABLA 1

OBSERVACIONES DEL FLUJO DE AVES

PUNTO	FECHA	HORAS (Solares) Comienzo	Observación	Nº BANDO	ESPECIE	Nº INDIVIDUOS	DIRECCION Entrada	Salida	OBSERVACIONES	ALTURA
A_1	4-2-86	11.50	11.51	1	Gaviota argéntea	3	S	N	Ciclean	
A_1	4-2-86	"	12.03	2	Avefría	95	-	W	Salen a prados del W	
A_1	6-2-86	11.03	11.05	3	Gaviota reidora	15	N	S	-	
A_1	"	"	11.08	4	Gaviota argéntea	3	N	S	-	
A_1	"	"	11.11	5	Gaviota reidora	22	NW	NW	Ciclean y se recí-cian por el mismo lugar	
A_1	"	"	11.13	6	"	45	NE	S	Ciclean sobre carretera	
A_1	"	"	11.19	7	"	7	N	S	-	
A_3	"	9.50	9.55	8	Cormorán grande	2	NE	N	Llevan y salen al poco rato con pe-scado en pata	
A_1	7-2-86	12.50	13.03	9	Gaviota argéntea/ sombría	4	S	NE	-	
A_1	"	"	13.02	10	Paloma brava	4	S	N	-	
A_2	"	11.06	11.08	11	Gaviota argéntea/ sombría	3	N	S	-	
A_2	"	"	11.11	12	Gaviota argéntea	9	SW	NE	Pasan bordeando por la ría	
A_2	"	"	11.13	13	Gaviota argéntea/ sombría	14	SE	N	Giran y ciclean	
A_2	"	"	11.14	14	"	11	S	N	Ciclean sobre la cabecera	
A_2	"	"	11.14	15	Gaviota argéntea	4	S	N	Giran	
A_2	"	"	11.15	16	Gaviota argéntea/ sombría	8	SW	N	Vuelos continuos	

TABLA 3

OBSERVACIONES DE AVES POSADAS EN PISTA Y AREAS CIRCUNDANTES

BANDO	FECHA	Horas de Observación (solar)	RETICULA	ZONA DE LA PISTA	ESPECIE	INDIVIDUOS
B_1	29-01-86	6.00	E6		Gaviota argéntea	3
B_2	29-01-86	6.00	E6-F6	Parking de aviones	Gaviota argéntea	2
B_3	29-01-86	6.00	G5	Rodadura norte	" "	2
B_4	29-01-86	8.00	E6-F6	Parking de aviones	" "	2
B_5	29-01-86	8.00	G5	Rodadura norte	" "	3
B_6	29-01-86	8.00	G3	Explanada TLS	" "	2
B_7	29-01-86	8.00	H6	-	" "	11
B_8	29-01-86	8.00	G4	Pista de despegue cabecera	" "	2
B_9	29-01-86	10.00	G4	Pista de despegue cabecera	" "	1
B_{10}	29-01-86	10.00	F6	Parking de avionetas	" "	1
B_{11}	29-01-86	12.00	H6	-	" "	14
B_{12}	29-01-86	12.00	G4	Pista de despegue cabecera	Chorlito dorado	1
B_{12}	29-01-86	14.30	F6-F6	Parking de aviones	Gaviota argéntea	1
B_{13}	29-01-86	14.30	G3	Explanada TLS	" "	2
B_{14}	30-01-86	6.00	E6-F6	Parking de aviones	" "	2
B_{15}	30-01-86	8.30	E6-F6	Parking de aviones	" "	2
B_{16}	30-01-86	8.30	F5	Parking avionetas	" "	1
B_{17}	30-01-86	10.30	G3	Explanada TLS	" "	3
B_{18}	30-01-86	13.30	F6-F6	Parking aviones	" "	2
B_{19}	31-01-86	9.30	G5	Rodadura norte	" "	1
B_{20}	31-01-86	9.30	G3	Explanada TLS	" "	2
B_{21}	31-01-86	15.00	G3	Explanada TLS	" "	1
B_{22}	01-02-86	8.30	G5	Rodadura norte	" "	1
B_{23}	01-02-86	8.30	F4	Pista de despegue trans medio	" "	4
B_{24}	01-02-86	12.00	F6-F6	Parking aviones	" "	1
B_{25}	01-02-86	12.00	F6	Parking avionetas	" "	2

TABLA 4 : DORMIDEROS

PUNTO	FECHA	HORARIO OBSERVACION (SOLAR)
D-1	30/2/86	15,30 - 17,10

Hora de observación	Especie	Nº individuos	Dirección entrada
16,18	Estornino pinto	7	SW
16,19	"	2	NW
16,19	"	8	NE
16,20	"	3	NE
16,21	"	10	NE
16,21	"	60	W
16,22	"	53	W
16,24	"	1	W
16,25	"	20	W
16,25	"	10	NW
16,25	"	11	W
16,25	"	2	NW
16,31	"	260	W
16,32	"	1	W
16,34	"	2000	W
16,34	"	500	W
16,35	"	120	W
16,36	"	5	E
16,38	"	25	W
16,38	"	15	W
16,42	"	1	W
16,43	"	10	W
16,44	"	10	W
16,48	"	40	SE
16,51	"	15	SE
16,53	"	11	W
16,53	Lavandera blanca	25	NE
16,55	Estornino pinto	6	S

TABLE 4

PUNTO	FECHA	HORARIO OBSERVACION (SOLAR)
D-1	30/2/86	15,30 - 17,10

Hora de observación	Especie	Nº individuos	Dirección entrada
16.55	Estornino pinto	10	W
16,57	"	60	SW
16,57	"	30	NE