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THE USE OF RECOVERIES OF RINGED BIRDS IN ORDER TO ASSESS POTENTIAL BIRD HAZARD IN AERODROMES

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ABSTRACT

In order to give to each aerodrome a rough risk value regarding the potential bird hazard, recoveries of ringed birds (data from the Italian Ringing Scheme) have been used. Six Italian international airports were selected as example sites (Milan, Venice, Genoa, Rome, Cagliari and Palermo) and recoveries around each site were analyzed. For each bird species a risk value was calculated considering weight, strike statistics, habitat and behaviour. Examples of monthly and seasonal risk scales are shown for selected sites. This kind of analysis can be a usefull tool in order to give important information for bird strike hazard prevention.

(Keywords: Recoveries of ringed birds, Bird risk value, Aerodrome bird hazard)

1. INTRODUCTION

Background knowledge and monitoring of the avian community and migratory routes in aerodromes and their surroundings is extremely important for bird strike prevention. General direct methods for investigating the above are well established and standardized (Bibby et al. 1992, Koskimies & Vaisanen 1991) and different methods, specifically calibrated in airports, can be used as well (i.e. Montemaggiori 1992). Anyhow such methods usually require specialized local technical staff and long periods for gathering complete data.

This paper suggests an indirect method for obtaining background information on birds around airports using data collected by National Ringing Schemes.

Most countries have National Ringing Schemes. Scientific bird ringing is a research method based on the individual marking of birds. Any record of a ringed bird, either through recapture and subsequent release, or on the occasion of its final recovery as a dead bird, is collected by the National Ringing Scheme and tells the ornithologists a lot about bird life and movements. In many cases the data collected in each country consists of hundreds of thousands of records. The European Union for Bird Ringing Data Bank, for example, contains 1.225.000 recoveries from all European Ringing Centres (Jenni et al. 1994).

The Italian Ringing Scheme (Istituto Nazionale per la Fauna Selvatica), has its own computer data base with more than 27.000 records stored in a standard format.

Using this large amount of data the Bird Strike Committee Italy, in collaboration with Istituto Nazionale per la Fauna Selvatica and with Azienda Autonoma di Assistenza al Volo, started to work on the production of airport maps containing information about seasonal presence of birds and their potential hazard for civil aviation. This paper gives the first results obtained.

2. METHODS

Six international airports distributed throughout Italy were selected as example sites: Milan Linate, Venice Tessera, Genoa Sestri, Rome Fiumicino, Cagliari Elmas and Palermo Punta Raisi (Fig. 1). For each airport a surrounding area of 160 square Km was selected, in order to cover most of the flying procedures during take off and landing of the aircrafts.

Each area has been subsequently divided into 400 smaller sub-areas (2 x 2 Km) and the recoveries of ringed birds for each sub-area were selected. Only recoveries of birds ringed outside Italy or birds found at least 2 km away from the original ringing site were used during the analysis. All data from the nineteen thirties till present day was taken into account.

A risk value scale from 0 to 10 has been calculated for each recovered bird species to assess the potential of serious bird strikes at Italian airports. Specific risk values were calculated in the following manner:

for each species a value of between 0.0 – 3.1 was given based on the percentage of strikes (the species with the most strikes was given a value of 3.1 and the other species given a proportional value). Strike statistics were obtained from Thorpe (1990).

For each species a value of between 0.0 – 2.5 was given for bird size (the largest species was given a value of 2.5 and the other species given a proportional value). Medium weight values were obtained from Perrins (1987).

Each species were given a points value of between 0.0 – 2.0 for bird behaviour characteristics (a value of 2.0 was given to the species whose behaviour, especially

flock behaviour and migrating habits, presented the greatest risk to aircraft and other species were given a proportional value).
For each species a value of between 0.0 – 2.4 was given for airfield affinity. Again the species that had the highest airport affinity was given a value of 2.4 and other species were given proportional values. Airfield affinity refers to breeding, wintering, migrating and feeding habitat.
These four totals were then added to give a *species risk value* of between 0 – 10.
The species risk values were then multiplied by the number of individual birds recovered in the sub–areas, giving a *species value per sub–area*. All the species values per sub–area were then added to give an overall *sub–area value*. Finally by adding all the sub–area values we got an overall *airport total risk value*.
We also plotted simple maps showing sub–area values.
By analysing the recoveries dates we also calculated the monthly risk values for each study site, and seasonal variation at Venice Airport.

3. RESULTS

A total of 1634 recoveries of ringed birds were analysed, covering 133 different species (76 non Passerines and 57 Passerines). According to the calculated species risk values most of recovered species (92.5 %) show low risk values, between 0 and 3 (Tabs. 1–6), and only 10 species seem to be seriously hazardous: *Phalacrocorax carbo*, *Ciconia ciconia*, *Cygnus olor*, *Anas penelope*, *Hirundo rustica* and *Corvus corone cornix* with species risk value of 4; *Phoenicopterus ruber* of 5; *Vanellus vanellus* of 6; *Larus ridibundus* of 7 and *Larus cachinnans* of 8.
At Milan Linate Airport 260 recoveries of 57 species are recorded (Tab. 1), given an airport total risk value of 641. At Venice Tessera Airport (Tab. 2) 781 recoveries (73 species), given an airport total risk value of 2089. At Genoa Sestri Airport (Tab. 3) 308 recoveries (69 species), given an airport total risk value of 641. At Rome Fiumicino Airport (Tab. 4) 93 recoveries (40 species), given an airport total risk value of 248. At Cagliari Elmas Airport (Tab. 5) 183 recoveries (38 species), given an airport total risk value of 506. At Palermo Punta Raisi Airport (Tab. 6) 9 recoveries (7 species), given an airport total risk value of 25.
Distributions of recoveries around each site, within an area of 160 square Km, are shown in Figs. 2–7. An example of the situation in the same site during different seasons (spring, summer, autumn and winter) is presented for Venice Tessera Airport (Figs. 8–11), and Tab. 7 shows the number of records per season.
Finally, risk value per month in selected sites, calculated as percentage within each airport, is shown in Fig. 12.

4. DISCUSSION

According to the calculated species risk value scale Lapwing, Black–headed Gull and Herring Gull are the most dangerous recovered species as regards the potential hazard of strike with aircrafts. A similar result was obtained from a more complete study, which used a different methodology, carried out at Rome Fiumicino Airport (Montemaggiori 1992).
From the selected sites Venice Tessera Airport was the most hazardous, with a total airport risk value much higher then the others (due also to higher number of recoveries).

Seasonal distribution of recoveries also shows a much higher concentration of birds during the autumn migration in Venice (Figs. 9–10, Tab. 7), with consequent higher risk value (Fig. 12).
Finally the late autumn and winter months (from October to March) are the most potentially hazardous in all the selected sites (Fig. 12), while the summer period generally shows very low risk values.
In order to better explain such results, some points must be discussed.
First of all, the different number of species recovered among selected sites probably reflects the environmental differences existing between them. Venice Airport, for example, with 73 species recorded, is located in a very complex habitat, including large wetlands – very attractive for the birds – and a notched coast line. Palermo, on the contrary, with only 7 species recovered, is located in a much more homogeneous area, and it is mainly surrounded by sea. Moreover some areas, like Venice and Genoa, are located along the most important bird migratory routes, specially during autumn migration (Spina et al. 1992), and represent important breeding and wintering sites for the birds.
Secondly, the difference in number of recoveries among sites could be biased by some other factors, for example:
many recoveries come from hunting activity. A higher hunting pressure on an area presumably results in a higher number of recoveries. In Italy more then 1.500.000 hunters are active throughout the country, but obviously there are areas where hunters are more active. Also the scientific Ringing Stations, which contribute with controls of ringed birds to the final number of recoveries, are not uniformely distributed in Italy – there are very few in the South, for example.
Finally, the hunting season, from September–October to February–March, must be also taken into account in order to better understand differences between monthly risk values.

5. CONCLUSIONS

The data of recovered ringed birds stored in National Ringing Schemes Data Banks are a very good qualitative and quantitative source of information in order to achieve background knowledge about birds presence around airports. The results obtained from their analysis give an interesting picture of the general bird situation around each selected site.
Despite the presence of some data biases, as mentioned previously, the advantages of this type of analysis seem to overcome the disadvantages. Data collected and stored in the same standard manner already exist throughout Europe, so the same analysis methods can easily be exported in each country.
The use of recoveries dates and locations seems to be a usefull tool to issue specifc local and temporal warnings (BIRDTAMS) for pilots and local airport staff in order to prevent serious bird strikes.
The results presented in this paper are preliminary, but Bird Strike Committee Italy wishes to continue this study and to issue local maps for all Italian airports, trying to apply the obtained results in order to alert all interested staff.

6. REFERENCES

BIBBY, C.J., HILL, D.A. & BURGESS, N.D. 1992. Bird census techniques. *Academic Press*, London: 257 pp.

JENNI, L., BERTHOLD, P., PEACH, W. & SPINA, F. (Eds.). 1994. Bird ringing in science and environmental management . *EURING*, Compositori, Bologna: 25 pp.

KOSKIMIES, P. & VAISANEN, R.A. 1991. Monitoring bird populations. *Zoological Museum, Finnish Museum of Natural History*, University of Helsinki: 144 pp.

MONTEMAGGIORI, A. 1992. Bird community at Rome international Airport of Fiumicino. A study for better facing bird hazard. *BSCE 21*. Jerusalem 23th 27th March 1992. Working papers 32: 303–314.

PERRINS, C. 1987. Uccelli d'Italia e d'Europa. *De Agostini*, Novara: 320 pp.

SPINA, F., BENDINI, L. & MONTEMAGGIORI, A. 1992. Distribuzione delle ricatture degli uccelli inanellati all'estero ai fini della definizione delle rotte di migrazione. Elaborazione Sez. II *INFS*: 1–4 ed Allegati 1–5: 149 pp.

THORPE, J. 1990. Analysis of bird strikes reported by European Airlines 1981–1985. *BSCE 20*. Helsinki 21th–25th May 1990. Working papers 28: 263–301.

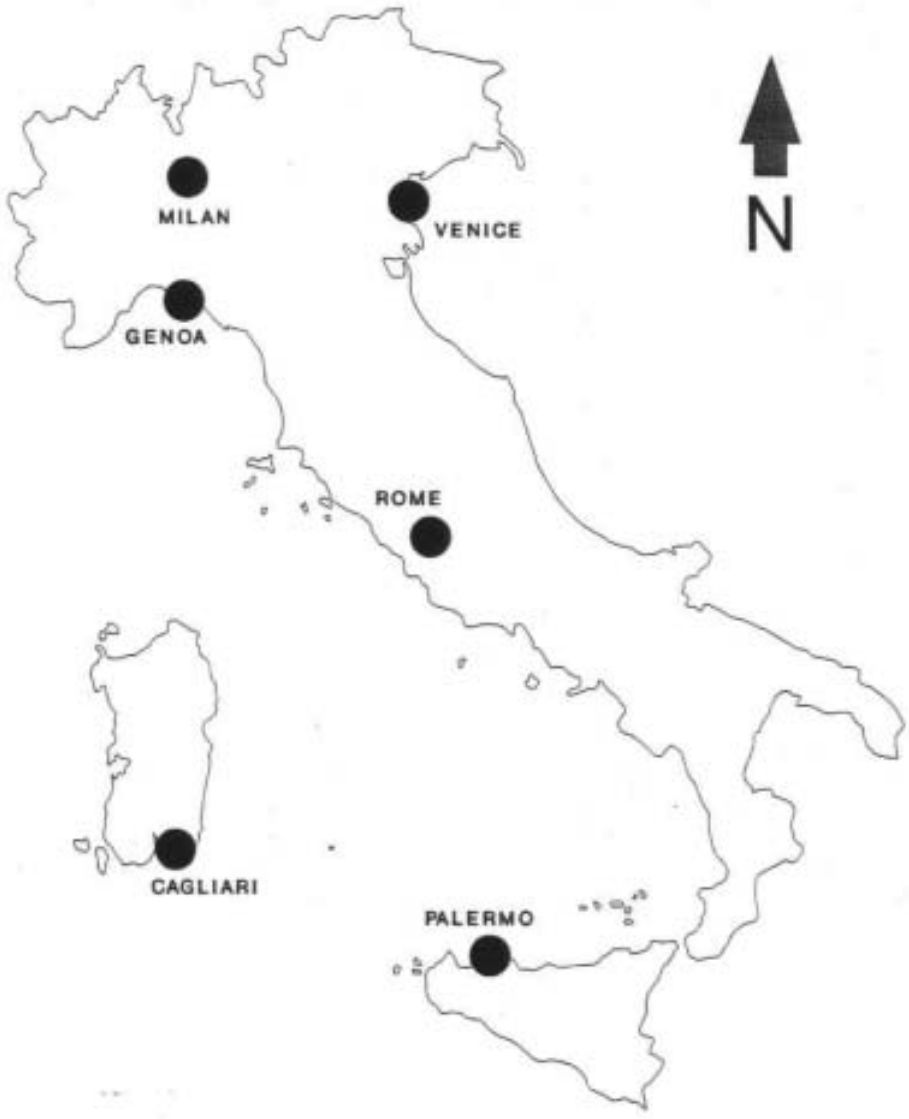


FIGURE 1. Location of the six selected airports.

TABLE 1. Risk value and no. of recoveries per species in an area of 160 Km^2 around Milan.

Species	Risk value	Number of recoveries	Species	Risk value	Number of recoveries
Phalacrocorax carbo	4	2	Anthus pratensis	2	6
Ixobrychus minutus	0	1	Anthus spinoletta	1	3
Nycticorax nycticorax	2	5	Motacilla flava	3	1
Ardea cinerea	3	3	Cinclus cinclus	0	1
Ardea purpurea	1	1	Prunella modularis	0	1
Anas crecca	3	45	Erithacus rubecula	0	6
Anas platyrhynchos	3	4	Oenanthe oenanthe	1	1
Anas acuta	3	2	Turdus merula	2	8
Anas querquedula	3	16	Turdus pilaris	1	7
Anas clypeata	3	4	Turdus philomelos	1	12
Aythya ferina	3	1	Turdus iliacus	1	9
Aythya fuligula	3	1	Hippolais icterina	0	1
Pandion haliaetus	2	2	Sylvia communis	0	1
Falco naumanni	3	1	Sylvia borin	0	1
Falco subbuteo	1	1	Sylvia atricapilla	0	1
Gallinula chloropus	1	1	Phylloscopus collibita	0	2
Fulica atra	3	1	Regulus regulus	0	2
Vanellus vanellus	6	5	Ficedula hypoleuca	0	5
Calidris minuta	2	1	Parus caeruleus	0	1
Philomachus pugnax	3	4	Sturnus vulgaris	3	32
Gallinago gallinago	1	5	Passer montanus	2	4
Tringa totanus	1	2	Fringilla coelebs	1	4
Tringa nebularia	1	1	Fringilla montifringilla	1	2
Tringa glareola	2	3	Carduelis chloris	3	1
Actitis hypoleucos	1	1	Carduelis spinus	1	3
Larus ridibundus	7	18	Carduelis cannabina	2	1
Sterna caspia	1	1	C. coccothraustes	0	1
Alauda arvensis	3	2	Emberiza schoeniclus	1	7
Anthus trivialis	1	2			

TABLE 2. Risk value and no. of recoveries per species in an area of 160 Km^2 around Venice.

Species	Risk value	Number of recoveries	Species	Risk value	Number of recoveries
Podiceps cristatus	1	1	Tringa nebularia	1	1
Phalacrocorax carbo	4	7	Tringa glareola	2	5
Ixobrychus minutus	0	1	Actitis hypoleucos	1	1
Ardeola ralloides	1	1	Larus melanocephalus	3	9
Egretta alba	2	2	Larus ridibundus	7	88
Ardea cinerea	3	6	Larus canus	1	1
Ardea purpurea	1	3	Larus cachinnans	8	10
Ciconia ciconia	4	1	Sterna caspia	1	3
Platalea leucorodia	2	1	Sterna albifrons	2	131
Cygnus olor	4	1	Chlidonias nigra	2	1
Anas penelope	4	5	Alcedo atthis	0	1
Anas strepera	3	3	Upupa epops	1	1
Anas crecca	3	116	Riparia riparia	3	4
Anas platyrhynchos	3	23	Anthus spinoletta	1	1
Anas acuta	3	12	Motacilla flava	3	1
Anas querquedula	3	17	Motacilla alba	3	1
Anas clypeata	3	2	Prunella modularis	0	1
Aythya ferina	3	4	Erithacus rubecula	0	6
Aythya fuligula	3	4	Turdus merula	2	5
Circus aeruginosus	2	3	Turdus pilaris	1	10
Falco tinnunculus	3	2	Turdus philomelos	1	7
Porzana porzana	0	1	Turdus iliacus	1	1
Gallinula chloropus	1	8	Cettia cetti	1	1
Fulica atra	3	20	Acroc. schoenobaenus	0	16
Himantopus himantopus	2	1	Acrocephalus scirpaceus	0	4
Charadrius hiaticula	2	4	Acroc. arundinaceus	0	3
Charadrius alexandrinus	1	25	Sylvia curruca	0	1
Calidris minuta	2	5	Sylvia atricapilla	0	2
Calidris temminckii	1	1	Ficedula albicollis	0	1
Calidris ferruginea	1	2	Panurus biarmicus	0	3
Calidris alpina	2	61	Remiz pendulinus	0	14
Philomachus pugnax	3	6	Sturnus vulgaris	3	19
Gallinago gallinago	1	6	Passer italiae	2	1
Limosa limosa	2	2	Fringilla montifringilla	1	2
Numenius phaeopus	3	1	Carduelis spinus	1	4
Tringa erythropus	1	1	Emberiza schoeniclus	1	23
Tringa totanus	1	39			

TABLE 3. Risk value and no. of recoveries per species in an area of 160 Km^2 around Genoa.

Species	Risk value	Number of recoveries	Species	Risk value	Number of recoveries
Phalacrocorax carbo	4	4	Hirundo rustica	4	3
Nycticorax nycticorax	2	4	Anthus pratensis	2	1
Egretta garzetta	2	2	Bombycilla garrulus	1	1
Ardea purpurea	1	4	Prunella modularis	0	1
Ciconia ciconia	4	2	Erithacus rubecula	0	3
Anas crecca	3	1	Phoenicurus ochruros	0	1
Anas acuta	3	1	Phoenicurus phoenicurus	0	1
Anas querquedula	3	3	Turdus merula	2	13
Anas clypeata	3	1	Turdus pilaris	1	4
Bucephala clangula	1	1	Turdus philomelos	1	12
Buteo buteo	2	1	Turdus iliacus	1	3
Falco tinnunculus	3	7	Acroc. melanopogon	0	1
Falco subbuteo	1	2	Acroc. schoenobaenus	0	1
Alectoris rufa	2	1	Sylvia communis	0	1
Coturnix coturnix	2	1	Sylvia borin	0	1
Charadrius alexandrinus	1	1	Sylvia atricapilla	0	9
Vanellus vanellus	6	3	Ficedula hypoleuca	0	1
Calidris minuta	2	1	Parus ater	0	2
Scolopax rusticola	2	1	Parus major	0	5
Tringa totanus	1	2	Sturnus vulgaris	3	20
Tringa glareola	2	2	Passer italiae	2	4
Actitis hypoleucos	1	2	Passer montanus	2	1
Larus ridibundus	7	19	Fringilla coelebs	1	26
Larus fuscus	1	3	Fringilla montifringilla	1	8
Larus cachinnans	8	4	Serinus serinus	2	9
Sterna hirundo	2	1	Carduelis chloris	3	5
Columba palumbus	3	2	Carduelis carduelis	3	26
Streptopelia turtur	3	1	Carduelis spinus	1	30
Asio flammeus	1	1	Carduelis cannabina	2	10
Caprimulgus europaeus	2	1	C. coccothraustes	0	10
Jynx torquilla	0	3	Emberiza citrinella	0	2
Dendrocopos major	0	1	Emberiza cia	1	1
Calandrella brachydactyla	2	1	Emberiza hortulana	1	2
Alauda arvensis	3	1	Emberiza schoeniclus	1	4
Riparia riparia	3	1			

TABLE 4. Risk value and no. of recoveries per species in an area of 160 Km^2 around Rome.

Species	Risk value	Number of recoveries	Species	Risk value	Number of recoveries
Sula bassana	2	2	Tringa glareola	2	2
Phalacrocorax carbo	4	4	Larus ridibundus	7	5
Ardea cinerea	3	3	Larus cachinnans	8	1
Ciconia ciconia	4	1	Sterna caspia	1	4
Anas crecca	3	1	Hirundo rustica	4	1
Anas platyrhynchos	3	1	Erithacus rubecula	0	1
Anas querquedula	3	4	Phoenicurus ochruros	0	1
Aythya ferina	3	1	Turdus merula	2	4
Milvus migrans	3	1	Turdus philomelos	1	7
Buteo buteo	2	1	Acroc. arundinaceus	0	2
Falco subbuteo	1	1	Sylvia curruca	0	1
Coturnix coturnix	2	2	Sylvia communis	0	1
Pluvialis apricaria	3	1	Sylvia borin	0	1
Vanellus vanellus	6	7	Sylvia atricapilla	0	1
Calidris alpina	2	2	Phylloscopus collybita	0	1
Philomachus pugnax	3	3	Regulus regulus	0	1
Lymnocriptes minimus	1	1	Panurus biarmicus	0	2
Gallinago gallinago	1	3	Corvus corone cornix	4	1
Tringa totanus	1	1	Sturnus vulgaris	3	14
Tringa ochropus	2	1	Carduelis chloris	3	1

TABLE 5. Risk value and no. of recoveries per species in an area of 160 Km^2 around Cagliari.

Species	Risk value	Number of recoveries	Species	Risk value	Number of recoveries
Phalacrocorax carbo	4	9	Gallinago gallinago	1	1
Nycticorax nycticorax	2	1	Tringa totanus	1	16
Egretta garzetta	2	2	Larus ridibundus	7	26
Ardea cinerea	3	3	Larus genei	3	1
Platalea leucorodia	2	1	Larus cachinnans	8	1
Phoenicopterus ruber	5	21	Motacilla cinerea	1	1
Anas crecca	3	3	Erithacus rubecula	0	13
Anas querquedula	2	1	Phoenicurus ochruros	0	1
Circus aeruginosus	2	1	Turdus merula	2	9
Pandion haliaetus	2	1	Turdus philomelos	1	29
Falco tinnunculus	3	1	Turdus iliacus	1	4
Porzana porzana	0	1	Acrocephalus scirpaceus	0	1
Gallinula chloropus	1	1	Sylvia atricapilla	0	5
Fulica atra	3	4	Phylloscopus collybita	0	3
Himantopus himantopus	2	1	Ficedula hypoleuca	0	1
Charadrius dubius	3	1	Parus major	0	1
Calidris minuta	2	1	Sturnus vulgaris	3	12
Calidris alpina	2	2	Serinus serinus	2	1
Philomachus pugnax	3	1	Carduelis cannabina	2	1

TABLE 6. Risk value and no. of recoveries per species in an area of 160 Km^2 around Palermo.

Species	Risk value	Number of recoveries	Species	Risk value	Number of recoveries
Phalacrocorax carbo	4	2	Falco tinnunculus	3	2
Ixobrychus minutus	0	1	Larus ridibundus	7	1
Ardea purpurea	1	1	Lanius senator	1	1
Pandion haliaetus	2	1			

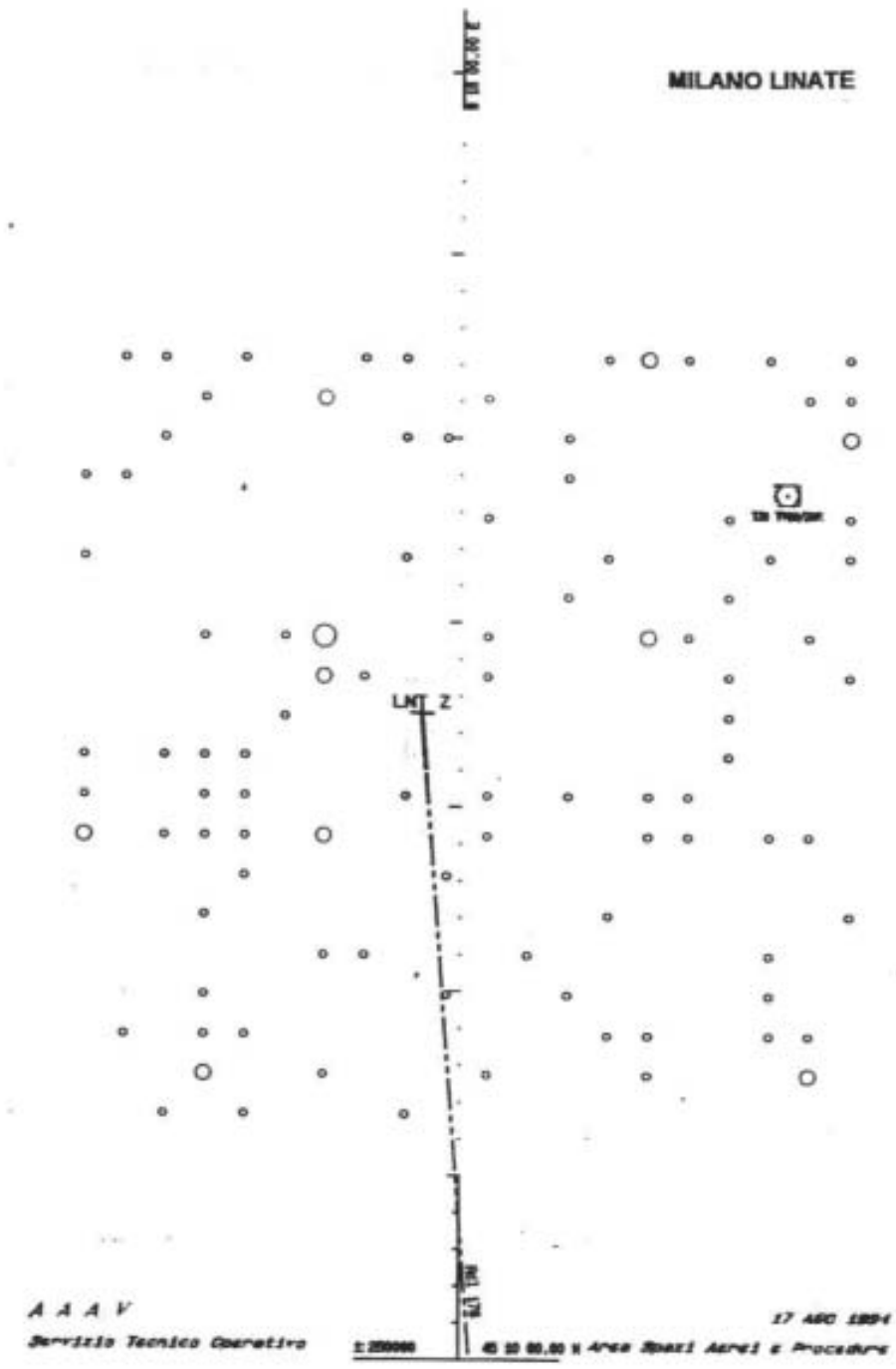


FIGURE 2. Distribution of recoveries of ringed birds around Milan Airport. Each circle represents the total risk value of a 4 square Kms sub-area (sum of risk values per species per no. of specific recoveries). Small circle = total risk value between 1 and 20, medium circle = total risk value between 21 and 60, large circle = more than 61. Cross (LNT Z) = airport localizer; solid line = run-way; dashed line = main Instrumental Landing System final tract.

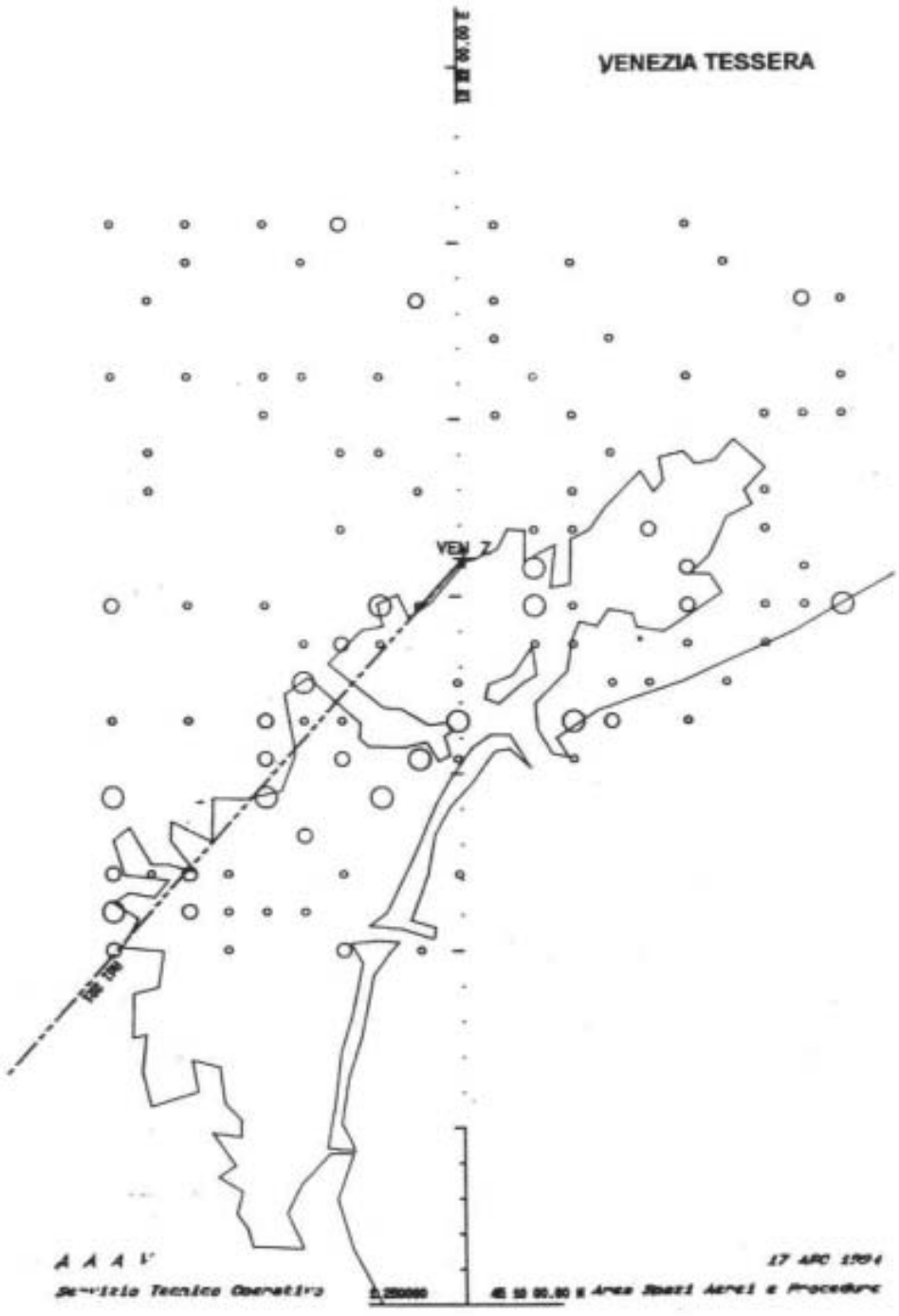


FIGURE 3. Distribution of recoveries of ringed birds around Venice Airport. Each circle represents the total risk value of a 4 square Kms sub–area (sum of risk values per species per no. of specific recoveries). Small circle = total risk value between 1 and 20, medium circle = total risk value between 21 and 60, large circle = more than 61. Cross (VEN Z) = airport localizer; solid line = run–way; dashed line = main Instrumental Landing System final tract; thin solid line = coast line.

FIGURE 4. Distribution of recoveries of ringed birds around Genoa Airport. Each circle represents the total risk value of a 4 square Kms sub–area (sum of risk values per species per no. of specific recoveries). Small circle = total risk value between 1 and 20, medium circle = total risk value between 21 and 60, large circle = more than 61. Cross (GSE Z) = airport localizer; solid line = run–way; dashed lines = main Instrumental Landing System final tracts; thin solid line = coast line.

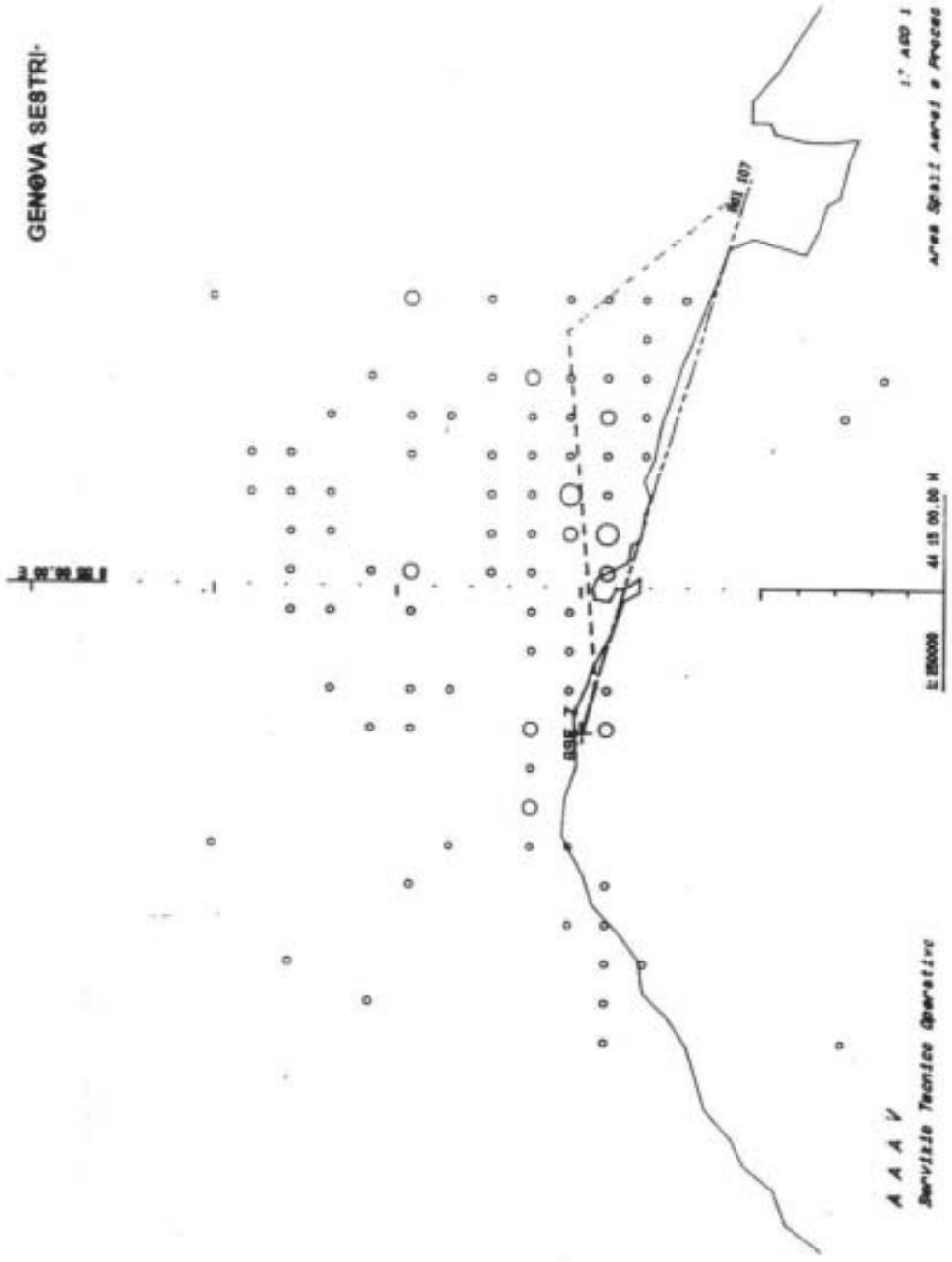


FIGURE 5. Distribution of recoveries of ringed birds around Rome Airport. Each circle represents the total risk value of a 4 square Kms sub–area (sum of risk values per species per no. of specific recoveries). Small circle = total risk value between 1 and 20, medium circle = total risk value between 21 and 60. Crosses (FRR Z, FEE Z, FLI Z) = airport localizers; solid lines = run–ways; dashed lines = main Instrumental Landing System final tracts; thin solid line = coast line. CIA Z = Ciampino airport localizer.

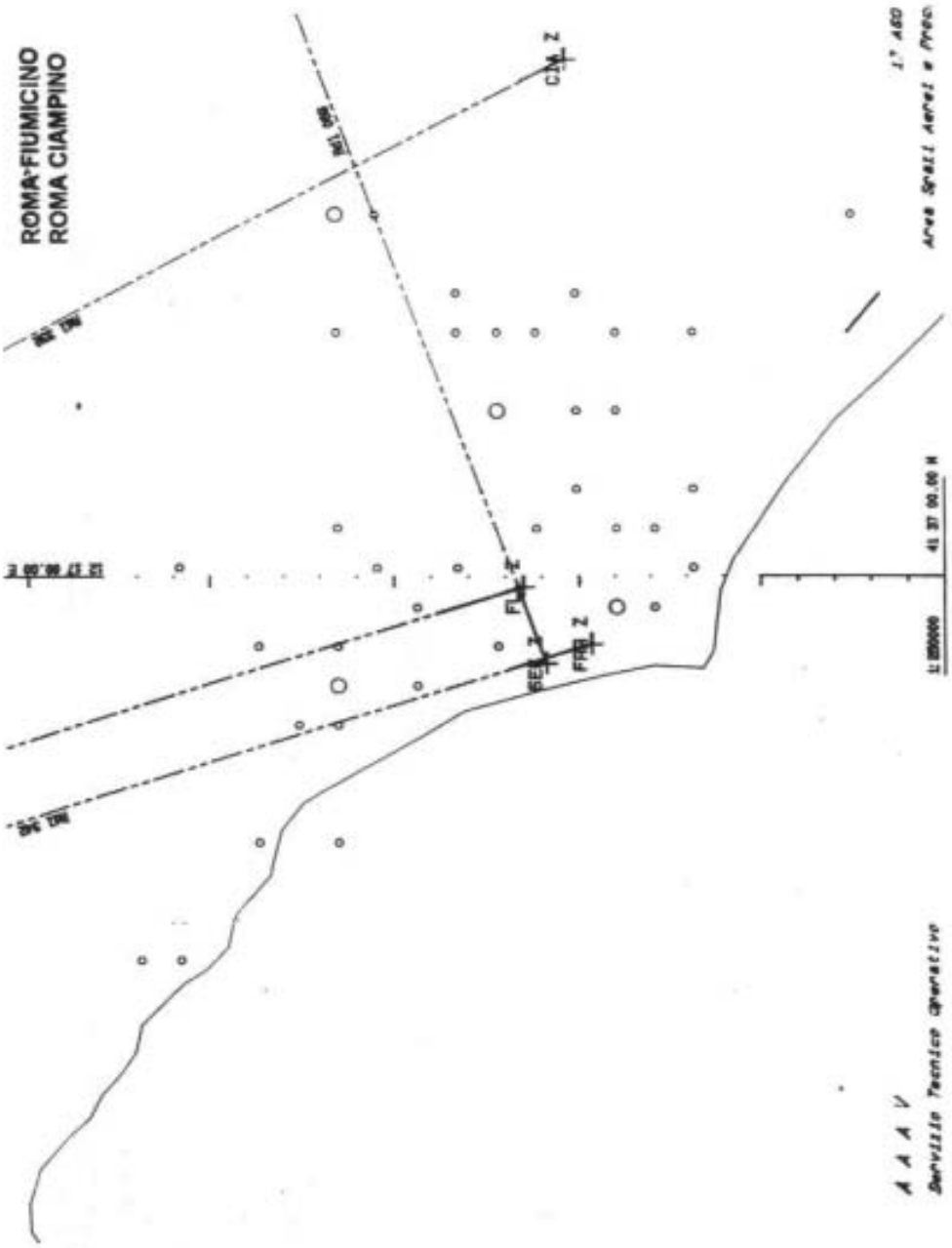


FIGURE 6. Distribution of recoveries of ringed birds around Cagliari Airport. Each circle represents the total risk value of a 4 square Kms sub–area (sum of risk values per species per no. of specific recoveries). Small circle = total risk value between 1 and 20, medium circle = total risk value between 21 and 60, large circle = more than 61. Cross (IEL Z) = airport localizer; solid line = run–way; dashed line = main Instrumental Landing System final tract; thin solid line = coast line.

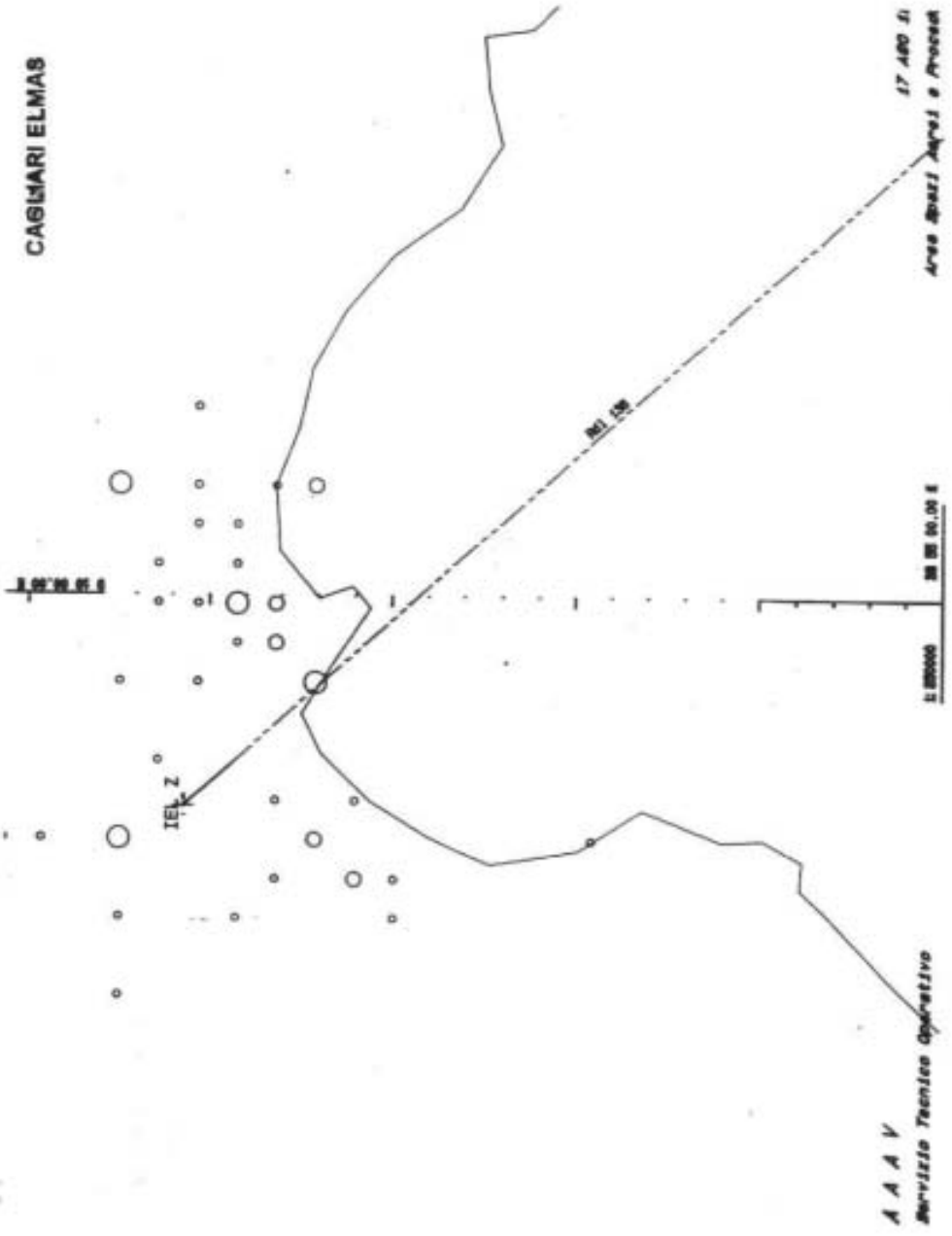
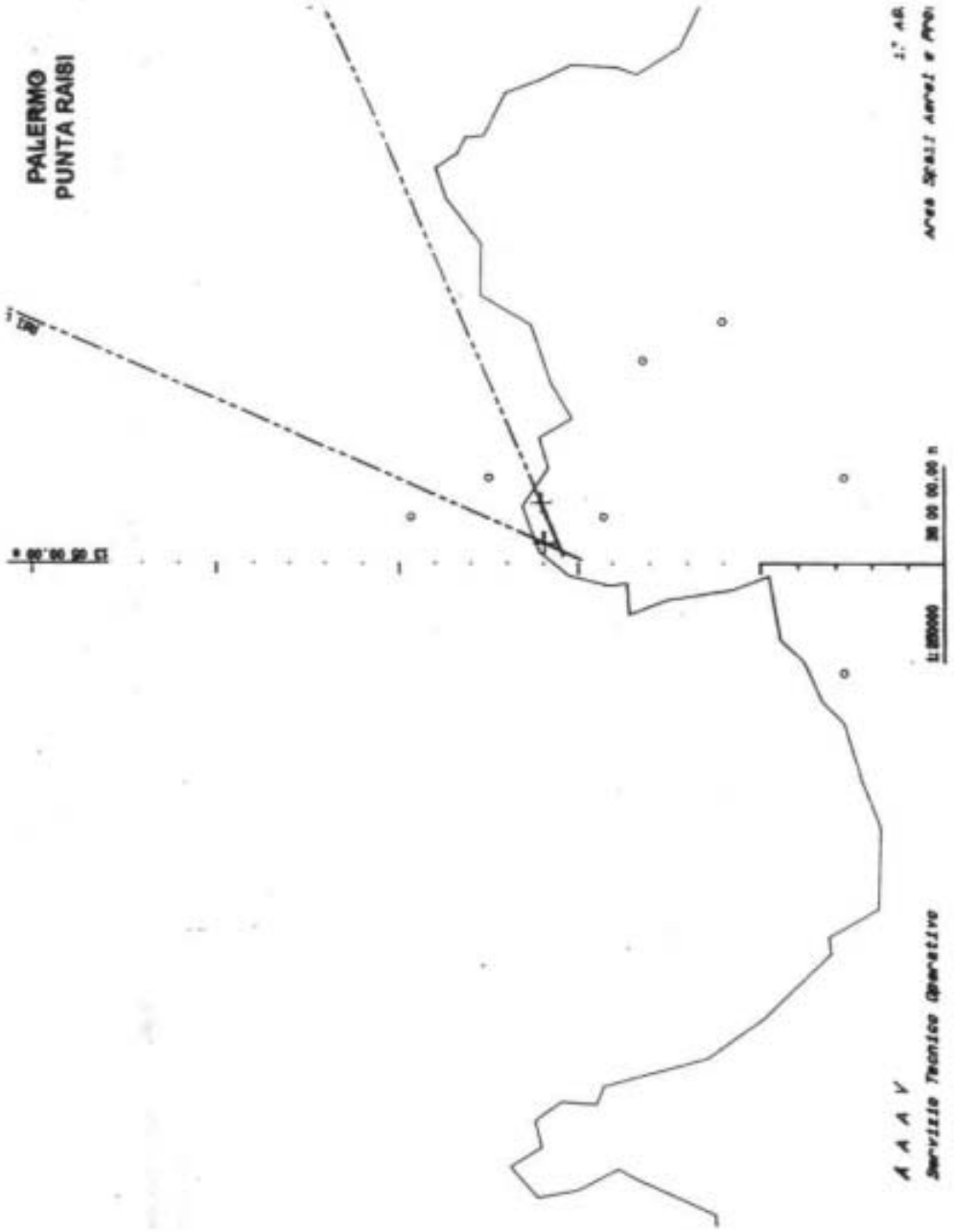


FIGURE 7. Distribution of recoveries of ringed birds around Palermo Airport. Each circle represents the total risk value of a 4 square Kms sub–area (sum of risk values per species per no. of specific recoveries). Small circle = total risk value between 1 and 20. Crosses = airport localizers; solid lines = run–ways; dashed line = main Instrumental Landing System final tract; thin solid line = coast line.



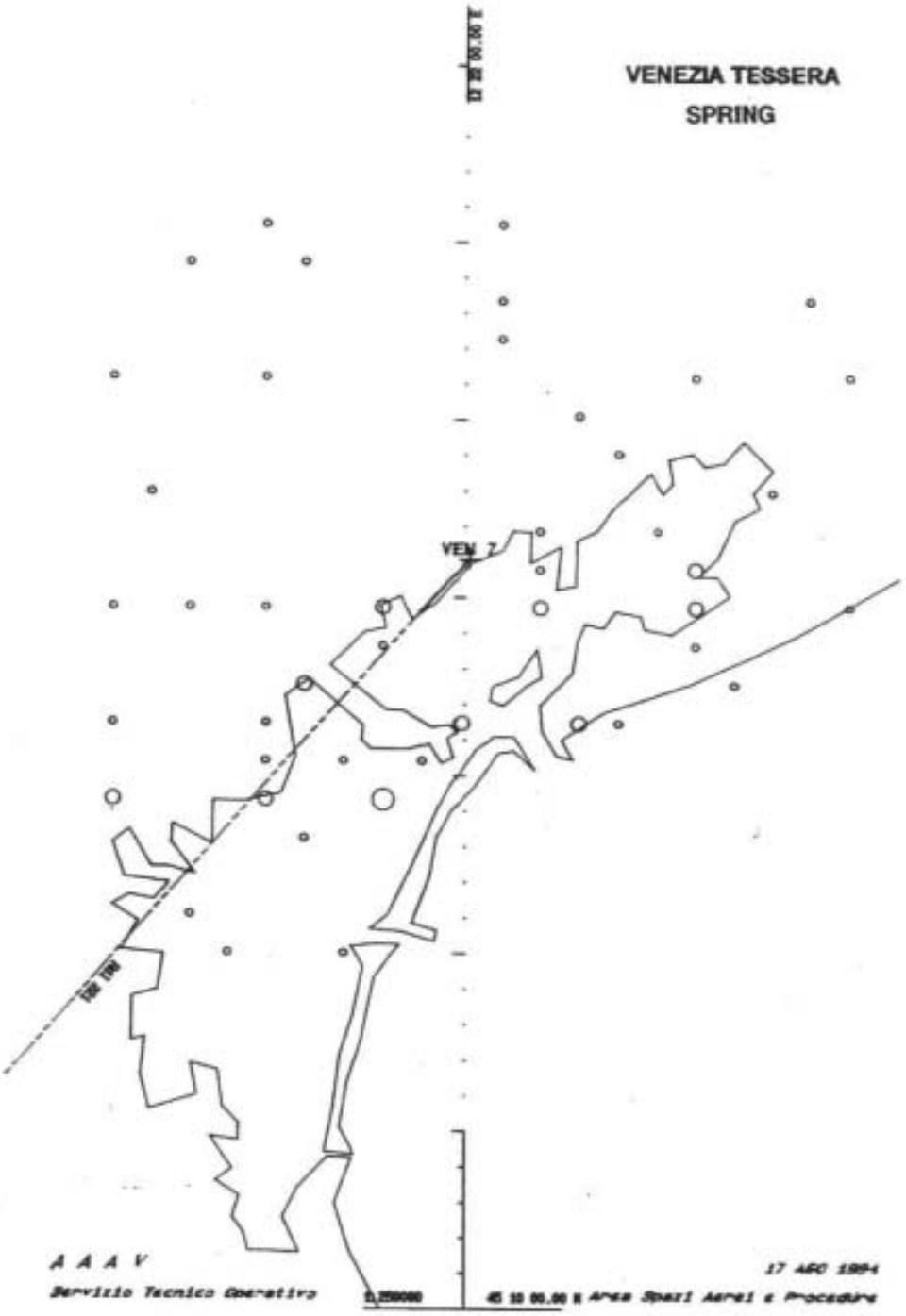


FIGURE 8. Distribution of recoveries of ringed birds around Venice Airport in spring (March, April and May). Each circle represents the total risk value of a 4 square Kms sub–area (sum of risk values per species per no. of specific recoveries). Small circle = total risk value between 1 and 20, medium circle = total risk value between 21 and 60, large circle = more than 61. Cross (VEN Z) = airport localizer; solid line = run–way; dashed line = main Instrumental Landing System final tract; thin solid line = coast line.

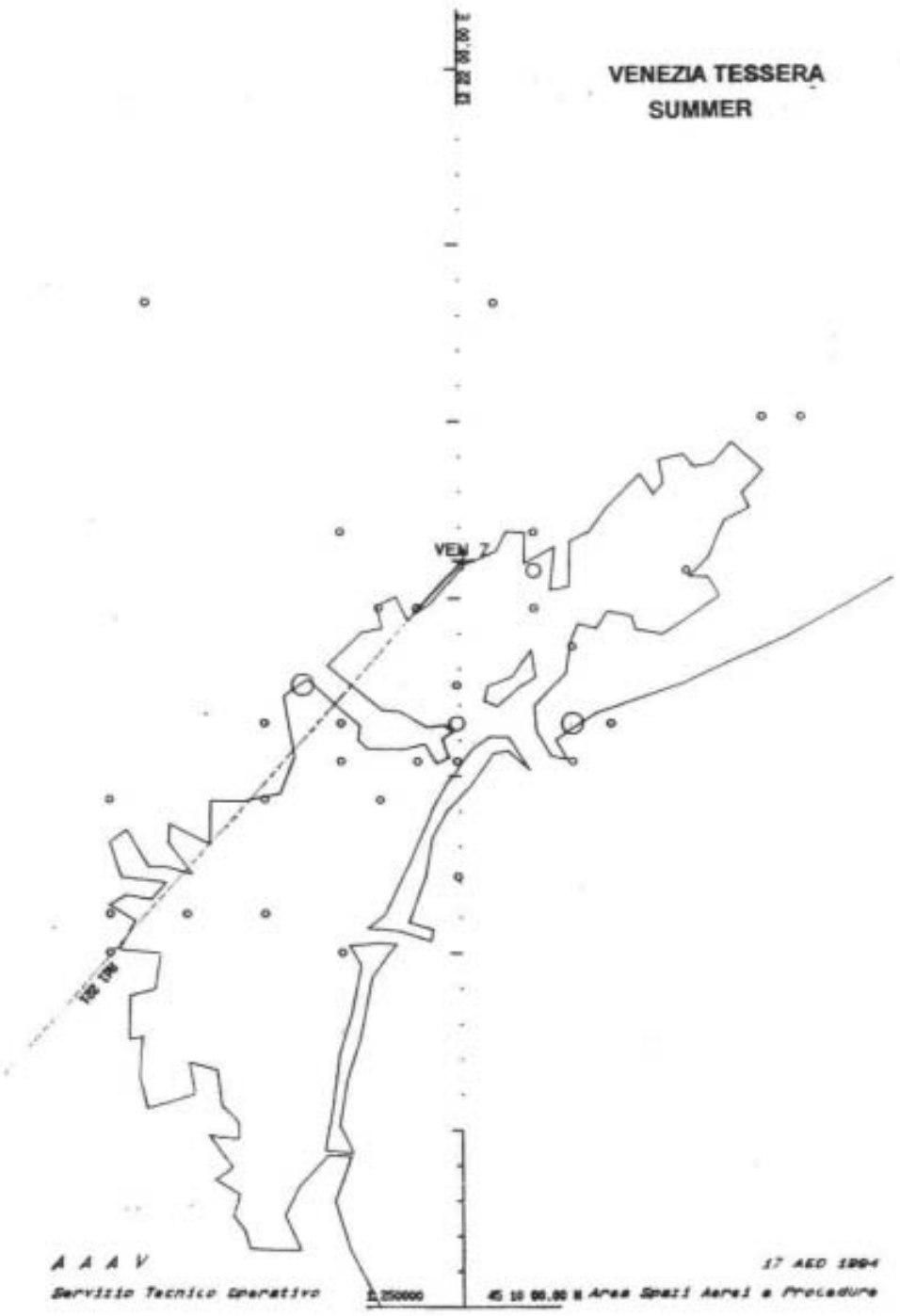


FIGURE 9. Distribution of recoveries of ringed birds around Venice Airport in summer (June, July and August). Each circle represents the total risk value of a 4 square Kms sub–area (sum of risk values per species per no. of specific recoveries). Small circle = total risk value between 1 and 20, medium circle = total risk value between 21 and 60, large circle = more than 61. Cross (VEN Z) = airport localizer; solid line = run–way; dashed line = main Instrumental Landing System final tract; thin solid line = coast line.

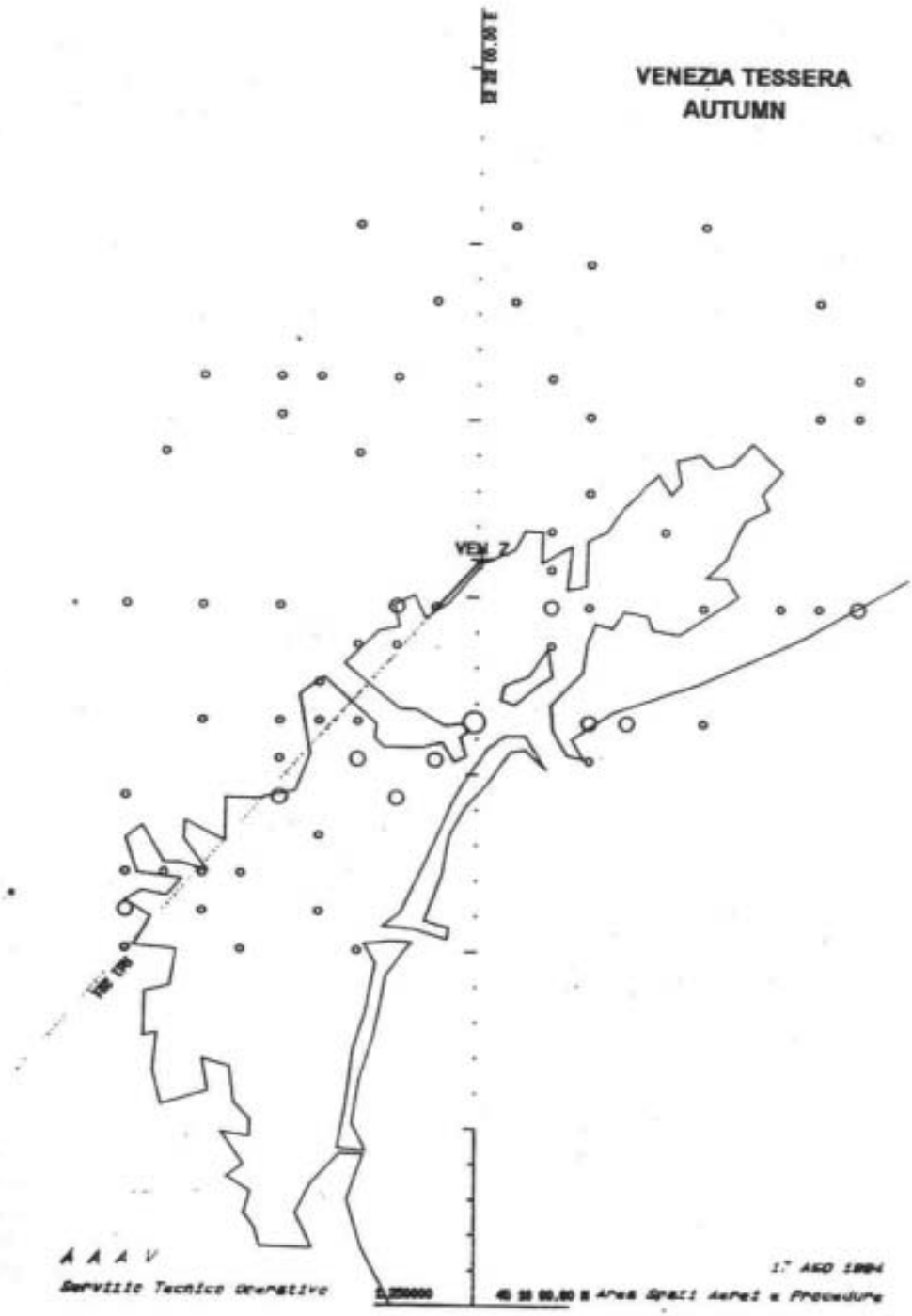


FIGURE 10. Distribution of recoveries of ringed birds around Venice Airport in autumn (September, October and November). Each circle represents the total risk value of a 4 square Kms sub–area (sum of risk values per species per no. of specific recoveries). Small circle = total risk value between 1 and 20, medium circle = total risk value between 21 and 60, large circle = more than 61. Cross (VEN Z) =, airport localizer; solid line = run–way; dashed line = main Instrumental Landing System final tract; thin solid line = coast line.

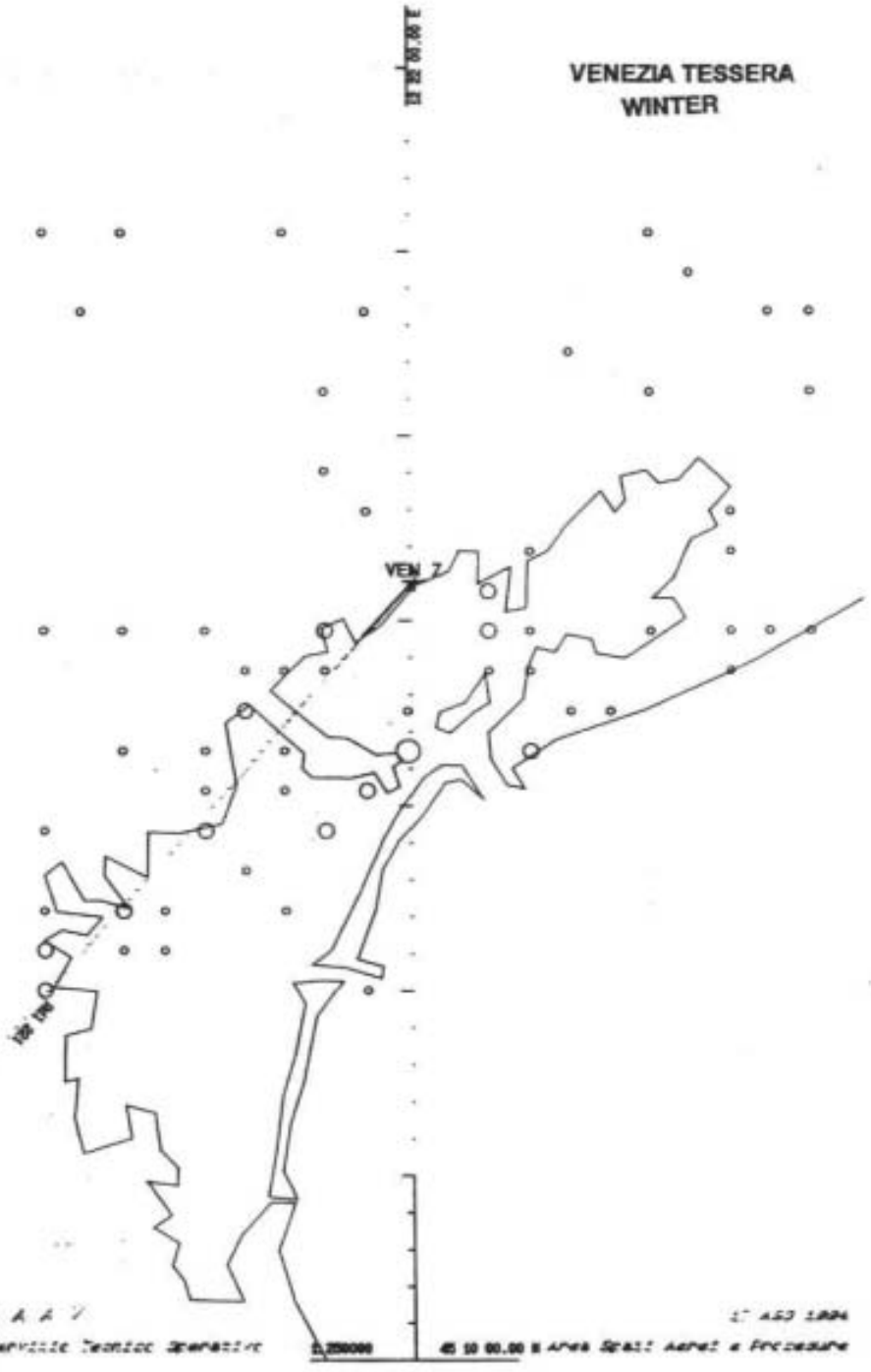


FIGURE 11. Distribution of recoveries of ringed birds around Venice Airport in winter (December, January and February). Each circle represents the total risk value of a 4 square Kms sub-area (sum of risk values per species per no. of specific recoveries). Small circle = total risk value between 1 and 20, medium circle = total risk value between 21 and 60, large circle = more than 61. Cross (VEN Z) = airport localizer; solid line = run-way; dashed line = main Instrumental Landing System final tract; thin solid line = coast line.

TABLE 7. No. of recoveries per species per season in an area of 160 Km² around Venice.

Species	Season				Species	Season			
	Spr	Sum	Aut	Win		Spr	Sum	Aut	Win
Podiceps cristatus				1	Tringa nebularia			1	
Phalacrocorax carbo	1		2	4	Tringa glareola		3		2
Ixobrychus minutus		1			Actitis hypoleucos		1		
Ardeola ralloides	1				Larus melanocephalus		2	5	2
Egretta alba				2	Larus ridibundus	13	20	27	28
Ardea cinerea	2		2	2	Larus canus				1
Ardea purpurea		1	2		Larus cachinnans	4	4		2
Ciconia ciconia	1				Sterna caspia		1	2	
Platalea leucorodia				1	Sterna albifrons	2	123	6	
Cygnus olor			1		Chlidonias nigra		1		
Anas penelope	1		2	2	Alcedo atthis				1
Anas strepera			1	2	Upupa epops			1	
Anas crecca	50	4	27	35	Riparia riparia		4		
Anas platyrhynchos		1	9	13	Anthus spinoletta			1	
Anas acuta	7		3	2	Motacilla flava			1	
Anas querquedula	12	2	3		Motacilla alba			1	
Anas clypeata	1		1		Prunella modularis			1	
Aythya ferina				4	Erithacus rubecula			2	4
Aythya fuligula			1	3	Turdus merula			3	2
Circus aeruginosus	2			1	Turdus pilaris			2	8
Falco tinnunculus	1			1	Turdus philomelos	1		6	
Porzana porzana			1		Turdus iliacus			1	
Gallinula chloropus		2	2	4	Cettia cetti	1			
Fulica atra		1	6	13	Acroc. schoenobaenus		16		
Himantopus himantopus		1			Acrocephalus scirpaceus		4		
Charadrius hiaticula		1	2	1	Acroc. arundinaceus		3		
Charadrius alexandrinus	12	7	6		Sylvia curruca			1	
Calidris minuta		1	2	2	Sylvia atricapilla		1	1	
Calidris temminckii			1		Ficedula albicollis			1	
Calidris ferruginea	1	1			Panurus biarmicus	3			
Calidris alpina	28	3	15	15	Remiz pendulinus	1	3	5	5
Philomachus pugnax	3		3		Sturnus vulgaris	2		12	5
Gallinago gallinago	1	1	3	1	Passer italiae			1	
Limosa limosa	2				Fringilla montifringilla			2	
Numenius phaeopus				1	Carduelis spinus	1		1	2
Tringa erythropus			1		Emberiza schoeniclus	1	4	14	4
Tringa totanus	6	13	11	9					

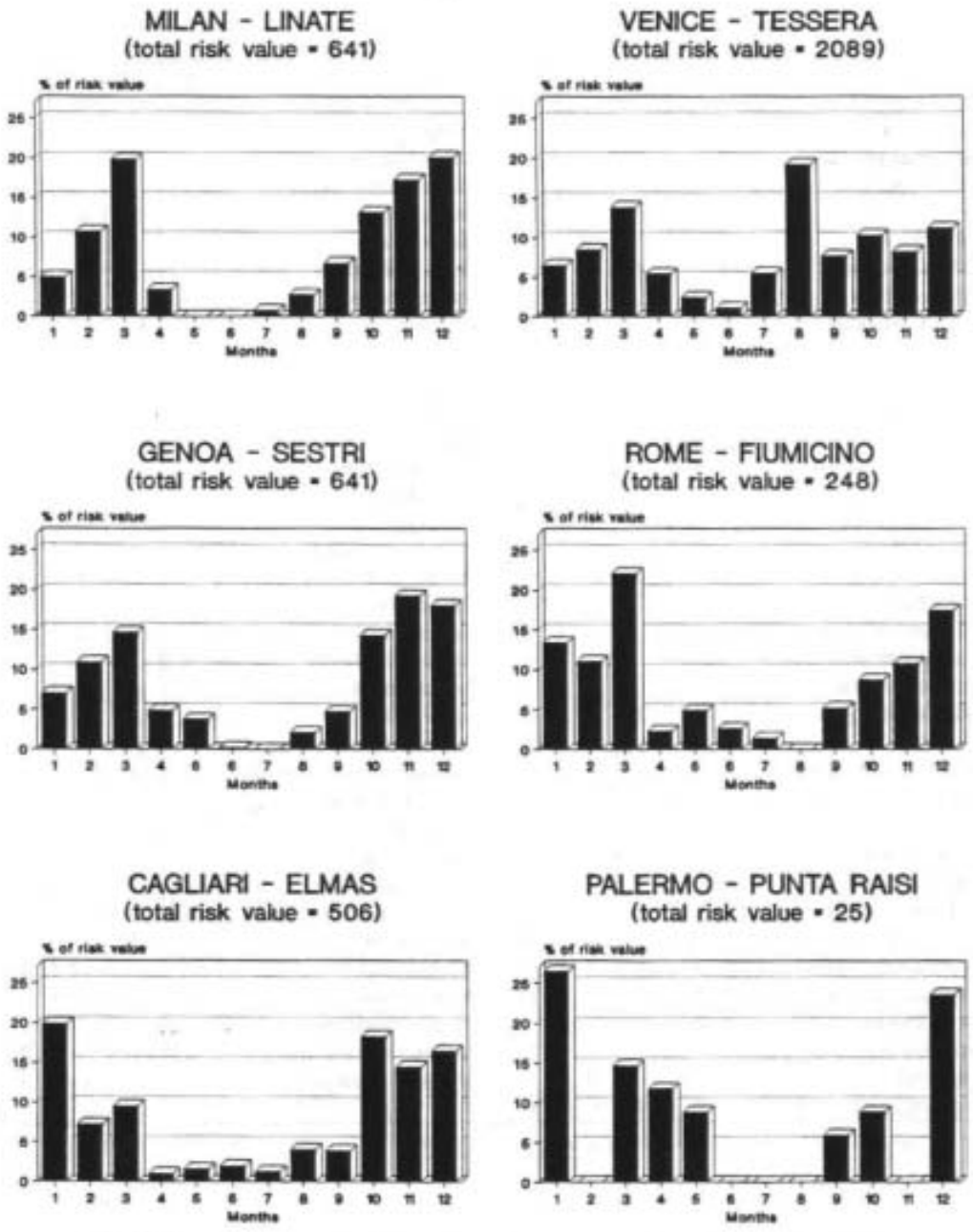


FIGURE 12. Airport risk values per month of the six sites.