

STUDY OF THE MIGRATION PATTERNS OF TURTLE DOVE *STREPTOPELIA TURTUR* AND QUAIL *COTURNIX COTURNIX* OVER THE MALTESE ISLANDS

FINAL REPORT

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INTRODUCTION

The value of the Maltese Islands as a place from which to observe bird migrations has long been recognized. Despite the small size, they carry an amazing diversity of avifauna numbering over 257 species, alas only during migration, for very few species and numbers of individuals remain on the islands even during the breeding season (Sultana et al 1975). All authors on Maltese ornithology agree that the islands are only a stop-over site for the migratory birds, whose presence usually lasts only a few days at a time during the two migration periods of autumn and spring.

Schembri (1843, cited by Despott 1917) was probably the first to publish a complete work on Malta's birds, with notes on 230 species. Wright (1864a, 1864b, 1865, 1869, 1870, 1874) gave accounts of 278 species recorded on the Maltese islands, with notes on migration of these species and their presence on the islands during autumn and spring period. Despott (1917) was the next systematic recorder of Maltese birds. He cited a number of published papers carrying information on the birds of Malta, two as early as 1760 and 1772 and a number of others published between 1843 and 1916. He listed 250 species of birds and gave brief information on each one.

Foreign visitors stationed on Malta, gave accounts of the migration of birds. Payn (1938) after having spent April of 1936 in Malta and Gozo, wrote notes on 39 species that he encountered during his stay, the turtle dove being one of them. He limited his observations to visible migration only. Gibb (1951) was stationed in Malta from August 1941 until July 1945. He spent most of his time in Malta, with few short visits to Gozo. Most of his observations were during his duty hours in an anti-aircraft unit. He also collected information from aircraft spotters and from personal observations during his off-duty time. He listed 10 species breeding on the islands, whose presence was not well documented and brought up conflicting comments by Wright and Despott. Furthermore, he wrote notes on the presence or absence of 30 species, comparing his observations with those of Wright and Despott. Finally, in Appendix II, he listed a large number of migrant species, their presence or absence during the two migration periods (autumn/spring) and their approximate status, always comparing his observations to those by Wright and Despott. He included comments on turtle dove and quail.

A number of guides (or check lists) have been written on the birds of the Maltese Islands. The earliest one is by Roberts (1954), who in the brief introduction discussed the bird migration behavior of the various species groups, linking their appearance with local weather conditions. He presented brief description of the birds and their biology and the time they appear on the islands during migration. He often referred to the writings of Wright and Despott. De Lucca (1969a) wrote a check list of the birds of Malta, with a very brief note on each species, mostly on the migration and the time of year of its presence on the Maltese Islands. In the brief introductory chapter, he tried to link the presence of migratory birds to local weather phenomena, particularly prevailing winds. The next bird guide was by Sultana et al. (1975), followed by the revised edition of the same book (Sultana and Gauci 1982). A brief description of the island topography and discussion of bird migration in relation to local winds and other weather phenomena is given in the introduction. The species accounts also contain information on the dates of appearance of the various species on the Maltese islands. Another important publication is by Bannerman and Vella-Gaffiero (1976) which gives rather extensive accounts of birds, including information on the bird migration phenology in the Maltese Archipelago. The latest book on the birds of Malta which includes historical information, information on the hunting traditions of the Maltese people, as well as detailed species accounts is by Fenech (2010).

Observations on the migrant bird species over the Maltese Islands, including numbers and dates for each year are published in the "Bird Notes" and "Systematic List" sections in the issues of "Ill Merill", the official Bulletin of the Malta Ornithological Society and later christened as the ornithological journal of Birdlife Malta.

De Lucca (1969b) was the first and probably the last to give detailed information on the phenology of bird migration over the Maltese islands, in relation to local weather conditions and topography, including notes on selected species, the turtle dove and quail among them.

The objectives of this study were to reveal the phenology of migration of the turtle dove (*Streptopelia turtur*) and European quail (*Coturnix coturnix*) over the Maltese Islands during the spring and autumn of 2008 and 2009 and compare parameters between these two periods.

LOCATION OF STUDY

The Maltese Islands are a group of small, low islands aligned in a NW-SE direction and located in the central Mediterranean approximately 96 km from Sicily and 290 km from North Africa. The Maltese archipelago consists of three inhabited islands: Malta (245.7 km2), Gozo (67.1 km2) and Comino (2.8 km2) together with a number of small uninhabited islets (each less than 10 ha). Maximum rise is 253 m (Dingli Cliffs, Malta) and 191 m in Gozo. The population is 404,962 (2005 census) with a population density of c. 1298/km^2.

The climate is typically Mediterranean: the average annual rainfall is 553.3 mm of which some 85% falls during the period October to March. The arid period extends from the last decade of March to the first decade of September, with peak aridity occurring between June and August. The mean monthly temperature range is 12.4^{o}C (January)–26 °C (August), with the mean annual temperature at 19.4^{o}C (1975-2000). The Islands are windy and sunny. Average wind speed ranges from 3.85 m/s (December) to 5.32 m/s (February). Only 8% of the days of the year are calm. The predominant wind is the north-westerly, which on average blows on 18% of the windy days. The other winds are all nearly equal in occurrence. The average daily number of sunshine hours ranges from 5.1 (December and January) to 11.8 (July) (Schembri 1997, MEPA 2004b, Attard 2007).

The main geomorphologic features are karstic limestone plateau, (terraced) hillsides with clay taluses, gently rolling limestone plains, valleys that drain run-off water during the wet season, steep sea cliffs on the southern, southwestern and western coasts and gently sloping rocky shores to the north-east.

The only natural source of water is rain falling on the islands' land surface and on groundwater. There are no perennial surface streams or lakes in Malta, only minor springs. Rain water flows along the bed of valleys during the wet season. A few of these however, drain perennial springs originating from perched aquifers and therefore attain the character of miniature river valleys with some water flowing throughout the year and with more extensive flow during the wet season. Some springs are perennial and run with diminished flow also in the dry season (Cassar et al. 2008)

Although small, the Maltese Islands have a considerable diversity of landscapes and ecosystems which are representative of the range and variety of those of the Mediterranean region. The main vegetation assemblages are maquis, garigue and steppe; minor ones include patches of woodland, coastal wetlands, sand dunes, freshwater, and rupestral

communities; the latter are the most scientifically important in view of the large number of endemic species they support. Human impact is significant. The most widespread natural vegetation type is the garigue (low growing shrubs on karst landscape) (Schembri 1997). There are only remnants of once more extensive woodland (c. 0.5% of land surface).
Registered agricultural land falls under three categories:
-dry farmed land that depends almost exclusively on rainwater for irrigation
-irrigated land that has a continuous supply of water from sources other than rainwater
-unutilized/garigue which is all non-productive land
Some 38% of Malta's surface area and 33% of Gozo's is registered as agricultural land with 4.8% and 4.1% falling under the unutilized category. Most of the agricultural land is hilly and thus extensive tracts are terraced. Soil was retained within these land parcels by means of limestone rubble walls. On a more flat land, rubble walls are used to delineate property boundaries.
Approximately 27.7% of the national territory is being developed to accommodate settlements and related urban infrastructure (Attard 2007, Cassar et al. 2008)

MATERIALS AND METHODS

Observers were used to record turtle doves and quail, each one located on his own piece of land property. The daily observation period was from sunrise to sunset, every day, during the designated observation periods. Observers recorded flying turtle doves, within their field of view. The use of observers to record visible migration is a classic method of bird migration research. Systematic observations of visible migration make the recording of diurnal and seasonal migration patterns possible and provide insight into the temporal distribution and density of passage migrants at certain days or over the migration season. Comparisons of these migration patterns over the years reveal daily and seasonal patterns of migration, as well as weather effects and long-term developments. Individual observers can be employed or observatories can be instituted at strategic sites along known migration routes (Alerstam 1994, Berthold 1996 and 2001, BTO Migration Watch). De Lucca (1969b) used observers at 7 strategic locations to collect data for his study of bird migration over Malta and Gozo. Birdlife Malta (Malta Ornithological Society) uses observers to record visible migration over the Maltese Islands, as published in the issues of "Il Merrill".

Quail were sampled either in the morning and/or in the afternoon usually with the aid of a dog and for those not possessing one, by walking and traversing the land in close parallel lines as not to leave any suitable habitat unsearched. The use of dogs in counting ground birds, such as quail, is a time-honored method in scientific research (Zwickel 1980).

The observers recorded data and other pertinent information on a specially designed observation sheet, such as number of birds encountered within given time brackets, direction of the prevailing wind and cloud cover on the given scale (0, ¼, ½, ¾ and 4/4).

For the spring period of 2008, 19 geographical grids (4 of them in Gozo and 15 in Malta) were selected as study sites and an observer was assigned on each grid, except for 3 grids where 2 observers were assigned, for a total of 25 observers. Quail were not sampled sufficiently during this period, because due to the closing of the spring hunting season, police did not allow hunters, and observers for that matter, to use dogs for flushing and counting quail. Observations for spring periods ran from April 10 to May 20.

From the autumn period of 2008 and thereafter, more grids and observers were added for more efficient sampling, as recommended in the revised methodology. As a rule of thumb, 2 observers were assigned per grid, preferably located at the two distal ends of the grid, as to cover the area adequately. However, this was not always feasible. Thirty eight geographical grids (6 of them in Gozo and 32 in Malta) were selected and the total number of observers increased to 72. Thirty grids had 2 observers each, 6 grids had one observer and only 2 grids had three observers. Observations for the autumn periods ran from August 8 to December 15.

Prevailing wind directions were obtained from the Maltese Meteorological Services at Malta International Airport. For turtle dove wind direction for the same day of observations was used since this species is mainly a diurnal migrant (Alerstam1994, Newton 2008). For quail the prevailing wind direction of the previous day was used, since it is mainly a nocturnal migrant and usually arrive the night before (Guyomarc'h and Wallace 1998, Newton 2008).

Classification of habitat in the observation grids was assigned into five categories, with the aid of Google Earth:

1. Coastal barren areas
2. Cultivated fields
3. Terrace fields
4. Build-up areas
5. Rows or patches of natural vegetation

Then, habitat types in the grids were classed either as such or as combinations of the above categories, as follows:

1. Cultivated fields
2. Coastal barren areas & terrace fields
3. Terrace field bordering natural vegetation rows or patches
4. Terrace fields bordering build-up areas
5. Build-up areas bordering natural vegetation patches

Grids were assigned to three categories (high, intermediate and low) using as criteria both the mean and total number of turtle doves and quail recorded in the grid. For a grid to

be assigned to either high or low category it must have both values belonging to either high or low level. Those that did not satisfy the above criteria were assigned to the intermediate category. Maps were drawn for each species for both spring and autumn migration periods using a code of three colors, one for each category.

Two-way analysis of variance (ANOVA) was used to investigate differences in the numbers of turtle doves and quail recorded in the Maltese Islands during the spring and autumn migration periods of 2008 and 2009. Pearson correlation (two-tailed) was used to investigate the influence of mean wind speed, maximum wind speed and rain on the migration behavior of turtle doves and quail.

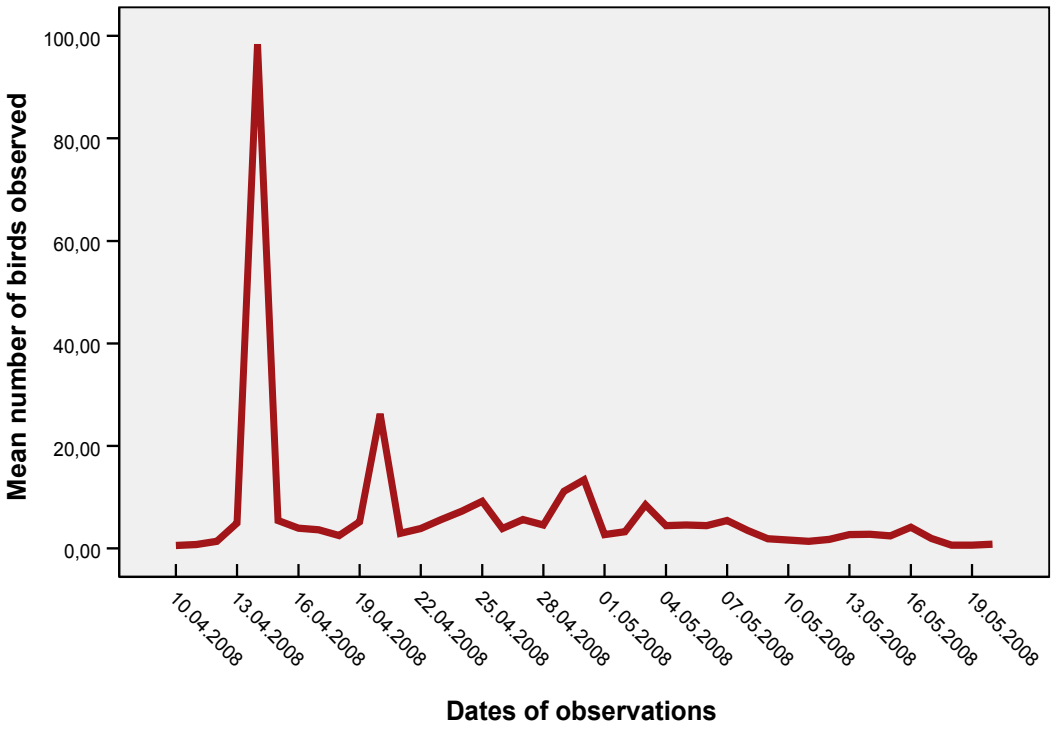
RESULTS

MIGRATION DATES

Spring 2008

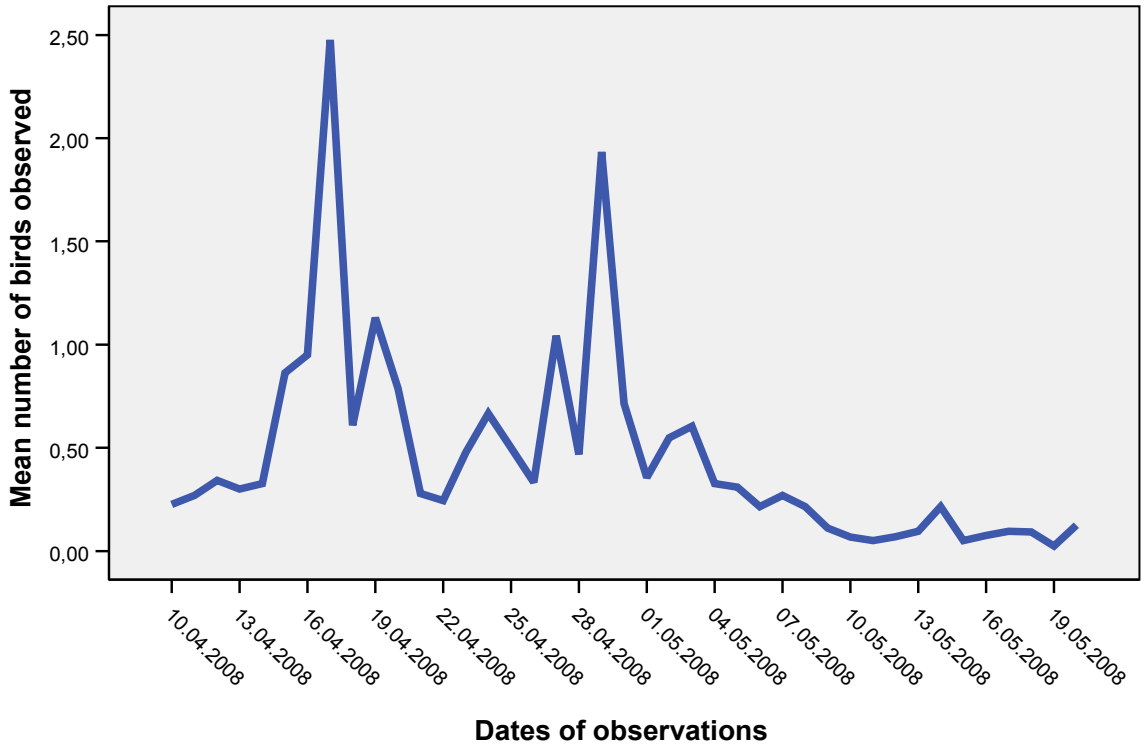
Based on the number of turtle doves and quail recorded, migration during the spring of 2008 must have had already started before the first day of observations, and probably continued for a short time after observations had ceased. The first turtle dove was recorded on April 10. Presence of turtle doves showed the largest peak on April 14, and four smaller peaks on April 20, 29, 30 and May 3. Mean number of birds observed for the high peak was 98.41 and for the smaller ones, 26.25, 11.11, 13.33 and 8.48, respectively. In between these peaks, mean values remained below 11.11 birds per day. After May 8, mean values gradually diminished from 4.12 to 0.60 birds per day. The last turtle doves were recorded on May 20 (Figure 1.1.1).

Fig. 1.1.1. Mean number of turtle doves observed per day during the Spring 2008 migration period, over the Maltese Islands.



Quail presence showed two large peaks, the highest one on April 17, with a mean number of 2.47 birds observed per day and the other on April 29 with a mean number of 1.93 birds per day. A series of smaller peaks occurred between these dates, with mean values ranging between 0.60 and 1.13 birds per day. In May, the number of quail observed gradually diminished and after May 7, mean number reached 0.26 birds observed per day. The last quail were recorded on May 20 (Figure 1.2.1).

Fig. 1.2.1 Mean number of quail observed per day during the Spring 2008 migration period, over the Maltese Islands

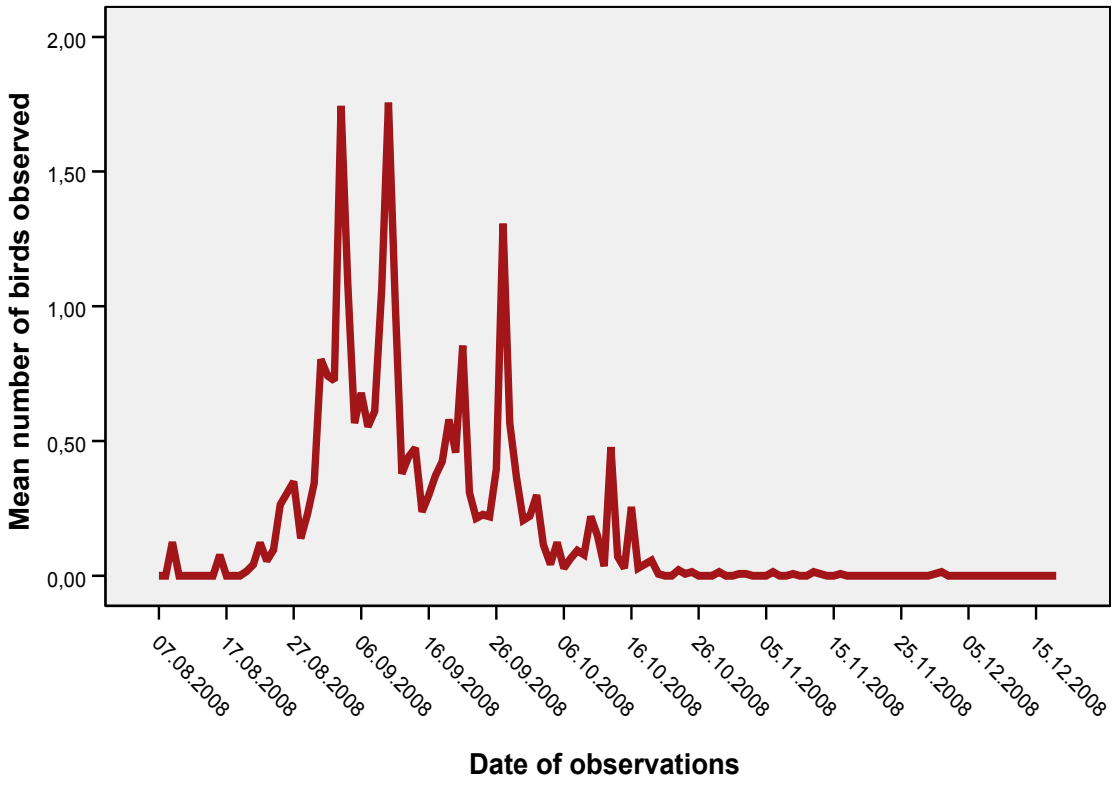


Autumn 2008

During the autumn 2008 migration period, the first turtle dove was observed on August 9. The presence of turtle doves became regular only after August 20 and the bulk of the birds appeared on the Maltese Islands from September 3 to September 27. The three highest peaks were recorded on September 3, 10 and 27. Mean number of bird observed per day were 1.74, 1.75 and 1.30, respectively. Two minor peaks occurred on September 21 and October 13. Mean values for these peaks were 0.85 and 0.47, respectively. After

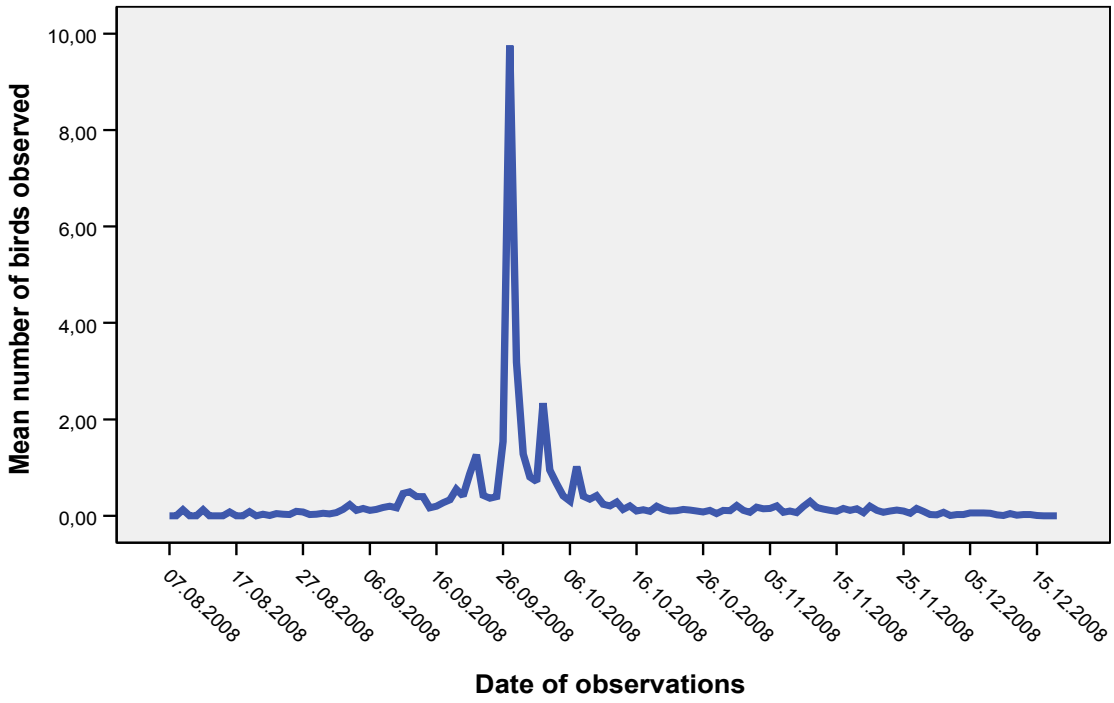
October 19, the number of birds dropped sharply, with mean values remaining below 0.05 birds per day and presence of birds became irregular. The last turtle doves were observed on December 1 (Figure 2.1.1)

Fig. 2.1.1. Mean number of turtle dove observed per day during the Autumn 2008 migration period, over the Maltese Islands.



During this period, the first quail was recorded on August 9. Quail presence became regular only after August 21. Quail numbers showed only one major peak, which actually lasted one day -September 27- reaching a mean value of 9.75 birds observed. The peaks on either side of the grand passage (September 22, October 2 and 7) were very small in comparison, with daily mean values of 1.26, 2.33 and 1.02 birds, respectively. After October 7, observers recorded very small numbers with daily mean values below 0.40 birds. After November 28, mean daily values dropped down to 0.09 birds observed per day. The last quail were observed on December 15 (Figure 2.2.1).

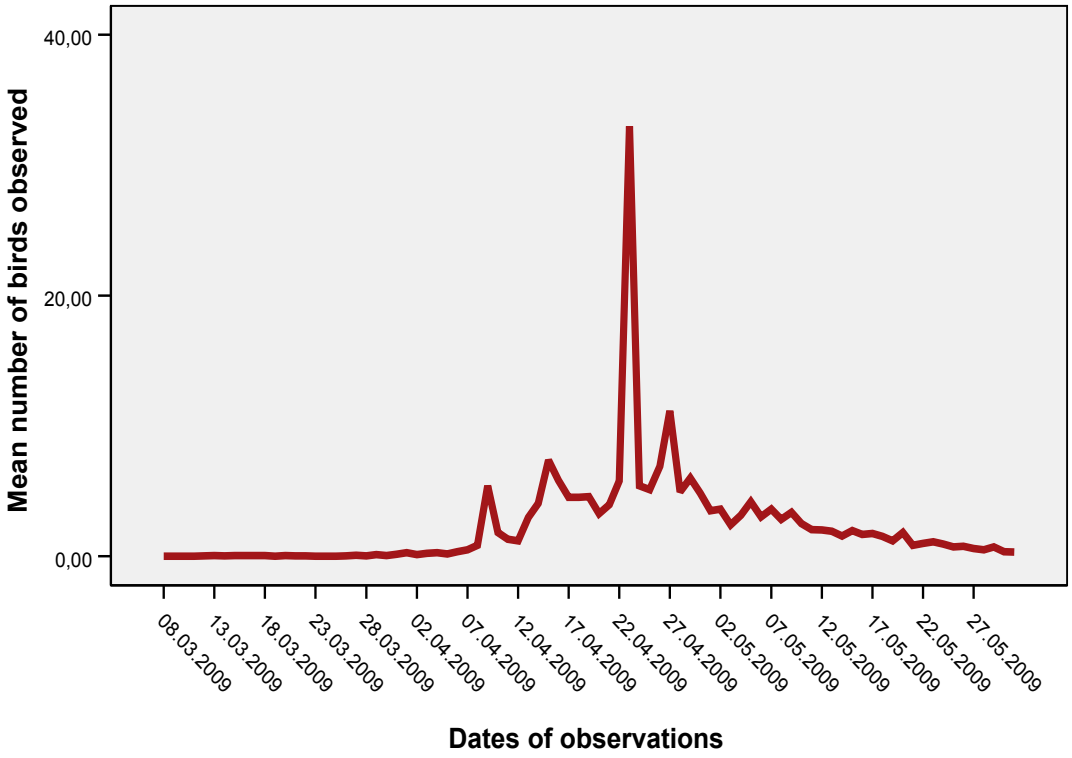
Fig. 2.2.1. Mean number of quail observed per day during the Autumn 2008 migration period, over the Maltese Islands.



Spring 2009

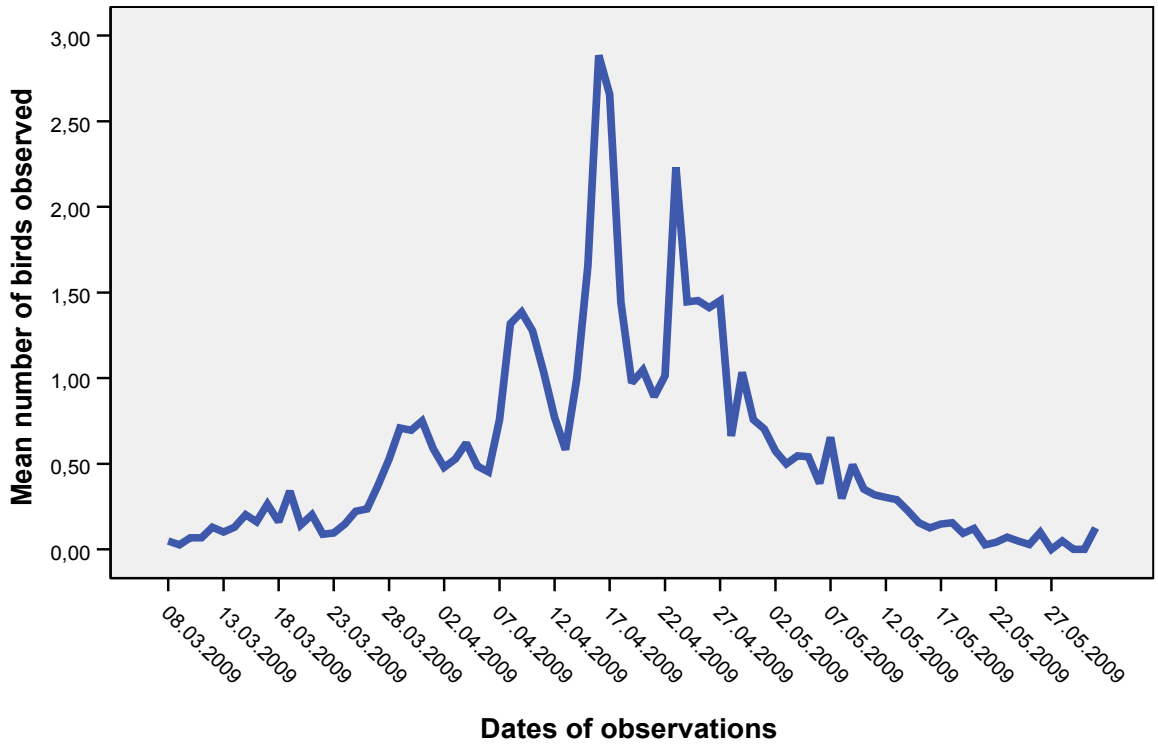
The first turtle dove was observed on March 8. Presence of turtle doves became regular after March 26. Highest peak was on April 23 with a mean number of 32.97 birds recorded. There were three smaller peaks on April 9, 15 and 27, with mean daily values of 5.39, 7.35 and 11.13 birds observed, respectively. Numbers of turtle doves gradually diminished after April 29, with mean daily values ranging from 5.8 down to 0.33 birds observed. May 31 marked the last observation of turtle doves of this period (Figure 3.1.1).

Fig. 3.1.1. Mean number of turtle doves observed per day during the Spring 2009 migration period, over the Maltese Islands



During this period, quail were first recorded on March 8. Since that day, quail presence was regular with mean annual values up to 0.5 birds per day. Numbers started increasing after March 29, with mean daily values over 0.70 birds observed per day. The highest peak in quail numbers occurred on April 16 with mean number of 2.88 of birds observed per day. Smaller peaks occurred on April 9, 23 and 27, with mean daily numbers of 1.38, 2.22 and 1.45 birds, respectively. After this date, a decline in quail numbers was observed with mean daily values below 0.75 birds observed per day. After May 25, the appearance of quail became irregular and the last observation on quail was May 31 (Figure 3.2.1.).

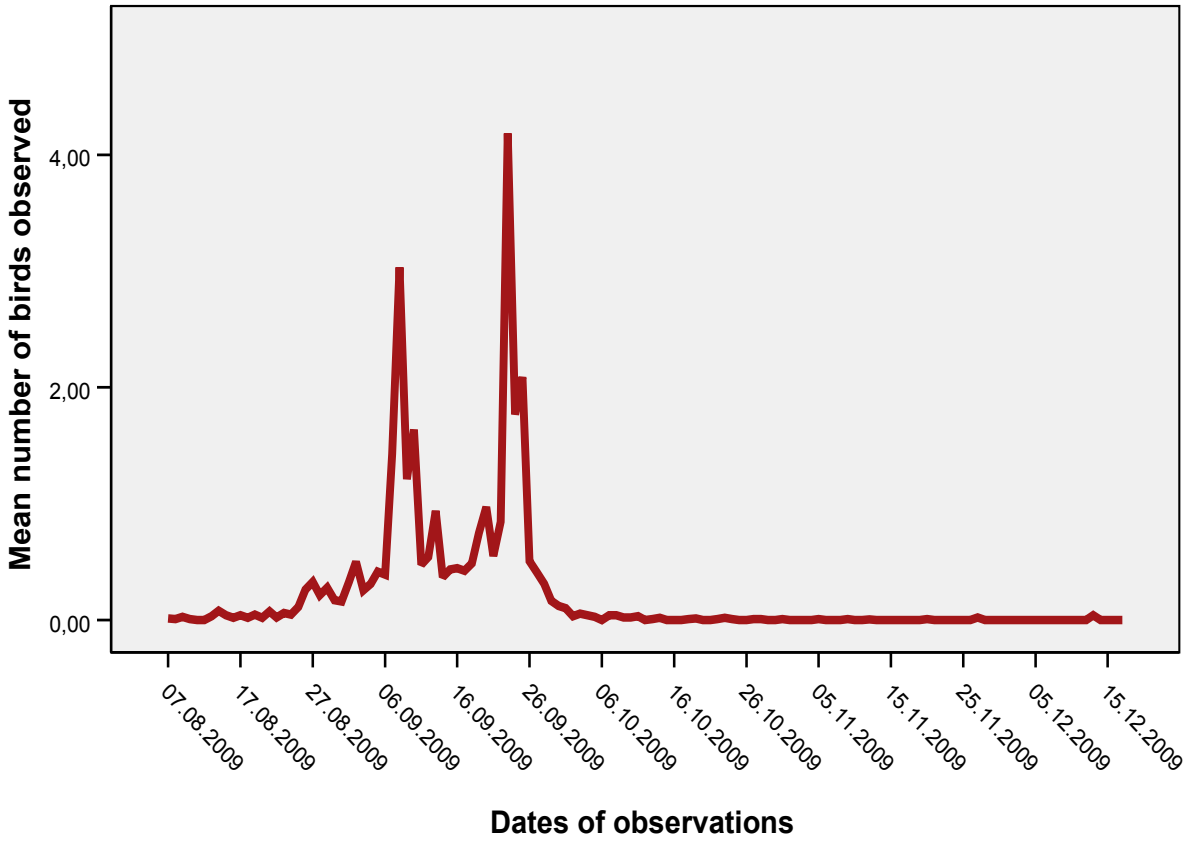
Fig. 3.2.1. Mean number of quail observed per day during the Spring 2009 migration period, over the Maltese Islands.



Autumn 2009

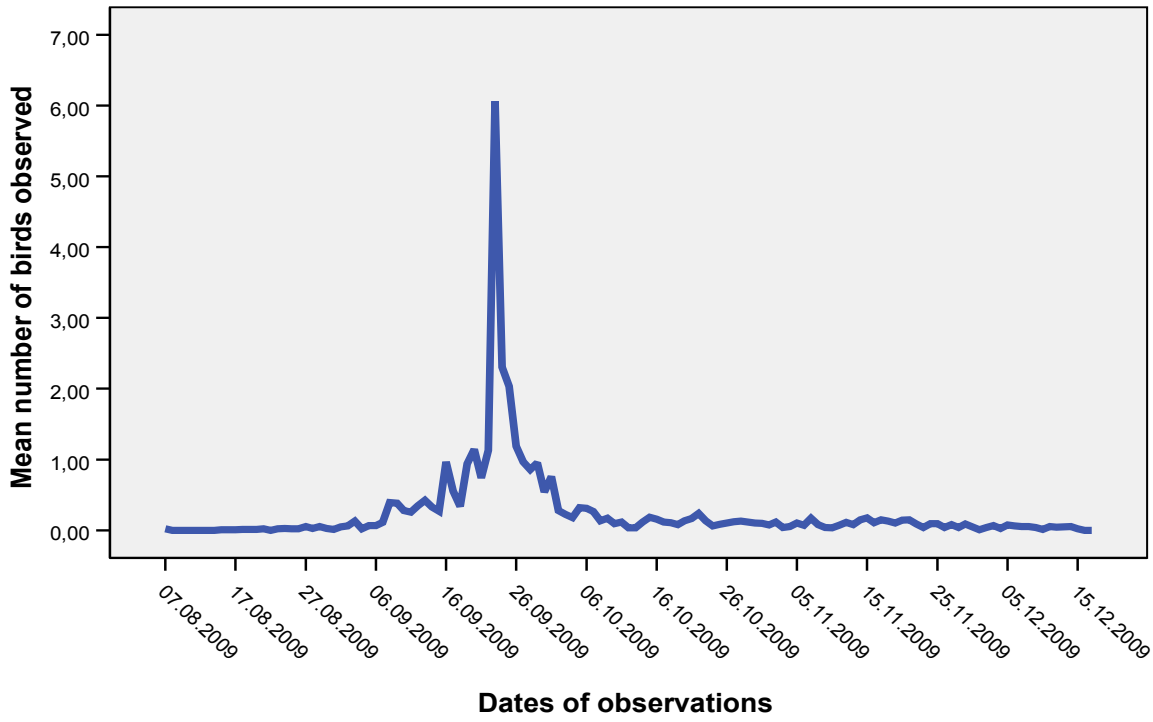
Presence of turtle doves was first recorded on August 7 and became regular after August 13. Turtle doves numbers showed two large peaks during this period, the smaller one on September 8 and the larger one on September 23, with mean values of 3.03 and 4.18 birds observed, respectively. After September 29, numbers dropped sharply. The presence of this species became irregular after October 4 with mean values ranging below 0.04 birds observed per day. The last turtle dove was observed on December 13 (Figure 4.1.1).

Fig. 4.1.1. Mean number of turtle doves observed per day during the Autumn 2009 migration period, over the Maltese Islands.



Quail first appeared on the Islands on August 7, but their presence became regular after August 20. Quail numbers exhibited only one major peak on September 23 with daily mean value of 6.06 birds observed. On either side of the peak, numbers remained very low. From the beginning of observations to the peak date, daily mean values ranged from 0.01 to 1.12 birds observed. The number of quail sharply dropped after October 2, with mean daily values below 0.32 birds observed. After November 28, quail presence became irregular, reaching mean values below 0.05 birds observed per day. The last observation of quail was on December 15 (Figure 4.2.1).

Fig. 4.2.1. Mean number of quail observed per day during the Autumn 2009 migration period, over the Maltese Islands.



WEATHER CONDITIONS AFFECTING MIGRATION OF TURTLE DOVES AND QUAIL

During spring 2008, the great majority of turtle doves arrived with NW wind prevailing, and much smaller numbers, with E and S winds. There is complete agreement between wind direction as reported by the Meteorological services and by observers (Figures 1.1.2 and 1.1.3).

Fig. 1.1.2. Percentage of turtle doves observed in relation to prevailing wind direction as reported by the Maltese Meteorological Services , during Spring 2008 migration period, over the Maltese Islands

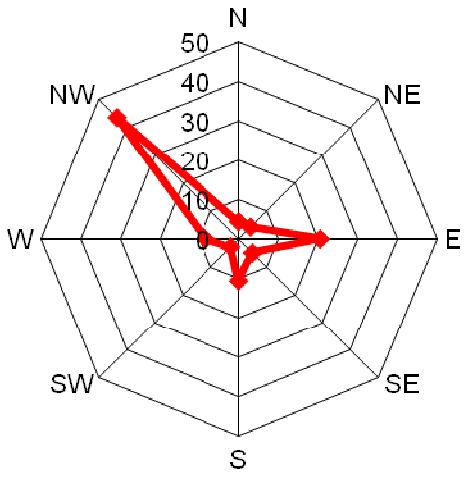
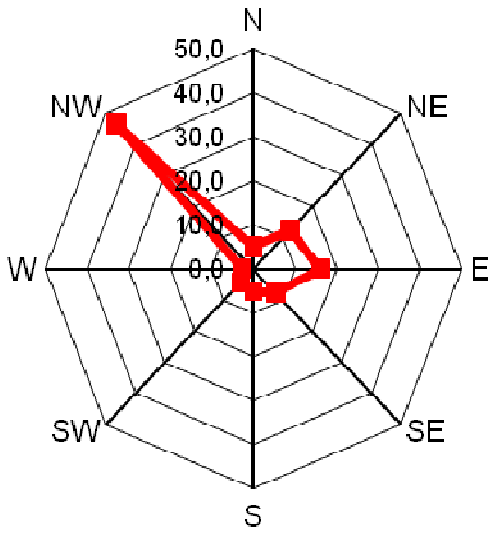
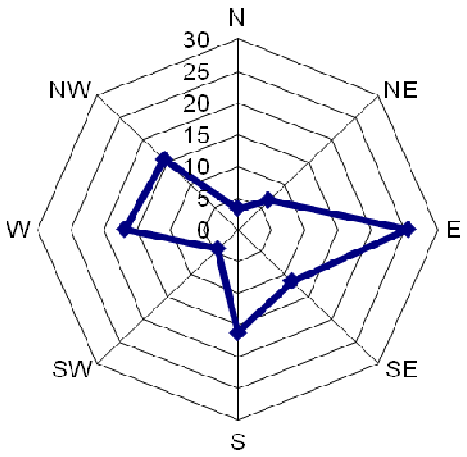


Fig. 1.1.3. Percentage of turtle doves observed in reletion to prevailing wind direction as reported by observers at the time of observation, during Spring 2008 migration period, over the Maltese Islands



The majority of quail came in with E, SE and S winds and fewer with NW and W wind, according to the prevailing wind reported by the Maltese Meteorological Services (Figure 1.2.2). Observers reported that most quail arrived with NW and SE winds, and to a lesser extent, NE and E wind (Figure 1.2.3).

Fig. 1.2.2. Percentage of quail observed in relation to prevailing wind direction as reported by the Maltese Meteorological Services , during Spring 2008 migration period, over the Maltese Islands



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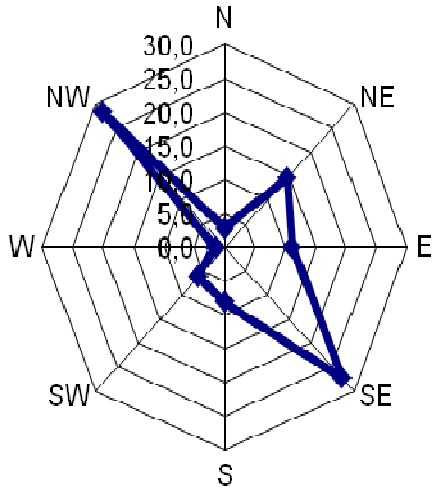


During autumn 2008, the great majority of turtle doves came to the Islands with westerly winds (primarily W wind, fewer with NW and SW winds) and to a lesser extent, S and NE winds (Figure 2.1.2). Observers recorded most doves coming with westerly winds but they reported two major directions, NW and SW and to a lesser extent, NE wind (Figure 2.1.3).

Fig. 2.1.2. Percentage of turtle doves observed in relation to prevailing wind direction as reported by the Maltese Meteorological Services , during Autumn 2008 migration period, over the Maltese Islands

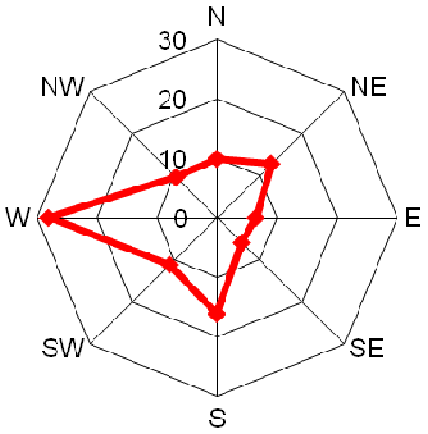
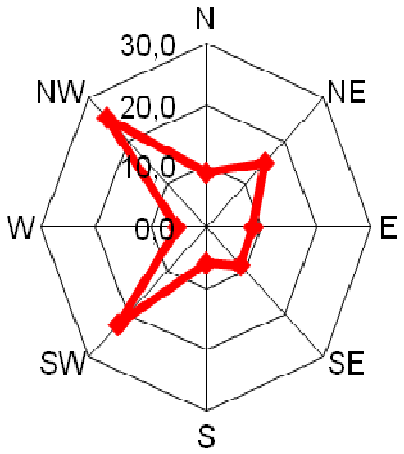


Fig. 2.1.3. Percentage of turtle doves observed in reletion to prevailing wind direction as reported by observers at the time of observation, during Autumn 2008 migration period, over the Maltese Islands



The great majority of quail arrived primarily with westerly winds (the great majority with W wind, fewer with NW and SW winds) and few with easterly winds (SE, E and NE), according to the prevailing wind report by the Maltese Meteorological Services (Figure 2.2.2). The

observers reported the majority of birds arriving with NW wind, while fewer numbers were reported with NE, SE and SW winds (Figure 2.2.3).

Fig. 2.2.2. Percentage of quail observed in relation to prevailing wind direction as reported by the Maltese Meteorological Services , during Autumn 2008 migration period, over the Maltese Islands

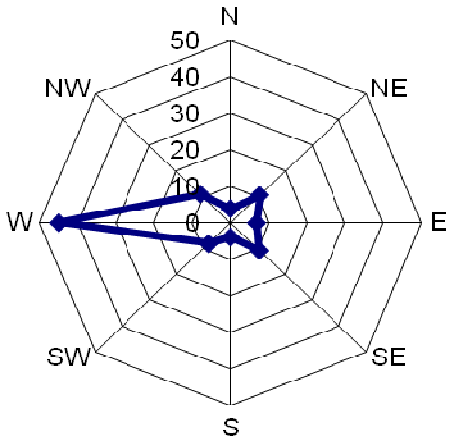
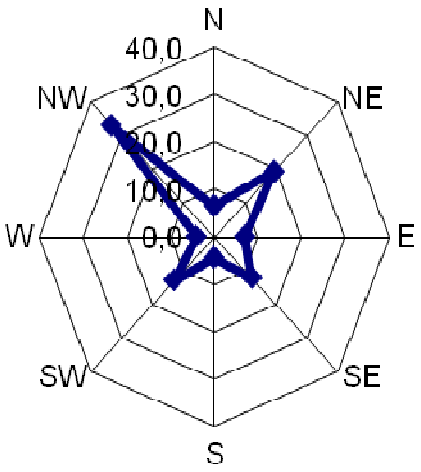


Fig. 2.2.3. Percentage of quail observed in reletion to prevailing wind direction as reported by observers at the time of observation, during Autumn 2008 migration period, over the Maltese Islands



Most turtle doves, during spring 2009, arrived primarily with westerly winds (primarily W and SW, fewer with NW winds) and to a lesser extent SE wind (Figure 3.1.2).

Observers reported that the majority of birds arrived with NW wind and smaller numbers with easterly winds (SE and NE and E winds) (Figure 3.1.3).

Fig. 3.1.2. Percentage of turtle doves observed in relation to prevailing wind direction as reported by the Maltese Meteorological Services , during Spring 2009 migration period, over the Maltese Islands

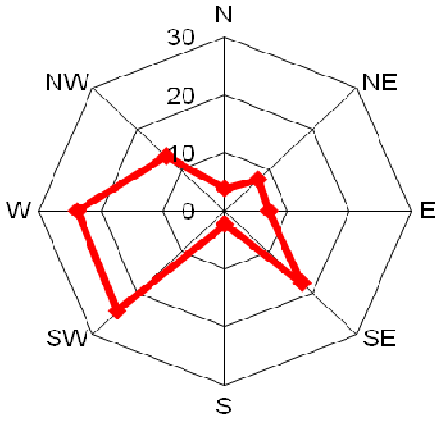
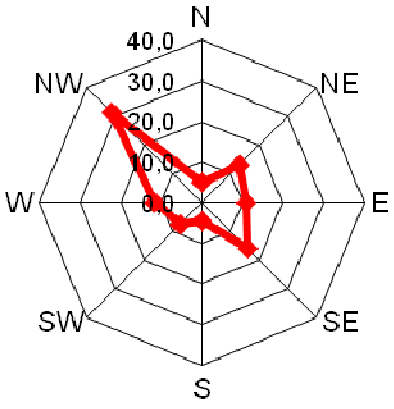


Fig. 3.1.3. Percentage of turtle doves observed in reletion to prevailing wind direction as reported by observers at the time of observation, during Spring 2009 migration period, over the Maltese Islands



Most quail arrived with westerly winds (primarily W and smaller number with NW and SW) and fewer birds with easterly winds (SE, E and NE), according to prevailing wind direction report by the Maltese Meteorological Services (Figure 3.2.2). Observers reported that the majority of quail arrived with NW and SE winds and smaller number with NE and E winds (Figure 3.2.3).

Fig. 3.2.2. Percentage of quail observed in relation to prevailing wind direction as reported by the Maltese Meteorological Services , during Spring 2009 migration period, over the Maltese Islands

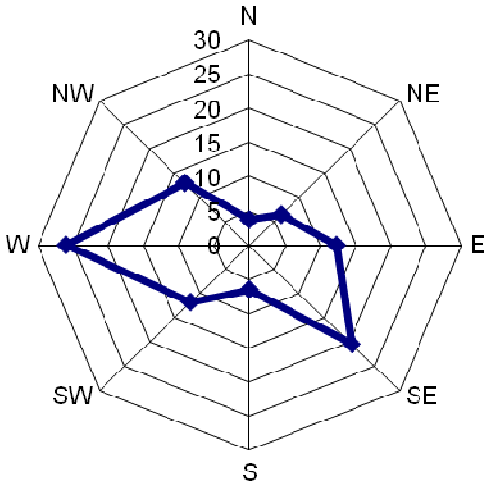
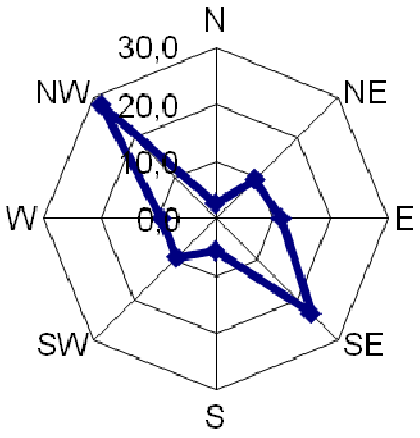


Fig. 3.2.3. Percentage of quail observed in reletion to prevailing wind direction as reported by observers at the time of observation, during Spring 2009 migration period, over the Maltese Islands



In the autumn of 2009, turtle doves arrived primarily with easterly winds (SE, E and NE), and fewer with westerly winds (NW, W and SW), according to prevailing wind direction report of the Maltese Meteorological Services (Figure 4.1.2). Observers reported that the majority of turtle doves arrived with SE, NE and E winds and to a lesser extent, with NW wind (Figure 4.1.3).

Fig. 4.1.2. Percentage of turtle doves observed in reletion to prevailing wind direction as reported by the Maltese Meteorological Servises , during Autumn 2009 migration period, over the Maltese Islands

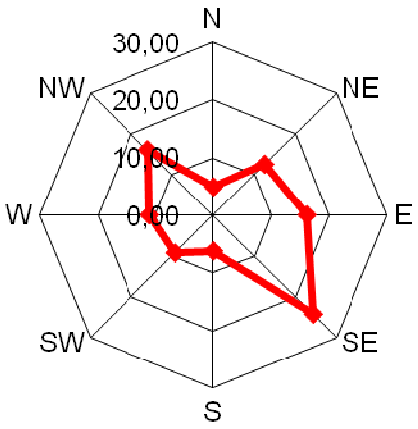
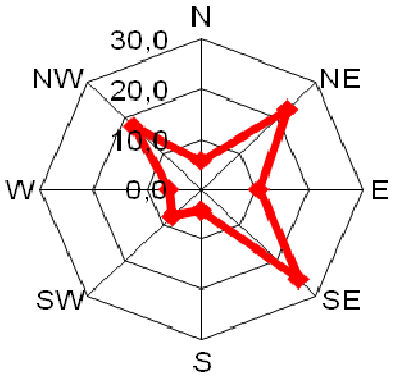


Fig. 4.1.3. Percentage of turtle doves observed in reletion to prevailing wind direction as reported by observers at the time of observation, during Autumn 2009 migration period, over the Maltese Islands



According to prevailing wind direction given by the Maltese Meteorological Services, quail arrived mainly with easterly winds (primarily SE, but smaller number with E and NE wind) and to a lesser extent, NW wind (Figure 4.2.2). Observers reported that the majority of quail arrive with SE wind and to a lesser extent, westerly winds (NW, W and SW) (Figure 4.2.3).

Fig. 4.2.2. Percentage of quail observed in reletion to prevailing wind direction as reported by the Maltese Meteorological Servises , during Autumn 2009 migration period, over the Maltese Islands

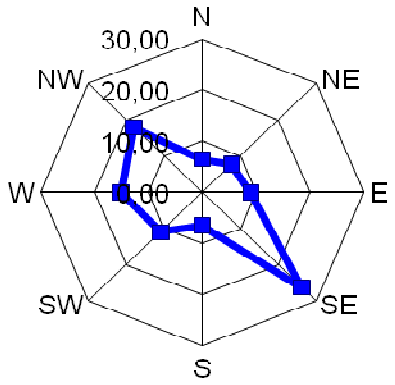
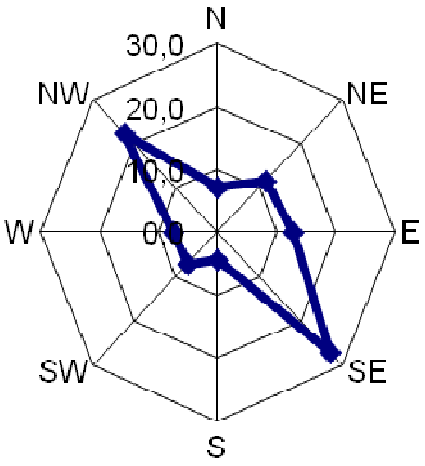


Fig. 4.2.3. Percentage of quail observed in reletion to prevailing wind direction as reported by observers at the time of observation, during Autumn 2009 migration period, over the Maltese Islands



Cloud cover did affect the presence of the two migrant species under study. Increased cloud cover usually inhibited migratory movements causing more birds to remain grounded. Thus more birds, both turtle doves and quail, were counted during cloudy days (Figures A.1 and A.2).

Fig. A.1. Effect of cloud cover (as reported by observers) on turtle dove migration during *Spring and *Autumn 2008 and 2009, over the Maltese Islands.

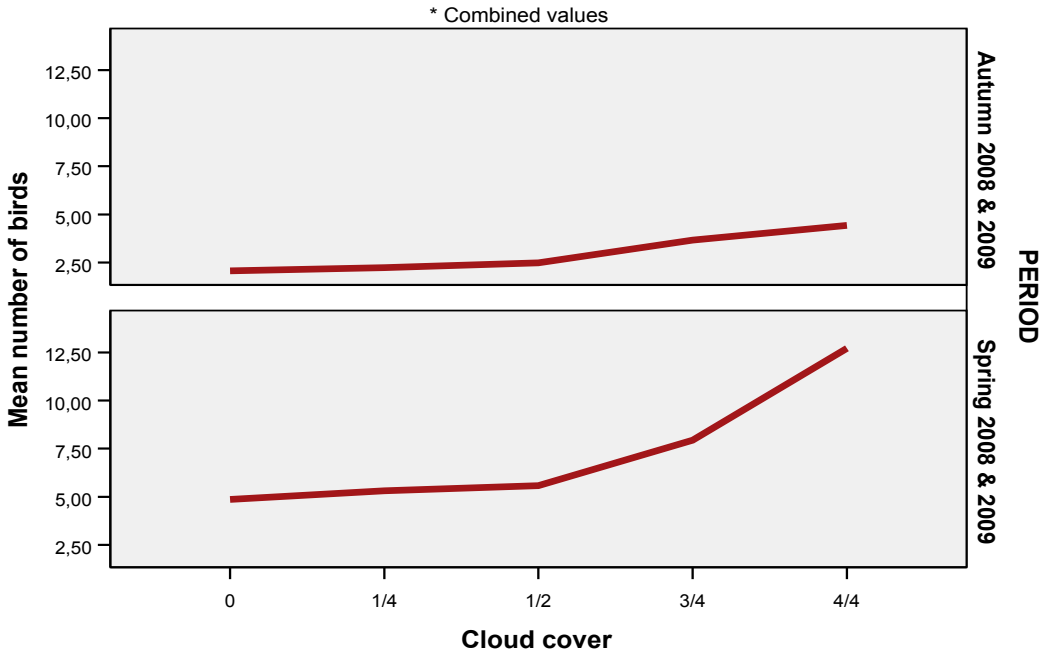
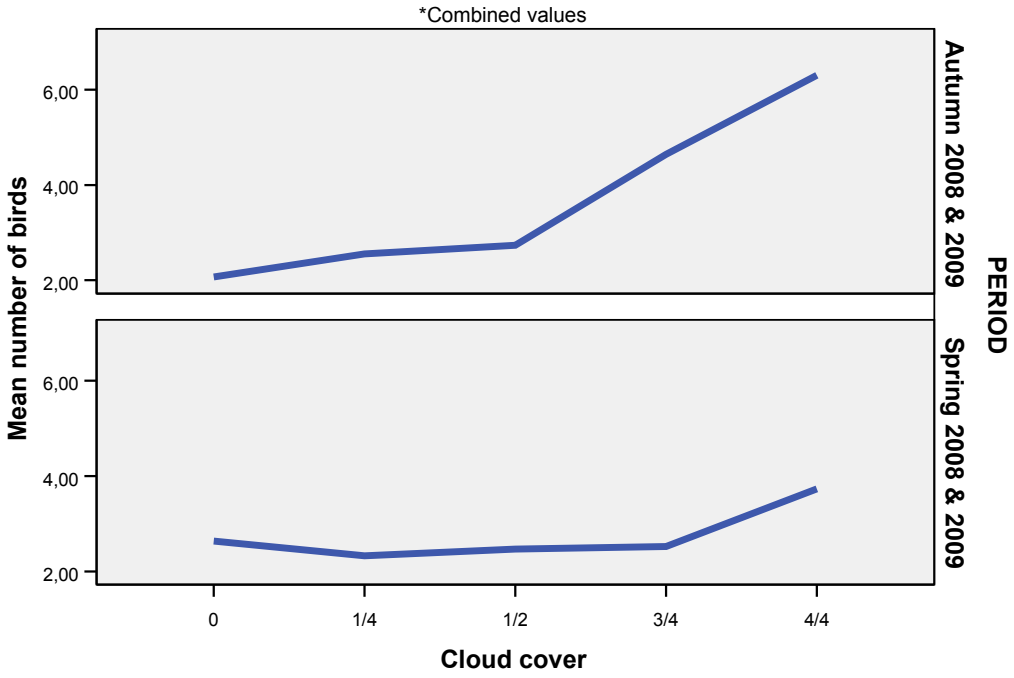


Fig. A.2. Effect of cloud cover (as reported by observers) on quail migration during *Spring and *Autumn 2008 and 2009, over the Maltese Islands.



There was no significant correlation between Mean Wind Speed values and number of turtle doves counted during both the spring (r=0.043, p=0.01, n=5595) and autumn (r=0.129, p=0.01, n=2997) migration periods. The same was true for quail for both spring (r=-0.34, p=0.01, n=2938) and autumn (r=0.049, p=0.01, n=3564). There was no significant correlation between Maximum Wind Speed values and number of turtle doves observed during spring (r=0.013, p=0.01, n=4451) and autumn (r=0.137, p=0.01, n=2997) periods. There was also no significant correlation between Maximum Wind Speed values and numbers of quail recorded during spring (r=-0.032, p=0.01, n=2650) and autumn (r=0.032, n=0.05, n=3566) migration periods.

On the other hand, there was a significant correlation between Rain Day Total values and numbers of migrant birds recorded, during the autumn migration period for both turtle dove (r=0.395, p=0.01, n=1160) and quail (r=0.353, p=0.01, n=1427). This correlation was not significant for the spring migration period for neither turtle dove (r=0.035, p=0.05,n=4073) or quail (r=0.20, p=0.01, n=2362)

NUMBERS OF MIGRANT TURTLE DOVES AND QUAIL DURING SPRING AND AUTUMN

Mean numbers of turtle observed per day were significantly higher during the spring migration periods of 2008 and 2009, compared to the autumn ones (Two –way ANOVA, $F=1160.211$, $df=1$, $p<0.05$). Mean numbers of quail observed were also significantly higher in the spring than autumn (Two-tailed ANOVA, $F=191.903$, $df=1$, $p<0.05$) (Table 1).
This means that much higher numbers of turtle doves and quail were observed during the spring migration periods, than during the autumn ones.

Table 1. Mean number of turtle doves and quail observed per day during Spring and Autumn migration periods of 2008 and 2009 on the Maltese islands.

Species	Spring 2008 Mean +/- S.E.	Autumn 2008 Mean +/- S.E.	Spring 2009 Mean +/- S.E.	Autumn 2009 Mean +/- S.E.
Turtle dove	12.25 +/- 1.58	0.20 +/- 0.01	2.41 +/- 0.08	0.22 +/- 0.01
Quail	0.82 +/- 0.12	0.34 +/- 0.02	0.59 +/- 0.02	0.25 +/- 0.01

DISTRIBUTION OF MIGRANT TURTLE DOVES AND QUAIL IN THE MALTESE ISLANDS

DATES AND NUMBERS

Turtle dove

In the spring of 2008, turtle doves were first recorded in both islands on April 10 (beginning of observations). The first peak of turtle dove numbers on both islands was on

April 14, with mean number of 99.71 and 92.75 birds observed in Malta and Gozo, respectively. A higher peak occurred in Gozo on April 20 with a mean of 118.62 birds observed, while in Malta only a mean of 7.30 birds was recorded. There were 3 other peaks, on April 29 in Gozo with a mean number of 20.12 and birds observed, while on Malta a mean of 9.16 birds was recorded, on April 30 with mean number of 6.87 birds recorded in Gozo and 14.85 in Malta and on May 3 with a mean number of 19.12 birds recorded in Gozo and 6.05 in Malta. The mean daily number of turtle doves recorded in Gozo was higher on 26 out of 41 days of observations, compared to Malta. Mean number of birds observed per day ranged from 1.00-11.42 for Gozo and 0.43-9.94 for Malta (high peaks excluded). The last observations of turtle doves were on May 20, in both islands.

During the autumn 2008, the first turtle dove was recorded in Malta on August 7, while in Gozo, on August 20. Three peaks in both islands occurred of approximately equal magnitude, on September 3, 10 and 27. Mean number of birds recorded in Malta were 1.72, 1.69 and 1.32 and in Gozo 1.88, 2.16 1nd 1.16, respectively (Figure 5.1). There seems to be no clear differentiation in the mean numbers per day recorded between the two islands. The last turtle doves were recorded on October 25 in Gozo and December 1, in Malta.

During spring 2009, the first turtle dove was recorded in Malta on March 8, while on Gozo, on March 20. The highest peak in turtle dove numbers was on April 23 in both islands, but much higher in Gozo, with mean number of 74.54 birds recorded, while for Malta the mean number of birds was 25.72 for that day. The mean number of turtle doves recorded in Gozo was higher on 37 out of 85 days of observations, compared to Malta. Mean number of birds observed per day ranged from 0.04-13.27 for Gozo and 0.03-5.99 for Malta (high peaks excluded). The last turtle doves were recorded on May 31, on both islands.

During autumn 2009, there were two simultaneous peaks on both islands, of similar magnitude. The smaller one was on September 8 (mean number of birds observed 3.24 in Gozo and 2.13 in Malta) and the higher one on September 23, with mean number of 4.40 birds observed in Malta and 3.31 in Gozo (Figure 6.1). There seems to be no clear differentiation in the numbers recorded between the two islands. The last turtle dove was recorded in Gozo on October 27 and in Malta on December 13.

Quail

In the spring of 2008, the first observation of quail in both islands was on April 10. During spring migration, quail arrived in Gozo at first, in much higher numbers, than in Malta. Two high peaks occurred in Gozo on April 17 and 29, with mean number of 8.88 and 9.00 birds recorded, respectively. On the same dates, only a mean of 0.72 and 0.40 birds were recorded on Malta. The number of quail recorded in Gozo was higher on 38 out of 41 days of observations compared to those recorded in Malta and specifically during April 11 thru 30, May 1-15 and 17-19. Mean number of birds observed per day ranged from 0.12-4.75 for Gozo and 0.02-0.61 for Malta (high peaks excluded). The last quail were recorded on May 19 in Gozo and May 20, in Malta.

During the autumn migration period of the same year, the first observations of quail were on August 9 in Malta and August 23, in Gozo. The high peak in quail numbers occurred on September 27, in both islands. Mean number of birds observed were 14.27 for Gozo and 9.08 for Malta for that day (Figure 5.2). There seems to be no clear differentiation in the mean numbers per day recorded between the two islands. The last quail recorded were on December 13 in Gozo and December 15 in Malta.

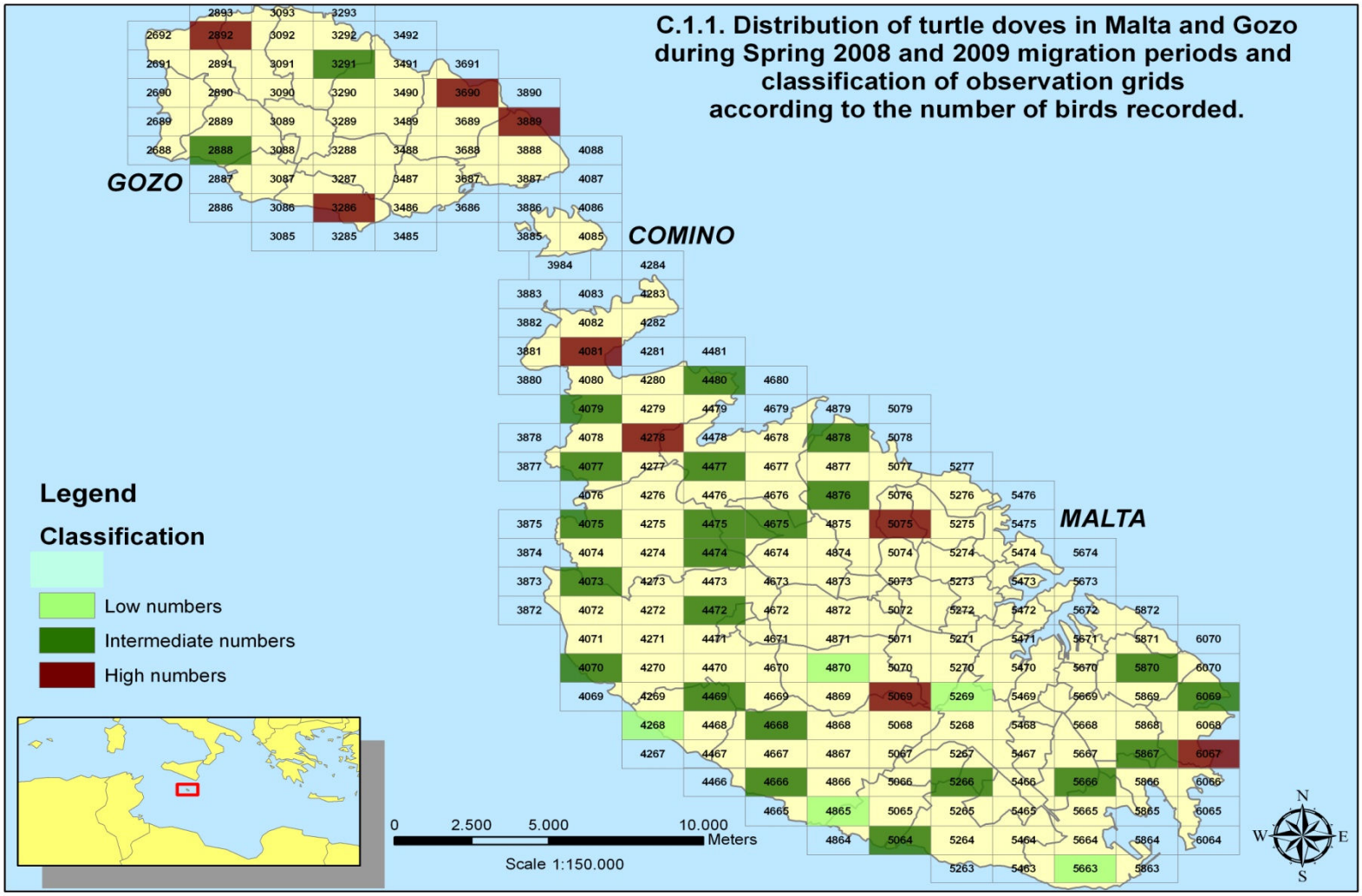
In the spring 2009, the first quail were recorded on March 8 in Malta and March 9, in Gozo. Quail numbers showed two high peaks in Gozo, on April 16 and 23. Mean values of birds observed were 7.45 and 6.95, respectively. On those dates, mean values of only 2.08 and 1.40 birds were observed in Malta. The number of quail recorded in Gozo was higher on 53 out of 85 days of observations compared to those recorded in Malta and specifically during March 24-31, April 1-30 and May 1-15. Mean number of birds observed per day ranged from 0.04 -4.22 for Gozo and 0.02-2.50 for Malta (high peaks excluded). The last quail observed during this period were on May 28 in Gozo and May 31 in Malta.

During the autumn of the same year, the first quail was recorded on August 7 in Malta and August 24, in Gozo. Quail numbers peaked on September 23, with mean number of birds observed 6.63 in Gozo and 6.05 in Malta (Figure 6.2). There was a minor peak on September 19 with a mean number of 2.31 birds recorded in Gozo and 0.73 in Malta, and another one on September 24 with a mean of 3.54 and 2.12 birds observed in Gozo and Malta, respectively. There seems to be no clear differentiation in the numbers recorded per day between the two islands. The last quail observed were on December 6 in Gozo and December 15, in Malta.

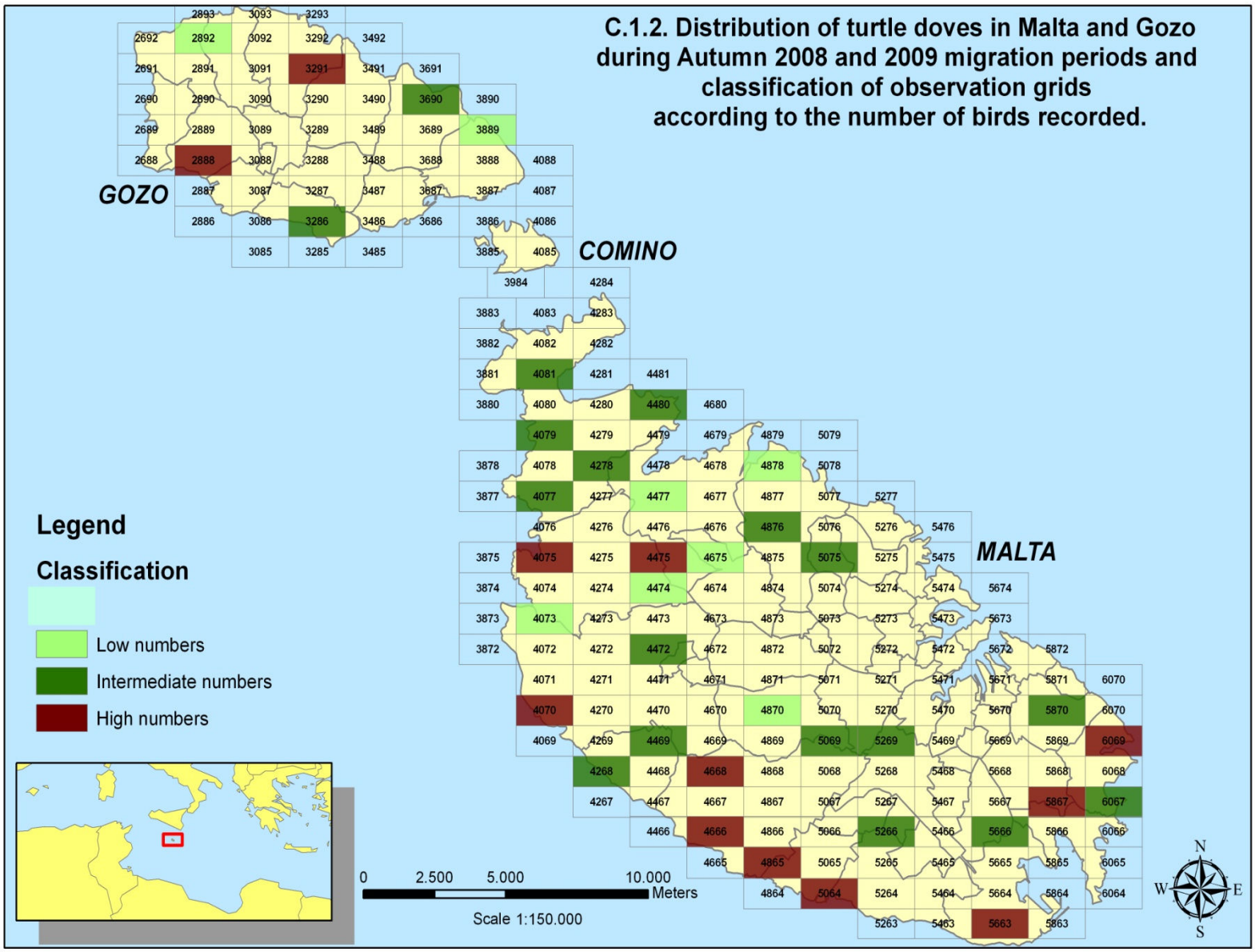
SPATIAL DISTRIBUTION

Turtle dove

During the spring migration periods, turtle doves spread more to the northwest, west and east part of Malta, as well as inland, where they appeared in high numbers, having a rather even distribution on the island at this time. In Gozo, high numbers appeared on all observation grids, along both the north and south coast of the island (Map C.1.1)

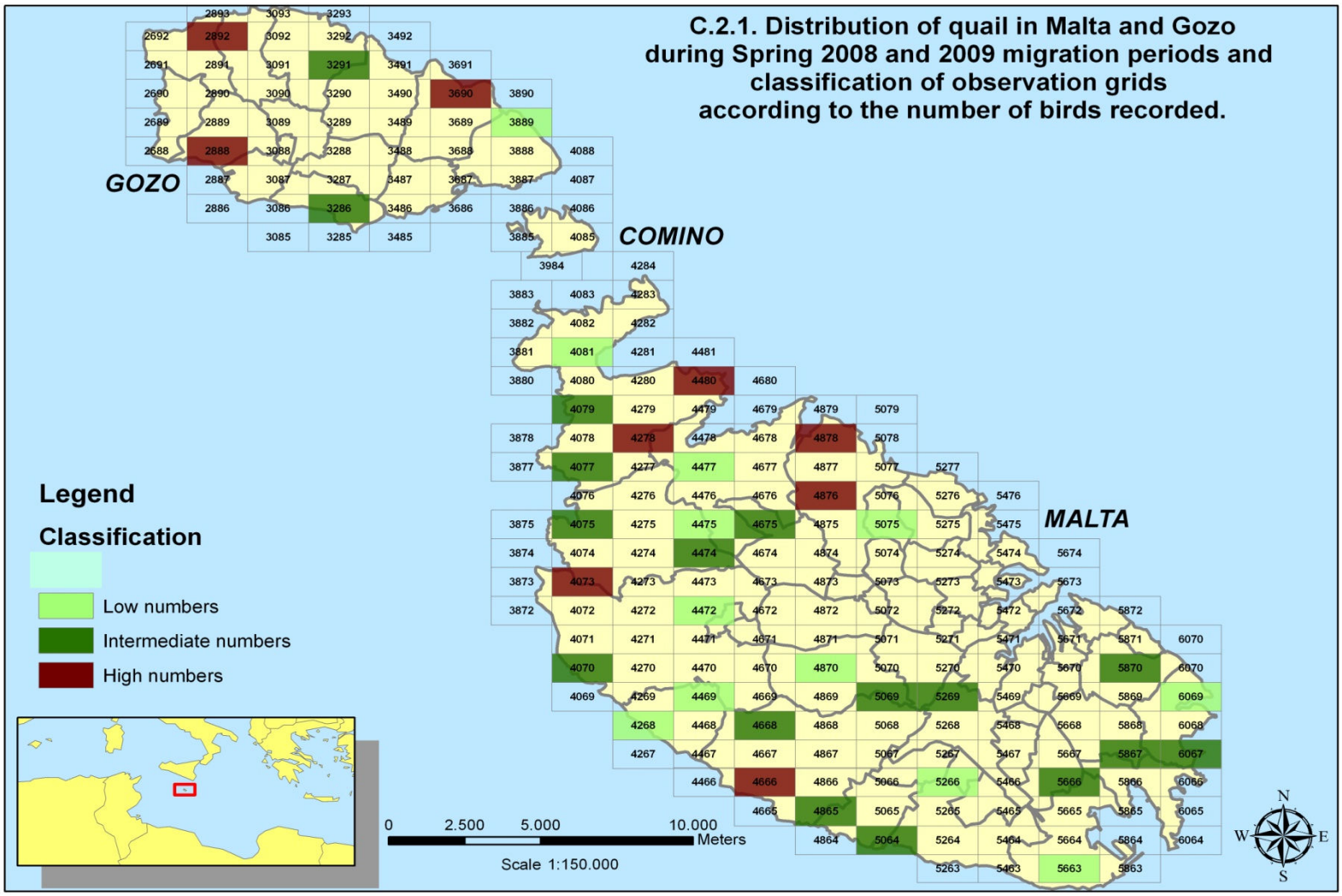


During the autumn migration periods, turtle doves in Malta seem to have concentrated more on the NW part and the south and eastern coastline. Inland grids carried smaller numbers. In Gozo, grids on the north and south coast carried the highest numbers, while the grids on the NE and E side carried small number of birds (Map C.1.2)

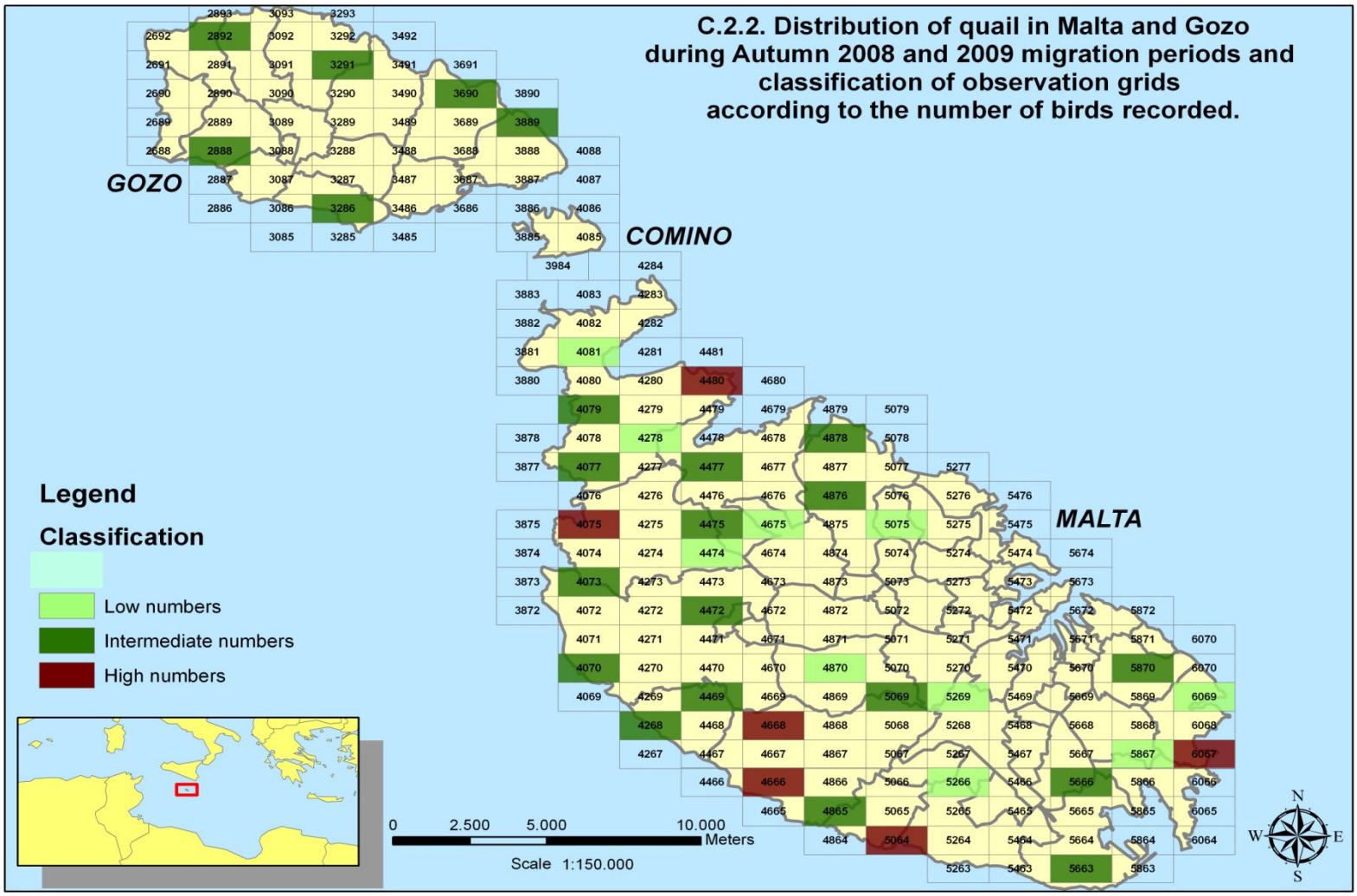


Quail

During the spring migration periods, quail in Malta seemed to concentrate in the north-northwest area and along the west coast of the island. Distribution on the rest of the island was variable, with grids inland holding lower numbers. Higher numbers were also recorded along the south and south-east coast of the island. In Gozo, high numbers appeared on the north and south coasts, with all but one grid on the NE, belonging to the high and intermediate category (Map C.2.1)



During the autumn migration periods, the highest numbers of quail in Malta were recorded along the west and south coast, and to a lesser extent, the southeast coast. In Gozo, all grids were classed in the intermediate category (Map C.2.2).



It must be noticed that for both species, observation grids during either spring or autumn migration period changed classification. This means that birds seemed to prefer some areas more than others during each migration period. Differences in the total numbers of both turtle dove and quail observed in each grid during each of the four migration periods covered by the study, are shown in Figures 7, 8, 9 and 10.

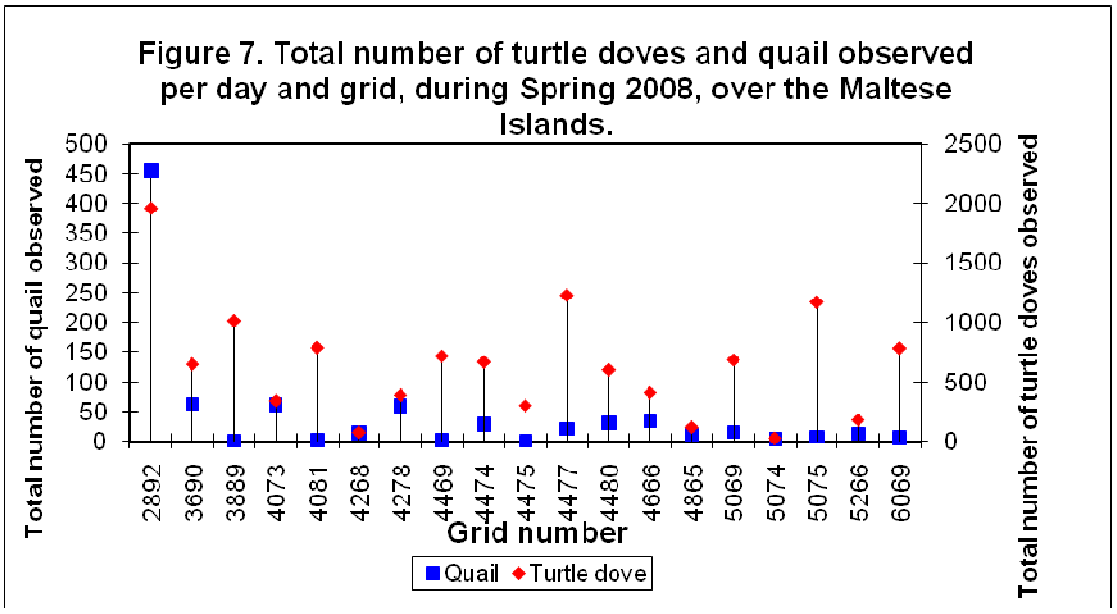


Figure 7. Total number of turtle doves and quail observed per day and grid, during Spring 2008, over the Maltese Islands.

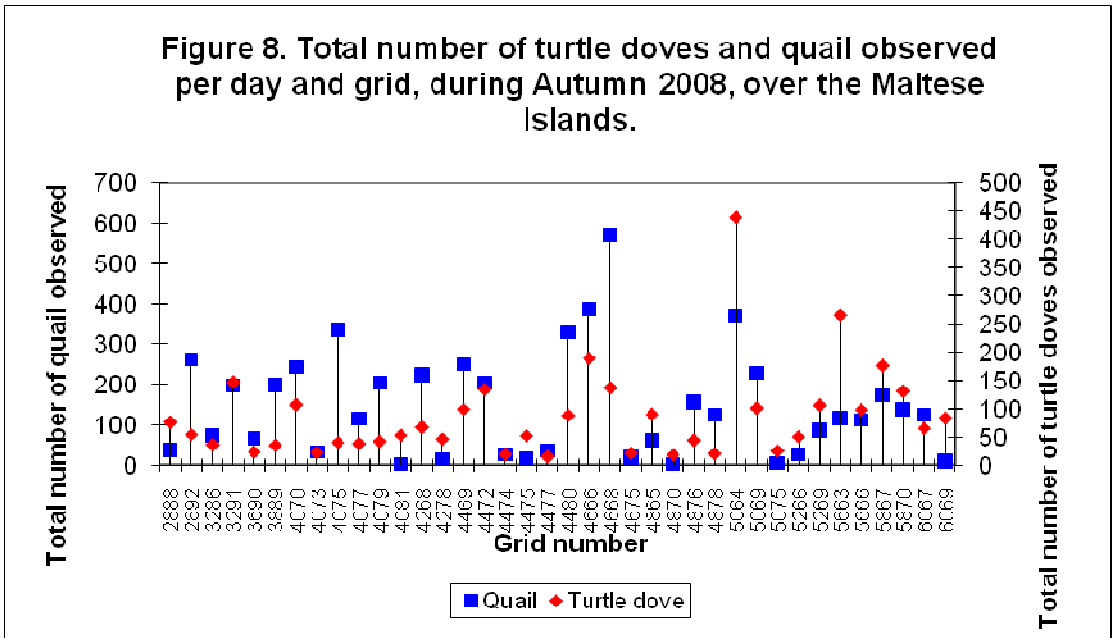


Figure 8. Total number of turtle doves and quail observed per day and grid, during Autumn 2008, over the Maltese Islands.

Figure 9. Total number of turtle doves and quail observed per day and grid, during Spring 2009, over the Maltese Islands.

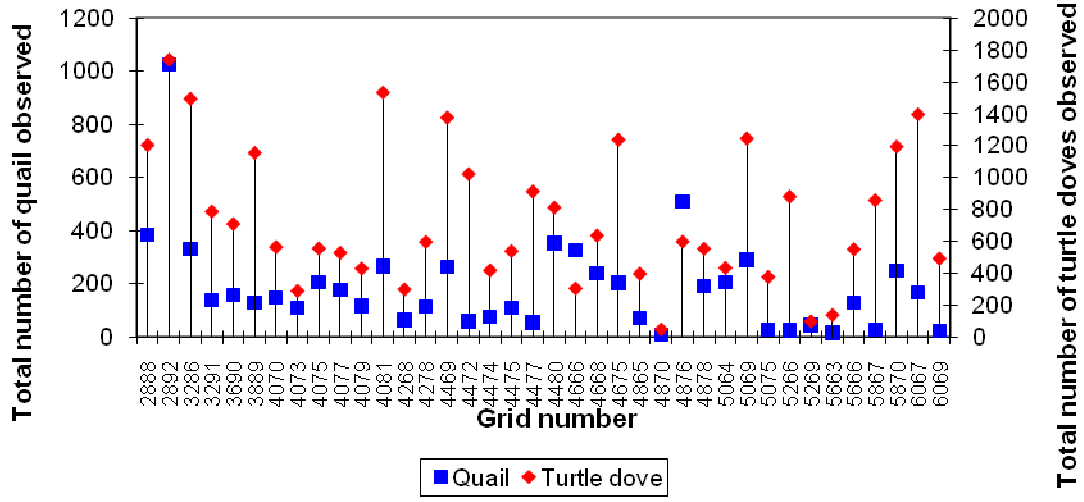
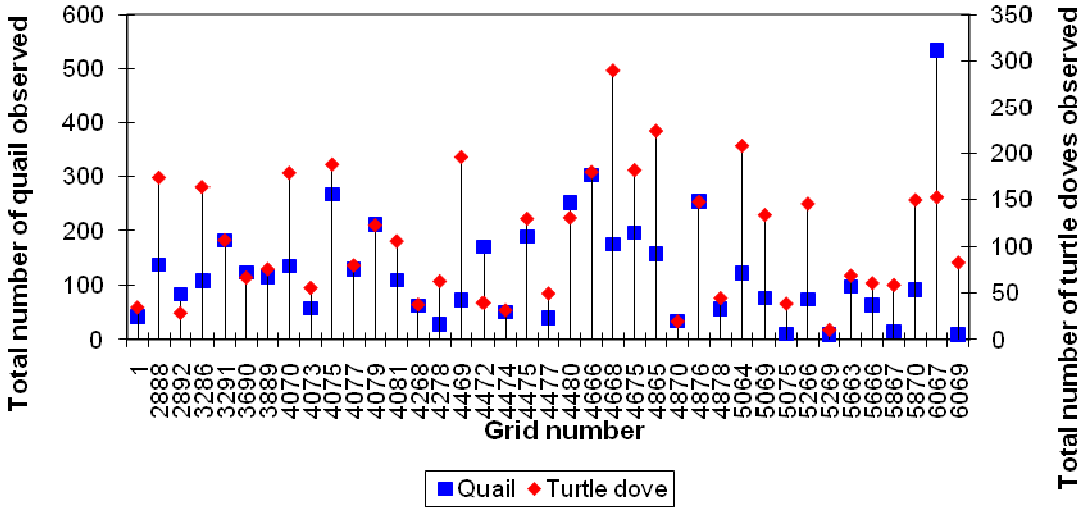
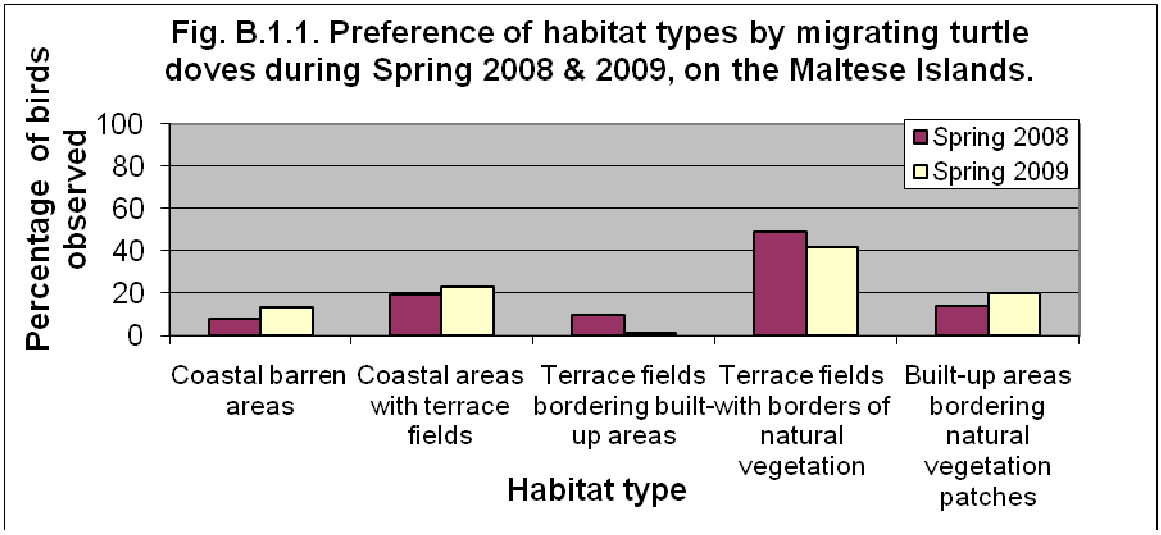


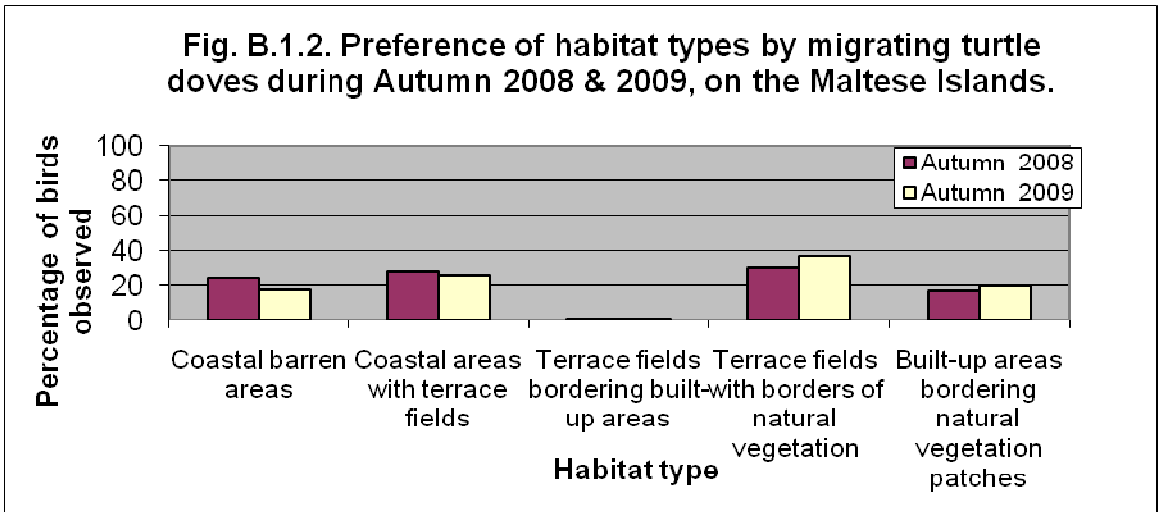
Figure 10. Total number of turtle doves and quail observed per day and grid, during Autumn 2009, over the Maltese Islands.



HABITAT USE

Turtle doves used terrace fields with natural vegetation borders more than any other types, during both spring and autumn. This habitat type was used more during spring than autumn. Cultivated fields and coastal barren areas with terrace fields were used more during autumn rather than in the spring, the second being used more than the first, during both periods. Built-up areas bordering natural vegetation patches were used about equally during both periods. Terrace fields bordering built-up areas were the least used (Figures B.1.1 and B.1.2).





Quail used terrace fields with natural vegetation borders more than the other habitat types, during both spring and autumn migration periods at about the same rate, with the exception of spring 2008, when use was much higher. Cultivated fields and coastal barren areas with terrace fields were used more in the autumn than in the spring, the second being used more than the first, during both periods. Built-up areas bordering natural vegetation patches were used about equally during both spring and autumn. Use of terrace fields bordering built-up areas was minimal during both periods (Figures B.2.1 and B.2.2).

Fig. B.2.1. Preference of habitat types by migrating quail during Spring 2008 & 2009, on the Maltese Islands.

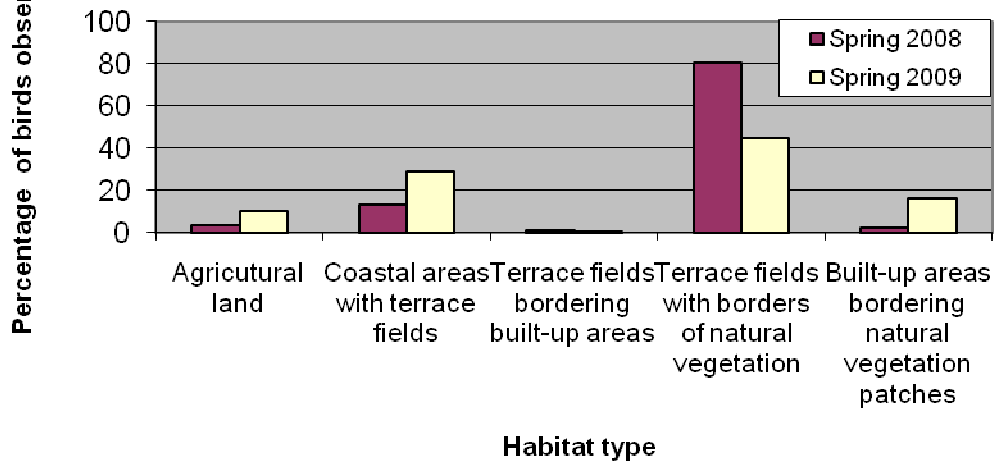
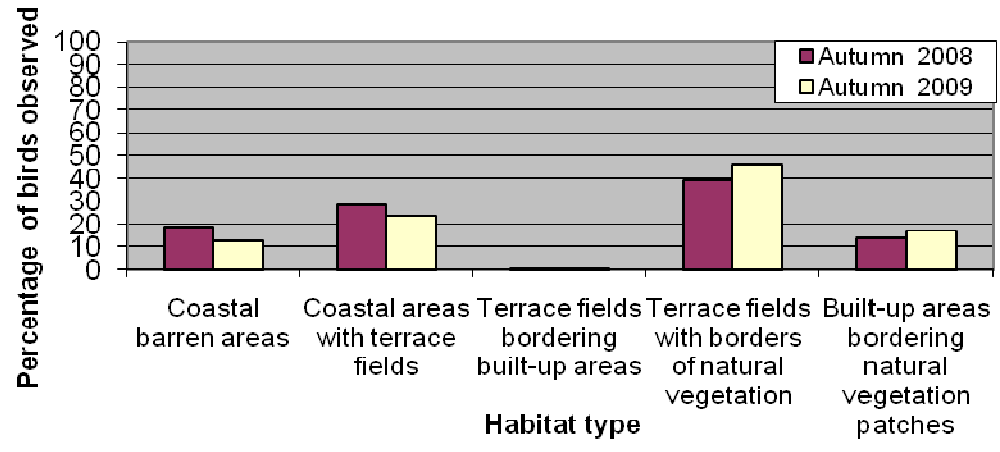


Fig. B.2.2. Preference of habitat types by migrating quail during Autumn 2008 & 2009, on the Maltese Islands.



DISCUSSION

GENERAL

The Mediterranean Sea is in the path of a great number of migrating birds, to and from Europe. Moreau (1953, 1961 and 1972) provided abundant evidence that passerine and similar species cross the Mediterranean Sea in a broad front, instead of concentrating at narrow crossings. He mentioned that quail were rarely seen except close to the land they are approaching, thus assuming that many species cross in the dark or travel too high for 4detection. Moreau (1938) concluded that the extent of concentration on the short crossings had been exaggerated for such species.

Moreau (1953) in discussing migration over the Maltese Islands, pointed out that there was lack of evidence in favour of high concentrations of small birds. Gibb (1951) also concluded that birds in the Maltese Islands were seldom present in such numbers as to suggest that the Islands receive any concentrated stream passing on a narrow front. Moreau (1961) cited Steinbacher (1954, 1955) who made a rather extensive study of migration in Sicily and concluded that migrant birds did not concentrate extensively on Sicily any more than they do on Malta. Casement (1966), through radar observations of migrant birds over the Mediterranean, concluded that the short crossing form Sicily to Tunisia may encourage concentrations of larger soaring birds, but evidence showed that this was not true for night migrants and similar other birds.

So Malta receives only a small fraction of the birds that travel along a broad front over the Mediterranean. De Lucca (1969a) also supported this view by stating that several species were present on most days on the Maltese Islands, but spectacular passages were scarce and irregular.

MIGRATION DATES

The great majority of turtle doves were present on the Maltese Islands from April 10 thru May 20, during the both spring migration periods of the study. The majority of quail were present during the same period for a slightly shorter time, from April 10 thru May 12.

During the autumn migration period of 2008 and 2009, most turtle doves were recorded between September 7 and 28. Quail were most abundant during the same period. Observations for the present study were obtained from March thru May for the spring migration period and August thru December for the autumn one. There are no observations beyond these periods.

Ornithologists and observers of Maltese birds, in earlier years, generally agree with the dates of appearance of turtle doves and quail on the islands as recorded by this study, each however with varying degree of accuracy. Wright (1864a) stated that turtle doves pass in large flocks in April and May and then again in September. For quail, he stated that they pass in the greatest numbers in September, but large flights may occur in April.

According to Roberts (1954), turtle doves are common passage migrants in the Maltese Islands during April and May and then in September and October. He offered no information on quail, but instead he quoted Wright (1864a). De Lucca (1969a) wrote that turtle doves, as well as quail, were present from March to May and September thru October. Bannerman and Vella-Gaffiero (1976) cited Schembri (1843) who wrote that the turtle dove is met in April and September. They also quoted Wright (1864a) on this matter and further stated that this species appears in the autumn between the end of August and the beginning of October. They offered no information on quail. Sultana and Gauci (1982) stated that turtle doves migrate through the Maltese Islands during spring, from late March to early June and most from mid-April to mid-May, while in autumn, they pass from late August to mid-October, occasionally until late November. In the earlier version of this guide (Sultana et al. 1975) mentioned that a single turtle dove reported in November, may have been an escapee. However, the present study and other works verify presence of turtle doves during this month and even until December. For quail, the dates given are from late February to May in the spring and late August to mid-November in the autumn, with the bulk of birds occurring in April and September. Gibb (1947) gave exact dates of observation for the beginning and end of migration through the Maltese Islands for a number of bird species, during the period 1941-1945. In the spring of 1942, extreme dates for turtle doves were April 11 and June 28. During the years 1943, 1944 1nd 1945, first and last dates of migration fell within these brackets. For autumn migration, the extreme dates given were September 3 (1942) and October 8 (1944). Presence of turtle doves during the rest of the years fell within the aforementioned dates.

Observations published in “Il Merill” agree with the findings of the study. The first turtle doves during the spring migration period were recorded between March 3 and 11, but their presence became regular during April. The height of migration was reported from mid-April to mid-May, but passage continued until late May. There were scattered sightings during June and even during July of 1-6 birds at a time. During the autumn migration period, the first birds were recorded during the first half of August. The bulk of the birds were observed from late August through late September. Passage of birds was recorded into October, with the last birds having been recorded during the second half of this month. The latest records of turtle doves were on November 7 (1991) and on November 24 (1984).

Few irregular sightings of quail of no more than 1-3 birds at a time have been recorded on single dates even in February, usually during the second half of the month. Quail have been recorded even in January, in two separate years, 1975 and 1997. Otherwise, quail were first reported within the first half of March and as early as March 1. The majority of birds were reported passing during the month of April in some years, while in others between mid-April and mid-May. According to these observations, spring migration extended till the last half of May. During the autumn season, birds were reported as early as July 31 (1977), but usually the first arrivals were recorded in mid-August. The majority of birds were present on the Islands from mid-September to mid-October. The last birds were mostly recorded during the last half of November, but there were cases of quail being present between December 11 thru 25 (1978, 1993 and 1995). (“Il Merill” 1970-2005).

The Carnet de Chasse recorded turtle doves shot and/or trapped, in single- figure numbers, in January (2002-2007) and February (2004-2007) and few quail having been harvested in January (2002-2007) and February (2003, 2004, 2005 and 2007) (MEPA 2002-2007).

Fenech (2010) stated that turtle doves are present in the Maltese islands from March to early June (most seen from mid-April to mid May) and from mid-August to September. He gave certain dates for 2008, such as April 14 as a peak date, which coincides with the findings of this study and other peak dates such as May 4, close to May 3, reported as a minor peak in this study. He also mentioned other dates as high peaks, but observations are from few or even one location with often less that 100 birds reported. For quail, he did mention the dates of September 27 and 28, 2008, the first coinciding with the grand peak reported also by the study. He gave no dates for the spring 2009, but did report the strong passage on September 23, which coincides with the grand passage recorded by

the present study. He did not specify numbers of birds observed, but rather gave descriptions of the situation. He did not give spring migration dates for 2009, but did mention that in the autumn of that year, quail were more numerous between September 8 and the end of October.

Turtle doves in the Mediterranean migrate in late July to September, with strugglers into October. The main northward passage is in the second half of April, with the breeding areas reoccupied during May (Cramp 1985). The autumn passage of quail through the Mediterranean is from late August to October (peak in mid-September), while in the spring they cross from March to mid-May with peak in April (Cramp 1980). The above agree with the findings of the study and reinforce the notion that the two species move over the Mediterranean in a broad front.

WEATHER CONDITIONS AFFECTING MIGRATION OF TURTLE DOVE AND QUAIL

There are no mono-factorial links between climate and weather and bird migration. Migrant birds prefer to fly with light favourable tailwinds and clear skies. There is a clear tendency to reduce or interrupt migratory activity for hours or even several days in poor weather conditions, such as headwinds, cloudiness, precipitation etc. (Berthold 2001). Normally, precipitation and cloudiness reduce birds aloft, but rarely suppress migration totally (Berthold 1996). Wind is another immediate influencing factor in bird migration. Migrants tend to fly low in opposing winds and settle down or reach coastlines or islands. High or low migratory activity may be due to a favourable or non-favourable conjunction of weather variables and not to optimum or not values of one or few of them (Newton 2008).

During the spring of 2008 and 2009 turtle doves arrived primarily with westerly winds and fewer with easterly winds. This agrees with the findings of De Lucca (1969b) who reported that during the spring migration, westerly winds favoured the appearance of most day migrants, such as the turtle dove. He also mentioned that many birds, turtle doves included, were grounded with westerly winds, especially during the height of spring migration (late April-early May).

During the autumn of 2008 the majority of turtle doves also arrived with westerly winds and in the spring of 2009 most came with westerly winds and fewer with SE wind. These observations agree with De Lucca (1969b) who observed that daily migrants, such as this species, appeared with westerly winds, but also pointed out that high numbers were also recorded with easterly winds, especially trans-Saharan migrants.

During the spring of 2008 the majority of quail came with easterly winds and fewer with NW and W winds, while in the same period of 2009 more birds arrived with W, NW and SW winds, while somewhat fewer birds, with easterlies. This agrees only in part with Wright (1864a) who wrote that quail in the spring appear with NNW to SSW winds and with Sperling (1864) who stated that quail appeared in great numbers if there was wind from the west or northwest, but very few if the wind were from the eastward. On the other hand, this study is in agreement with De Lucca (1969b) who stated that mainly easterly winds are associated with night migrants, such as this species. He also mentioned that quail were also found with westerly winds, during this time of the year.

During the autumn migration period of 2008, the majority of quail appeared with W wind and in 2009, mainly with SE wind and a lesser extent, westerly winds (NW, W and SW). These findings agree partly with Wright (1864a) who stated that quail at this time of the year pass with SSE and NNE winds and with Sperling (1864) who wrote that the right time to look for quail in the autumn is with easterly or south-easterly wind. The findings of this study agree in general with De Lucca (1969b) who reported that during autumn, night migrants pass mostly with easterly winds. He did mention, however, that quail are also found with westerly winds.

Sultana and Gauci (1982) expressed scepticism concerning the writings of De Lucca (1969b), stating that in their experience, there is no evidence to support a connection between specific wind direction and appearance and numbers of day or night migrants since large influxes of either category of birds occur at the onset of head winds, regardless of their easterly or westerly component.

NUMBERS OF MIGRANT TURTLE DOVE AND QUAIL DURING SPRING AND AUTUMN

Migrant turtle doves passing through the Maltese Islands are more plentiful in the spring than in the autumn. Earlier ornithologists and observers of Maltese birds attested this fact.

Wright (1864a) stated that turtle doves pass in large flocks in the spring and in the autumn they reappear on their way from Europe, but are not generally as plentiful as in spring. Despott (1917) wrote that this bird is seen in great numbers only in the spring. Roberts (1954) referred to this species as a common passage migrant in the spring, re-passing in much smaller numbers in the autumn. De Lucca (1969a) stated that the turtle dove is very common and regular in spring and frequent in autumn. Elsewhere, he wrote that turtle doves pass in much smaller numbers in autumn than spring (De Lucca 1969b). Sultana et al. (1975) and Sultana and Gauci (1982) characterized this bird as a common spring migrant. They also stated that in autumn it passes in much smaller numbers. Bannerman and Vella-Gaffiero (1976) referred to the statements by Wright (1864a), Despott (1917) and De Lucca (1969a) and further stated that the turtle dove in its spring migrations can be termed as common, while in the autumn it arrives in much smaller numbers. Finally, Sultana and Falzon (2002) referred to the turtle dove as common in the spring and scarce in the autumn, while Fenech (2010), as very common in the spring and common in the autumn.

Harvest numbers are generally an indication of the relative availability of the game species in pursuit. The Carnets de Chasse indicate that for the years 2002-2007 the turtle dove harvested during spring (March-May) ranged from 24,804 to 47,949 birds, while those harvested during autumn (September-February) ranged from 3,730 to 6,193 birds (MEPA 2002-2007). The results of the 2007 portion of this study (conducted under a different consultant) are also in agreement. Mean daily number of turtle doves observed was 3.99 (+/-1.590) in the spring, while only 0.299 (+/-0.038) in the autumn. Likewise, the mean number of turtle doves harvested per day was 0.699 (+/-0.20) in the spring and 0.088 (+/-0.016) in the autumn (Thomaidis and Micali 2008).

Migrant quail numbers were also higher in the spring than the autumn, as shown by the findings of the present study. Data from the year 2007 verify that the mean number of quail recorded per observation day during spring 2007 were 0.528 (+/- 0.101), while only

0.153 (+/-0.018) during the autumn period of the same year. The recorded harvest in the study was in accordance to the relative availability of quail during the two migration periods, 0.255(+/-0.006) harvested per day in the spring and 0.071(+/-0.009) in the autumn (Thomaidis and Micali 2008). According to the Maltese Carnets de Chasse for the years 2002-2007, the number of quail harvested during the spring migration (March –May) ranged from 12,823 to 27,647, while those harvested during autumn (September-February) ranged from 4,305 to 8,422, the difference stemming from the higher number of quail passing through in the spring (MEPA 2002-2007). Most of the earlier ornithologists or observers did not make any comments on the difference in numbers of migrant quail in the Maltese Islands, during spring and autumn migration periods. The problem is that almost none of them counted quail systematically and efficiently. Wright (1864) stated that quail come in the greatest numbers in September, though in April very large flights occur. De Lucca (1969b) commented that he recorded more quail in the autumn (612) than in the spring (381). However, he seemed to express some doubt over these results, as he stated that more counts are needed. He carried out observations during spring of 1963, autumn 1965 and spring 1966, from 7 observation points (6 in Malta and 1 in Gozo) with the help of three other observers. Extra counts to determine the volume of migration during the two migration periods were made in autumn of 1965 and spring of 1967. He did not specify the method by which he obtained those figures. Also, the irregularity of the observation seasons may have contributed to this discrepancy. Bannerman and Vella-Gaffiero (1976) referred to the writings of Wright (1864a) and Schembri (1843), who claimed that quail were very common during both seasons especially during autumn. Sultana and Gauci (1982), Sultana and Falzon (2002) and Fenech (2010) did not offer any comment on differences in migrant quail numbers during spring and autumn migration.

A further proof that quail were not systematically counted is the small number of observations for this species compared to those for turtle dove, which are published in “Il Merill” (1970-2005). Only sporadic observations on quail are recorded for spring migration periods, and as for the autumn ones, only scant records, to the point that only four less observations are recorded for the entire autumn migration period in certain years (one in 1978, 1979, 1980, 1985, 1986, 1987, 1989 and 1990, two in 1988 and four in 1982). This is all due to the cryptic nature of quail, which is very difficult, under normal circumstances, to locate and flush without the aid of a dog. Another reason may have been denial of access to the observers to private property to count quail.

The reason for the difference in the numbers of migrant turtle doves and quail during spring and autumn over the Maltese Islands is probably that these birds use different routes during the two migration periods. Loop or eclipse migration is found in a number of bird species and may be clockwise or counter-clockwise. This causes big seasonal differences in the number of birds observed at particular stopover sites, or some sites that are favoured in the autumn are almost deserted in the spring. The most spectacular migration is that of the red-backed shrike (*Lanius collurio*). These birds travel from the Iberian Peninsula in an easterly direction through central Italy, former Yugoslavia, Greece and North-East Africa to the resting areas in Central and South Africa. In the spring, they migrate along east Africa, through the Arabian Peninsula and the Middle East to reach Europe (Berthold 2001, Newton 2008). Another such species is the pied flycatcher (*Ficedula hypoleuca*), which leaves north central Europe in the autumn and migrates along the western coast of Europe into northeast Africa. The return trip takes place through Tunisia, Malta, Sardinia and Corsica into central Europe (Newton 2008). De Lucca (1969b) suggested loop migration through Malta for a number of species, including the quail and starling (*Sturnus vulgaris*), based on ringing recoveries of birds that were ringed at a time of the year other than the one they were recovered. Moreau (1961), based on observations of others, concluded that in the sector of Mediterranean that comprises Tunisia, Tripoli and Cyrenaica (Libya) and Malta, far more migrants are seen in the spring than in autumn. Thus, it may be concluded that Malta is on the return corridor of loop migration of a number of species, including those under study.

Loop migrations of turtle doves also occur in Cyprus where they are more numerous in the spring than autumn (Cramp 1985). Turtle doves were observed more frequently during spring migration than during the autumn one, through six coastal observatories in England from 1963-1998, probably because they follow a different migration route during each migration period (Browne and Aebischer 2003). Cramp (1980) and Guyomarc'h and Wallace (1998) cited Toschi (1956), who described circular movements of quail around the western Mediterranean. Berthold (2001) cited Schuz et al. (1971) who stated that quail follow an anti-clock-wise migration loop.

DISTRIBUTION OF MIGRANT TURTLE DOVES AND QUAIL IN THE MALTESE ISLANDS DURING MIGRATION

During the spring migration period, it seems that Gozo and Malta share numbers of turtle doves just about equally and their arrival in both islands is more or less simultaneous. However, it is clear that quail first arrived in Gozo and then in Malta, according to the findings of this study. It is not known whether the birds that land in Gozo, later move to Malta or if they are different groups or if they mix. Wright (1864a) stated that during spring migration Gozo was the most favoured locality for quail. Payn (1938) also noticed that during spring, most migrant birds arrived in Gozo before they did so in Malta. He further commented that this was a theory commonly held by the Maltese. Moreau (1953) also referred this phenomenon by citing Gibb (in litt.) who stated that although he had not experienced Gozo sufficiently to compare migration, he noted that Gozo had more cover and thus was a more favoured halting place for birds than Malta.

Wright (1864a) also stated that in the spring, quail arrived chiefly to the west and north-west coasts, while in the autumn they are more numerous on the east and south-east coasts. This study generally agrees with the above statements, as quail in the spring concentrated in the north-west and west side of the island of Malta and in the autumn they concentrate along the west and south coasts and to a lesser extent, the east coast. The study only partly agrees with De Lucca (1969b), who wrote that during spring, quail are found in good numbers on the east and northeast coasts, but during autumn, they are found on both western and eastern coasts.

There are no comments from earlier observers on the distribution of turtle doves in the Maltese islands during the two migration periods.

HABITAT USE

Turtle dove and quail are primarily seed eaters. They are ground feeders, their diet comprising mainly seeds of field weeds and cereals and secondarily of invertebrates (Cramp 1980, 1985). Weeds are short-lived annual plants that occur commonly on shores and beaches (coastal areas), in gravelly soils, windfall areas and heaths. Weeds have also

colonized agricultural country and their availability –and that of seeds thereafter-reflects not only natural conditions, but also activities of farmers (Alerstam 1994). All these describe well the types of habitats that turtle doves and quail use during their stop-over in the Maltese Islands. Terrace fields with borders of natural vegetation and coastal areas are good habitats for the growth of annual plants. Agricultural areas are also good places for these birds to forage, since they can feed on the gleanings of cereals, as well as seeds of weeds growing in or near the fields. These areas also provide good habitats for small invertebrates which complement the diet of the aforementioned species. It is possible that the choice of habitats and distribution in the Islands reflect the feeding preferences and seasonal availability of those food items.

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