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Winter bird surveys in Cyprus, 2007–2016. Analysis of the population trends

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Abstract. Cyprus is an important area for birds, hosting over 400 species. To protect the island's rich avifauna effectively, it is important that the population status and trends in bird populations are monitored. The Game and Fauna Service has been conducting a series of bird surveys annually, for more than a decade, covering a range of habitats. In this report, we present the preliminary findings of the systematic winter bird surveys for the years 2007 to 2016. Surveys were conducted on an annual basis, from January through February, along fifty-five road transects, covering a total length of 488.8 km. Using Poisson regression models, we analyzed the population trends of twenty selected species. Eight species showed statistically significant positive trends, whereas three species showed statistically significant negative trends. Nine species showed either weak trends or were stable.

Introduction

Cyprus is the third largest Mediterranean island, after Sicily and Sardinia, covering an area of 9251 km². It is located at the northeast end of the Mediterranean basin, 75 km from the nearest mainland (Turkey). The island is dominated by two mountain ranges, the central Troodos Mountains and the smaller Pendathaktylos Range with the large, flat central plain of Mesaoria in between (Flint and Stewart 1992). Cyprus is characterized by a typical Mediterranean climate with dry, hot summers and wet, mild winters (Giannakopoulos et al. 2010).

The island is important for birds, both at the European and global scale. Over 400 bird species have been recorded in Cyprus. Being on one of the major bird migration routes across the Mediterranean and at the crossroads linking Europe with Africa and the Middle East, over 200 species occur as regular passage migrants (Flint and Stewart 1992). Millions of migrants use the island as a resting and refueling point during each migratory season, including significant numbers of birds of prey such as the Red-footed falcon (*Falco vespertinus*) and the Pallid harrier (*Circus macrourus*). Cyprus is well known for its large numbers of wintering Greater flamingos (Phoenicopterus roseus) and other waterbirds. Around 90 species are regular winter visitors with another 30 being classified as irregular (Flint and Stewart 1992).

To monitor the bird populations on the island, the Game Fauna Service has been conducting various systematic bird surveys annually, for more than a decade, covering a wide range of areas and habitats. One of those surveys is the winter survey, first started in 2005, and later expanded in 2007 to cover more sites and species. Winter surveys are carried out annually, from January through February, after the end of the hunting season, with the aim to assess the population status of the resident game species (e.g. Chukar partridge *Alectoris chukar cypriotes*, Black francolin *Francolinus francolinus*, Common woodpigeon *Columba palumbus*) before the beginning of the nesting season. It should be noted that a summer population count is also conducted, at the same survey sites, to quantify the level of productivity for that year. This report summarizes and discusses the preliminary results of the analyses of the winter surveys, using data from 2007 to 2016, for twenty selected species.

Methods

Surveys were carried out along fifty-five roadside transects covering a total length of 488.8

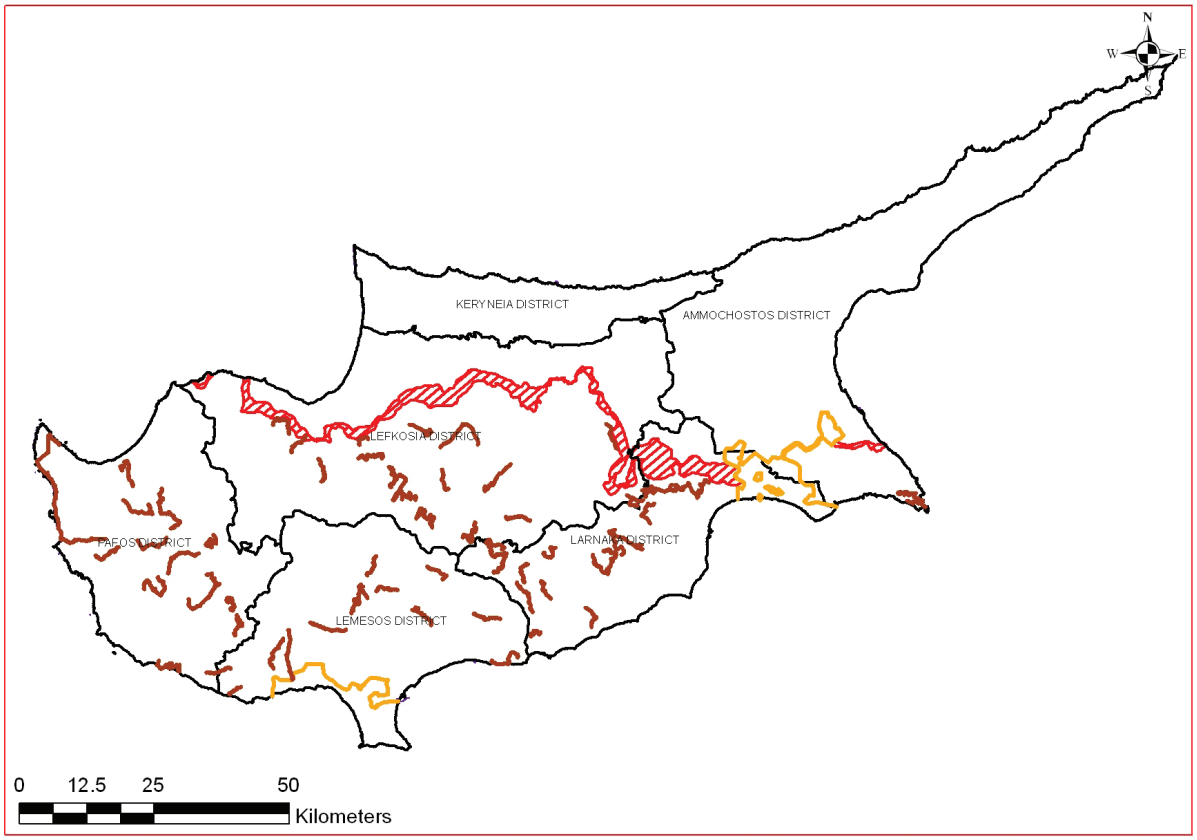

Figure 1. Map of Cyprus showing the road transects (brown lines) used for the annual winter bird surveys. Surveys are conducted only in the southern part of the island where the Government of Cyprus exercises effective control. The Turkish-occupied northern part is not surveyed. The red line across the island indicates the UN Buffer zone between the Government-controlled area and the Turkish-occupied north. The two yellow lines indicate the UK Sovereign Bases Areas.

km (Figure 1). The roadside count method was chosen because it is time-efficient and can traverse through large parts of habitats in a relatively short time. Roadside surveys are used primarily in North America to assess breeding (Sauer et al. 2005) and wintering wildlife (Sauer and Link 2002), and are considered cost-effective by many of the U.S. state wildlife agencies (Sands and Pope 2010) because they allow for a large area, a wide range of habitats, and multiple species to be sampled in a relatively short time period (Tapper 1988). Two important assumptions are that roadside surveys sample habitats in proportion to their availability and that they are equivalent to counts in roadless sites (Rosenberg and Blancher 2005, Thogmartin et al. 2006, Thogmartin 2010). For that reason, the survey routes were selected on the basis of (a) broad geographic coverage and representation of all major habitat types, (b) the existence of secondary, dirt roads with very low traffic so observers could have the time needed to identify and count species (Pandolfino et al. 2011a, 2011b). Although it is possible that for practical reasons the chosen survey routes do not meet the assumptions fully, it is unlikely that any resulting bias was large enough to have affected the validity of the results.

The length of the survey routes varied from 5–20 km (the average length was 8.9 km). Each route was surveyed by the same two teams of two observers to minimize inter-observer bias. Observers drove along each route, in the same direction each time, at a slow speed (~10 km/hour), counting all the birds that were seen while driving and at pre-selected stops (approximately every 200 m). All surveys were conducted during the first 3 hours after sunrise. Surveys were postponed or terminated during unsuitable weather conditions, such as heavy fog, precipitation, or strong winds.

Using Poisson regression models, we ran a preliminary analysis on the population trends of twenty species, selected to represent a wide range of orders (e.g. Accipitriformes, Galliformes, Columbiformes and Passeriformes) with different status on the island (i.e. species with winter-

Table 1. List of the twenty species, selected for the trend analysis, and their relevant status

Common Name	Scientific name	Status in Cyprus
Northern (hen) harrier	*Circus cyaneus*	Localized winter visitor to Cyprus and scarce passage migrant
Western marsh harrier	*Circus aeruginosus*	Common passage migrant and localized winter visitor mostly in major wetlands
Eurasian sparrowhawk	*Accipiter nisus*	Scarce winter visitor and passage migrant, breeding in very small numbers in some years
Common buzzard	*Buteo buteo*	Fairly common passage migrant (especially subspecies *Vulpinus* in fall migration) whereas is a fairly common winter visitor
Long-legged buzzard	*Buteo rufinus*	Fairly common resident, expanding during the last 20 years and scarce passage migrant
Common kestrel	*Falco tinnunculus*	Common resident and passage migrant
Chukar partridge	*Alectoris chukar*	Very common resident
Common woodpigeon	*Columba palumbus*	Common resident and winter visitor
Woodlark	*Lullula arborea*	Localized resident and common winter visitor
Eurasian skylark	*Alauda arvensis*	Common passage migrant and winter visitor
European robin	*Erithacus rubecula*	Very common passage migrant and winter visitor
Western black redstart	*Phoenicurus ochruros*	Common passage migrant and winter visitor
Common stonechat	*Saxicola torquata*	Common winter visitor
Finsch's wheatear	*Oenanthe finschii*	Localized winter visitor in small numbers, mostly in open, rocky areas
Common chaffinch	*Fringila coelebs*	Common resident of forests and winter visitor
European serin	*Serinus serinus*	Locally common resident, winter visitor and spring passage migrant
European greenfinch	*Carduelis chloris*	Common resident, passage migrant and winter visitor
European goldfinch	*Carduelis carduelis*	Common resident, passage migrant and winter visitor
Common linnet	*Carduelis cannabina*	Common resident, passage migrant and winter visitor
Corn bunting	*Miliaria calandra*	Common resident, Passage migrant and winter visitor

ing populations only, species with wintering and resident populations, and species with resident populations only) (Table 1). Models were fitted to annual totals summed from all 55 transects, all of which were counted in every year of the study period. It should be clarified at this point that the data on one of the species included, the Western marsh harrier (*Circus aeroginosus*), were not collected during the aforementioned road transect surveys but during the monthly wetland monitoring census, which are also conducted by the Game Fauna Service. It was decided that the species should be included so that a comprehensive overview on the trends of the wintering raptors in Cyprus could be attained. To make the results of the Western marsh harrier comparable to the other species, we used only counts from December, which for most years was the month with the maximum count. All statistical analyses were conducted using the R programming language (R Core Team 2016).

Results

Table 2 presents the minimum, maximum, mean, and the standard deviation of the number of individuals for each of the twenty species. According to the results of the regression analyses (Table 2), eight species showed statistically significant positive trends (p-value <0.05); the Chukar Partridge, the Common woodpigeon, the Woodlark (*Lullula arborea*), the European robin (*Erithacus rubecula*), the Common chaffinch (*Fringilla coelebs*), the Common linnet (*Carduelis cannabina*), the European Goldfinch (*C. carduelis*) and the European Greenfinch (*C. chloris*) (Figure 2). Three species showed statistically significant negative trends; the Western black redstart (*Phoenicurus ochruros*), the European serin (*Serinus serinus*) and the Corn Bunting (*Miliaria calandra*) (Figure 3). Nine species, including all the wintering and resident raptors, showed no statistically significant trend (Figure 4).

Table 2. Results of the regression analyses for each of the species analyzed. The minimum, maximum, mean values, and standard deviation of the number of individuals recorded are also presented. Species with statistically significant trends are shown in bold.

Species	Min	Max	Mean	Standard deviation	Regression Coefficient	Standard error (SE)	p-value
Western marsh harrier	1	11	4.7	3.35	0.04	0.03	0.108
Northern (hen) harrier	1	13	5.3	3.62	0.04	0.05	0.352
Eurasian sparrowhawk	0	14	4.4	4.14	0.08	0.05	0.130
Common buzzard	0	14	5.9	5	0.07	0.05	0.109
Long-legged buzzard	7	19	12.4	3.98	0.06	0.03	0.057
Common kestrel	67	107	91.7	13.29	0.00	0.01	0.913
Chukar partridge	**422**	**1568**	**904.3**	**363.04**	**0.10**	**0.00**	**0.000*** **
Common woodpigeon	**783**	**2931**	**1607.4**	**705.57**	**0.03**	**0.00**	**0.000*** **
Woodlark	**138**	**399**	**236.2**	**80.75**	**0.05**	**0.01**	**0.000*** **
Eurasian skylark	70	810	317.7	216.9	0.00	0.01	0.672
European robin	**179**	**674**	**389.5**	**156.07**	**0.12**	**0.01**	**0.000*** **
Western black redstart	**39**	**98**	**65.3**	**19.26**	**–0.03**	**0.01**	**0.031***
Common stonechat	196	415	291.9	60.93	0.01	0.01	0.123
Finsch's wheatear	2	17	6.6	4.2	–0.08	0.04	0.067
Common chaffinch	**1551**	**3186**	**2448.4**	**512.89**	**0.03**	**0.00**	**0.000*** **
European serin	**569**	**1142**	**875.8**	**215.64**	**–0.04**	**0.00**	**0.000*** **
European greenfinch	**104**	**486**	**259.3**	**99.7**	**0.08**	**0.01**	**0.000*** **
European goldfinch	**354**	**781**	**560.1**	**146.5**	**0.04**	**0.00**	**0.000*** **
Common linnet	**230**	**872**	**481.8**	**188.4**	**0.04**	**0.01**	**0.000*** **
Corn bunting	**419**	**852**	**642.3**	**144.11**	**–0.02**	**0.00**	**0.000*** **

Significance levels: * <0.05, **<0.01, ***<0.001

Discussion

Winter is a critical period for many species, since is often a period of food shortage and sometimes of extreme weather conditions. These adversities may affect birds' survival rates, fitness, and ability to return to their breeding grounds, if migratory. Winter counts are thus important because many species are limited by their ability to survive this period (Ralph et al. 1995). An understanding of their population ecology and trends requires monitoring programmes in wintering areas. This paper presents the preliminary population trends, for twenty selected species, demonstrating how a robust and representative monitoring scheme, for resident and wintering birds established in Cyprus, can be used to monitor population trends.

Raptors

Surveys for raptors often have been conducted along roads where raptors are observed and counted from vehicles. These surveys have been used to describe raptor distribution (Andersen et al. 1985, Yosef et al. 1999, Bak et al. 2001) and to assess changes in raptor abundance through time (Hubbard et al. 1988, Herremans and Herremans-Tonnoeyr 2001, Goldstein and Hibbitts 2004). Though in our case the wintering raptors have not exhibited any statistically significant trend over the time period examined, and their numbers were generally low, some comments about their annual abundance can be made. Usually, raptor abundance is driven by food availability. Eurasian sparrowhawk, Common buzzard, and Northern (hen) harrier maxima were reached during 2013, a year that coincided with high numbers of Common chaffinch, Corn bunting and Common woodpigeon. The maximum number for the Western marsh harrier was recorded in December 2012, when the highest number of waterbirds was observed (>25000) (Ministry of Interior Annual Report 2012). The same winter was also when the maximum number of individuals was recorded for the other wintering raptors (counted in Jan-Feb 2013).

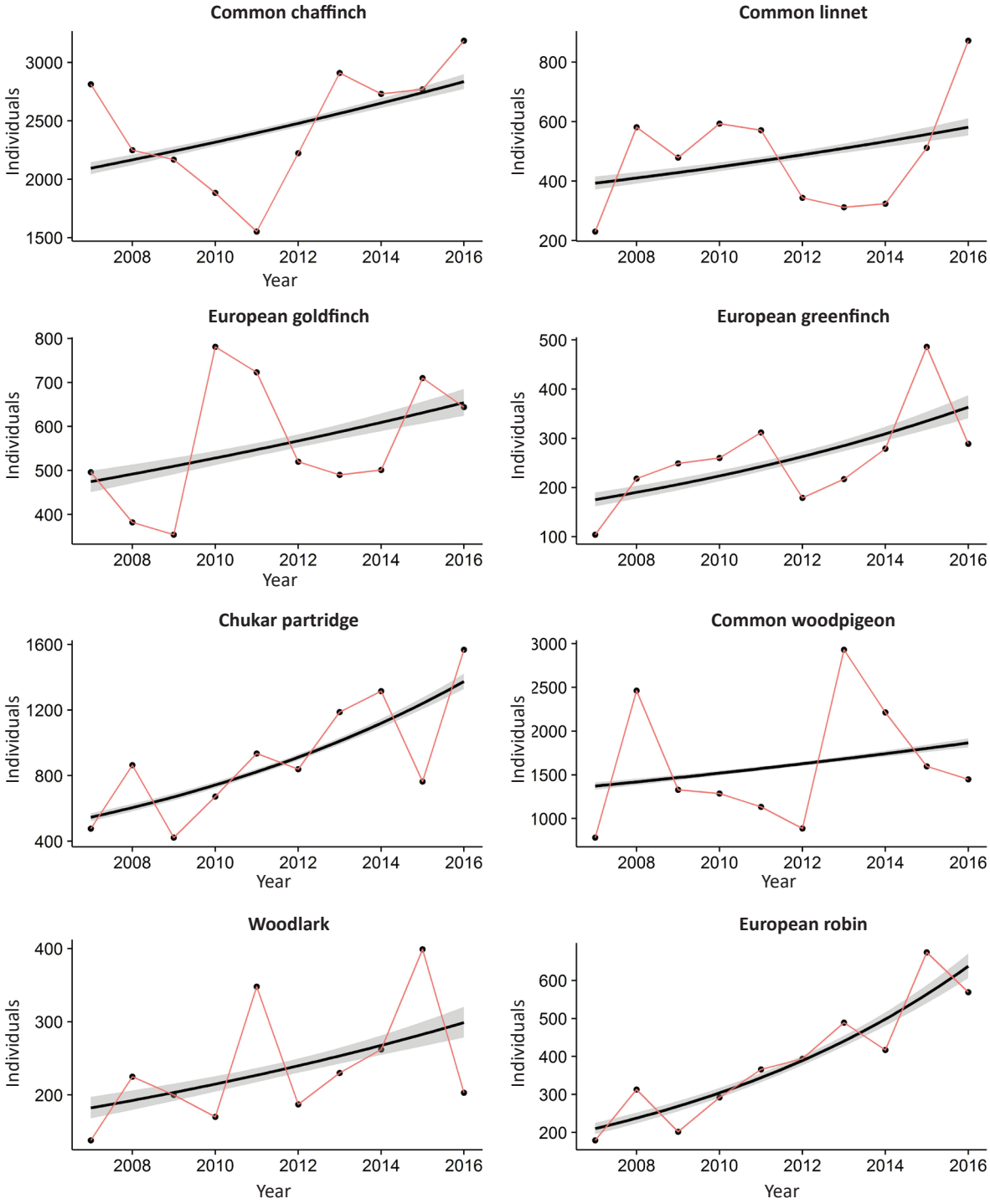

Figure 2. Poisson regression plots for the eight species with statistically significant positive trends, showing the actual number of individuals over time and the slope. Shaded area represents 95% CI's.

The Long-legged buzzard is a relatively new breeding bird on the island with the first nest found in 1992 (Kourtellarides 1998). Its increasing trend (Figure 4), although not significant (p-value = 0.057), is consistent with the species' expanding range mostly during the last decade when nesting territories doubled from 34 in 2005 (Kassinis 2009) to more than 70 in 2015 (Kassinis unpublished data). Stable numbers (or absence of a significant trend over the decade examined) of Common kestrel match the species stable population status, for the period 2008–2012, reported in the National Summary submitted to the European Union in 2014 (European Commission 2014) under Article 12 of the Birds Directive (2009/147/EC).

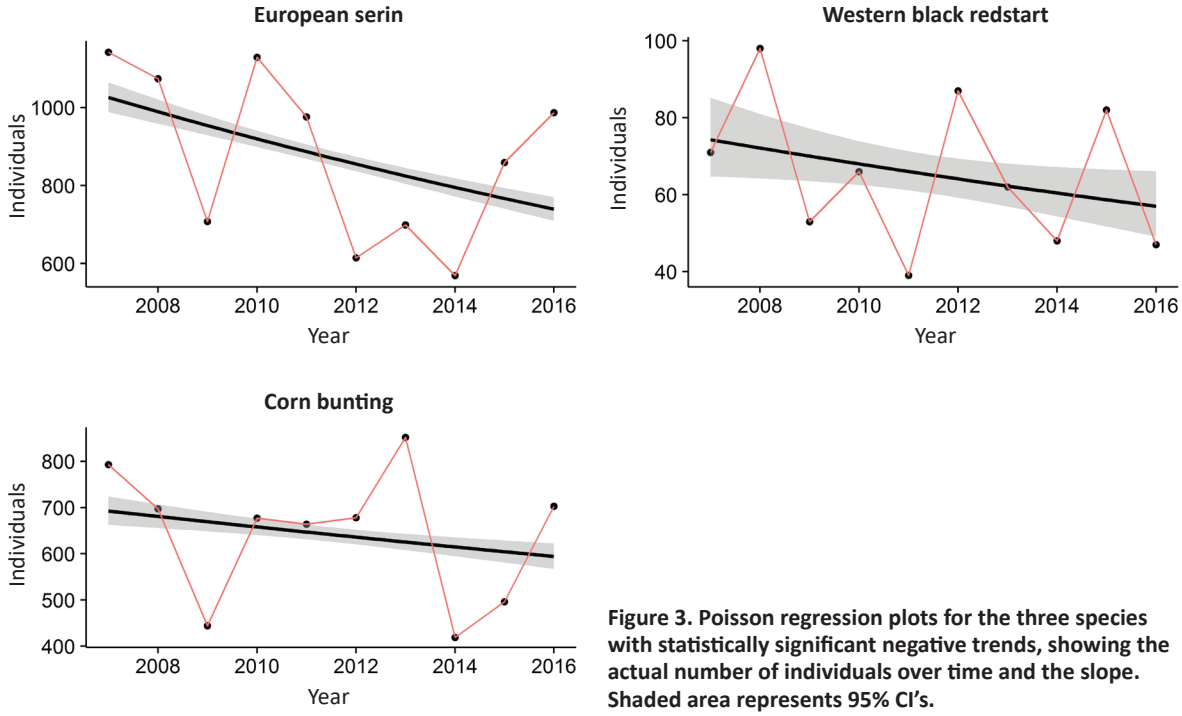

Figure 3. Poisson regression plots for the three species with statistically significant negative trends, showing the actual number of individuals over time and the slope. Shaded area represents 95% CI's.

Finches

Common chaffinch's positive trend is different from the species' breeding population status, which has been reported as stable (European Commission 2014). A possible explanation could be that the breeding population is being augmented by wintering conspecifics that in some years are in large numbers European greenfinch's increasing trend also matches the species' increasing breeding population status on the island (European Commission 2014). Common linnet and European goldfinch's positive trends, however, do not agree with the species' breeding population statuses reported as declining (10–20%) in the National Summary (European Commission 2014). As with Common chaffinch, a possible explanation for this could be increasing immigration of wintering conspecifics that compensate for the small decline that the breeding populations show. European serin's negative trend also differs from the reported species' breeding population status, which is considered to be strongly increasing (50–75%).

Other Species

The European robin showed a strong positive trend, which was expected considering the species trend in Europe from 1980–2011 (BirdLife International 2016). Based on provisional data from twenty-seven European countries, collected for the purposes of the Pan-European Common Bird Monitoring scheme, the overall species' population was increasing (BirdLife International 2016). Chukar partridge's positive trend is consistent with the species' breeding population status reported in the National Summary (European Commission 2014). It had its lowest population numbers in winter 2009, after a severe drought year in 2008 when the total precipitation recorded on the island was 272.3 mm, or 54% of the long-term mean (Department of Meteorology 2008). Common woodpigeon's positive trend differs from the species breeding population status that has been reported as stable. A possible explanation, like in the case of the Common chaffinch, is that Common woodpigeon's breeding population is being augmented by wintering conspecifics that are also in large numbers in some years. Woodlark's positive trend, on the other hand, cannot be compared to the species breeding status, since there are no reliable estimates for this species and its trend as a breeding bird remains unknown, according to the National Summary (European Commission 2014). Similarly, it is unclear what the reason is for Western black redstart's negative trend (Figure 3) and therefore it's worth examining in the future its population numbers in more detail. The same is true for the Corn bunting, which is also decreasing according

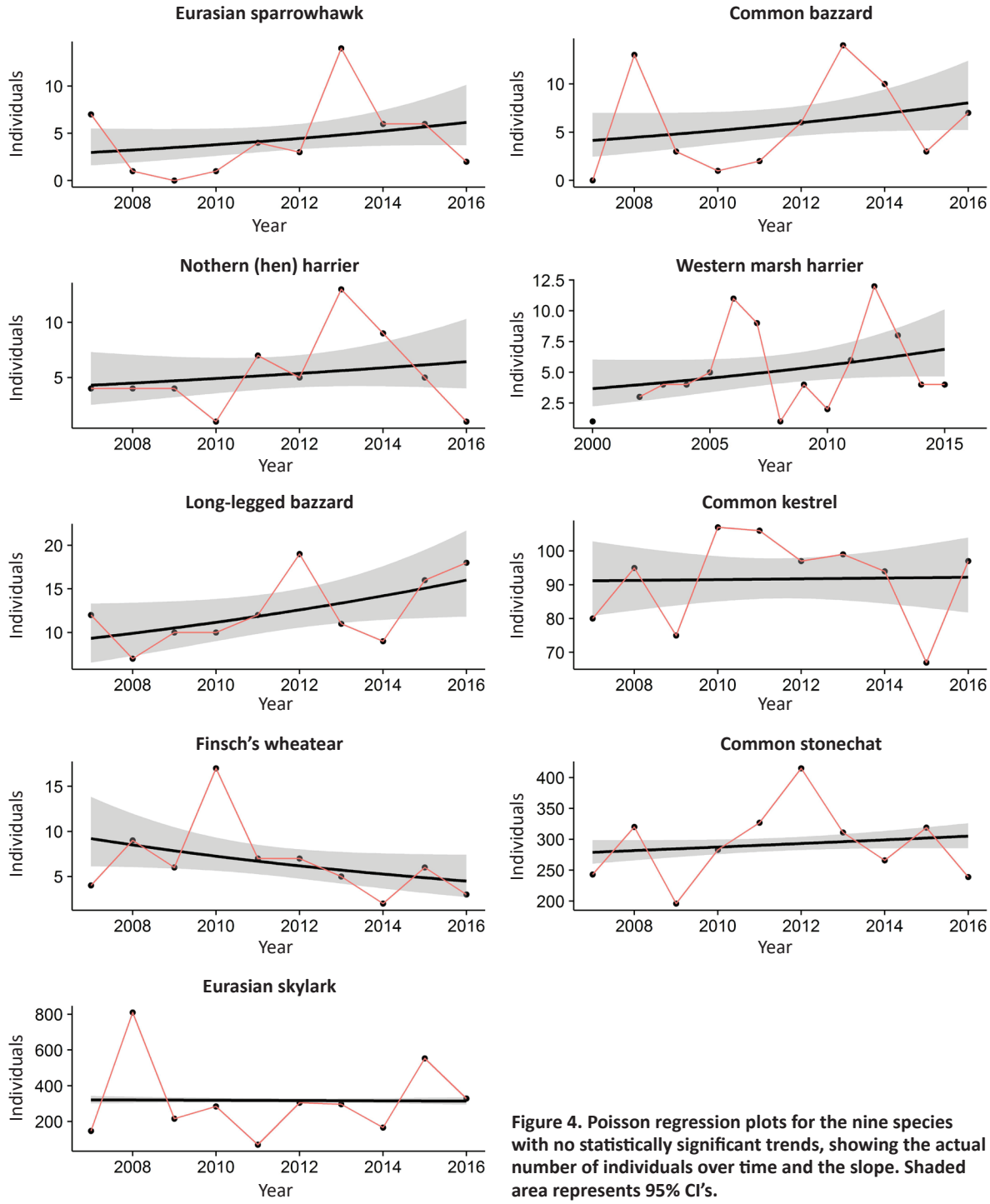

Figure 4. Poisson regression plots for the nine species with no statistically significant trends, showing the actual number of individuals over time and the slope. Shaded area represents 95% CI's.

to our analysis, although according to the National Summary its breeding trend is strongly increasing (75–150%).

Conclusion

In summary, based on the results of the trend analyses, eight of the twenty species showed strong positive trends whereas three species showed negative trends. The rest showed either weak trends or were stable. It is worth highlighting that, in some cases annual counts fluctuated noticeably (Table 2; Figure 4). Unfortunately, the statistical method chosen to analyze the trends does not allow us to test for significant annual changes. In the future, we will be analyzing the data, combined with the data from the summer surveys, using more robust tools, such as the "TRends and Indices for Monitoring data" (TRIM) software (Pannekoek and van Strien 2001). Such

tools will allow us to explore the annual fluctuations in more detail.

It is likely that parts of the observed fluctuations in the population numbers can be explained by climatic factors. Although for the purposes of this report, weather related parameters (such as temperature, rainfall, and snow) were not tested for any correlations with the recorded trends; climatic factors are probably affecting several of the species examined. Cold fronts, strong winds, floods or droughts have been shown to seasonally shape the environment birds live in and affect their presence and abundance. For example, climate change has been suggested as the cause of many recent changes in species distributions (Stenseth et al. 2002, Walther et al. 2002). The Eastern Mediterranean's progressively warmer climate and drier conditions are possibly causing some wintering visitors to stay to the north of Cyprus, or attract other species that are adapted to these new conditions.

The expansion of Long-legged buzzard over the last 2 decades might be partly explained by this factor. A case of a species that has changed its status from migrant breeder to resident and winter visitor is the Spur-winged Lapwing (*Vanellus spinosus*), which has established a resident population during the last decade (Kassinis et al. 2010).

Some caution, however, must be exercised when interpreting the results for some of the species, such as the finches (i.e. Common chaffinch, Common linnet, European serin and European goldfinch), Woodlark, Corn Bunting and Common woodpigeon, because they have both a resident and wintering bird status and their numbers are frequently augmented by wintering conspecifics.

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