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Floristic and structural differentiation between gardens of primary and secondary residences in the Costa Brava (Catalonia, Spain)

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Abstract Urban sprawl along the Mediterranean coast is characterized by single-family houses and domestic gardens. Many new residences are secondary homes for socio-demographically diverse tourists. We explore the differences between the residence types in terms of their garden structures and plant compositions using socioeconomic and legacy attributes. Outdoor areas of 245 primary and secondary homes were investigated to determine plant compositions, land cover and household characteristics. Then, the outdoor land cover was compared between the two residence types. Vector fitting in ordination space assessed the influences of socioeconomic and legacy effects on plant compositions. Finally, generalized linear models (GLMs) assessed the influence of these variables on garden structures. Relevant differences exist in the plant compositions of primary and secondary residences. Furthermore, secondary residences have larger areas of trees, shrubs, flowers and swimming pools, while vegetable gardens are more common at primary residences. Overall, socioeconomic effects appeared to strongly constrain the features of household gardens.

Keywords Private landscapes · Primary & secondary homes · Plant composition · Garden structure · Socioeconomic profiles

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Introduction

Over the last few decades, changes in urban growth patterns have been notably intense along the Spanish Mediterranean coast (EEA 2006). In particular, recent urban development has led to the creation of new suburbs, i.e., urbanization, which is characterized by low-density urban sprawl (Durà 2003; Martí 2005; Nel·lo 2001). The concept of dispersion includes not only settlements physically separated from existing urban areas but also estates located outside of consolidated urban cores (Valdunciel 2011).

The idea of residential development has its roots in the tradition of the garden-city model developed in Britain and the USA in the early twentieth century, and it emerged as an attempt to synthesize the advantages of the city and the country (Bruegmann 2005). Historically, in Mediterranean cities, wealthy residents owned summer cottages near the city, in addition to their primary urban residence (Fraguell 1994). Both traditions emerged in Catalonia in the 1920s and materialized in the construction of the first home-garden projects for the bourgeoisie (Valdunciel 2011).

At the end of the 1960s, American cities and then European cities began an inexorable trend of decentralizing the population and economic activities and reducing urban densities (Durà 2003). Many urban functions, in terms of infrastructure, were spread over a more expansive territory; thus, the phenomenon of urbanization and/or city sprawl was initiated (Dematteis 1998). Berry (1976) empirically confirmed the loss of population in metropolitan areas in favor of bordering regions and noted that there was a structural change in the urbanization process: counter-urbanization. Since the 1980s, several studies noted the same phenomenon in European cities and interpreted it as the expression of a change in the life cycle of urban development, moving from "urbanization" to "de-urbanization" (Chesire and Hay 1986; Hall and Hay 1980; van den Berg et al. 1982).

During this period, the coast of Catalonia (NE Spain) developed a model of mass tourism based on the production of a large number of hotel establishments, holiday resorts and services (Martí and Pintó 2012). A substantial part of the tourism demand, from overseas and from within the metropolitan region of Barcelona and other large cities nearby, began to show interest in accommodations for secondary residences, i.e., residential tourism. According to Fraguell (1994), between 1960 and 1970, secondary residences in the Costa Brava increased from 4000 to over 28,000. During the 1970s, growth continued; in 1981, approximately 73,300 secondary residences had been established. Over 1996–2001, 1543 single residential houses were built each year; between 2002 and 2008, this number increased to 2400 (CAATEEG 2012). By 2011, approximately 105,000 secondary residences were established, which was approximately 47 % of the total households in the Costa Brava (IDESCAT 2014). In the first stage of development, housing was located in privileged spaces, such as bays and beaches; however, in later stages, housing increasingly occupied inland areas (Valdunciel 2011).

The progressive adoption of the dispersed urban model was partially favored by an overall increase in income, a higher dependence on the private automobiles, a strong filtering process by the property market and a lack of planning, which led to socialization of secondary residences (Cagmani and Gibelli 2002). The combination of urban and social phenomena has resulted in notably different demographic and socioeconomic characteristics of the urbanized populations compared with the population living in high-density urban areas (Garcia et al. 2013). Moreover, houses in low-density residential areas gradually switched from being

almost exclusively secondary residences to becoming permanent residences (Catalán et al. 2008).

Sprawl attenuates the levels of over-densification in central districts but also standardizes the landscape and homogenizes urban environments (Catalán et al. 2008; EEA 2006). Moreover, colonialism and globalization have resulted in changes to cultivated urban floras (Kendal et al. 2012a; La Sorte et al. 2014).

Specifically, domestic gardens, which may account for a large proportion of suburban areas (Goddard et al. 2009; Loram et al. 2007), reportedly host high levels of plant gamma biodiversity (Daniels and Kirkpatrick 2006; Lubbe et al. 2010; Smith et al. 2006) and provide valuable ecosystem services (see Cook et al. 2012). At the global scale, few studies have examined floristic similarities among gardens and the factors that shape plant distributions. In this regard, Padullés et al. (2014a) concluded that worldwide gardens (including home gardens and domestic gardens) are significantly different in terms of plant compositions; socioeconomic factors seem to impose stronger constraints than biophysical factors. At the household scale, different demographic, cultural and socioeconomic characteristics of garden owners have been related to plant richness and composition (Bigirimana et al. 2012; Hope et al. 2003; Lubbe et al. 2010). In addition, cognitive factors translated into motivations, attitudes and preferences toward gardening practices may also determine the structure of a household's outdoor space (Kendal et al. 2012b; Larsen and Harlan 2006; Larson et al. 2009).

This study reports the findings of a survey of households in low-density suburban areas of the Costa Brava in northeastern Catalonia (Spain). The area is favored by owners of second homes and is one of the most popular national and international tourist destinations in the country. The study was designed to (1) expose the socioeconomic and demographic differences in household owners of primary and secondary residences; (2) compare plant richness and compositions of both types of residences; and (3) assess the relative importance of the selected socioeconomic and legacy variables (and their relation with the residence type) on garden plant compositions and outdoor land cover structure. Our hypothesis is that, although low-density suburbs in the study area are heterogeneous in terms of socioeconomic status, the type of residences also determines the garden composition and design. The results may be useful for promoting more environmentally friendly urban landscapes and for directing urban planning policies in the context of the increasing water demand.

Material and methods

Study area

The study area comprised low-density suburban developments from 5 municipalities of the Costa Brava (Northeast Catalonia, Spain). Four of these municipalities (Roses, Castelló d'Empúries, Sant Pere Pescador and l'Escala) are located in coastal areas, while the other (l'Armentera) is located inland (Fig. 1; Table 1). The total population of these municipalities was approximately 45,360 in 2013 (IDESCAT 2014). The entire area is 128 km^2 and is located at an average height of 9.2 m above sea level. The climate is typical Mediterranean, with an average annual temperature of 15 °C, fluctuating from 30 °C in the summer to 3 °C in the winter. The average annual rainfall, which is mainly concentrated in the autumn and spring, is 623 mm (MSC 2014).
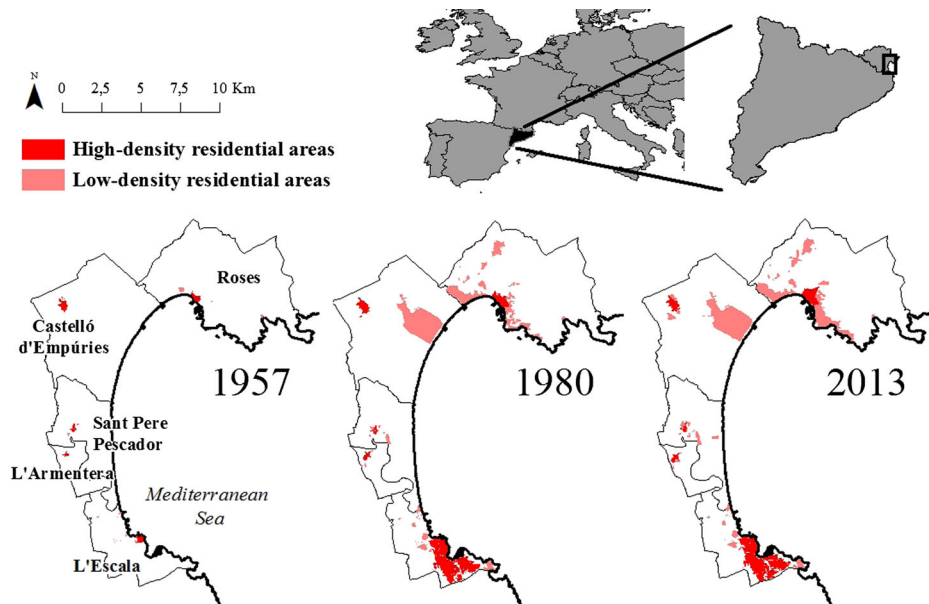
Fig. 1 Location of the surveyed municipalities and their urban land evolution (1957–2013). Land use data from 1957 and 1980 were obtained from Martí (2005)

In recent decades, tourism has led to unprecedented development of urban land, mainly for hotels and recreational residences. Within the last 30 years, the total number of houses has doubled, and 68 % are now secondary residences (IDESCAT 2014). Two remarkable residential marinas are found in the area: Santa Margarita and Empuriabrava; the latter is the largest residential marina in Europe. Suburban residents differ significantly in terms of their social background and status compared with those living in the neighborhoods of more compact cities. In particular, a high percentage of suburban residents are non-natives. In Castelló d'Empúries, for instance, 49 % of inhabitants in 2011 were foreign, primarily from France and Germany (IDESCAT 2014).

Table 1 Description of urban municipalities in the Costa Brava

Municipality	Population (2013)[a]	Area (km²)[a]	Households (1981)[a]	Households (2011)[a]	Increase in number of households (1981–2011) (%)	Proportion of secondary residences (2011)	Number of households in analysis
L'Escala	10513	16	8008	14994	187	66	3
Castelló d'Empúries	11910	42	6447	16412	255	67	184
Roses	19891	46	11362	25712	226	60	25
L'Armentera	871	6	435	754	173	38	10
Sant Pere Pescador	2175	18	795	1636	206	38	23
Total	45360	128,5	27047	59508	220	63	245

[a] Values for the municipalities include all people, land area and households

Sample selection

Of all low-density suburban developments located in the five municipalities of the study area, we selected only those situated within 1 km of the Aiguamolls de l'Empordà Natural Park (International Union for Conservation of Nature category V). This choice was made in order to preserve the maximum possible homogeneous conditions for soil, slope and climate. Using the information contained in the cadastre (Directorate General for Cadastre Electronic Site 2012), we obtained a layer with all detached, semi-attached and attached single-family houses. A total of 6,586 single-family houses were located in the study area (85 in l'Escala, 98 in l'Armentera, 490 in Sant Pere Pescador, 503 in Roses and 5,410 in Castelló d'Empúries). Of this population, a sample of 258 households was randomly selected using the "subset features" tool in ArcGis 10 (Esri, Redlands, CA). Of the 258 surveys, only 245 were used in this analysis due to missing data. A sample size calculation based on a Poisson distribution confirmed that the sample included a representative proportion of the population.

Data collection

In our study, a garden is defined as "an area of enclosed ground, cultivated or not, within the boundaries of an owned or rented dwelling, where plants are grown and other materials are arranged spatially" (Bhatti and Church 2000, p. 1). To characterize household outdoor surfaces, we used ortho-images with a pixel size of 0.1 m×0.1 m that were obtained from the Cartographic Institute of Catalonia (ICC 2013). Each image had been previously corrected. Using ArcGis 10 (Esri, Redlands, CA), the area of the outdoor features was measured. Six polygon layers were created: swimming pool, vegetable garden, spontaneous vegetation, lawn, trees, shrubs and flowers and artificial surfaces (mainly paved areas). All data obtained from this classification were validated in the field.

All plants growing in the 245 private gardens were inventoried, including those in pots and ponds. For turf, a randomly selected plot of 0.5 m^2 for each household was analyzed. For those plants that could not be identified at the species level, the genus was recorded. Scientific nomenclature follows the International Plant Name Index (IPNI 2012). Native plants were classified following the methods of Bolós et al. (2005). To include secondary residents in the survey and facilitate plant identification, all of the data were collected from May to July 2013.

The questionnaire was organized into three sections: (i) physical characteristics of the dwelling and outside space; (ii) socio-demographic information on household owners; and (iii) a series of questions concerning preferences and/or reasons for gardening. The questionnaire items addressing preferences were designed as Likert-type statements that were rated on a five-point scale ranging from 1 ("completely disagree") to 5 ("completely agree"). Eight items were used to measure the reasons for gardening: "to add aesthetic value to my house" (RG1); "to connect with nature" (RG2); "to have a hobby" (RG3); "to produce food and other household products" (RG4); "to have a place to relax" (RG5); "to perform domestic activities, such as eating and drying clothes" (RG6); "to have an area for recreational and leisure activities" (RG7); and "to add economic value to my house" (RG8).

Data analysis

First, we descriptively explored a set of housing and socio-demographic variables regarding the type of residence owned using the nonparametric Mann–Whitney U-test. This test was

chosen because the data did not meet the assumptions of normality and homoscedasticity. The chi-squared test was used for comparisons among the types of residences with regard to the other discrete variables.

To facilitate the interpretation of the results, principal components analysis (PCA) was conducted with varimax rotation and using the set of housing and socio-demographic variables. Garden size and household size were discarded from this part of the analysis, as no statistically significant differences were found among residence types. This step helped identify linear combinations of the original variables. Factors with eigenvalues greater than 1 and items with a load factor above 0.4 formed the basis for interpreting the results (Hair et al. 1999). At the end of the PCA, two factors were extracted from the six original variables, explaining approximately 56 % of the variance (Table 2). The KMO index was 0.52, indicating that a considerable intercorrelation existed among the variables; therefore, a PCA was appropriate. Accordingly, Bartlett's test of sphericity (Chi-square=203.2, df=15, $p<0.01$) confirmed that significant correlations existed among the variables, indicating that the model factor was relevant. Because we aimed to identify which factors better defined each type of residence (based on the average differences between them), a Welch's corrected t-test was conducted. Any significant result regarding the comparison test between the two types of residences indicates that the averages significantly differ. Concerning the reasons for gardening, only two out of the eight items (RG5 and RG6) were significantly different among residence types. Therefore, these two variables were treated independently in subsequent tests. All of the analysis was conducted using SPSS (version 19 for Windows; IBM Corp., Armonk, NY).

The second part of the study sought to elucidate the actual interaction of the residence type and garden structure and composition. The Bray-Curtis coefficient (Bray and Curtis 1957) was used to compute the compositional dissimilarities between all pairs of gardens according to their plant compositions. This coefficient is known to be robust and effective for community analysis (Faith et al. 1987). The dissimilarity matrix was constructed in one to four dimensions using non-metric multidimensional scaling (NMDS) (Kruskal 1964) with the *vegan* package in R 2.15.2 (R Core Development Team 2012). Using the *envfit* function, principal components coupled with RG5 and RG6 variables were fitted to the ordination as linear vectors to show the direction of the gradients (Oksanen 2008). The type of residence (primary vs. secondary) was also included in the analysis as a single factor by considering the interactions among the variables.

Cluster analysis was conducted to obtain an empirical classification of the different landscapes using the scores of the four dimensions of the ordination as input. Two garden

Table 2 Rotated component matrix of principal component analysis (PCA; varimax rotation with Kaiser normalization)

Variable	Components	
	1	2
Age of the building	0.741	
Average age of household	0.840	
Length of residence	0.639	
Level of education		0.685
Birth place		0.691
Income level		0.755

plant assemblages were defined from a cluster analysis (presence–absence data), using Ward's method and the relative Euclidian distance. The resulting assemblages were compared, using a Chi-square test, with the type of residence to determine the strength of the relationships between floristic and residential groups.

Indicator plant species of primary and secondary residences were established using the function *multipatt* in the *indicspecies* package in R. This asymmetric technique is based on the indicator value (IndVal) index that accounts for the presence or absence of species in a priori partitioning of sites (Legendre and Legendre 1998). A randomization procedure is used to test the statistical significance of species' indicator values (Dufrêne and Legendre 1997). However, by default, the *multipatt* function uses an extension of the original IndVal method because the function looks for indicator species of both individual site groups and combinations of site groups, as explained in De Cáceres et al. (2010).

Generalized linear models (GLM) were used to investigate the relative contribution of each principal component and residence type in relation to the surfaces of each type of outdoor surface, i.e., artificial surfaces, trees, shrubs and flowers, lawns, vegetable gardens, and swimming pools (spontaneous vegetation was excluded from the analysis as it only could be found in four study cases). This method of analysis was chosen because of the non-normal distribution of the five dependent variables. For artificial land cover, trees, shrubs and flowers, a Poisson distribution was chosen. However, the preliminary results returned scaled deviance values, indicating that the Poisson distribution was over-dispersed. To correct for this, the scale parameter was changed to a Pearson Chi-Square, which corrected the overdispersion (Hutcheson and Sofroniou 1999). This part of the analysis was conducted in SPSS using the GLM analysis tool and a log link function. For the three other land cover types (vegetable garden, lawn and swimming pool), a zero inflated Poisson regression was used due to the large proportion of households without these types of land cover types (Long 1997). Vuong tests were used to determine the improvement in the zero-inflated models over ordinary Poisson regression models (Vuong 1989). The *zeroinfl* function in the MASS package in R was used for these tests. The information criterion (AIC) was chosen as the most appropriate strategy for selecting the proper covariance structure (Kincaid 2005).

Results

Socioeconomic and demographic characteristics of primary and secondary residences

Table 3 shows the average values and frequencies of the different housing, socioeconomic and attitudinal variables according to the type of residence (primary vs. secondary), along with the results of the various statistical tests applied. According to the results, secondary residences included in the analysis are significantly older than the primary residences. Moreover, residents in secondary homes were also significantly older on average (approximately 65 years) compared with those in primary homes (53 years). As expected, 83 % of the Spanish individuals dwelled in a primary residence, while 62 % of the foreign residents owned a secondary home. Regarding income levels, primary residences had a larger number of individuals with medium and low income levels (66 and 75 %, respectively) compared with secondary residences (34 and 25 %, respectively). Approximately 56 % of secondary home owners had higher incomes than primary home owners. A similar trend can be observed regarding the variable

Table 3 Socio-economic/demographic characteristics and reasons for gardening according to the type of residence

Socio-economic and demographic characteristics		Total	Primary residences	Secondary residences	Test statistic and significance
N	Total number of households in analysis	245	140	105	-
Average age of the building	Years	26.2	24.0	29.3	Mann–Whitney, $U=6051.5$; $p<0.01$
Garden size	m^2	138.0	135.9	141.0	Mann–Whitney, $U=6930.5$; $p>0.05$
Average age	Years	57.9	52.8	65.1	Mann–Whitney, $U=4863.5$; $p<0.01$
Household size	Number of residents	2.3	2.4	2.2	Mann–Whitney, $U=7004.0$; $p>0.05$
Place of birth	Spain (%)	46.9	82.5	17.5	Chi-square$=51.6$ ($p<0.01$)
	Rest of the world (%)	53.1	38.2	61.7	
Income level (m€/year)	Low (less than 18) (%)	26.6	75.0	25.0	Chi-square$=21.8$ ($p<0.01$)
	Medium (between 18 and 42) (%)	34.8	66.3	33.7	
	High (more than 42) (%)	38.7	41.4	58.6	
Length of residence (years)	Low (less than 10) (%)	33.2	65.9	34.1	Chi-square$=12.4$ ($p<0.01$)
	Medium (between 11 and 20) (%)	38.7	65.7	34.3	
	High (more than 21) (%)	28.1	41.7	58.3	
Level of education	First grade: Primary school or lower (%)	31.3	65.0	35.0	Chi-square$=6.1$ ($p<0.05$)
	Second grade: Secondary and/or technical school (%)	39.1	63.0	37.0	
	Third grade: University degree or higher (%)	29.7	47.4	52.6	
Reasons for gardening					
RG1	Score	4.3	4.3	4.3	Mann–Whitney, $U=7925.0$; $p>0.1$
RG2	Score	3.6	3.5	3.7	Mann–Whitney, $U=7026.0$; $p>0.1$
RG3	Score	2.7	2.7	2.7	Mann–Whitney, $U=7532.0$; $p>0.1$
RG4	Score	1.5	1.5	1.4	Mann–Whitney, $U=7599.5$; $p>0.1$
RG5	Score	4.2	3.8	4.7	Mann–Whitney, $U=3133.5$; $p<0.01$
RG6	Score	3.9	4.1	3.7	Mann–Whitney, $U=6380.5$; $p<0.01$
RG7	Score	4.0	4.0	4.0	Mann–Whitney, $U=7926.0$; $p>0.1$
RG8	Score	1.1	1.0	1.1	Mann–Whitney, $U=7657.0$; $p>0.1$

"educational level". Residents of secondary homes appeared to have lived in the study area longer (58 % of the total for more than 21 years). Only two of the reasons for owning a garden differed between residence types. Residents of secondary homes preferred to cultivate their gardens to have a place to relax (RG5), while owners of primary residences preferred to use their gardens for domestic activities, such as eating and drying clothes (RG6).

The results from the rotated factor matrix are presented in Table 2. Regarding the loadings of each variable, the principal components are interpreted as follows: PC 1 represented 30.2 % of the total variance and included the age of the building, the average age of the household and the length of residence (legacy effects). The rotated factor loadings (RFLs) were positive for all variables that provided evidence that positive values of this factor could represent those elderly residents who had invested in buying a second home a long time ago and still live there. PC 2 represented 25.6 % of the total variance and combined level of education, birthplace and income level (socioeconomic effects). The positive RFL of all these variables suggested that positive values of this component fit with those of wealthy people who are more highly educated and are mostly born in foreign countries.

Welch's unpaired T-Test confirmed that both legacy effects and socioeconomic effects differed between residence types (T-test=24.0; $p<0.01$; T-test=23.7; $p<0.01$, respectively). All principal components mentioned here were included in the following GLM and vector fitting processes.

Plant richness and composition in primary and secondary residences

A total of 630 plant species were recorded in the 245 household gardens included in the analysis. Of these species, 76 % were exotic. Figure 2 shows the average values for the species groups per plot. Neither the overall plant richness nor the exotic plant richness appeared to be significantly different between the primary and secondary residences. However, the native plant richness is slightly but significantly higher in primary residences. Although this result must be treated cautiously, two hypotheses are offered to explain it: (1) primary residences
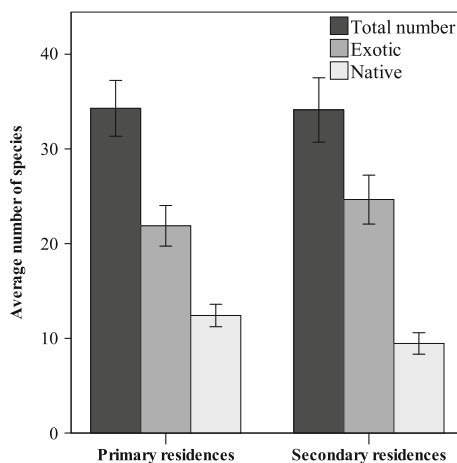

Fig. 2 Average species numbers and confidence intervals across all plots for native and exotic plant species in the primary and secondary residences of the Costa Brava (Spain). The number of native species is significantly higher in primary residences ($p<0.01$, Mann-Whiney U-Test)

have more weeds; or (2) primary homeowners have a sense of attachment to their location and likely prefer autochthonous species.

Garden plants are mainly cultivated for ornamental purposes in both primary (74 %) and secondary (77 %) residences, although a higher proportion of edible plants (9 %) and weeds (15 %) could be found in primary homes compared with secondary homes (8 and 13 %, respectively). Table 4 presents the indicator plants of each residence type. Among the characteristic species of primary residences, the presence of weeds, such as *Oxalis corniculata*, *Sonchus oleraceus*, *Euphorbia helioscopia* or *Taraxacum officinale*, and edible species, such as *Prunus avium*, *Lactuca sativa* or *Phaseolus vulgaris*, are highlighted. Moreover, secondary residences are mainly represented by ornamental species, such as *Nerium Oleander*, *Bougainvillea* sp., *Chamaerops humilis* or *Lantana camara*.

The NMDS analysis (Table 5) showed that taxonomic dissimilarity was most strongly related to socioeconomic effects ($R^2=24$), legacy effects ($R^2=18$ %), the type of residence ($R^2=10$ %) and preferences for gardens as a place of relaxation ($R^2=9$ %) (Stress= 0.19). Although no separate clusters were obtained among all of the plots, the association between the two empirical assemblages obtained through Ward's method and the residence types was confirmed (Chi-square=13.8; df=1; $p<0.01$). These results may suggest that plant compositions would indeed be different between primary and secondary residences.

Predictors of outdoor land use areas

Figure 3 shows the proportion of the six outdoor land cover types according to the residence type. Outdoor areas of both primary and secondary residences are mainly dominated by artificial surfaces, representing more than half of the total area. Trees, shrubs and flowers also compose a large share of the land cover in both residence types and compose a significantly larger share in secondary homes. In contrast, as expected, the proportion of outdoor area occupied by vegetable gardens appeared to be significantly higher in primary residences. Moreover, swimming pools of secondary homes tended to occupy a significantly larger proportion of the space compared with primary residences.

The overall results of the GLM for the five outdoor variables are found in Table 6. The omnibus test, which uses a likelihood ratio to test goodness-of-fit, indicated that the models are a good fit for artificial surfaces and areas occupied by trees, shrubs and flowers. For the remaining three variables (vegetable garden, lawn and swimming pool areas), Vuong's test confirmed that the zero-inflated models were superior to the standard Poisson model. Socioeconomic effects had a significant negative influence on vegetable garden areas. Therefore, Spanish residents with low to medium incomes and educational levels owned significantly larger orchards. The opposite was observed with artificial areas, trees, shrubs, flowers and swimming pool areas. Accordingly, secondary residences were more likely to contain a larger swimming pool. The interactions of both types of variables (residence type and socioeconomic and legacy effects) also had a significant effect on two land cover types. Primary residences with positive socioeconomic effects tended to have fewer artificial surfaces, suggesting that upper social classes from foreign countries preferred vegetated gardens. However, primary residences with positive legacy effects had larger swimming pools, which might indicate that older residents that had been living in the same house for a long time were more likely to own a large pool.

Table 4 Indicator species of primary and secondary residences according to the IndVal method. The observed frequency of each species at each type of residence, the plant use, and immigration status of the plant are presented

Species name	Observed frequencies in households (%)		Stat.	p-level	Type of residence	Plant use	Immigration status
	Main	Secondary					
Abies alba Mill.	6	1	0.23	0.04	Primary	Ornamental	Native
Agave americana L.	5	17	0.36	0.01	Secondary	Ornamental	Exotic
Allium schoenoprasum L.	9	20	0.37	0.01	Secondary	Ornamental, Edible	Exotic
Alocasia macrorrhizos (L.) G. Don	6	0	0.24	0.01	Primary	Ornamental	Exotic
Aloe juvenna Brandham & S. Carter	0	4	0.20	0.03	Secondary	Ornamental	Exotic
Bougainvillea sp.	19	46	0.57	<0.01	Secondary	Ornamental	Exotic
Capsella bursa-pastoris (L.) Medik.	5	0	0.22	0.05	Primary	Weed	Native
Carpobrotus sp.	5	15	0.34	0.01	Secondary	Ornamental	Exotic
Chamaerops humilis L.	12	31	0.48	<0.01	Secondary	Ornamental	Native
Cotoneaster lacteus W. W. Sm.	3	10	0.28	0.03	Secondary	Ornamental	Exotic
Euphorbia helioscopia L.	25	9	0.43	<0.01	Primary	Weed	Native
Euphorbia pseudocactus A. Berger	0	4	0.20	0.02	Secondary	Ornamental	Exotic
Foeniculum vulgare Mill.	8	1	0.27	0.02	Primary	Weed	Native
Hatiora gaertneri (Regel) Barthlott	13	3	0.33	0.01	Primary	Ornamental	Exotic
Hibiscus rosa-sinensis L.	11	25	0.42	<0.01	Secondary	Ornamental	Exotic
Jacobaea maritima (L.) Pelser & Mejiden	1	9	0.27	0.01	Secondary	Ornamental	Native
Lactuca sativa L.	11	3	0.29	0.03	Primary	Edible	Exotic
Lantana camara L.	13	29	0.45	<0.01	Secondary	Ornamental	Exotic
Lantana montevidensis (Spreng.) Briq.	5	13	0.32	0.02	Secondary	Ornamental	Exotic
Mandevilla laxa (Ruiz & Pav.) Woodson	12	28	0.44	<0.01	Secondary	Ornamental	Exotic
Musa × paradisiaca L.	0	7	0.26	<0.01	Secondary	Ornamental	Exotic
Nerium oleander L.	22	56	0.64	<0.01	Secondary	Ornamental	Exotic
Ocimum basilicum L.	5	14	0.32	0.02	Secondary	Ornamental, Edible	Exotic
Opuntia ficus-indica (L.) Mill.	5	13	0.31	0.03	Secondary	Ornamental	Exotic
Oxalis corniculata L.	39	12	0.55	<0.01	Primary	Weed	Native
Parietaria judaica L.	11	2	0.31	0.01	Primary	Weed	Native
Phaseolus vulgaris L.	5	0	0.22	0.05	Primary	Edible	Exotic
Plantago lanceolata L.	8	1	0.27	0.02	Primary	Weed	Native
Platycodon grandiflorus A. DC.	5	12	0.29	0.04	Secondary	Ornamental	Exotic
Plumbago auriculata Lam.	6	22	0.42	<0.01	Secondary	Ornamental	Exotic
Prunus avium (L.) L.	17	5	0.36	0.01	Primary	Edible	Native
Pyrus communis L.	5	0	0.22	0.05	Primary	Edible	Exotic
Schefflera arboricola Hayata	17	6	0.36	0.02	Primary	Ornamental	Exotic
Senecio vulgaris L.	6	0	0.24	0.01	Primary	Weed	Native
Sonchus oleraceus L.	33	10	0.51	<0.01	Primary	Weed	Native
Sonchus tenerrimus L.	13	3	0.32	0.01	Primary	Weed	Native
Stellaria media Cirillo	13	4	0.32	0.01	Primary	Weed	Native
Taraxacum officinale F. H. Wigg.	14	5	0.32	0.05	Primary	Weed	Native

Table 4 (continued)

Species name	Observed frequencies in households (%)		Stat.	*p*-level	Type of residence	Plant use	Immigration status
	Main	Secondary					
Taxus baccata L.	1	7	0.25	0.01	Secondary	Ornamental	Native
Trifolium sp.	13	3	0.32	0.01	Primary	Weed	Native
Yucca guatemalensis Baker.	10	26	0.43	<0.01	Secondary	Ornamental	Exotic

Discussion and conclusion

The difference between primary and secondary homes was examined to determine whether the occupancy characteristics affect household garden structures and plant compositions. The results indicate that differences in the functionality of both residence types have translated into subtle plant differences. Primary homes hosted high native plant richness, especially that resulting from the presence of native weeds rather than the deliberate choices of owners. Thus, the assumption of Misetic (2006) and Stedman (2006) may be applicable in some circumstances; namely, that individuals can develop a strong bond and identification with the location of their secondary or holiday home.

The social heterogeneity in suburban developments of the Costa Brava has also generated a mosaic of lifestyles and a variety of gardens. As reported in other private landscape studies, garden characteristics are usually influenced by socioeconomic and demographic attributes of household owners (Acar et al. 2007; Kirkpatrick et al. 2007; Lubbe et al. 2010; Marco et al. 2010; van Heezik et al. 2013). Along these lines, garden plants in exclusive neighborhoods mainly have an ornamental function, while those in popular neighborhoods have a more utilitarian function (Bigirimana et al. 2012). In our case study, a higher proportion of vegetable garden species and weeds were found in primary residences where the average socioeconomic status is lower. Food security guaranteed through urban and peri-urban agriculture has long been considered a significant component of the livelihood strategies for many households (Bernholt et al. 2009; Thompson et al. 2009). The economic crisis that has plagued the country since 2008 may have favored an increase in these types of species in residential landscapes (Padullés et al. 2014b).

In terms of garden structure, the comparisons suggested that areas devoted to trees, shrubs, flowers, lawns and swimming pools differ among residence types. Accordingly, Garcia et al. (2014) reported that secondary residents opposed lawn gardens significantly more often than

Table 5 Correlations between environmental variables and NMDS axis scores for microhabitats (using *envfit* procedure (Oksanen 2008))

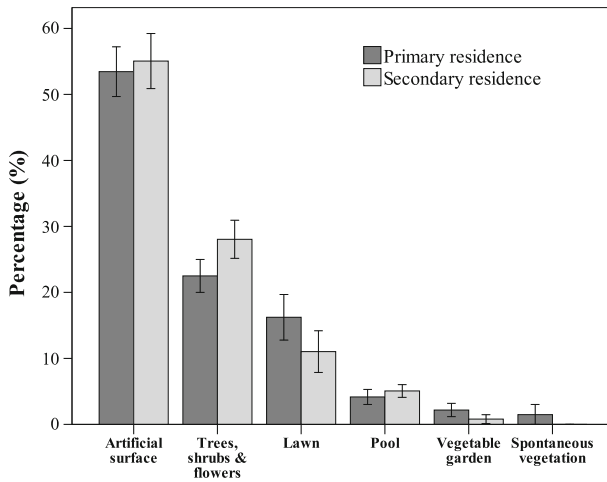|		Axis 1	Axis 2	Axis 3	r^2	*P*-value
Socioeconomic factors		0.89	0.12	−0.43	0.24	<0.01
Legacy factors		0.51	0.75	−0.42	0.18	<0.01
RG5 ("to have a place to relax")		0.94	0.30	−0.18	0.09	<0.01
Residence type	Primary residence	−0.09	−0.03	0.03	0.10	<0.01
	Secondary residence	0.13	0.04	−0.04		

Fig. 3 Characterization of primary and secondary residences in the Costa Brava (Spain) according to the percentages and confidence intervals of land use of outdoor areas (aggregated). The proportion of outdoor area occupied by trees, shrubs, flowers and pools is significantly higher in secondary residences ($p<0.05$, Mann-Whiney U-Test), whereas the percentage area occupied by vegetable gardens is significantly lower in this typology ($p<0.05$, Mann-Whiney U-Test)

primary residents in another region of Catalonia (Spain). This finding might be explained by the elevated maintenance required by this type of vegetation throughout the year. Nevertheless, swimming pools were found to be larger in secondary residences, i.e., globally, high water-demanding landscapes may result (Hof and Wolf 2014).

Based on our results, variations in socioeconomic characteristics of household owners may also change the garden land cover structure. Specifically, higher socioeconomic status, represented here by wealthy residents, mainly foreigners, with elevated educational levels, would have garden areas occupied by more artificial surfaces, trees, shrubs, flowers and swimming pools. In contrast, this group would cultivate few vegetable gardens. In other garden studies conducted in Spain, income has generated contradictory results in terms of preferences for land cover types (Domene and Saurí 2003; Garcia et al. 2014). However, this variable is positively correlated with higher plant diversity (Hope et al. 2003; Kinzig et al. 2005; van Heezik et al.

Table 6 Beta values for housing variables in the GLM analyses. AIC values are also shown

Parameters		Artificial surface	Trees, shrubs and flowers	Vegetable garden	Lawn	Pool
AIC		15206	17677	1340	13402	1482
Intercept		4.929**	4.278**	1.772	0.194	0.274
Residence type[a]		−0.023	0.066	0.146	0.223	−0.820*
	Legacy effects	0.097	0.245	0.592	0.466	0.756*
	Socioeconomic effects	−0.190**	−0.004	−0.244	0.023	−0.062
Legacy effects		−0.006	0.247	−0.182	−0.248	−0.094
Socioeconomic effects		0.312**	0.220*	−0.589**	−0.245	0.411*

[a] Primary residence is the reference category

*, ** Significant at $P \leq 0.05$ and 0.01, respectively

2013). Regarding educational level, previous studies in the U.S. (Troy et al. 2007) and Australia (Luck et al. 2009; Kendal et al. 2012c) also found this variable to be a good predictor of the proportion of vegetated areas on private properties. In addition, Garcia et al. (2014) also concluded that residents with elementary educational levels preferred vegetable gardens in their yards. Nevertheless, private landscapes may become a symbol of social conformity or status, particularly in Anglo-Saxon urban landscaping (Askew and McGuirk 2004).

Legacy effects were less significant than socioeconomic attributes in both plant composition and garden structure. Secondary residences included in our study were relatively old buildings that have been occupied by the same residents for a long time. Troy et al. (2007) found a strong *legacy* effect with respect to the presence of trees in neighborhoods. In our case, although plant composition was strongly related to a household's legacy, the garden structure was not significantly related to any of the land cover areas. This result contradicts the expected results, i.e., that a significant association exists between legacy effects and the area cultivated for vegetable production. In this regard, we expected that households with higher legacy effects would dedicate their yard to the production of food as a result of the likely rural background of the owners (Head et al. 2004). However, contradictory results may be found in the scientific literature. Preferences for manicured lawn gardens were associated with both older homeowners (Van den Berg and Van Winsum-Westra 2010) and households with children (Yabiku et al. 2008). The interactions between residence types and legacy effects suggested that primary homes built long ago and occupied for many years contain significantly larger swimming pools. In the past, real estate companies and the media remarkably contributed to the increased idealization of commercialized yards with pools and grass (Garcia et al. 2014).

Overall, these results provide the first general perspective on how household outdoor areas are organized in the rather unexplored framework of primary and secondary residences. Floristic and structural characteristics of the gardens of both residential types are a consequence of the functional characteristics provided by the owners in an attempt to improve their quality of life. Differences in outdoor characteristics should be assessed by managers to carefully monitor how suburban residential areas evolve in the future. The socioeconomic and demographic changes taking place in the Mediterranean context will definitely alter the dynamics of these urban landscapes. An integrative approach at the city, urban and suburban scale should be implemented for a better understanding of the role of domestic gardens. Finally, all these issues should be addressed when implementing compulsory municipal urban ordinances that promote more Mediterranean and environmentally friendly private landscapes.

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