

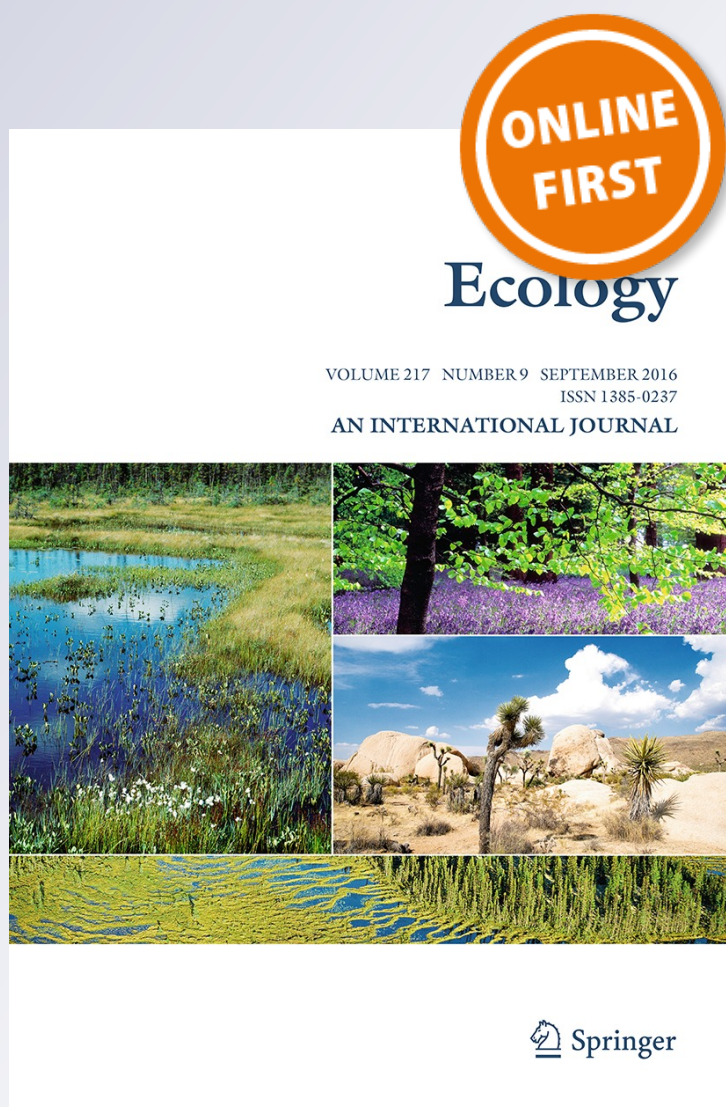
# *Translocation of Limonium perplexum (Plumbaginaceae), a threatened coastal endemic*

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# Translocation of *Limonium perplexum* (Plumbaginaceae), a threatened coastal endemic

Emilio Laguna  · Albert Navarro · Patricia Pérez-Rovira · Inmaculada Ferrando · P. Pablo Ferrer-Gallego

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**Abstract** *Limonium perplexum* Sáez and Rosselló is an herbaceous—perennial to annual—, triploid apomictic halophyte which only lives on a small outcrop (40 sq. m.) of a low coastal cliff in Serra d'Irta (Peñíscola, Castellón, Valencian Community, Spain). The population has been observed to fluctuate between 19 and 383 individuals, and the site is affected by collapse risk caused by marine storms. To save this species, 9 new populations—neopopulations—have been planted close by—0.12 to 7.35 km—, with 4,198 individuals planted throughout 2005–2014. The fluctuation of the native population shows a correlation between the number of individuals and the maximum daily rainfall of the second quarter—April to June. Survival of the founder individuals on available microhabitats fluctuates between 36 and 77 %. New populations show a strong initial decline during the

first 2 years, but in that time an initial pool of seeds is generated, which can yield the first recruitment of seedlings. The establishment of new generations is not apparently restricted by seeds, but by the need to grow in safe conditions—mainly on rock crevices holding soil and being protected against the effects of excessive wind and sun radiation. Similarity between the inter-annual changes in censuses of the native population and neopopulations is taken as a measurement of the establishment success. Apparently no former similar works have been published with endangered species of *Limonium*, although this genus holds more than 400 species.

**Keywords** *Limonium* · Apomixis · Translocation · Critically endangered species · Coastal cliffs · Neopopulation

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## Introduction

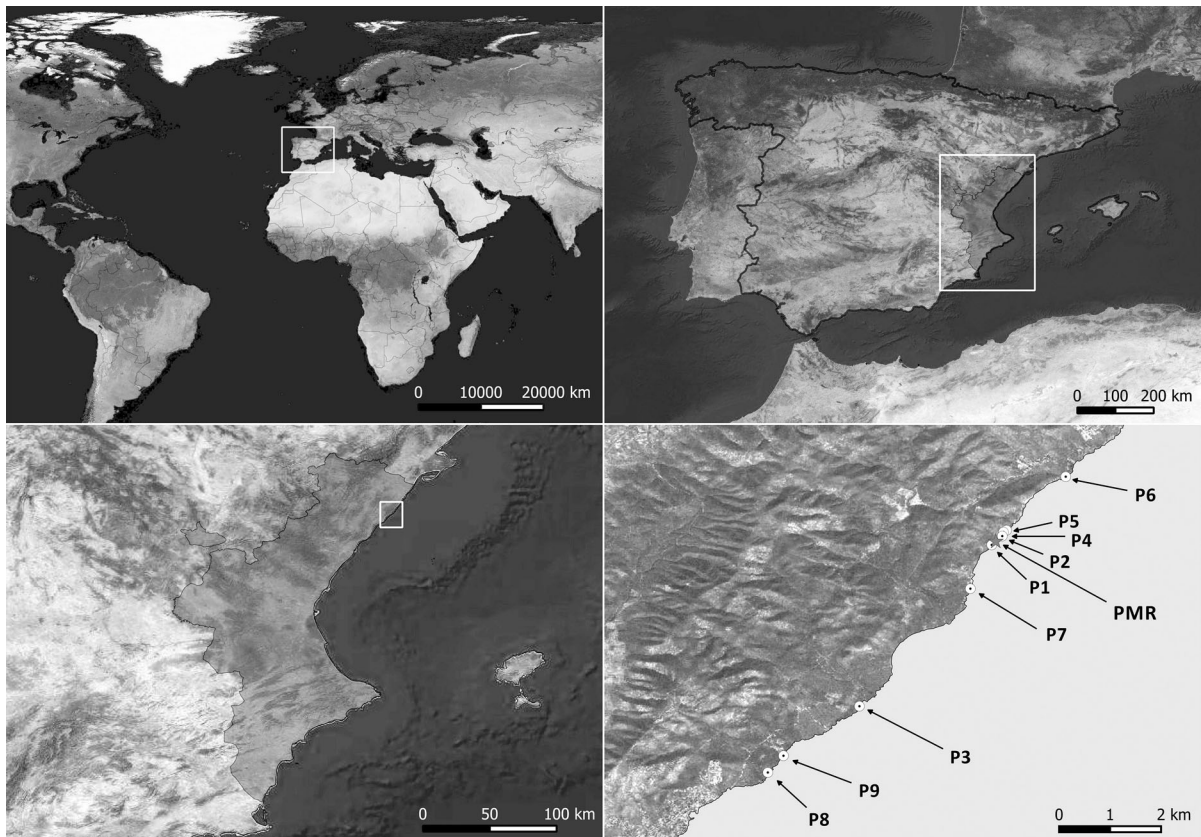
Translocations are a fundamental and increasingly important element in conservation strategies of the most endangered species of fauna and flora (Griffith et al. 1989; Given 1994; Maunder 1992; Maschinski et al. 2012; Guerrant 2013; IUCN/SSC 2013; Ren et al. 2014; Abeli and Dixon 2016). Their use is increasing (see Godefroid et al. 2011; Albrecht et al. 2011; Dalrymple et al. 2011, 2012) and can be justified by the accelerated rate of species extinction, which is

closely related to human activity (Ricketts et al. 2005) and may increase in the future due to global change (Thuiller 2007; Maschinski et al. 2013; Abeli et al. 2014).

Within Europe, the Spanish territory of the Iberian Peninsula and the Balearic Islands contains several major hotspots of plant diversity (Davis et al. 1994; Médail and Quézel 1997, 1999) showing an extensive list of endemic and threatened species (Aedo et al. 2013; Moreno 2008). In this territory, the genus *Limonium* (Plumbaginaceae) is the one with the highest number of recognized species—107 according to Erben (1993)—with 74 listed in the Spanish Red List of Threatened Vascular Plants (Moreno 2008) according to IUCN Criteria (IUCN/SSC 2001). One of the richest territories in *Limonium* species is the Valencian Community (Fig. 1), having at least 26 endemic species, many of them threatened (Crespo and Lledó 1998; Laguna 1998; Aguilera et al. 2010). This genus has chromosomal peculiarities (Erben

1979) and floral biology traits (Baker 1966) that make it prone to endemization processes (Erben 1993; Crespo and Lledó 1998). The most threatened endemic species of *Limonium* of the Valencian territory is *L. perplexum* Sáez and Rosselló (Aguilera et al. 2010), represented by a single population restricted to a small terrace on a coastal cliff of Serra de Irta, in the province of Castellón (Fig. 1).

Paradoxically, there is a strong contradiction between the abundance of endangered species of this genus (see Moreno 2008) and the extensive lacking of available published papers reporting translocation projects dealing with these species. There is a list of papers linking the knowledge on some *Limonium* species with conservation recommendations (e.g. Hegazy 1992; Khan et al. 2012; Caperta et al. 2014; Foggi et al. 2014), but the only translocation action reflected on scientific or technical communications consisted of the punctual transplantation of living adults of *Limonium estevei* Fern. Casas from



**Fig. 1** Location maps of the Iberian Peninsula (*top left*), Valencian Community (*top right*), Serra d'Irta (*bottom left*) and the natural (PMR) and planted populations of *L. perplexum* (P1–P9)

transformed habitats scheduled to be urbanized, towards more suitable protected sites (Rodríguez-Tamayo et al. 2005, with *L. estevei* Fern. Casas).

This paper addresses the work developed to conserve *Limonium perplexum* by establishing *safety neopopulations*. This concept, proposed by Laguna and Ferrer-Gallego (2012), designates conservation translocations made in close proximity of current populations of a species, and occupying sites where the survival probability is high, according to the knowledge on the species. Since there is no evidence that *L. perplexum* grew in a larger range in the past, any neopopulation can be considered as a close-range form of an assisted colonization, according to IUCN/SSC (2013). As a main hypothesis of this paper, it has been assumed that the success of the translocation could be accepted when the population dynamics of the new populations was similar to that of the donor population.

## Materials and methods

### Background information

*Limonium perplexum* is a low herbaceous plant with rosette leaves that grows 35–40 cm tall (Crespo 2004; Aguilera et al. 2010). It forms a part of the permanent chasmophyte communities exposed to salt-laden sea spray [*Crithmo-Staticetea* Br.-Bl. in Br.-Bl., Roussine and Nègre 1952] (Costa 1982; Crespo et al. 2003; Crespo 2004; Aguilera et al. 2010), and is considered a characteristic species of the plant association *Crithmo-Limonietum girardiani* Costa 1982. *L. perplexum* has a flexible biotype (Aguilera et al. 2010; Ferrando et al. 2014), from therophyte living 3–9 months growing on shallow soil to chamaephyte—up to 7 years old—established on deep crevices.

All individuals flower in the first year, with flowering and fruiting completed between July and September. Therophytic individuals die after producing seeds, while perennials bloom again every year. No detailed study about reproductive biology has been made, but plants in ex situ culture produce around 280 viable seeds per individual (Servicio de Vida Silvestre 2014). Dispersal units often are barochorous spikelets or seeds wrapped in the calyx (pers. obs.). According to Crespo (2004) the species is anemochorous and

myrmecochorous. Dry branches with spikelets, detached from the mother plant by wind or seabird's passage or other vertebrates, can also act as dispersal vector (pers. obs.).

*L. perplexum* is a triploid species ( $2n = 3x = 27$ , Sáez and Rosselló 1999; Rosato et al. 2012). It is considered a self-incompatible and apomictic species (see Sáez and Roselló 1999). Consistent with this, plants of the original population have virtually no genetic diversity (Palacios and González-Candelas 1997; Palacios 1999). Regarding its sexual expression, it is considered an allogamous hermaphrodite (Crespo 2004), but sexual reproduction can only be achieved if pollen comes from other species with a compatible pollen/stigma combination, resulting in hybrid seeds. Although *L. perplexum* coexists with the annual diploid *L. echioides* (L.) Mill. ( $2n = 18$ ), and two triploid chamaephytes living in separated populations near the site—*L. girardianum* (Guss.) Fourr. ( $2n = 26$ ) and *L. virgatum* (Willd.) Fourr. ( $2n = 27$ )—, no hybrids have been found in situ in Serra d'Irta. According to Crespo and Lledó (1998 as *L. cavanillesii*), Sáez and Rosselló (1999) and Lledó et al. (2005), *L. perplexum* is related morphologically and/or genetically to species that have ranges as far as Southern France, Balearic Islands and Central and Southeastern Spain.

The unique population of *L. perplexum* occupies an approximate area of 40 m<sup>2</sup> on a low terrace 3–4 m above the sea level, partially affected by risk of collapse, because its base is strongly undermined by sea waves (Servicio de Vida Silvestre 2014). The geological materials are Quaternary conglomerates compounded by gravel and clay matrix, forming a pudding stone (Ferrando et al. 2014). Both north and south of the cliff, the conglomerate layer ends abruptly, changing to limestone where *L. perplexum* does not grow, being substituted by *L. girardianum* and other characteristic species of *Crithmo-Staticetea*. The alternate pudding stone and limestone stratum recurs along 10 km and similar habitats to the population site can be easily found throughout.

The population occurs on public property owned by the Spanish state. There are no direct significant anthropogenic risks, however, trampling from tourism and fishing activity pose potential threats (Crespo 2004), and any extension of a nearby road could generate negative effects on the population (runoff, dust deposition on leaves, etc.). No effects of predators or herbivores have been observed.

*L. perplexum* is strictly protected by the Spanish and Valencian laws since 2009 at the maximum legal level—'Imperiled of Extinction'—(Aguilella et al. 2010). Following Spanish legal requirements on endangered flora and fauna, a recovery plan was prepared and approved by the Valencian government in 2014, although technical aspects of this plan are still subject to ongoing public consultation (Servicio de Vida Silvestre 2014). Ferrando et al. (2014) and Ferrer-Gallego et al. (2012) have shown several actions for ex situ conservation of this species including protocols for germination, seed production and plant cultivation in nursery. *L. perplexum* is an orthodox species for ex situ conservation in gene-banks, often showing high germination rates (97.0 %) and velocity ( $T_{50} = 2$  days). Most seed accessions are preserved in the CIEF (Valencian Center for Forestry Research and Experimentation, Quart de Poblet, Valencia) where the cultivation of the species is also carried out (Ferrer-Gallego et al. 2012). *In vitro* propagation protocol has been refined by Amo-Marco and Ibáñez (1998), although its use is not required for purposes of conservation. Ibáñez (2013) states that in the process of in vitro propagation several mutations have been identified, discouraging the employment of these plants for conservation translocations.

Serra d'Irta is a calcareous mountain range of about 12 km length opposite to the sea in the N of the province of Castellon—latitudes from 40°15'35"N to 40°20'00"N (Fig. 1). The rock outcrop where *L. perplexum* is part of a series of alternating small capes and bays, just South from the historic site named 'Torre de la Badum'. The whole range is protected since 2002 as a Natural Park, managed by the Department of Environment of the Valencian government. The exact site where the population of this species is located is strictly protected since 2001 as a 'Plant Micro-reserve'—hereinafter PMR—named 'Torre de la Badum', measuring 0.34 ha. The model of establishment and management of the Valencian PMR has been explained by Laguna (2001), Moreno et al. (2003), Laguna et al. (2004) and several chapters of the book edited by Kadis et al. (2013).

#### Field methods and data analysis

To ensure the conservation of *L. perplexum* by creating safety neopopulations (Laguna and Ferrer-

Gallego 2012), nine plantations were established from 2005 to 2014 in different sites of the shoreline cliffs in Serra d'Irta (Fig. 1; Table 1). Planting was preferred rather than sowing, following the recommendations found in translocations literature (Primack and Drayton 1997; Drayton and Primack 2000; Jusaitis et al. 2004; Menges 2008; Bowles et al. 2015). The donor population has been named PMR. To carry out plantations P1–P9, sites with the same geological stratum as the PMR and located at the same height 2–5 m above sea level and distance to the sea as the PMR approximately 5–15 m from the sea were selected. In addition to the geological material and the location, it was considered relevant when sites could harbour at least 1 specimen per 4 m<sup>2</sup> of *Crithmum maritimum*, the dominant species of the plant community. Only one population (P6) is scarcely different from PMR—the original stratum is partially covered with sand and pieces of marine shells—, although *C. maritimum* is also present. Seedlings of *L. perplexum* with well-developed basal leaves rosette, 3–5 months old, were planted. Seedlings were watered after plantation. In the absence of rain they were watered 2 weeks after plantation.

The translocated plants were produced in the CIEF's nursery, following the methodology of Ferrer-Gallego et al. (2012). Original seeds from PMR were only used to produce seedlings for plantations P1–P4. Subsequent plantings (P5–P9) have been made using plants grown from seeds produced ex situ. The number of individuals planted, as well as planting times, depended on external factors (availability of personnel, vehicles, etc.), without responding to a fixed design. The specimens were produced in planting tubes, 1 × 1 × 3 cm, capable of implantation in small rock holes/crevices or soil hollows. Plantlets were planted taking advantage of the availability of microsites for each zone, mimicking the situation of native individuals in the PMR population. Censuses of adult plants were performed once a year—typically in early to mid summer—both in PMR and in the neopopulations P1–P8.

Given the repeated observation of population fluctuations in PMR (Gómez-Serrano et al. 2005; Ferrando et al. 2014), it was hypothesized that a correlation with the variation in climate parameters could be found, paying particular attention to the values of temperature and rainfall in the period January–June, which coincides with the majority of

**Table 1** Location, planting dates and number of specimens planted at the nine neopopulation sites (P1–P7)

	UTM cell 1 × 1 km	Distance from the native population (km)	Plantation date	Number of planted individuals
P1	31T BE7566	0.12	05.12.2005	44
P2	31T BE7566	0.18	05.12.2005	72
P3	31T BE7361	5.00	27.03.2007	142
P4	31T BE7566	0.28	13.12.2010	56
P5	31T BE7566	0.36	19.12.2011	166
P6	31T BE7667	1.70	28.11.2011	406
P7	31T BE7565	1.33	28.11.2012	1374
P8	31T BE7159	7.35	03.03.2014	1308
P9	31T BE7260	6.88	02.12.2014	630
Total				4198

UTM cells correspond to the datum ETRS89

the plant life cycle (pers. obs.). The nearest coastal weather station named ‘Ribera de Cabanes’ is located 25 km South from the PMR, and has gathered data since year 2002. The joint availability of meteorological data and PMR census spans from 2002 to 2014. Data of 15 parameters—9 of them related to temperature and 6 to rainfall, see Table 3—from January to June were obtained. The correlation between the population fluctuations of the PMR and the weather parameters were tested using the Pearson’s coefficient ( $r$ ), and Holm correction for multiple comparisons was applied.

Correlations between the variation in population size of PMR and the oldest neopopulations (P1–P3) were also carried out to verify a similar dynamic that would corroborate the success of translocations.

Packages used for statistical treatments and correlation tests were XLSTAT v. 2008.5.01 (<http://www.xlstat.com>), PAST 3.x (<http://folk.uio.no/ohammer/past/index.html>) and R (<https://stat.ethz.ch/R-manual/>).

## Results

### Plantations and survival

4,198 individuals have been planted (Table 1). The distance between centroids of the 9 plantation sites and PMR varies from 0.12 (P1) to 7.35 km (P8). The distance between the two most distant plantations (P6 and P8) is 9.53 km. Table 2 refers to the survival of planted specimens in P1–P8. Recruitment of

individuals from seed produced on site started 2–3 years after planting, excluding P3, which showed recruitment after 1 year (Tables 1, 2).

### Natural population censuses (PMR) and their relationship with climatic parameters

Since 1995, censuses of adult plants have been conducted in the only natural population, except for one interruption—year 2000 (Gómez-Serrano et al. 2005). The population has undergone marked fluctuations (Gómez-Serrano et al. 2005; Ferrando et al. 2014), ranging between 19 and 383 individuals (Fig. 2).

Table 3 shows correlation results between censuses of PMR and 15 climatic parameters. Although significant correlations for 4 parameters were found, the use of Holm method for multiple comparisons shows that only maximum rainfall in 1 day in the second quarter (PMaxd2T,  $r = 0.779$ ) is consistent.

### Change in population size of translocated populations P1–P7

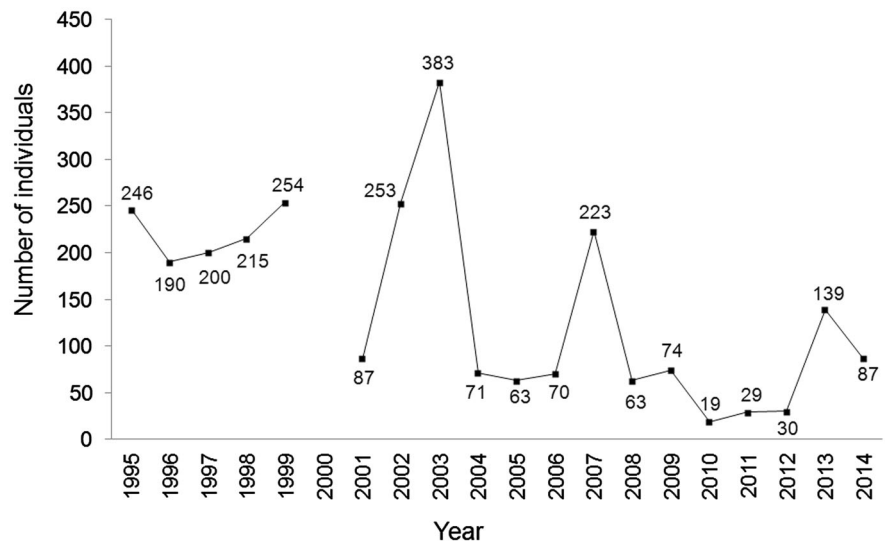
After initial establishment, the neopopulations experienced a trend to decline in population numbers in the 2nd or 3rd year after planting (Fig. 3). From then on, a spatial microdistribution pattern—not analysed in this paper since no detailed monitoring has been done—is observed, showing new seedlings gathered in microsites with more soil. Germination occurs during winter—pers. obs.—and seemingly there is a severe

**Table 2** Results of the first census of survival of planted specimens, after reproductive age

	Survival census date	Time after plantation (days)	Survival (amount of individuals)	Survival (%)	First year with F1
P1	05.09.2006	274	28	63.36	2007
P2	05.09.2006	274	33	45.83	2008
P3	08.08.2007	132	110	77.47	2008
P4	11.07.2011	210	28	50.00	2013
P5	12.07.2012	206	60	36.14	2013
P6	12.07.2012	227	212	52.22	2013
P7	14.07.2013	228	283	20.59	2014
P8	15.07.2014	134	486	37.16	–

Planting dates are given in Table 1. The column First Year with F1 shows the first year where new recruited seedlings (first in situ generation, F1) were found

P9 was first surveyed in 2015

**Fig. 2** Changes in the number of individuals in the original population (PMR) between 1995 and 2014

mortality rate as spring draws on and rainfall diminishes. It has been observed that the population is not necessarily established at the plantation site, and new seedlings could grow up to 15 m from the location where founders were planted.

Population variation of the native (PMR) and the oldest translocated (P1–P3) populations

Comparing censuses of PMR and neopopulations P1–P3 during 2008–14 period (Fig. 4), significant correlations between PMR data and the oldest plantation data are obtained, P1 ( $r = 0.862$ ,  $p = 0.013$ ) and P2 ( $r = 0.823$ ,  $p = 0.023$ ), indicating that these populations follow a similar pattern of change than PMR, and therefore could

be considered as fully established translocations. Although no significant correlation has been found between PMR and P3, there is a slightly significant one between P1 and P3 ( $R = 0.777$ ,  $p = 0.040$ ).

## Discussion

Results indicate that the new populations are establishing with their own recruitment, and a global census pattern is correlated with the PMR data for the oldest plantations.

The plant survival of the initial pool for each neopopulation, excluding the already mentioned case of P7, ranges from 36.15 (P5) to 77.47 % (P3). These



**Table 3** Linear correlation coefficients ( $r$ ) and their probability values ( $p$ ) found by comparing the PMR annual number of individuals and the 15 climatic parameters through the period 2002–2014

Climatic parameters	$r$	$p$	$p'$
Temperatures			
T1S	0.524	0.066	0.660
T1T	0.392	0.185	1.000
T2T	0.256	0.398	1.000
TMax1S	0.567	0.043*	0.516
TMax1T	0.035	0.910	1.000
TMax2T	0.537	0.059	0.649
TMin1S	0.389	0.189	1.000
TMin1T	0.389	0.189	1.000
TMin2T	-0.170	0.578	1.000
Rainfall			
P1S	0.482	0.096	0.864
P1T	-0.220	0.470	1.000
P2T	0.720	0.006*	0.078
Pmaxd1S	0.725	0.005*	0.070
PMaxd1T	-0.370	0.214	1.000
PMaxd2T	0.779	0.002*	0.030*

Asterisks (\*) show the existence of correlation at a significance level of  $p \leq 0.05$ . Last column ( $p'$ ) expresses the  $p$  values after Holm correction for multiple comparisons

T1S, average temperature of the first semester (January–June); T1T, average temperature of the first quarter, winter period (January–March); T2T, average temperature of the second quarter, spring period (April–June); P1S, accumulated rainfall in the first semester; P1T, accumulated rainfall in the first quarter; P2T, Accumulated rainfall in the second quarter; TMax1S, mean of the average of maximum temperatures in the first semester; TMax1T, mean of the average of maximum temperatures in the first quarter; TMax2T, mean of the average of maximum temperatures in the second quarter; TMin1S, mean of the average of minimum temperatures in the first semester; TMin1T, mean of the average of minimum temperatures in the first quarter; TMin 2T, mean of the average of minimum temperatures in the second quarter; PMaxd1S, maximum rainfall in 1 day in the first semester; PMaxd1T, maximum rainfall in 1 day in the first quarter; PMaxd2T, maximum rainfall in 1 day in the second quarter

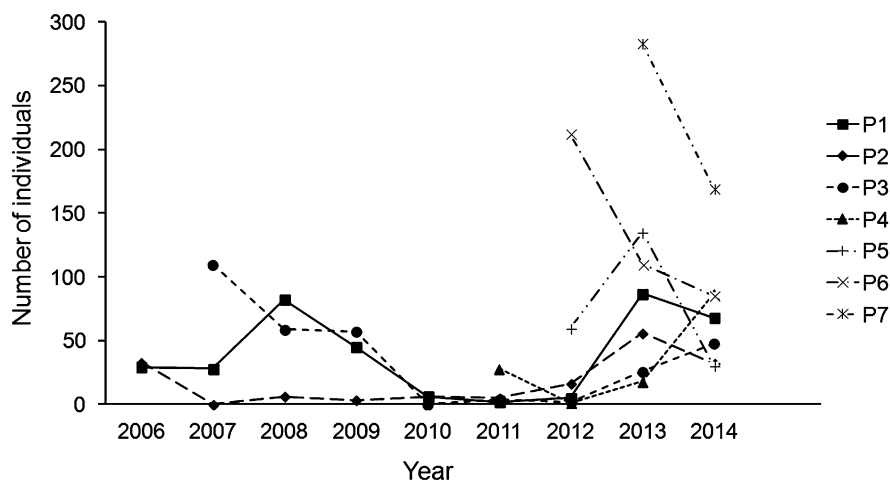
values can be assumed as acceptable, bearing in mind that only 1–2 supplemental watering events were usually performed after planting, and that the plants had to overcome the late spring period with a progressive increase in temperature and evapotranspiration. The importance of irrigation has been highlighted by several authors (Monks and Coates 2002; Primack and Drayton 1997; Kaye 2011).

According to the obtained correlation dates, the PMR shows some inter-annual fluctuations that could be influenced by rainfall amounts during the first semester and most notably by the daily maximum rainfall in spring. Although the situation of plants in the waterfront ensures a constant supply of humidity provided by dew and sea spray (Costa 1982), the higher significant correlation found with PMaxd2T (Table 3) indicates that the species may need an additional natural water supply as temperatures and evapotranspiration rise during spring period. Additionally, the presence of episodes of heavy rain may favour an increased recruitment of plants, however, no specific monitoring has been conducted to support this effect.

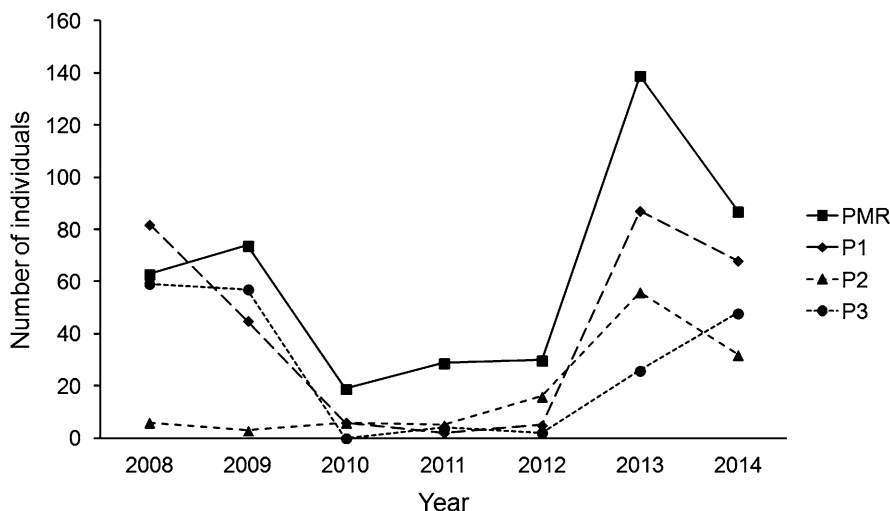
The oldest neopopulations (P1–P3) appear to be sufficiently established particularly from the fifth or sixth year, when the minimum number of plants increases substantially, and population dynamics are correlated with PMR. Minor lapses—cases of P4–P9—do not allow inferences related to demographic development, as neopopulations probably do not have enough seeds to ensure sufficient regular recruiting (see below). These results reinforce the review made by Godefroid et al. (2011) with other species, on the limited validity of data to infer the translocation success if the monitoring ceases after a too short period of 1–4 years. Simultaneously, the results discourage us to accept single success criteria to measure the translocation success like the proposal made by Sarrazin and Barbault (1996) such as the verification of reproduction in the first generation already born in situ.

The importance of edaphic seed bank for the translocation success has been highlighted by many authors (Parsons and Zedler 1997; Davy 2002; Holl and Hayes 2006; Clark et al. 2007). Germination tests show that *L. perplexum* seeds have no inner dormancy (Ferrer-Gallego et al. 2012) and analysis of their viability after long-time storage—20 years—have shown a progressive loss of viability (unpublished data), so a long-term edaphic seed bank could not be theoretically established. However, it is well known that soil salt can act as seed preservative and germination retardant in halophytes (Gul et al. 2013), so the regular addition of new seeds of *L. perplexum* to the soil can generate a temporary, but effective, seed bank. This fact can explain not only the evolution of neopopulations, but the maintenance of the donor population PMR.

**Fig. 3** Results (number of individuals) of the interannual censuses of the first seven plantations (P1–P7)



**Fig. 4** Recent changes of the number of individuals in the censuses PMR and the three oldest neopopulations (P1–P3)



Clearly seedlings planted in P1 (44 specimens) and P2 (72 specimens) may be sufficient to establish new stable populations, provided that weather conditions are similar in coming monitoring. Although minimum viable population is a recurrent topic in plant conservation biology (Frankham et al. 2002; Brigham and Schwartz 2003), and some discussion can be opened about the minimum viable number of founder individuals, a new population could even be generated after one unique plant due to apomixis. In addition to this, in the worst scenario of negative stochastic events, a complete population could vanish—because of cliff collapses caused by strong storms—, regardless of population size. A future strategy for *L. perplexum* should be based on the establishment of more small

neopopulations—like P1 and P2—, instead of a few big ones.

As stated before, translocation success into a neopopulation of *L. perplexum* is not strongly limited by the seed availability but by the quantity and/or quality of safe sites—suitable microhabitats, such as provided by the pudding stone microrelief, plenty of holes which protect the plants against the sea waves, trampling, etc.—, that are able to ensure the seed germination and the further growth of new seedlings. According to Clark et al. (2007) the species is mainly affected by establishment limitations, instead of seed limitations. The importance of safe sites on a small scale has been underlined by several authors (Eriksson and Ehrlén 1992; Duncan et al. 2009; Graae et al. 2010) and together with other specific species aspects

and restoration techniques, may be essential to explain the reintroduction success (Kaye 2011). In addition, there are increasing evidences on the importance of choosing microsites for plant translocations (Maschinski et al. 2012; Wendelberger and Maschinski 2016).

In several cases—P2 in 2007, P3 in 2010—the apparent vanishing of some neopopulations has been noticed (see Fig. 3). However, the ‘disappearance’ of individuals at the implantation site does not necessarily mean a translocation failure, but a transition stage waiting for a more noticeable recruitment in the forthcoming years. This fact reinforces the critique made by Godefroid et al. (2011) on the early abandonment of post-plantation monitoring. A basic lesson can be learnt: an extant plant population is not only formed by the visible individuals, but also by their viable seeds or propagules. In fact, maybe some abandoned ‘failed’ translocations worldwide could be only ‘dormant populations’ waiting to wake up.

As a main result, the correlation between PMR and P1–P2 censuses opens the use of plant demography as a useful tool to measure the success of a translocation. Although demography is a main topic in plant translocation (Menges 2008; Maschinski et al. 2012; Ren et al. 2014), the success has been often measured or supported using some parameters—demographic structure, increasing number of recruited plants, changes in demographic processes, etc.—only measured in the same translocated population (i.e. Albrecht and MacCue 2010; Albrecht and Maschinski 2012; Bowles et al. 2015), but not by comparing the changes in annual censuses between the donor population and the translocated one. This comparison can only be made if the donor population is not modified—by means of reinforcements, frequent seed collections, etc.—and this condition can be extended to other comparative traits—fruit set or seed set used by Abeli et al. 2016.

Facing future scenarios, most coastal halophytes such as *L. perplexum* could be threatened by sea level rise, one of the expected effects of climatic change (Flowers and Muscolo 2015), but many of their current habitats are impossible to re-create artificially. Similar future problems can be drafted for other coastal endangered species worldwide currently benefited by translocation projects (i.e. Maschinski and Duquesnel 2006; Fotinos et al. 2015). It is important to note that current forecasts for Spain show the downward trend of spring rainfall in different studied scenarios (Moreno-Rodríguez 2005). Although some specimens

of *L. perplexum* behave like annual plants, it does not ensure major capacity to adapt through genetic selection, since the species is apomictic and therefore lacks genetic plasticity which could help this adaptation. If seeds have no dormancy and may completely lose viability in few years, if the temporary edaphic seed bank is not renewed, then several consecutive dry spring seasons could cause the extinction of the PMR and neopopulations.

Finally, we consider the need to open a debate on the conservation of apomictic species, given the importance of genetic aspects linked to small populations in other translocation projects (e.g. Menges 2008; Grommbridge et al. 2012; Jamieson and Lacy 2012; Keller et al. 2012). Focus on the classic genetic aspects of small plant populations is not appropriate for taxa such as *L. perplexum*, which necessarily resorts to asexual reproduction. The main genetic issue relevant for this case is hybridization risk; fine works on ex situ artificial pollination should be performed in the near future. Simultaneously, future research works on the in situ viability of seeds and their dynamics should be undertaken. In addition, adaptive management of translocations (see Rout et al. 2009) should focus in this case on the demographic evolution and on a better knowledge of the microhabitat suitability, which are two key questions to ensure the long-term self-maintenance of this species.

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