Towards an integrative management of Invasive Alien Plant Species in Mediterranean sea cliffs of European interest

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Baseline situation

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Executive summary

To assess the effect of the conservation actions foreseen into the conservation of HCI1240 and endemic species, the baseline situation in the Costa Brava and the Parc Natural del Cap de Creus (PNCC) has been determined through: (1) the evaluation of the conservation status of HCI1240 by estimating its distribution area, evaluating the structure and functions of HCI1240, and detecting actual and potential pressures and threat; (2) update information related to the threatened endemic species (*Limonium geronense*, *L. tremolsii*, and *Seseli farrenyi*); (3) update information about the most severe IAPS present in HCI1240 (*Carpobrotus acinaciformis*, *C. edulis*, *Opuntia ficus-indica*, *O. stricta*, and *Gazania rigens*) that will be remove in selected areas; and (4) the evaluation of the threat by IAPS in the HCI1240 by improving knowledge about their presence and distribution in the Costa Brava.

Disclaimer

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1. Introduction

1.1. Description and scope of the preparatory action A1

To assess the effect of the conservation actions foreseen in the project (actions C1-C4) into the conservation of HCI1240 and endemic species (action D1), it is necessary to determine the baseline situation in the Costa Brava and the *Parc Natural del Cap de Creus* (PNCC). Moreover, the available previous information about the covering and distribution of severe IAPS (invasive alien plant species) within the PNCC is coarse and does not allow an accurate determination of the baseline situation for these species. Therefore, action A1 is mainly addressed to (1) determine the current degree of conservation of HCI1240 and (2) enhance and update information related to the threatened endemic species (*Limonium geronense*, *L. tremolsii*, and *Seseli farrenyi*) and the most severe IAPS present in HCI1240 (*Carpobrotus acinaciformis*, *C. edulis*, *Opuntia ficus-indica*, *O. stricta*, and *Gazania rigens*) that feed conservation and eradication actions, respectively.

The fieldwork in this early phase of action A1 aims to assess the impact on habitat HCI1240 in PNCC of the IAPS eradication carried out in this area. Subsequent evaluations will allow us to know if the status of the habitat and the populations of *Limonium geronense*, *L. tremolsii*, and *Seseli farrenyi* have improved and if the impact of the IAPS has decreased. Moreover, a precise idea of the initial state of the main IAPS in the whole Costa Brava will allow us to check their evolution in future years through the volunteers' network.

2. Baseline situation

2.1. Conservation status of the habitat 1240 in the Cap de Creus area

Introduction

The habitat type targeted by the LIFE medCLIFFS project is HCI1240 – 'Vegetated sea cliffs of the Mediterranean coasts with endemic *Limonium* spp.'. HCI1240 is the most frequent coastal habitat of the PNCC (*Parc Natural del Cap de Creus*), with 313.4 ha (Fig. 1), which represents nearly half of the total HCI1240 area in Catalonia (652.3 ha) and about one quarter in Spain (1266.01 ha). Thus, it is of paramount importance to establish the initial conservation status of HCI1240 and monitor it yearly. As specified in the Grant Agreement, the conservation status of HCI1240 have been evaluated by means of: (1) estimating its area of occupancy (AOO) *sensu* International Union for Conservation of Nature—

IUCN; (2) evaluating the structure and functions of HCI1240; and (3) detecting actual and potential pressures and threats (and whether there are mitigation/conservation measures). The second aspect included two types of measures, biotic traits (e.g. species richness) and the current degree of anthropisation; while the biotic measures have been planned to be taken in selected plots (primarily located close to the places where eradication actions take place), the degree of anthropisation had to be observed in the whole PNCC. To be more efficient, the plots already designed for monitoring endemic and invasive species have been used as plots for monitoring HCI1240, always trying to be more efficient and to maximise their diversity so that there would be a clear representation of the entire habitat.

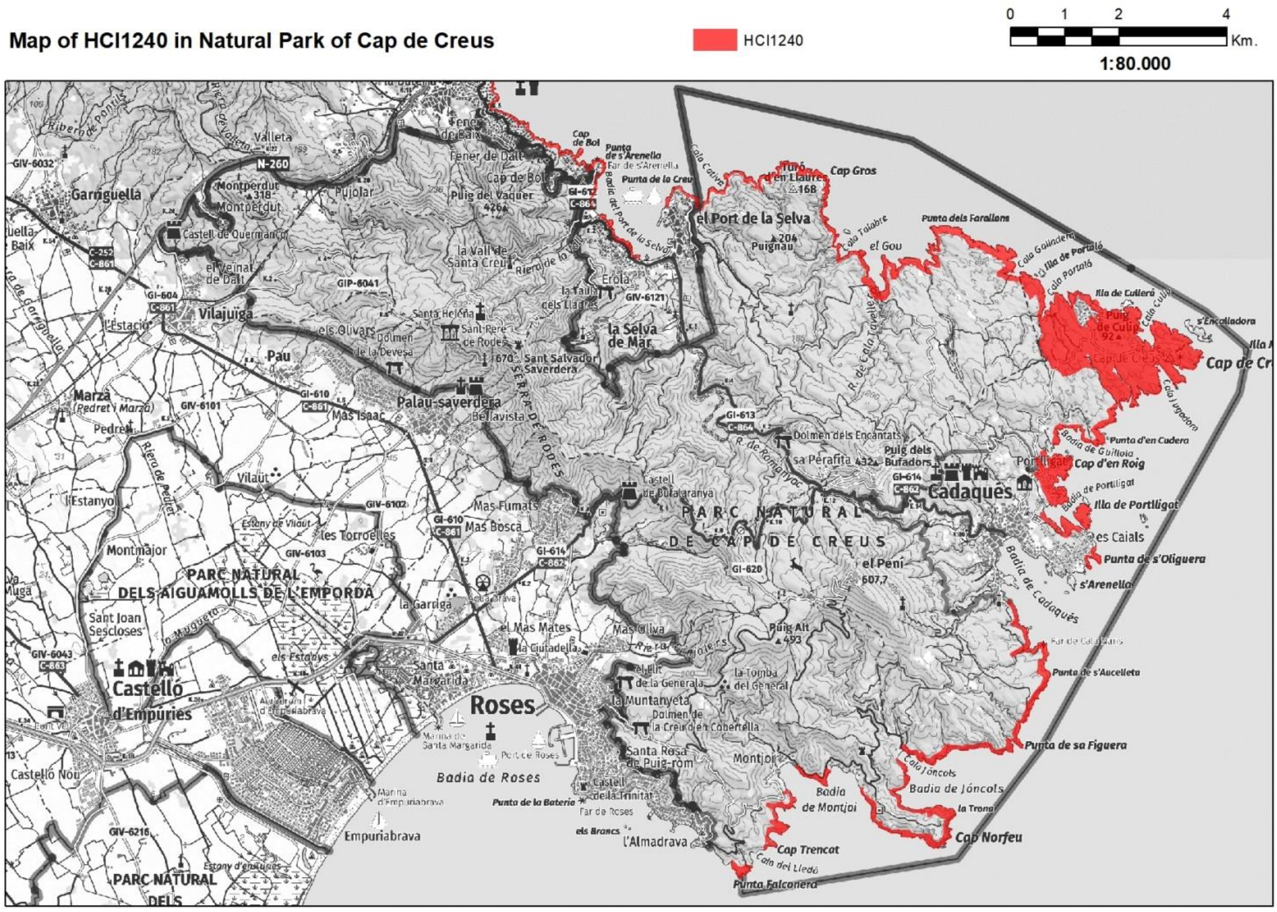

Figure 1. Map of the HCI1240 in the PNCC (*Parc Natural del Cap de Creus*).

Methods applied

Within the HCI1240, we selected four plots of 100 m^2 in which we carried out floristic rélevés (Fig.2 and Table 1), that represents 0.12% of the total area of this habitat in PNCC. These plots have different orientations, are close to areas where IAPS (invasive alien plant species) will be removed, and of easy access. We measured, among others (Table 2): (1) coverage/abundance of each species; (2) vegetation coverage in percentage; (3) the ratio of native/non-native plant species; (4) type of substrate; (5) slope and orientation; and (6) actual and potential anthropogenic impacts. These baseline data will allow us to appreciate if there is any trend of change in terms of abundance, disappearance of the species or the appearance of new ones throughout the control period.

Table 1. Plots used to estimate the baseline conservation status of HCI1240 of the PNCC

Plot	Geographic coordinates (lat. – long.)	Invasive or endemic species monitored within the plot
Est del Port de la Selva	42.336385 – 3.194268	*Carpobrotus* + *Gazania*
Tudela 1	42.327467 – 3.294533	*Limonium tremolsii*
Tudela 2	42.326500 – 3.297783	*Limonium tremolsii*
Far Cap de Creus	42.319600 – 3.311767	*Limonium tremolsii*

As a part of this initial assessment of the status of conservation of this habitat, we gathered data on former vegetation relevés in close locations. However, comparisons have been forcibly qualitative given that former and present relevés were carried out with different methodologies (e.g., different sizes, different periods of the year). These former relevés (for qualitative comparisons purposes) have been selected according to the following criteria: (1) they should be geographic closeness to the current relevés; and (2) they should belong to the same plant community. Former relevés have been obtained from SIVIM (*Sistema de Información de la Vegetación Ibérica y Macaronésica*). To make sure that point (2) is met, apart from visual inspection, we have also consulted relevant accounts (Pérez-Haase, 2011) and the 2nd Edition of *Manual dels hàbitats de Catalunya*. The degree of anthropisation (e.g. presence of debris, closeness of roads, agricultural and farming activities, and so on) within and around plots was also measured for the whole areas of PNCC showing HCI1240 (by visits to numerous random locations). Within these places we also tried to detect potential threats, and we recorded whether mitigation measures are in place. The degree of actual threats and human activities is classified into three categories: high, medium and low/absent.

Figure 2. Plot of 100 m2 in Cap de Creus, built with non-invasive techniques: the strings and nails were removed after inventorying. The coordinates of the four plot corners were georeferenced with the aid of a GPS.

Results

Estimation of area of occupancy (AOO) of HCI1240 in the PNCC

We assume that the AOO of HCI1240 remains equal as estimated by Pérez-Haase (2011) so, 313.4 ha in the PNCC.

Evaluation of the structure and functions of HCI1240 in the PNCC, and detection of actual and potential pressures and threats

The measurements carried out in the four plots (Table 2) indicate that the HCI1240 is not suffering from heavy episodes of plant invasion; one plot show no presence of APS (alien plant species), whereas two plots show little presence; this situation, however, might only apply for the areas of the PNCC far from human presence. For instance, the plot of Port de la Selva, which is located in the margin of the coastal path (*camí de ronda*) and in front of vacation houses, is covered by over 20% of IAPS (*Carpobrotus* sp. and *Gazania rigens*). The population of Tudela 1, although at present is within the core area of PNCC, was once located within a tourism resort ("Club Med"), dismantled in 2009 (and Tudela

2 is just a few dozen meters far away). Although eradication measures of IAPS are carried periodically, new invasion episodes are often detected (particularly involving *Carpobrotus* spp.). Thus, we believe that the threat posed by IAPS to HCI1240 in the PNCC should be regarded as moderate.

Table 2. Measurements carried out in four plots used to estimate the baseline conservation status of HCI1240 of the PNCC

	Est del Port de la Selva	Tudela 1	Tudela 2	Far Cap de Creus
Geographic coordinates	42.336385 – 3.194268	42.327467 – 3.294533	42.326500 – 3.297783	42.319600 – 3.311767
Elevation	4 m	22 m	11 m	22 m
Type of substrate	Sandy and gravelly soil	Schistous rocks	Sandy soils with some schistous rocks	Schistous rocks
Terrain slope and orientation	0-5%, NE	10%, N	10%, SSE	10-25%, NE
Percent vegetation coverage	60%	15-20%	70%	5%
Ratio of APS/native plant species (amount APS/total species; coverage APS/total species)	2/16 (11%; 21.5%)	2/19 (9.5%; 1%)	1/10 (9.1%, 5.5%)	0/13 (0%, 0%)
Degree of anthropisation				
Agricultural and farming activities	No	No	No	No
Urbanisation degree	Medium (some terraced houses nearby)	No urbanisation	No urbanisation	Low (a few buildings around)
Close to industrial areas/transportation	No	No	No	No
Population density (of closest urban areas)	Medium	Not close to urban areas	Not close to urban areas	Not close to urban areas
Accessibility degree	High (close to a frequented path)	Medium	Medium	Medium (close to a road)
Tourism activities	High	Medium	Medium	Low (no suitable place to walk)
Other (fill)	-	Debris (plastic fragments)	-	-
Pressures/threats				
Actual (potential)	Tourism, private gardens (dog urine and faeces)	Tourism (high volume of visitors in summer)	Tourism (high volume of visitors in summer)	Occasional visitors
Mitigation/conservation measures	Eradication of IAPS 1.5 km away	Eradication of IAPS around (*Gazania rigens*, *Carpobrotus* sp.)	Eradication of IAPS around (*Gazania rigens*, *Carpobrotus* sp.)	Eradication of IAPS half km away

Regarding the native species, the number of species contained ranged between 13 and 19 native species. Based on the observed plant composition observed by us and on the 11 relevés carried out formerly (1990s) within the same UTM of 10 × 10 km (31TEG18) (Table 3), the plot of Port de la Selva belongs to the *Thymelaeo hirsutae-Plantaginetum subulatae* community. Although direct comparisons are not possible (see Methods), it should be noted that all the former relevés failed to detect APS. This probably reflects that these former relevés would have been carried out in areas as less anthropised as possible (as botanists are used to do) but also an increasing presence of APS in recent times. The remaining three plots (Table 4) belong to *Armerietum ruscinonensis*. This community is, however, not very different from the former and, indeed, both communities are merged with the *Manual dels hàbitats de Catalunya* (habitat code 18.221). As for the Port de la Selva Plot, no APS were detected in the former 26 relevés carried out in the same UTM of 10 × 10 km (31TEG28).

Table 3. Floristic inventory in Port de la Selva plot (Community *Thymelaeo hirsutae-Plantaginetum subulatae*)

Plant taxa	El Port de la Selva
Camphorosma monspeliaca	2
Carpobrotus sp.	2
Gazania rigens	2
Paronychia argentea	2
Plantago coronopus	2
Thymeaea hirsuta	2
Avena sp.	1
Dactylis glomerata	1
Daucus carota	1
Helichrysum stoechas	1
Lagurus ovatus	1
Trifolium angustifolium	1
Asparagus acutifolius	+
Crithmum maritimum	+
Cynodon dactylon	+
Echinops ritro	+
Limonium sp.	+
Sonchus tenerrimus	+

Table 4. Floristic inventories in three plots: Tudela 1, Tudela 2 and Far Cap de Creus (Community *Armerietum ruscinonensis*)

Plant taxa	Tudela 1	Tudela 2	Far Cap de Creus
Anagallis arvensis		+	
Andryala integrifolia	+	+	+
Armeria ruscinonensis	1	2	+
Artemisia gallica	1		
Asparagus acutifolius	+		
Astragalus tragacantha	1		
Atriplex portulacoides (*Halimione portulacoides*)	1		
Bromus sp.		1	
Carpobrotus sp.	+		
Crithmum maritimum	2	2	
Daucus gingidium	1		1
Drosanthemum floribundum	1		
Euphorbia sp.			+
Gazania rigens	+	1	
Koeleria pyramidata (= *K. splendens*) (confer)	1		1
Helichrysum stoechas	2	3	1
Lagurus ovatus		2	+
Limonium tremolsii	2	2	1
Lotus corniculatus	1		
Parapholis incurva	1		
Petrosedum sediforme subsp. *sediforme*			+
Phagnalon saxatile	+		
Pistacia lentiscus			+
Plantago coronopus	1	2	+
Polycarpon polycarpoides			1
Polypogon monspeliensis	1		
Reichardia picroides			1
Sonchus tenerrimus	1		
Trifolium sp.	1		
Urospermum dalechampii		1	

Judging on the information contained in Table 2, the degree of anthropisation is low-medium of HCI1240 within the PNCC. The best conserved areas of HCI1240 are, as one might expect, within the core area of the PNCC. The HCI1240 is not urbanised, but some areas are not far from populated places (e.g. Cadaqués or el Port de la Selva villages); it is worrisome the existence of many small roads and trails (including the core areas of the PNCC), some relatively very crowded during the summer. Although some mitigation measures are in place (e.g. in summer the access by car to the lighthouse and the closeby restaurant is restricted), visitors are not always using the marked trails. Another threat to the habitat is the stone stacking, which we have personally observed in several places. The threats of tourism (like trampling, plant collection, maintenance/construction of tourist infrastructure and habitat degradation due to the urbanisation of tourist sites) should be closely monitored, as they might significantly increase in the coming years due to the post-COVID-19 touristic boom. The threat derived from private gardens (i.e. garden escapees) seems to be limited to the areas of the PNCC close to human settlements.

Conclusions

The fieldwork carried out during the first year of the project (action A1) focused on the HCI1240 is indicating that this habitat is in a relatively good state of conservation, and it is suffering from moderate threats, mainly stemming from touristic activities. Although the effects of APS are not very significant in well protected areas within the PNCC, its impact can be important near human settlements. The results presented here constitute the baseline of the conservation status of HCI1240 in the PNCC, and the same measures will be replicated at the end of the project to evaluate with precision whether the conservation status of the habitat is maintained, is worsening or, hopefully, is improving.

2.2. Endemisms growing in HCI1240 in the Cap de Creus area

Introduction

As noted in the description of the action A1, the evaluation of the conservation status of HCI1240 had to be done exclusively in Cap de Creus Natural Park (PNCC), including data from the most severe invasive alien plant species (IAPS) (*Carpobrotus acinaciformis*, *C. edulis*, *Opuntia maxima*, *O. stricta*, and *Gazania rigens*) as well as from the endemic and threatened species affected by these IAPS (*Limonium geronense*, *L. tremolsii*, and *Seseli farrenyi*). Certainly, these IAPS have been detected in many places where the three endemic species occur, thus representing a direct threat to their conservation (Sáez et al., 2010; Saura-Mas, 2020a). Although not included neither in the Habitats Directive nor in the European Red List, these three endemic species are very valuable in terms of biodiversity at European level, since their distribution area is limited to the northern coastal area of the Girona province, in particular to the PNCC (ES5120007 SCI) and its surrounding area.

Limonium geronense is considered to be endemic to the northern area of the Costa Brava region (Sáez et al., 2010). Some populations are very close or even inside Cadaqués-Port Lligat villages; thus, urbanisation poses a major threat to these populations. The only population outside the PNCC grows in Portbou (just 10 km far away), and had only 95 individuals in 2006 (Sáez et al., 2009); however, this population was not relocated by Saura-Mas in 2020 (Saura-Mas, 2020a), and the census carried out by this researcher in 2020 was of 3313 individuals (all reproductive) distributed in eight populations that occupied 101,480 m^2. The species is listed as VU ("Vulnerable") according to the International Union for Conservation of Nature (IUCN) criteria in the Spanish red list (Moreno, 2011). It is also included in the red list of Catalonia (Aymerich & Sáez, 2021) and in the catalogues of protected species at both Catalonian (Generalitat de Catalunya, 2008, 2015) and Spanish (Gobierno de España, 2015) levels, considered in both cases as "vulnerable".

Limonium tremolsii is endemic to the Costa Brava (Sáez et al., 2010) although, according to Saura-Mas (2020a), the only verified populations are those within the PNCC. The 2020 census was of 336,677 individuals (all reproductive) distributed among the known seven populations (although about 92% of all individuals are located in a single population; Tudela site, within the PNCC). The area of occupancy (AOO) was 371,210 m^2 (Saura-Mas, 2020a). The species is listed as NT ("Near Threatened") according to the IUCN criteria in the most recent Catalan (Aymerich & Sáez, 2021) and Spanish red lists (Moreno, 2011). It is also included in the catalogue of protected species of Catalonia (Generalitat de Catalunya, 2008, 2015) as "vulnerable".

Seseli farrenyi is a plant strictly endemic to the PNCC (Sáez et al., 2010), with only three populations of this species being known until 2020 (Saura-Mas, 2020b). The species suffered great declines (of over 90%) during the first decade of the 21th century (the total population size decreased from 2066 individuals in 1999 to 148 in 2010), followed by some demographic stabilisation (with yearly oscillations), though a decline could be inferred from the most recent censuses (N = 293 in 2017, N = 284 in 2018, N = 237 in 2019, and N = 199 in 2020; Saura-Mas, 2020b). Fortunately, in 2021 an additional three populations of *S. farrenyi* were discovered also within the PNCC, which meant an increase of the total population size to 838 individuals. Although the species was listed as EN ("Endangered") according to the IUCN criteria in the most recent Catalan (Aymerich & Sáez, 2021) and Spanish red list (Moreno, 2011), now it ranks as CR ("Critically Endangered") according to López-Pujol et al. (2010) and Saura-Mas (2020b). The species is included in the catalogues of protected species at both Catalonian (Generalitat de Catalunya, 2008, 2015) and Spanish (Gobierno de España, 2015) levels (both as "in danger of extinction"). Being regarded by the local environmental authorities as the species of most conservation concern in Catalonia, *S. farrenyi* will be recipient of the first recovery plan for a plant species that will be launched in the whole country.

The assessment of the conservation status of the three endemic and threatened species, as specified, have been done through the following tasks: (1) calculating of the area of occupation (AOO) and extent of occurrence (EOO) within the PNCC for each species; (2) calculating the area of AOO of each of the populations detected for each species (within the PNCC); (3) estimating the size of each population [separately for young seedlings/juveniles (vegetative), adults (reproductive) and senescent (or dead in the current season)]; and (4) detecting real and potential threats to each of the populations of the three species, as well as at the species level.

Methods applied

To estimate the baseline for *Limonium geronense*, we have chosen two of the eight existing populations and we have carried out a direct census to calculate the number of individuals. The two populations to be censused were Caials Nord (Limger04) as an example of a large population and Cadaqués–S'Instrument (Limger02) as an example of a small one (shaded in blue in Table 5). Making censuses of all populations has been considered unreliable given the allocated time and the phenology period of these plants. Three categories of individuals have been distinguished in the census:

1. **Reproductive individuals**: those with inflorescence (from this year or dried inflorescences remaining from the last season).
2. **Vegetative individuals**: individuals only with a rosette of leaves, either because they are seedlings or because they have not yet flowered (i.e., juveniles).
3. **Senescent/dead**: individuals with dry parts or completely dry (dead in the current season).

Table 5. Census size of *Limonium geronense* populations as carried out by Saura-Mas (2020a)

Population (location)	No. individuals	Area (m²)	Census method	Population code
Cap Norfeu	838	84,554.1	Direct census	Limger01
Cadaqués–S'Instrument	7	0.68	Direct census	Limger02
Caials Sud	1816	2,976.4	Direct census	Limger03
Caials Nord	491	8813.8	Direct census	Limger04
S'Alqueria–Platja d'en Ballesta	8	43,3	Direct census	Limger05
Cap d'en Roig	102	1309.3	Direct census	Limger06
Cala Sant Lluís	46	141.9	Direct census	Limger07
Guillola – Punta d'es Gavià	5	2367.8	Direct census	Limger08

The size of the six remaining populations of *L. geronense* has been estimated on the basis of the demographic trend of the two populations where direct censuses have been carried out (Limger02 and Limger04). First, a ratio of the total number of individuals (seedlings/juveniles + reproductives + senescent/dead) per area unit (see below) of Limger02 and Limger04 populations have been calculated from both the data taken in 2022 during our field trips as well as from the censuses that Saura-Mas carried in 2020 (Saura-Mas, 2020a).

$$\text{Ratio} = \frac{\text{Population size (no.individuals)}}{\text{Population area}}$$

The difference between the ratios (averaged for the two populations) between the year 2020 and 2022 can be interpreted as a sort of "change rate" for the period 2020–2022. Values >1 mean population size increases, whereas values <1 should be interpreted as population declines (and = 1, no change).

$$\text{Change rate} = \frac{\text{Average ratio in 2022}}{\text{Average ratio in 2020}}$$

Assuming that the remaining six populations of *L. geronense* (Limger01, Limger03, Limger05, Limger06, Limger07, and Limger08) are showing the same demographic trend as Limger02 and Limger04, we have used this change rate to estimate their current (2022) population size taking the original censuses of the year 2020 (*N* = 2815 in 2020 summing the six populations), as follows:

$$\text{Estimated no. of individuals in 2022} = \text{change rate} \times \text{no. of individuals in 2020}$$

Finally, the total number of individuals of *L. geronense* for the year 2022 have been obtained by summing the (real) size of the two populations where direct censuses have been carried out (Limger02 and Limger04) and the estimated size of the six non-visited populations (Limger01, Limger03, Limger05, Limger06 and Limger07). Please note that for these estimations we are assuming that the area of these four populations is constant through time.

The calculation of the EOO at the species level has been done by drawing a minimum convex polygon (in which none of its internal angles exceed 180 degrees), as recommended by the IUCN (2012), and which was drawn with the online tool GeoCAT (http://geocat.kew.org/). For the AOO, polygons have been made as close as possible to the shape of the populations (that is, any angle size is allowed). The sum of the AOO values of each population is the AOO estimation at the species level. For all populations the AOO for the year 2020 (as provided by Saura-Mas, 2020a) have been taken as the baseline values for the year 2022 (i.e., we are assuming that the area of these populations remains constant), except in Limger02 and Limger04 for which we have drawn new polygons (Fig. 3).

The detection of real and potential threats has been done for the two populations where direct censuses have been carried out (Limger02 and Limger04), although we are also providing an evaluation at the species level.

Figure 3. Location of the two populations of *Limonium geronense* (Limger02 and Limger04) where fieldwork has been carried out in 2002 (in order to estimate their population size, AOO, and threats), in yellow. The red line indicates the places where removal of IAPS will take place during action C3.

To measure the initial situation for *Limonium tremolsii*, we decided to carry out different plots in those populations that were easily accessible. The following populations were ruled out: Cala Bona and Platja de ses Ielles (Limtre07) because the impossibility of using a boat within the framework of the present project, S'Encalladora (Limtre06) as it is located in an island (again, a boat is needed), and Es Bol d'es Prim (Limtre02) and Portaló (Limtre03) that are almost inaccessible (their access would need climbing techniques and climbing material).

A total of five plots have been made, four of them located in Tudela (Limtre04), which is the population with the highest number of individuals, and one at Far de Cap de Creus (Limtre05), which is the second largest population (shaded in blue in Table 6). The plots occupy 100 m², all being a square of 10 × 10 m except for one that measures 5 × 20 m in order to adapt to the irregularity of the terrain (Fig. 4). The selection of plots has been made maximising different environmental conditions where the species is found (orientation, type of substrate, inclination, plant cover, etc.). As done for *L. geronense*, we have distinguished three categories of individuals (vegetative, reproductive, and dead/senescent) for the censuses of the plots.

Table 6. Census size of *Limonium tremolsii* populations as carried out by Saura-Mas (2020a)

Population (location)	No. individuals	Area (m²)	Census method	Population code
From Cala s'Arenassa to the Punta dels Forellons	239	22,788	Indirect census (by plots)	Limtre01
Es Bol d'es Prim	648	13,562.2	Direct census	Limtre02
Portaló	48	949.9	Direct census	Limtre03
Tudela	309.682	143,371.4	Indirect census (by plots)	Limtre04
Far de Cap de Creus	25.945	168,823.4	Indirect census (by plots)	Limtre05
S'Encalladora	20	4632.6	Direct census	Limtre06
Morro de cala Bona and Platja de ses Ielles	45	17,082.4	Direct census (using a boat)	Limtre07

As for *L. geronense*, we estimated the ratio of the total number of individuals (seedlings/juveniles + reproductives + senescent/dead) per area unit for both populations of *L. tremolsii* (Limtre04 and Limtre05). For Limtre04, we have averaged data from the four plots:

$$\text{Ratio} = \frac{\text{No. individuals of a plot}}{100\ \text{m}^2\ \text{(plot area)}}$$

The ratio corresponding to the year 2020 for these two populations (Limtre04 and Limtre05) has been obtained from the censuses that Saura-Mas carried in 2020 (Saura-Mas, 2020a). Again, as for *L. geronense*, the difference between the ratios of each population between the year 2020 and 2022 has been interpreted as a sort of "change rate" for the period 2020–2022. The change rate averaged for the two populations (Limtre04 and Limtre05) has been used to estimate the size for the year 2022 of the five populations not visited by us (Limtre01, Limtre02, Limtre03, Limtre06 and Limtre07; N = 1000 in 2020 summing the five populations). Finally, the total number of individuals of *L. tremolsii* for the year 2022 has been obtained by summing the estimated size of the five non-visited populations to the estimated size of Limtre04 (applying the average ratio for the four plots) and Limtre05 (the ratio obtained for the single plot). Please note that for these estimations we are assuming that the area of these four populations is constant through time.

Figure 4. Location of the five 100 m²-plots of *Limonium tremolsii* where fieldwork has been carried out in 2002, indicated with green (population Limtre04) and yellow (population Limtre05) arrows. The red line indicates the places where removal of IAPS will take place during action C3.

The calculation of the EOO at the species level for *L. tremolsii* have been done as explained for *L. geronense*. For the AOO, we have taken the values provided by Saura-Mas (2020a) as the baseline values for the year 2022.

The detection of real and potential threats has been done for the two populations where we have designed 100m²-plots to make direct censuses (Limtre04 and Limtre05), although we are also providing an evaluation at the species level.

For *Seseli farrenyi*, we have taken the results of the censuses that Saura-Mas is carrying out yearly (commissioned by the PNCC); censuses are detailed for each population and are provided separately for vegetative and reproductive individuals (although not distinguishing between juveniles and senescent individuals). The yearly reports sent by this researcher to the PNCC also includes data on the

AOO for each of the populations, which are taken by us. We have estimated the EOO using the methodology explained above for the two *Limonium* taxa. Given that the populations of *S. farrenyii* are located very close to each other, we have estimated both the potential and real threats considering all populations as a whole (and adding commentaries for a given population when necessary).

Results

According to the data taken in June 2022, the number of individuals in the two selected populations of *L. geronense* was 1869, of which 1637 were in the population of Caials Nord (Limger02) and 232 in the population of Cadaqués–S'Instrument (Limger04) (Table 7). In the first population there were some areas buried by dry remains of *Carpobrotus* spp. from previous removal actions that have surely caused the death of some individuals (Fig. 7). Regarding the demographic structure of the two censused populations, the average percentage of reproductive/juvenile/senescent individuals is 70.1%/22.6%/7.3%.

Table 7. Census of *L. geronense* carried out in June 2022 and change rate calculated through the relation between the ratio of 2022 and the original ratio of 2022

Population (Location)	No. individuals	Reproductive / Juvenile / Senescent	Area (m^2)	Ratio 2022 (ind./m^2)	Ratio 2020 (ind./m^2)	Change rate
Caials Nord	1637	1136 / 388 / 113	11,808	0.1386	0.0557	2.4883
Cadaqués–S'Instrument	232	175 / 34 / 23	1595	0.1455	10.2941	0.0141

Since the population of Cadaqués–S'Instrument (Limger02) of 2022 is much larger than that indicated by Saura-Mas (2020a), both in terms of the number of individuals (direct census) and the sampled area (Table 7), we have considered that the change rate of this population for the period 2020–2022 does not obey in any way to a natural change in the size of the population. While the exact reason for this change is unknown, we believe that it could be due to differences in the methods employed. We should bear in mind that the censuses of 2020 and 2022 have been done by different teams (Saura-Mas for the former, ours for the latter), which supposes a certain (and almost unavoidable) bias in the methodology, especially with regard to the count of individuals. For example, in the 2020 report all counted individuals were considered reproductive, while in the 2022 we were able to detect juveniles (Fig. 8) and senescent in addition to reproductives (see below). This might partly explain that the 2022 censuses of Limger02 and Limger04 are larger than those of 2020.

Figure 7. Individuals of *Carpobrotus* spp. were piled up (after their removal) on a population of *Limonium geronense*, in Caials Nord.

Figure 8. Juvenile individuals (including seedings) of *Limonium geronense*, in Caials Nord.

In contrast to Limger02, both the number of individuals and the area for Limger04 are showing a limited increase of 2022 with respect to 2020 (Table 7), which would be compatible with a natural demographic fluctuation. Thus, we have only used the change rate (2.4883) of this latter population (Limger04) instead of averaging the values of change rate of the two populations. This change rate has been applied to the five non-visited populations (that summed a total of 2815 individuals in 2020), so the total number of individuals estimated in these five populations is 7005; when they are that added to the estimated census for Limger02 and Limger04, we obtain a total of 8874 individuals at the species level.

According to the data taken in June 2022, the number of individuals of *L. tremolsii* in the censused plots ranges between 23 and 180 (Table 8). Based on these censuses, the ratio of individuals per area unit for each plot has been calculated (Table 4). Regarding the demographic structure of the five studied plots, the average percentage of reproductive/juvenile/senescent individuals is 86.9%/5.5%/7.6%.

Table 8. Census of *L. tremolsii* as of June 2022, and estimated ratio of individuals per area unit

Plot (location)	No. individuals	Reproductive / Juvenile / Sensecent	Plot dimensions	Ratio (ind./m²)
Tudela 1	180	136 / 10 / 34	10 × 10 m	1.8000
Tudela 2	175	168 / 2 / 5	10 × 10 m	1.7500
Tudela 3	153	119 / 24 / 10	5 × 20 m	1.5300
Tudela 4	165	161 / 2 / 2	10 × 10 m	1.6500
Far de Cap de Creus	23	21 / 0 / 2	10 × 10 m	0.2300

After averaging the individual values of the ratios for each of the four plots of population Limtre04 (Tudela), we have estimated the change rate of this population for the period 2020–2022. For Limtre05 (Far de Cap de Creus population), we have used the ratio of the single plot (0.2300; Table 8) to estimate the change rate. The ratios for the year 2020 have been obtained from the original data of Saura-Mas (2020a).

Table 9. Census of *L. tremolsii* carried out in June 2022 and change rate calculated through the relation between the ratio of 2022 and the original ratio of 2022

Population (Location)	Area (m²)	No. ind. 2022	No. ind. 2020	Ratio 2022 (ind/m²)	Ratio 2020 (ind/m²)	Change rate
Tudela	143,371.4	241,222	309,682	1.6825	2.1600	0.7789
Far de Cap de Creus	168,823.4	38,829	25,945	0.2300	0.1537	1.4964

The change rate for the Tudela population is lower than 1 (0.7789), which indicates that it has decreased during the period 2020–2022; the size of this population would have been reduced from 309,682 individuals in 2020 to 241,222 in 2022 (Table 9). In contrast, the Far de Cap de Creus population shows a change rate higher than 1 (1.4964), suggesting a population expansion (25,945 individuals in 2020 × 1.4964 = 38,829 individuals in 2022; Table 9). After averaging the change rate for the two populations (1.1377), the total number of individuals estimated in the five non-visited populations is 1138; when they are that added to the estimated census for Limtre04 and Limtre05, we obtain a total of 281,189 individuals at the species level.

For *S. farrenyi*, the newly discovered populations have increased the total population size to 838 individuals in 2021 (the last year we have got census data; Saura-Mas, 2021; Table 10). However, the species is probably still showing a demographic decline, as observed in recent times for the populations EBP, ECM, and SES. The combination of these three populations has gradually decreased its population size from 2017 (*N* = 293) to 2020 (*N* = 199). In 2021, the three populations had only 137 individuals. Although we could not know how the newly discovered populations have evolved in terms of demography, it is likely that they have followed the same trend as the remaining ones.

Table 10. Census size and AOO of *Seseli farrenyi* populations as carried out by Saura-Mas (2021)

Population (location)	No. individuals	No. reproductive indiv.	AOO (m^2)
EBP (es Bol d'es Prim)	109	18	700
ECM (Es Camallerús)	25	11	700
SES (Ses Estenedors)	3	1	200
CTP (Corral de la Tia Pastora)	488	42	1400
FOR (Ses Formigues)	28	11	700
ROV (Sa Rovellada)	185	35	1600
TOTAL	838	118	5300

The EOO of *L. geronense* and *L. tremolsii* were very similar, being that of the former a little larger (5.951 km^2 and 5.661 km^2, respectively), despite the polygons having a different shape (Figs. 9-10). In contrast, *L. geronense* showed a much lower estimation of AOO compared to *L. tremolsii* (104,795.8 m^2 vs. 371209.9 m^2); most populations of *L. geronense* are very small (typically occupying less than 10,000 m^2; Table 5), while all populations except two of *L. tremolsii* are >10,000 m^2; Table 6). The EOO of *S. farrenyi* is much smaller: 2.175 km^2 (Fig. 11); while their populations are also of very small size (between 700 and 5300 m^2 (Table 10).

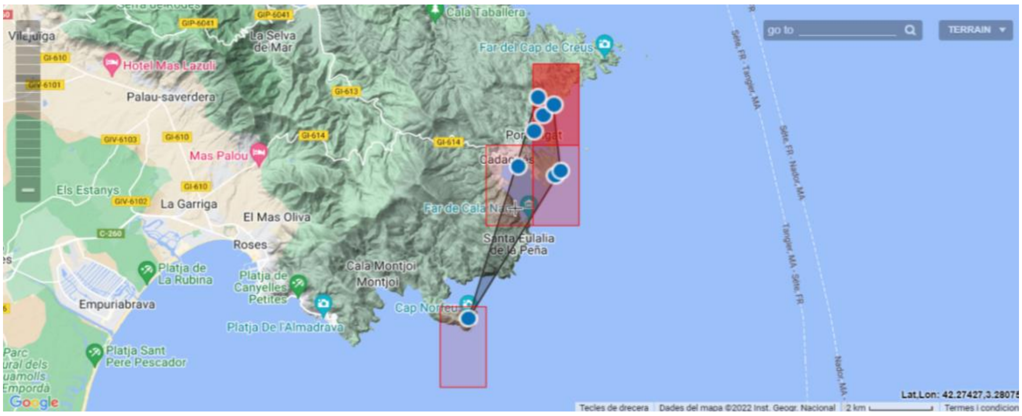

Figure 9. Estimation of EOO for *L. geronense* with the online tool GeoCAT (http://geocat.kew.org/).

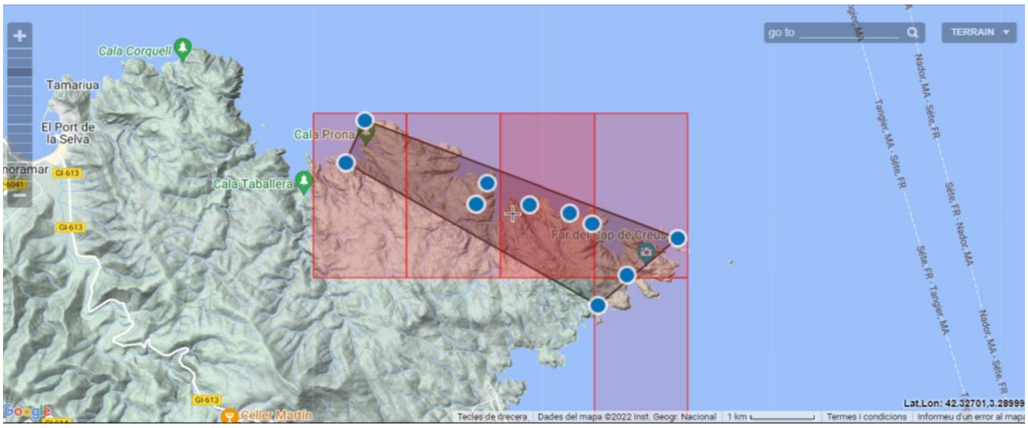

Figure 10. Estimation of EOO for *L. tremolsii* with the online tool GeoCAT (http://geocat.kew.org/).

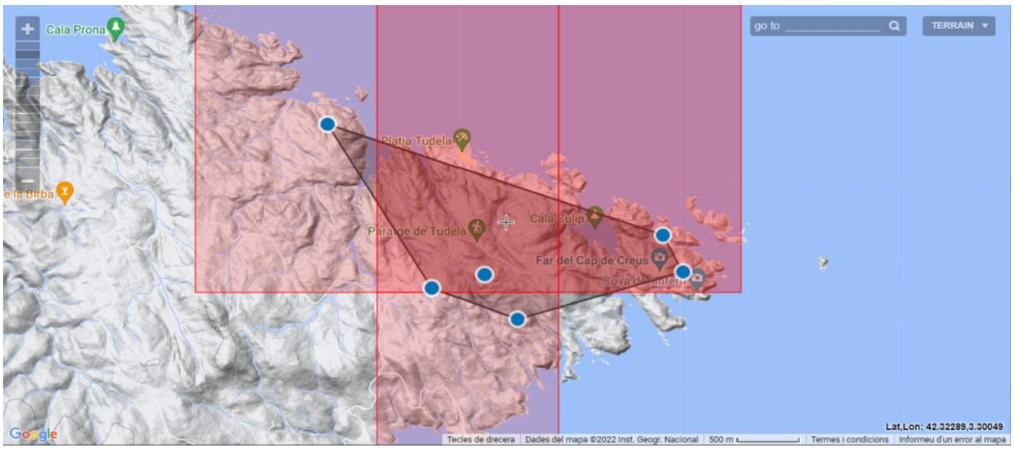

Figure 11. Estimation of EOO for *S. farrenyi* with the online tool GeoCAT (http://geocat.kew.org/).

Regarding current and potential threats to the three endemic and threatened species, all of them show menaces, some of them due to their biological and ecological traits. For the two *Limonium* species, the proportion of viable pollen in their populations is very low (only from 1 to 5.2% for *L. geronense*, and from 0 to 12.9% for *L. tremolsii*; Sáez et al., 2010). For *S. farrenyi*, a threat is the paucity of reproductive individuals within the natural populations: only a small number of individuals bloom every year (around 27% in late 1990s–early 2000s; Rovira et al., 2002); this percentage, however, seems to have dropped below 20% according to the demographic monitoring carried out since 2010 (Martinell & López-Pujol, 2014; CEBCAT-La Balca, 2016), with some years with a particularly low number of reproductive individuals (3% in 2014 and 3.4% in 2019; S. Saura-Mas & G. Carrion, 2019, personal communication). Other traits that could compromise its viability are the lack of soil seed bank and that seed germination and seedling recruitment are highly episodic (Martinell & López-Pujol, 2014). Population fragmentation is already showing the first genetic signs, as the values of genetic differentiation are relatively high (Garcia-Jacas et al., 2021). The small size of the populations is also a problem for the species, as any stochastic event (e.g. storms, extreme dry and hot episodes) may mean their extinction or decimation (the size of the populations of *S. farrenyi* ranges between 2 and 536 individuals in 2022; Table 10). Although some populations of the two species of *Limonium* are large or relatively large (38,829 and 241,222 individuals for Limtre05 and Limtre04, respectively, of *L. tremolsii*, and 1637 individuals for Limger04 of *L. geronense*), the rest of populations are small or very small (sometimes with less than 10 individuals; see above).

Regarding the anthropogenic threats, there are some threats that are affecting, in general terms, all populations from all species; the main is the over-frequentation, as the PNCC is a very visited place (estimation of around 450,000 visitors for 2021; P. Feliu, pers. comm.), mostly because of their beautiful landscapes but also their attractive beaches; some populations are very close to beaches and to trails, so the risk of trampling is very high, as well as the risk of nitrification (e.g. dog faeces and urine; Fig. 12). For example, two of the largest populations of *L. geronense* (Limger03 in Caials Sud and Limger04 in Caials Nord) are located within the village of Cadaqués, with plenty of houses with gardens and a beach (Caials) located just a few meters away from the individuals. The largest populations of *L. tremolsii*, despite not being located within or near urban areas, are in places of tourist interest (Limtre04 in Tudela, where the "Club Med" was located—and today, a place with a crowded trail by tourists, and Limtre05 in the Cap de Creus lighthouse area, where there is a restaurant and the start point of some tourist trails). The locus classicus of *S. farrenyi* is also located near the lighthouse; this could be the reason why this population has been declining and today it is on the brink of extinction (Garcia-Jacas et al., 2021). The IAPS are an important threat, as we have observed them within or very close to the populations of endemic species (Fig. 13). Even the eradication of IAPS could be problematic if the removed plants are not correctly disposed; for example, we were able to observe that removed individuals of *Carpobrotus* spp. in Caials Nord were piled up over individuals of *L. geronense* in Caials Nord (Fig. 14). As potential threats, urbanisation (unlikely within the PNCC but likely in areas outside the PNCC) and climate change should be mentioned. Climate change would exacerbate the occurrence of extreme weather events (Hoegh-Guldberg et al., 2019), which could be lethal for species with small and fragmented populations.

Figure 12. Dog faeces on an individual of *Limonium geronense*, Caials Nord

Figure 13. Individuals of *Limonium geronense* "buried" by achenes of *Gazania rigens*, in Caials Nord population.

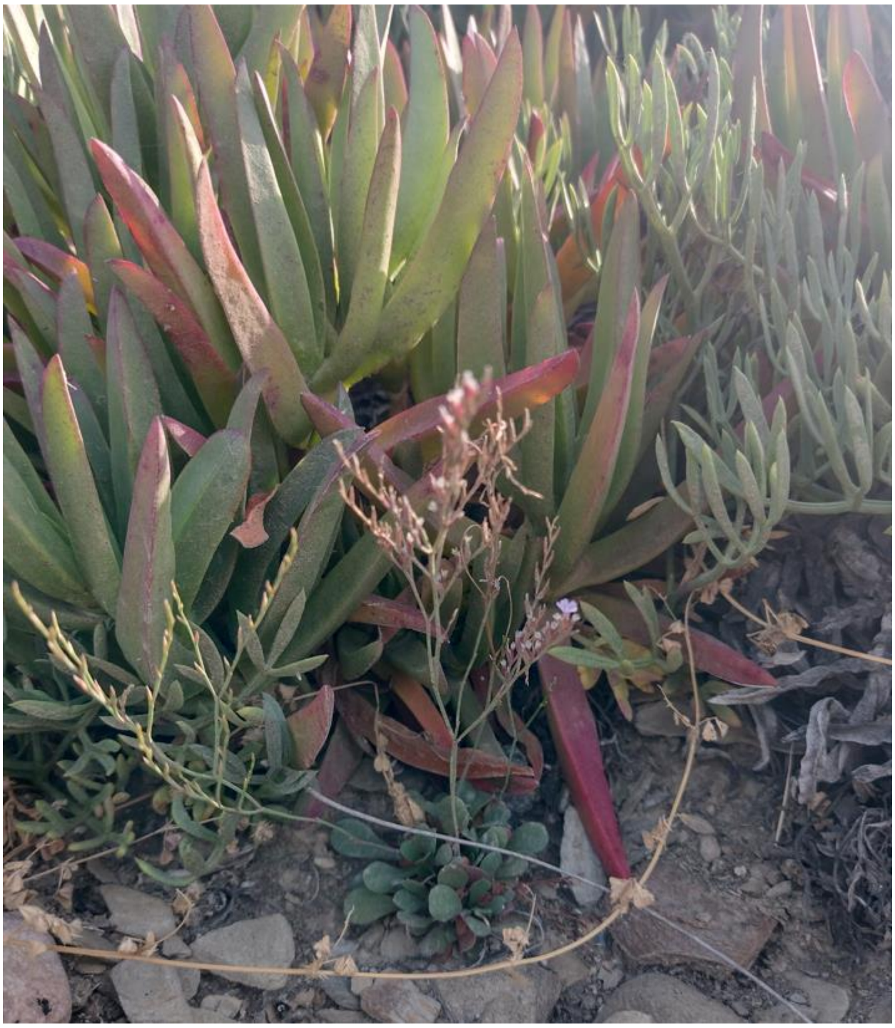

Figure 14. An individual of *Limonium geronense* threatened by *Carpobrotus* spp., in Caials Nord population.

Conclusions

There are contrasting values of total population size between the two endemic and threatened species of *Limonium* as estimated for the year 2022; while is very low for *L. geronense* (*N* = 8874 individuals for the eight known populations), the value for *L. tremolsii* is much higher (N = 281,189 individuals summing the seven known populations), suggesting that this latter species would be more viable. However, *L. tremolsii* is showing a declining demographic trend (its total population size has decreased by 16.5% with respect to the year 2020), while nearly 86% of all individuals of the species are located in a single population (Tudela). In contrast, *L. geronense* would be experiencing some demographic expansion, as its population size would be more than doubled. Anyway, many populations of *L.*

geronense (and also several of *L. tremolsii*) are on the brink of extinction because their size is below most minimum viable population (MVP) standards (Jamieson & Allendorf, 2012). The finding of vegetative (juvenile) individuals in the populations of both species offers a window of hope, as in 2020 only reproductive individuals were observed. Regarding *S. farrenyi*, the discovery of three new populations have meant the increase of its population size, though it is likely on a demographic decline. The three endemic species are currently menaced by a series of human derived-activities, chiefly over-frequentation and spread of invasive alien species, although urbanization and climate change should be considered potential threats.

2.3. Invasive plant species affecting HCI1240 in the Cap de Creus area

Introduction

As specified in the description of Action A1, data have been collected from the most severe IAPS (invasive alien plant species) whose eradication works are foreseen in action C3 within the *Parc Natural del Cap de Creus* (PNCC). Our fieldwork has been conducive to determining the baseline situation of a series of highly problematic IAPS, which will be monitored during the period 2023–2026. These species are the following: *Carpobrotus edulis*, *C. acinaciformis*, *Opuntia ficus-indica* (= *O. maxima*), *O. stricta* and *Gazania rigens*. Due to the difficulty in differentiating *C. edulis* from *C. acinaciformis* (apart from the fact that, very often, intermediate forms are found between these two species; Campoy et al., 2018), it has been considered more effective to treat these two species as a complex.

Both *Carpobrotus edulis* and *C. acinaciformis* (Aizoaceae) are native to South Africa, and have been introduced to all five continents, causing important ecological and economic impact on the coastal habitats. Both species are included in the official Catalogue of Invasive Alien Species of Spain. In the Mediterranean region, the invasive Carpobrotus are currently described as *C. edulis-acinaciformis* complex, an entity including *C. edulis*, *C. acinaciformis* and hybrid forms between the two species (i.e., the "hybrid swarm" *C. aff. acinaciformis*; Campoy et al., 2018). Although there is not available information about when the species started to colonise the Costa Brava, it would be a long time ago, probably expanding due to its gardening uses (Campoy et al., 2018). *Carpobrotus* spp. are the most frequent IAPS in the Costa Brava (as well as in many other HCI1240 areas throughout the EU) together with *Opuntia* spp. Within the PNCC, extant data indicated that it would occupy 300 ha with coverage rates ranging from 10 to 100% depending on the area (G. Carrion, pers. comm.).

Opuntia ficus-indica (Cactaceae) probably originated in Mexico as a result of several hybridisation processes. Mostly because of its uses (as ornamental, live hedge, forage, food, and medicinal plant), it has become naturalised in the five continents. Having been included in the official Catalogue of Invasive Alien Species of Spain, it is extremely common in the coastal areas of Catalonia (where it was already present in the late 18th century; Gómez, 1784), including the Costa Brava. In the PNCC, it is especially abundant around urban areas, although it is also frequent in natural areas. *Opuntia stricta* (also a Cactaceae species) is hard to distinguish from *O. dillenii* and they are probably forming a complex. As for *O. ficus-indica*, *O. stricta* is included in the official Catalogue of Invasive Alien Species of Spain, and is native to North America. *Opuntia stricta* is included in the IUCN list of the 100 worst invasive alien species in the world. At present it occurs in the five continents, but its occurrence in Catalonia is recent, probably during the 20th century (Gobierno de España, 2013). It is very common in the Costa Brava as well as in other Mediterranean coastal areas, particularly within HCI1240. In the PNCC it usually appears together with *O. ficus-indica* in urban areas but also in natural areas, with coverages that are similar (10–90%). According to the most recent estimations by the staff of PNCC, the sum of the two species occupies 5000 ha in the PNCC (G. Carrion, pers. comm.).

Gazania rigens (Asteraceae) is a very popular and widely grown ornamental plant of Southern African origin, with numerous cultivars and hybrids known that can be found as escaped or naturalised in all the continents. It has been found as occurring in the wild in several coastal areas throughout the European Union, but at the northern section of the Costa Brava it is particularly abundant. This IAPS is a recent newcomer not yet listed in official catalogues (although its incorporation is being processed). In the PNCC, in the beginning it was only linked to garden areas of Cadaqués village. However, since the removal of *Carpobrotus* spp. in different areas of the Park (e.g. Tudela or Far de S'Arenella areas), this species has thrived greatly taking advantage of the land removed from eradication works. At the PNCC, nowadays there are thousands of individuals in 85 ha that can attain a coverage of 30% (although in Tudela the coverage could be even higher; G. Carrion, pers. comm.).

As specified in the Grant Agreement, the following parameters would be measured for the IAPS mentioned above: (1) area of occupation (AOO) and extent of occurrence (EOO) within the PNCC of each species; (2) AOO of each of the populations detected for each species; and (3) size of each population through censuses (separately for vegetative, reproductive, and senescent individuals). After starting the fieldwork,we realised, however, that some of these parameters were not well suited for determining the baseline situation of IAPS, partly due to the fact that the effort to obtain data throughout the PNCC area is too high, and partly because IAPS do not tend to form discrete populations; instead, they tend to form density gradients that move through space. We considered that the use of plots is, by far, the most appropriate method to assess the incidence of invasive species in the PNCC and to evaluate their evolution. Therefore, AOO has only been estimated for the whole PNCC. In contrast, population-level AOO has not been measured (as it is very hard to define populations of

IAPS). On the contrary, detailed data has been taken from the plots as specified in the Methods (see below). Regarding the EOO of the PNCC we decided to restrict its estimation to the core area of the PNCC which is, by far, the part of the PNCC better conserved but, at the same time, that with the highest concentration of HCI1240.

Methods applied

Although, as stated above, we have some estimations on the AOO of the IAPS that have been provided by the PNCC staff (300 ha of *Carpobrotus*, 5,000 ha of *Opuntia* spp., and about 85 ha of *Gazania rigens*), they are just approximate values while not very updated. On the other hand, there is a precise mapping within the Integral Natural Reserve (RNI, Fig. 15) of the PNCC (it is the core area; i.e., the part of the PNCC most strictly preserved), carried out since 2016 for *Carpobrotus* spp., *Gazania rigens*, *Opuntia ficus indica*, and *Opuntia stricta*. This cartography was generated by two students (Antoine Hebert and Alba Montoro, white dots and red dots in Fig. 15, respectively), one of whom produced a BSc dissertation on the subject (Montoro, 2016). According to Montoro (2016) the methodology used to georeference invasive plants was the following: (1) observation of an individual or a population, (2) georeferencing of the point using a GPS (since the error of the used GPS was up to 10 m, we only georeferenced points of the same species separated by a minimum of 15 m) and (3) indicating for each point the species and the minimum number of individuals observed, their coverage (based on an 10 × 10 m-area) and other data of interest. The total census obtained is indicated in Table 11.

Table 11. Census of IAPS populations depicted in Fig. 15

IAPS	No. of points (red – white)	Coverage (m^2) (red points)
Carpobrotus spp.	1389 – 448	8229
Opuntia ficus-indica (= *O. maxima*)	421 – 61	2272
Opuntia stricta	85 – 8	426
Gazania rigens	174 – 0	893

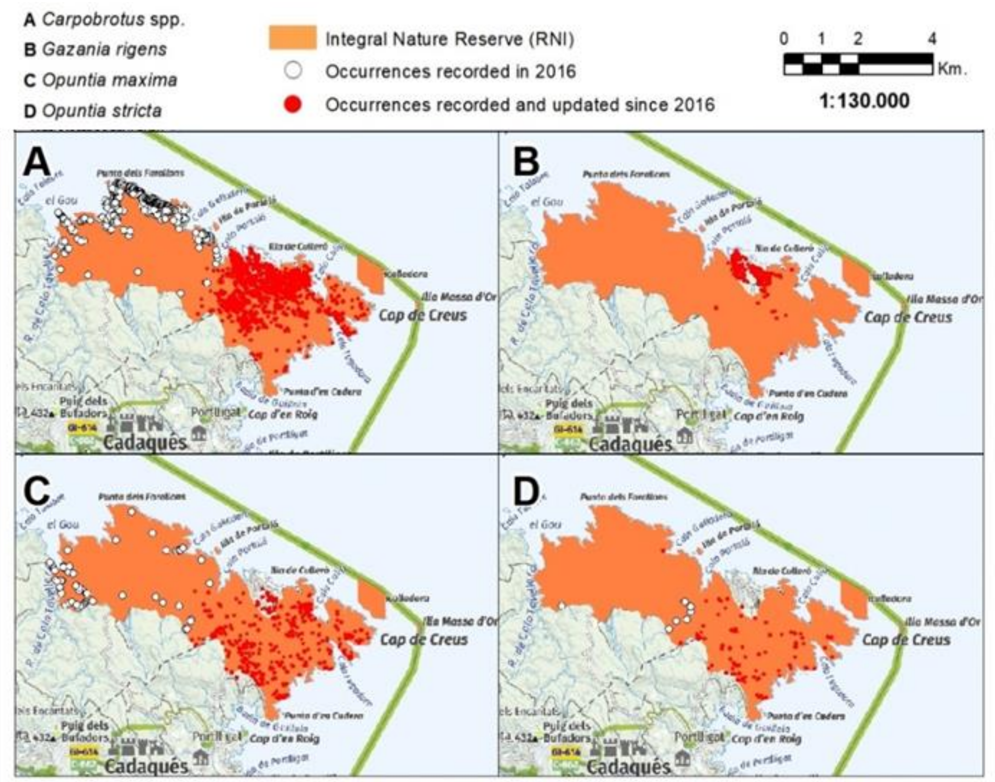

Figure 15. Location map of IAPS in the core area of PNCC.

In order to estimate the AOO for the IAPS in the PNCC we have used the precise data from the Montoro (2016) cartography as a basis. Based on this cartography, and in accordance with the availability of time and resources within the framework of the present project, we have designed a methodology for calculating a change rate of this cartography (which is for the year 2016) with respect to the present. Applying this change rate to the approximate area provided by the park technicians we have got the values of AOO corresponding to the current situation (year 2022) of the IAPS under study.

To minimise the GPS error—both the original error in obtaining the Montoro (2016) cartography and the current error in the field work carried out in 2022—a surrounding area of 20 m-radius (buffer zone) has been added to each point on the map in Fig. 15, which ensures that the taxon will be present in such area. These polygons have been created in ArcGIS and transformed into a kmz layer that has been added to a Google My Maps file so that it can be accessed directly from the cell phone. Thanks to this method, during the fieldwork one could know if he/she is located inside or outside the polygon using the GPS of the cell phone (Fig. 16).

Figure 16. Generated polygons for the different IAPS based on the 2016 cartography.

In order to calculate this change rate, different random points were visited within the core area of the PNCC, of two different types: (1) points where the species was indicated as present in the 2016 cartography (that is, we have visited polygons; see Fig. 16) and (2) places where the species was absent (as absences, we considered those places in the 2016 cartography where no individuals were present in an intermediate point between two or more contiguous polygons; these intermediate points can be called "interbuffers", Fig. 17).

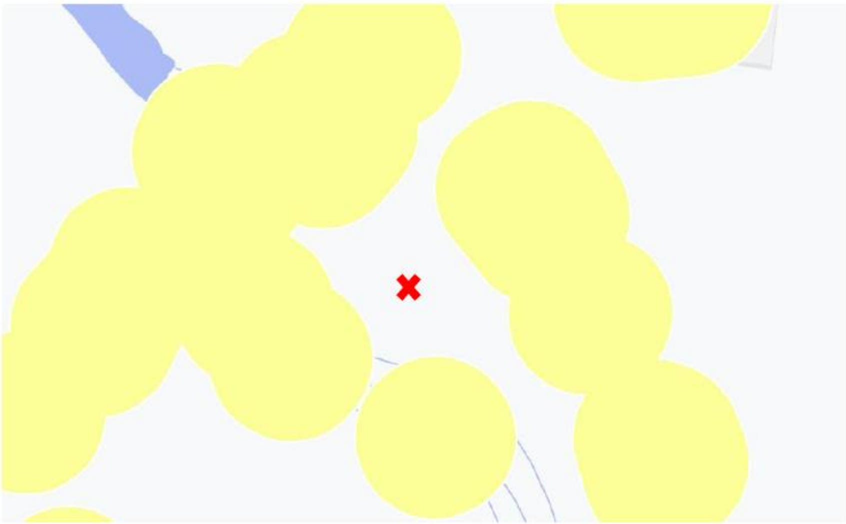

Figure 17. In red, an “interbuffer” absence, located between two or more contiguous polygons.

The symbology used during fieldwork is composed by two digits, the first is indicating whether the species was present or absent in the Montoro (2016) cartography while the second is indicating whether the species was present or absent in 2022:

- 1/0: we visited the polygon (buffer zone) but we failed to locate the species (which was present there in 2016); that is, the IAPS has disappeared from that place
- 1/1: we visited the polygon (buffer zone), where we have found one or more individuals of the species; that is, the species is still occurring on that place
- 0/1: we have found the species in a point outside the defined polygons (in an interbuffer zone; e.g., red X-shape cross in Fig. 17); i.e., we have observed the species in 2022 in a place where it was absent in 2016
- 0/0: we have not found any individual of an IAPS in an interbuffer zone (e.g., red X-shape cross in Fig.17); that is, its absence in that place (in 2016) is confirmed.

Finally, we have added the symbology 0/1* for those cases when one or more individuals of an IAPS were found in a point not included neither in the polygons nor in interbuffer zones; thus, we could consider these points as "random absences" in the 2016 cartography and, therefore, equivalent to a new introduction in that place.

The minimum number of polygons that we have visited was 50 for each taxon, although this number varied depending on the abundance of each species. In the case of *Opuntia stricta*, this value (50) could not be reached due to the low number of polygons derived from the 2016 cartography.

The change rate has been calculated through dividing the sum of all presences in 2022 (those that belong to categories 1/1, 0/1, and 0/1*) by the sum of presences in the 2016 cartography (i.e., 1/0 and 1/1):

$$\text{Change rate} = \frac{\text{sum of presences in 2022 (1/1, 0/1 and 0/1*)}}{\text{sum of presences in 2016 (1/0 and 1/1)}}$$

If the change rate is greater than 1, it means that at present there is a higher number of individuals than that indicated in the cartography of Montoro (2016) and, therefore, that the IAPS is expanding. If, on the other hand, the change rate is less than 1, it means that the current number of individuals is less than that mapped in 2016 and therefore the IAPS is declining. A change factor equal to 1 implies that there has been no expansion or decline, i.e. that it has remained stable (if we check for differences at each sampling there may be changes in presence/absence, but overall the species remain in equilibrium).

The obtained change rate has been multiplied by the AOO estimations provided by the PNCC staff for each of the IAPS. By means of this, we have got the values of AOO corresponding to the current situation (year 2022) of the IAPS under study:

$$AOO_{2022} = \text{change rate} \times AOO_{2016} \text{ (e.g. 85 ha for } G.\ rigens\text{)}$$

The calculation of the EOO at the species level has been done by drawing a minimum convex polygon (in which none of its internal angles exceed 180 degrees), as recommended by the IUCN (2012), and which was drawn with the online tool GeoCAT (http://geocat.kew.org/).

Regarding the Results on the population size of each IAPS, we have estimated it through the use of plots (three plots per species). For all plots, a direct census has been made and, in the case of the two species of *Opuntia* and of *Gazania*, by differentiating phenophases (seedlings/juveniles, reproductive [adults] and senescent/dead individuals), following the system used for endemic plants. In the case of *Carpobrotus* spp., due to the extreme difficulty in determining the number of individuals (it would be necessary to uproot all the individuals), we have measured their coverage within the plot.

In total, eight plots were made since in some of them it was possible to census more than one species of interest, thus reducing the sampling effort (Table 12, Fig. 18). The selection of the plots has been made maximising different environmental conditions where the species can be found (orientation, type of substrate, inclination, plant cover, etc.). All the plots have been placed outside the removal areas (since within the removal area the company in charge of these works will generate a report on the presence of IAPS before and after eradication actions). The plots are of 100 m^2, in most cases corresponding to a square of 10 × 10 m, except for one of 5 × 20 m due to the irregularity of the terrain.

Table 12. Designed plots for the studied IAPS within the PNCC

Plot (location)	Coordinates (lat. – long.)	IAPS
West of Port de la Selva	42,336385 – 3,194268	*Carpobrotus* spp. + *Gazania rigens*
West of Far de s'Aranella	42,351814 – 3,181225	*Carpobrotuss* spp. + *Gazania rigens* + *Opuntia stricta*
S'Alqueria	42,301704 – 3,283716	*Opuntia ficus-indica*
West of Tudela	42,324892 – 3,294043	*Carpobrotus* spp. + *Gazania rigens*
Sa Conca (camí del far de cala Nans)	42,277214 – 3,278479	*Opuntia ficus-indica*
Sa Conca (camí del far de cala Nans)	42,277056 – 3,278839	*Opuntia stricta*
Cala Calitjàs	42,251832 – 3,23925	*Opuntia stricta*
Cala Calitjàs	42,250878 – 3,244407	*Opuntia ficus-indica*

Figure 18. Plots for censusing the IAPS.

In order to be able to monitor these plots as accurately as possible, a detailed direct count of the IAPS individuals has been carried out in order to establish a starting situation. For each plot, a sketch of the spatial arrangement of the plants has been drawn up (Fig. 19-20), in addition to taking additional notes on each individual (or group of individuals), also differentiating between reproductive, vegetative and senescent.

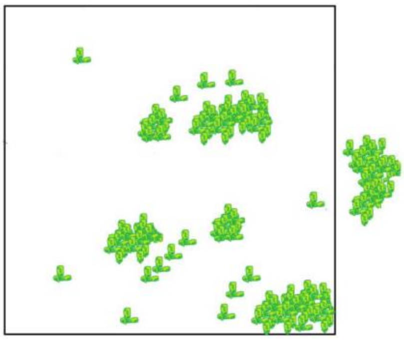

Figure 19. Schematic representation of the spatial arrangement of the Cala Calitjàs plot of *Opuntia stricta*, including also the individuals that are located nearby.

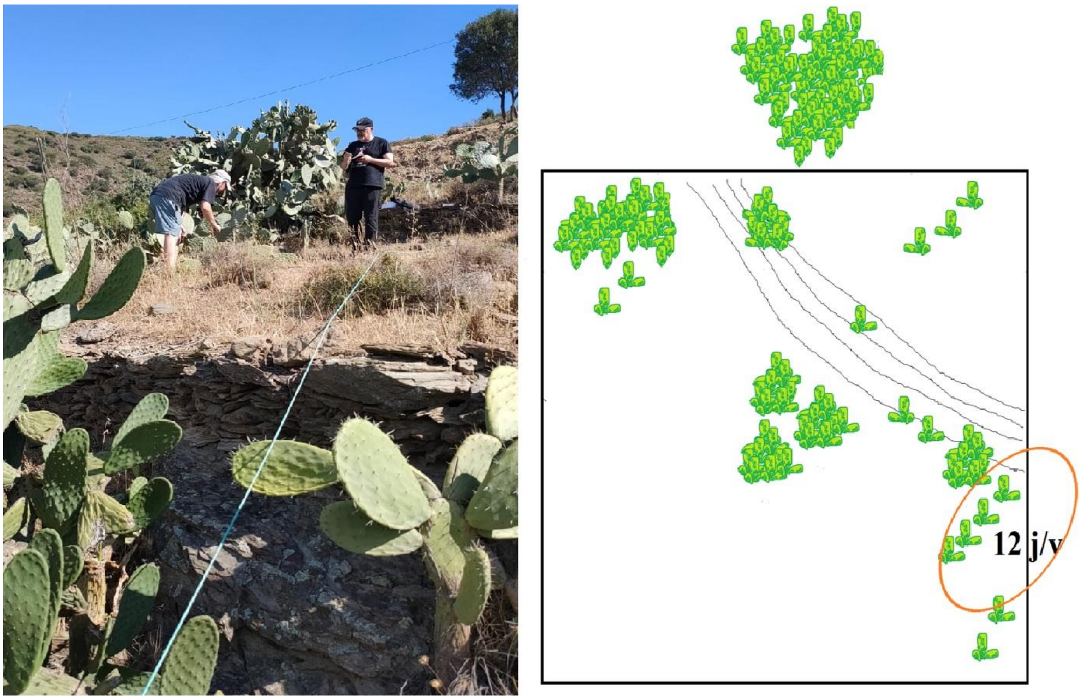

Figure 20. Plot of *Opuntia ficus-indica* in Cala Calitjàs. Left, two members of the field team working on the plot. Right, schematic diagram of the spatial distribution of individuals ("12j/v" means that there were 12 juveniles in this section of the plot).

Results

Following the methodology explained in the previous section, we obtained the change rate (CR) and, subsequently, an estimation of AOO (in ha) for the year 2022 for each species.

For *Gazania rigens* (Fig. 21), we had an estimation for AOO of about 85 ha as provided by the staff of the PNCC. Applying a change rate of 0.90 (see Fig. 22) we are obtaining a current value of AOO of 76.9 ha; that is nearly 10% smaller than the former estimations.

Figure 21. Vegetative individuals of *Gazania rigens* found at a place not detected in the 2016 cartography (i.e., a presence 0/1*)

		points	pres. 2016	pres. 2022
Gazania rigens	1 / 0	9	9	0
	1 / 1	33	33	33
	0 / 1	1	0	1
	0 / 1*	4	0	4
	0 / 0	3	0	0
		50	42	36

CR
0.90

Gazania rigens		
Original AOO	85	ha
Updated AOO	76.9	ha

Figure 22. Updated estimation of AOO for *Gazania rigens*. CR means change rate.

For *Carpobrotus* ssp., we had an initial estimation of 300 ha for its AOO according to previous reports from the PNCC. Applying a change rate of 1.13 (see Fig. 23), we are updating the AOO to 339.5 ha; i.e. about 13% larger than the former estimations.

		points	pres. 2016	pres. 2022
***Carpobrotus* spp.**	1 / 0	7	7	0
	1 / 1	31	31	31
	0 / 1	6	0	6
	0 / 1*	6	0	6
	0 / 0	6	0	0
		56	38	43

CR
1.13

***Carpobrotus* spp.**		
Original AOO	300	ha
Updated AOO	339.5	ha

Figure 23. Updated estimation of AOO for *Carpobrotus* spp. CR means change rate.

Although the plots of *Opuntia ficus-indica* and *O. stricta* have been made separately, we are providing an updated estimation for AOO jointly for the two species, as the old estimation of AOO (ca. 5000 ha) we got from the technicians of the PNCC did not differentiate the two IAPS. Applying the change rate of 0.91 (see Fig. 24), we obtain an estimated AOO for the year 2022 of area occupied by the species of 4553.6 ha; that is, about 9% lower today when compared to the former estimation. We should bear in mind that this is an estimation merging the two species. To do the estimations of AOO for each species, we are first estimating it on the basis of the presence rates for the year 2016 (38 of a total of 56 for *O. ficus-indica*, and 18 of a total of 56 for *O. stricta*; Fig. 24), obtaining values of 3395 ha and 1605 ha for *O. ficus-indica* and *O. stricta*, respectively. The updated AOO for the year 2022 should be calculated, instead, using the current presence rates (41 of a total of 51 for *O. ficus-indica*, and 10 of a total of 51 for *O. stricta*; Fig. 24), obtaining areas of 3660.7 ha and 892.9 ha for *O. ficus-indica* and *O. stricta*, respectively. In other words, despite that there is a general decline when we estimate the AOO for *Opuntia* spp., *O. ficus-indica* is actually increasing slightly (AOO = 3395 ha in 2016 vs. 3661 ha in 2022; while *O. stricta* has experienced an important decline (AOO = 1605 ha in 2016 vs. 893 ha in 2022). This may have important conservation implications within the PNCC, as more efforts should be allocated to the eradication of *O. ficus-indica*. The setting up of different plots in 2022 and their monitoring in the following 4 years (2023–2026) will allow us to discern whether this inferred (slight) expansion of *O. ficus-indica* and (substantial) decline of *O. stricta* is certainly a consolidated trend within the PNCC. The observations of *O. ficus-indica* by our research group (https://www.xenoplants.org/) since at least one decade ago suggest that this IAPS is actively expanding in many places of Catalonia (with some punctual reversals due to the attack by *Dactylopius opuntiae*); in contrast, *O. stricta* seems to be restricted to the NE part of Catalonia, with no apparent diffusion to other parts of the country.

		points	pres. 2016	pres. 2022
Opuntia spp.	1 / 0	20	20	0
	1 / 1	36	36	36
	0 / 1	7	0	7
	0 / 1*	8	0	8
	0 / 0	5	0	0
		76	56	51

CR
0.91

Opuntia spp.		
Original AOO	5000	ha
Updated AOO	4553.6	ha

		points	pres. 2016	pres. 2022
O. stricta	1 / 0	10	10	0
	1 / 1	8	8	8
	0 / 1	1	0	1
	0 / 1*	1	0	1
	0 / 0	3	0	0
		23	18	10

Opuntia stricta		
Original AOO	1605	ha
Updated AOO	892.9	ha

		points	pres. 2016	pres. 2022
O. ficus-indica	1 / 0	10	10	0
	1 / 1	28	28	28
	0 / 1	6	0	6
	0 / 1*	7	0	7
	0 / 0	2	0	0
		53	38	41

Opuntia ficus-indica		
Original AOO	3395	ha
Updated AOO	3660.7	ha

Figure 24. Updated estimation of AOO for *Opuntia* spp. CR means change rate.

The values of EOO within the core area of the PNCC are 10.9 km^2 for *Carpobrotus* spp, 0.8 km^2 for *Gazania rigens*, 9.9 km^2 for *Opuntia ficus-indica*, and 4.7 km^2 for *O. stricta* (Figs. 25–28).

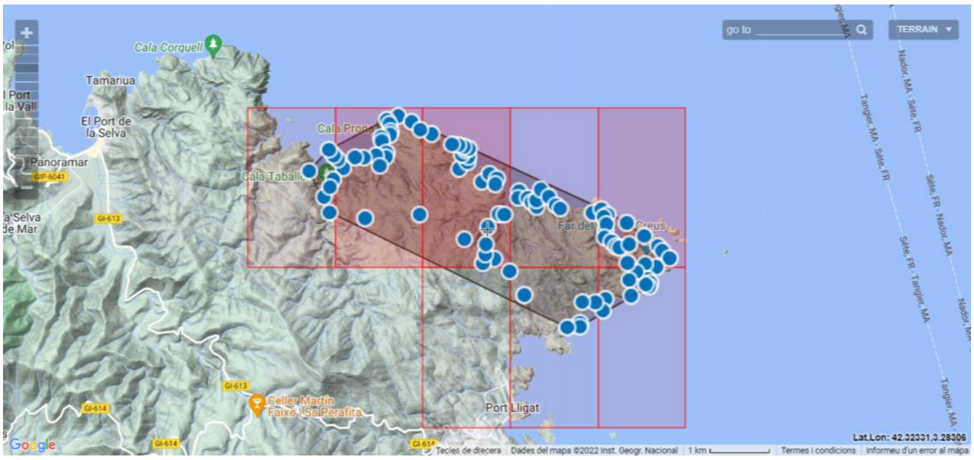

Figure 25. Estimation of EOO for *Carpobrotus* spp. within the core area of the PNCC with the online tool GeoCAT (http://geocat.kew.org/).

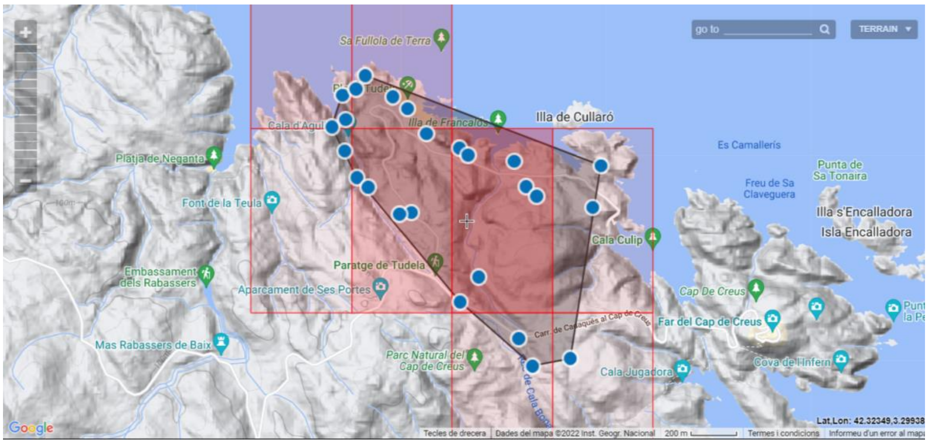

Figure 26. Estimation of EOO for *Gazania rigens*. within the core area of the PNCC with the online tool GeoCAT (http://geocat.kew.org/).

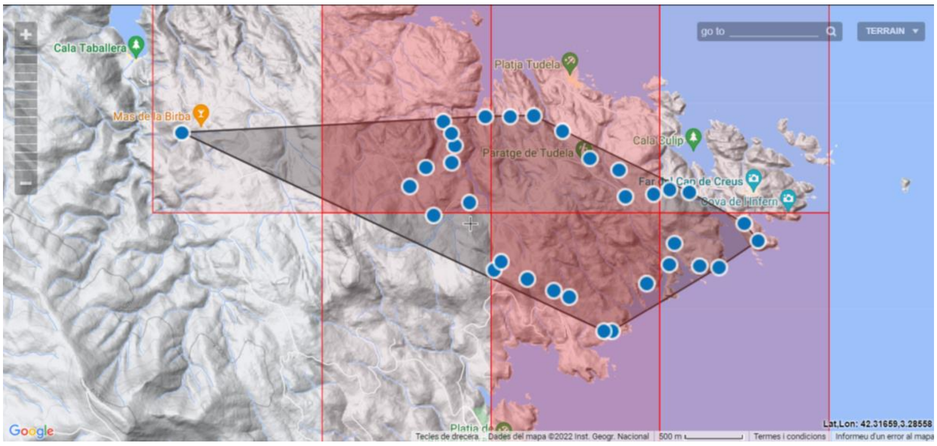

Figure 27. Estimation of EOO for *Opuntia stricta*. within the core area of the PNCC with the online tool GeoCAT (http://geocat.kew.org/).

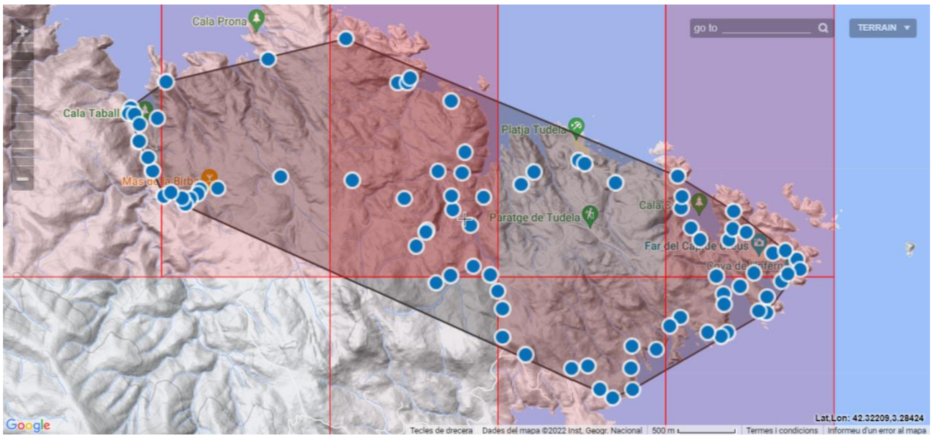

Figure 28. Estimation of EOO for *Opuntia ficus-indica*. within the core area of the PNCC with the online tool GeoCAT (http://geocat.kew.org/).

Regarding the censuses (or, for the specific case of *Carpobrotus* spp., the coverage estimation) carried out in the designed plots for the IAPS, the results are highly discordant among them (Table 13). For *Gazania rigens*, one plot had 71 individuals, another 37 and this third, only 10. All three plots showed vegetative (juvenile) individuals, but none senescent ones. The coverage of *Carprobrotus* spp. was always low, although for West of Tudela it was extremely low (2–3%). The plots showed somewhat higher censuses for *O. ficus-indica* with respect to *O. stricta*, but in all cases we found a preponderance of vegetative individuals (in contrast to the plots of *Gazania rigens*; where the reproductive individuals clearly outnumbered the vegetative ones; Table 13). It should be noted that the highest number of individuals detected for *Gazania rigens* (and the highest coverage of *Carpobrotus* spp.) correspond to the two plots with the highest anthropogenic impacts (West of Port de la Selva and West of Far de s'Arenella).

Table 13. Census data (or coverage for the specific case of *Carpobrotus* spp.) for all the plots of the studied IAPS within the PNCC

Plot (location)	IAPS	Census (total: reproductive/vegetative/senescent) (or coverage)
West of Port de la Selva	*Carpobrotus* spp.	10%
	Gazania rigens	37: 22/15/0
West of Far de s'Arenella	*Carpobrotuss* spp	15–20%
	Gazania rigens	71: 66/5/0
	Opuntia stricta	8: 1/7/0
S'Alqueria	*Opuntia ficus-indica*	9: 4/5/0
West of Tudela	*Carpobrotus* spp.	2–3%
	Gazania rigens	10: 5/5/0
Sa Conca (camí del far de cala Nans)	*Opuntia ficus-indica*	11: 1/10/0
Sa Conca (camí del far de cala Nans)	*Opuntia stricta*	10: 2/8/0
Cala Calitjàs	*Opuntia stricta*	19: 5/14/0
Cala Calitjàs	*Opuntia ficus-indica*	28: 6/22/0

Conclusions

The fieldwork for determining the baseline situation of the most problematic IAPS within the PNCC has been adapted to the demographic traits of the species; for example, given the impossibility of making direct counts in *Carpobrotus* spp. (due the difficulty to distinguish what is an individual), we did an estimation of the coverage. We have also developed a specific methodology to update the old AOO estimations of the PNCC staff, based on the setting up of buffer areas that were added to the available cartography and that helped us to discern whether past occurrences of IAPS are still in place and whether there are new occurrences. Within the PNCC, the most frequent IAPS is *Opuntia ficus-indica* (3661 ha), which seems to be expanding in recent years (but which needs to be confirmed by the 2023–2026 monitoring), followed by *O. stricta* (893 ha) that, on the contrary, would be experiencing some decline. The two species with the smallest occupation area are *Carpobrotus* spp. (340 ha) and *Gazania rigens* (77 ha), the former seemingly expanding and the later declining. By means of a series of 100 m^2 plots, we have censused the four IAPS by phenophases (with the exception of *Carprobrotus* spp., as commented above), and their 5-year monitoring (2022–2026) will allow us to determine their demographic tendency and, thus, to know whether the eradication measures carried out in selected areas of the PNCC are useful to reduce the population size of IAPS.

2.4. Invasive plant species affecting HCI1240 in the Costa Brava area

Introduction

As specified in the description of Action A1, we have evaluated the threat posed by IAPS (invasive alien plant species) and PIAPS (potentially invasive alien plant species) to the HCI1240 in the whole Costa Brava. To do it, we did extensive fieldwork between December 2021 to August 2022 in order to detect populations (or isolated individuals) of IAPS and PIAPS and to determine its invasion stage. This was done with two objectives: (1) to get a general view of the invasiveness of alien plants in the Costa Brava; and (2) to select a set of IAPS and PIAPS that will be monitored during the project duration (2023-2026). For the second aim, we already had a preliminary list of about 30 IAPS and PIAPS (see project's memory) that was based on previous knowledge, either on our own observations and publications (Mesquida et al., 2017; Gómez-Bellver et al., 2019*a*,*b*, 2020a) and also from others (e.g. Aymerich, 2015, 2016). The selection of the list of plants to be monitored (that was finally of 33 taxa) was based on (1) their observed invasion behaviour during our fieldwork (December 2021-August 2022), and (2) the criterion to include the priority species according to the Information system of the exotic species of Catalonia (EXOCAT), the list of IAS that are of priority for the Government of Catalonia, and the official Catalogue of Invasive Alien Species of Spain. For example, *Cenchrus setaceus* and *Fallopia baldschuanica* have been selected as species to be monitored but we failed to observe it during our fieldwork (despite the fact that we know that the species is present in other places of Costa Brava).

Methods applied

As visiting all 256 km of coastline of Costa Brava was not reliable (it would take several years), we focused on all areas with HCI1240 within and around populated places (where the occurrence of IAPS and PIAPS is more likely); however, we also visited many coast stretches still in a natural (or semi-natural) status, in order to avoid leaving long stretches of coastline without surveying. These latter sampling points were selected with the help of the official high-resolution cartography of Generalitat de Catalunya (Cartographic and Geologic Institute of Catalonia). In total, we visited about 100 km of coastline along the Costa Brava, from the city of Blanes (the southernmost tip of the Costa Brava) to the French border (Fig. 29). In all sampling points, we walked along the many trails (*camins de ronda*) that are located close to the coastal cliffs (in most cases, these trails are located so close that the HCI1240 can be surveyed visually from the path). When this was not possible, we walked carefully through the rocky cliffs.

All alien plants we observed (either IAPS or PIAPS) were annotated. We also recorded the geographic coordinates of all our observations (with the help of Zamiadroid, an app for cell phones which allow georeferencing plant observations and representing them in GoogleEarth), as well as some of the native accompanying species. For each occurrence of alien species, we also recorded the invasion status (i.e., whether the plants are in an initial phase of establishment, they are already established or they are actively invading the local habitats).

For each IAPS and PIAPS recorded in HCI1240 along the Costa Brava, we gathered data on the life cycle and functional traits, native range, invasion status in Catalonia and invasion status in the Costa Brava, introduction pathway, and intentionality of introduction in Catalonia from the literature and from our observations. For the selected 33 IAPS and PIAPS, we generated maps of distribution based on our fieldwork (December 2021-August 2022). The invasion status on the Costa Brava has been categorised as follows: (1) casual, when our observations of the localities suggested that the individuals do not form self-replacing populations (see definitions regarding invasion status in Pyšek et al., 2004); (2) naturalised, when they apparently form self-replacing populations without direct human intervention for a period of at least 10 years; in practice, records were regarded as naturalised when there were individuals in different developmental stages (seedlings, young adults, and mature individuals), and (3) invasive, when self-replacing populations are very large and are apparently damaging the recipient ecosystem.

Figure 29. Map of the 1563 sample points (in green) distributed along the Costa Brava and visited between December 2021 to August 2022. In red the situation of the areas with HCI1240.

Results

We observed a total of 121 plant taxa (Table 14), including either IAPS or PIAPS, in the HCI1240 for the whole Costa Brava, with a total of 1563 observations. Of these, some are very relevant species: one is new for Europe (*Agave parryi*), one is new for the Iberian Peninsula (*Asparagus falcatus*), and four are new for Catalonia (*Aloe striata*, *Ficus pumila*, *Phormium tenax*, and *Senecio articulatus*). There were also some species that have been recorded for the first time in the Costa Brava: *Asparagus aethiopicus*, *Bougainvillea glabra*, *Cylindropuntia imbricata*, *Nicotiana tabacum*, *Opuntia elata*, and *Selenicereus undatus*.

Table 14. IAPS and PIAPS observed by us in the HCI1240 for the whole Costa Brava*

Taxon	Cat.	Nov.	Native range	Family	Fun. traits	Intr. path.	Int. intr.	Inv. status
Acacia dealbata	+	.	AUS	Fabaceae (mimosoid)	TR	G	D	N (N)
Acacia longifolia	+	.	AUS	Fabaceae (mimosoid)	TR	G	D	N (N)
Acacia saligna	+	.	AUS	Fabaceae (mimosoid)	TR	G	D	N (N)
Acanthus mollis	+	.	PLAR	Acanthaceae	PF	G	D	N (N)
Aeonium arboreum	+	.	PLAR	Crassulaceae	SU	G	D	N (N)
Aeonium haworthii	+	.	PLAR	Crassulaceae	SU	G	D	C (C)
Agave americana subsp. *americana*	+	.	NAR-TRO	Asparagaceae (Agavoideae)	SU	G & S	D	N (N)
Agave beaulueriana	+	.	NAR-TRO	Asparagaceae (Agavoideae)	SU	G	D	C (C)
Agave difformis	+	.	NAR	Asparagaceae (Agavoideae)	SU	G	D	N (N)
Agave fourcroydes	+	.	ART	Asparagaceae (Agavoideae)	SU	G & S	D	N (N)
Agave lurida	+	.	NTRO	Asparagaceae (Agavoideae)	SU	G	D	C (C)
Agave parryi	.	EU	NAR-TRO	Asparagaceae (Agavoideae)	SU	G	D	C (C)
Agave salmiana var. *ferox*	+	.	NAR-TRO	Asparagaceae (Agavoideae)	SU	G	D	C (C)
Agave salmiana var. *salmiana*	+	.	NAR-TRO	Asparagaceae (Agavoideae)	SU	G	D	N (N)
Agave sisalana	+	.	ART	Asparagaceae (Agavoideae)	SU	G	D	N (N)
Ailanthus altissima	+	.	PLAR	Simaroubaceae	TR	G	D	I (I)
Allium neapolitanum	+	.	PLAR	Amaryllidaceae (Allioideae)	BU	G	D	N (N)
Allium triquetrum	+	.	PLAR	Amaryllidaceae (Allioideae)	BU	A & G	D	N (N)
Aloe arborescens	+	.	PLTRO-SAF	Asphodelaceae (Asphodeloideae)	SU	G	D	N (N)
Aloe maculata	+	.	PLTRO-SAF	Asphodelaceae (Asphodeloideae)	SU	G	D	N (N)
Aloe striata	.	CA	PLTRO-SAF	Asphodelaceae (Asphodeloideae)	SU	G	D	C (C)

Table 14. IAPS and PIAPS observed by us in the HCI1240 for the whole Costa Brava*								
Taxon	Cat.	Nov.	Native range	Family	Fun. traits	Intr. path.	Int. intr.	Inv. status
Aloe vera	+	.	PLAR	Asphodelaceae (Asphodeloideae)	SU	G & M	D	C (C)
Aloiampelos ciliaris	+	.	SAF	Asphodelaceae (Asphodeloideae)	SU	G	D	N (N)
Anredera cordifolia	+	.	NTRO	Basellaceae	CL	G	D	N (N)
Araujia sericifera	+	.	NTRO	Apocynaceae (Asclepiadoideaee)	CL	G & T	D	N (N)
Arundo donax	+	.	PLAR-TRO	Poaceae (Arundinoideae)	PG	G	D	I (I)
Asparagus aethiopicus	+	CB	SAF	Asparagaceae (Asparagoideae)	CL	G	D	C (C)
Asparagus falcatus	.	IP	SAF	Asparagaceae (Asparagoideae)	SH	G	D	C (C)
Austrocylindropuntia subulata	+	.	NTRO	Cactaceae	SU	G	D	N (N)
Beta vulgaris	+	.	PLAR	Amaranthaceae	PF	A	D	N (N)
Bougainvillea glabra	+	CB	NTRO	Nyctaginaceae	CL	G	D	C (C)
Carpobrotus aff. acinaciformis	+	.	SAF	Aizoaceae	SU	G	D	C (I)
Carpobrotus edulis	+	.	SAF	Aizoaceae	SU	G	D	I (I)
Cenchrus longisetus	+	.	PLTRO	Poaceae (Panicoideae)	PG	G & S	D	N (N)
Chenopodium nutans	+	.	AUS	Amaranthaceae	PF	TC	A	I (I)
Coronilla glauca	+	.	PLAR	Fabaceae (Papilionoideae)	SH	G	D	N (N)
Cortaderia selloana	+	.	NTRO	Poaceae (Danthonioideae)	PG	G	D	I (I)
Cotoneaster pannosus	+	.	PLAR-TRO	Rosaceae	SH	G	D	N (N)
Cotyledon orbiculata	+	.	PLTRO-SAF	Crassulaceae	SU	G	D	N (N)
Crassula multicava	+	.	SAF	Crassulaceae	SU	G	D	N (N)
Crassula ovata	+	.	SAF	Crassulaceae	SU	G	D	C (C)
Crassula tetragona	+	.	SAF	Crassulaceae	SU	G	D	N (N)
Cylindropuntia imbricata	+	CB	NAR-TRO	Cactaceae	SU	G	D	N (N)
Cylindropuntia pallida	+	.	NAR-TRO	Cactaceae	SU	G	D	I (I)
Cymbalaria muralis	+	.	PLAR	Plantaginaceae	AF	G & M	D	N (N)
Datura stramonium	+	.	NTRO	Solanaceae	AF	G & M	D	N (N)
Delairea odorata	+	.	SAF	Asteraceae	CL	G	D	I (I)
Dimoorphotheca ecklonis	+	.	SAF	Asteraceae	PF	G	D	C (N)
Disphyma crassifolium	+	.	SAF	Aizoaceae	SH	G	D	N (N)
Drosanthemum floribundum	+	.	SAF	Aizoaceae	SU	G	D	N (N)

Table 14. IAPS and PIAPS observed by us in the HCI1240 for the whole Costa Brava*								
Taxon	Cat.	Nov.	Native range	Family	Fun. traits	Intr. path.	Int. intr.	Inv. status
Echium candicans	+	.	PLAR	Boraginaceae	PF	G	D	C (C)
Euonymus japonicus	+	.	PLAR	Celastraceae	SH	G	D	C (C)
Ficus carica	+	.	PLAR	Moraceae	TR	A	D	N (N)
Ficus pumila	.	CA	PLAR-TRO	Moraceae	CL	G	D	C (C)
Freesia leichtlinii subsp. *alba*	+	.	SAF	Iridaceae	BU	G	D	C (C)
Gazania rigens s.l.	+	.	SAF	Asteraceae	AF	G	D	N (I)
Ipomoea indica	+	.	PNTRO	Convolvulaceae	CL	G	D	N (N)
Iris albicans	+	.	PLAR-TRO	Iridaceae	PF	G	D	C (C)
Iris × *germanica*	+	.	PLAR	Iridaceae	PF	G	D	I (N)
Kalanchoe tubiflora	+	.	PLTRO	Crassulaceae	SU	G	D	C (N)
Kalanchoe × *houghtonii*	+	.	ART	Crassulaceae	SU	G	D	N (I)
Kleinia articulata	.	CA	SAF	Asteraceae	SU	G	D	(C)
Kleinia mandraliscae	+	.	SAF	Asteraceae	SU	G	D	C (C)
Lantana camara	+	.	NAR-TRO	Verbenaceae	SH	G	D	N (N)
Lonicera japonica	+	.	PLAR-TRO	Caprifoliaceae	CL	G	D	I (I)
Malephora purpureocrocea	+	.	SAF	Aizoaceae	SU	G	D	N (N)
Malephora uitenhagensis	+	.	SAF	Aizoaceae	SU	G	D	N (N)
Matthiola incana	+	.	PLAR	Brassicaceae	PF	G	D	N (N)
Medicago arborea	+	.	PLAR	Fabaceae (Papilionoideae)	SH	A & G	D	C (C)
Mesembryanthemum cordifolium	+	.	PLTRO-SAF	Aizoaceae	SU	G	D	N (N)
Mesembryanthemum × *vascosilvae*	+	.	ART	Aizoaceae	SU	G	D	N (N)
Mirabilis jalapa	+	.	NTRO	Nyctaginaceae	PF	G	D	C (C)
Myoporum laetum	+	.	AUS-NZ	Scrophulariaceae	TR	G	D	N (N)
Nicotiana glauca	+	.	NTRO	Solanaceae	TR	G	D	N (N)
Nicotiana tabacum	+	CB	NTRO	Solanaceae	AF	A	D	C (C)
Oenothera lindheimeri	+	.	NAR	Onagraceae	PF	G	D	C (C)
Onobrychis viciifolia	+	.	PLAR	Fabaceae (Papilionoideae)	PF	A & S	D	N (N)
Opuntia aurantiaca	+	.	NTRO	Cactaceae	SU	G	D	N (N)
Opuntia elata	+	CB	NTRO	Cactaceae	SU	G	D	N (N)
Opuntia elatior	+	.	NTRO	Cactaceae	SU	G	D	N (N)
Opuntia lindheimeri var. *linguiformis*	+	.	NAR	Cactaceae	SU	G	D	N (N)

Table 14. IAPS and PIAPS observed by us in the HCI1240 for the whole Costa Brava*

Taxon	Cat.	Nov.	Native range	Family	Fun. traits	Intr. path.	Int. intr.	Inv. status
Opuntia lindheimeri var. *linguiformis*	+	.	NAR	Cactaceae	SU	G	D	N (N)
Opuntia ficus-indica	+	.	NAR-TRO	Cactaceae	SU	A & G	D	I (I)
Opuntia leoglossa	+	.	ART	Cactaceae	SU	G	D	N (N)
Opuntia leucotricha	+	.	NAR	Cactaceae	SU	G	D	C (C)
Opuntia monacantha	+	.	NTRO	Cactaceae	SU	G	D	N (N)
Opuntia puberula	+	.	NAR-TRO	Cactaceae	SU	G	D	N (N)
Opuntia robusta	+	.	NAR-TRO	Cactaceae	SU	G	D	C (C)
Opuntia stricta var. *dillenii*	+	.	NAR-TRO	Cactaceae	SU	G	D	C (C)
Opuntia stricta var. *stricta* f. *inerme*	+	.	NAR-TRO	Cactaceae	SU	G	D	I (I)
Oxalis pes-caprae	+	.	SAF	Oxalidaceae	PF	TC	A	N (N)
Parthenocissus tricuspidata	+	.	PLAR-TRO	Vitaceae	CL	G	D	C (C)
Phlomis fruticosa	+	.	PLAR	Lamiaceae	SH	G	D	N (N)
Phoenix canariensis	+	.	PLAR	Arecaceae	TR	G	D	N (N)
Phormium tenax	.	CA	NZ	Asphodelaceae (Hemerocallidoideae)	PF	G	D	C (C)
Phyllostachys aurea	+	.	PLAR-TRO	Poaceae (Bambusoideae)	PG	G	D	N (N)
Phytolacca dioica	+	.	NAR-TRO	Phytolaccaceae	TR	G	D	C (C)
Pittosporum tobira	+	.	PLAR	Pittosporaceae	SH	G	D	N (I)
Podranea ricasoliana	+	.	SAF	Bignoniaceae	CL	G	D	C (C)
Polygala myrtifolia	+	.	SAF	Polygalaceae	SH	G	D	C (C)
Portulacaria afra	+	.	PLTRO-SAF	Didiereaceae	SU	G	D	C (C)
Pyrus communis	+	.	PLAR	Rosaceae	TR	A	D	N (C)
Sedum praealtum	+	.	NTRO	Crassulaceae	SU	G	D	C (C)
Selenicereus undatus	+	CB	NTRO	Cactaceae	SU	G	D	C (C)
Senecio angulatus	+	.	SAF	Asteraceae	CL	G	D	N (I)
Senecio inaequidens	+	.	SAF	Asteraceae	PF	TC	A	I (I)
Senecio pseudolongifolius	+	.	PLTRO-SAF	Asteraceae	SH	G	D	N (N)
Senecio pterophorus	+	.	SAF	Asteraceae	SH	TC	A	I (N)
Spartium junceum	+	.	PLAR	Fabaceae (Papilionoideae)	SH	G & S	D	C (C)
Tecomaria capensis	+	.	SAF	Bignoniaceae	SH	G	D	C (C)
Teucrium fruticans	+	.	PLAR	Lamiaceae	SH	G	D	N (N)
Tradescantia fluminensis	+	.	NTRO	Commelinaceae	PF	G	D	I (I)

Table 14. IAPS and PIAPS observed by us in the HCI1240 for the whole Costa Brava*								
Taxon	Cat.	Nov.	Native range	Family	Fun. traits	Intr. path.	Int. intr.	Inv. status
Trichocereus macrogonus	+	.	NTRO	Cactaceae	SU	G	D	C (C)
Tropaeolum majus	+	.	NTRO	Tropaeolaceae	CL	G	D	N (N)
Vitis riparia	+	.	NAR	Vitaceae	CL	A	D	I (N)
Washingtonia filifera	+	.	NTRO	Arecaceae	TR	G	D	C (N)
Wigandia urens	+	.	NTRO	Hydrophyllaceae	SH	G	D	C (C)
Xanthium spinosum	+	.	NTRO	Asteraceae	AF	TC	A	N (N)
Yucca aloifolia	+	.	NTRO	Asparagaceae (Agavoideae)	SU	G	D	N (N)
Yucca gigantea	+	.	NTRO	Asparagaceae (Agavoideae)	SU	G	D	C (C)
Yucca gloriosa	+	.	NAR-TRO	Asparagaceae (Agavoideae)	SU	G	D	N (N)

*Columns information: (1) "Cat.": taxa that appear in the catalogue of plants of Catalonia by Sáez & Aymerich (2021), (2) Novelty ("Nov."): first observed in CB (Costa Brava, CA (Catalonia), IP (Iberian Peninsula) or EU (Europe), (3) Native range: ART (Artificial), AUS (Australia), AUS-NZ (Australia and New Zealand), NAR (Nearctic), NAR-TRO (Nearctic-tropical), NTRO (Neotropical), NZ (New Zealand), PLAR (Palearctic), PLAR-TRO (Palearctic-tropical), PLTRO (Paleotropical), PLTRO-SAF (Paleotropical and South-africa), PNTRO (Pantropical), and SAF (South-africa), (4) Family, (5) Functional traits ("Fun. traits") based on Aymerich & Sáez (2019): AF (annual forbs), BU (bulbous monocots), CL (climbers), PF (perennial forbs), PG (perennial grasses), SH (shrubs), SU (succulent plants), and TR (trees), (6) Introductory pathway ("Intr. Path."): A (agriculture), G (gardering), M (medicinal), S (soil stabilisation), T (textile), and TC (trade contaminant), (7) Intentionality introduction ("Int. intr."): D (subspontaneous, deliberate) and A (adventive, unintentional), (8) Invasion status ("Inv. status") in Catalonia (and in the Costa Brava in parentheses): C (casual), I (invasive), and N (naturalised).

Despite not being new, we also observed some very invasive species. One was *Cylindropuntia pallida* in Lloret de Mar in February 2022 (Fig. 30); after alerting of its presence, it was finally removed in July 2022 by the Generalitat de Catalunya. Another very problematic species was *Opuntia aurantiaca*, observed in Tossa de Mar in February 2022 (still to be removed). It should be also noted that three species not listed in the official Catalogue of Invasive Alien Species of Spain are showing a worrying situation in the Costa Brava: *Kalanchoe × houghtonii*, *Pittosporum tobira*, and *Senecio angulatus*. *Kalanchoe × houghtonii*, of (artificial) hybrid origin and present in Catalonia since early 2000s (Mesquida et al., 2017), is showing a very aggressive behaviour, often forming monospecific carpets and, in the HCI1240, it finds an ideal niche as coastal cliffs are open and sunny places. We have observed it in almost all the sampling points along the Costa Brava, in some places forming really large populations (probably of thousands of individuals; Fig. 31). One of its parental species (*K. tubiflora*, native to Madagascar), despite being less problematic, is also already naturalised in the Costa Brava. *Pittosporum tobira*, which is often sold in gardening shops, has been noted as invasive in other places of Catalonia (e.g. Montseny) including some parts of the Costa Brava (municipality of Llançà: Giménez, 2012). It has a very high rusticity (it tolerates saline soils) and its fruits are dispersed by birds, which makes it very easy to invade new areas. In the Costa Brava, we have observed it seriously invading some areas, being capable to even form small stands. *Senecio angulatus* is probably the most aggressive invader in the coastal areas of Catalonia only after *Ailanthus altissima*. In the Costa Brava is very common, often forming large populations that invade both coastal cliffs but also nearby shrublands and even closed forests. Because of its climber nature, it can completely cover the local vegetation, such as lentisk stands (*Pistacia lentiscus*; Fig. 32).

Figure 30. *Cylindropuntia pallida* invading the rocky cliffs in Lloret de Mar (southern Costa Brava).

Figure 31. Large population of ***Kalanchoe* × *houghtonii*** near Roses, in Cap de Creus. This species is capable of forming monospecific carpets that could reach 1000 plants/m^2.

Figure 32. ***Senecio angulatus*** **covering the native** ***Pistacia lentiscus*** **in Calella de Palafrugell, central Costa Brava.**

Within and around the HCI1240 of the Costa Brava, IAPS and PIAPS are mostly affecting the populated areas, as one could anticipate. The most affected places are the coast cliffs on the sparse urbanised areas with terraced houses or villas, as they often have private gardens with lots of alien plants. Discarded plants and pruning remains are often dumped nearby, which may constitute actual sources of invasion; in addition, the small fences of these private houses often act as inefficient barriers to plant dispersal. The number and density of populations of both IAPS and PIAPS is decreasing when increasing the distance from urban areas, though we have been able to detect some species very far away from populated places (e.g. *Kalanchoe* × *houghtonii* near Punta Falconera in Cap de Creus; Fig. 33). We must remark that for most of these are plants they are used to living with; e.g. *Agave americana* and *Opuntia* *ficus-indica* have been planted (and probably escaped) in the area since more than one century ago. This would avoid being aware of their invasive behaviour, and for most cases they may remain unnoticed, even for the biodiversity managers. During our fieldwork we have observed that local people are often reluctant on eradicating alien plants, either because they believe that these plants are actually native, or because they think that eliminating them will involve a loss of biodiversity and loss of aesthetic value of landscape.

Fig. 33. ***Kalanchoe* × *houghtonii* near Punta Falconera in Cap de Creus; this population is far away from any populated place.**

The 121 detected species have various origins (Table 15), including plants from the Palearctic (30 taxa, i.e., 24.8%), South Africa (23 taxa, 20.7%), the Neotropics (24 taxa, 19.8%), and the Nearctic (21 taxa, 17.4%). Five taxa have an artificial origin (*Agave fourcroydes*, *A. sisalana*, *Kalanchoe* × *houghtonii*, *Mesembryanthemum* × *vascosilvae*, and *Opuntia leoglossa*). The most represented families are Cactaceae (18 taxa, 14.9%), Asparagaceae (14 taxa, 11.6%), Asteraceae (10 taxa, 8.3%), Crassulaceae (9 taxa, 7.4%), and Aizoaceae (both with 8 taxa, 6.6%). Asparagaceae is ranking the second because of the finding of many taxa of the genus *Agave* (9 taxa) and *Yucca* (3 taxa). The most represented genus is, however, *Opuntia*, with 13 taxa (Table 15). Other genera with several taxa are *Aloe* (4 taxa), and *Acacia* and *Crassula* (3 taxa each), The very large number of succulent plants detected in the HCI1240 of the Costa Brava does not agree what it was found for the whole Catalonia, where the most important families were Asteraceae, Poaceae, Fabaceae, Rosaceae and Brassicaceae (Aymerich & Sáez, 2019). The overrepresentation of succulent plants in the Costa Brava (54 taxa out of 121, that is 44.6%; which should be compared with <10% for the whole Catalonia, see Aymerich & Sáez, 2019) is probably because most alien escaping episodes were originated from the private gardens of terraced houses and villas, which frequently harbour these plants (there is a "boom" of xero-gardening and xero-landscaping in the Catalan coastal areas; Aymerich & Sáez 2019). The Costa Brava is one of the clearest examples of the negative impacts of the sequential real estate bubbles that have destroyed most of the coastal habitats of Spain since the 1950s (Martí & Pintó, 2012), and many urbanised areas are very close or even invading the HCI1240. Up to 39 of the 121 alien taxa (33.1%) detected by us are plants that are not still established (i.e., casual) in the places we have seen them, although one of them (*Pyrus communis*) is already naturalised in other places of Catalonia; 65 of the 121 taxa (53.7%) are naturalised in the Costa Brava; of these, three are regarded as casual (*Kalanchoe tubiflora*, *Osteospermum ecklonis*, and *Washingtonia filifera*; these species should be, therefore, upgraded to naturalised at national Catalonian level) and three invasive for Catalonia (*Iris* × *germanica*, *Senecio pterophorus*, and *Vitis riparia*). Finally, 17 out of 121 species (14.0%) form invasive populations at the HCI1240 in the Costa Brava, four of them being catalogued as naturalised (*Gazania rigens*, *Kalanchoe* × *houghtonii*, *Pittosporum tobira*, *Senecio angulatus*) and one as casual (*Carpobrotus aff. acinaciformis*) for Catalonia, so the status of these five species should be updated at regional (Catalonian) level.

The 33 selected plant species to be monitored are mostly invasive in the Costa Brava: there are 24 IAPS and nine PIAPS. Among the IAPS, 16 are catalogued species (i.e., listed in the official Catalogue of Invasive Alien Species of Spain) (see Table 16). During the fieldwork we have been able to detect 31 taxa through 1146 observations (we have only failed to observe *Cenchrus setaceus* and *Fallopia baldschuanica*), i.e., an average of 37 records per taxa. The most observed species were two taxa of *Opuntia*, *O. stricta* (*N* = 190) and *O. ficus-indica* (*N* = 116), followed by *Carpobrotus acinaciformis* (*N* = 106), *Pittosporum tobira* (*N* = 96), *Kalanchoe* × *houghtonii* (*N* = 80), *Carpobrotus edulis* (*N* = 77), *Agave americana* (*N* = 67), *Gazania rigens* (*N* = 63), and *Senecio angulatus* (*N* = 53) (Table 16). Some of these species, with a clear invasive character in the HCI1240 along the Costa Brava, are not still catalogued as invasive for Spain (e.g. *Gazania rigens*, *Kalanchoe × houghtonii*, *Senecio angulatus*). As well, *Pittosporum tobira*, though not regarded as invasive (PIAPS), locally shows invasive behaviour. *Opuntia stricta*, despite being the IAPS with more recorded locations, it is only present almost exclusively in the coastal stretch between Roses and the French border; on the contrary, the other above mentioned species are present in a more or less continuous way along the Costa Brava (particularly *Pittosporum tobira*; see Appendix). The less observed species were, apart from *Cenchrus setaceus* and *Fallopia baldschuanica* (both *N* = 0), *Cylindropuntia pallida* (*N* = 1), *Opuntia aurantiaca* (*N* = 1), *Cenchrus longisetus* (*N* = 2), and *Senecio inaequidens* (*N* = 2) (Table BB). Some of these species, despite apparently not very common in the Costa Brava, are potentially very dangerous; *Cylindropuntia pallida* and *Opuntia aurantiaca* are very aggressive invaders elsewhere (including other parts of Catalonia; for example, *O. aurantiaca* formed large infestations in Pau and Vilajuïga, not far away from Cap de Creus, from where it was removed; Gómez-Bellver et al., 2020b) and, thus, their monitoring is of paramount importance.

Table 15. List of the 33 selected plant species to be monitored in the Costa Brava

Plant taxa	Catalogued IAPS	Non catalogued IAPS	PIAPS	No. of occurrences observed	Inv. status*
Acacia dealbata	•			13	N (N)
Agave americana	•			67	N (N)
Ailanthus altissima	•			13	I (I)
Araujia sericifera	•			6	N (N)
Arundo donax	•			28	I (I)
Carpobrotus acinaciformis	•			106**	C (I)
Carpobrotus edulis	•			77**	I (I)
Cenchrus longisetus	•			2	N (N)
Cenchrus setaceus	•			0	N (-)
Chenopodium nutans		•		5	I (I)
Cylindropuntia pallida	•			1	I (I)
Delairea odorata		•		16	I (I)
Dimorphotheca ecklonis			•	30	C (N)
Disphyma crassifolium			•	12	N (N)
Drosanthemum floribundum			•	14	N (N)
Fallopia baldschuanica	•			0	I (-)
Gazania rigens		•		63	N (I)
Ipomoea indica	•			10	N (N)
Kalanchoe tubiflora			•	5	C (N)
Kalanchoe × houghtonii		•		80	N (I)
Lonicera japonica		•		15	I (I)

Table 15. List of the 33 selected plant species to be monitored in the Costa Brava					
Plant taxa	Catalogued IAPS	Non catalogued IAPS	PIAPS	No. of occurrences observed	Inv. status*
Matthiola incana			•	35	N (N)
*Mesembryanthemum cordifolium****			•	36	N (N)
Opuntia aurantiaca		•		1	N (N)
Opuntia ficus-indica	•			116	I (I)
Opuntia lindheimeri var. *linguiformis*			•	5	N (N)
Opuntia stricta	•			190	I (I)
Oxalis pes-caprae	•			35	N (N)
Phyllostachys aurea			•	6	N (N)
Pittosporum tobira			•	96	N (I)
Senecio angulatus		•		53	N (I)
Senecio inaequidens	•			2	I (I)
Senecio pterophorus		•		8	I (N)

* Invasion status in Catalonia (and in the Costa Brava in parentheses): C (casual), I (invasive), and N (naturalised).
** There were 3 occurrences of *Carpobrotus* that could not be assigned to either *C. acinaciformis* or *C. edulis*.
*** It includes *Mesembryanthemum* × *vascosilvae* (4 of the 36 occurrences are for the hybrid).

Conclusions

The extensive fieldwork (December 2021–August 2022) to ascertain the threat posed by IAPS and PIAPS to the HCI1240 in the whole Costa Brava has resulted in the observation of up to 121 plant taxa in a total of 1563. Some of these observations are very relevant, as we have been able to detect a species new for Europe (*Agave parryi*), one new for the Iberian Peninsula (*Asparagus falcatus*), and four new for Catalonia (*Aloe striata*, *Ficus pumila*, *Phormium tenax*, and *Senecio articulatus*). In addition, six species have been recorded for the first time in the Costa Brava. It is noteworthy the overrepresentation of succulent plants in the Costa Brava (nearly 45% of all observed taxa), which clearly points out the importance of gardening trends as the origin for these escaping episodes, linked to the "boom" of xero-gardening and xero-landscaping in the Catalan coastal areas. Unfortunately, most of the 121 plant taxa (67.8%) show signs of establishment in the Costa Brava (i.e., they are already naturalised), and some are showing clear signs of invasion (17 plant taxa); *Kalanchoe* × *houghtonii*, *Pittosporum tobira*, and *Senecio angulatus* are among the worst invaders in the HCI1240 of the Costa Brava. Our fieldwork has also allowed us to select a set of 33 plant taxa to be monitored in the coming four years.

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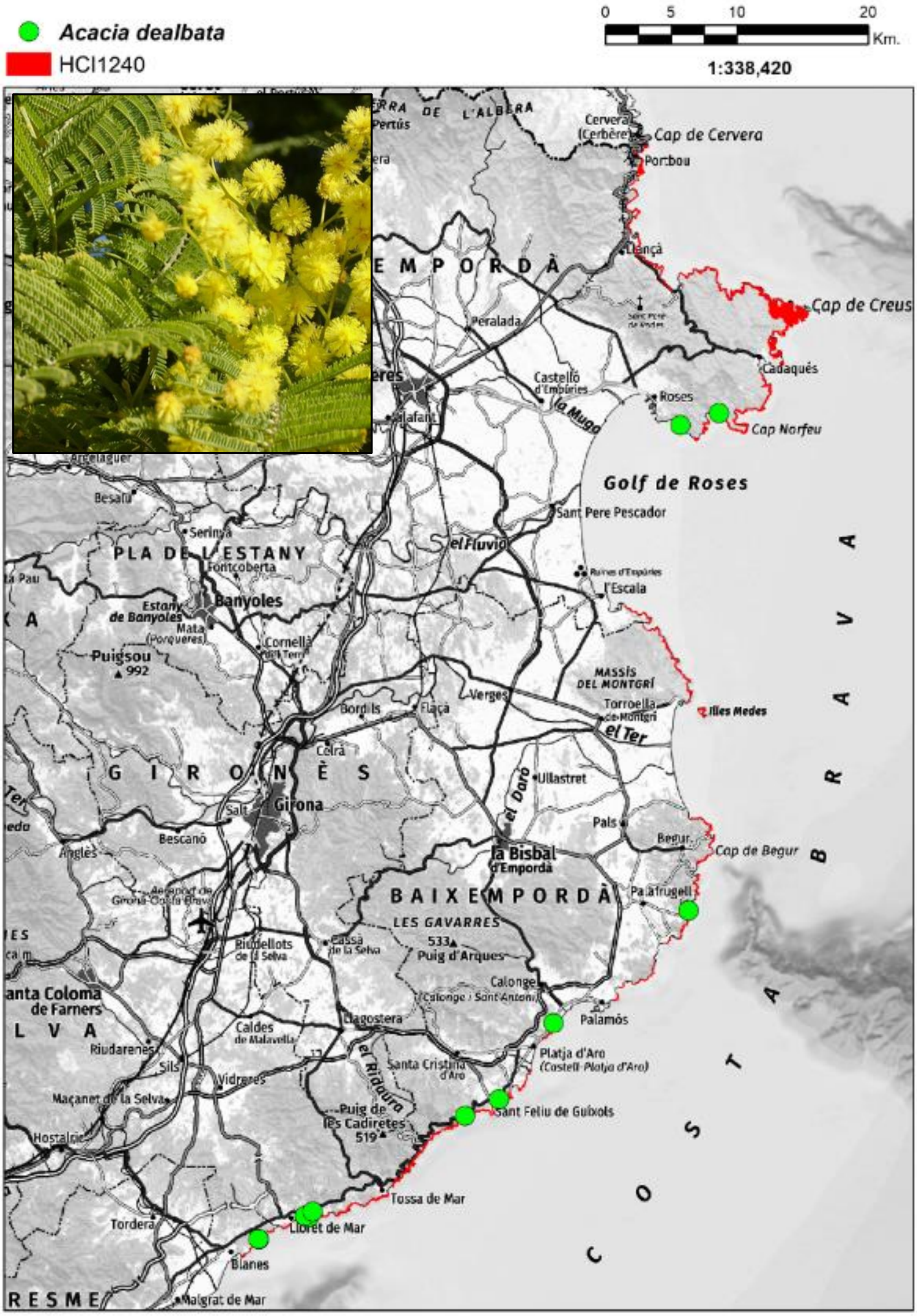
4. Appendix

Maps of IAPS listed in Table 15 in the Costa Brava


Acacia dealbata
HCI1240
0 5 10 20
Km.
1:338,420
Cap de Cervera
Portbou
Llançà
Cap de Creus
Cadaqués
Roses
Cap Norfeu
Peralada
Castelló d'Empúries
la Muga
EMPORDÀ
Golf de Roses
Sant Pere Pescador
el Fluvià
L'Escala
PLA DE L'ESTANY
Banyoles
Fontcoberta
Puigsou
992
Besalú
Serinyà
Cornellà del Terri
Bordils
Flaçà
Verges
Torroella de Montgrí
el Ter
Illes Medes
MASSÍS DEL MONTGRÍ
GIRONÈS
Girona
Salt
Bescanó
Anglès
Ullastret
el Daró
Pals
Begur
Cap de Begur
la Bisbal d'Empordà
BAIX EMPORDÀ
LES GAVARRES
Palafrugell
Cassà de la Selva
Riudellots de la Selva
533
Puig d'Arques
Calonge
Palamós
Platja d'Aro
(Castell-Platja d'Aro)
Llagostera
Santa Cristina d'Aro
Sant Feliu de Guíxols
Caldes de Malavella
Santa Coloma de Farners
Riudarenes
Sils
Vidreres
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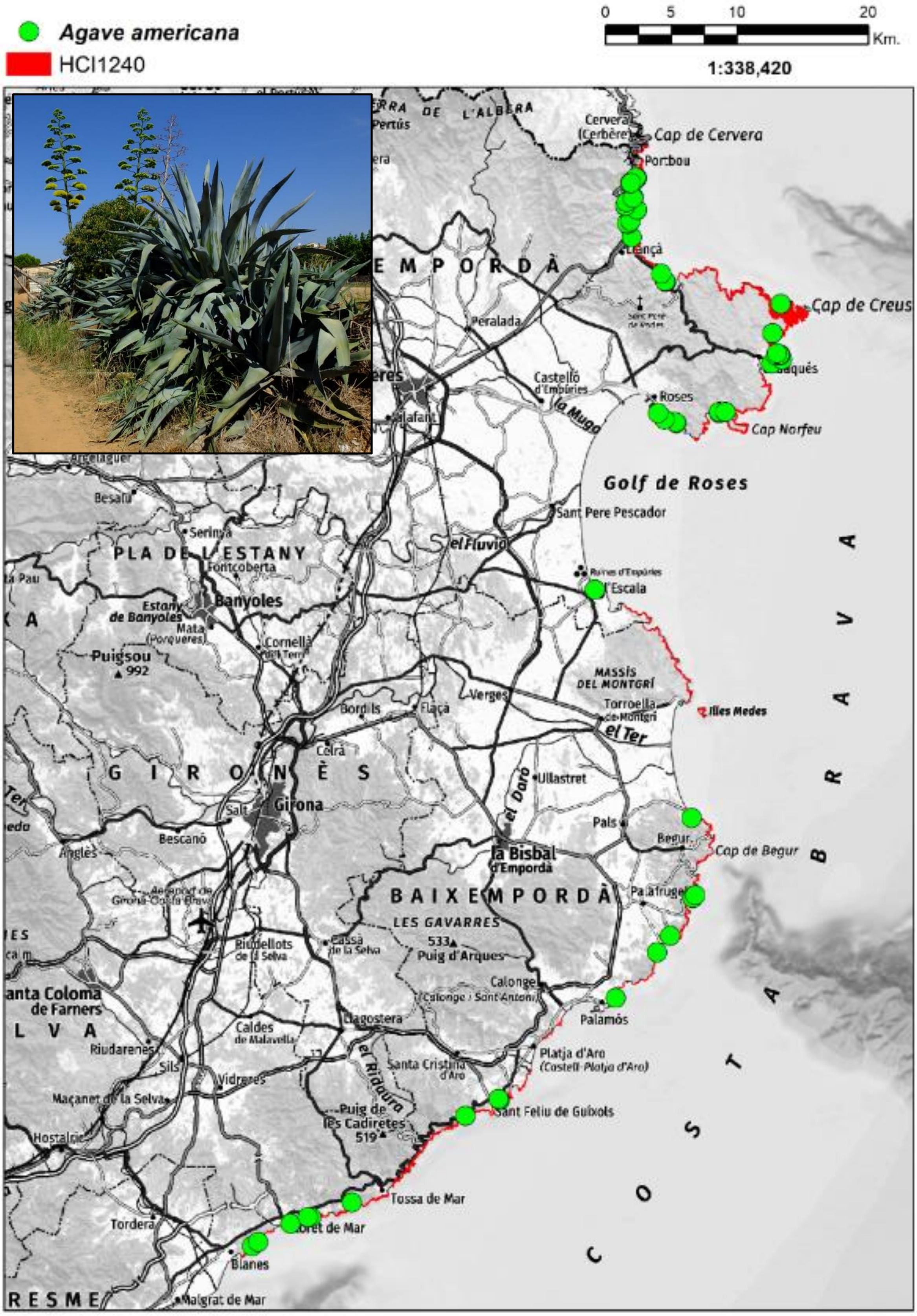
Hostalric
Puig de les Cadiretes
519
Tossa de Mar
Lloret de Mar
Tordera
Blanes
Malgrat de Mar
COSTA BRAVA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Cap de Cervera
Portbou
Llançà
EMPORDÀ
Peralada
Cap de Creus
Cadaqués
Castelló d'Empúries
la Muga
Roses
Cap Norfeu
Golf de Roses
Sant Pere Pescador
el Fluvià
PLA DE L'ESTANY
Fontcoberta
Banyoles
Estany de Banyoles
Puigsou
992
Cornellà del Terri
L'Escala
MASSÍS DEL MONTGRÍ
Torroella de Montgrí
el Ter
Illes Medes
Verges
Flaçà
Bordils
Celrà
GIRONÈS
Girona
Salt
Bescanó
Anglès
Ullastret
el Daró
Pals
Begur
Cap de Begur
la Bisbal d'Empordà
BAIX EMPORDÀ
Palafrugell
LES GAVARRES
Cassà de la Selva
Riudellots de la Selva
533
Puig d'Arques
Calonge
Calonge i Sant Antoni
Palamós
Santa Coloma de Farners
Riudarenes
Caldes de Malavella
Llagostera
Sils
Vidreres
Santa Cristina d'Aro
Platja d'Aro (Castell-Platja d'Aro)
Sant Feliu de Guíxols
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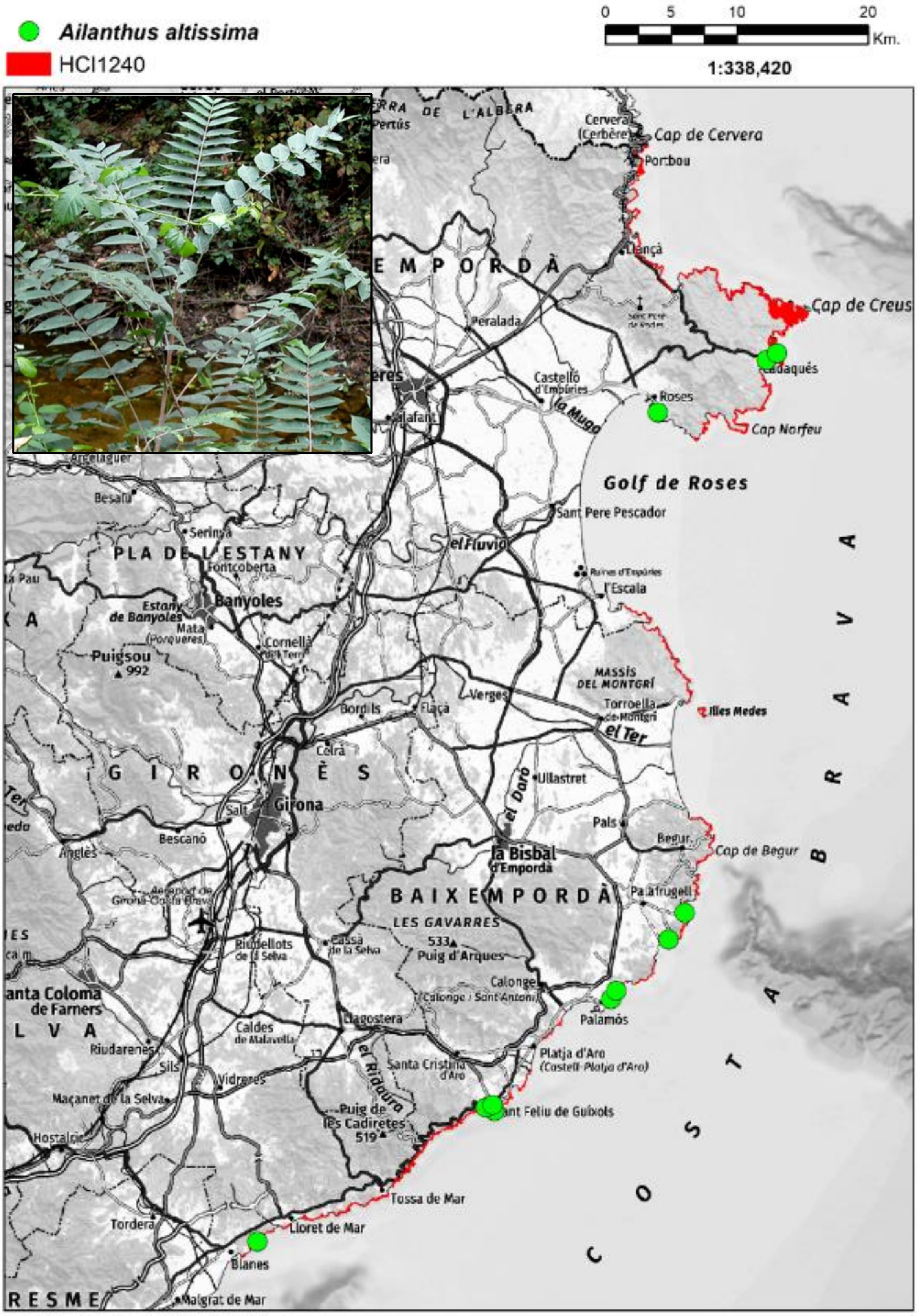
Puig de les Cadiretes
519
Tossa de Mar
Lloret de Mar
Tordera
Blanes
Malgrat de Mar
COSTA BRAVA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Cap Norfeu
Golf de Roses
Sant Pere Pescador
el Fluvià
PLA DE L'ESTANY
Fontcoberta
Banyoles
Estany de Banyoles
Besalú
Serinyà
Argelaguer
Puigsou
992
Cornellà del Terri
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MASSÍS DEL MONTGRÍ
Torroella de Montgrí
el Ter
Illes Medes
Verges
Bordils
Flaçà
Celrà
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Salt
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Anglès
Ullastret
el Daró
Pals
Begur
Cap de Begur
la Bisbal d'Empordà
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Palafrugell
LES GAVARRES
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Puig d'Arques
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Calonge
Palamós
Llagostera
Santa Coloma de Farners
Riudarenes
Caldes de Malavella
Sils
Vidreres
Santa Cristina d'Aro
Platja d'Aro
(Castell-Platja d'Aro)
Puig de les Cadiretes
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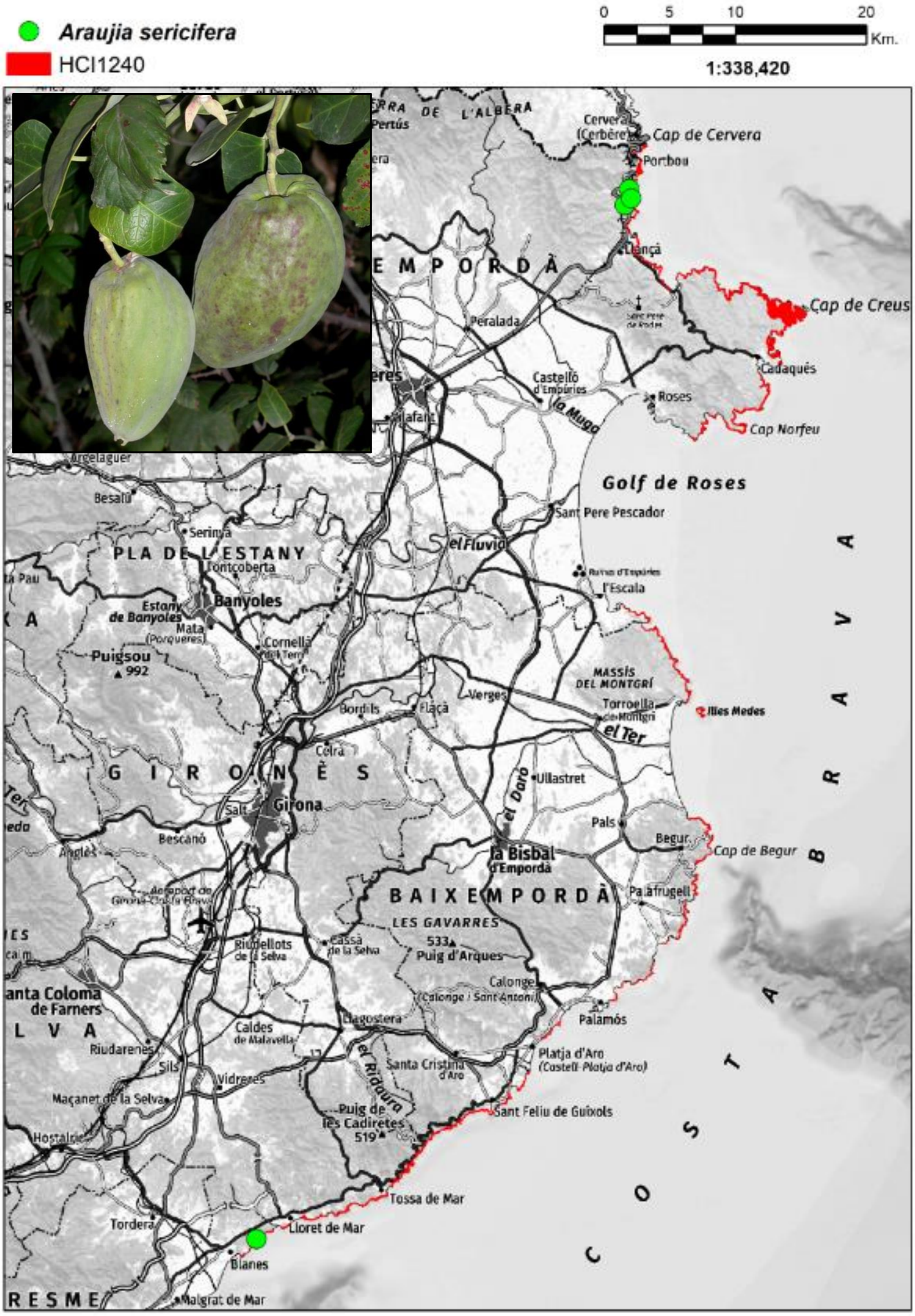
Maçanet de la Selva
Hostalric
Tordera
Tossa de Mar
Lloret de Mar
Blanes
Malgrat de Mar
COSTA BRAVA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Cap Norfeu
Golf de Roses
Sant Pere Pescador
el Fluvià
Argelaguer
Besalú
Serinyà
PLA DE L'ESTANY
Fontcoberta
Banyoles
Estany de Banyoles
Cornellà del Terri
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992
l'Escala
MASSÍS DEL MONTGRÍ
Torroella de Montgrí
Illes Medes
el Ter
Verges
Bordils
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Salt
Bescanó
Anglès
Ullastret
el Daró
Pals
Begur
Cap de Begur
la Bisbal d'Empordà
BAIX EMPORDÀ
Palafrugell
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533
Puig d'Arques
Cassà de la Selva
Riudellots de la Selva
Calonge
Palamós
Santa Coloma de Farners
Riudarenes
Caldes de Malavella
Llagostera
el Ridaura
Santa Cristina d'Aro
Platja d'Aro
Sils
Vidreres
Maçanet de la Selva
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Puig de les Cadiretes
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Sant Feliu de Guíxols
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Lloret de Mar
Tordera
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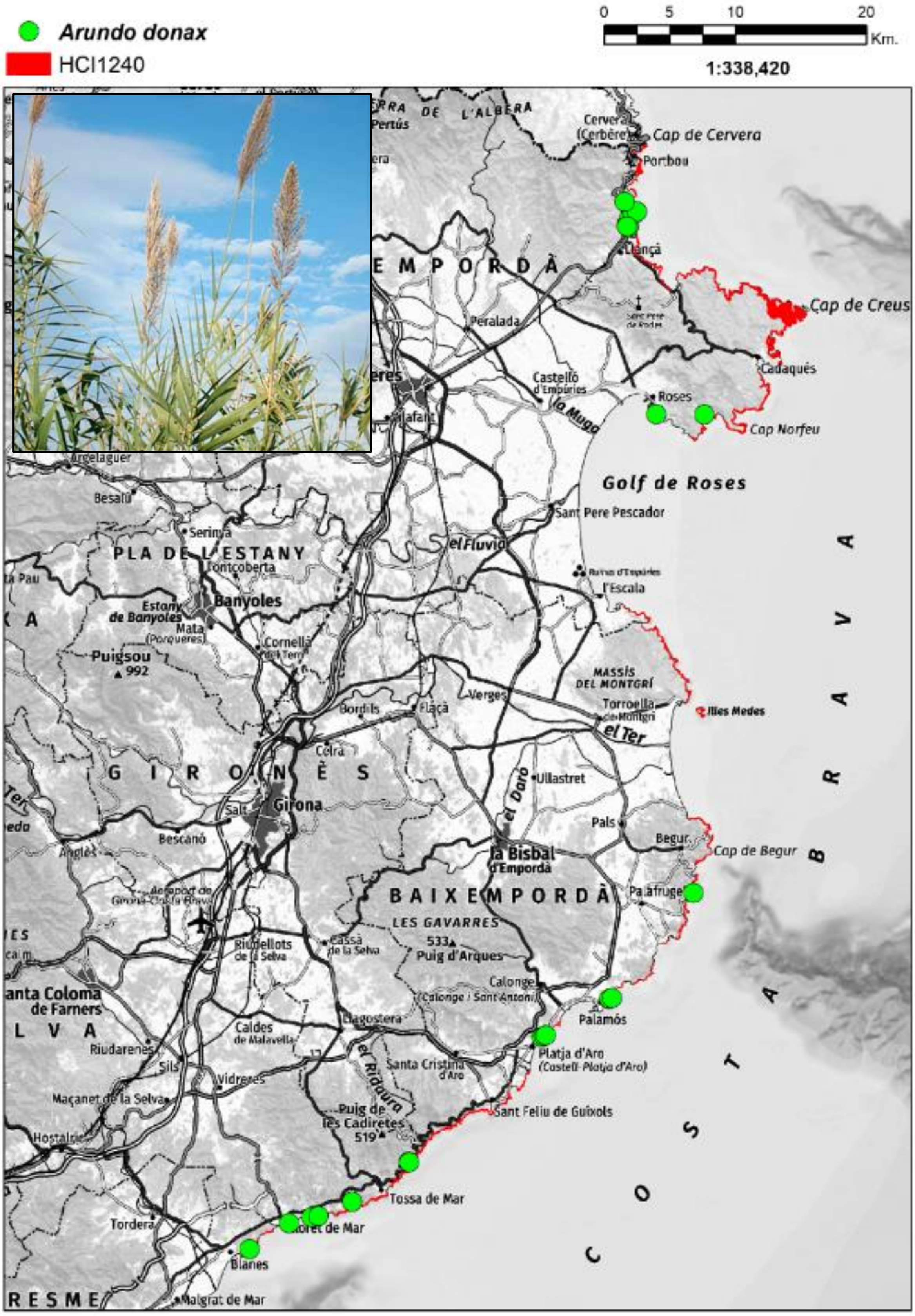
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Cap de Cervera
Portbou
Llançà
EMPORDÀ
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Roses
Cap Norfeu
la Muga
Golf de Roses
Sant Pere Pescador
el Fluvià
PLA DE L'ESTANY
Banyoles
Estany de Banyoles
Puigsou 992
Besalú
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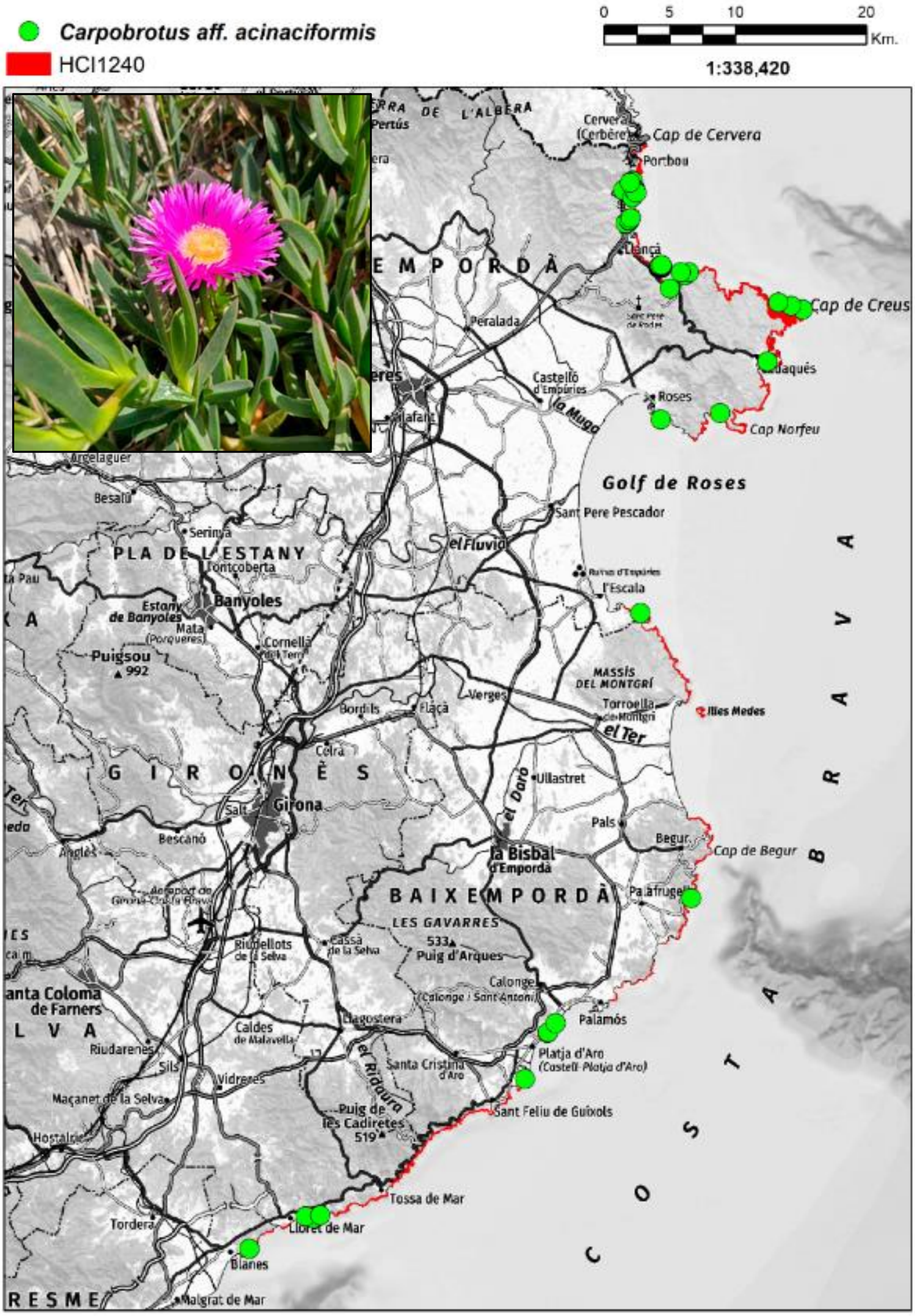
Argelaguer
l'Escala
MASSÍS DEL MONTGRÍ
Torroella de Montgrí
Illes Medes
el Ter
Verges
Bordils
Flaçà
Celrà
GIRONÈS
Girona
Salt
Bescanó
Anglès
Ullastret
el Daró
Pals
Begur
Cap de Begur
la Bisbal d'Empordà
BAIX EMPORDÀ
Palafrugell
LES GAVARRES
533 Puig d'Arques
Cassà de la Selva
Riudellots de la Selva
Calonge
Calonge i Sant Antoni
Palamós
Platja d'Aro (Castell-Platja d'Aro)
Santa Coloma de Farners
Caldes de Malavella
Llagostera
Santa Cristina d'Aro
el Ridaura
Riudarenes
Sils
Vidreres
Maçanet de la Selva
Hostalric
Sant Feliu de Guíxols
Puig de les Cadiretes 519
Tossa de Mar
Lloret de Mar
Tordera
Blanes
Malgrat de Mar
COSTA BRAVA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Km.
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Cap de Cervera
Portbou
Llançà
Cap de Creus
Cadaqués
Roses
Cap Norfeu
Golf de Roses
Sant Pere Pescador
L'Escala
Illes Medes
el Ter
Begur
Cap de Begur
Palafrugell
Palamós
Platja d'Aro
Sant Feliu de Guíxols
Tossa de Mar
Lloret de Mar
Blanes
Malgrat de Mar
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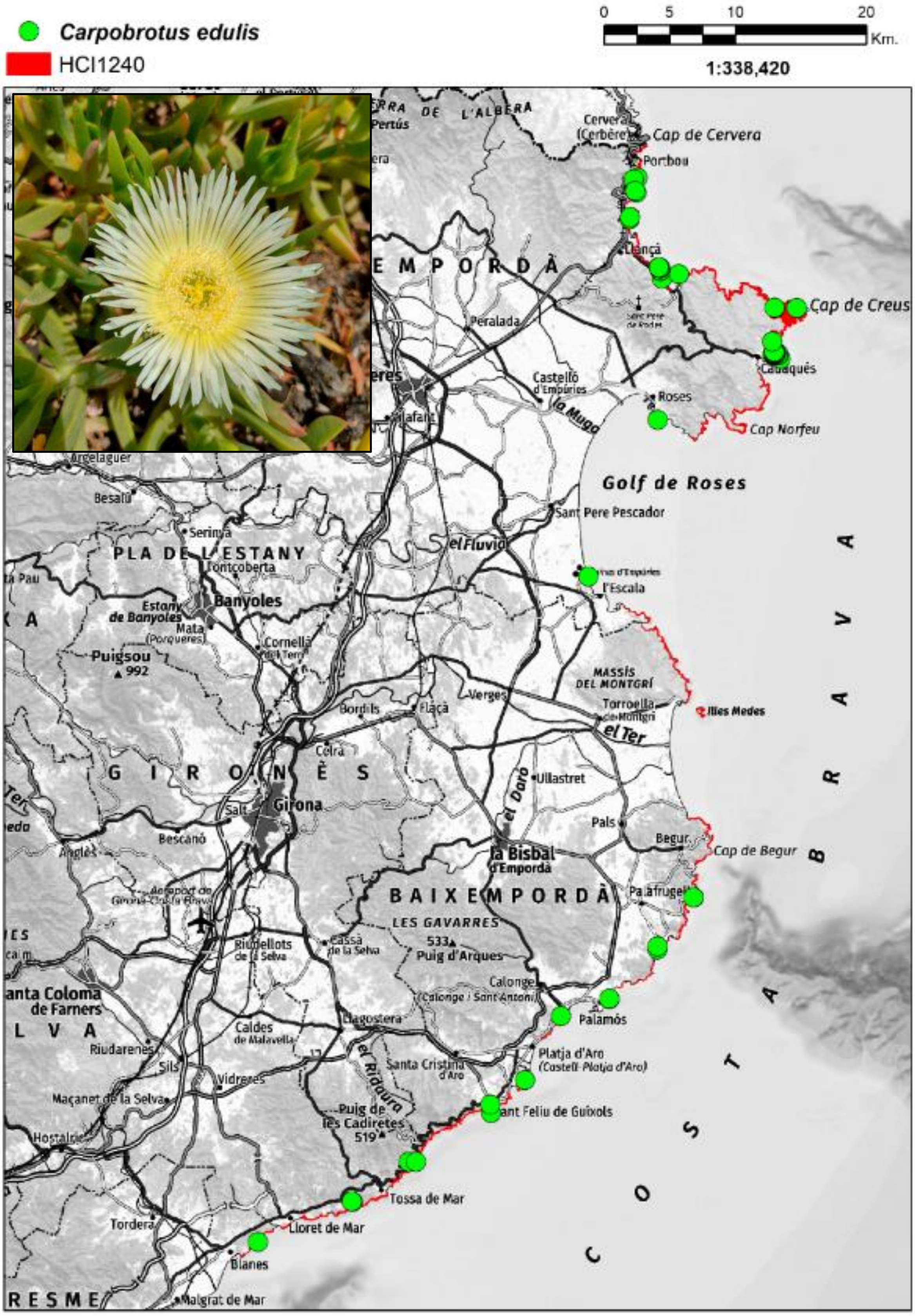
Banyoles
la Bisbal d'Empordà
COSTA BRAVA


Carpobrotus edulis
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Km.
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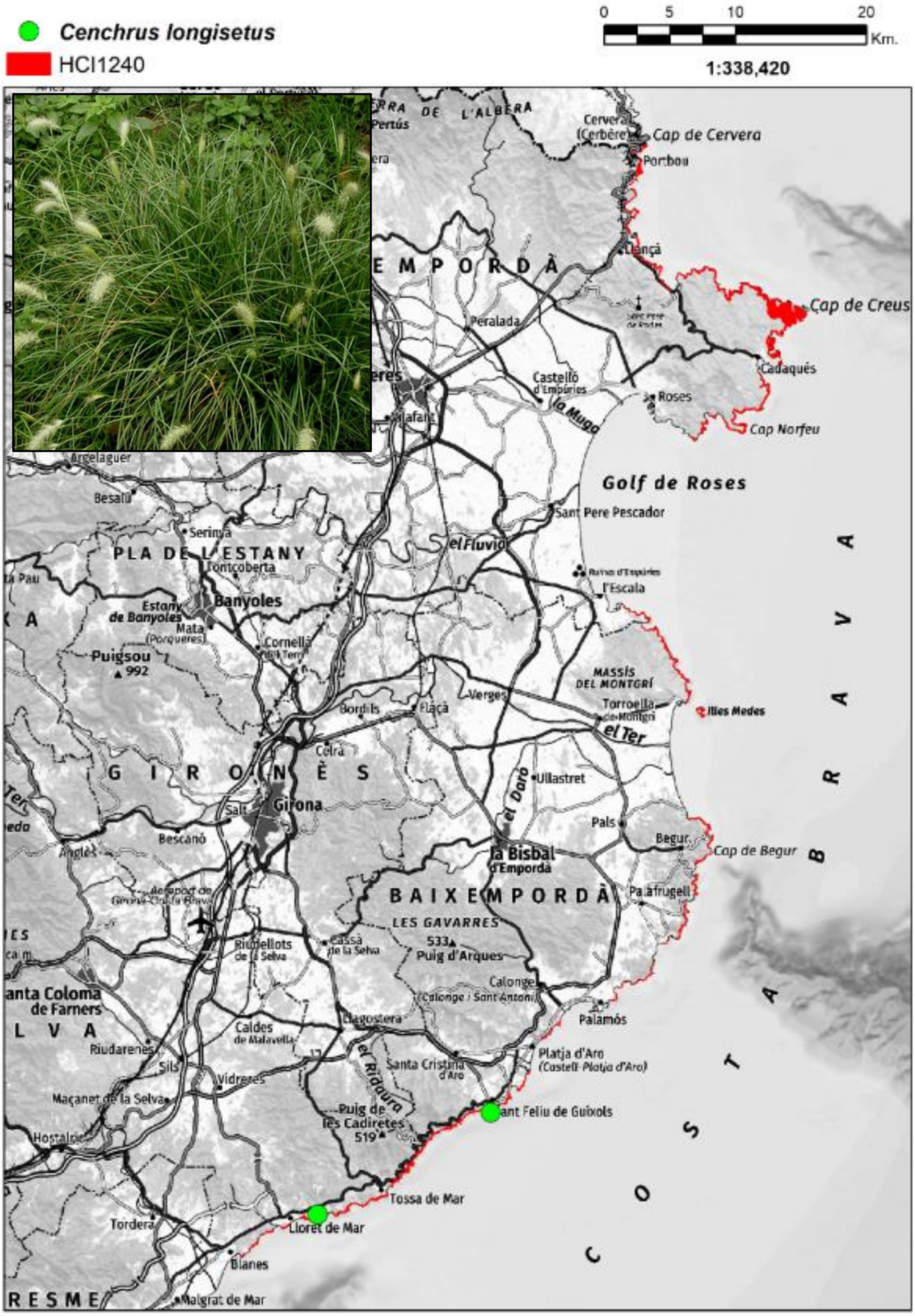
Cap de Cervera
Portbou
Llançà
Cap de Creus
Cadaqués
Roses
Cap Norfeu
EMPORDÀ
Peralada
Castelló d'Empúries
la Muga
Golf de Roses
Sant Pere Pescador
el Fluvià
L'Escala
PLA DE L'ESTANY
Banyoles
Estany de Banyoles
Puigsou 992
Besalú
Argelaguer
Serinyà
Fontcoberta
Cornellà del Terri
Bordils
Flaçà
Verges
Massís del Montgrí
Torroella de Montgrí
el Ter
Illes Medes
Celrà
GIRONÈS
Girona
Salt
Bescanó
Anglès
Ullastret
el Daró
Pals
Begur
Cap de Begur
la Bisbal d'Empordà
BAIX EMPORDÀ
Palafrugell
LES GAVARRES
533 Puig d'Arques
Calonge
Calonge i Sant Antoni
Palamós
Platja d'Aro
(Castell-Platja d'Aro)
Sant Feliu de Guíxols
Santa Cristina d'Aro
Cassà de la Selva
Riudellots de la Selva
Llagostera
el Ridaura
Caldes de Malavella
Santa Coloma de Farners
Riudarenes
Sils
Vidreres
Maçanet de la Selva
Hostalric
Puig de les Cadiretes 519
Tossa de Mar
Lloret de Mar
Blanes
Tordera
Malgrat de Mar
COSTA BRAVA


Cenchrus longisetus
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Portbou
EMPORDÀ
Llançà
Cap de Creus
Peralada
Cadaqués
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Golf de Roses
Sant Pere Pescador
el Fluvià
PLA DE L'ESTANY
Banyoles
l'Escala
Besalú
Serinyà
Fontcoberta
Estany de Banyoles
Puigsou
992
MASSÍS DEL MONTGRÍ
Torroella de Montgrí
Illes Medes
el Ter
Verges
Bordils
Flaçà
Celrà
GIRONÈS
Girona
Salt
Bescanó
Anglès
Ullastret
el Daró
Pals
Begur
Cap de Begur
la Bisbal d'Empordà
BAIX EMPORDÀ
Palafrugell
LES GAVARRES
533
Puig d'Arques
Cassà de la Selva
Riudellots de la Selva
Calonge
Palamós
Llagostera
Caldes de Malavella
Santa Coloma de Farners
Riudarenes
Sils
Vidreres
Santa Cristina d'Aro
el Ridaura
Platja d'Aro
(Castell-Platja d'Aro)
Sant Feliu de Guíxols
Puig de les Cadiretes
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Maçanet de la Selva
Hostalric
Tossa de Mar
Lloret de Mar
Tordera
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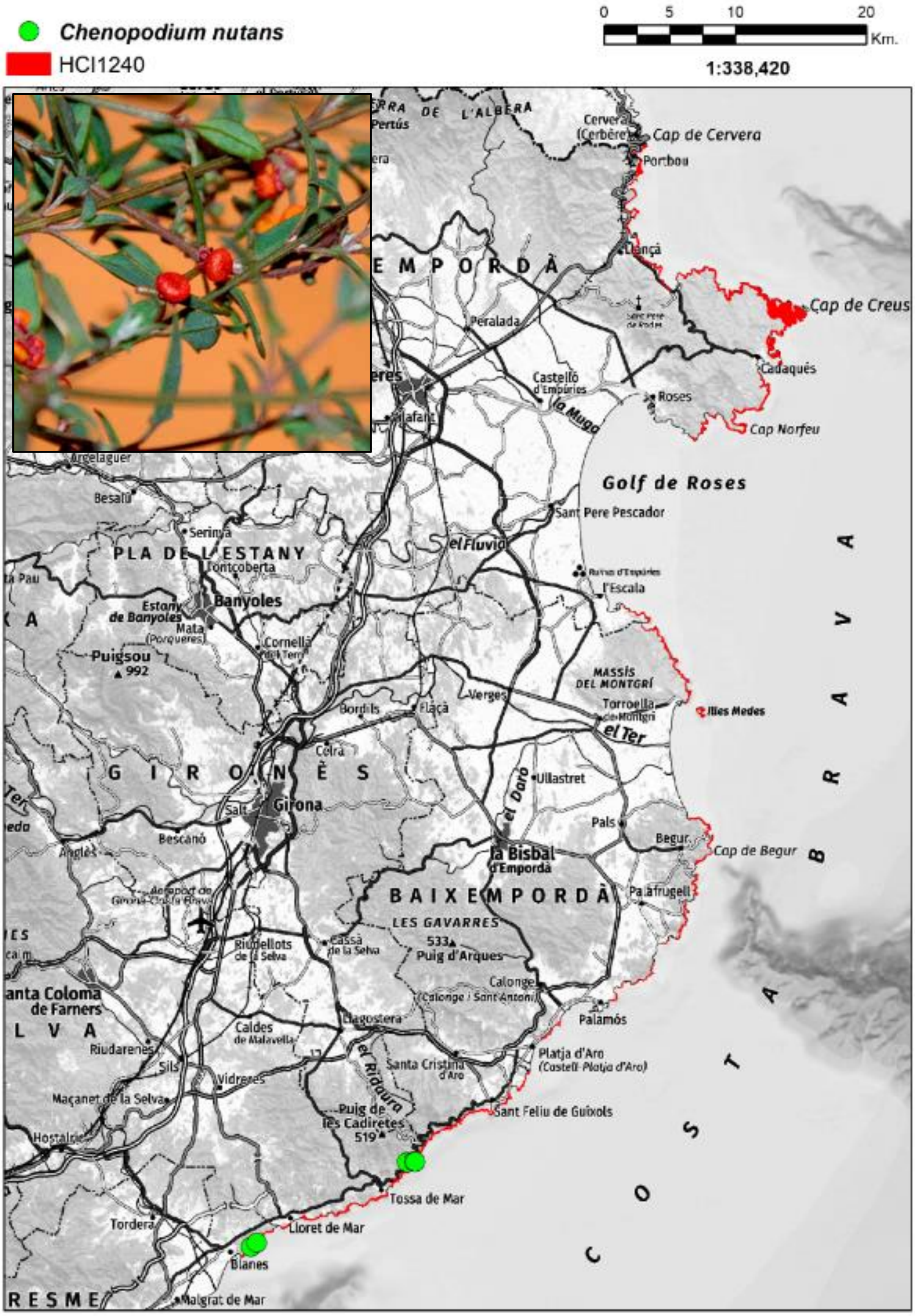
Chenopodium nutans
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Cap de Cervera
Portbou
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EMPORDÀ
Cap de Creus
Peralada
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Roses
la Muga
Cap Norfeu
Golf de Roses
Sant Pere Pescador
el Fluvià
Besalú
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Cornellà del Terri
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992
Massís del Montgrí
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Illes Medes
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Bordils
Flaçà
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Celrà
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Cap de Begur
Bescanó
Anglès
la Bisbal d'Empordà
Palafrugell
BAIX EMPORDÀ
LES GAVARRES
533
Puig d'Arques
Riudellots de la Selva
Cassà de la Selva
Calonge
Santa Coloma de Farners
Palamós
Caldes de Malavella
Llagostera
Riudarenes
Sils
Santa Cristina d'Aro
Platja d'Aro
Vidreres
el Ridaura
Maçanet de la Selva
Puig de les Cadiretes
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Sant Feliu de Guíxols
Hostalric
Tossa de Mar
Tordera
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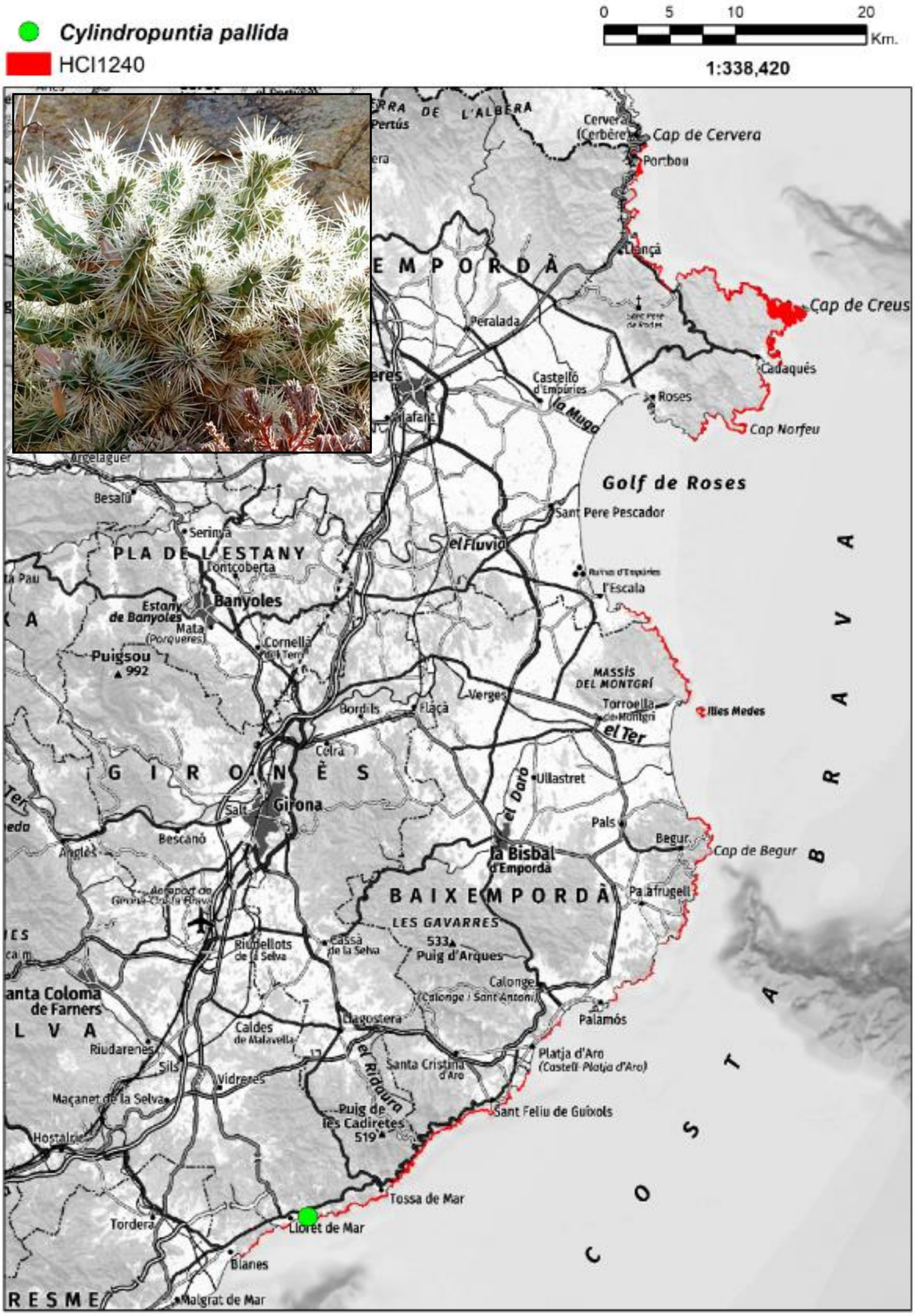
COSTA BRAVA


Cylindropuntia pallida
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Cap de Cervera
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Llançà
Cap de Creus
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Roses
Cap Norfeu
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la Muga
Golf de Roses
Sant Pere Pescador
el Fluvià
PLA DE L'ESTANY
Banyoles
Estany de Banyoles
Besalú
Serinyà
Puigsou 992
L'Escala
MASSÍS DEL MONTGRÍ
Torroella de Montgrí
Illes Medes
el Ter
Verges
Bordils
Flaçà
Celrà
GIRONÈS
Girona
Salt
Bescanó
Anglès
Ullastret
el Daró
Pals
Begur
Cap de Begur
la Bisbal d'Empordà
Palafrugell
BAIX EMPORDÀ
LES GAVARRES
533 Puig d'Arques
Cassà de la Selva
Riudellots de la Selva
Calonge
Palamós
Platja d'Aro (Castell-Platja d'Aro)
Santa Coloma de Farners
Caldes de Malavella
Llagostera
Santa Cristina d'Aro
Sant Feliu de Guíxols
el Ridaura
Puig de les Cadiretes 519
Riudarenes
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Vidreres
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Hostalric
Tossa de Mar
Lloret de Mar
Blanes
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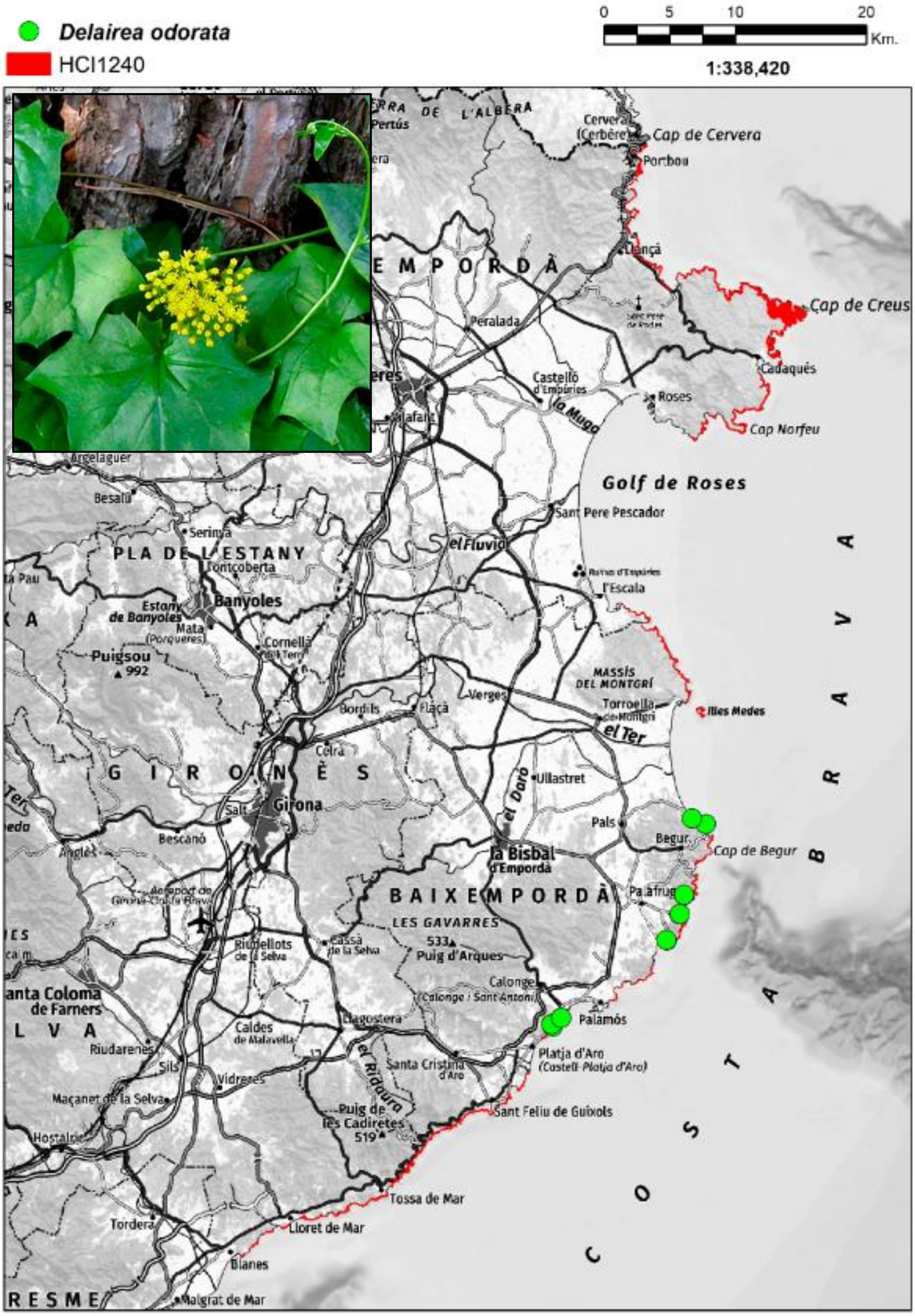
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Portbou
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Cap de Creus
Cadaqués
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Golf de Roses
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PLA DE L'ESTANY
Banyoles
L'Escala
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LES GAVARRES
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Santa Cristina d'Aro
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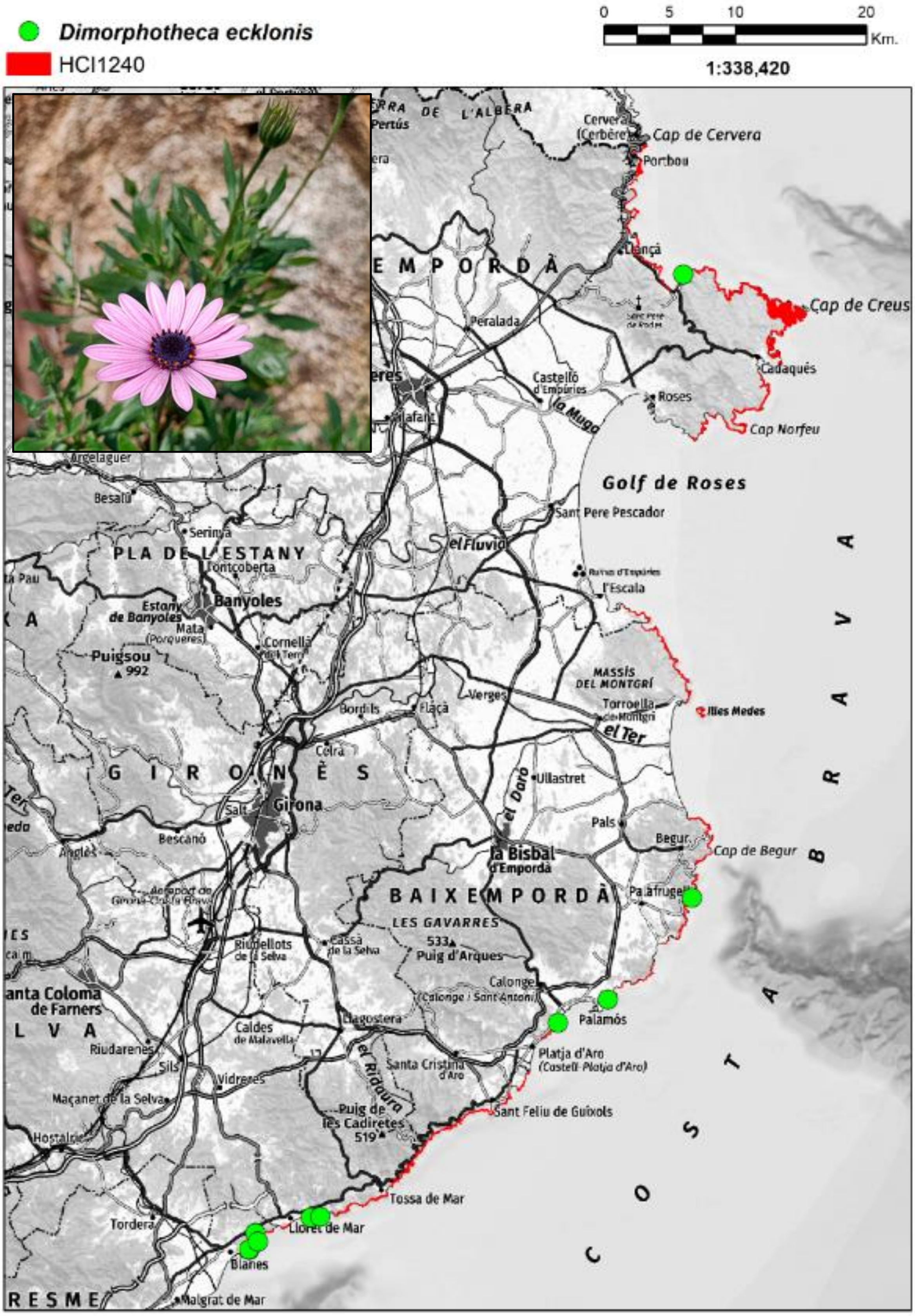
Dimorphotheca ecklonis
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Llançà
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Cadaqués
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la Muga
Cap Norfeu
Golf de Roses
Sant Pere Pescador
el Fluvià
L'Escala
PLA DE L'ESTANY
Banyoles
Besalú
Serinyà
Puigsou
992
MASSÍS DEL MONTGRÍ
Torroella de Montgrí
Illes Medes
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Verges
Bordils
Celrà
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Pals
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la Bisbal d'Empordà
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Palafrugell
LES GAVARRES
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Puig d'Arques
Calonge
Palamós
Platja d'Aro
(Castell-Platja d'Aro)
Cassà de la Selva
Llagostera
Caldes de Malavella
Santa Cristina d'Aro
Sant Feliu de Guíxols
el Ridaura
Puig de les Cadiretes
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Tossa de Mar
Lloret de Mar
Blanes
Malgrat de Mar
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Vidreres
Sils
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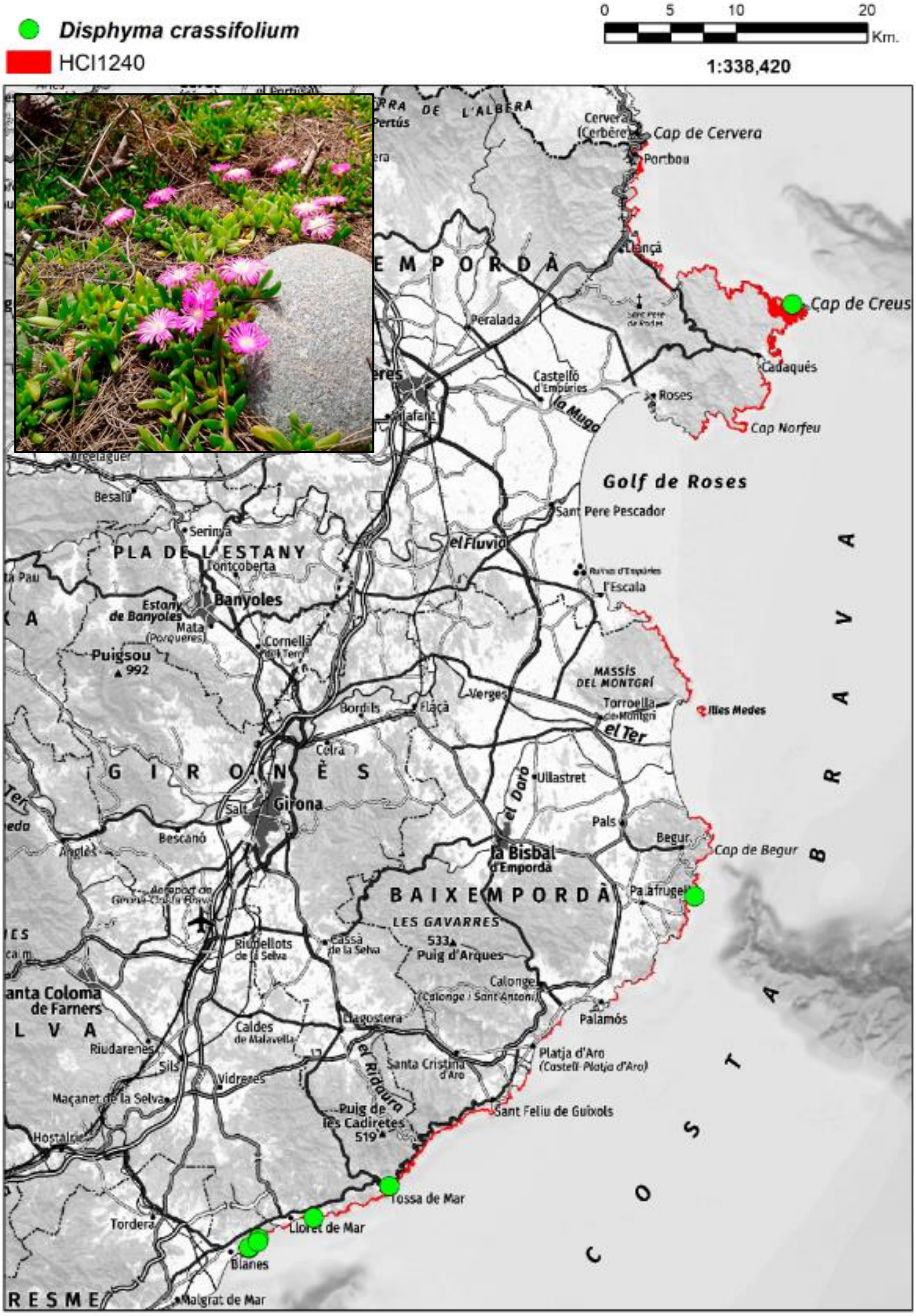
Santa Coloma de Farners
Anglès
COSTA BRAVA


Disphyma crassifolium
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Roses
Cap Norfeu
Golf de Roses
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Peralada
PLA DE L'ESTANY
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GIRONÈS
Girona
BAIX EMPORDÀ
la Bisbal d'Empordà
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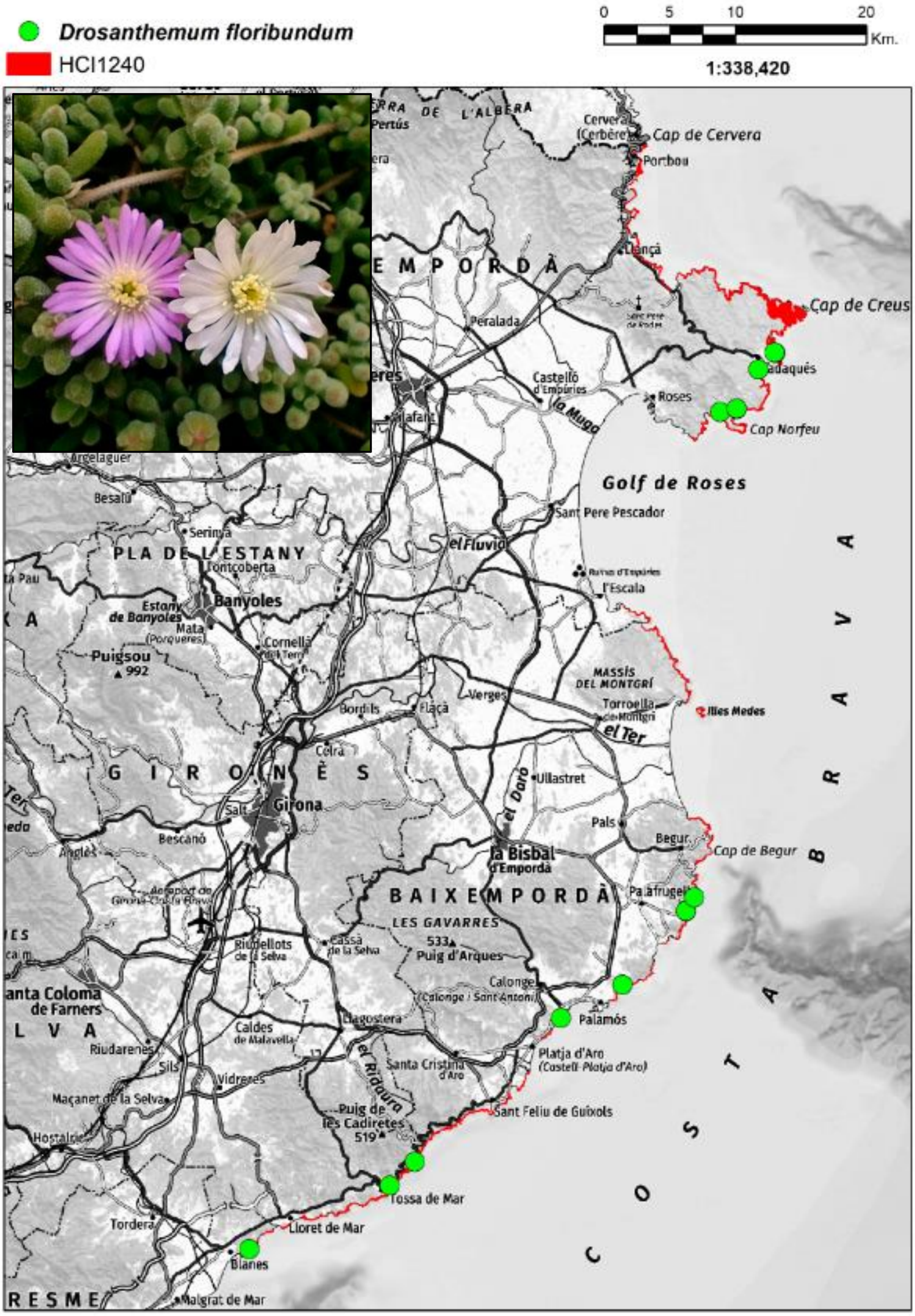
Drosanthemum floribundum
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Cap de Cervera
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Llançà
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Peralada
Cap de Creus
Cadaqués
Castelló d'Empúries
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la Muga
Cap Norfeu
Golf de Roses
Sant Pere Pescador
el Fluvià
PLA DE L'ESTANY
Fontcoberta
Banyoles
Estany de Banyoles
Besalú
Serinyà
Argelaguer
Puigsou 992
L'Escala
MASSÍS DEL MONTGRÍ
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Illes Medes
el Ter
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LES GAVARRES
533 Puig d'Arques
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Riudellots de la Selva
Llagostera
Palamós
Platja d'Aro
Santa Cristina d'Aro
el Ridaura
Sant Feliu de Guíxols
Puig de les Cadiretes 519
Tossa de Mar
Lloret de Mar
Blanes
Malgrat de Mar
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Santa Coloma de Farners
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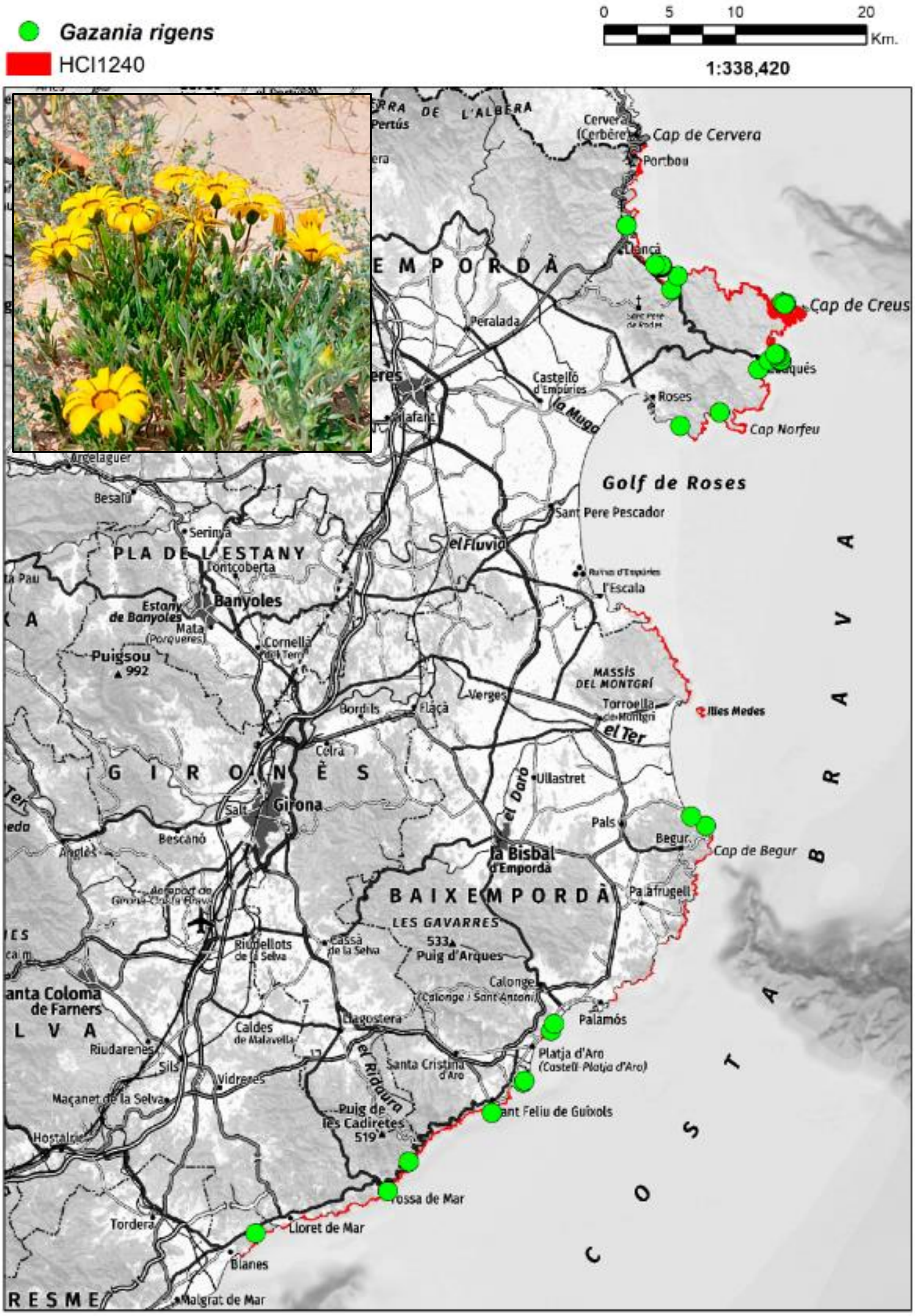
Gazania rigens
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Km.
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Cap de Cervera
Portbou
Llançà
EMPORDÀ
Peralada
Cap de Creus
Castelló d'Empúries
la Muga
Roses
Cap Norfeu
Golf de Roses
Sant Pere Pescador
el Fluvià
PLA DE L'ESTANY
Banyoles
Estany de Banyoles
Puigsou
992
L'Escala
MASSÍS DEL MONTGRÍ
Torroella de Montgrí
Illes Medes
el Ter
Verges
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Flaçà
Celrà
GIRONÈS
Girona
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la Bisbal d'Empordà
Palafrugell
BAIX EMPORDÀ
LES GAVARRES
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Puig d'Arques
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Santa Cristina d'Aro
Sant Feliu de Guíxols
Puig de les Cadiretes
519
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Lloret de Mar
Blanes
Tordera
Malgrat de Mar
Santa Coloma de Farners
Riudarenes
Sils
Vidreres
Maçanet de la Selva
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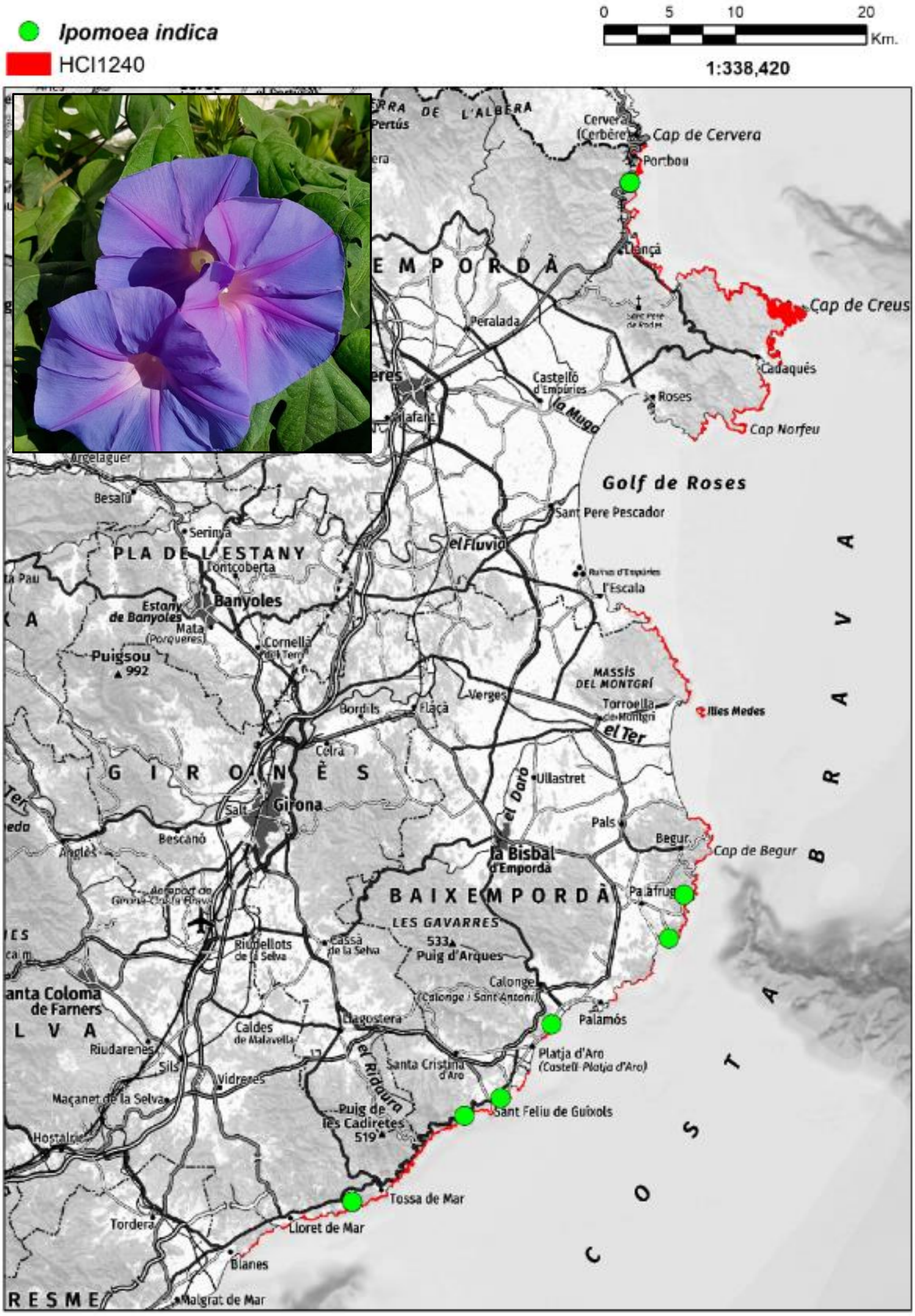

Ipomoea indica
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Km.
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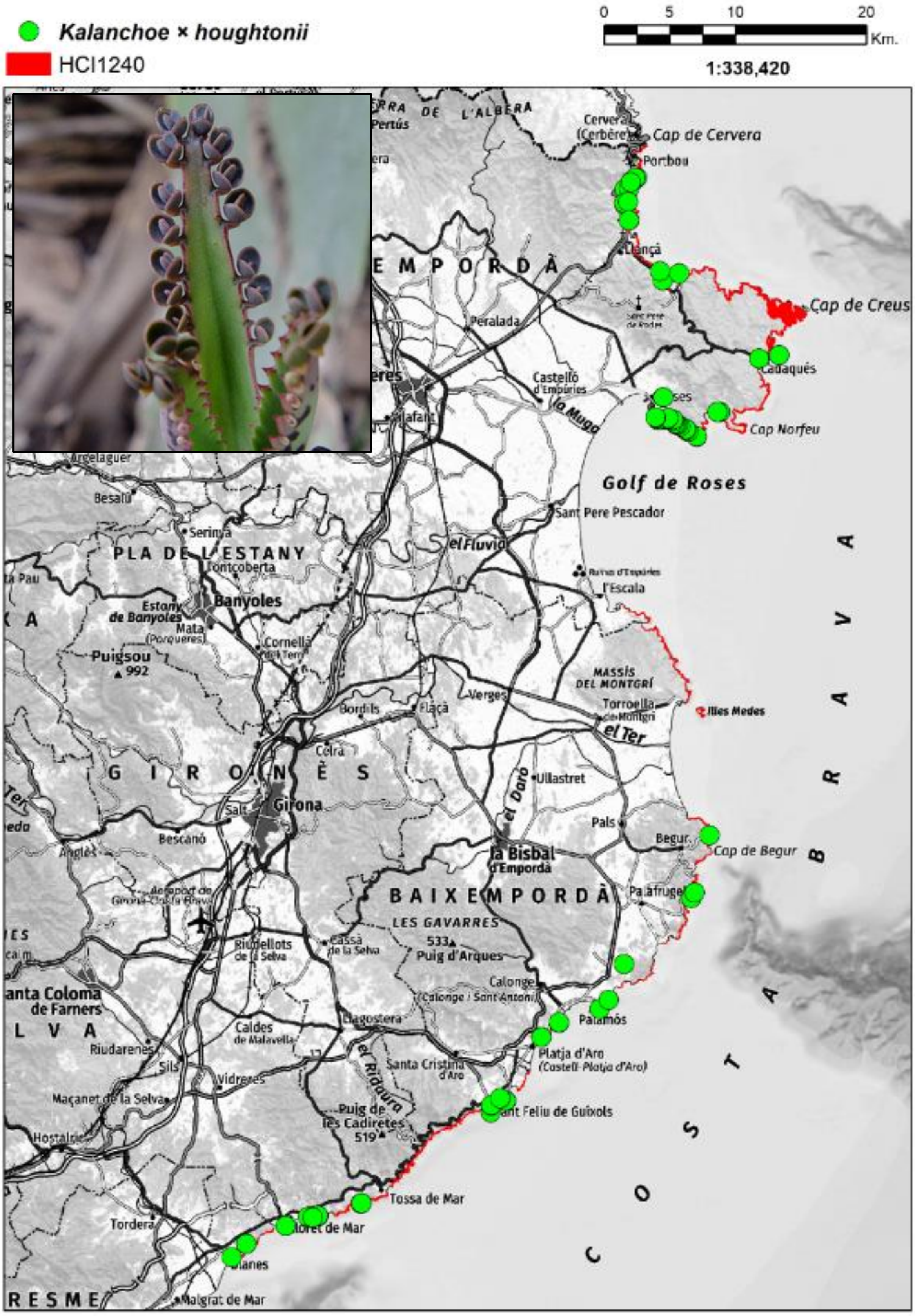
Cap de Cervera
Portbou
Llançà
Cap de Creus
Cadaqués
Roses
Cap Norfeu
Peralada
Castelló d'Empúries
la Muga
Golf de Roses
Sant Pere Pescador
EMPORDÀ
el Fluvià
L'Escala
MASSÍS DEL MONTGRÍ
Torroella de Montgrí
Illes Medes
el Ter
Ullastret
Pals
Begur
Cap de Begur
la Bisbal d'Empordà
BAIX EMPORDÀ
Palafrugell
LES GAVARRES
533 Puig d'Arques
Calonge
Palamós
Platja d'Aro (Castell-Platja d'Aro)
Sant Feliu de Guíxols
Santa Cristina d'Aro
Puig de les Cadiretes 519
Tossa de Mar
Lloret de Mar
Blanes
Malgrat de Mar
Tordera
Hostalric
Maçanet de la Selva
Vidreres
Sils
Riudarenes
Caldes de Malavella
Llagostera
el Ridaura
Cassà de la Selva
Riudellots de la Selva
Santa Coloma de Farners
Girona
Salt
Celrà
Bordils
Flaçà
Verges
GIRONÈS
Bescanó
Anglès
PLA DE L'ESTANY
Banyoles
Estany de Banyoles
Cornellà del Terri
Puigsou 992
Serinyà
Besalú
Argelaguer
COSTA BRAVA


Kalanchoe × houghtonii
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0 5 10 20
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Cap de Cervera
Cerverà (Cerbère)
Portbou
Llançà
E M P O R D À
Peralada
Cap de Creus
Cadaqués
Castelló d'Empúries
la Muga
Cap Norfeu
Golf de Roses
Sant Pere Pescador
el Fluvià
Argelaguer
Besalú
Serinyà
PLA DE L'ESTANY
Fontcoberta
Banyoles
Estany de Banyoles
Mata (Porqueres)
Puigsou 992
Cornellà del Terri
Ruïnes d'Empúries
l'Escala
MASSÍS DEL MONTGRÍ
Torroella de Montgrí
Illes Medes
el Ter
Verges
Bordils
Flaçà
Celrà
G I R O N È S
Girona
Salt
Bescanó
Anglès
Ullastret
el Daró
Pals
Begur
Cap de Begur
la Bisbal d'Empordà
B A I X E M P O R D À
Palafrugell
LES GAVARRES
533 Puig d'Arques
Cassà de la Selva
Riudellots de la Selva
Calonge
Calonge i Sant Antoni
Palamós
Platja d'Aro (Castell-Platja d'Aro)
Llagostera
el Ridaura
Santa Cristina d'Aro
Caldes de Malavella
Santa Coloma de Farners
Riudarenes
Sils
Vidreres
Maçanet de la Selva
Puig de les Cadiretes 519
Hostalric
Tossa de Mar
Tordera
Malgrat de Mar
C O S T A B R A V A


Kalanchoe tubiflora
HCI1240
0 5 10 20
Km.
1:338,420
Cap de Cervera
Portbou
Llançà
EMPORDÀ
Peralada
Cap de Creus
Cadaqués
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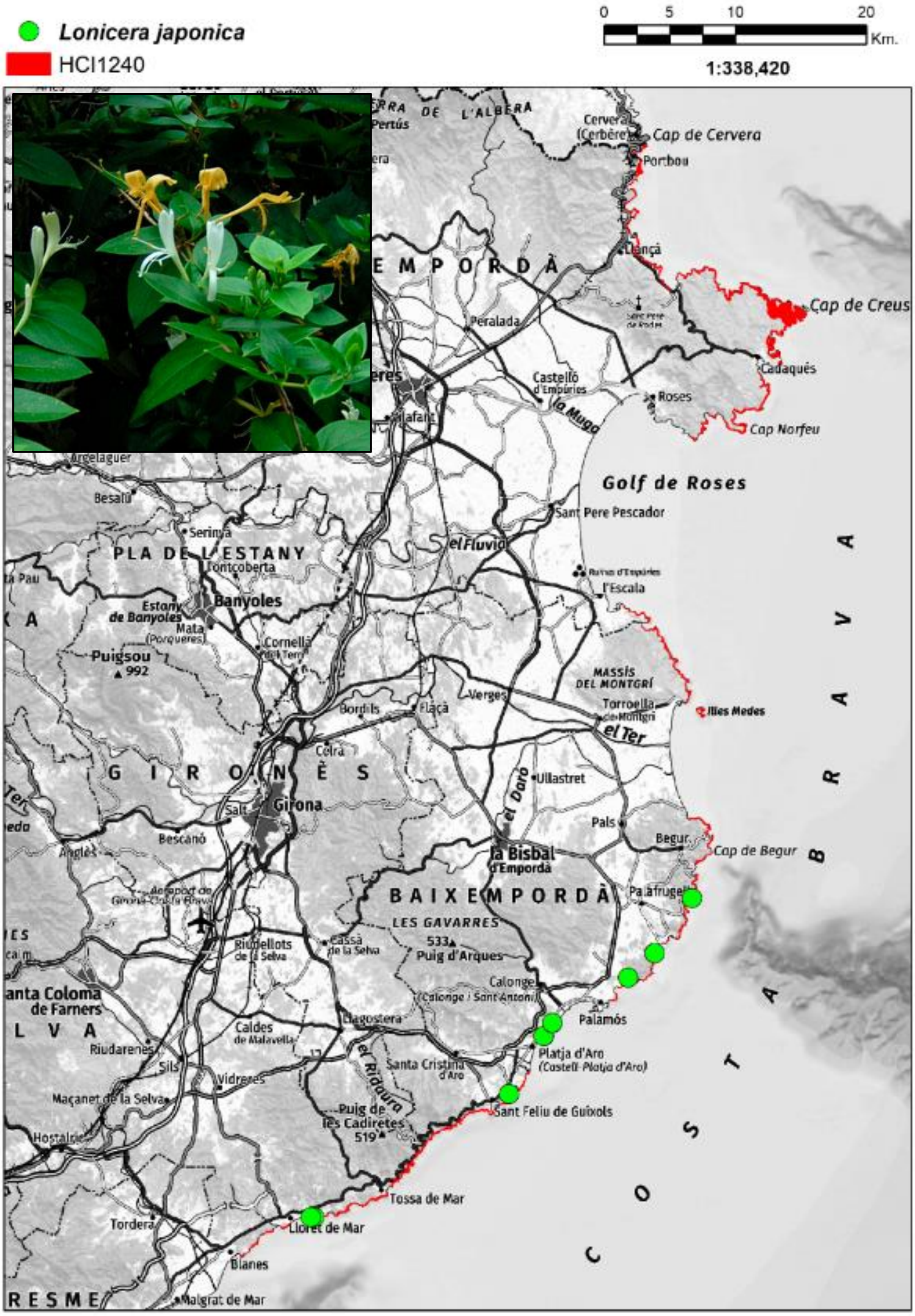
la Muga
Roses
Cap Norfeu
Golf de Roses
Sant Pere Pescador
el Fluvià
PLA DE L'ESTANY
Banyoles
Besalú
Argelaguer
Serinyà
Fontcoberta
Estany de Banyoles
Puigsou 992
Cornellà del Terri
L'Escala
MASSÍS DEL MONTGRÍ
Torroella de Montgrí
Illes Medes
el Ter
Verges
Bordils
Flaçà
Celrà
GIRONÈS
Girona
Salt
Bescanó
Ullastret
el Daró
Pals
Begur
Cap de Begur
la Bisbal d'Empordà
BAIX EMPORDÀ
Palafrugell
LES GAVARRES
533 Puig d'Arques
Cassà de la Selva
Riudellots de la Selva
Calonge
Palamós
Platja d'Aro
Santa Cristina d'Aro
Llagostera
Caldes de Malavella
el Ridaura
Santa Coloma de Farners
Riudarenes
Sils
Vidreres
Maçanet de la Selva
Hostalric
Puig de les Cadiretes 519
Sant Feliu de Guíxols
Tossa de Mar
Lloret de Mar
Blanes
Tordera
Malgrat de Mar
COSTA BRAVA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Cap de Cervera
Portbou
Llançà
Cap de Creus
Cadaqués
Roses
Cap Norfeu
Golf de Roses
Sant Pere Pescador
Peralada
Castelló d'Empúries
la Muga
EMPORDÀ
PLA DE L'ESTANY
Banyoles
el Fluvià
l'Escala
MASSÍS DEL MONTGRÍ
Torroella de Montgrí
Illes Medes
el Ter
Verges
Bordils
Flaçà
Celrà
GIRONÈS
Girona
Salt
Bescanó
Ullastret
el Daró
Pals
Begur
Cap de Begur
la Bisbal d'Empordà
BAIX EMPORDÀ
Palafrugell
LES GAVARRES
Puig d'Arques
Calonge
Palamós
Platja d'Aro
Santa Cristina d'Aro
Sant Feliu de Guíxols
Llagostera
Cassà de la Selva
Caldes de Malavella
Riudarenes
Sils
Vidreres
Maçanet de la Selva
Hostalric
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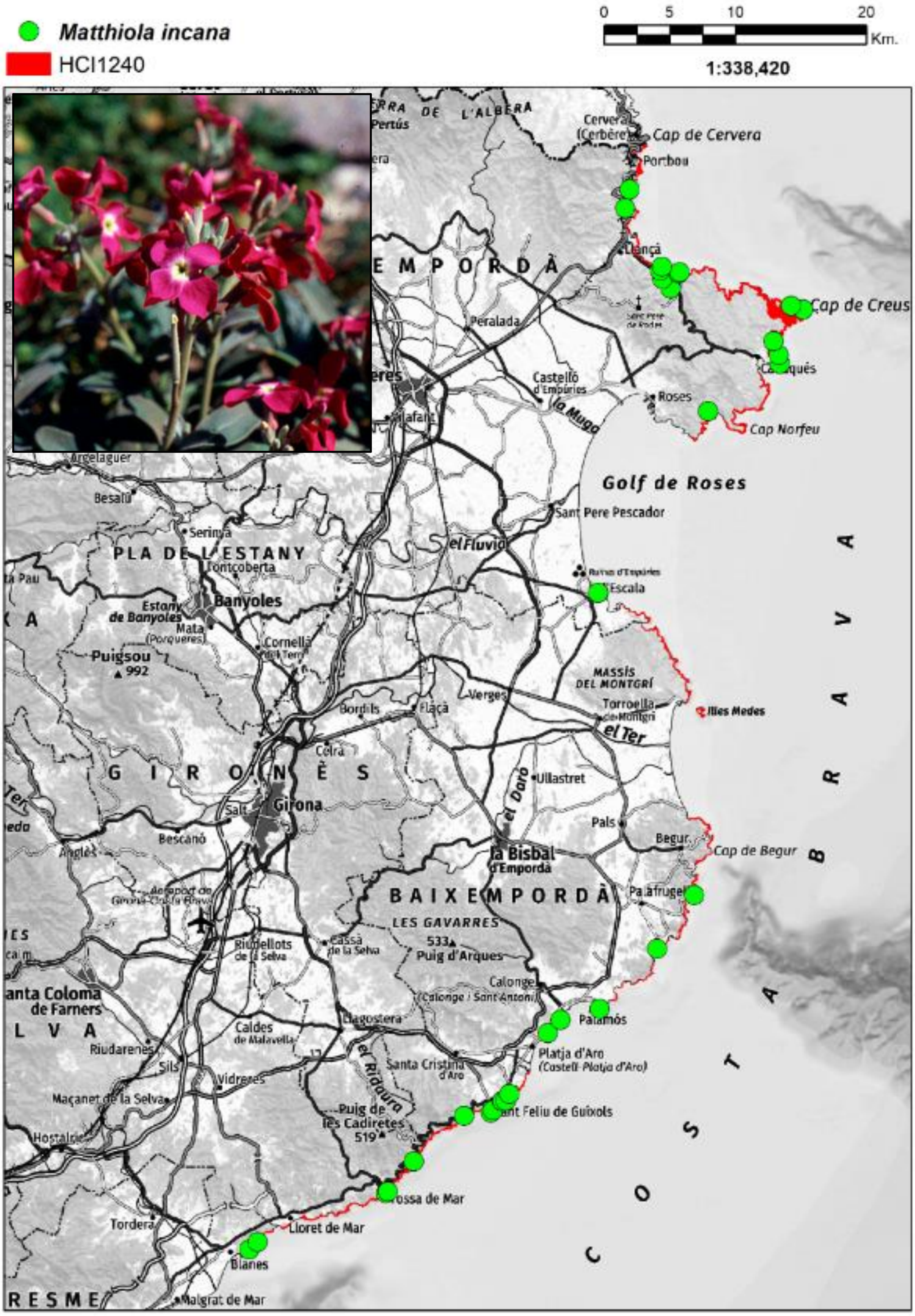
Blanes
Malgrat de Mar
Besalú
Serinyà
Puigsou
992
Santa Coloma de Farners
COSTA BRAVA


Matthiola incana
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Cap de Cervera
Portbou
Llançà
EMPORDÀ
Peralada
Cap de Creus
Castelló d'Empúries
la Muga
Roses
Cap Norfeu
Golf de Roses
Sant Pere Pescador
el Fluvià
PLA DE L'ESTANY
Banyoles
Estany de Banyoles
Puigsou
992
Besalú
Argelaguer
l'Escala
MASSÍS DEL MONTGRÍ
Torroella de Montgrí
Illes Medes
el Ter
Verges
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Flaçà
Celrà
GIRONÈS
Girona
Salt
Bescanó
Anglès
Ullastret
el Daró
Pals
Begur
Cap de Begur
la Bisbal d'Empordà
Palafrugell
BAIX EMPORDÀ
LES GAVARRES
533
Puig d'Arques
Cassà de la Selva
Riudellots de la Selva
Calonge
Palamós
Platja d'Aro
(Castell-Platja d'Aro)
Santa Cristina d'Aro
Llagostera
el Ridaura
Santa Coloma de Farners
Caldes de Malavella
Riudarenes
Sils
Vidreres
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Hostalric
Puig de les Cadiretes
519
Tossa de Mar
Lloret de Mar
Tordera
Blanes
Malgrat de Mar
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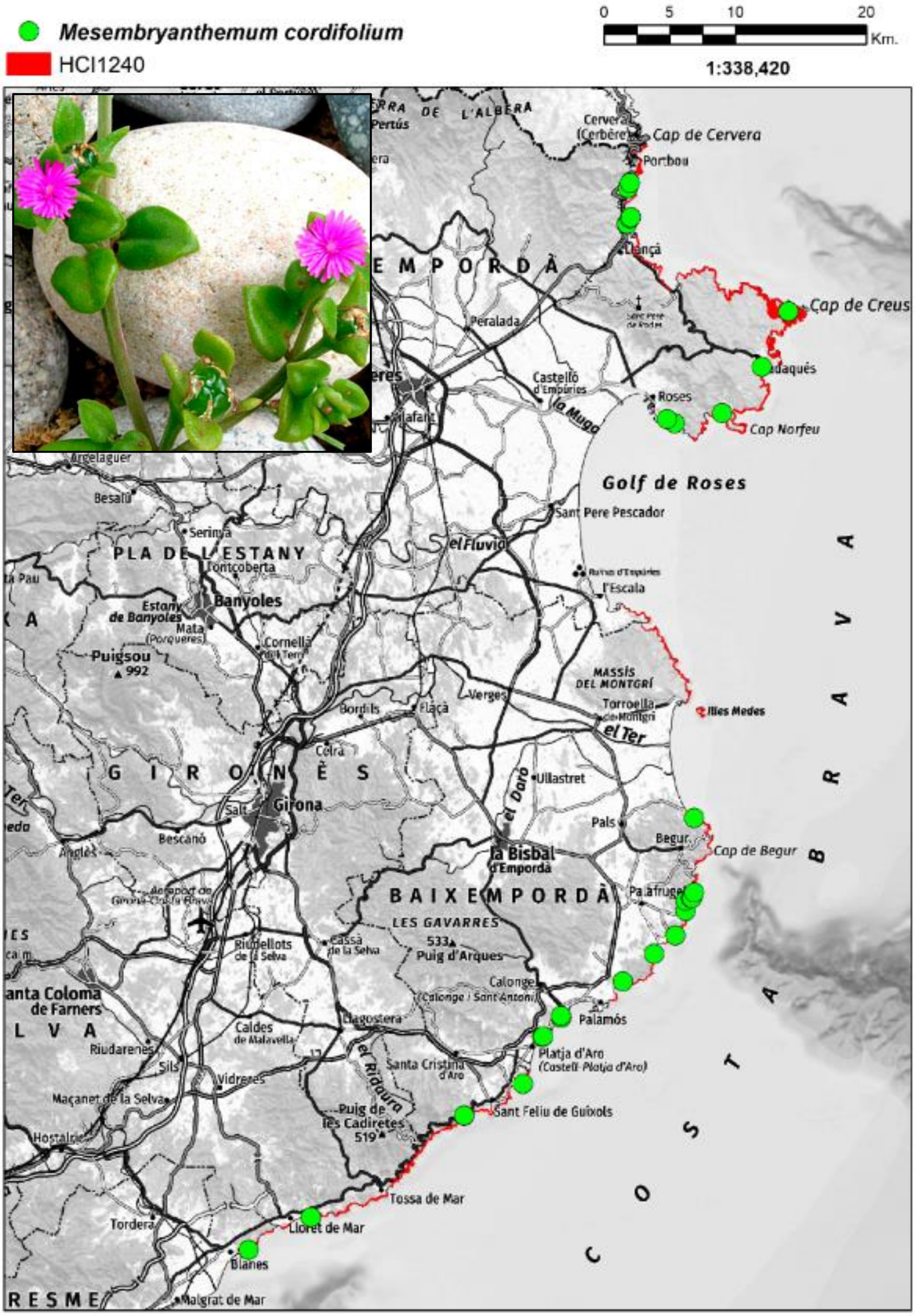
Mesembryanthemum cordifolium
HCI1240
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Km.
1:338,420
Cap de Cervera
Cerverа (Cerbère)
Portbou
Llançà
EMPORDÀ
Peralada
Cap de Creus
Cadaqués
Castelló d'Empúries
la Muga
Roses
Cap Norfeu
Golf de Roses
Sant Pere Pescador
Besalú
Serinyà
PLA DE L'ESTANY
Fontcoberta
Banyoles
Estany de Banyoles
Mata (Porqueres)
Cornellà del Terri
Puigsou
992
el Fluvià
l'Escala
MASSÍS DEL MONTGRÍ
Torroella de Montgrí
Illes Medes
el Ter
Verges
Bordils
Flaçà
Celrà
GIRONÈS
Girona
Salt
Bescanó
Anglès
Ullastret
el Daró
Pals
Begur
Cap de Begur
la Bisbal d'Empordà
BAIX EMPORDÀ
Palafrugell
LES GAVARRES
533
Puig d'Arques
Cassà de la Selva
Riudellots de la Selva
Calonge
Palamós
Platja d'Aro
Santa Cristina d'Aro
Llagostera
Caldes de Malavella
el Ridaura
Santa Coloma de Farners
Riudarenes
Sils
Vidreres
Maçanet de la Selva
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Puig de les Cadiretes
519
Sant Feliu de Guíxols
Tossa de Mar
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Blanes
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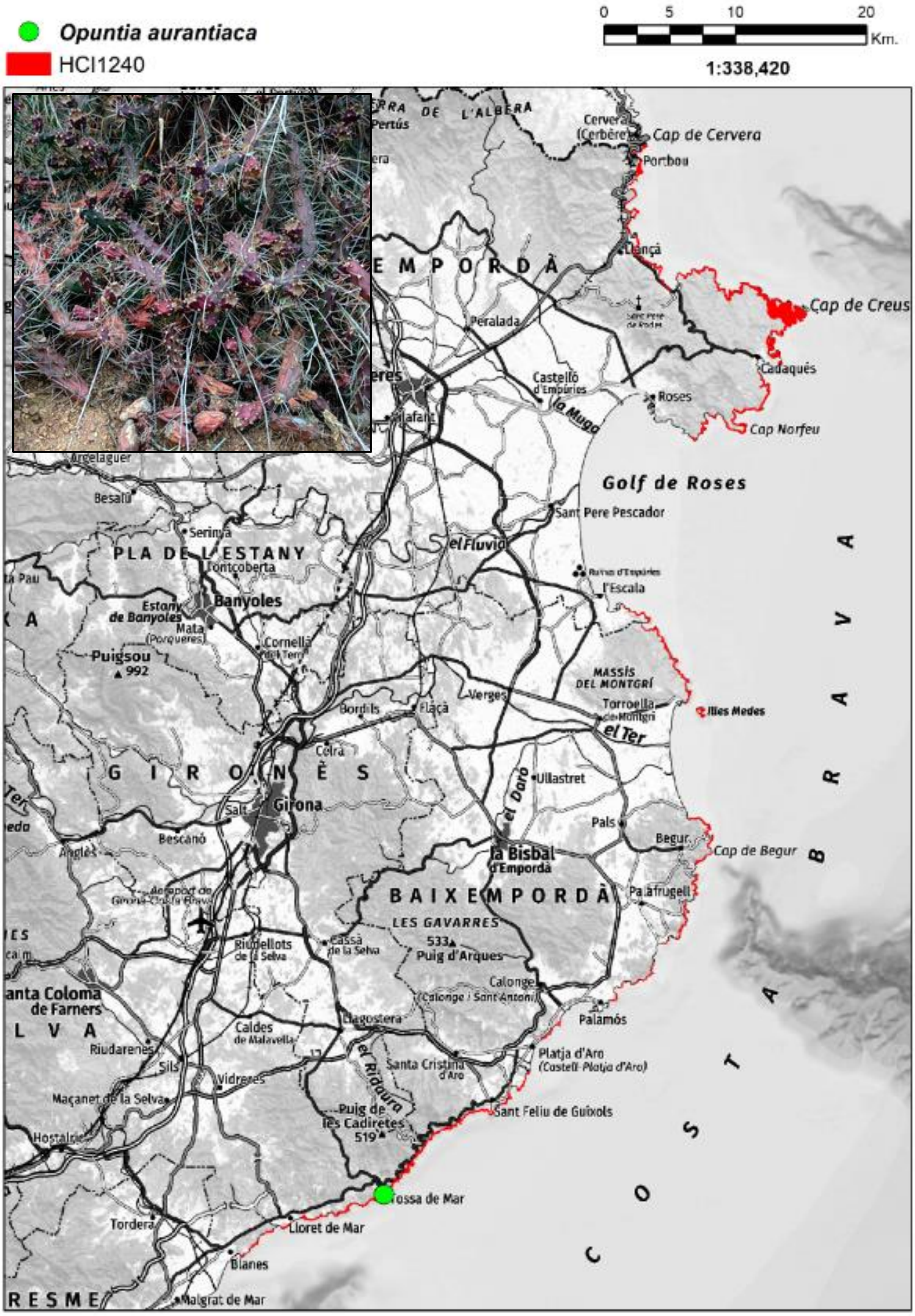
COSTA BRAVA


Opuntia aurantiaca
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Km.
1:338,420
Cap de Cervera
Portbou
Llançà
Cap de Creus
Cadaqués
Roses
Cap Norfeu
Golf de Roses
Sant Pere Pescador
l'Escala
Illes Medes
Torroella de Montgrí
el Ter
el Fluvià
la Muga
Peralada
Castelló d'Empúries
E M P O R D À
PLA DE L'ESTANY
Banyoles
G I R O N È S
Girona
Salt
Celrà
Bordils
Flaçà
Verges
Ullastret
Pals
Begur
Cap de Begur
la Bisbal d'Empordà
Palafrugell
BAIX EMPORDÀ
LES GAVARRES
533 Puig d'Arques
Calonge
Palamós
Platja d'Aro
Sant Feliu de Guíxols
Santa Cristina d'Aro
Llagostera
Cassà de la Selva
Caldes de Malavella
Vidreres
Sils
Riudarenes
Maçanet de la Selva
Santa Coloma de Farners
Hostalric
Tordera
Puig de les Cadiretes 519
Tossa de Mar
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Argelaguer
Serinyà
Puigsou 992
Bescanó
Anglès
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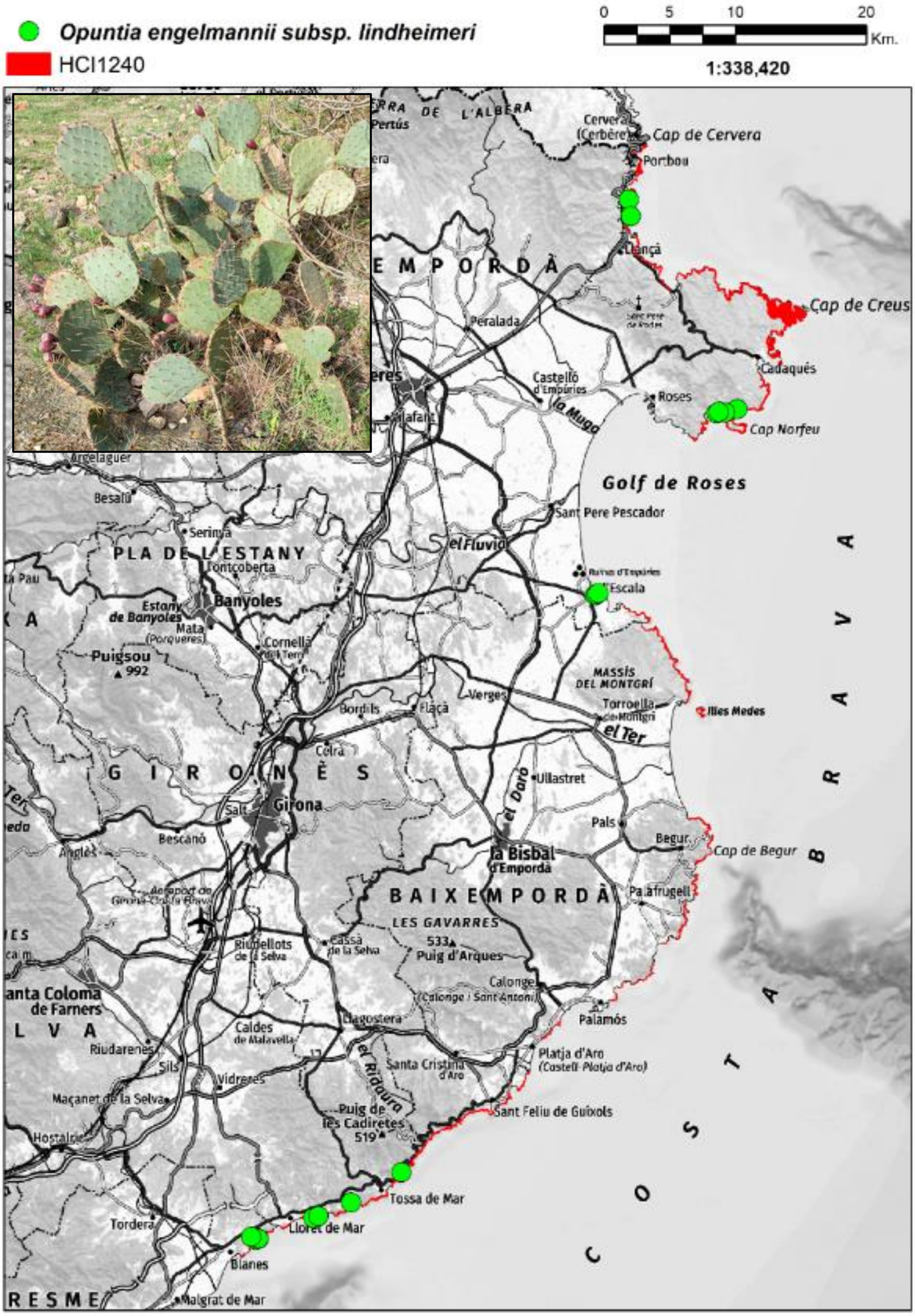
Opuntia engelmannii subsp. lindheimeri
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Cap de Cervera
Portbou
Llançà
EMPORDÀ
Peralada
Cap de Creus
Cadaqués
Castelló d'Empúries
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Cap Norfeu
la Muga
Golf de Roses
Sant Pere Pescador
el Fluvià
L'Escala
Argelaguer
Besalú
Serinyà
PLA DE L'ESTANY
Fontcoberta
Banyoles
Estany de Banyoles
Mata (Porqueres)
Cornellà del Terri
Puigsou 992
MASSÍS DEL MONTGRÍ
Torroella de Montgrí
Illes Medes
el Ter
Verges
Bordils
Flaçà
Celrà
GIRONÈS
Ullastret
el Daró
Girona
Salt
Bescanó
Pals
Begur
Cap de Begur
la Bisbal d'Empordà
Palafrugell
BAIX EMPORDÀ
LES GAVARRES
533 Puig d'Arques
Cassà de la Selva
Riudellots de la Selva
Calonge
Calonge i Sant Antoni
Palamós
Santa Coloma de Farners
Llagostera
Caldes de Malavella
Riudarenes
Sils
Vidreres
Santa Cristina d'Aro
Platja d'Aro (Castell-Platja d'Aro)
Maçanet de la Selva
Hostalric
Puig de les Cadiretes 519
el Ridaura
Sant Feliu de Guíxols
Tossa de Mar
Lloret de Mar
Tordera
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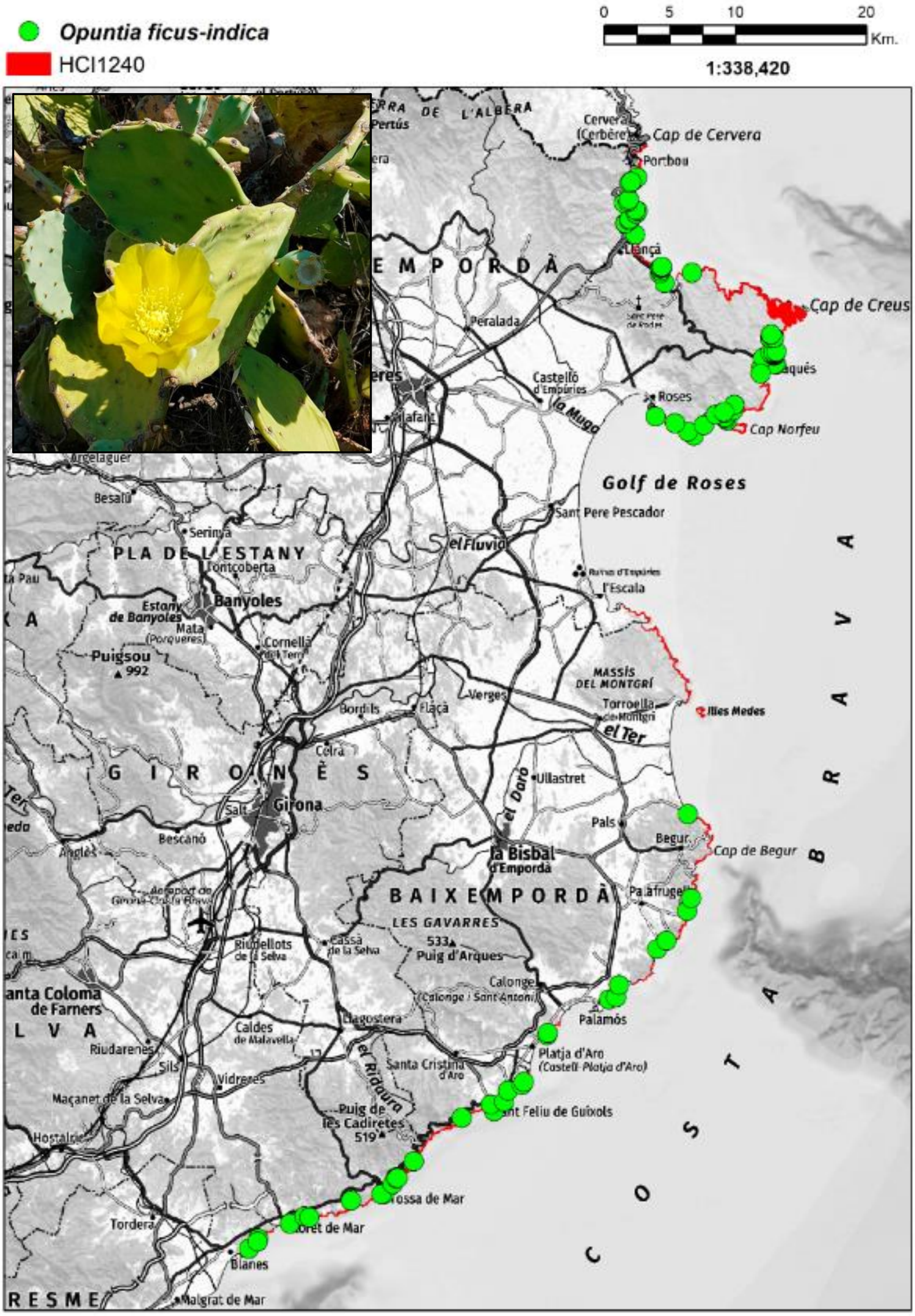
Malgrat de Mar
COSTA BRAVA


Opuntia ficus-indica
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Cap de Cervera
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Llançà
Cap de Creus
Cadaqués
Roses
Cap Norfeu
Golf de Roses
Sant Pere Pescador
EMPORDÀ
Peralada
Castelló d'Empúries
la Muga
el Fluvià
L'Escala
PLA DE L'ESTANY
Banyoles
Estany de Banyoles
Puigsou 992
GIRONÈS
Girona
Salt
Celrà
Verges
Torroella de Montgrí
el Ter
Illes Medes
Massís del Montgrí
Ullastret
el Daró
Pals
Begur
Cap de Begur
la Bisbal d'Empordà
BAIX EMPORDÀ
Palafrugell
LES GAVARRES
533 Puig d'Arques
Calonge
Palamós
Platja d'Aro (Castell-Platja d'Aro)
Sant Feliu de Guíxols
Llagostera
Caldes de Malavella
Santa Cristina d'Aro
Puig de les Cadiretes 519
Tossa de Mar
Lloret de Mar
Blanes
Malgrat de Mar
Tordera
Hostalric
Santa Coloma de Farners
Riudarenes
Sils
Vidreres
Maçanet de la Selva
Cassà de la Selva
Riudellots de la Selva
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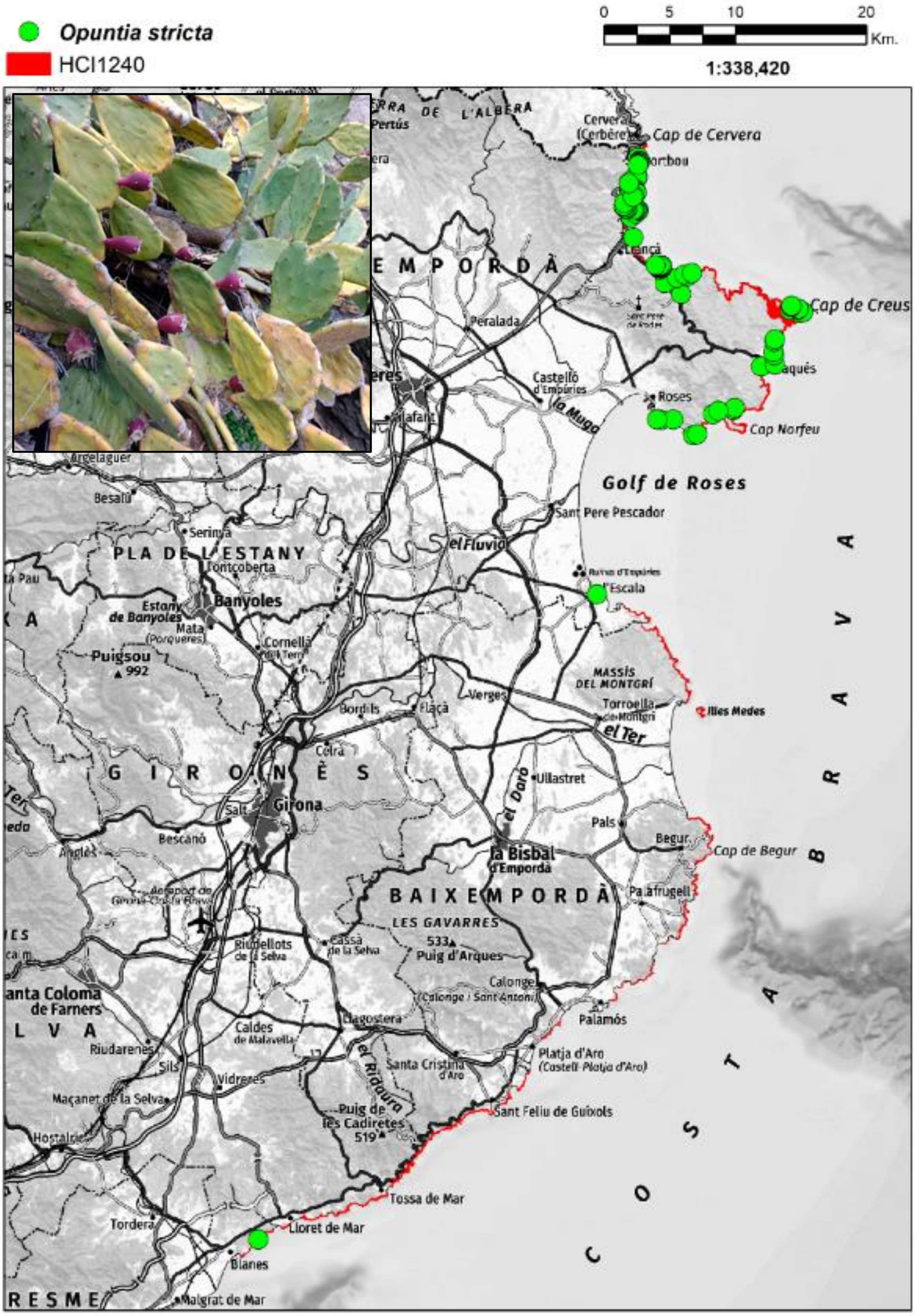
Bordils
Flaçà
COSTA BRAVA


Opuntia stricta
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Cap de Cervera
Cap de Creus
Roses
Cap Norfeu
Golf de Roses
Sant Pere Pescador
L'Escala
Illes Medes
Torroella de Montgrí
Begur
Cap de Begur
Palafrugell
Palamós
Platja d'Aro
Sant Feliu de Guíxols
Tossa de Mar
Lloret de Mar
Blanes
Malgrat de Mar
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GIRONÈS
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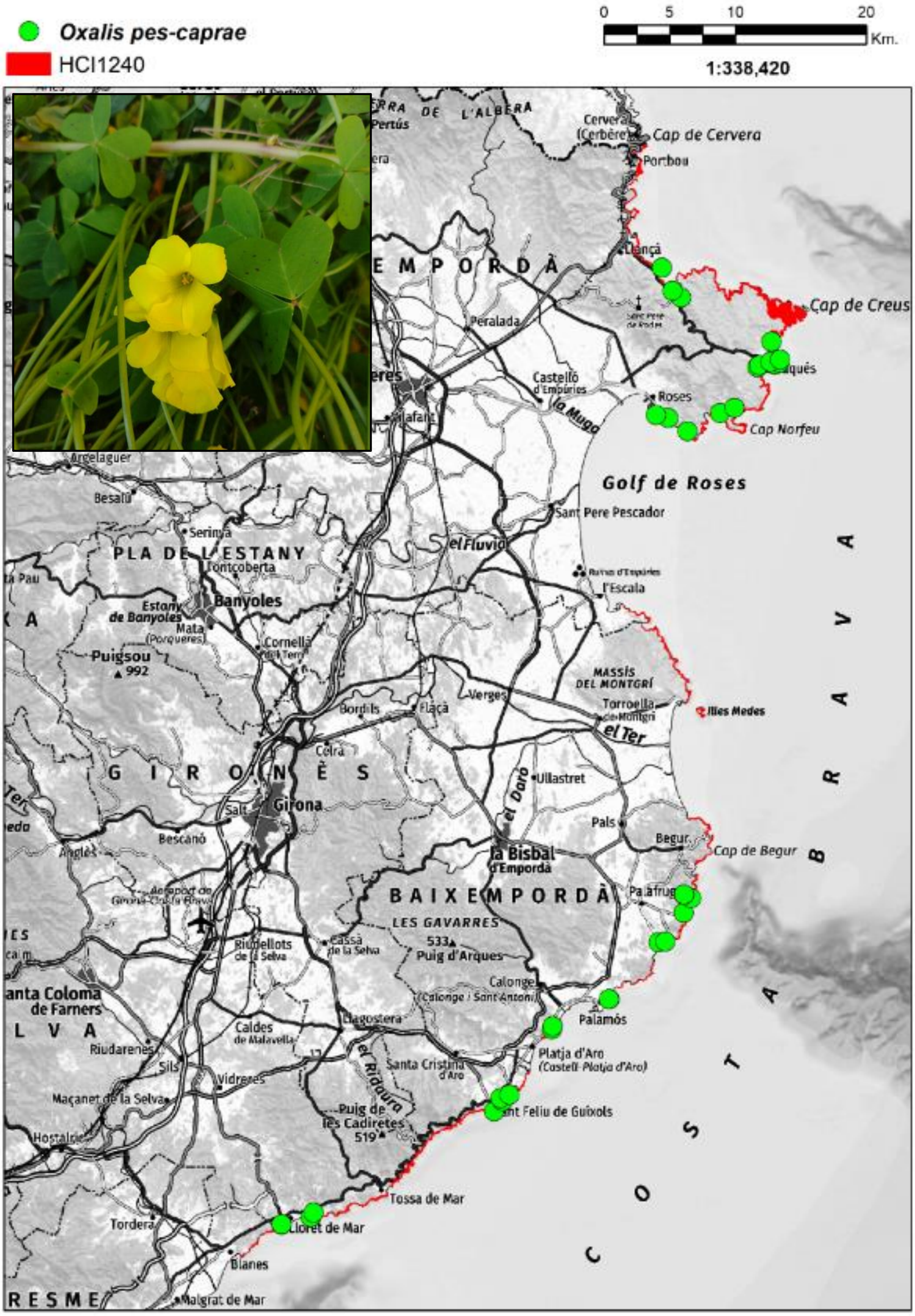
Oxalis pes-caprae
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Cap de Cervera
Portbou
Llançà
EMPORDÀ
Cap de Creus
Peralada
Castelló d'Empúries
Roses
Cap Norfeu
la Muga
Golf de Roses
Sant Pere Pescador
el Fluvià
PLA DE L'ESTANY
Banyoles
Estany de Banyoles
Serinyà
Fontcoberta
Besalú
Argelaguer
Puigsou
992
Cornellà del Terri
Bordils
Flaçà
Verges
l'Escala
MASSÍS DEL MONTGRÍ
Torroella de Montgrí
Illes Medes
el Ter
GIRONÈS
Celrà
Girona
Salt
Bescanó
Anglès
Ullastret
el Daró
la Bisbal d'Empordà
Pals
Begur
Cap de Begur
BAIX EMPORDÀ
Palafrugell
LES GAVARRES
533
Puig d'Arques
Cassà de la Selva
Riudellots de la Selva
Calonge
Calonge i Sant Antoni
Palamós
Platja d'Aro
(Castell-Platja d'Aro)
Llagostera
Caldes de Malavella
Santa Cristina d'Aro
el Ridaura
Sant Feliu de Guíxols
Puig de les Cadiretes
519
Santa Coloma de Farners
Riudarenes
Sils
Vidreres
Maçanet de la Selva
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Tordera
Tossa de Mar
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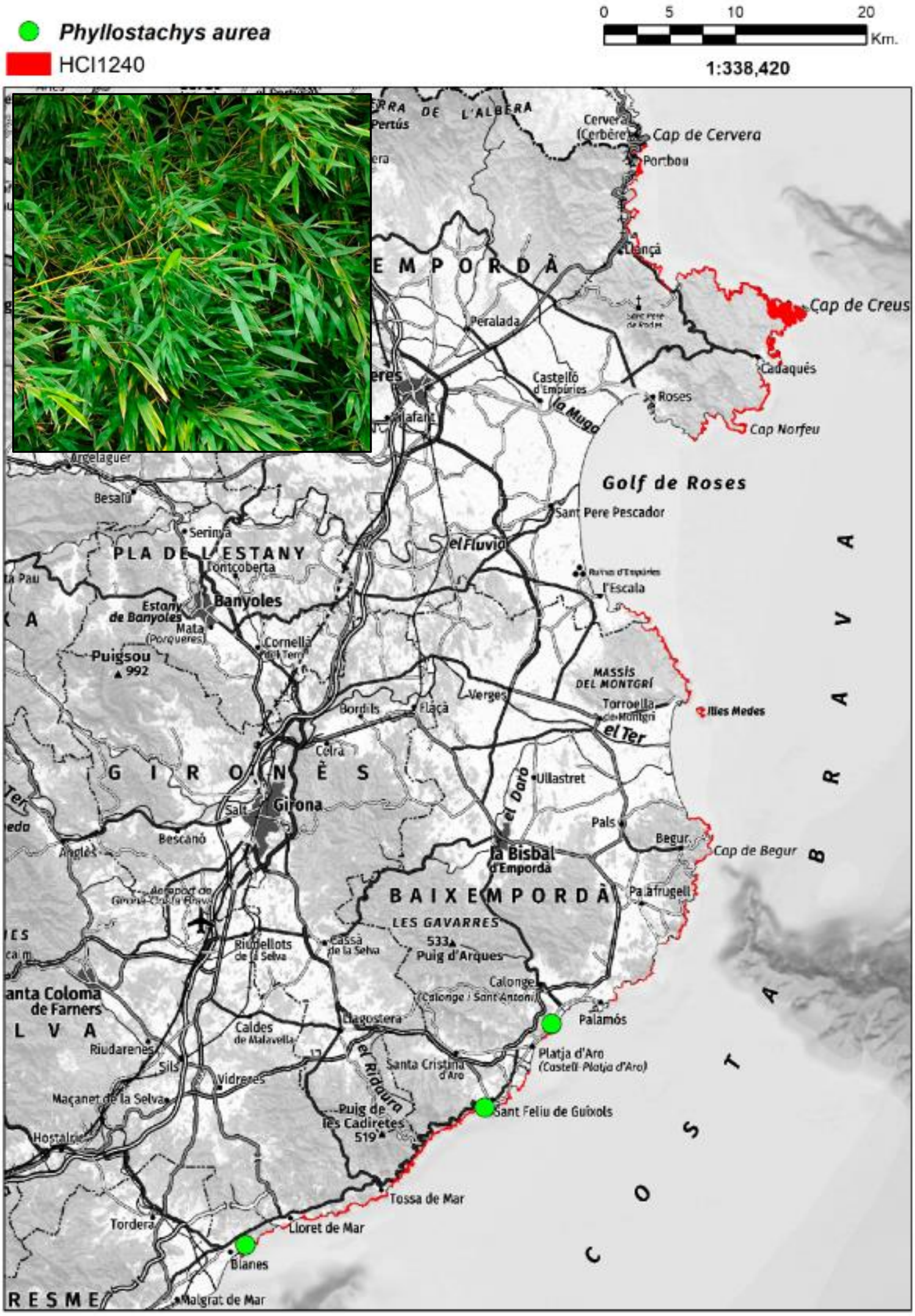
Phyllostachys aurea
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Cap de Cervera
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Cerverà (Cerbère)
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Llançà
Cap de Creus
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Cadaqués
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Roses
la Muga
Cap Norfeu
Golf de Roses
Sant Pere Pescador
el Fluvià
PLA DE L'ESTANY
Besalú
Argelaguer
Serinyà
Fontcoberta
Banyoles
Estany de Banyoles
Mata (Porqueres)
Cornellà del Terri
Puigsou
992
l'Escala
MASSÍS DEL MONTGRÍ
Torroella de Montgrí
Illes Medes
el Ter
Verges
Bordils
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Celrà
GIRONÈS
Girona
Salt
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Anglès
Ullastret
el Daró
Pals
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Cap de Begur
la Bisbal d'Empordà
Palafrugell
BAIX EMPORDÀ
LES GAVARRES
533
Puig d'Arques
Cassà de la Selva
Riudellots de la Selva
Calonge
Calonge i Sant Antoni
Palamós
Platja d'Aro
(Castell-Platja d'Aro)
Llagostera
Caldes de Malavella
el Ridaura
Santa Cristina d'Aro
Sant Feliu de Guíxols
Puig de les Cadiretes
519
Santa Coloma de Farners
Riudarenes
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Tossa de Mar
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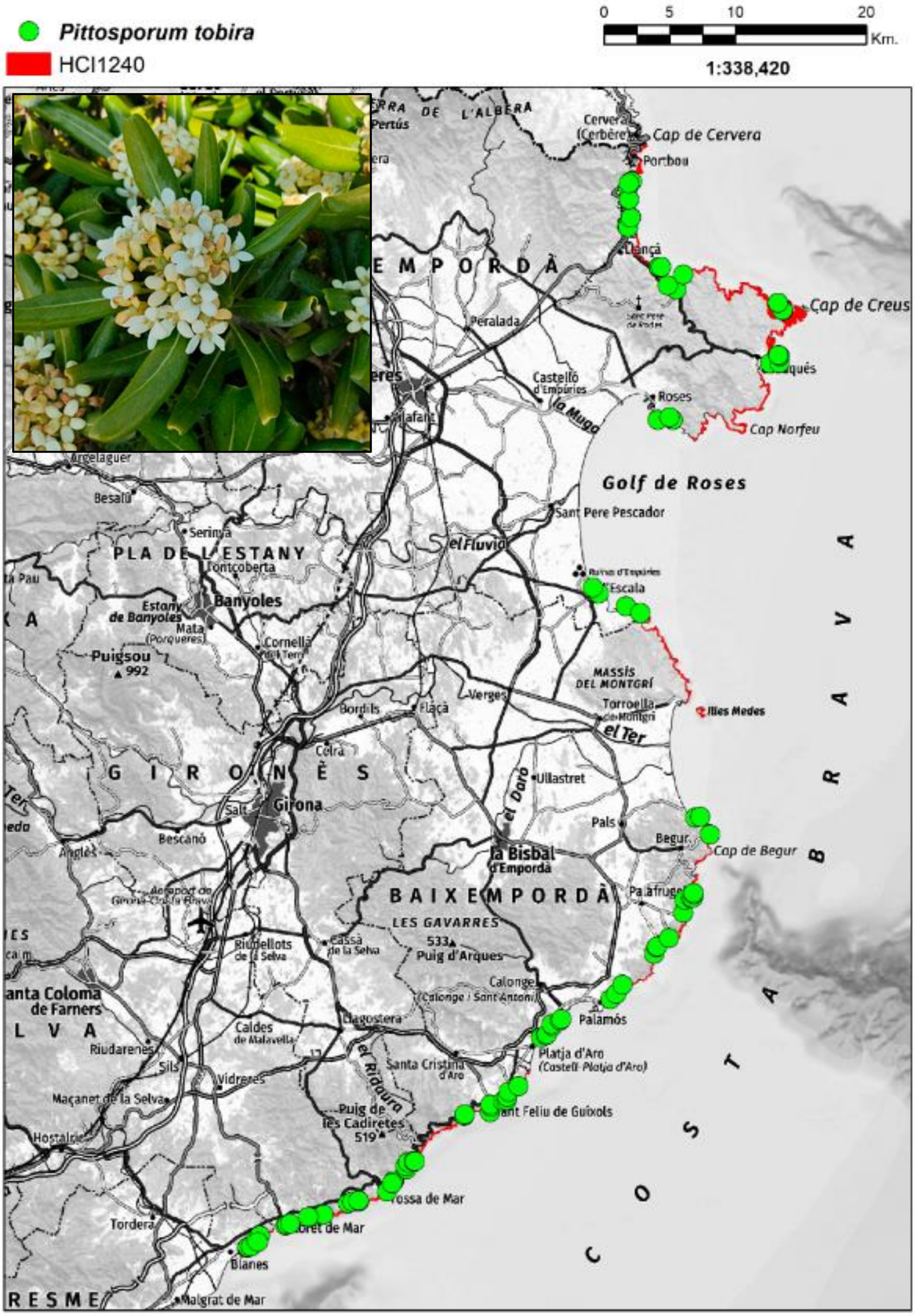
COSTA BRAVA


Pittosporum tobira
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Cap de Cervera
Portbou
Cerverа (Cerbère)
Llançà
EMPORDÀ
Peralada
Cap de Creus
Castelló d'Empúries
Roses
Cap Norfeu
la Muga
Golf de Roses
Sant Pere Pescador
el Fluvià
PLA DE L'ESTANY
Banyoles
L'Escala
MASSÍS DEL MONTGRÍ
Torroella de Montgrí
Illes Medes
el Ter
GIRONÈS
Girona
Ullastret
el Daró
Pals
Begur
Cap de Begur
la Bisbal d'Empordà
BAIX EMPORDÀ
Palafrugell
LES GAVARRES
Puig d'Arques
Calonge
Palamós
Platja d'Aro
Sant Feliu de Guíxols
Tossa de Mar
Lloret de Mar
Blanes
Malgrat de Mar
Santa Coloma de Farners
Besalú
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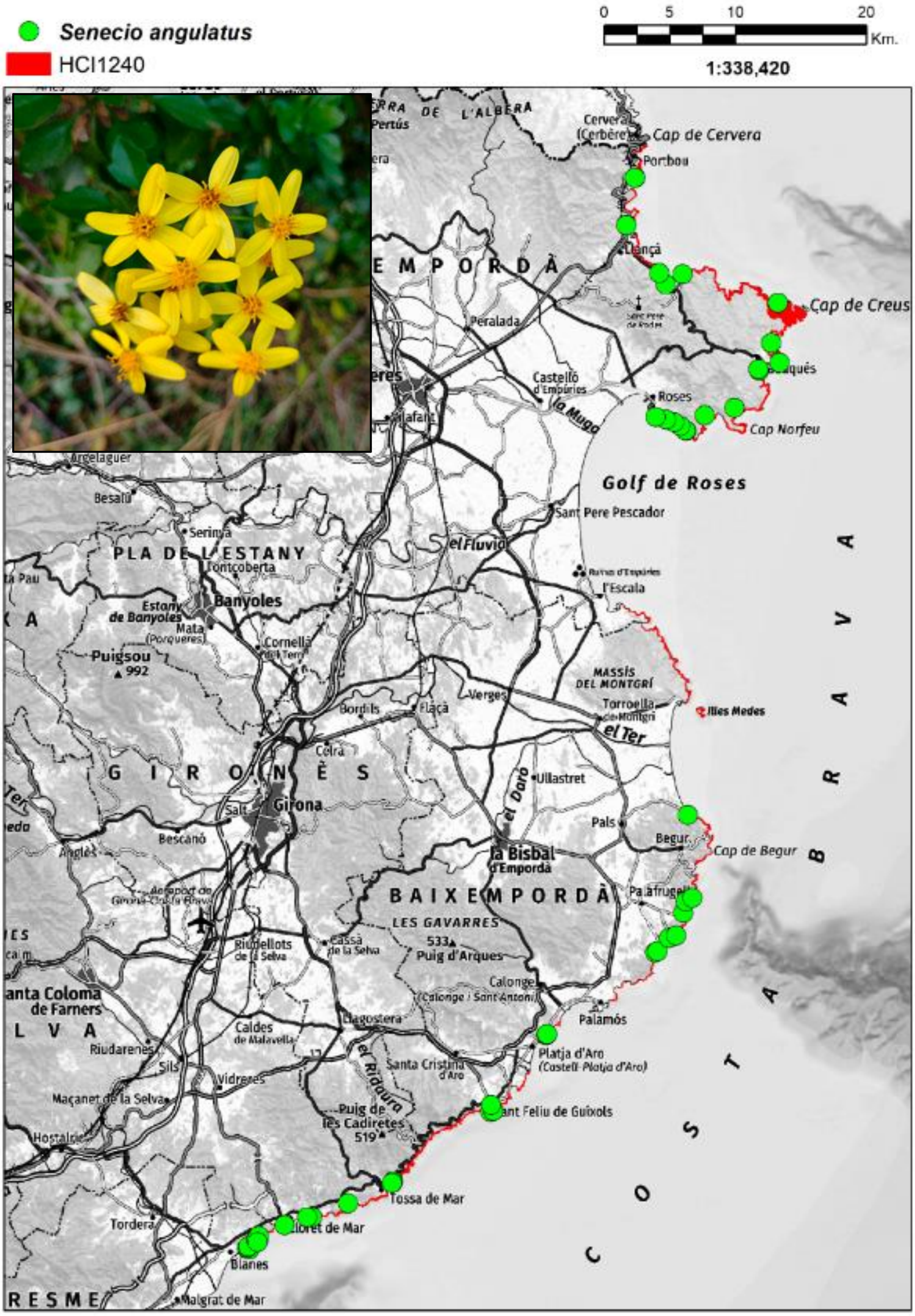
Senecio angulatus
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Km.
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Cap de Cervera
Portbou
Llançà
Cap de Creus
Roses
Cap Norfeu
Golf de Roses
Sant Pere Pescador
L'Escala
Illes Medes
Torroella de Montgrí
Begur
Cap de Begur
Palafrugell
Palamós
Platja d'Aro
Sant Feliu de Guíxols
Tossa de Mar
Lloret de Mar
Blanes
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EMPORDÀ
BAIX EMPORDÀ
GIRONÈS
PLA DE L'ESTANY
Banyoles
Girona
la Bisbal d'Empordà
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Castelló d'Empúries
Figueres
Besalú
Puigsou 992
Ullastret
Pals
Santa Coloma de Farners
Hostalric
Tordera
COSTA BRAVA


Senecio inaequidens
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Km.
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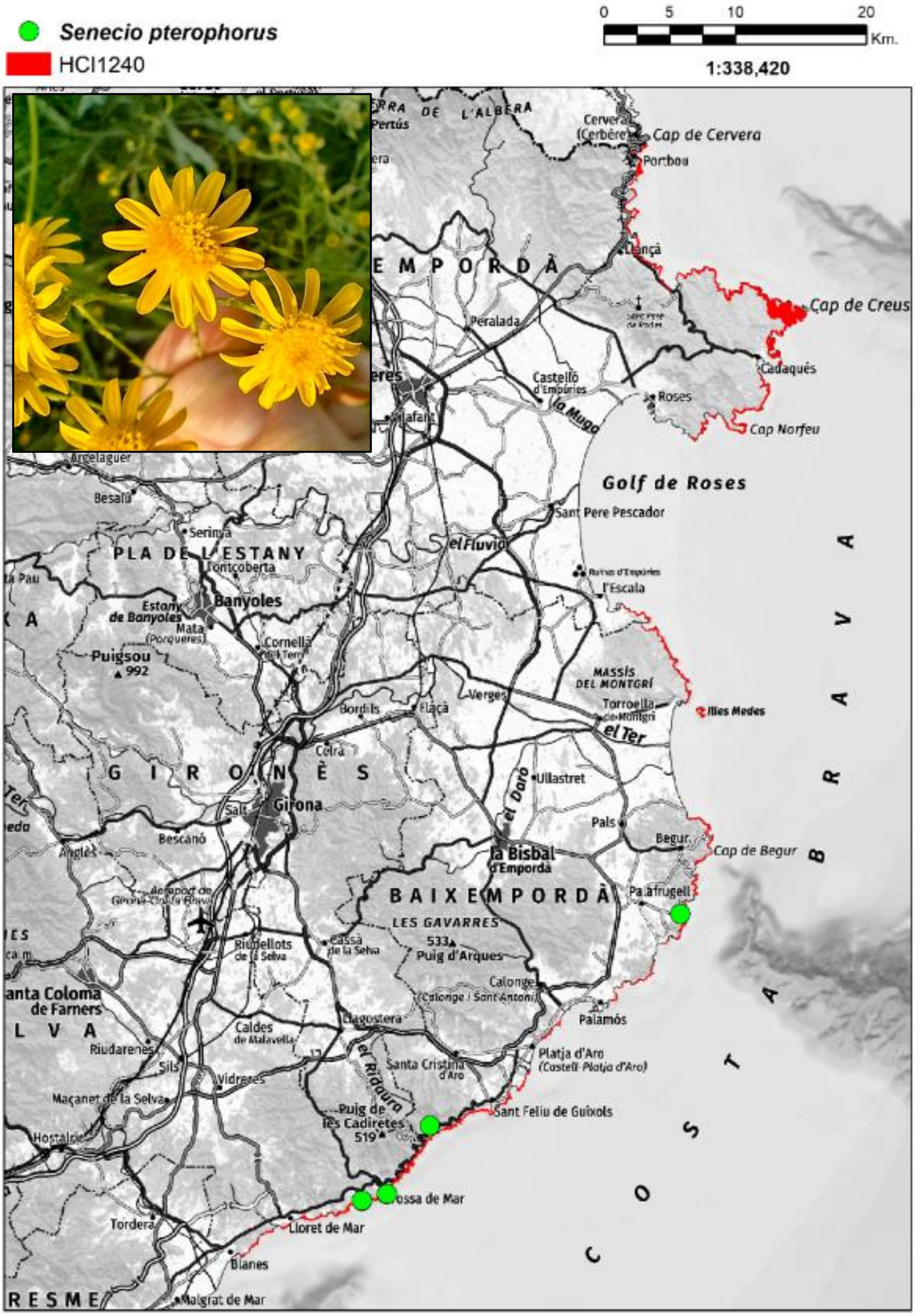
Cap de Cervera
Portbou
Llançà
EMPORDÀ
Cap de Creus
Peralada
Cadaqués
Castelló d'Empúries
Roses
la Muga
Cap Norfeu
Golf de Roses
Sant Pere Pescador
Besalú
Serinyà
PLA DE L'ESTANY
Fontcoberta
Banyoles
Estany de Banyoles
Mata (Porqueres)
Cornellà del Terri
Puigsou
992
el Fluvià
l'Escala
MASSÍS DEL MONTGRÍ
Torroella de Montgrí
Illes Medes
el Ter
Verges
Bordils
Flaçà
Celrà
GIRONÈS
Ullastret
el Daró
Salt
Girona
Bescanó
Anglès
Pals
Begur
Cap de Begur
la Bisbal d'Empordà
Palafrugell
BAIX EMPORDÀ
LES GAVARRES
533
Puig d'Arques
Cassà de la Selva
Riudellots de la Selva
Calonge
Santa Coloma de Farners
Caldes de Malavella
Llagostera
Palamós
Platja d'Aro (Castell-Platja d'Aro)
Riudarenes
Sils
Vidreres
Santa Cristina d'Aro
el Ridaura
Maçanet de la Selva
Puig de les Cadiretes
519
Sant Feliu de Guíxols
Hostalric
Tossa de Mar
Tordera
Lloret de Mar
Blanes
Malgrat de Mar
COSTA BRAVA


Senecio pterophorus
HCI1240
0 5 10 20 Km.
1:338,420
Cap de Cervera
Portbou
Llançà
EMPORDÀ
Peralada
Cap de Creus
Cadaqués
Castelló d'Empúries
Roses
la Muga
Cap Norfeu
Golf de Roses
Sant Pere Pescador
el Fluvià
Besalú
Serinyà
PLA DE L'ESTANY
Fontcoberta
Banyoles
Estany de Banyoles
Cornellà del Terri
Puigsou
992
L'Escala
MASSÍS DEL MONTGRÍ
Torroella de Montgrí
Illes Medes
el Ter
Verges
Bordils
Flaçà
Celrà
GIRONÈS
Girona
Salt
Bescanó
Ullastret
el Daró
Pals
Begur
Cap de Begur
la Bisbal d'Empordà
Palafrugell
BAIX EMPORDÀ
LES GAVARRES
533
Puig d'Arques
Calonge
Palamós
Platja d'Aro (Castell-Platja d'Aro)
Sant Feliu de Guíxols
Santa Cristina d'Aro
Llagostera
Caldes de Malavella
Riudellots de la Selva
Cassà de la Selva
Santa Coloma de Farners
Riudarenes
Sils
Vidreres
Maçanet de la Selva
Hostalric
Puig de les Cadiretes
519
el Ridaura
Tossa de Mar
Lloret de Mar
Blanes
Tordera
Malgrat de Mar
Argelaguer
COSTA BRAVA