

**LIFE22-NAT-ES-LIFE Phoenix****LIFE Phoenix  
Restoration and improvement of Priority Habitat 9370\*  
“Palm groves of *Phoenix*”**

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**Deliverable D2.2****Palm Grove Management Plan in Crete**

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# *Palm Grove Management Plan: Crete, Greece*



Restoration and improvement of Priority Habitat 9370\*  
“Palm groves of *Phoenix*”

**LIFE PHOENIX** / LIFE22-NAT-ES-LIFE Phoenix

*Compiled by: UoC - NHMC, HSPN and HOMEOTECH*

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This Management Plan is conceived as a living document for the duration of the LIFE Phoenix project, so it is intended to be regularly updated in line with an adaptive management approach.

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## 1. INTRODUCTION

Endemic palm groves of the genus *Phoenix* create an important natural and semi-natural ecosystems in Europe, with an outstanding ecological and socio-economical value that are only present in Spain (with *Phoenix canariensis* in the Canary Islands) and Greece (with *P. theophrasti* in Crete). Their uniqueness justifies the inclusion in Annex I of the EU Directive 92/43 and the designation as Priority Habitat 9370\* “Palm groves of *Phoenix*”, with a total of only 53 Natura 2000 sites designated for its conservation at the EU level.

Both species, and the habitat they configure, face similar conservation problems in both regions. The main shared threats are related to climate change effects, pests and invasive plant species. Other important issues are more directly linked to human activities, with different level of importance depending on the region: in Gran Canaria, hybridization with *P. dactylifera* due to past bad practices; in Crete, overgrazing and tourist visitor pressure, while hybridization and pests are mainly considered through a precautionary approach.

*Phoenix theophrasti* is a rare endemic palm species confined in the South Aegean Archipelago and in the Datça peninsula. The biggest and most important stands of the palm are found on Crete Island which can grow on sandy beaches and estuaries and although the palm is used as an ornamental tree on the Island, it should be emphasized that the natural groves represent the most important genetic reservoir of the species. Thus, any improvement in the management of Priority Habitat 9370\* is necessary and will contribute to the conservation of the species.

The overall aim of LIFE *Phoenix* is to improve the conservation status of Priority Habitat 9370\* on the islands of Gran Canaria and Crete by tackling their most important risks and threats. In this sense, this Palm Grove Management Plan represents the main document synthesizing the guidelines to implement a comprehensive conservation strategy for Priority Habitat 9370\* in Crete.

## 2. BACKGROUND

The Cretan palm *Phoenix theophrasti* is distributed scarcely across the Island of Crete and it grows on sandy beaches, along small rivers and estuaries in thermophilous areas of Crete. The natural populations of the species consist of a few individuals up to a few dozen, while the largest population throughout its range of distribution constitutes a few hundred individuals. It is believed that in some areas, the palms have suffered a degree of fragmentation due to expansion of agriculture and grazing. Currently, the main issues the species face are tourist visitors pressure and drought mainly driven by climate change. Moreover, for the biggest population located at the Vai beach on the eastern side of Crete an additional threat is the infection of the red weevil (*Rynchophorus ferrugineus*).

On Crete, six sites of the Habitat 9370\* have been selected for the LIFE *Phoenix* project which cover a total estimated surface of 27.26 ha. These areas are scattered in six different Natura 2000

sites and include 100% of the total surface in Greece under EU protection for Priority Habitat 9370\* (27.26 ha). Regardless of the protection Natura 2000 areas provide, this priority habitat still faces the following threats, which are considered as the most important to be addressed:

**a) Overgrazing:** Unregulated and poorly managed livestock grazing in Crete has caused significant damage to the palm groves of *Phoenix theophrasti* and other associated endemic plant species, necessitating the establishment of a monitoring system. Currently, the majority of these populations face the threat of severe degradation. While grazing on palms is considered a natural occurrence to some extent, in certain sites, including Chrysoskalitisa, Martsalo, and Ag. Nikitas have suffered damage not only to palm suckers but also to the bark. In some areas, no juvenile palms have been observed, likely due to grazing pressures. Grazing intensity on individual palms in the most affected areas ranges from 43% in Souda Plakias to complete destruction (100%) in Chrysoskalitisa, Drapano, Martsalo, Preveli, and Ag. Nikitas. Protective measures, such as fencing, have been implemented in key locations like Agios Nikitas and Vai. However, additional fencing is needed in sites such as Chrysoskalitisa, Plakias, Preveli, and Martsalo, while repairs are required in Agios Nikitas, and expansions are necessary in Vai.

**b) Visitors pressure:** Tourism poses a significant threat to the palm groves, particularly in the two most prominent areas, Vai and Preveli, which attract over 100,000 visitors annually, including the surrounding areas. In Preveli, free campers often reside in the forest for months, setting up tents and shelters. In contrast, Chrysoskalitisa, Ag. Nikitas and Martsalos experience much lower visitor numbers, due to remoteness of these areas, although no precise information on number of visitors exist. None of these sites have a visitor management plan, leaving them vulnerable to the impacts of unregulated and expanding tourism. These pressures include soil compaction, littering and an increased risk of fire. Additionally, poorly planned tourism infrastructure development and a general lack of awareness about the importance, legal protection, and challenges faced by these endemic palm groves exacerbate the threat posed by tourism.

**b) Pests and invasive alien species (IAS):** The *Rhynchophorus ferrugineus* beetle has caused widespread damage to palm trees across Europe and is particularly harmful due to the difficulty of detecting infestations in their early stages. First recorded in Crete in 2005, this pest has since spread almost throughout the island. In areas where *P. theophrasti* coexists with *P. canariensis*, such as Vai, the beetle's preference for *P. canariensis* does not eliminate the risk of it also infecting and damaging *P. theophrasti*; indeed, in August 2023 the first infection of *R. ferrugineus* was found on two palms of the endemic species of *Phoenix theophrasti* in the parking area of Vai palm forest, Sitia. A major threat and persisting problem is the existence of a plant nursery in close proximity with the Vai forest, where it acts as a stepping stone for the red weevil.

Additionally, competition for water and nutrients between *P. theophrasti* and the native species *Nerium oleander*, but also between the non-native species like *Eucalyptus* spp. could disrupt the ecological balance of Crete's palm forests. Poor management practices have increased threats such as fungal infections caused by *Graphiola phoenicis*, which have become prevalent in the Vai region. These conditions have also contributed to the spread of the native *Nerium oleander*. Surveys over the past decade have revealed that fungal infections, particularly *Graphiola phoenicis*, have affected the majority of palms in all key areas, including Vai, Preveli, Ag. Nikitas,

Souda Plakias, and Chrysoskalitisa. Additional unidentified fungal infections have been reported in Vai and Chrysoskalitisa but are less widespread. Furthermore, after the 2010 wildfire in Preveli, the invasive weed *Oxalis pes-caprae* proliferated, taking advantage of the loss of native understory plants.

**c) Climate change:** A serious problem in Crete is the occurrence of intended fires as a grazing method and the wildfires. Concerning palm stands, the biggest wildfire event happened in August 2010, which burned almost the entirety of the *P. theophrasti* trees in Preveli stand. Regulations and fire prevention plans developed by the regional authorities, although these plans have not been activated. There were two more, smaller wildfire incidents in the same area (2019 and 2021) and another one in Chrysoskalitissa in 2007 with two burned palm trees, which demonstrate the urgency for wildfire prevention and conservation measurements to be undertaken. Another alarming effect of climate change that indirectly can affect palm groves, is the drop of groundwater availability and repeated, more frequent and longer droughts as a result of reduced rainfall. Additionally, in recent years, rainfall phenomena are much more dramatic, with large amounts of water arriving in a short period of time, resulting in landslides and soil drift. On Crete, the distribution of rainfall decreases from north-western to south-eastern part leading to water stress, poor soil quality and soil loss. These factors might threaten the health of palm trees with delayed flowering time and germination, less growth of new palms, changes in phenology and a probable increase in pest infections as well as an increase of invasive alien species.

**d) Hybridization:** Hybridization among species of the genus *Phoenix* is a well-documented phenomenon. Previous research has identified *Phoenix theophrasti* and *P. dactylifera* as closely related species capable of interbreeding, with one reference of purposeful hybridization between those two species in Chrysoskalitissa monastery in Chania. Although hybridization is not considered a significant concern for most populations of *P. theophrasti*, due to their isolation in remote areas, it poses a more substantial threat to the large population in the Vai palm forest in eastern Crete. This is due to the proximity of a commercial plantation of *Phoenix* species next to the protected forest. As for the smaller populations in Ag. Nikitas and Martsalo, located along the southern coast of the Heraklion prefecture, are situated in highly remote areas, making the possibility of hybridization very low. However, the lack of information can be an added problem since hotels/gardens continue to plant *Phoenix* species other than *P. theophrasti*, thus posing a risk to the genetic purity of the native populations.

### 3. DESCRIPTION OF THE PROJECT SITES

In Greece, Habitat 9370\* is present only in Crete where it usually can be found in ravines, small streams and estuaries in alluvial and sandy soils, in thermophilus areas in Crete. The Habitat is represented by the presence of thermophilus plant elements, such as *Arisarum vulgare*, *Aristolochia cretica*, *Arum ssp.*, *Ceratonia siliqua*, *Olea europaea*, *Pistacia lentiscus*, *Dracunculus vulgaris*, *Juncus ssp.*, *Nerium oleander* etc. but the habitat is mostly characterized by the presence of the endemic *Phoenix theophrasti* where it can grow into almost monospecific formations especially in Vai on the eastern part of the island. In other palm groves like in Souda Plakias, the trees grow alongside a small permanent stream where they co-exist with cultivations and livestock pens. The competition for water availability increases water stress for palm trees, therefore they can be more prone to insect infestations.

#### 3.1 SAC GR4320006: “VAI” [VOREIOANATOLIKO AKRO KRITIS: DIONYSADES, ELASA KAI CHERSONISOS SIDERO (AKRA MAVRO MOURI – VAI – AKRA PLAKAS) KAI THALASSIA ZONI]

The habitat 9370\*, located in Vai on the eastern coast of the Lassithi Prefecture, extends in an area of 19.08 hectares, making it the largest and most prominent, natural forest of *Phoenix theophrasti* (Cretan date palm) in Europe (Fig.1). The geological substrate comprises alluvium and phyllite-quartzite, with sandy clay loam soil. The site has a flat topography and a north-facing aspect. The palm forest is interspersed with vegetation such as *Cistus creticus*, *Thymbra capitata*, *Sarcopoterium spinosum*, *Pistacia lentiscus*, *Nerium oleander* and *Arundo donax*. Approximately 5,000 palms, a mix of mature and juvenile, male and female trees, are distributed throughout the site, the majority of them in good health. Most trees are less than 10 meters tall, with an average trunk diameter of 0.5 meters and a median of six trunks per tree.

The forest area, wholly owned by the Monastery of Toplou, includes adjacent lands that were previously reforested with *P. theophrasti* by the local forestry department. Under the LIFE Phoenix project, two additional areas are designated for planting *P. theophrasti*, and these, alongside the previously reforested area, will be fenced as part of the project. Currently, the targeted habitat covers 75.73% of the total area, the previously reforested area accounts for 13.64%, and the areas slated for reforestation constitute 10.63%. Historically, grazing was extensive within the palm forest until the 1970s but ceased following fencing and management by the forestry authority. Outside the protected habitat, other monastic lands are leased for activities such as livestock grazing. Neighboring land uses include small-scale farming, greenhouse and nursery development, fisheries, and tourism.

Threats to the habitat include recreational activities, tourist infrastructure near the forest and coastline, illegal hunting, overgrazing, agricultural intensification, and localized desertification. The palm forest of Vai is designated as an aesthetic forest under Government Gazette 979/1985 and protected under the Barcelona Convention, a Presidential Decree on small island wetlands (Government Gazette AAP 229/19.06.2012), and as a Landscape of Special Natural Beauty

(Government Gazette 534/B/1983). Managed by the local Forestry Department, the area was fenced in 1982, and operating regulations have been enforced since. Conservation measures implemented to mitigate pressures include addressing threats from tourism, fungal infections, red palm weevil infestations, hydrological alterations, and hybridization. Although a management plan for the entire Natura 2000 site was drafted in 1998 under LIFE B4-3200/95/851, it has not been institutionalized or implemented to date.

Plant species included in the Annex II of the Directive 92/43/EEC:

- *Crepis pusilla*: Annex II Habitats Directive, priority species, Rare.
- *Silene holzmannii*: Annex II Habitats Directive, priority species, Rare
- *Lygeum spartum*: peculiar grass, the only European member of its tribe. One of the very rare grasses in Greece.

Other protected plant species present in the SAC:

- *Anthemis filicaulis*: Endemic of Eastern Crete, in the Presidential Decree 67/81
- *Asperula crassula*: Endemic of Eastern Crete, Rare, IUCN category: EN (endangered)
- *Carlina sitiensis*: Endemic of Eastern Crete and Kasos Island, in the Presidential Decree 67/81
- *Muscari dionysicum*: Endemic of S.E Aegean Islands, in the Presidential Decree 67/81
- *Anthemis ammanthus* ssp. *ammanthus*: Endemic of S. Aegean, very rare in eastern Crete, IUCN category: NT (Near Threatened)
- *Anthemis ammanthus* ssp. *palacea*: Endemic of Kriti-Karpathos area, very rare in eastern Crete, IUCN category: NT (Near Threatened)

Bird species included in Annex I of the Birds Directive present in the SAC:

The site is part of the easternmost migration corridor of Crete. Bird species included in Annex I of the Birds Directive present in the SAC:

- *Ardea purpurea*: Endangered (EN)
- *Ardea cinerea*: Least Concern (LC)
- *Egretta garzetta*: Least Concern (LC)
- *Ardeola ralloides*: Vulnerable (Vu)
- *Nycticorax nycticorax*: Least Concern (LC)
- *Ixobrychus minutus*: Least Concern (LC)

Other protected animal species present in the SAC:

- *Hierophis gemonensis*: Protected by the Presidential Decree 67/81, Bern Convention Appendices II
- *Mediodactylus kotschyi*: Annex IV of the Directive 92/43/EEC, Presidential Decree 67/81, Bern Convention Appendices II

- *Hemidactylus turcicus*: Presidential Decree 67/81, Bern Convention Appendices III
- *Lacerta trilineata*: Annex IV of the Directive 92/43/EEC, Presidential Decree 67/81, Bern Convention Appendices II
- *Podarcis erhardii*: Annex IV of the Directive 92/43/EEC, Presidential Decree 67/81, Bern Convention Appendices II
- *Telescopus fallax*: Annex IV of the Directive 92/43/EEC, Presidential Decree 67/81, Bern Convention Appendices II
- *Pinna nobilis*: CR (critically endangered according to IUCN evaluation), Annex IV of Directive 92/43/EEC



**Figure 1:** The Vai Palm Forest

### 3.2 SAC GR4310005: “Agios Nikitas” [ASTEROUSIA (KOFINAS)]

The habitat 9370\* at Agios Nikitas and Agios Antonios spans 0.93 ha comprising 142 *Phoenix theophrasti* trees, located approximately 145 m above sea level to the northwest of Agios Nikitas Monastery (Fig. 2-4) The site is underlain by carbonate sandstones and features sandy loam soils. Two fenced locations enclose the palm trees.

A 2009 survey recorded 123 male palms and 19 female palms, most in good condition, with only two juveniles identified, indicating limited regeneration. The average tree height is below 5 m, with an average trunk diameter of 0.45 m and a median of six trunks per tree. The habitat is heavily influenced by anthropogenic pressures, including grazing and historical fires. Goat grazing is prevalent, and signs of past fires are evident. During the 2009 assessment, the fungal leaf disease *Graphiola phoenicis* was observed affecting many palms. The southeastern section of the site is subject to moderate to severe erosion. Vegetation is dominated by phrygana due to grazing and fire activity, with sparse occurrences of evergreen sclerophyllous shrubs, pine (*Pinus brutia*), and Italian cypress (*Cupressus sempervirens*), primarily confined to less accessible southern slopes or protected areas owned by the church or state.

The surrounding area includes unique vegetation, such as a small carob tree (*Ceratonia siliqua*) forest at Treis Ekklesies, and two notable *Phoenix theophrasti* stands near the Agios Nikitas Monastery and the Agios Antonios Church. Human activities in the region include livestock grazing, agriculture, apiculture, fishing, and tourism. Ownership of the 9370\* habitat area is predominantly public forest land, managed by the Monastery of Agios Nikitas. The surrounding lands are either private or leased by local shepherds and are intensively grazed.

Plant species included in the Annex II of the Directive 92/43/EEC:

- *Crepis pusilla*: priority species, Rare
- *Origanum dictamnus*: Endemic of Crete. Protected by the Presidential Decree 67/81. Near threatened (NT) under IUCN criteria

Other protected plant species present in the SAC:

- *Alkanna sieberi*: Endemic of Crete. Protected by the Presidential Decree 67/81
- *Campanula jaquinii*: Endemic of Crete. Protected by the Presidential Decree 67/81. Endangered (En) by the IUCN Red Data List
- *Crocus oreocreticus*: Endemic of Crete. Protected by the Presidential Decree 67/81.
- *Hypericum jovis*: Endemic of Crete. Protected by the Presidential Decree 67/81.
- *Lomelosia minoana* ssp. *asterusica*: Endemic of Crete, Vulnerable

Bird species included in Annex I of the Birds Directive present in the SAC:

- *Gypaetus barbatus*: Critically Endangered (CR) under IUCN criteria
- *Gyps fulvus*: Endangered (En) under IUCN criteria
- *Falco peregrinus*: Vulnerable (Vu) under IUCN criteria
- *Aquila fasciata*: Endangered (En) under IUCN criteria
- *Aquila chrysaetos*: Endangered (En) under IUCN criteria
- *Falco biarmicus*: Endangered (En) under IUCN criteria

Other protected animal species present in the SAC:

- *Zamenis situla*: Annex II/IV of Directive 92/43/EEC, Bern Convention II & III

- *Mauremys rivulata*: Annex II/IV of Directive 92/43/EEC, Bern Convention II, Presidential Decree 67/81
- *Bufo viridis*: Annex IV of Directive 92/43/EEC, Bern Convention II, Presidential Decree 67/81
- *Chalcides ocellatus*: Annex IV of Directive 92/43/EEC, Bern Convention II, Presidential Decree 67/81
- *Hyla arborea*: Annex IV of Directive 92/43/EEC, Bern Convention II, Presidential Decree 67/81
- *Natrix tessellata*: Annex IV of Directive 92/43/EEC, Bern Convention II, Presidential Decree 67/81
- *Telescopus fallax*: Annex IV of Directive 92/43/EEC, Bern Convention II, Presidential Decree 67/81
- *Felis silvestris*: Annex IV of Directive 92/43/EEC
- *Tadarida teniotis*: Presidential Decree 67/81
- *Pipistrellus kuhlii*: Presidential Decree 67/81



**Figure 2:** Aerial photo of Agios Nikitas' palm forest



**Figure 3:** Evidence of heavy grazing



**Figure 4:** North part of the forest

### 3.3 SAC GR4310004: “Martsalo” [DYTIKA ASTEROUSIA (APO AGIOFARANGO EOS KOKKINO PYRGO)]

The 9370\* habitat in Martsalo Gorge encompasses an area of 0.32 ha and supports 15 mature *Phoenix theophrasti* trees, all in good condition (Fig. 5). The palm trees coexist with a variety of other species, including *Pistacia lentiscus*, abandoned olive trees (*Olea europaea*), *Arum* spp. (Araceae), *Mandragora officinarum*, *Ceratonia siliqua* and *Nerium oleander*.

The absence of juvenile palms indicates a lack of natural regeneration in the area. The habitat is subject to significant pressures from overgrazing by goats, which damage the root systems by consuming the palm hearts, further inhibiting regeneration. Both the northern slopes and the riverbed of the gorge exhibit severe erosion. In 2009, fungal presence was documented, albeit at low levels.

To date, no targeted management or conservation measures have been implemented, apart from the fencing of the Wildlife Refuge. Ownership of the 9370\* habitat is divided between the Monastery of Odigitria and public forest lands, with the entire habitat located on public forest land. Surrounding monastic lands are leased to local shepherds and used as pasture, leading to extensive overgrazing. Stray goats frequently enter the gorge and graze within the habitat.

Plant species included in the Annex II of the Directive 92/43/EEC:

- *Anacamptis pyramidalis*: Protected by the Presidential Decree 67/81, CITES Convention
- *Himantoglossum robertianum*: Protected by the Presidential Decree 67/81, CITES Convention
- *Campanula creutzburgii*: Endemic of Crete. Protected by the Presidential Decree 67/81.
- *Campanula saxatilis* sub. *saxatilis*: Endemic of Crete, Protected by the Presidential Decree 67/81.
- *Crepis tybakiensis*: Endemic of Crete, Protected by the Presidential Decree 67/81.
- *Nepeta melissifolia*: Endemic of Crete, NT (Near Threatened)
- *Ebenus cretica*: Endemic of Crete

Bird species included in Annex I of the Birds Directive present in the SAC:

- *Gyps fulvus*: Endangered (En) under IUCN criteria
- *Gypaetus barbatus*: Critically Endangered (CR) under IUCN criteria
- *Falco peregrinus*: Vulnerable (Vu) under IUCN criteria
- *Aquila fasciata*: Endangered (En) under IUCN criteria
- *Aquila chrysaetos*: Endangered (En) under IUCN criteria



**Figure 5:** Habitat 9370\* in Martsalo gorge

### 3.4 SAC GR4330003: “Preveli” [KOURTALIOTIKO FARANGI – MONI PREVELI – EVRYTERI PERIOCHI]

The site covers a wide area in the south-central part of Rethymno prefecture including the Kourtalotis and Frati Gorges and their estuaries, the east part of mount Kouroupa and the east part of Agiou Vasileiou plain. River Kourtalotis is one of the few aquatic systems with continuous flow on Crete. It feeds into a small bay with a sandy beach close to the monastery of Preveli, where a small brackish lake forms. This is also the location of the second most important Cretan Date Palm (*Phoenix theophrasti*) forest in Crete (Fig. 6, 7). The site is characterized by rocky areas at the slopes of the gorge, with chasmophytic and phryganic vegetation, as well as steep cliffs towards the coast. Aegean *Quercus* woods and *Olea-ceratonia* stands are present as well as small coastal habitats at the estuary of the river, with *Vitex-agnus castus* and halophytic vegetation (*Juncus maritimus* and *Phragmites australis*) and small sand dunes, while along their riverbeds *Nerium oleander* and *Platanus orientalis* form galleries. The main human activities are livestock breeding, agriculture and tourism. The main threats of the area include illegal hunting, road construction, arson and controlled burning used by livestock breeders for habitat improvement of pasturelands. Other threats include wind farm construction plans, urban and residential development, and tourism.

Habitat type 9370\* is located along the riverbank Preveli, approximately 600 meters from the beach, covering an area of 2.93 hectares. The geology of Preveli consists of limestones and dolomites, with sandy loam soils. The primary slope hosting the majority of the palm trees is flat (0°) and faces south. The area also contains old stone structures, terraced fields, a church, and evidence of historical human habitation within caves along the gorge.

The palm forest at this site includes approximately 300 *Phoenix theophrasti* individuals, a mix of mature and juvenile trees, with male and female specimens in equal proportion, all in good health. The palms typically measure under 6 meters in height, with an average trunk diameter at breast height of 0.55 meters, and a median of six trunks per tree.

In 2009, many palms were affected by fungal infections, including white mold (*Aspergillus* spp.), black mold (*Cladosporium* spp.), and *Graphiola phoenicis*. Reports of potential genetic introgression with *Phoenix dactylifera* have been previously documented; however, recent genetic analyses have found no evidence to support these claims. The surrounding area comprises public forest land managed by the Rethymnon Forestry Department and land owned by the Monastery of Preveli, used for olive cultivation or leased as pastureland. Other activities include tourism, with small businesses offering boat rentals and beach services and the existence of a small bar/café on the beach next to the palm trees.

In August 2010, a wildfire severely damaged the palm forest. Although the initial impact on the ecosystem appeared devastating, the natural regeneration process exceeded expectations, with nearly all palms recovering through apical growth and basal shoots. Before the fire, overgrazing by goats and camping by tourists caused vegetation loss and soil compaction around the palm trees. In response to the fire, authorities prohibited grazing and camping, installed temporary fencing around the estuary, and undertook horticultural interventions in the burnt areas. A fire

prevention study prepared in 2020 is currently being implemented to mitigate future risks. However, camping still exists further inside the gorge and a significant number of tourists visit the river's sources for bathing, posing risks to water quality and causing disturbances to the overall ecosystem.

Plant species included in the Annex II of the Directive 92/43/EEC:

- *Origanum dictamnus*: Endemic of Crete. Protected by the Presidential Decree 67/81. Near threatened (NT) under IUCN criteria.

Other protected plant species present in the SAC:

- *Campanula saxatilis ssp. saxatilis*: Endemic of Crete, Protected by the Presidential Decree 67/81. Endangered (En) under IUCN criteria
- *Asperula rigida*: Endemic of Crete.
- *Crepis auriculifolia*: Endemic of Crete, Protected by the Presidential Decree 67/81. Vulnerable (Vu) under IUCN criteria
- *Verbascum arcturus*: Endemic of Crete
- *Valeriana asarifolia*: Greek endemic

Bird species included in Annex I of the Birds Directive present in the SAC:

- *Gypaetus barbatus*: Critically Endangered (CR) under IUCN criteria
- *Aquila fasciata*: Endangered (En) under IUCN criteria
- *Falco peregrinus*: Vulnerable (Vu) under IUCN criteria

Other protected animal species present in the SAC:

- *Zamenis situla*: Annex II/IV of Directive 92/43/EEC, Bern Convention II & III
- *Mauremys rivulata*: Annex II/IV of Directive 92/43/EEC, Bern Convention II, Presidential Decree 67/81
- *Bufo viridis*: Annex IV of Directive 92/43/EEC, Bern Convention II, Presidential Decree 67/81
- *Chalcides ocellatus*: Annex IV of Directive 92/43/EEC, Bern Convention II, Presidential Decree 67/81
- *Hyla arborea*: Annex IV of Directive 92/43/EEC, Bern Convention II, Presidential Decree 67/81
- *Lacerta trilineata*: Annex IV of Directive 92/43/EEC.
- *Hypsugo savii*: Annex II of Directive 92/43/EEC, Bern Convention II, Presidential Decree 67/81



**Figure 6:** The Preveli palm forest



**Figure 7:** The Megalos Potamos river and the Preveli Palm Forest

### 3.5 SAC GR4340012: “Souda-Plakias” [ASFENDOU – KALLIKRATIS KAI PARAKTIA ZONI]

The 9370\* habitat at this site is located adjacent to a ravine and along the riverbed that defines the western boundary of the Souda region, covering an area of 3.74 hectares (Fig. 8, 9). The soil in this habitat is classified as sandy clay loam, and the average slope of the ravines is 25°, with a southern aspect. The area supports approximately 237 *Phoenix theophrasti* trees, of which 201 are mature and 36 juveniles, indicating active regeneration. Of these, 136 trees are male and 65 females, with the majority in very good health. Most palms are under 5.5 meters in height and a median of five trunks per individual.

Historical pressures on the site include light goat grazing and previous fire incidents, as documented in 2009. Many palms were affected by *Graphiola phoenicis*, and reports of genetic introgression with *Phoenix dactylifera* exist but recent analyses have found no evidence to support these claims. Over the past decade, the habitat has faced significant pressures from increased tourism, real estate development, and associated infrastructure expansion. Livestock breeding and agriculture remain the dominant land uses in the area.

Although the *P. theophrasti* clusters predominantly exist within riparian zones designated as public forest land, ownership disputes persist over approximately 25% of the habitat due to claims by private individuals. This issue reflects a broader problem in Crete, stemming from the absence of an official and ratified land cadaster.

The surrounding region exhibits complex geomorphological features, particularly at higher elevations, including gorges (e.g., Kallikratis and Argouliano), dolines, cliffs, and plateaus. The area is primarily covered by phrygana vegetation dominated by *Sarcopoterium spinosum* and formations of the *Euphorbio-Verbascion* alliance. Chasmophytic vegetation prevails on the slopes and cliffs of the gorges, while extensive oak forests contribute significantly to the region's ecological value.

Plant species included in the Annex II of the Directive 92/43/EEC:

- *Origanum dictamnus*: Endemic of Crete. Protected by the Presidential Decree 67/81. Near threatened (NT) under IUCN criteria.

Other protected plant species present in the SAC:

- *Centaurea poculatoris*: Endemic of Crete. Protected by the Presidential Decree 67/81. Near threatened (NT) under IUCN criteria
- *Crepis auriculifolia*: Endemic of Crete, Protected by the Presidential Decree 67/81. Vulnerable (Vu) under IUCN criteria
- *Verbascum arcturus*: Endemic of Crete
- *Valeriana asarifolia*: Greek endemic

Bird species included in Annex I of the Birds Directive present in the SAC:

- *Gypaetus barbatus*: Critically Endangered (CR) under IUCN criteria
- *Aquila fasciata*: Endangered (En) under IUCN criteria

Other protected animal species present in the SAC:

- *Zamenis situla*: Annex II/IV of Directive 92/43/EEC, Bern Convention II & III
- *Mauremys rivulata*: Annex II/IV of Directive 92/43/EEC, Bern Convention II, Presidential Decree 67/81
- *Bufotes viridis*: Annex IV of Directive 92/43/EEC, Bern Convention II, Presidential Decree 67/81
- *Chalcides ocellatus*: Annex IV of Directive 92/43/EEC, Bern Convention II, Presidential Decree 67/81
- *Hyla arborea*: Annex IV of Directive 92/43/EEC, Bern Convention II, Presidential Decree 67/81
- *Lacerta trilineata*: Annex IV of Directive 92/43/EEC.
- *Pipistrellus kuhlii*: Presidential Decree 67/81



**Figure 8:** *Phoenix theophrasti* trees next to the stream and the Souda beach



**Figure 9:** *Phoenix theophrasti* trees surrounded by olive trees

### 3.6 SAC GR4340015: “Chrysoskalitissa” [PARALIA APO CHRYSOSKALITISSA MECHRI AKROTIRIO KRIOS]

The site is characterized by a variety of habitat types, most of them fairly well conserved (typical ammophilous and halophytic flora, dune juniper thickets, *Juniperus oxycedrus* and *J. phoenicea* arborescent matorrals, Oleo-ceratonion tall scrub communities, calcareous cliffs; one of the most diverse and endemic-rich groups of communities).

The 9370\* habitat in this area is located at Aspri Limni, northwest of the Chrysoskalitissa Monastery, near a small coastal lagoon surrounded by karstic rocks and adjacent to a stream bed with patchy water presence (Fig. 10, 11). During the LIFE04NAT\_GR\_000104 project, titled “A Pilot Network of Plant Micro-Reserves in Western Crete” (2005–2006), 63 *Phoenix theophrasti* trees were recorded, and a micro-reserve covering 7.87 hectares was established to protect the habitat. This micro-reserve included 39 Cretan date palms.

A study conducted in 2008–2009 recorded 82 palm trees in the area, including 71 mature individuals and 11 juveniles, indicating ongoing regeneration. Of the mature trees, 68 were male and 3 female, with the overall population exhibiting good health. Most trees were less than 3 meters in height and a median of five trunks per tree. Most palms were affected by the fungal pathogen *Graphiola phoenicis*. The Special Environmental Study for Elafonisi (2009), which also encompassed this site, identified the Cretan date palms at Chrysoskalitissa as being at the ecological limits of the species’ natural range. The study proposed designating the area as a “Nature Conservation Zone”. Although the site is classified as 100% public forest land, ownership disputes involving local shepherds persist due to the absence of an official and ratified land cadaster, a widespread issue across Crete. The primary threats to the habitat include ongoing road construction providing access to sensitive areas, illegal hunting, overgrazing, controlled burning by livestock breeders to enhance pastures, reduction or abandonment of traditional land uses, greenhouse expansion, and increasing tourism pressures.

Plant species included in the Annex II of the Directive 92/43/EEC:

- *Androcymbium rechingeri*: Endemic of Crete. Protected by the Presidential Decree 67/81. Endangered (En)
- *Crepis pusilla*: priority species, Rare

Other protected plant species present in the SAC:

- *Alkanna sieberi*: Endemic of Crete. Protected by the Presidential Decree 67/81
- *Bellevalia brevipedicellata*: Endemic of Crete. Protected by the Presidential Decree 67/81. Endangered (En)

Other protected animal species present in the SAC:

- *Bufotes viridis*: Annex IV of Directive 92/43/EEC, Bern Convention II, Presidential Decree 67/81
- *Chalcides ocellatus*: Annex IV of Directive 92/43/EEC, Bern Convention II, Presidential Decree 67/81

- *Hyla arborea*: Annex IV of Directive 92/43/EEC, Bern Convention II, Presidential Decree 67/81
- *Lacerta trilineata*: Annex IV of Directive 92/43/EEC



**Figure 10:** The wider area of Chrysoskalitissa



**Figure 11:** *Phoenix theophrasti* trees in Chrysoskalitissa

## 4. NEW BASELINE STUDIES

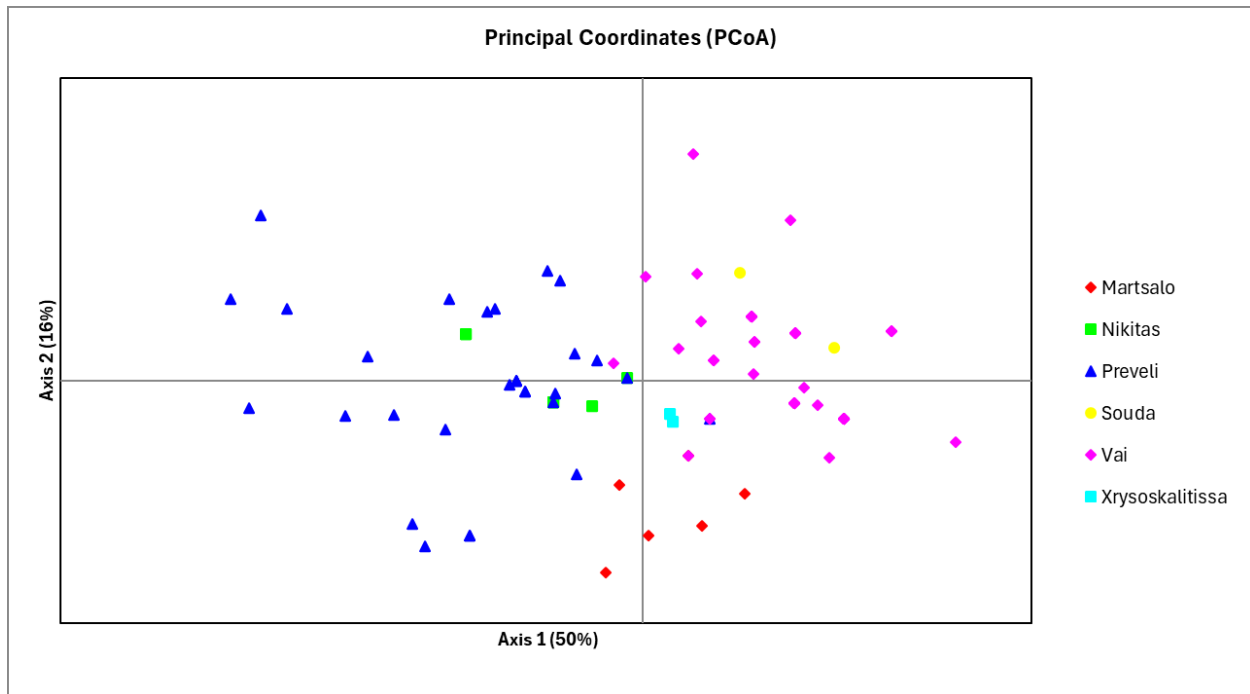
### 4.1 Genetic context & Hybridisation

It is already well known that different species of the genus *Phoenix* can hybridize and the hybrids are usually viable. *Phoenix theophrasti* can hybridize both with *P. canariensis* and *P. dactylifera*, though most of the times such hybrids have been forced by humans. For the purpose of the genetic analyses in the framework of LIFE Phoenix project, several surveys have been carried out in all six populations of *P. theophrasti* on Crete, firstly for detecting morphologically, potential hybrids and secondly to collect leaf samples for the hybridisation and genetic analyses. During the visits, collection of samples followed the instructions as described in the “Protocol for the collection of leaf samples from *Phoenix* specimens for DNA extraction for genetic analysis” created in the framework of the LIFE Phoenix project. An identification code was assigned for each specimen, along with information regarding height, geographical coordinates, substrate etc. Fieldtrips for collecting leaf samples were conducted between March to mid-May 2024 in the six palm groves across Crete and the number of specimens was relevant to the size of each population (Table 1). Hence, for the largest palm grove in Vai, a total of 50 leaf specimens were collected, while for the smallest populations in Martsalo and Chrysoskalitissa, three and four specimens respectively. A total of 96 specimens were genetically analyzed using 17 microsatellites.

Despite potential threats such as various anthropogenic pressures, including tourism and the introduction of other *Phoenix* species into private gardens, **genetic analysis indicates no hybridization between *P. theophrasti* and other palm species such as *P. canariensis* or *P. dactylifera*.** This result highlights the genetic integrity of *P. theophrasti*, even in environments where it coexists with closely related species.

Notably, *P. theophrasti* exhibits very low genetic diversity compared to other *Phoenix* species. Principal Coordinate Analysis (PCoA) revealed that the largest genetic distance occurs between "Preveli" and "Vai" populations, indicating a genetic differentiation within the species (Table 2), yet this differentiation is not enough to form a distinct cluster for each population (Fig. 12). Furthermore, population structure analysis (STRUCTURE software) identified K=2 as the most suitable model to describe the genetic structuring of *P. theophrasti*, a result that is consistent also with the PCoA findings.

These results emphasize the distinctiveness of *P. theophrasti* within the *Phoenix* genus and underline the importance of conserving its genetic resources. In light of its low genetic diversity and the significant genetic distance between populations, conservation strategies should prioritize the preservation of both genetic integrity and the unique genetic identity of geographically isolated populations.



**Figure 12:** PCoA plot depicting genetic differentiations between palm populations

**Table 1:** Number of collected leaf samples from each SAC for the genetic/hybridization analysis

9370* Habitat	Number of specimens for genetic analysis
Vai - GR4320006	50
Agios Nikitas - GR4310005	6
Martsalo - GR4310004	5
Preveli - GR4330003	28
Souda Plakias - GR4340012	4
Chrysoskalitissa - GR4340015	3

**Table 2:** Pairwise Population Matrix of Nei Genetic Distance. The biggest genetic distance is shown with red.

	Martsalo	Nikitas	Preveli	Souda	Vai	Xrysoskalitissa
Martsalo	0.000					
Nikitas	0.065	0.000				
Preveli	0.072	0.007	0.000			
Souda	0.094	0.122	0.144	0.000		
Vai	0.064	0.067	0.084	0.072	0.000	
Xrysoskalitissa	0.026	0.042	0.057	0.074	0.041	0.000

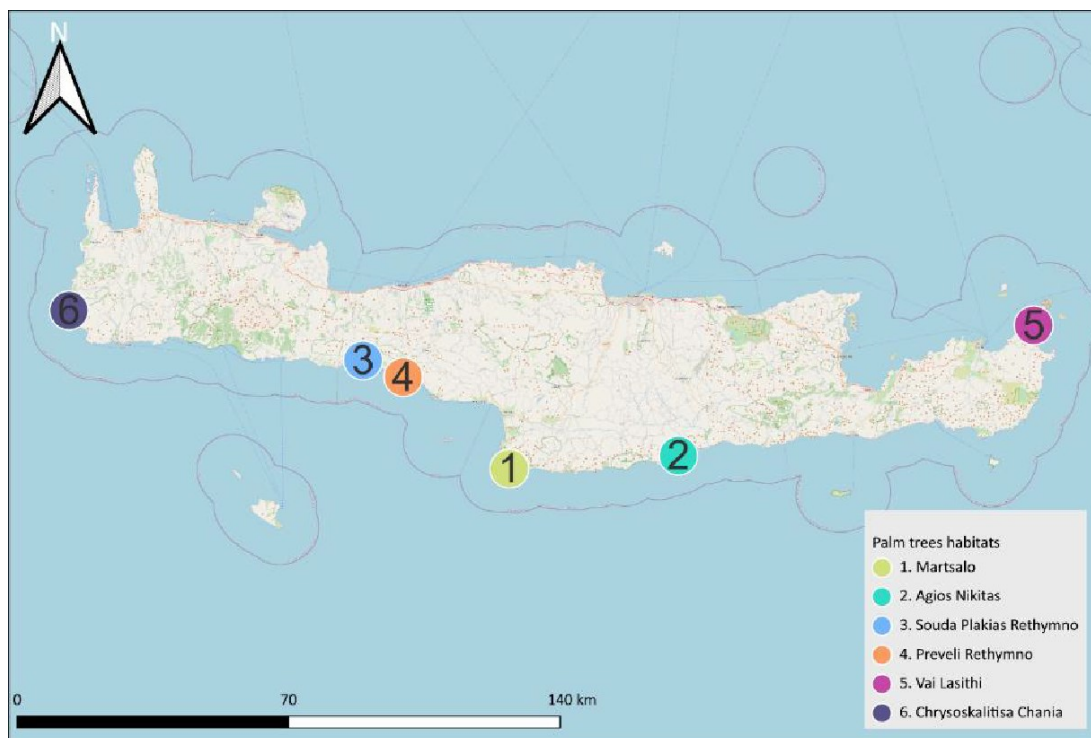
## 4.2 IAS: Pest surveillance (*Rhynchophorus ferrugineus*)

The initial step was to map the distribution boundaries of *Phoenix theophrasti* habitats in Crete and integrate this spatial data into a Geographic Information System (GIS) to enable systematic monitoring and advanced spatial analysis. The surveyed sites of *Phoenix theophrasti* on the island comprise a diverse array of distinct ecosystem types.

The sites include:

1. Vai Palm Forest in Lasithi Regional Unit (GR4320006), the largest and most well-known palm grove in Crete, where *P. theophrasti* forms dense populations,
2. Martsalo Gorge, in Heraklion Regional Unit (GR4310004), known for its remote palm populations and rugged terrain.
3. Agios Nikitas Palm Forest in Heraklion Regional Unit (GR4310005), one of the densest and most isolated palm colonies in the area.
4. Preveli Palm Forest, in Rethymno Regional Unit (GR4310004), which is a popular tourist site where palm trees form dense clusters along the riverbed.
5. Souda Plakias, also in Rethymno Regional Unit (GR4340012), where palms create a mixed natural and anthropogenic landscape as they grow among olive groves and populated areas.
6. Aspri Limni, located near Chrysoskalitissa Monastery in Chania Regional Unit (GR4340015), represents the westernmost and most isolated population of palms on the island.

These habitats (Fig. 13) represent the complete geographical range of *Phoenix theophrasti* on Crete, offering critical insights into the spatial distribution, ecological condition, and anthropogenic or environmental threats affecting this rare Mediterranean species. Data utilized for this analysis were derived from Natura 2000 habitat classifications, previous studies (e.g., Chrysoskalitissa), and photo interpretive analyses based on 2015 orthophotos and Google Earth imagery



**Figure 13:** Inspected Habitats of *Phoenix theophrasti* in Crete

A comprehensive survey was subsequently conducted across all known *P. theophrasti* distribution sites to assess potential infestation by *Rhynchophorus ferrugineus*. The assessment focused on identifying both pathognomonic and non-pathognomonic symptoms, including leaf chewing, stem perforations, infestations at the leaf base, crown separation, leaf drop, wilting of inner leaves, and other indicators (Table 3).

**Table 3:** Pathognomonic and Non-Pathognomonic Symptoms of RPW (Kontodimas *et al.* 2017)

Pathognomonic symptoms of RPW	Non-Pathognomonic Symptoms
Sewing” holes in the leaves caused by RPW adults	The crown lacks the typical round and symmetrical shape
Chewing symptoms from RPW larvae	A gap between the inner and outer leaves
Collapsed leaves and presence of holes, galleries, larvae, cocoons, and adults at the leaf base	Some leaves are broken at the base
Asymmetric inner leaf growth	Some leaves are damaged at the periphery
Crown partially collapsed	Outer leaves are dry
Absence of young leaves	Discolored leaf tips
Symptoms of the infestation in the upper area of the stipe	Wilted leaves in the crown of young trees
Wilted inner leaves	
Dry offshoots(s)	
Dry or fresh sawdust	
Oozing from the stipe	
Burrow at the base of the stipe	

During the inspection, unmanned aerial vehicles (drones) were deployed to capture an aerial overview of the vegetation and delineate the distribution boundaries of the *Phoenix theophrasti*

stands (Fig. 14). When required, drones were maneuvered to within a few meters of individual palms to closely examine potential signs of *Rhynchophorus ferrugineus* infestation. Throughout the survey, hundreds of ground-level and aerial photographs, 360-degree panoramic images, and videos documenting all observed palms were captured. The collected material was subsequently reviewed in detail, allowing the identification of individuals exhibiting potential symptoms of insect presence. These individuals underwent additional ground-level inspection by the survey team. Further analysis of the photographic and video data continued in the office, where geotagged images and videos were integrated into a Geographic Information System (GIS) and a dedicated image database for extended investigation (<https://samaritakis.gr/phoenicea>).

Finally, all palm specimens were observed from the ground using magnifying tools (binoculars and cameras with telephoto lenses) to look for possible signs of infestation by *Rhynchophorus ferrugineus* (Fig. 15).

Based on observations from the Vai forest indicating a preference of *Rhynchophorus ferrugineus* for stunted palm trees, particular attention was directed toward individuals exhibiting stunted growth characteristics. If drone flights detected a potential infestation from insect feeding on a palm, the coordinates were marked, and a more extensive ground inspection was conducted using binoculars and telephoto lenses. Where the terrain and accessibility allowed, a thorough examination was carried out with ladders (Fig. 16).



**Figure 14:** Visual inspection with aerial unmanned vehicles



**Figure 15:** Visual inspection with binoculars



**Figure 16:** A thorough examination was carried out with ladders where the terrain and accessibility allowed

### 1. Vai Palm Forest (GR4320006)

During visits to the Vai Palm Forest efforts by the Forest Service to combat infestations of the red palm weevil (*Rhynchophorus ferrugineus*) were observed, based on recommendations from a study by Dimitrios N. Avtzis and Fotios Xystrakis (Forest Research Institute, ELGO DIMITRA). Initial signs of infestation appeared in August 2023 near the parking area, where one tree was saved while another succumbed. Systematic inspections from fall 2023 to spring 2024 revealed several affected palms, particularly in the western beachside region (Fig. 17), with harsher conditions and human activity contributing to higher infestation rates. Around 300 palms were chemically treated or removed if severely damaged. The infestation predominantly affects saplings and smaller offshoots, which are easier to handle but remain vulnerable. Stunted palms in certain areas of the forest (Fig. 18), exhibiting disrupted physiology, were found to be particularly susceptible to infestation. Such weakened trees are more attractive to pests like the red palm weevil, which can detect stressed hosts (Abe et al., 2009). These findings highlight the need for sustained monitoring and targeted interventions to protect this rare ecosystem from further degradation.



**Figure 17:** *Rhynchophorus ferrugineus* insects found infesting a palm tree in the Vai Palm Forest



**Figure 18:** Stunted palm trees

## 2. Agios Nikitas (GR4310005)

The Agios Nikitas palm forest, located in a remote area of southern Heraklion, is a dense cluster of palms sustained by water from the Kefalovrisi spring, which is essential for its vitality. This isolated forest, surrounded by rugged terrain, has been shielded from potential *Rhynchophorus ferrugineus* infestations due to the absence of nearby agricultural activities, palm plantations, or even tourist sites that could facilitate the spread of the red palm weevil. A protective fence has been installed to prevent grazing by local sheep and goat herds, although evidence of livestock intrusion was observed in the southern section of the forest. Despite this, the majority of the palms remain in good health, showing no visible signs of pest infestation. The trees exhibit lush foliage and stable growth, though a few younger palms displayed minor grazing damage from livestock. The forest's seclusion further enhances its resilience to invasive species, as its distance from infested areas reduces the risk of pest introduction. Combined with its natural water source and limited human disturbance, this palm forest serves as a valuable refuge for native palms. However, continued monitoring is necessary to detect and mitigate potential risks, such as livestock intrusion or accidental pest introduction, to safeguard the forest's health and stability.

## 3. Martsalo Gorge (GR4310004)

At the entrance of the gorge, a very small population creates a striking natural landscape, enhancing the area's biodiversity and ecological value. Recent inspections revealed no visible signs of *Rhynchophorus ferrugineus* infestation among the palms. The absence of typical pest-related symptoms—such as damaged fronds, trunk cavities, or weakened crowns—indicates that this colony remains unaffected by the invasive weevil. The palms exhibit robust health, with vibrant green fronds, strong crowns, and stable growth patterns across the observed clusters. The gorge's remote and naturally protected location likely contributes to its resistance to weevil infestation, as its isolation minimizes exposure to potential pest sources. This colony, along with Agios Nikitas, plays a vital role in sustaining the native palm populations of southern Heraklion, underscoring the need for continued conservation and protective measures to preserve these unique habitats.

## 4. Moni Preveli (GR4310004)

On both sides of the Megalos Potamos River lies the second largest *P. theophrasti* palm forest on the island of Crete. This ecosystem experiences significant anthropogenic pressure during the tourist season, with thousands of visitors on its paths, thereby increasing the strain on the forest habitat. In August 2010, the forest suffered a large-scale fire that nearly devastated it. However, due to the forest's inherent resilience and favorable environmental conditions, it has largely recovered within a relatively short timeframe. Recent assessments revealed no visible signs of *Rhynchophorus ferrugineus* activity. The palm population appears to be in good health, as evidenced by the presence of lush, green fronds and vigorous growth patterns, indicating that the forest is currently thriving (Fig. 5, Fig. 6). This observation highlights the ecosystem's resilience but underscores the necessity of ongoing monitoring to identify potential threats and ensure the continued vitality of this important habitat.

## 5. Souda Plakias (GR4340012)

In Souda Plakias, the palm trees are widely dispersed across a landscape that includes streams, residential/touristic areas and cultivated lands, primarily olive groves. This fragmented distribution results from land use and a popular beach attracting significant tourist traffic. The presence of residential settlements, agricultural activities and tourism creates considerable anthropogenic pressures on the ecosystem, with various interventions—such as land management practices, water usage, and maintenance of tourist areas—affecting the natural habitat of the palms. Despite these challenges, the majority of palms surveyed in the area were found to be in good health, showing no visible signs of *Rhynchophorus ferrugineus* infestation. The absence of typical symptoms suggests that the beetle has not yet impacted this population (Fig. 14). However, given the high level of human activity in the region, continued monitoring is advised to assess the potential stress on the habitat and the risk of invasive species introduction. While the current health of the palms indicates resilience, conservation efforts may be necessary to maintain this balance amid ongoing environmental pressures (Fig. 14-16)

## 6. Moni Chrysoskalitissa (GR4340015)

At the location of Aspri Limni, close to Moni Chrysoskalitissa, a scattered population of low-height native palm trees exist, with signs of grazing. This habitat represents the westernmost distribution of the species on the island of Crete and is considered the most vulnerable population due to significant anthropogenic and environmental pressures. In particular, the combined impacts of tourist activities and livestock grazing pose ongoing threats to the stability and regeneration of this habitat. In response to these pressures, a Micro-Reserve site was designated in 2006 specifically to support the conservation of this species. The Micro-Reserve plays an essential role in facilitating long-term monitoring of plant populations and implementing targeted habitat management practices to safeguard the species. Notably, during the recent survey of this area, no characteristic symptoms of infestation by the invasive red palm weevil (*Rhynchophorus ferrugineus*) were observed among the palms, indicating an absence of infestation at the time of inspection.

### 4.3 IAS: Invasive vegetation

The initial phase of assessing invasive vegetation involved a comprehensive survey to document all invasive and alien plant species across the six palm groves included in the project. Fieldwork was conducted during multiple excursions, primarily between February and June, to ensure the recording of species during their anthesis stage for accurate identification and characterization. In these fieldtrips a series of parameters were noted, such as density of alien species, height, proximity to palm trees etc (Table 4).

Overall, the *Phoenix theophrasti* groves were found to be in very good condition concerning invasive alien species (IAS). The remoteness of most sites has limited the introduction and

establishment of alien species, resulting in a relatively low number of such species recorded. Only two individuals of *Eucalyptus camaldulensis* in Martsalo Gorge were identified as problematic invasive species (Fig. 19, 20). Located in the riverbed, these trees compete with the native flora for water resources, posing a potential threat to the local ecosystem. In the Vai palm forest, *Oxalis pes-caprae* was observed in an open area in the southern part of the forest. This perennial neophyte, originating from South Africa, has naturalized in Crete. Although classified as invasive and listed in the “Alien Plants in Greece: A Web-Based Platform,” it is not typically considered invasive in most areas of Crete. Specifically within the Vai palm forest, the species does not pose a significant threat, as its spreading roots do not adversely affect *Phoenix theophrasti* individuals. Furthermore, removing *Oxalis pes-caprae* from this area could accidentally promote the establishment of other, potentially more invasive plant species, whose impacts on the ecosystem may be detrimental and unpredictable.

**Table 4.** Data summary for plant IAS.

<b>SAC</b>	GR4310004
<b>Name</b>	Martsalo Gorge
<b>Date</b>	20/03/2024
<b>Time</b>	11:00
<b>IAS</b>	<i>Eucalyptus camaldulensis</i>
<b>Surface</b>	Moderate - riverbed
<b>Density</b>	Very low (5%)
<b>Height</b>	15m.
<b>Condition</b>	Vigorous
<b>Distance to palm grove</b>	Very close proximity, almost inside the grove
<b>Endemic spp.</b>	<i>Crepis neglecta ssp. cretica</i> , <i>Centaurea idaea</i>
<b>Observations</b>	Presence of water



**Figure 19:** Palm grove in Martsalo. *Eucalyptus camaldulensis* can be seen on the right side.



**Figure 20:** Two individuals of *Eucalyptus camaldulensis* in the riverbed of Martsalo Gorge.

#### 4.4 Specific biodiversity indicators: Pollinators

The pollinator study, an essential action within the framework of the LIFE *Phoenix* project, was planned to be conducted during the spring season of 2024. This study aims to assess the diversity, abundance, and ecological role of pollinators within the target area to inform the *Phoenix* management plan, contributing to the long-term conservation and restoration of the habitat.

Despite extensive efforts by the University of Crete (UoC) team to identify a suitable external specialist to carry out the study, no qualified candidate was found. The challenges in recruiting a specialist resulted in the inability to implement the study during the appropriate biological window, as the activity was time-sensitive to the pollination season in spring. Consequently, this action remains pending and will be rescheduled for the spring of the following year, when the ecological conditions are optimal for pollinator monitoring.

## 5. HABITAT RESTORATION PLAN

### 5.1 Climate Change mitigation

Among the range of ecological restoration objectives considered for the project's palm groves, the mitigation of climate change effects represents an important line of collateral action. Depending on the possibilities and means available, this is intended to be carried out in a more localised manner in some cases (e.g. mulching and organic improvement of the soil) or more extensively in others (e.g. reforestation), also including intermediate situations (e.g. eradication of exotic vegetation and preventive grazing).

The common thread of all tasks under the umbrella of climate change mitigation is based on increasing soil moisture, improving soil condition and preventing forest fires. In this sense, the following concrete actions are proposed:

- a) **Removal of dead wood and invasive vegetation**, which pose a potential risk as they constitute fire propagation corridors along ravines. Detailed information on this aspect is provided in section 5.4.
- b) **Preventive grazing**, in coordination with some local farmers and shepherds who have their activity near the project's areas of intervention. This pilot action is proposed as a supporting method contributing to control invasive vegetation. At the same time, the temporary relocation of livestock is expected to have a positive effect in terms of soil fertilizing. Project partners are already in contact with some farmers/shepherds from both target SACs, in order to assess the most practical approach and possible real impact of this action within the context of this project

### 5.2 Hybridisation control

Despite the absence of hybridization in the populations analyzed, there are significant anthropogenic pressures that pose a potential threat to the genetic integrity of *P. theophrasti*. In almost all areas, high tourism activity and overgrazing exert considerable environmental stress. Moreover, many hotels in the region plant non-native *Phoenix* species, such as *P. dactylifera* and *P. canariensis*, as ornamental plants. Moreover, a plant nursery located near the largest palm forest actively cultivates these non-native *Phoenix* species, increasing the likelihood of future hybridization events through pollen transfer.

Given these pressures, continued monitoring of genetic integrity and hybridization risk is essential. Mitigation measures, such as regulating the planting of non-native *Phoenix* species near natural populations and raising awareness among local stakeholders, should be considered to preserve the genetic purity and ecological resilience of *P. theophrasti*. Additionally, a new hybridization analysis should be conducted in five years to monitor potential future hybridization events and ensure the ongoing protection of this endemic species.

### 5.3 Pest control and eradication: *Rhynchophorus ferrugineus*

An integrated pest management (IPM) approach is implemented by the Forest Service of Lasithi as proposed in the study, including:

- **Isolation and Monitoring of the Forest:**

- 1) **Exclusion Zone:** Establish a 10-kilometer radius exclusion zone around the Vai Forest to prevent other Phoenix species, such as *Phoenix dactylifera* and *P. canariensis*, which are highly susceptible to the weevil, from growing near the forest. These species can serve as stepping-stone hosts for the weevil.
- 2) **Monitoring Nearby Nurseries:** A nearby nursery within 500 meters of the forest, which houses susceptible palm species, poses a risk of re-infestation. Regular inspections are planned to ensure no weevils are introduced from this site.
- 3) **Removal of Invasive Species:** Other *Phoenix* species growing within or near the Vai Forest should be systematically removed to reduce the potential for cross-species infestation and protect the genetic integrity of *Phoenix theophrasti*.
- 4) **Continuous Monitoring:** Regular surveillance to detect new infestations early, using drones and ground inspections.

- **Suppression of the Weevil Population Within the Forest**

- 1) **Targeted Tree Removal:** Severely infested palms showing signs like umbrella-shaped crowns, indicative of late-stage infestation, will be removed. After chopping, trunks are covered with insecticidal nets and transported to a dedicated disposal site to prevent weevils from spreading during transit.

- 2) **Insecticidal Treatments:** For palms with early symptoms (e.g., feeding marks on leaves), controlled applications of insecticides (e.g., Azadirachtin, Emamectin) will be used. Application timing (late fall to early spring) minimizes attracting new weevils and enhances effectiveness.

- 3) **Biocontrol Agents:** Entomopathogenic fungi (e.g., *Beauveria bassiana*) and nematodes (e.g., *Heterorhabditis bacteriophora*) are employed for sustainable pest control. Given their sensitivity to high temperatures, they are applied during cooler months.

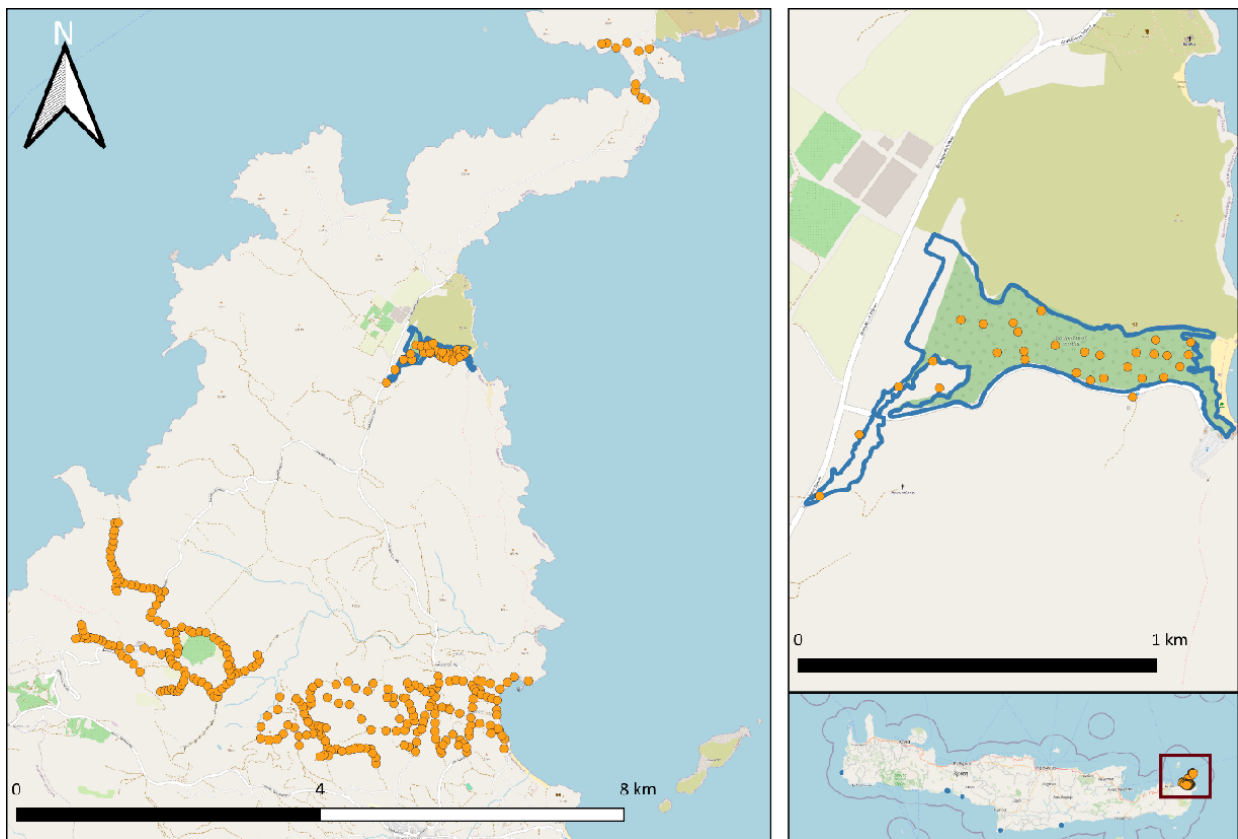
- **Creation of a 5-kilometer Buffer Zone with Pheromone Traps**

- 1) **Trap Placement:** Within a 5-kilometer perimeter, 300 pheromone black-colored traps set at ground level were distributed to lure and trap adult weevils (Fig. 21, 22).

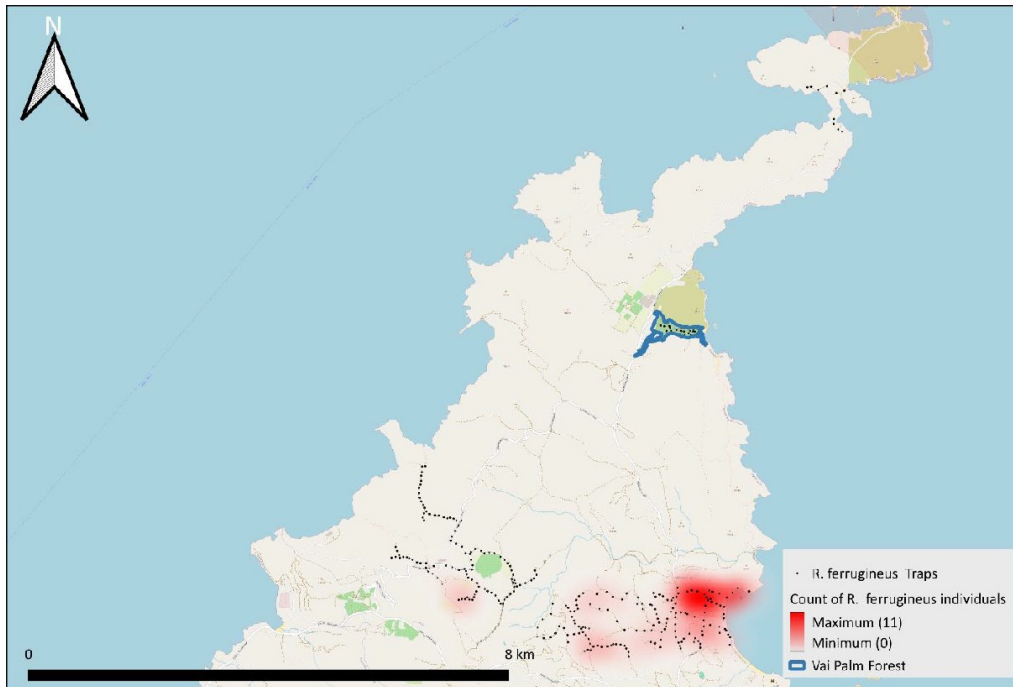
- 2) **Trap Baiting:** 271 Traps outside the palm forest are baited with the pheromone *ferrugineol* and plant material to enhance their attractiveness. Each trap also contains insecticides to eliminate captured weevils. 29 traps inside the forest were baited only with plant material and no pheromone so that no new weevil is attracted inside the forest.

- 3) **Monitoring and Maintenance:** Regular inspection and replenishment of pheromones ensure continued trap efficacy, with trapped data recorded weekly to track weevil movement around the forest.

- **Systematic Inspection and Surveillance for New Infestation Sites**
  - 1) Regular Ground Inspections: Weekly ground patrols, especially in peak infestation periods (June-July, October-November), help detect new weevil hotspots early.
  - 2) Aerial Surveys with Drones: Drones equipped with infrared sensors may detect early signs of infestation (e.g., thermal anomalies in stressed palms). This technology offers better visibility in densely forested or difficult-to-access areas.
- **Public Awareness and Community Engagement**
  - 1) Visitor Education: Information pamphlets and signs at the forest entrance explain the threat posed by the weevil, symptoms of infestation, and preventive measures, encouraging visitor vigilance.
  - 2) Community Reporting: Contact details for local authorities will be provided for reporting sightings of suspected infestations, fostering public engagement in monitoring efforts.



**Figure 21:** Distribution of 300 traps



**Figure 22:** Spots of the 300 traps installed and heatmap of the *R. ferrugineus* individuals found during the 2 measurements carried out in October 2024.

#### 5.4 Control and eradication of invasive vegetation.

Invasive vegetation mainly affects the palm grove located in Martsalos area (GR4310004) where two individuals of the invasive species *Eucalyptus camaldulensis* are found. In order to improve the health of the palm trees and maintain the balance in the habitat, it is proposed to completely remove them. The reason is that they displace other vegetation around them as they are competitive species and have high water requirements.

The removal process initially involves the felling of the individuals. This is followed by controlled burning of the stumps and uprooting of potential rootstocks within a radius of 20 m. This is done to support the growth of the palms and to prevent competition from eucalyptus. *Eucalyptus* being a hydrophilic species has high water requirements which can lead to problems in the growth of palms. Therefore, by removing it, competition for water resources is reduced, providing better conditions for healthy palm growth.

Afterwards, the logging products over 12 cm thick are cut into smaller pieces, 1.20-1.30 m long. The transportation of the logs will be carried out by animals to the parking area near the Holy Monastery of Saints Parthenios and Eumenios, where they will be stacked. Similarly, the residues produced (sub-basement cleaning products - branching products) will be transported by animals or by hand to the stacking area and will be crushed with a wood crusher, while the wood products will be scattered in the bushes of the surrounding area, or were indicated by the Forestry Service, and not also on the road deck or in the ditches of these roads.

This methodology was previously implemented in Preveli, another area of LIFE Phoenix, just before the project began in the winter of 2023. Two *Eucalyptus* trees were removed to favor the growth of *Phoenix* plants. The results showed an increase in palm tree regeneration as competition for resources decreased and growth rates improved.

## 5.5 Specific Forest Management techniques

Specific management techniques have been planned under the LIFE Phoenix project for the improvement of the 9370\* habitat in Crete. These techniques can be categorized in four main categories, erosion control, direct anthropic impacts, fire risk prevention and purely management Techniques.

### 5.5.1 Erosion Control

Construction of dry-stone walls and gabion structures for streambed protection in Martsalos were planned in order to control erosion. More specific, it is proposed to add a small adjacent polygon in the middle and east of habitat 9370\*, as there are palm trees with exposed roots due to the erosion observed in the area, making them vulnerable to both grazing and drying. Therefore, it is suggested to construct semi-circular cross-section dry stone walls for each individual tree, to retain the soil and combat the above-mentioned phenomenon. Specifically, the six (6) new walls will have a height of 0.80 m, a width of 0.60 m, and variable lengths 57.40 m in total. Suitable stones collected from the project area will be used for the construction of these dry-stone walls. There are three main reasons explaining the need to build the walls using dry stone construction. Dry stone walls are part of cultural heritage, as they are the product of a traditional building technique that dates back centuries. This gentle building technique offers many advantages. Dry stone walls are an excellent example of material recycling and are constructed in such a way that they have an adaptable structure. Unlike modern rigid concrete walls, they can respond with localized deformations without cracking and remain unaffected by severe weather conditions. Additionally, they enhance the landscape, forming structures well adapted to the environment, and they serve a triple purpose: demarcation, barrier, and support. Finally, the cavities in dry stone walls provide temporary or permanent shelter for small wildlife (butterflies, reptiles, birds), as well as for various plant species, contributing to the protection of nature.

Additionally, due to the unfavorable geological conditions, high water velocities resulting from the steep slopes in Martsalos contribute to significant erosion and consequently the strong erosion, it is proposed to construct wire mesh gabions for riverbed protection at two positions across the streambed to protect it. The gabions will be made of wire mesh with a loop opening of 80 mm and a wire diameter of 3 mm, and they will be filled with stones collected from the project area.

### 5.5.2 Reduction of direct anthropic impacts

The first Action for the mitigation of anthropic impacts is the construction or repair of fences in five locations where the priority habitat is found. The N2K areas where the fences are going to be placed or repaired are Agios Nikitas (GR4310005), Martsalos (GR4310004), Preveli

(GR4330003), Chrisoskalitissa (GR4340005) and Vai (GR4320006). This Action targets to the protection of palm stands from grazing and tourists' pressure and consequently to their preservation and the creation of ideal conditions for their regeneration and strengthening.

### Grazing

Specifically, in Agios Nikitas it was observed that there are palm groves near the habitat that have not been included in it and, therefore, were not fenced. To protect these, it is proposed to construct eight (8) new fences to effectively safeguarding them from grazing. The fences will be 1.62 meters high with a total length of 910.8 m.

Additionally, in Martsalos a new fence will be created for the protection of the new 150 seedlings from grazing. The total length of this fence will be 99 m.

In Preveli, the construction of a new fence is deemed necessary in order to protect the palm trees in the habitat. Habitat 9370\* in this area has the peculiarity of being divided, due to the Kourtaliotis River, into an eastern and a western section. The eastern section has a fence, which is damaged in most parts and needs to be replaced with a new one. On the western side, visitors continue to enter the habitat uncontrollably, even today, when strong winds prevail in the area, seeking shelter. For this reason, it is proposed to construct a new fence, of the same type as the eastern section. The total length of the two fences proposed for Preveli is 173.2 m.

Moreover, in Chrysoskalitissa, the presence of a significant number of palm trees outside the protected habitat with the code 9370\* has been observed. To protect these, the construction of a new fence with a total length of 726.m is proposed. The fence will serve as a means of maintaining the balance of the ecosystem, limiting uncontrolled human activity (e.g. grazing) or other threats that could have a negative impact on this sensitive area.

### Tourists' pressure

Protection of habitat 9370\* in the area of Vai is particularly demanding, as the location attracts a large number of visitors. For this reason, it is proposed to construct new fences, with a total length of 312.5 m. The first fence will be constructed near the boundary of the habitat and the beach, creating a clear separation between the two areas. It will extend along the coastline, following the natural topography of the land, so that it blends into the landscape and remains as discreet as possible. Specifically, it will be placed at the northeastern edge of habitat 9370\*, starting from the point where a stream flows into the beach and continuing northward, surpassing the end of the habitat's boundary. The second fence will enclose a part of the habitat in the southeastern area, to the right of the entrance for visitors to the Vai beach. Its purpose is to protect this specific section of the habitat, preventing visitor access to the palm forest. On the left side of the entrance, a fence of the same type as the proposed one has already been constructed, ensuring uniformity and visual continuity in the landscape

Furthermore, in order to mitigate anthropic impact, plans are in place to demarcate trails in the Preveli area. Habitat 9370\* in this area is unique because it is divided, due to the Kourtaliotis River, into eastern and western sections. It is proposed to demarcate two trails, one in each section of the habitat. The western trail has a length of 403.7 meters, while the eastern trail is 520.4 meters long. In the western trail, there are scattered positions where wooden railings are installed, covering approximately 30% of the total length, and these will be dismantled.

The construction of the railings will be made from chestnut wood, which aesthetically blends with the area, with a maximum above-ground height of 0.80 meters. Every 1.50 meters, the vertical posts will be driven 40 cm into the ground with a pointed end at one side, after they have been tarred. At the top of each post, a plant-based rope made of 100% jute, 20 mm in diameter, will be fastened, with the aim of demarcating the trail and helping to keep visitors strictly within it in an aesthetically acceptable manner.

Finally, eight information boards will be placed in six key areas: Agios Nikitas (GR4310005), Martsalos (GR4310004), Preveli (GR4330003) – with two boards, Chrisoskalitissa (GR4340005), Souda-Plakias (GR4340012), and Vai (GR4320006) – with two boards. These boards aim to indirectly reduce human impact on the environment by informing the public about the project and its objectives. They will raise awareness of the environmental issues being addressed and highlight the positive impact on local biodiversity, ecosystems, and heritage. Positioned in prominent, high-traffic areas, the boards will provide accessible information about priority habitats and their significance. The goal is to educate the public and influence their behavior, particularly in Preveli and Vai, where thousands of tourists visit each summer

### 5.5.3 Fire Risk Prevention

Fire risk is also a very severe threat for the priority habitat. Thus, water tanks are going to be installed in Vai. In this area, a fire safety system was previously installed, but it has never functioned and, in its current condition, cannot be repaired. Therefore, to maintain and protect the habitat, six (6) plastic cylindrical vertical water tanks will be installed, each with a capacity of 10 m<sup>3</sup>, to provide a water supply point for fire engines, sufficient for the area, and to ensure the fire safety of habitat 9370\* in the region. These tanks will be installed at an elevation of 17.5 meters, approximately 300 meters west of the habitat, side-by-side in a paved parking area. The tanks will be anchored on a 20 cm thick clean cement layer of unreinforced concrete, C12/15 class, on a 30 cm thick geotechnical layer of crushed material.

The tanks to be installed must be equipped with appropriate water supply valves with a STORZ coupling of 0.062 m and 0.110 m diameter to allow for the filling of fire engines either by natural flow or by pumping. The above valves must be positioned at the lowest accessible point of the tank. Additionally, there must be an inspection hatch for checking the tank's fill level and an accessible point for refilling. Finally, the tanks will be placed in a location that ensures a minimum elevation difference from the parking area where the fire engines will be filled, so that refilling can be done by gravity

### 5.5.4 Vital space enhancement

Resprouting in palm trees is a vital regenerative process and it is necessary to provide the essential space to grow and to develop new root suckers and basal shoots. *Phoenix theophrasti* is a large palm tree with one or more main trunks that can grow up to 10 meters tall, surrounded by dense clumps of shorter shoots growing as suckers at the base, creating a small cluster of palms nearby named as spot. This Action will take place in Chrisoskalitissa, where the surrounding competitive vegetation of palm spots will be removed (70 spots in total) for a

maximum radius of 4 meters. This includes the removal of all competitive plants or shrubs that are within this radius, in order to create the vital space for *P. theophrasti* to thrive. Additionally, the soil will be shaped to improve water retention, in order to create better growth conditions for palms, as they are species that tend to occupy available space through offshoots.

This procedure is essential to provide enough space around the base of the tree to allow for the free growth of new shoots. Crowding or restricting the area around the trunk can hinder this process and limit the tree's ability to regenerate. Additionally, maintaining a healthy environment by removing competing plants, such as weeds or invasive species, ensures that the palm has access to the necessary resources like water, nutrients, and light. Proper pruning, by removing damaged or diseased parts of the tree, also encourages the growth of new shoots and improves air circulation, which helps the plant recover more quickly. Finally, ensuring the palm tree receives adequate watering and nutrient support without over-saturating the soil will help stimulate root growth and resprouting. By implementing these practices, the natural resprouting capacity of palm trees can be enhanced, ensuring their long-term health and resilience in their ecosystems.

## 5.6 Ex-situ conservation

The ex-situ conservation planned for LIFE Phoenix project involves seed banks creation and seedlings production that will be used later on the reforestation works. In this procedure seeds will be collected from the purest palm trees in order to avoid hybridization with other Phoenix species. A specific protocol created during the project will be used to ensure the genetic quality. It is expected the collection of the seeds to be made for at least three years, in order to collect at least 4000 - 6000 seeds from all 9370\* stands in Crete. The appropriate period is between December to January based on seed maturity.

The main tasks will involve: Preparation of the fruits, disinfection and drying of the seeds, for subsequent storage for 4 months in chambers with controlled ventilation and humidity; final storage in the germplasm bank, in airtight containers at 4°C with silica gel.

Another goal of the ex-situ conservation is to produce a number of around 2.500 seedlings that will be used both for the reforestation works during the project and for material for future plantations. Consequently, it is crucial to ensure genetic purity of the produced material. The same protocol will be used in that direction.

The collected seeds will be used for the production of plants for the reforestation works in the project area. The protocol to ensure seed purity will also be used at the stage of seedlings production.

The production of the seedlings will take place in a public nursery of Chania where all appropriate adaptations will be developed to guarantee the viability of the seed bank and the future production of *Phoenix theophrasti* seedlings of high quality.

## 5.7 Aforestation works

Aforestation works planned under LIFE Phoenix project in Crete focus on the enrichment of 9370\* habitat in three target area, Agios Nikitas (GR4310005), Martsalo (GR4310004) and Chrisoskalitissa (GR4340005). For the plantations mechanical means will not be used to dig planting holes; instead, the holes will be dug manually. The planting holes that will be opened will be cylindrical, with dimensions of 0.30x0.30 x 0.40 meters. All plant handling, from extraction from the nursery to planting, requires careful and time-sensitive measures to minimize plant disturbance, which could negatively affect not only their normal growth in the coming years but also their survival.

The plants should be planted at the same depth as they were in the nursery from which they were uprooted, or even better, the root collar should be planted 2-3 cm deeper. The plants should be planted in such a way that their root system maintains its natural arrangement as much as possible, as it had in its original soil. The cutting of excess roots should be kept to a minimum and performed just before planting. The soil surrounding the roots should be adequately compacted to ensure it is in close contact with all the roots without crushing or cutting them. The root system will be surrounded by planting soil. The plants will be transported to the planting sites with careful handling and will be removed from the protective medium just before planting. They will be planted at the designated position according to the plan, in the center of the hole, vertically. watered with 16 liters of water per plant, 12 times in the first year and 10 times in the second year (22 total), until the plants acclimatize to the new environment.

A free planting arrangement with an average of 100 seedlings per hectare, aimed at creating clusters that closely resemble the natural presence of the species. These clusters will consist of small groups, typically 15-20 individuals. The number of palm trees to be planted at each site was determined based on the specific needs of each area. Therefore, approximately 500 palm trees will be planted in Agios Nikitas, 150 in Martsalos, and 300 in Chrisoskalitissa.

Upon completion of the planting work, watering will be done to settle the soil, close any gaps, ensure the desired degree of soil compaction, and improve the soil's contact with the roots or plant ball.

For the first two years, certain procedures will be followed to create favorable conditions for their survival and to establish an appropriate growth environment. To achieve this goal, water retention basins will be created for each seedling once a year, and each plant will be watered with 16 liters of water per plant, 12 times in the first year and 10 times in the second year (22 total), until the plants acclimatize to the new environment.

## 6. MONITORING PLAN

A list of indicators has been defined to ensure the monitoring of the different aspects during the implementation of the project and in After-LIFE period considered for this Management Plan:

- a. Climate Change (fire prevention; improvement of soils and hydrology): it is foreseen to repeat the study on soils and hydrology at the end of the project, including the same type of parameters. Indicators on fire prevention are related to the surface in which fire risk is reduced by preventive grazing and the elimination of dead wood and invasive vegetation.
- b. Genetics and hybridisation: indicators will measure the reduction of hybridisation risk due to the presence of non-native or invasive and hybrid specimens of Phoenix, as well as by the delimitation and monitoring of Critical Conservation Areas within the project palm groves.
- c. Pests (*Rhynchophorus ferrugineus*): the project will regularly monitor the evolution of the impact of this insect within the target palm groves, as well as the effects of the trap networks, the phytosanitary treatments applied and the elimination of severely damaged palm trees. Indicators will measure the extent of these actions, the performance of the traps and the surface where the pathogen is controlled or eradicated.
- d. Invasive vegetation: the main indicator regarding this issue is the surface where the target IAS are eradicated or controlled (in the area of Crete only *Eucalyptus* has been recorded).
- e. Ex-situ conservation: indicators will allow monitoring activities such as seed collection, germplasm conservation and seedling production.
- f. Reforestation: the project will regularly monitor parameters such as the reforested surface, the number of planted individuals for each of the selected endemic species, their condition and survival rates throughout the project, as well as other parameters related to the irrigations applied.
- g. Biodiversity (pollinators): the study on diversity and abundance of the target groups (bees, butterflies and some families of flies) will be repeated at the end of the project, assessing the same type of parameters.

**Table 5.** Monitoring indicators of the Palm Grove Management Plan

Indicator	Unit	Method	Frequency
<b>Climate Change</b>			
Surface under preventive grazing	Ha	Field monitoring and GIS cartography	Once a year
Surface where dead wood and plant IAS are eliminated	Ha	Field monitoring and GIS cartography	Every 6 months

Estimated quantity of accumulated dead wood eliminated	Tons	Field monitoring	Every 6 months
Surface where mulch layer is applied	Ha	Field monitoring and GIS cartography	Every 6 months
Surface where organic amendment or livestock fertilizing is applied	Ha	Field monitoring and GIS cartography	Once a year
Hydrology and soil parameters, meteorological data from existing stations	M3	Field survey and lab analyses	At the end of the project
<b>Genetics and hybridisation</b>			
Number of non native and hybrid palm trees eliminated	Nº	Field monitoring and GIS cartography	Once a year
Surface delimited and monitored as Critical Conservation Areas	Ha	Field monitoring and GIS cartography	Once a year
Number of new palm trees genetically analysed	Nº	Field monitoring and GIS cartography	Only if new genetic studies are considered
<b>Pests (<i>Rhynchophorus ferrugineus</i>)</b>			
Number of damaged palm trees eliminated	Nº	Field monitoring and GIS cartography	Once a year
Number of palm trees with phytosanitary treatment	Nº	Field monitoring and GIS cartography	Once a year
Number of traps placed and monitored	Nº	Field monitoring and GIS cartography	Every 6 months
Surface controlled by the trap network	Ha	Field monitoring and GIS cartography	Every 6 months
Average number of individuals of <i>Rhynchophorus ferrugineus</i> per trap??	Nº	Field monitoring	Every 6 months
Other parameters?			
<b>Invasive vegetation</b>			
Surface under IAS plant control	Ha	Field monitoring and GIS cartography	Every 6 months

Surface under IAS plant eradication	Ha	Field monitoring and GIS cartography	Every 6 months
<b>Ex-situ conservation</b>			
Average number of seeds of <i>P. theophrasti</i> collected	Nº	Field monitoring	Once a year
Average number of seeds of <i>P. theophrasti</i> treated and prepared	Nº	Nursery reports	Once a year
Number of seedlings of <i>P. theophrasti</i> produced	Nº	Nursery reports	Once a year
Number of seeds of <i>P. theophrasti</i> prepared and conserved in the germplasm bank	Nº	ULPGC reports	Only once
<b>Reforestation</b>			
Number of seedlings of each species produced	Nº	Nursery reports	Once a year
Number of seedlings of each species planted	Nº	Field monitoring	Once a year
Average survival rate for each species	%	Field monitoring	Once a year
Surface reforested in each area of intervention	Ha	Field monitoring and GIS cartography	Once a year
Water consumption (volume) for irrigations	m3	Field monitoring	Every 6 months
<b>Biodiversity (pollinators)</b>			
Number of different species (diversity)	Nº	Field survey and lab identification	At the end of the project
Number of specimens of each species (abundance)	Nº	Field survey and lab identification	At the end of the project

## 7. CONCLUSIONS

The LIFE *Phoenix* project focuses on the conservation and restoration of Priority Habitat 9370\*, the palm groves of *Phoenix theophrasti* in Crete, addressing critical threats to this rare ecosystem. Genetic analyses confirmed no hybridization between *P. theophrasti* and other *Phoenix* species (*P. dactylifera* and *P. canariensis*), despite anthropogenic pressures such as nearby nurseries and ornamental plantings. However, genetic diversity across all six populations was found to be notably low, highlighting the species' vulnerability. Environmental and anthropogenic threats, including overgrazing, unregulated tourism, invasive species, and the red palm weevil (*Rhynchophorus ferrugineus*), pose ongoing challenges. Localized infestations of the weevil were documented, particularly in the Vai palm forest, necessitating integrated pest management efforts. Invasive species such as *Oxalis pes-caprae* was identified but it pose limited ecological risk as the species is naturalized and does not threaten the palm trees. However, the existence of two *Eucalyptus camaldulensis* individuals in Martsalo Gorge was considered dangerous therefore they will be removed. Additionally, past incidents like the 2010 fire in Preveli underscored the ecosystem's vulnerability but also demonstrated its capacity for regeneration under favorable conditions.

Future goals focus on addressing these threats through targeted actions. A follow-up hybridization analysis is proposed in 10 years to monitor risks from introduced *Phoenix* species. Habitat restoration efforts will include fencing, erosion control measures, fire prevention systems (e.g., water tanks in Vai), and reforestation to support palm tree regeneration. The production of seedlings will take place in the Forest Nursery of Chania, from each habitat separately. The total number produced by the end of the project will be 2,500. The pending pollinator diversity study will be rescheduled for spring 2025 to better inform management strategies. Public awareness initiatives, such as information boards at key sites, aim to reduce human impact and promote conservation efforts. Continuous monitoring of genetic integrity, pest populations, and habitat conditions will guide adaptive management strategies to ensure the long-term preservation of *P. theophrasti* and its unique habitat.

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## ANNEXES

*Map 1A. 9370\* stands in Chrisoskalitissa GR4340015*

*Map 1B. 9370\* stands in Souda-Plakias GR4340012*

*Map 1C. 9370\* stands in Preveli GR4330003*

*Map 1D. 9370\* stands in Martsalos GR4310004*

*Map 1E. 9370\* stands in Agios Nikitas GR4310005*

*Map 1F. 9370\* stands in Vai GR4320006*

*Map 2A. Interventions Map in Chrisoskalitissa (Fences)*

*Map 2A. Interventions Map in Chrisoskalitissa (Habitat Enhancement)*

*Map 2B. Interventions Map in Souda - Plakias*

*Map 2C. Interventions Map in Preveli (Fences)*

*Map 2C. Interventions Map in Preveli (Trails)*

*Map 2D. Interventions Map in Martsalos*

*Map 2E. Interventions Map in Agios Nikitas*

*Map 2F. Interventions Map in Vai*



9370\* stands in Chrysoskalitissa GR4340015



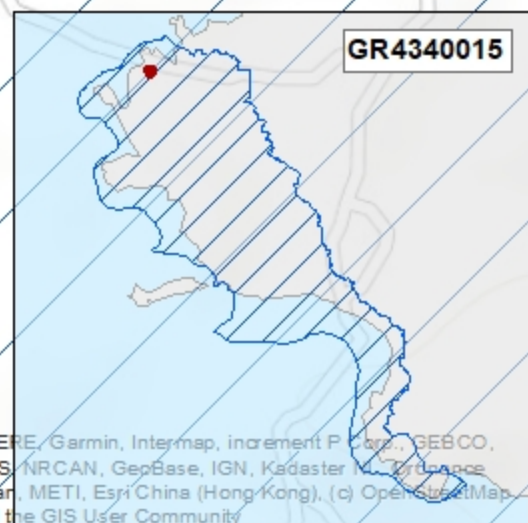
Target habitat

**Legend**

**SITETYPE**

-  SCI GR4340015
-  9370\* habitat

1 cm = 70 m



Sources: Esri, HERE, Garmin, Intermap, increment P., Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), (c) OpenStreetMap contributors, and the GIS User Community

532000

534000

# 9370\* stands in Souda – Plakias GR4340012



3896000

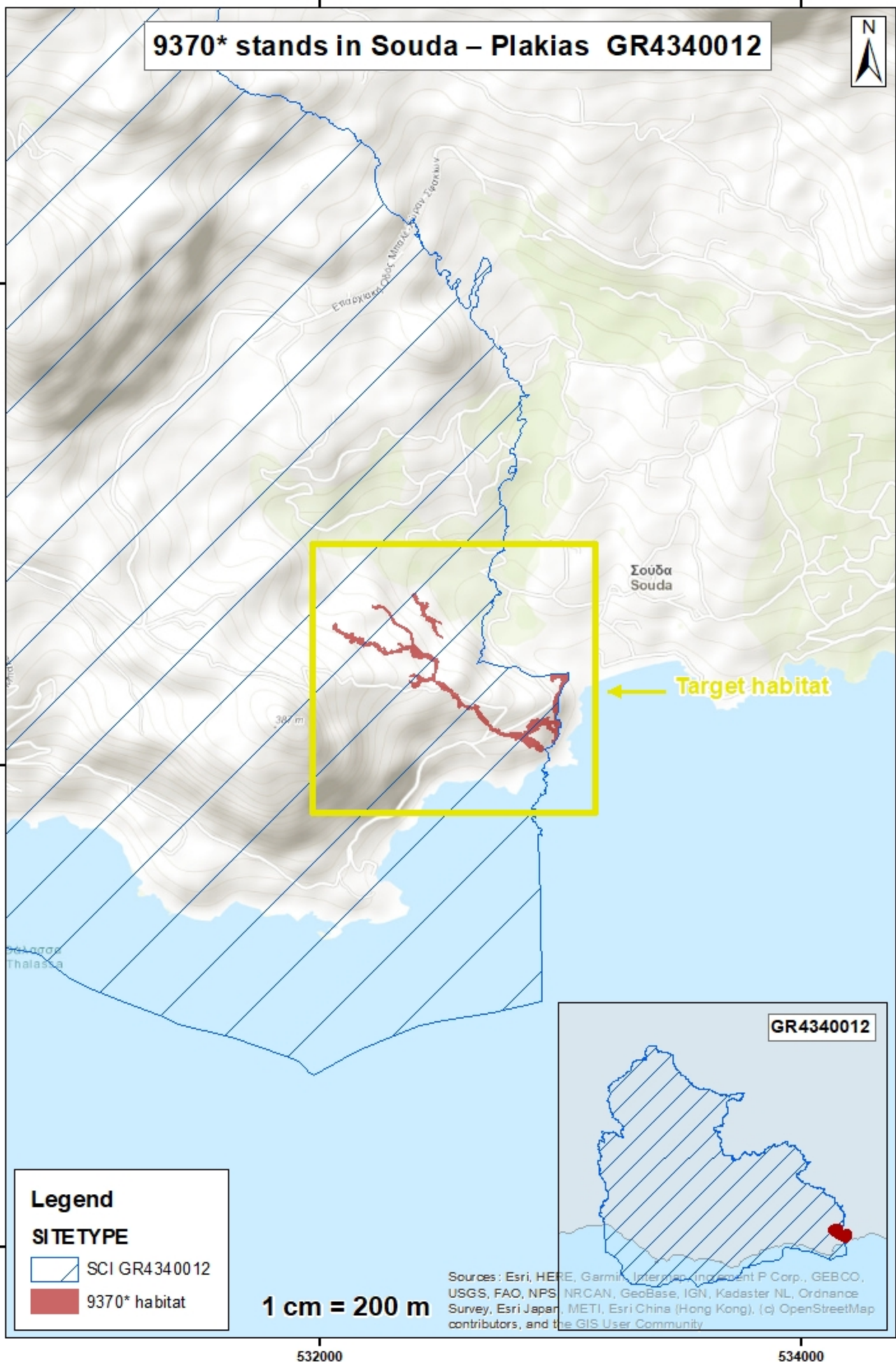
3896000

3894000

3894000

3892000

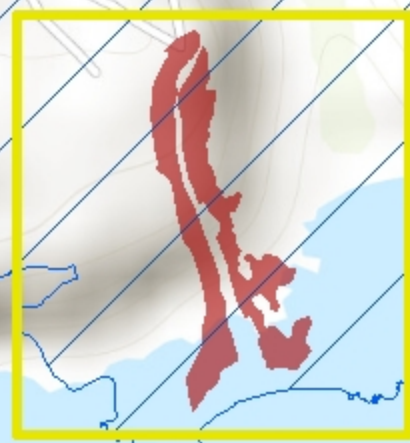
3892000



532000

534000



9370\* stands in Preveli GR4330003



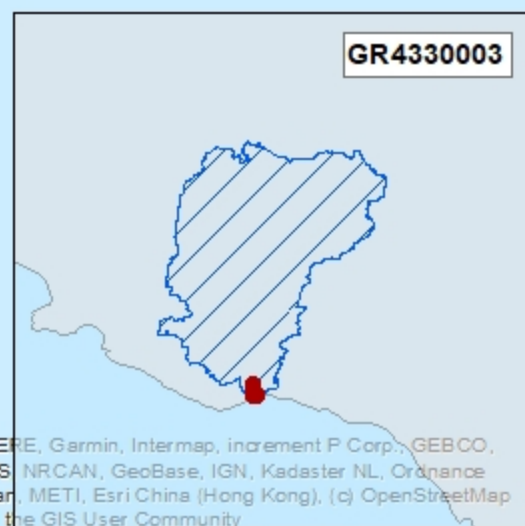
Target-habitat

**Legend**

**SITETYPE**

-  SCI GR4330003
-  9370\* habitat

1 cm = 100 m



Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), (c) OpenStreetMap contributors, and the GIS User Community

570400

571200

9370\* stands in Martsalos GR4310004



3867200

3867200

3866400

3866400

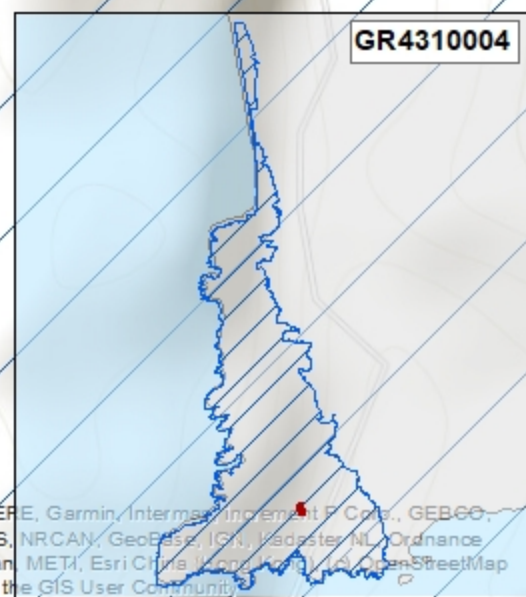


← Target habitat

3865600

3865600


192 m



GR4310004

**Legend**

**SITETYPE**

 SCI GR4310004

 9370\* habitat

1 cm = 80 m

Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), Swisstopo, Mapbox Contributors, and the GIS User Community

570400

571200

613600

614300

9370\* stands in Agios Nikitas GR4310005



3870000

3870000



← Target habitat

3869300

3869300


3868600

3868600

### Legend

#### SITETYPE

 SCI GR4310005

 9370\* habitat

1 cm = 70 m

GR4310005



Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), (c) OpenStreetMap contributors, and the GIS User Community

613600

614300



**9370\* stands in Vai GR4320006**

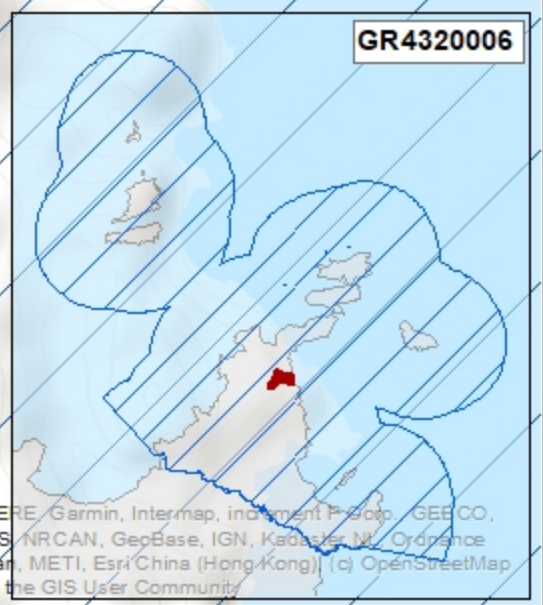


← **Target habitat**

**Legend**

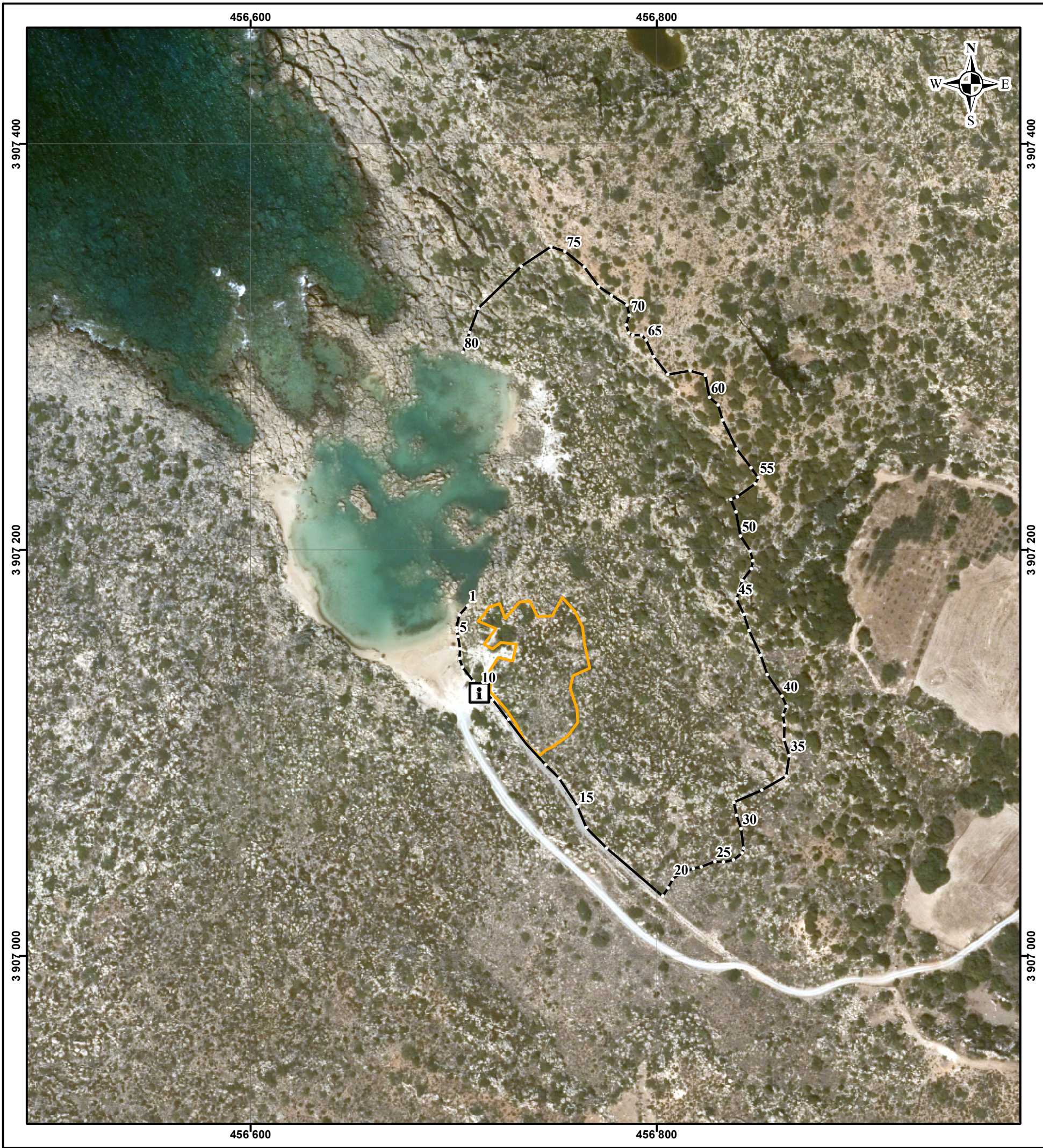
**SITETYPE**

-  SCI GR4320006
-  9370\* habitat



**1 cm = 200 m**

Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEE CO, USGS, FAO, NPS, NRCAN, Geobase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), (c) OpenStreetMap contributors, and the GIS User Community



**CRETE INSPECTORATE OF FORESTRY POLICY IMPLEMENTATION  
CHANIA FOREST DIRECTORATE**






**RESTORATION AND IMPROVEMENT  
OF PRIORITY HABITAT 9370\*  
PALM GROVES OF PHOENIX**

**Habitat 9370\* in Chrisoskalitissa**

**Proposed Intervention Map**

**SCALE 1 : 2.000**

**Legend**

-  Priority Habitat 9370\*
-  Fence
-  Information Board

Hellenic Geodetic Reference System 1987 (HGRS87)  
Reference Ellipsoid GRS 80  
Projection Transverse Mercator

BASE MAPS  
Orthophoto Maps 1:5.000 HELLENIC CADASTRE, (aerial photos 2014-15)

Orientation Map  
Scale 1: 750.000



Sources: Esri, HERE, Garmin, USGS, Intermap,

**Map Production**



**ENVIRONMENTAL  
MANAGEMENT COMPANY**

**THESSALONIKI 2024**

**Coordinate table of the vertices of the proposed fence**

Vertex	X	Y	Vertex	X	Y
1	456 706.90	3 907 172.60	41	456 854.30	3 907 138.80
2	456 702.80	3 907 168.00	42	456 851.10	3 907 148.20
3	456 701.30	3 907 161.80	43	456 845.40	3 907 160.40
4	456 701.60	3 907 160.00	44	456 842.70	3 907 168.40
5	456 702.10	3 907 157.30	45	456 839.30	3 907 175.80
6	456 703.20	3 907 151.10	46	456 841.90	3 907 184.80
7	456 702.70	3 907 146.50	47	456 846.50	3 907 190.70
8	456 704.30	3 907 142.20	48	456 847.30	3 907 194.80
9	456 709.80	3 907 135.30	49	456 846.10	3 907 199.40
10	456 712.90	3 907 132.60	50	456 841.10	3 907 207.00
11	456 719.20	3 907 126.20	51	456 838.90	3 907 218.60
12	456 726.90	3 907 116.50	52	456 836.30	3 907 224.80
13	456 745.30	3 907 094.10	53	456 839.70	3 907 226.30
14	456 751.90	3 907 087.50	54	456 848.40	3 907 232.50
15	456 761.00	3 907 073.50	55	456 849.90	3 907 235.60
16	456 765.20	3 907 063.20	56	456 846.40	3 907 240.50
17	456 775.20	3 907 053.10	57	456 839.30	3 907 249.70
18	456 802.80	3 907 029.40	58	456 832.30	3 907 264.00
19	456 805.60	3 907 033.40	59	456 830.20	3 907 271.40
20	456 807.70	3 907 037.70	60	456 825.80	3 907 275.10
21	456 810.90	3 907 040.30	61	456 823.90	3 907 286.00
22	456 813.30	3 907 041.00	62	456 816.30	3 907 288.30
23	456 818.00	3 907 043.20	63	456 805.40	3 907 286.30
24	456 821.80	3 907 043.90	64	456 798.40	3 907 295.20
25	456 828.50	3 907 046.60	65	456 794.70	3 907 303.40
26	456 832.90	3 907 046.30	66	456 792.50	3 907 305.80
27	456 837.80	3 907 047.30	67	456 788.10	3 907 305.60
28	456 842.00	3 907 050.60	68	456 786.10	3 907 306.90
29	456 842.60	3 907 053.20	69	456 784.90	3 907 311.00
30	456 841.50	3 907 062.70	70	456 786.50	3 907 315.60
31	456 839.20	3 907 069.30	71	456 785.30	3 907 320.60
32	456 837.90	3 907 075.60	72	456 777.60	3 907 325.40
33	456 851.60	3 907 081.70	73	456 771.40	3 907 329.70
34	456 863.70	3 907 088.60	74	456 764.30	3 907 339.40
35	456 865.10	3 907 098.80	75	456 754.80	3 907 347.00
36	456 862.70	3 907 106.60	76	456 747.80	3 907 349.40
37	456 862.80	3 907 113.80	77	456 733.20	3 907 339.70
38	456 862.20	3 907 118.80	78	456 712.10	3 907 319.00
39	456 863.90	3 907 123.00	79	456 707.60	3 907 307.10
40	456 861.60	3 907 128.00	80	456 704.50	3 907 297.10

*Hellenic Geodetic Reference System 1987 (HGRS87)  
Reference Ellipsoid GRS 80  
Projection Transverse Mercator*

456 600

456 800

457 000

3 907 400

3 907 400

3 907 200

3 907 200

3 907 000

3 907 000

456 600

456 800

457 000



**CRETE INSPECTORATE OF FORESTRY POLICY IMPLEMENTATION  
CHANIA FOREST DIRECTORATE**



**RESTORATION AND IMPROVEMENT  
OF PRIORITY HABITAT 9370\*  
PALM GROVES OF PHOENIX**

**Habitat 9370\* in Chrisoskalitissa**

**Proposed Intervention Map**

**SCALE 1 : 2.000**

**Υπόμνημα**



Priority Habitat 9370\*



Habitat 9370\* Habitat Enhancement

Hellenic Geodetic Reference System 1987 (HGRS87)  
Reference Ellipsoid GRS 80  
Projection Transverse Mercator

BASE MAPS  
Orthophoto Maps 1:5.000 HELLENIC CADASTRE, (aerial photos 2014-15)

Orientation Map  
Scale 1: 750.000



Sources: Esri, HERE, Garmin, USGS, Intermap,

**Map Production**



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**THESSALONIKI 2024**



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RETHYMNO FOREST DIRECTORATE**





**RESTORATION AND IMPROVEMENT  
OF PRIORITY HABITAT 9370\*  
PALM GROVES OF PHOENIX**

**Habitat 9370\* in Souda-Plakias**

**Proposed Intervention Map**

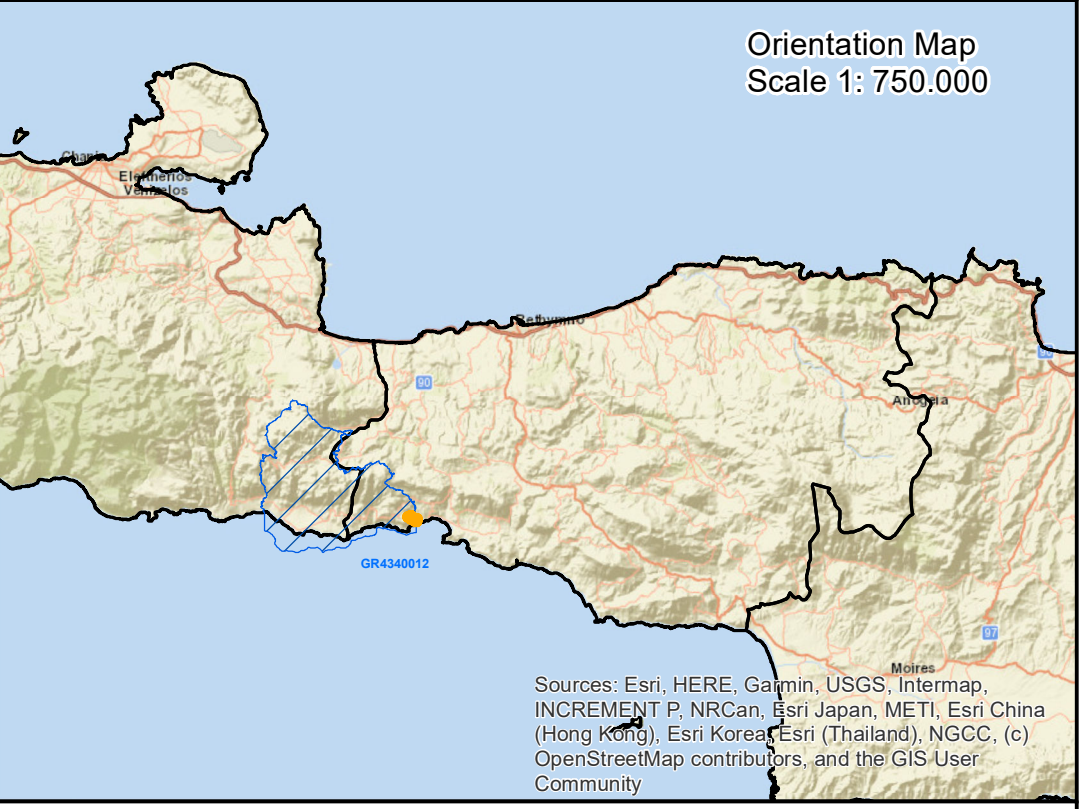
**SCALE 1 : 5.000**

**Legend**


-  Priority Habitat 9370\*
-  Information Board

Hellenic Geodetic Reference System 1987 (HGRS87)  
Reference Ellipsoid GRS 80  
Projection Transverse Mercator

BASE MAPS  
Orthophoto Maps 1:5.000 HELLENIC CADASTRE, (aerial photos 2014-15)



**Map Production**



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**RESTORATION AND IMPROVEMENT  
OF PRIORITY HABITAT 9370\*  
PALM GROVES OF PHOENIX**

**Habitat 9370\* in Prevelis**

**Proposed Intervention Map**

**SCALE 1 : 2.500**

**Legend**

-  Priority Habitat 9370\*
-  Fences
-  Information Boards

Hellenic Geodetic Reference System 1987 (HGRS87)  
Reference Ellipsoid GRS 80  
Projection Transverse Mercator

BASE MAPS  
Orthophoto Maps 1:5.000 HELLENIC CADASTRE, (aerial photos 2014-15)



**Map Production**



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**RESTORATION AND IMPROVEMENT  
OF PRIORITY HABITAT 9370\*  
PALM GROVES OF PHOENIX**

**Habitat 9370\* in Prevelis**

**Proposed Intervention Map**

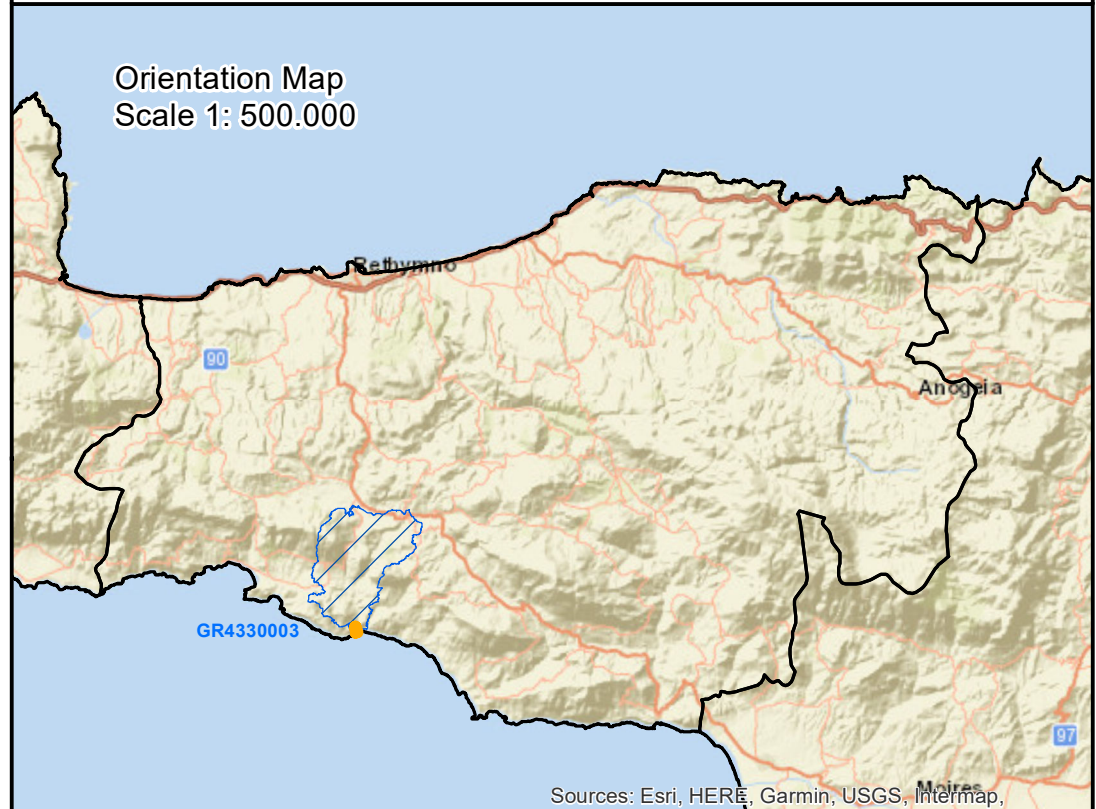
**SCALE 1 : 2.500**

**Legend**

-  Priority Habitat 9370\*
-  Trails

Hellenic Geodetic Reference System 1987 (HGRS87)  
Reference Ellipsoid GRS 80  
Projection Transverse Mercator

BASE MAPS  
Orthophoto Maps 1:5.000 HELLENIC CADASTRE, (aerial photos 2014-15)



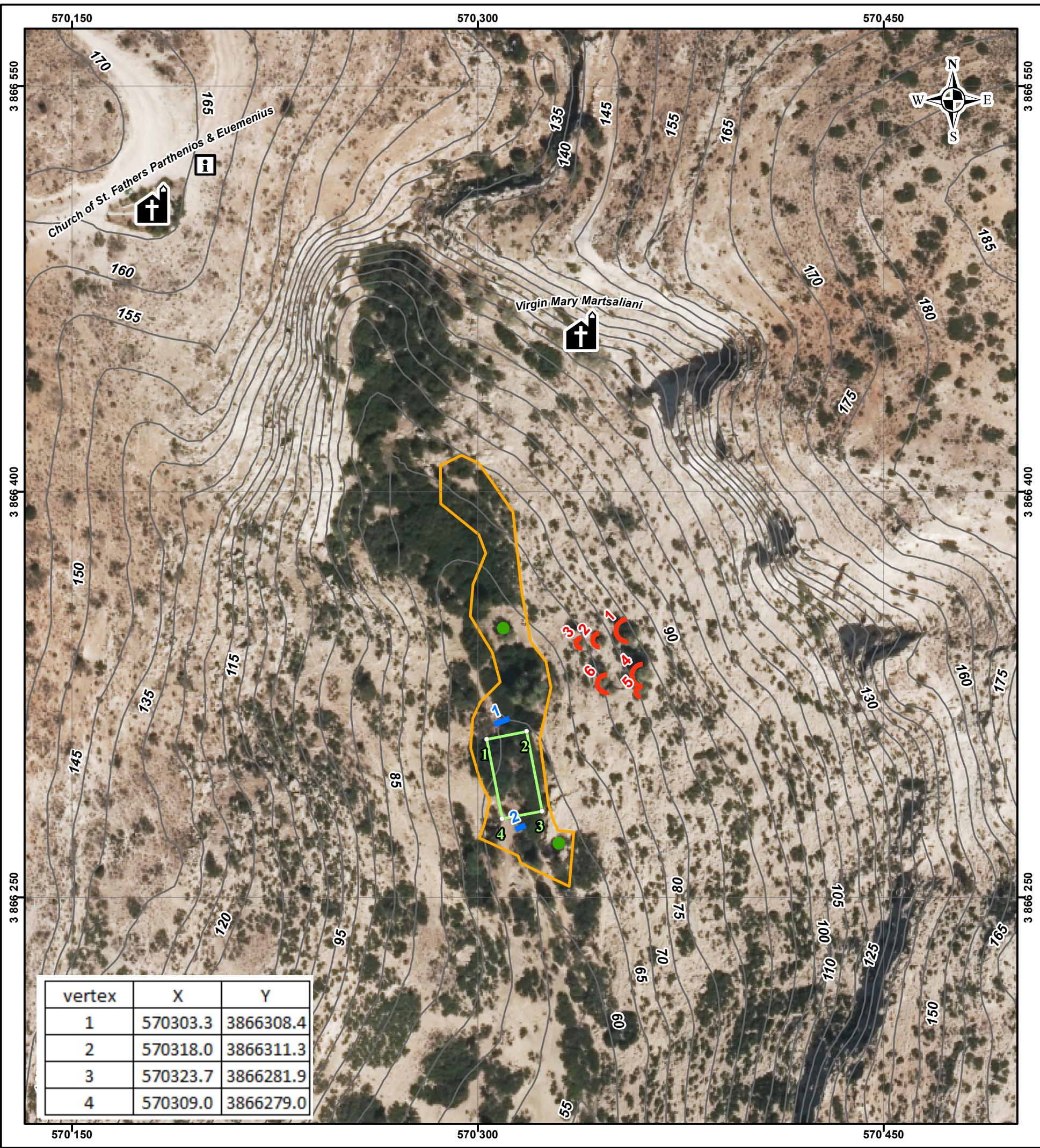
Sources: Esri, HERE, Garmin, USGS, Intermap,

**Map Production**



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HERAKLION FOREST DIRECTORATE**



**RESTORATION AND IMPROVEMENT  
OF PRIORITY HABITAT 9370\*  
PALM GROVES OF PHOENIX**

**Habitat 9370\* in Martsalos**

**Proposed Intervention Map**

**SCALE 1 : 1.500**

**Legend**

- Priority Habitat 9370\*
- 5m Contours
- Dry-stone walls
- Wire-mesh gabions for anti-erosion protection
- Information Board
- Habitat 9370\* Habitat enhancement - Fence
- Eucalyptus sp. removal

Hellenic Geodetic Reference System 1987 (HGRS87)  
Reference Ellipsoid GRS 80  
Projection Transverse Mercator

BASE MAPS  
Orthophoto Maps 1:5.000 HELLENIC CADASTRE, (aerial photos 2014-15)

Orientation Map  
Scale 1: 750.000

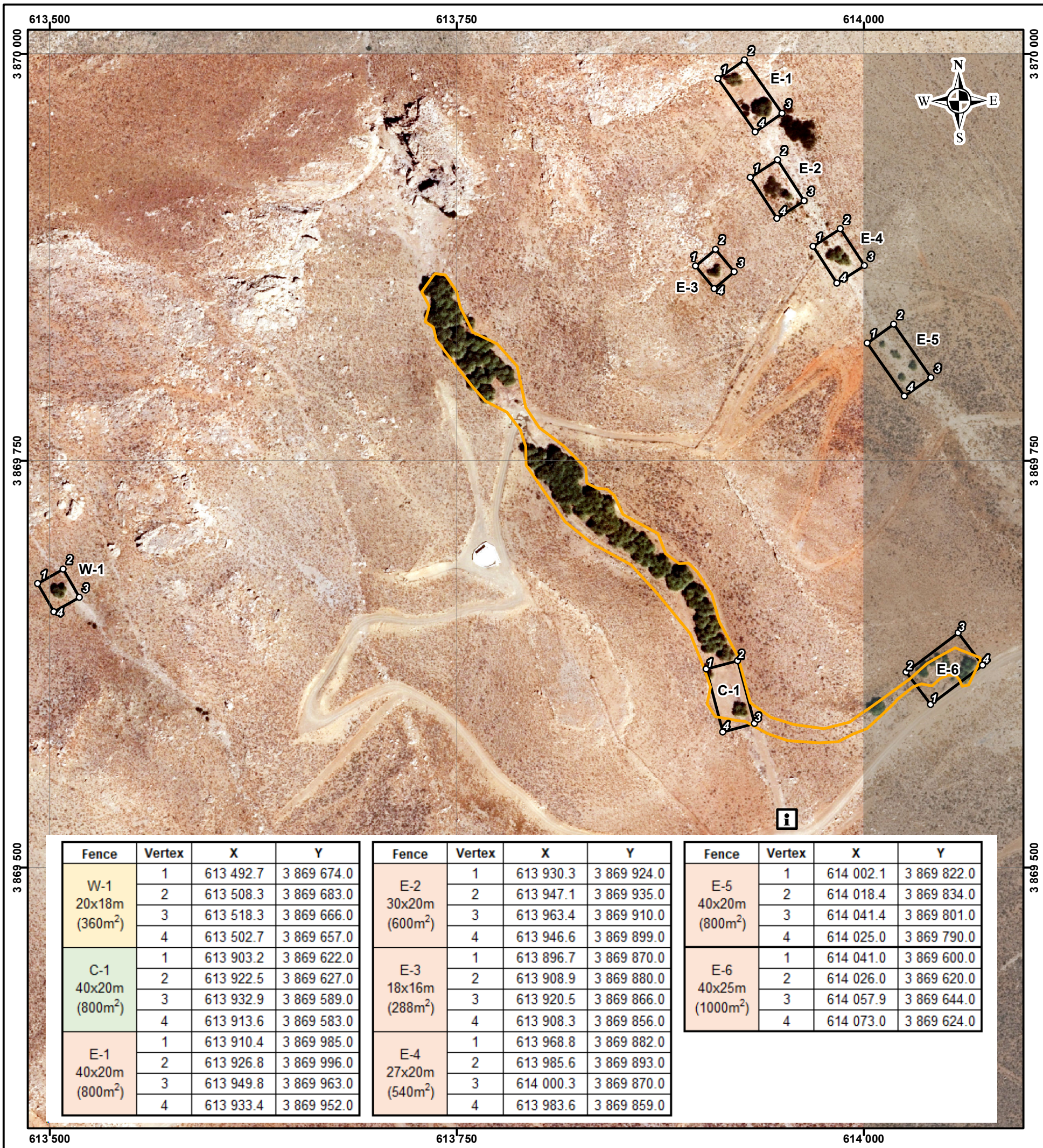


**Map Production**




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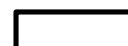

**RESTORATION AND IMPROVEMENT  
OF PRIORITY HABITAT 9370\*  
PALM GROVES OF PHOENIX**

**Habitat 9370\* in Agios Nikitas (Asterousia Mountains)**

**Proposed Intervention Map**

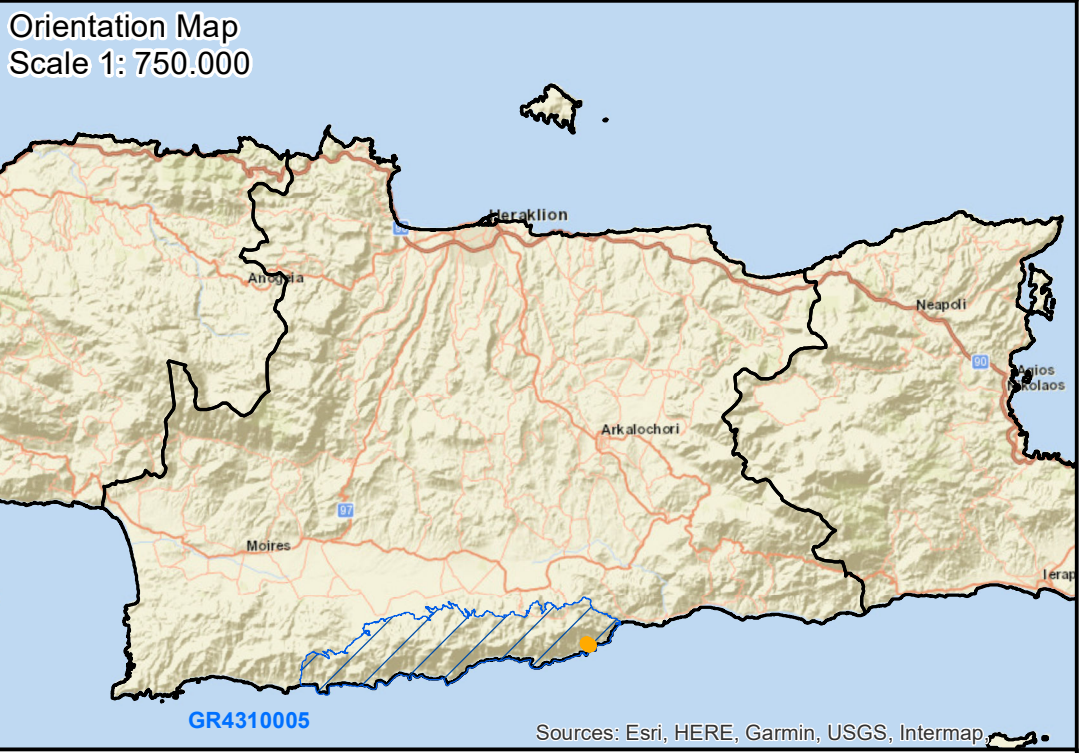
**SCALE 1 : 2.500**

**Legend**

-  Priority Habitat 9370\*
-  New Fences
-  Information Board

Hellenic Geodetic Reference System 1987 (HGRS87)  
Reference Ellipsoid GRS 80  
Projection Transverse Mercator

BASE MAPS  
Orthophoto Maps 1:5.000 HELLENIC CADASTRE, (aerial photos 2014-15)




Fence	Vertex	X	Y
W-1 20x18m (360m <sup>2</sup> )	1	613 492.7	3 869 674.0
	2	613 508.3	3 869 683.0
	3	613 518.3	3 869 666.0
	4	613 502.7	3 869 657.0
C-1 40x20m (800m <sup>2</sup> )	1	613 903.2	3 869 622.0
	2	613 922.5	3 869 627.0
	3	613 932.9	3 869 589.0
	4	613 913.6	3 869 583.0
E-1 40x20m (800m <sup>2</sup> )	1	613 910.4	3 869 985.0
	2	613 926.8	3 869 996.0
	3	613 949.8	3 869 963.0
	4	613 933.4	3 869 952.0

Fence	Vertex	X	Y
E-2 30x20m (600m <sup>2</sup> )	1	613 930.3	3 869 924.0
	2	613 947.1	3 869 935.0
	3	613 963.4	3 869 910.0
	4	613 946.6	3 869 899.0
E-3 18x16m (288m <sup>2</sup> )	1	613 896.7	3 869 870.0
	2	613 908.9	3 869 880.0
	3	613 920.5	3 869 866.0
	4	613 908.3	3 869 856.0
E-4 27x20m (540m <sup>2</sup> )	1	613 968.8	3 869 882.0
	2	613 985.6	3 869 893.0
	3	614 000.3	3 869 870.0
	4	613 983.6	3 869 859.0

Fence	Vertex	X	Y
E-5 40x20m (800m <sup>2</sup> )	1	614 002.1	3 869 822.0
	2	614 018.4	3 869 834.0
	3	614 041.4	3 869 801.0
	4	614 025.0	3 869 790.0
E-6 40x25m (1000m <sup>2</sup> )	1	614 041.0	3 869 600.0
	2	614 026.0	3 869 620.0
	3	614 057.9	3 869 644.0
	4	614 073.0	3 869 624.0

**Map Production**



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**RESTORATION AND IMPROVEMENT  
OF PRIORITY HABITAT 9370\*  
PALM GROVES OF PHOENIX**

**Habitat 9370\* in Vai**

**Proposed Intervention Map**

**SCALE 1 : 6.000**

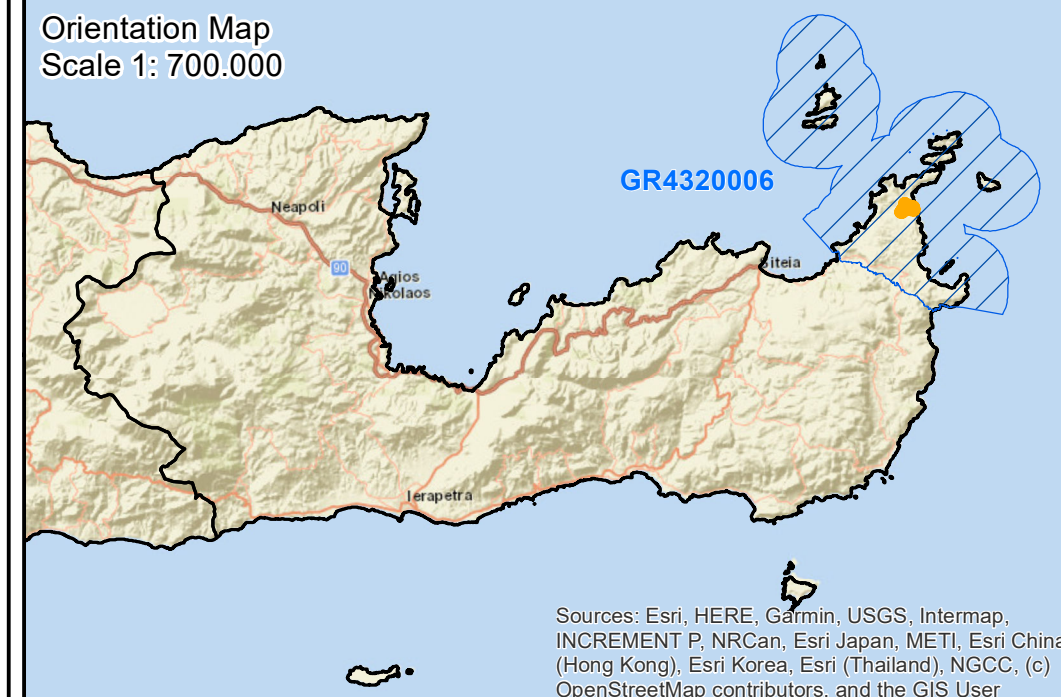
**Legend**

- Priority Habitat 9370\*
- Fences (312.5 m)
- Existing wooden structure for fence support
- Firefighting water tanks (60m<sup>3</sup>)
- Information Boards

Hellenic Geodetic Reference System 1987 (HGRS87)  
Reference Ellipsoid GRS 80  
Projection Transverse Mercator

BASE MAPS  
Orthophoto Maps 1:5.000 HELLENIC CADASTRE, (aerial photos 2014-15)

Orientation Map  
Scale 1: 700.000



Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User

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