MedMPAnet project

UNEP/SSFA/2014/DEPI/FMEB-MAP/090

REPLICATION ACTIVITY: INITIATING THE ESTABLISHMENT OF A NEW MPA IN TUNISIA

Ecological study for the creation of a Marine Protected Area (MPA) in the north-eastern part of the Kerkennah Islands in Tunisia

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LIST OF ACRONYMS AND ABBREVIATIONS

AAO	Association of Birdlovers (*Association des Amis des Oiseaux*)
ACI	Internal Cooperation Agreement
AECID	Spanish Agency of International Cooperation for Development (*Agence Espagnole de Coopération Internationale pour le Développement*)
APAL	Coastal Protection and Planning Agency (*Agence de Protection et d'Aménagement du Littoral*)
cm	Centimeters
cm/s	Centimeters per second
DEPI	Division of Environmental Policy Implementation
DGEF	Division of Global Environment Facility Coordination
EC	European Commission
FFEM	French Fund for Global Environment (*Fonds Français pour l'Environnement Mondial*)
GEF	Global Environment Facility
GIS	Geographic Information Systems
ha	Hectares
IBA	Important Bird and Biodiversity Areas
IUCN	International Union for Conservation of Nature
km	Kilometre
m	Metre
MAP	Mediterranean Action Plan
MCPA	Marine and Coastal Protected Area
MedMPAnet	Mediterranean Marine Protected Areas Network
MedPartnership	Strategic Partnership for the Mediterranean Sea Large Marine Ecosystem
MPA	Marine Protected Area
mm	Millimetre
MPD	Maritime Public Domain
m/s	Metre per second
NAP	National Action Plans
Protocole ASP/DB	Specially Protected Areas and Biological Diversity Protocol of the Barcelone Convention
RAC/SPA	Regional Activity Centre for Specially Protected Areas
SAP-BIO	Strategic Action Programme for the Conservation of Biological Diversity in the Mediterranean

SDF	Standard Data-Entry Form
SSFA	Small Scale Funding Agreement
UNEP	United Nations Environment Programme
WWF	World Wide Fund for Nature
ZICO	Important Area for the Conservation of Waterbirds (*Zone Importante pour la Conservation des Oiseaux d'eau*)

CHAPTER I: SITUATION AND GENERAL CONTEXT OF THE STUDY

I. General context of the study

The present study comes under the implementing of the MAP/UNEP-GEF Strategic Partnership for the Mediterranean Large marine ecosystem (MedPartnership), in particular its Component 3, Conservation of Biological Diversity: Implementing SAP BIO and the corresponding NAPs/Sub-component 3.1 Conservation of marine and coastal biodiversity as part of setting up a Mediterranean network of Marine Protected Areas (MPAs), the Regional Activity Centre for Specially Protected Areas (RAC/SPA) is implementing the Regional Project for Developing a Mediterranean Network of Marine and Coastal Protected Areas (MPAs) via enhancing the Creation and Management of MPAs (MedMPAnet Project).

The MedMPAnet Project is funded by the European Commission (EC), the Spanish Agency for International Cooperation for Development (*Agence Espagnole de Coopération Internationale pour le Développement,* AECID) and the French Fund for the Global Environment (*Fonds Français pour l´Environnement Mondial,* FFEM) and helps 12 Mediterranean countries: Albania, Algeria, Bosnia-Herzegovina, Croatia, Egypt, Lebanon, Libya, Montenegro, Morocco, Syria, Tunisia and Turkey.

The project aims to increase the ability to protect marine and coastal biodiversity of regional importance by setting up, in the Mediterranean region, a network that is ecologically representative, coherent and effective, backed by a regional network of managers of MPAs, according to the provisions of the Protocol on Specially Protected Areas and Biological Diversity (SPA/BD Protocol) of the Barcelona Convention.

Alongside the MedMPAnet Project, RAC/SPA and the UNEP signed a Small Scale Funding Agreement (SSFA). On the basis of the Internal Cooperation Agreement (ICA) between UNEP/MAP and UNEP/DGEF (now a part of UNEP-DEPI), UNEP has committed to cooperating with RAC/SPA on the project/programme entitled Strategic Partnership for the Mediterranean Greater Marine Ecosystem – a regional element of actions implemented for the protection of the environmental resources of the Mediterranean and its coastal areas (MedPartnership) – in thirteen Mediterranean countries.

The main aim of this SSFA is to undertake additional activities to boost the best ‘Replicable Practices’ for the creation of MPAs in the Mediterranean. The original project of MedPartnership, allocated resources for this purpose and replication activities were presented, discussed and endorsed by the 4th Steering Committee Meeting of the MedPartnership (Hammamet, Tunisia, February 2014).

Today the north-eastern part of the Kerkennah Islands has the status of sensitive coastal area, and constitutes one of the five sites chosen to enjoy Marine and Coastal Protected Area (MCPA) status by the National Programme for the Creation of Marine and Coastal Protected Areas in Tunisia, run by the Coastal Protection and Planning Agency (APAL), which is part of national policy on biodiversity as defined by the National Plan for Biodiversity approved in 1998, which aims to set up a network of Protected Areas along the Tunisian coast.

Sensitive coastal areas were defined by the law that created APAL as '*spaces which characterize the national natural heritage, presenting an ensemble of elements in a fragile ecosystem and constituting an outstanding natural landscape, threatened by degradation or unreasonable use and subjected to human-origin pressure that risks destabilising them*'.

1. Assessing the current situation

MCPAs in Tunisia have gone beyond their legal framework. MPAs were born before the Law of 21 July 2009 on MCPAs was passed.

The national programme for MCPAs selected five sites and involved two stages. The first was the creation of the National Park of the Galite archipelago. The second saw the extension of the MCPA network, i.e. the setting up of four other sites – the islands of Zembra and Zembretta, the Kuriat Islands, the north-eastern part of Kerkennah and the coast from Cap Negro to Cap Serrat.

With the passing of Law no. 2009-49 of 21 July 2009 Tunisia finally enjoyed a specific framework for these areas. The law defined them and clarified their legal system, more rigorous than that of the littoral or of the Maritime Public Domain (MPD). The main provisions were inspired by international norms on the subject, particularly those established by the International Union for the Protection of Nature (UICN).

The definition of a MPA according to Article 2 of the above-mentioned Law of 21 July 2009 states that 'Within the sense of the present law, 'marine and coastal protected areas' is understood as meaning the areas designated by the law with a view to protecting natural environments, flora, fauna, marine and coastal ecosystems of particular interest from a natural, scientific, instructive, recreational or educational point of view or which constitute outstanding natural landscapes that must be protected' (Source: Official Journal of the Tunisian Republic, JORT No. 58).

This broad definition expresses the difficulty regional and international instruments have in defining MPAs.

The Kerkennah Islands are classed as a nature reserve. This archipelago is a major migration route for birds crossing the Mediterranean between the Gulf of Gabès and southern Italy. The site has since 2001 been listed as an Important Zone for the Conservation of Waterbirds (ZICO) by Bird Life International and the Association of Birdlovers (AAO) (Bird Life International, 2015). From 2001 the north-eastern part of the site has seen a MPA set up there.

In this context, to help craft a zoning plan for outstanding marine habitats that will be a basic tool for crafting a management plan for the marine part of this future MCPA, a first phase concerning a management study for the sensitive zone of Kerkennah's north-eastern islets was carried out in 2001 by APAL; it aimed at understanding the spatio-temporal evolution of the site and identifying natural evolution scenarios. During this phase, the results obtained allowed the site's state of equilibrium to be determined, potential risks it could encounter to be identified, and potential and skills to be assessed as to development within the contexts of environment protection and making best social, economic and cultural use of it.

The present work, which complements that done in 2001 by APAL, aims at supplying further information on the natural elements of heritage value that lie around the islands of the concerned zone. Particular attention will be paid to the characterization and mapping of the meadows of the marine phanerogam *Posidonia oceanica* L. (Delile), species and habitats that are of Mediterranean importance, especially those appearing in the Annexes to the SPA Protocol. A Standard Data Form (SDF) for national inventories of natural sites of conservation interest will also be filled in.

2. Geographical situation and general introduction of the sensitive area north-east of the Kerkennah Islands

Lying between 11° and 11° 20' east of the Greenwich meridian and between 34° 36' and 34° 50' latitude north, at the entrance to the Gulf of Gabès in the south-east of Tunisia, the Kerkennah archipelago (*Qarqna*) lies about twenty kilometres (12 miles) from the Tunisian coast, about the level of the town of Sfax. There are two main islands, Gharbia (Dzira or Mellita) in the south-west, covering 49 sq. km., and Cherguia (or Kerkena) in the north-east, covering 110 sq. km. The latter is itself surrounded by a dozen islets (e.g. Charmandia, Sefnou, Roummadiya, Rakadiya, Lazdad, Gremdi, Haj Hmida). This is a flat archipelago with low steppe lying from south-west to north-east over about thirty kilometres but only including an area of about 160 sq. km. because it is so narrow – on these strips of land no point is more than 5 km. from the shore, whence the importance of the sea in the natural landscape and its evolution and, far back in time, in the lives of the inhabitants of Kerkennah (Trousset, 2005).

The two islands are linked by a raised path built above the old Roman road called El Kantra.

They are planted with palms all less than twenty metres tall. In the north-east of the Kerkennah archipelago, five islets extend the main island.

The study concerns the north-eastern part of Kerkennah, off the big Chergui island, none of which is more than 4 metres high (peak, Sefnou). This sector, and the contiguous marine part, contains five islets (Fig. 1).

• **Gremdi** is the biggest (about 196 hectares). It lies 900 m. east of El Attaya. It is now farmed intensively with olive trees, palm trees and cereal and fodder crops, annual crops that depend a lot on rainfall

• **Roumadiya** is an islet (about 167 hectares) lying 1.3 km. north-east of the Enf Erkik peninsular. It is the lowest islet, with a maximum height of I metre. 46% of its surface area is *sebkha* (Fig. 2)

• **Ramadiya** is also a flat islet with a surface area of 4.8 hectares, lying 2 km. west of the Enf Erkik peninsular. 38% of its surface area is *sebkha* and the rest is covered by maquis and brush

• **Sefnou** is an uninhabited islet (about 53 hectares) lying 1 km. north-east of Rass Bou Nouma. It is sometimes used for cereal production or grazing

• **Charmadia** (about 3.3 hectares) lies 3 km. north of Chargui Island. It is uninhabited and covered by maquis and brush.

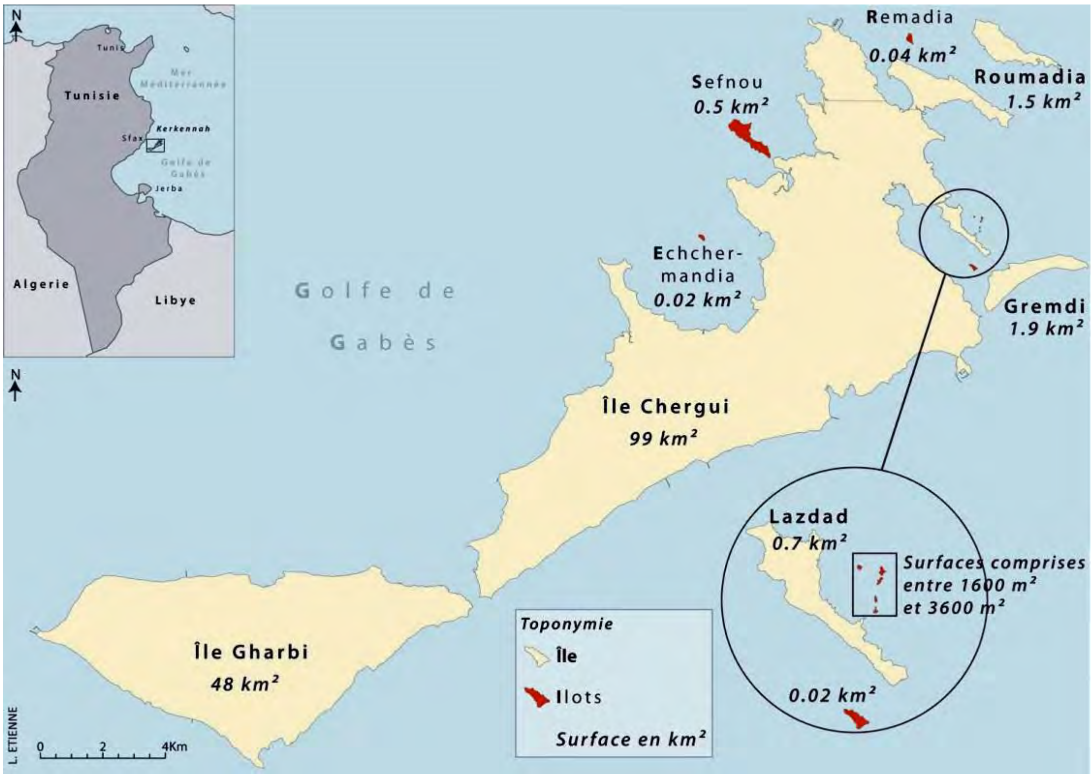

Fig.1. Location-toponomy-surface area of the islands and islets of the Kerkennah archipelago (Source: Etienne, 2014)

Fig. 2. General view of Roumadiya islet

CHAPTER II: PHYSICAL CONTEXT OF THE KERKENNAH ISLANDS

I. Topographical, geomorphological and oceanographic context

1. Origin, geological formations, geomorphology

The archipelago broke off from the continent during the latest phase of warming, which caused a rise in the sea level, accentuated in the archipelago by major subsidence that continues today (Paskoff & Sanlaville, 1983; Oueslati, 1986). The islands of the archipelago fall within the category of disarticulation islands according to the classification of islands by Aubert de la Rüe (1935) adopted by Bernardie and Taglioni in 2005. This classification is based on how they were formed and their distance from the continental mass (Etienne, 2014). They are cut off from the continent by difference in sea level, dependent and continental since geologically part of the continent. Lying in the Gulf of Gabès, the Kerkennah archipelago emerges from the continental shelf west of the town of Sfax (Etienne, 2014).

The archipelago is characterized by an impressive opposition between the very straight eastern coasts and the very indented western and northen coasts. These morphological features are due to two causes: first, the western coast is exposed to active dynamics, particularly the persistence and dominance all year round of northern and north-western swells, and then to neotectonic movement, particularly the N60[1] accident that are responsible for the rectilinear aspect of the Kerkennah Islands coast.

The geomorphological features of the shore in the Kerkennah Islands show that the 162-km.-long coasts are made up of 95 km. of *sebkha* edging, 43 km. of rocky cliffs, and 24 km. of sandy-clayey cliffs. This topography is the submerged extension of the continental topography.

2. Underwater topography and bathymetry

The archipelago’s topography is very low-lying, hardly emerging from a vast area of shallows in the Gulf of Gabès – the highest point is 13 metres above sea level. The archipelago is characterized by wide saline depressions, *chotts* or *sebkhas*, today unsuitable for agriculture, alternating with fairly marked relief that corresponds to Quaternary calcareous crusts partially covered by the Aeolian sand and themselves covering the red Mio-Pliocene clayey formations that the sea cuts into cliffs on the western coast (Trousset, 2005).

The islets in the north-east of the archipelago off the big island of Chergui are uninhabitable because there are no water spots, but until recently they, particularly the two bigger islets (Roumadiya and Gremdi) were used to graze herds and to plant fig and olive trees (APAL, 2001).

The coasts of the Kerkennah archipelago are mostly low-lying and the highest cliffs reach a maximum 11 metres. Its coasts are fairly varied, from the very exposed open cliff to the

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[1] These are bundles of faults in the North 60 tectonic direction, local overlappings or slidings, side by side with the Atlas direction that corresponds to the Atlas folds that took shape in the Tortonian (-11 MY).

maritime marshes in sheltered places. On the south and west fronts of the islands the coastline is more rectilinear. These coasts are also protected from the heavy swells, which are relatively rare, by a slope lying a few hundred metres from the shore. These natural obstacles form protective breakwaters. But on the northern front, the coastline is very jagged (Fig. 3) because eroded by sea storms caused by the strong winds that come in from the north or north-west (Dahech, 2007). The height of the archipelago's cliffs varies from a few centimetres to about 11 metres (Jorf). The cliffs are all active, which indicates current erosion of the coasts. The lowest coasts are made up of beaches and outlets of *sebkhas* or maritime marshes.

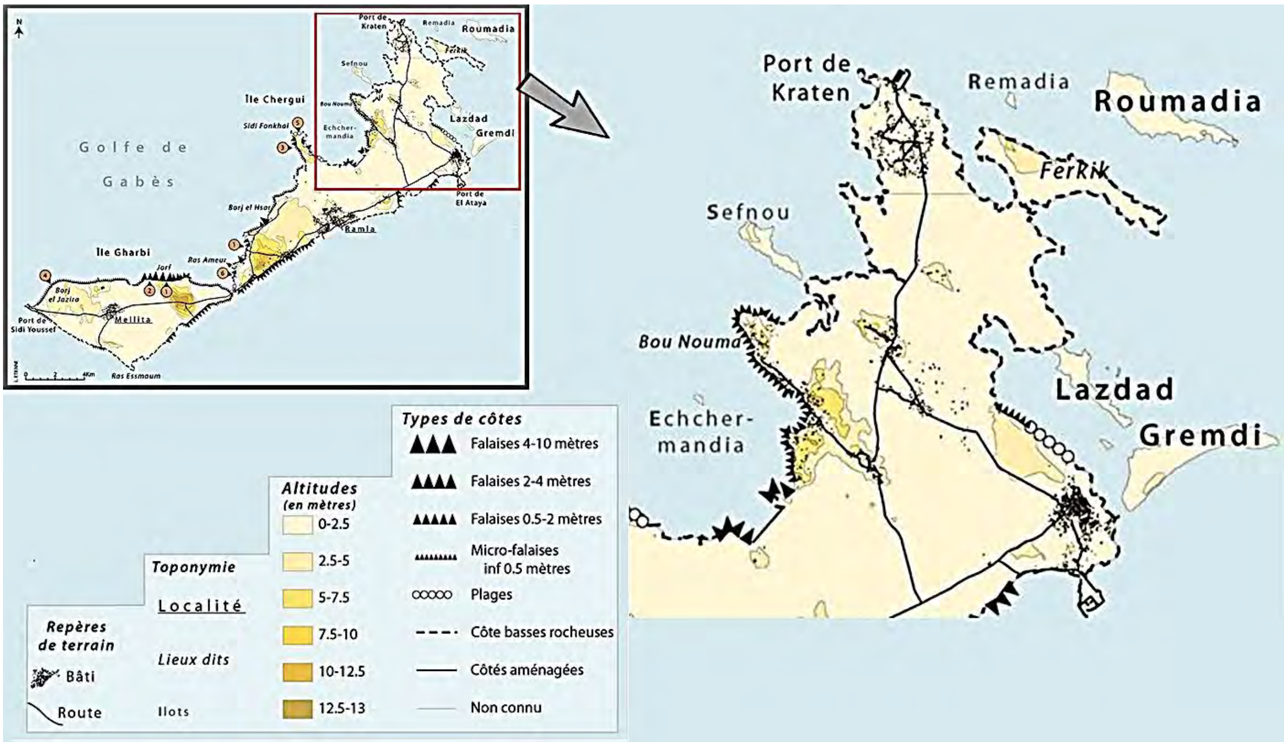


Fig. 3. Types of coast in the area of study (From Etienne, 2014, modified)

3. Littoral morphology, nature of coastal beds and bathymetry

The archipelago lies over the continental shelf of the Gulf of Gabès and represents the dry part of a vast underwater plateau whose shallows extend 9 to 50 km. around the islands. These are the shallows that in 1936 Jean Despois called the 'Kerkennah banks'. The bathymetry is very low and the depth usually varies between 0 and 5 metres but is more frequently under 2 metres (Fig 4). It can be 20 m. in the channels and 30 m. in the trenches. The 200 metre isobath is sometimes found nearly 400 km. from the coasts of the archipelago. The underwater beds of the area considered correspond to the greatest width of the country's continental shelf, with a considerable advance in the Kerkennah Mole with depths of under 50 m. over the Tunisian Shelf, where the break in the slope lies between 150 and 300 m. (Pergent & Kempf, 1993).

The islands are surrounded by shallows, cut up into channels that can be up to 13 metres deep, hard of access for craft other than the flat-bottomed boats (*felouka* or *loudes*) used since classical times by the people of the eastern coast of Tunisia.

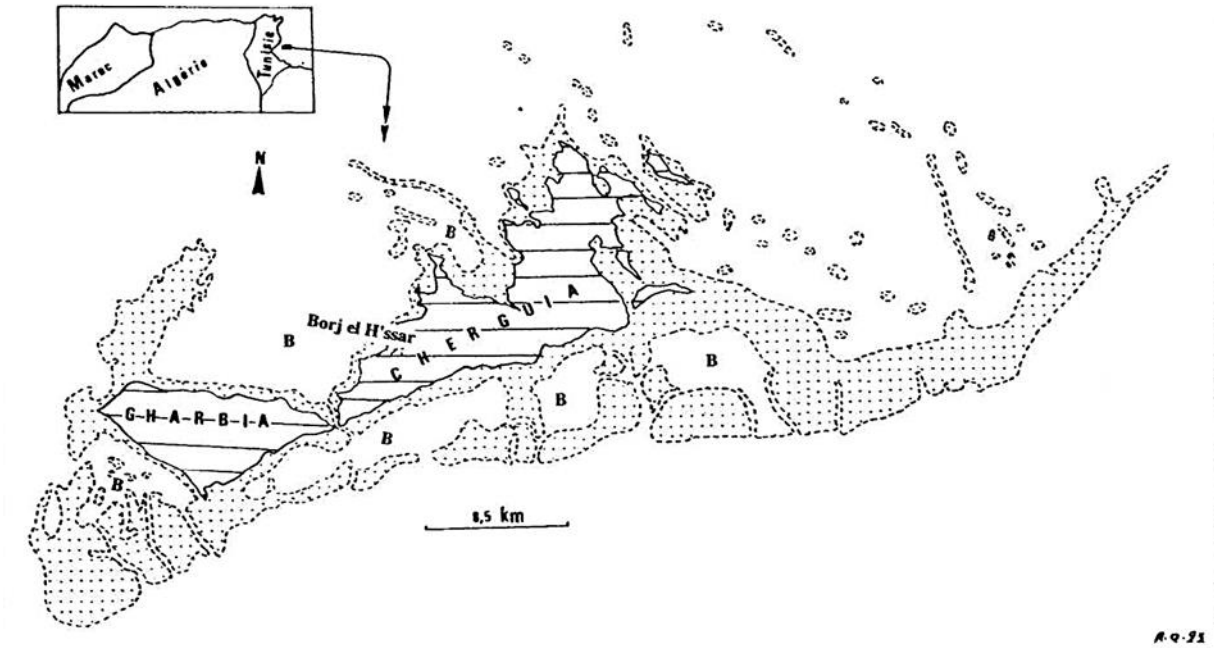


Fig. 4. Map of the Kerkennah islands and their shallows between 0 and -2 m. (dotted lines) and the *bhirats* (B) (From A. Oueslati, 1995)

This stretch of shallows that encompass the archipelago takes full size in the north, from Ras Kaboudia (Cap Brachodes or the classical Caput Vada) where the 40 m. isobath goes out up to 65 m. from the coast and is extended in the south up to the Mahrès latitude. Two main channels, those of Louza and of Sfax, penetrate it in the north and south respectively, between the islands and the continent (Trousset, 2005). The origin of these channels is controversial; perhaps they are former beds of rivers dating from the time when the Kerkennah islands were in a continental position, or perhaps tidal channels (Oueslati, 1986) now taken by underwater currents.

4. Coastal morphology

The archipelago is characterized by the striking opposition of its very rectilinear western coasts and its very jagged northen ones. These morphological features are essentially due to the west coast's exposure to the active dynamics provoked by the permanent swell of the northern and north-western sector on the one hand and the active neotectonic play on the other (APAL, 2001). The coastal morphology of the islets is varied; there are four types of coast – cliffs, rocky coasts, beaches and coasts with maritime marshes.

- The cliffs: These are forms of erosion resulting from the dynamics of the swell. These cliffs model the greatest part of the coast, revealing the fragility of the archipelago, and are usually small, rarely more than 3-4 metres and very varied in their lithology and modelling (Fig. 5). In the north-eastern part, little cliffs, like those of Sefnou, Gremdi and Roumadiya, can be seen

Fig. 5. Low-lying coast with micro-cliff (between 0.5 and 1 m. high) showing plant debris thrown up as wrack (*Cymodocea nodosa* and *Cystoseira* sp.)

- The low rocky coasts: These are also numerous, basically in the north-east of the archipelago and are always cut into carbonate rocks

- The beaches, holding a very secondary place in the islets, are usually located at the bottom of coves or the foot of cliffs. They are also very thin and narrow and thus very vulnerable

- The maritime marshes develop over low coasts with very little slope, sheltered from the strong currents, which allows fine material to be stored or turned into the soil of the *sebkhas*. They occupy a much greater place than the beaches, and they often include two main spaces: the first, nearest to the sea and always damp, is made up of the finest, often silty, materials and has no vegetation; this is the *slikke*. The second, lying higher, can also be covered by high tides and is covered with a carpet of halophilous plants like Salicornia (Fig. 6); this is the *schorre* (Etienne, 2014). Everywhere they show signs of erosion and are sometimes subject to sizeable withdrawal. The ensemble of marine marshes is criss-crossed by tidal channels permitting the outflow of seawater (Verger, 1995). Marine deposits and tidal channels enable the development of halophilous vegetation at their edges (Etienne, 2014).

Fig. 6. The *sansouires* (salt marshes), a characteristic plant formation composed of halophilous plants – here Salicornia; ripple-marks on the sand caused by currents are clearly visible

The islets all present a similar coastal morphology; at the level of different islets, common features can be made out (Fig. 7).

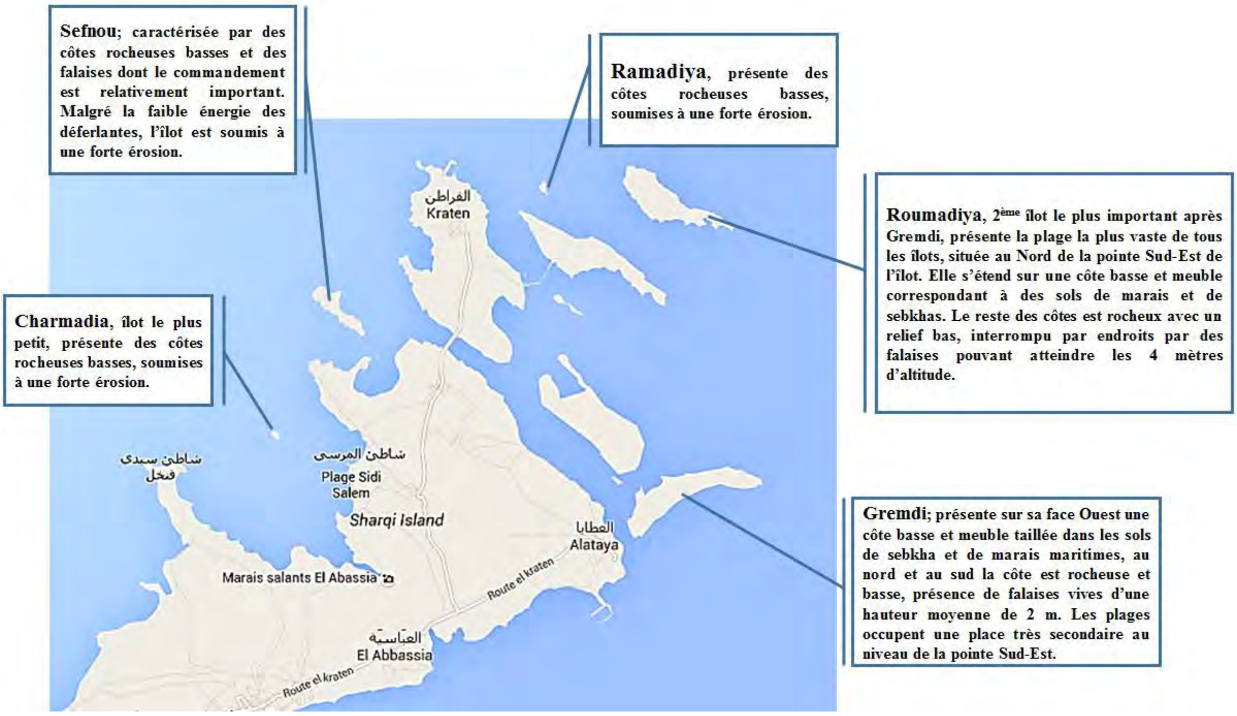


Fig. 7. Main features of the coastal morphology of the islets lying north-east of the Kerkennah archipelago

5. Nature of the coastal beds

Strictly speaking, the Kerkennah platform is a vast platform of 2-3 metres depth. The morphology of the Kerkennah platform is very complex, characterized by silty stretches or *bhirats*, belts or *tsirs*, and tidal channels or *oueds* (APAL, 2001; Etienne, 2014). There are:

5.1. The *bhirats* or silty stretches

These are depressions lying parallel to the east coast whose depth varies from 2-3 metres and can be greater than 5 m. They contain very still water and are usually surrounded by belts of Posidonia (*Posidonia oceanica*) that protect them from the violence of the water and encourage the sedimentation of fine particles. This configuration allows certain species of marine phanerogam, such as Cymodocea (*Cymodocea nodosa*) and weed like Caulerpa (*Caulerpa prolifera*) to settle and cover the bed, forming vast meadows that favour the reproduction of different animal species.

Along the eastern coast of Chergui four silty stretches can be identified; the biggest are Bhiret El Abbassia and Bhiret El Gremdi. These meniscus-shaped *bhirats* lying parallel to the coasts open onto the open sea via *oueds* or tidal channels (APAL, 2001).

In the north of Chergui, the biggest *bhirat* has an average depth of 4 metres but can be even more than 5 metres. It separates the northern islets (Roumadiya) from the zone called Hmadet El Babouche. In the west of Chergui, there are two: *Bhiret* Sefnou and *Bhiret* Sidi Fredj. These *bhirats* are completely surrounded by belts – *tsirs* (APAL, 2001).

5.2. The Posidonia belts or *tsirs*

These are narrow belts of Posidonia and sometimes Caulerpa meadows, not at all deep, that can surface at low tide, and are several kilometres long. Also called banks, these belts, which separate the silty stretches from each other, are made up of biogenic shell debris.

According to APAL (2001), two categories of bank have been identified:

Ba*nks running parallel to the coast*: Parallel to the eastern coast a long belt extends from the Ras El Besch promontory in the south-west to Sekiet Hmida, where it takes a north-north-easterly direction. The belt, about 77 kilometres long, goes round the platform to the south and the north. The shallows of this belt come within a few dozen centimetres of the surface at low tide. Further out, the break in the slope starts and quickly reaches the -5 and -10 metre isobaths. This long belt is interrupted by very narrow passages that open onto the *oueds* that lead out to sea.

North-east of Chergui, the biggest platform of the Kerkennah platform presents banks oriented north-west/south-east parallel to the coast like that of Roumadiya, on which is the island of the same name (APAL, 2001).

Banks running perpendicular to the coast: These are special in that they start from the island and extend towards the marine domain in the shape of littoral sedimentary constructions (arrows) or continental ripple-marks.

East of the archipelago these banks join the coast to the main bank that is parallel to it. They thus separate the *bhirats* from each other. In the west, the banks are wider and mark out the silty stretches (APAL, 2001).

5.3. The *oueds* or tidal channels

These *oueds* present long often winding depressions 5-12 metres deep and act as 'providers of fine sediment' that is deposited at the bottom of the *bhirats* and whose slopes are occupied by dense lawns of Caulerpa. The biggest is Oued Mimoun through which boats can approach the little fishing port of El Attaya (Trousset, 2005); higher than this *oued* come together four secondary *oueds* linking it to the *bhirats* of Al Abbassia and El Gremdi. Other *oueds* of equal size are Essmoum, Saâdoun, or Bouzrara (APAL, 2001). All the oueds (12 in all) lie to the east of the islands. They cut the big bank perpendicularly and act as outlets from the *bhirats* onto the open sea.

There are strong currents in these *oueds* (2-3 knots in the channels) (Pergent & Kempf, 1993). In Oued Mimoun, in times of neap water, the currents are no faster than 0.75 $m.s^{-1}$. In the narrowest passages and during the spring tides, they can reach 1.5 $m.s^{-1}$. In the *oueds* are shoals of fishes and dolphins that swim up the channels when the tide is rising and swim down them during the ebb tide. The *oueds* also act as navigation channels for boats and are the only way of getting out to sea (Gulf of Gabès) (APAL, 2001).

6. Hydrodynamic conditions

6.1. The tides

These are hardly noticeable on most Mediterranean coasts but the Kerkennah archipelago, Sfax and the Gulf of Gabès area is an exception to the rule, with significant periodic variations in sea level. The tide is semi-diurnal. Its size is greatest at the bottom of the Gulf (on average 1.8 m. in spring tide and 0.3 in neap water in 1991 (Pergent & Kempf, 1993) and dwindles on its periphery. Around the Kerkennah archipelago, the existence of a vast shallow plateau, covered with Posidonia meadows (and Cymodocea) modifies the advance of the tidal wave.

On the coasts of the Kerkennah archipelago, there is a considerable tidal range, and at the height of the spring tides (1.30 metres) the lowest parts, the *sebkhas*, are partially submerged (Paskoff & Sanlaville, 1983). The size of the tide varies from one region to the other according to the phase of the tidal cycle (Table 1).

Table 1. Variation of size of tide according to tidal cycle (From Bejaoui, 1988)

	Spring tide	**Neap water**
Low water	20-30 cm	50-80 cm
High water	90-120 cm	70-80 cm

6.2. Currents and swell

The water around the Kerkennah archipelago is subject to a mixed (eastern and western) influence. The influence of the Atlantic water characterizes the area in spring, whereas in the autumn there is an opposite trend marked by the arrival of the eastern flow. (Brandhorst, 1977)

In this area there are four kinds of current: currents due to the wind, tidal currents, swell currents and general currents. Wind-driven currents are very feeble in the Sfax roads, no greater than 0.5 $m.s^{-1}$ even in winter (north-west to south-west winds) and spring (north to north-north-east winds).

The seabeds are not deep and the presence of tidal channels causes powerful currents of 1.03 to 1.54 $m.s^{-1}$ in the underwater *oueds* (Pergent & Kempf, 1993), and thus good renewal of the waters as well as a sizeable tide (Fig. 8). This favourable environment has since classical times allowed a strong development of halieutic populations and thus a flourishing fishery activity (Slim *et al.*, 2004). Tidal currents are linked to the period of the tidal cycle and to morphological constraints.

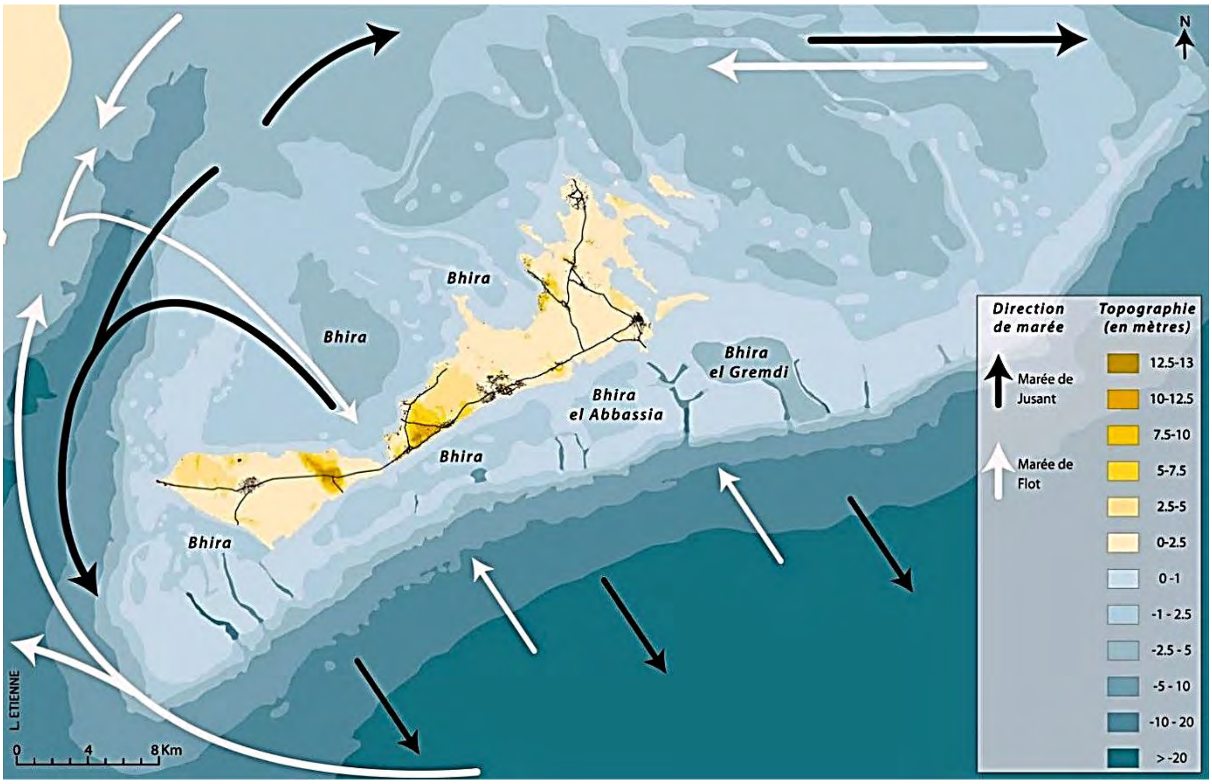


Fig. 8. Underwater topography, main currents and tide in the Kerkennah archipelago (Source: Etienne, 2014)

Four different dynamics dominate the coasts of the archipelago: i) the west to north-west swells give rise to a drift current going from north-west to south-east. The movements of water masses provoke either the erosion of the coast or the accumulation of sediment. Decanting happens in the bays of Sefnou and Charmandiya; ii) the northern swells give rise to a littoral drift divided into two branches that hug the northern coasts of the archipelago. This movement is also at the origin of a very pronounced erosion of the northern coasts of Chergui, particularly near Roumadiya; iii) the swells cause a littoral drift with low-intensity spread, usually cushioned by the belts lying parallel to the coast; there is therefore little erosion; iv) the south-western swells give rise to a drift current going from south to north. The drag is in the same direction, thus causing areas of sedimentary deposit in the bay of Charmandiya and the islets of Roumadiya and Gremdi (Geoid, 2001).

Sheltered by the Kerkennah Islands and the shallows that lie all round, the swells from the open sea are cushioned as they spread to the Sfax littoral (APAL-WWF, 2006). This phenomenon is strengthened by the presence of Cymodocea prairies and Posidonia meadows.

CHAPTER III: STRATEGY SELECTED FOR INVENTORYING AND ASSESSING HABITATS AND SPECIES

I. Chronological schedule for the assignment

The field campaign took place between 19 and 29 July 2015, using two fishing boats. During this assignment, the organisation and coordination of the activities was done by the representatives of RAC/SPA.

Apart from the days 23, 25 and 26 July 2015, when the meteorological conditions were unfavourable for prospecting, the sea was calm and the observations took place in good conditions.

Sunday 19 July

- Trip, Tunis-Monastir-Sfax-Kerkennah Islands
  - ✓ Departure: 8.30; arrival: 20.30
- Check-in at the Cercina Hotel

Monday 20 July

- Checking the terrain
  - ✓ 8.00 sail out from the El Attaya port
  - ✓ 17.00 return to the port
  - ✓ Prospecting the points
  - ✓ Initiating the team into prospection work
- 21.00 Debriefing; planning the next day’s prospecting

Tuesday 21 July

- Checking the terrain
  - ✓ 7.40 sail out from the El Attaya port
  - ✓ 12.30 return to the port
  - ✓ Prospecting the points
- 20.00 Debriefing; planning the next day’s prospecting

Wednesday 22 July

- Checking the terrain
  - ✓ 7.00 sail out from the El Attaya port
  - ✓ 12.50 return to the port
  - ✓ Prospecting the points
- 20.00 Debriefing; planning the next day’s prospecting

Thursday 23 July

- No field work because of bad weather conditions
- Start reconstructing the previous days’ data

- Packaging the samples gathered

Friday 24 July

- Checking the terrain
  - ✓ Forming work groups
  - ✓ 6.06 sail out from the El Attaya port
  - ✓ 13.50 return to the port
  - ✓ Prospecting the points
- 20.00 Debriefing; planning the next day's prospecting

Saturday 25 July

- No field work because of bad weather conditions
- Reconstructing the previous days' data
- Packaging the samples gathered

Sunday 26 July

- No field work because of bad weather conditions
- Reconstructing the previous days' data
- Processing the samples gathered
- Planning the next day's prospecting

Monday 27 July

- Checking the terrain
  - ✓ Two work groups
  - ✓ 6.55 sail out from the El Attaya port
  - ✓ 15.25 return to the port
  - ✓ Prospecting the points
- 20.00 Debriefing; planning the next day's prospecting

Tuesday 28 July

- Checking the terrain
  - ✓ Two work groups
  - ✓ 6.30 sail out from the El Attaya port
  - ✓ 13.30 return to the port
  - ✓ Prospecting the points
- 16.00 Debriefing
- From 18.00, preparing the equipment and processing the samples with a view to returning to Tunis

Wednesday 29 July

- Return to Tunis via Sfax
  - ✓ 8.30 leave Kerkennah
  - ✓ About 15.00 arrive in Tunis; hand over the equipment to RAC/SPA

II. Site of the study

The zone chosen for the study falls within the perimeter of the future MCPA in the north-east part of the Kerkennah Islands archipelago (Fig. 9). It stretches from 34°48'47.70"N, 11°17'46.30"E to 34°46'7.66"N, 11°22'17.98"E and covers an area of almost 40 sq. km. It was chosen for the present study by APAL and MedMPAnet.

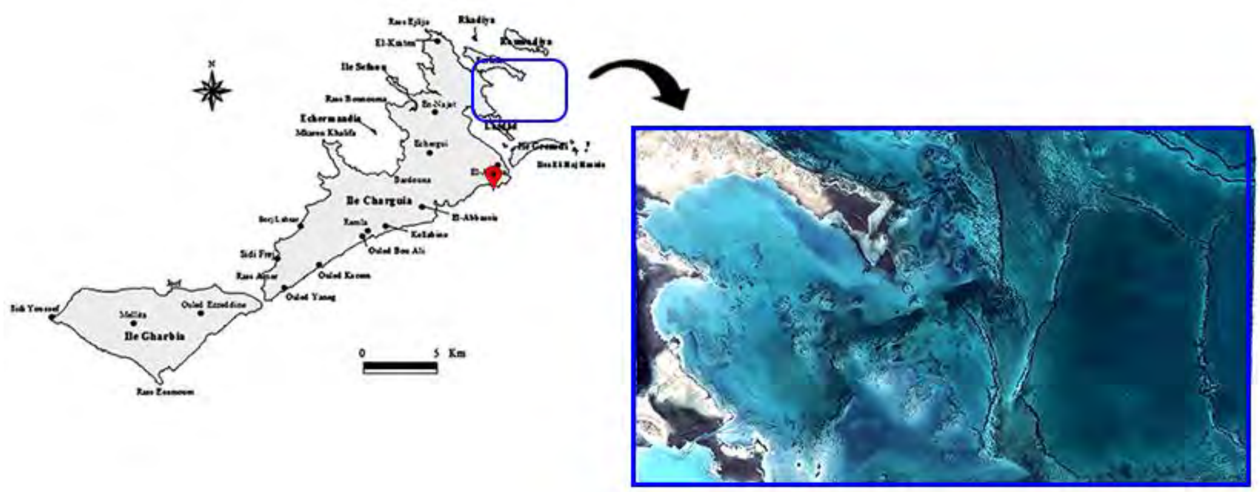


Fig. 9. Locating the area of study in the north-eastern part of the Kerkennah archipelago

III. Methods of study

In order to cover the entire area of study within the given time, the method of prospecting chosen was based on the transect technique. The transects were predefined from a study using satellite imaging. They were drawn over the image in an attempt to pass through a maximum of specific points corresponding to different shades of colour, shapes and textures. In all, almost 2,000 stations were explored by boat or on foot according to the depth, using a caulked window (Fig. 10), and 10 sites were inventoried by diving with or without an aqualung.

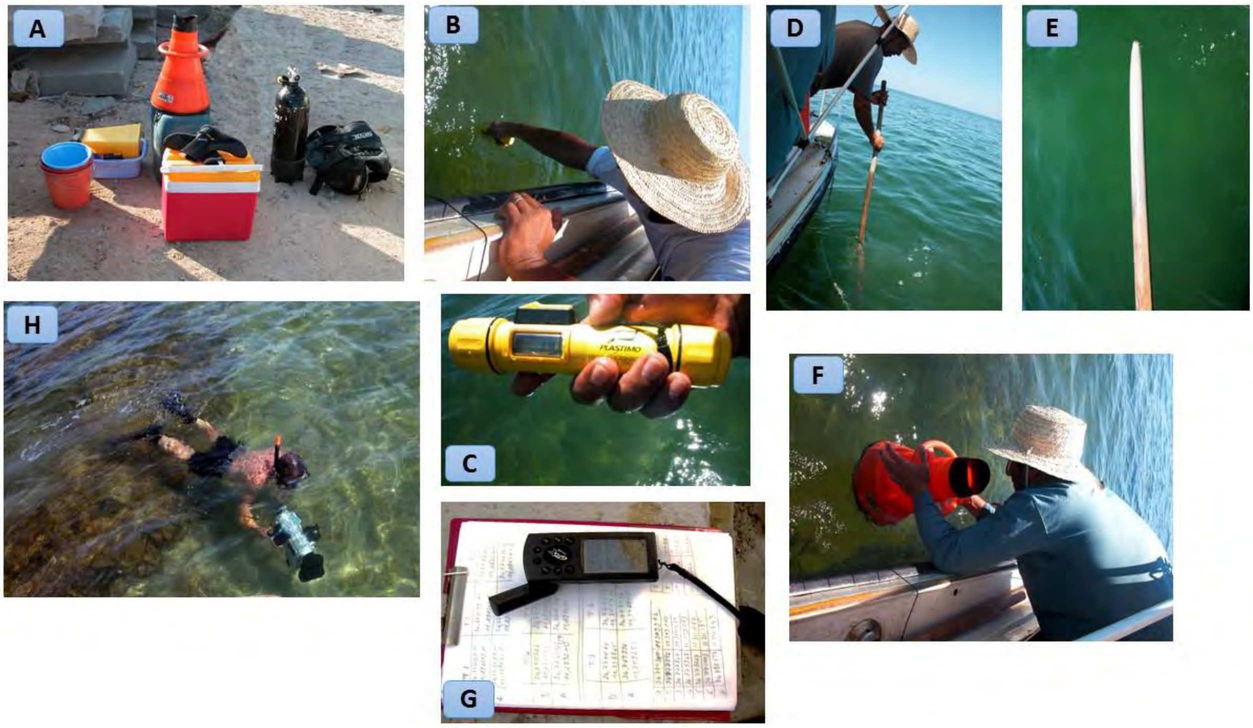


Fig. 10. a) Various equipment used; b) and c) Hand sonar used for bathymetric measuring; d) Navigation rod used to determine the type of bed; e) Tip of the rod coated with silt; f) Observations using a caulked window; g) GPS and slate; h) Underwater shot

The explorations concerned the beds lying between 0 and 2 metres down. The stations' depths were measured using an Echotest II Plastimo sounder.

Each station was precisely located using a GPS (Global Positioning System 72H and GPSMAP 176C from Garmin) and the main biocenoses and bed types encountered were recorded (Annex 1). The nature of the seabed was determined using a navigation rod.

Photographs were taken of the main biocenoses and species observed. Several algae, particularly species of the genus *Cystoseira*, were sampled for later identification and about thirty *Posidonia oceanica* fascicles were gathered at a depth of about 1 metre to carry out a phenological and lepidochronological analysis (Plate 1). *In situ* measurements were taken of the density of the Posidonia meadow by counting the number of fascicles within a standardised 20 cm.-sided square. Three sets of 20 countings were taken, and the results expressed as number of fascicles per square metre (Plate 1).

The main biocenoses observed were mapped by processing an image obtained from the Pleiades satellite (Airbus Defence and Space), ortho-rectified (DIMAP format), and taken on 8 March 2012 with a resolution of 0.5 m. (pixels)

The image was processed using the Exelis ENVI 5.0 and ESRI ArcMAP 10.2 software. Given the large size of the picture (>700 Mo) and the large surface area covered, the image was cut up into 24 equal-area bits (Fig. 11).

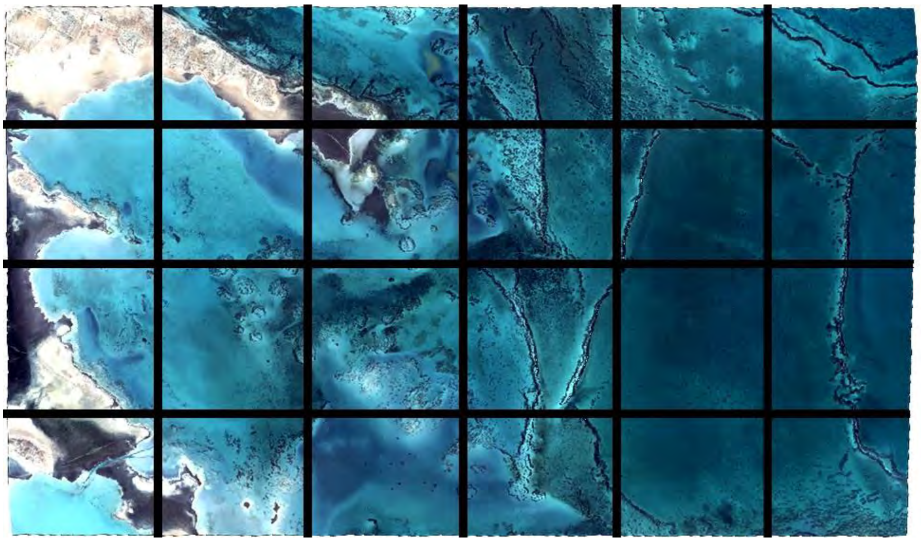


Fig. 11. Satellite image of the area studied cut up into 24 bits

Each bit was processed and classified according to the unsupervised method of classification, based on field information gathered from the field assignment. Although the unsupervised classification method is slower than the supervised method, it was used given the heterogeneity of the satellite image and the complexity of the area to be mapped.

As well as characterization of the Posidonia meadow, special attention was paid to the species listed in Annex II to the List of Endangered or Threatened Species of the SPA/BD Protocol (UNEP/MAP-RAC/SPA, 2007).

IV. Equipment and means implemented

1. Navigational means

1. Two flat-bottomed boats (Fig. 12), suited to the area of study, were used (Table 2).

Fig. 12. The two boats used for field prospection

Table 2. Features of the boats used for prospecting

Type of boat	Nature of hull	Length (m.)	Width (m.)	Height (m.)	Engine power (hp)	Form of hull	Type of engine
Rigid boat (1)	Glass fibre	5.20	2.12	0.85	85	Flat-bottom	Outboard 2-stroke
Rigid boat (2)	Glass fibre	4.5	2	0.85	20	Flat-bottom	

2. Technical means

Many technical means were implemented to carry out the field assignment (Table 3).

Table 3. Logistical means implemented for the assignment of prospecting the north-eastern part of the Kerkennah archipelago

Description	Quantity
Echotest II Plastimo hand-held echosounder	2
Compressed air compressor	1
15 litre diving bottles	4
Other diving equipment	4 sets
Underwater video camera	1
Underwater slate	4
PVC flexible tape measure	1
Metal quadrant	3
Caulked windows	2
GPS	3

Plate 1: Study and characterization of the state of the Posidonia meadow

***In situ* measurements:**
(Density, cover, graduated radials)

***In situ* observations and sampling**
(Observation by diver and underwater video)

Laboratory measurements
(Lepidochronological and phenological measurements)

CHAPTER IV: PRESENTING AND EXPLOITING THE RESULTS

Benthic bionomy – Description of the main biocenoses and bed types

The different biocenoses and associations identified and the different outstanding species encountered are described below.

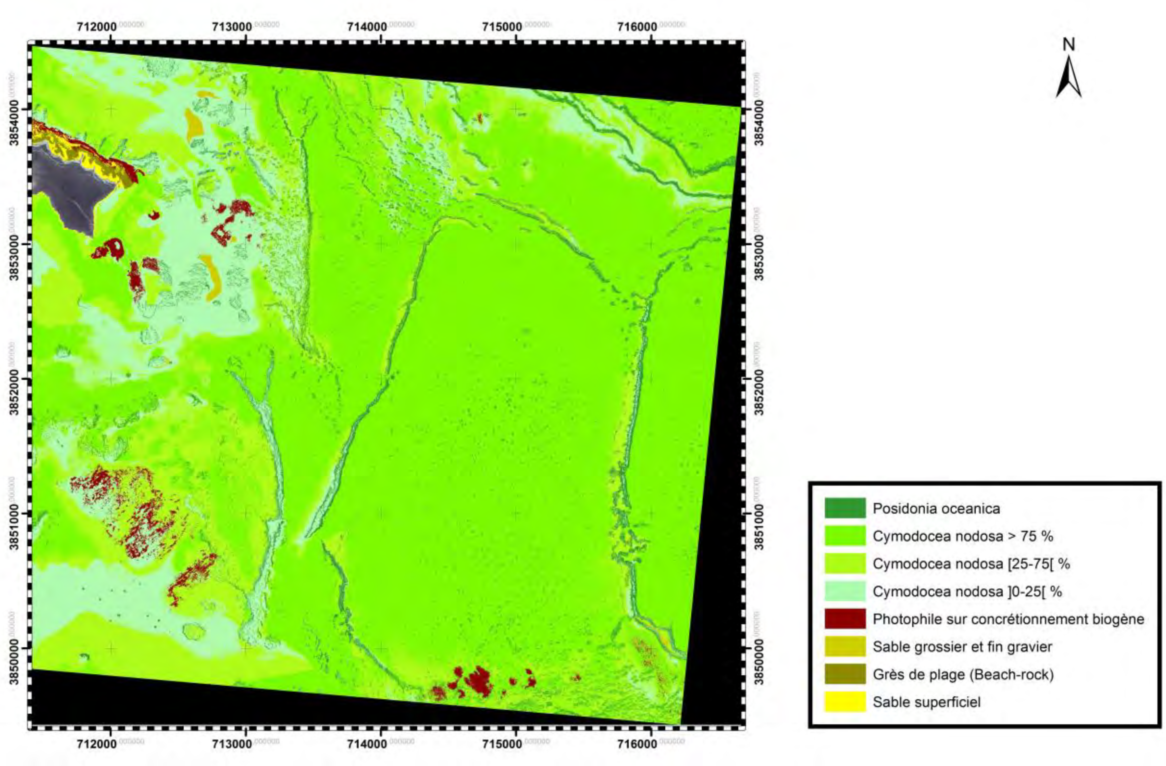
The benthic biocenoses are identified and classified at bathymetric level (Plate 2; Table 4) according to the classification of marine benthic biocenoses in the Mediterranean region crafted in the context of the Barcelona Convention (UNEP, MAP, RAC/SPA 2007). If a biocenosis is lacking in this document, the classification of the National Natural History Museum is considered (Michez *et al*., 2014). This new classification is based on the most recent updating of the lists of existing habitats, particularly the Natura 2000 habitats files and the ZNIEFF Inventory listing of Mediterranean biocenoses in the Provence-Alpes-Côte d'Azur Region (PACA).

Table 4. Benthic biocenoses identified during the study, classed by bathymetric level according to the typology of Mediterranean benthic biocenoses (UNEP-MAP-RAC/SPA, 2007; Michez *et al*., 2014)

LEVEL	SUBSTRATUM	BIOCENOSIS
SUPRALITTORAL	**SILTS**	➤ Biocenosis of slow-drying wrack under Salicornia (SDW)
	SANDS	➤ Biocenosis of supralittoral sands
		Facies of plantless sands with dispersed debris
		Facies of stranded phanerogams (higher part)
	HARD BEDS AND ROCKS	➤ Biocenosis of supralittoral rock (SR)
MEDIOLITTORAL	**SILTS, SANDY SILTS AND SANDS IN EURYHALINE AND EURYTHERMAL ENVIRONMENT**	➤ Biocenosis of silty sands and silts of lagoons and estuaries (SSLE)
		Associations with halophytes
	SANDS	➤ Biocenosis of mediolittoral sands
	HARD BEDS AND ROCKS	➤ Construction with *Neogoniolithon brassica-florida*
INFRALITTORAL	**FAIRLY SILTY FINE SANDS IN OPEN SEA**	➤ Biocenosis of high level fine sands (HLFS)
		➤ Biocenosis of well-calibrated fine sands (WCFS)
		Association with *Halophila stipulacea*
		Association with *Cymodocea nodosa* on WCFS
		➤ Biocenosis of superficial calm mode silty sands (CMSS)
		Association with *Cymodocea nodosa, Zostera noltii, Caulerpa prolifera,* and *Caulerpa ollivieri**
	FAIRLY SILTY COARSE SANDS	➤ Biocenosis of coarse sands and fine gravels tossed by waves (CSTW)
		Association with rhodoliths on CSTW (*Lithophyllum dentatum, Lithophyllum racemus, Lithophyllum incrustans*)
	POSIDONIA	➤ Biocenosis of *Posidonia oceanica* meadow

	***OCEANICA* MEADOW**	Biocenosis of *Posidonia oceanica* meadow association
		Striped meadow ecomorphosis
	HARD BEDS AND ROCKS	➢ Biocenosis of infralittoral algae
		Association with *Cystoseira crinita, C. foeniculacea* (Syn. *C. discors)* and *C. compressa/C. crinitophylla* *
		Association with *Cystoseira brachycarpa, C. funkii)* and *C. spinosa* var. *tenuior/C. squarrosa* *
		Association with *Cystoseira sauvageaueana* and *C. barbata* *
		Association with *Cystoseira spinosa* and *C. usneoides* *
		Association with *Corallina elongata* and *Herposiphonia secunda* *
		Association with *Padina pavonica, Dictyotales, Stypocaulon scoparium* and *Laurencia* spp./*Anadyomene stellata* *
		Association with *Codium* spp *
		Association with *Cladostephus spongiosus* (Syn. *C. hirsutus)* and *Dasycladus vermicularis* *
		Association with *Acetabularia acetabulum* *

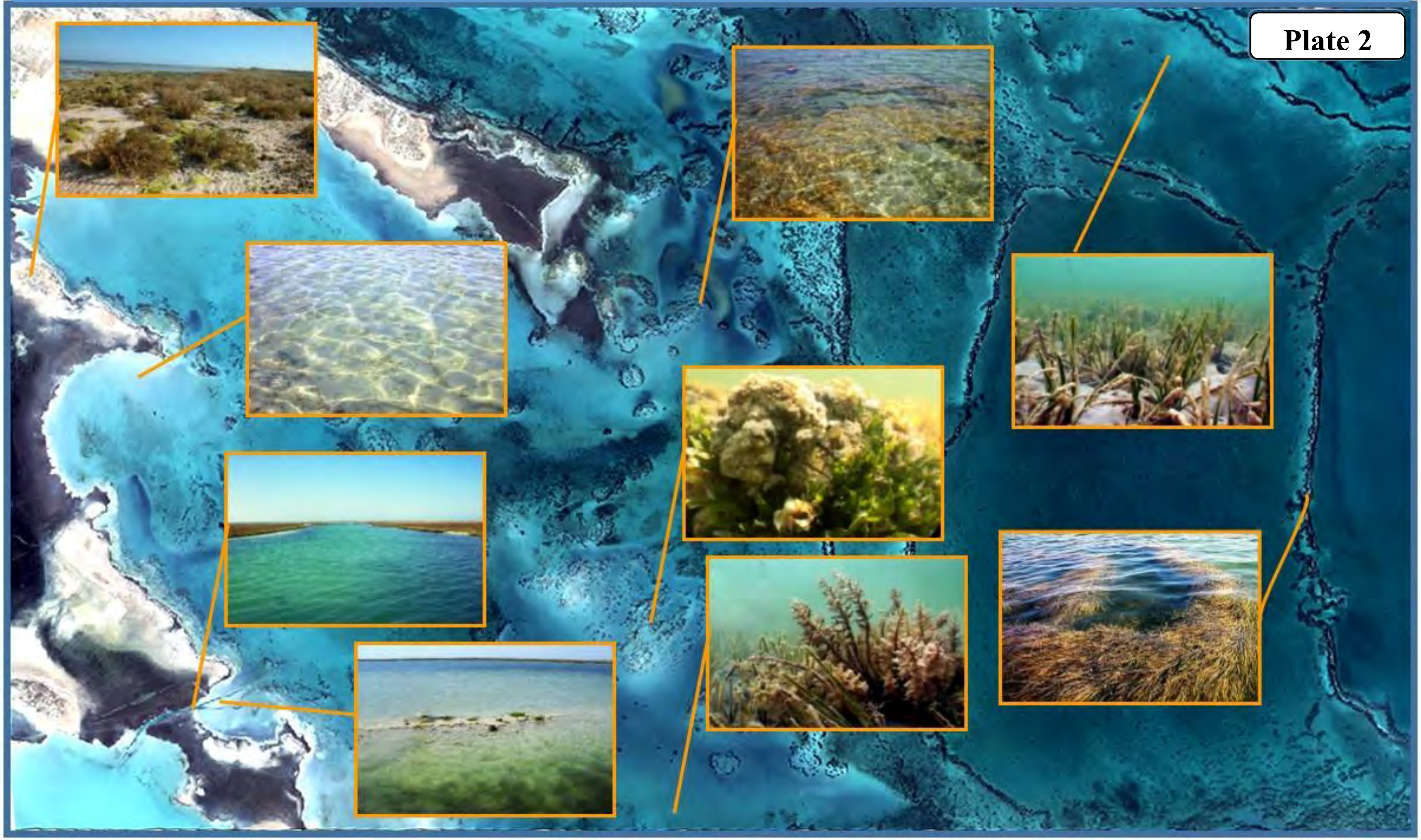
** See description suited to the situation in the area of study in the later part of the text*



Map 1: Cartography of key habitats and types of superficial bottoms*

**Please refer to the annex for a more visible map.*

THE DIFFERENT BIOCENOSES DISTRIBUTED AROUND THE AREA OF STUDY



I. Adlittoral level: land area

This 'land' level has not been the subject of specific observation; a recent, very detailed, study was done in the context of the programme on Small Mediterranean Islands (Médail *et al*., 2015). It looked at the flora and vegetation in the Kerkennah archipelago's islands and satellite islets; the main findings appear below.

'…One can make out three different communities linked to the sandy coasts, especially well represented in the Gremdi, Roumadiya and Gharsa islands. The first is made up of a small number of pioneer nitrophilous therophytes (e.g. *Cakile maritima*), that specialize in exploiting the organic sediment brought by the sea, which corresponds to habitat 1210 (= annual vegetation of the sea debris). The second is characterized by *Pancratium maritimum, Polygonum maritimum*, etc., species that are typical of habitat 2110 (= embryonic moving dunes); lastly, the 'white dunes' of the littoral belt corresponding to habitat 2120 (moving dunes with *Ammophila arenaria*).

On the slightly rocky coasts strongly affected by marine spray develop communities with halo-xerophilous therophytes with a very brief cycle that exploit the little layers of sandy-silty and salty soil that can accumulate in the hollows of the soil; this corresponds to habitat 1510 (=Mediterranean salty steppe: *Limonietalia, Frankenietalia pulverulentae*) with, as characteristic species, *Limonium avei, Frankenia pulverulenta,* etc.).

The clayey and salt-marshy soils allow a low shrubby vegetation to develop dominated by numerous species of Amaranthacea (genus *Arthrocnemum, Suaeda, Sarcocornia, Salsola, Halimione, Atriplex*, etc.) that form rather uniform and paucispecific plant formations of sansouires referred to habitat 1420 (=Mediterranean and thermo-Atlantic halophilous thickets: *Sarcocornietea fruticosae*); on the southern coast of Gremdi and in Sefnou a formation with *Limonium tunetanum* and *Juncus maritimus* falls within this wide type of vegetation. In an even more nitrophilous and xeric context there exists a facies characterized by the prevalence of *Limoniastrum monopetalum, Anabasis oropediorum, Halocnemum cruciatum, Salsola oppositifolia, Atriplex glauca, Nitraria retusa* and *Lycium schweinfurthii*, typical of habitat 1430 (=halo-nitrophilous thickets: *Pegano-Salsoletea*). Among these woody formations can be seen open clayey-sandy zones occupied by paucispecific phytocenoses, dominated by annual salicornia (*Salicornia* sp.) and corresponding to habitat 1310 (=pioneer vegetations with Salicornia and other annual species of the muddy and sandy zones: *Thero-Salicornietea*).

In slightly higher sectors, exposed to the wind, develop still more xerophilous herbaceous communities, dominated by perennial grasses such as esparto (*Lygeum spartum*) that can be linked to habitat 6220 (=sub-steppe areas of grasses and annuals: *Lygeo-Stipetea tenacissimae*). In the bigger islands, herbaceous formations of perennial plants are very discontinuous and are disturbed by grazing, and the big perennial grasses like *Stipa parviflora*, formerly much more widespread in Gremdi, have become extremely rare. But there exist various types of annual prairies that are very rich in species and overgrazing has given rise to the forming of herbaceous phytocenoses dominated by toxic bulbous plants like the asphodels and sea squill or very glandular and/or spiny hemicryptophytes (particularly the Asteraceae and Boraginaceae).

Centuries of overgrazing and wood cutting (cf. below) have caused the total absence of pre-forest and forest formations. The only appreciable woody plant is represented by various facies of very low and discontinuous *matorral*, dominated especially by suffrutescent chamaephytes (*Thymelaea hirsuta*, *Teucrium luteum* subsp. *Gabesianum*, *Helianthemum* spp. etc.) characteristic of habitat 5330 (=thermo-Mediterranean and pre-steppe thickets: Cisto-Micromerietea)….'.

II. Supralittoral level

In the Kerkennah archipelago, the supralittoral level lies above the level of high seas of average spring tides, and only the equinox tides or storm waves can submerge it. But it is regularly wetted by spray.

1. Silts

Biocenosis of slow-drying sea debris under salicornia

This biocenosis allows the sea debris to dry out more slowly because it is protected from the direct sun by salicornia. It is characterized by a great number of detritus-eating species (amphipods, isopods) and their predators (insects). In the site studied, this biocenosis has the particularity of being accessible by the tide where it is closest to the sea (Fig. 13). Also, the silty substratum is locally covered with gravel and small pebbles probably from the degradation of beach-rock; Fig. 13).

This is an area where sea debris accumulates, especially of marine phanerogams from the nearby meadows and lawns (*Posidonia oceanica* and *Cymodocea nodosa*) (Fig. 13). As well as marine-origin plants, this habitat also receives human-origin discharge of every kind, which pile up here. This macro-waste is essentially made up of plastic waste from unauthorized tips, building waste, waste from fishing boats (nets, floats…).

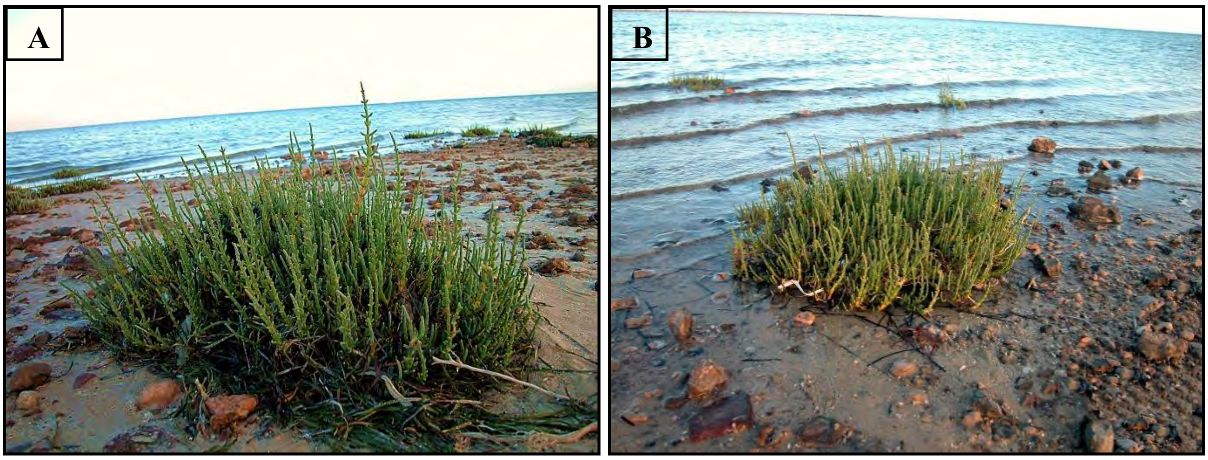


Fig. 13. Biocenosis of slow-drying wrack under salicornia (Arthrocnemum, Salicornioideae) at low tide (A) and high tide (B)

2. Sands

Biocenosis of supralittoral sands

This biocenosis corresponds to the upper beach which is mainly wetted during storms; as well as the humidity, the temperature presents strong variations. Many insects are present, as are amphipod crustaceans and isopods. The best represented facies is the 'Facies of sands without vegetation and with dispersed debris' (Fig. 14).

Fig. 14. Facies of sands without vegetation and with dispersed debris with gravels from the degradation of beach-rock (left) and washed up phanerogam leaves (right)

3. Hard beds and rocks

Biocenosis of supralittoral rock

The biocenosis of supralittoral rock corresponds, in the site studied, to the low rocky coasts formed of calcareous beach-rock. These formations are covered with gravel and small pebbles resulting from the erosion of that substratum (Fig. 15). The erosion is accentuated by the action of the spray and enclaves with variable salinity can form; seawater is trapped in the rocky cavities, including at low tide (Etienne, 2014). This process gives rise to specific coastal facies (Oueslati, 1986).

Fig. 15. Corroded sandstone veneer with signs of erosion (arrow)

III. Mediolittoral level

1. Silts, sandy silts and sands of the lagoons and estuaries

Biocenosis of silty sands and silts

This biocenosis corresponds to the extension of the slow-drying sea debris under salicornia biocenosis identified in the supralittoral (II.1), particularly the association with halophytes of type 1 that corresponds to the formations made up of annual halophilous plants of the genus Salicornia colonizing the periodically flooded sands and silts.

2. Sands

Biocenosis of mediolittoral sands

Starting from the shore, a strip is found that is fairly widely exposed when the sea is low and has no vegetation (Fig. 16 and 17). These bare beds shelter populations of varied invertebrates: Polychaeta (*Hediste diversicolor, Arenicola marina*), burrowing amphipods, bivalve molluscs and especially isopods such as *Tylos* sp. *Cyathura carinata*.

Fig. 16. Substratum of the foreshore formed by silty sand with shell debris and some gravel

When the sea is low, wisps and mounds of sand-dwellers (genus *Arenicola*) are seen in the foreshore.

Fig. 17. Sandy-silty strand at low tide (period of spring tide) basically covered with wisps and mounds of sand-dwellers (polychaeta worms) and stranded macrophytes (*Cystoseira*)

3. Hard beds and rocks

Biocenosis of upper and lower mediolittoral rock (Plate 3)

These biocenoses are strongly marked by the variability of submersions and hydrodynamics. They are often characterized by the presence of crusting algae that can constitute a true biogenic substratum.

In the eastern sector of the Kerkennah archipelago hardened beach sand, known as beach-rock, can regularly be seen. These are sandstone concretions, often stratified, that are found along the beaches like those that exist in tropical or subtropical areas. The rapid induration of beach-rocks is due to the evaporation of the water in the inter- to supra-tidal zone and the precipitation of carbonated cement. This type of formation is also called a pad or crest of the littoral belt (Oueslati, 1986) (Fig. 18).

As well as the beach sandstone, littoral organogenic concretions can be seen, basically made up of carbonated sedimentary rocks, whose structure is due to the accumulation of the fragments of skeletons or of calcareous shells of marine organisms (bivalves, foraminifera, etc.). These biogenic concretions act as substrata for the big brown photophilous algae of the genus *Padina*, *Laurencia* and *Cystoseira* and the green algae, essentially *Anadyomene stellata, Halimeda tuna, Acetabularia acetabulum*, *Dasycladus vermicularis* and *Caulerpa prolifera* (Fig. 19). Like the concretions with *Neogoniolithon brassica-florida*, observed further south (Bahiret El Bibans), several bioconstructor organisms are the cause of these formations (Fig. 20).

Fig. 18. Beach-rock observed at mediolittoral level in the Kerkennah archipelago

Fig. 19. Littoral organogenic concretions of photophilous algae
(Left: concretion with *Neogoniolithon brassica-florida*)

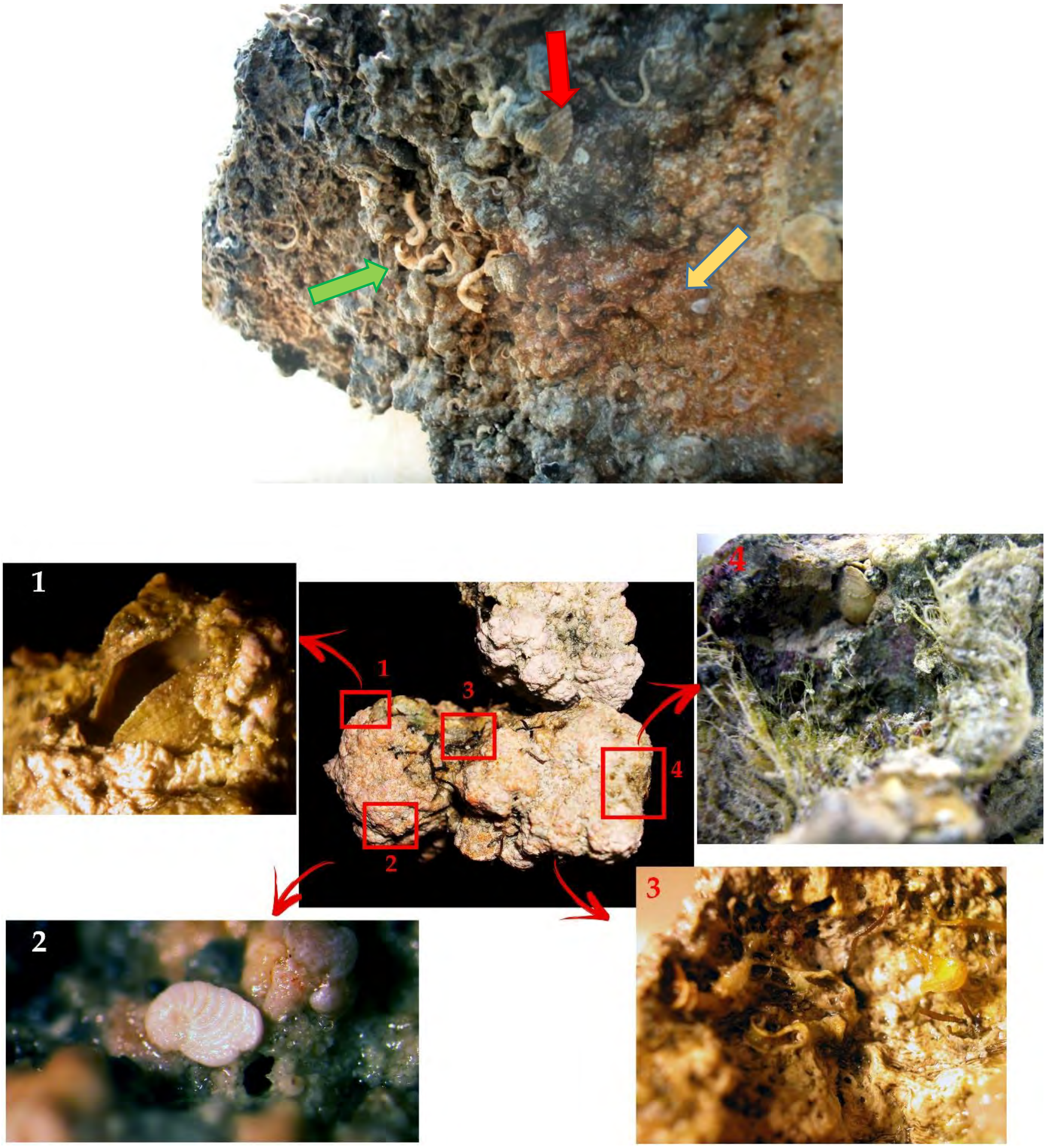


Fig. 20. Photograph (above): detail of a biogenic concretion showing the incorporation of fragments of calcareous sandstone (yellow arrow) made up of shell debris (red arrow) and Serpula-polychaetae (green arrow). Photograph (below): biogenic concretion formed of a fine layer of crusting calcareous alga (1) and (3) bivalve shells, (2) benthic foraminifers (here *Peneroplis pertusus*) and (3) species of the family of *Vermetidae.*

Plate 3: ILLUSTRATION OF FACIES WITH ORGANOGENIC CONCRETIONS IN THE ZONE

IV. INFRALITTORAL

1. Fairly silty fine sands

Biocenosis of superficial calm mode silty sands

This biocenosis starts near the coast, is rather shallow (going down to -3 m.), and occupies large fairly calm areas in the area of study that allow a fine sedimentation of the habitat, made from sandy-silty sediment sometimes mixed with fine gravel.

These shallow areas are subject to very variable environmental conditions (very big differences in seasonal and daily temperatures; strong sedimentation conditions) thus causing the flourishing of the marine phanerogam *Cymodocea nodosa* and filtering and burrowing species.

This habitat is in contact with the *Posidonia oceanica* meadow that usually follows this biocenosis, at depth.

Association with *Cymodocea nodosa*

This association extends out from the coast to -2 metres down; it presents a particular extension at the level of the area of study and the Kerkennah archipelago generally.

Cymodocea nodosa can support variations in salinity, luminosity and temperature and tolerates a large range of concentration of nutritive elements. It supports varied substratum conditions and thus can settle over both coarse sand and silt.

In the superficial shallows of the north-eastern islets, *Cymodocea nodosa* is often associated with *Caulerpa prolifera* with which it can form mixed lawns, contributing together to the sedimentary deposits (Fig. 21). Further out to sea the abundance of these 2 species changes, with fewer Cymodoceans and more Caulerpas. The accompanying species are essentially *Cystoseira foeniculacea* f. *schiffneri, Halimeda tuna, Padina pavonica* and *Dictyota linearis*.

Faunal populations associated with the Cymodoceas and/or mixed lawns are basically gasteropod molluscs, the most common of these being the species of the family of *Cerithiidae*, i.e. *Bittium reticulatum* and *Cerithium vulgatum*. The noble pen shell *Pinna Nobilis* is sometimes present. Bivalves such as *Tapes decussatus* and *Loripes lacteus*, polychaetae worms and sponges like *Sarcotragus* and *Aplysina* can locally be dominant.

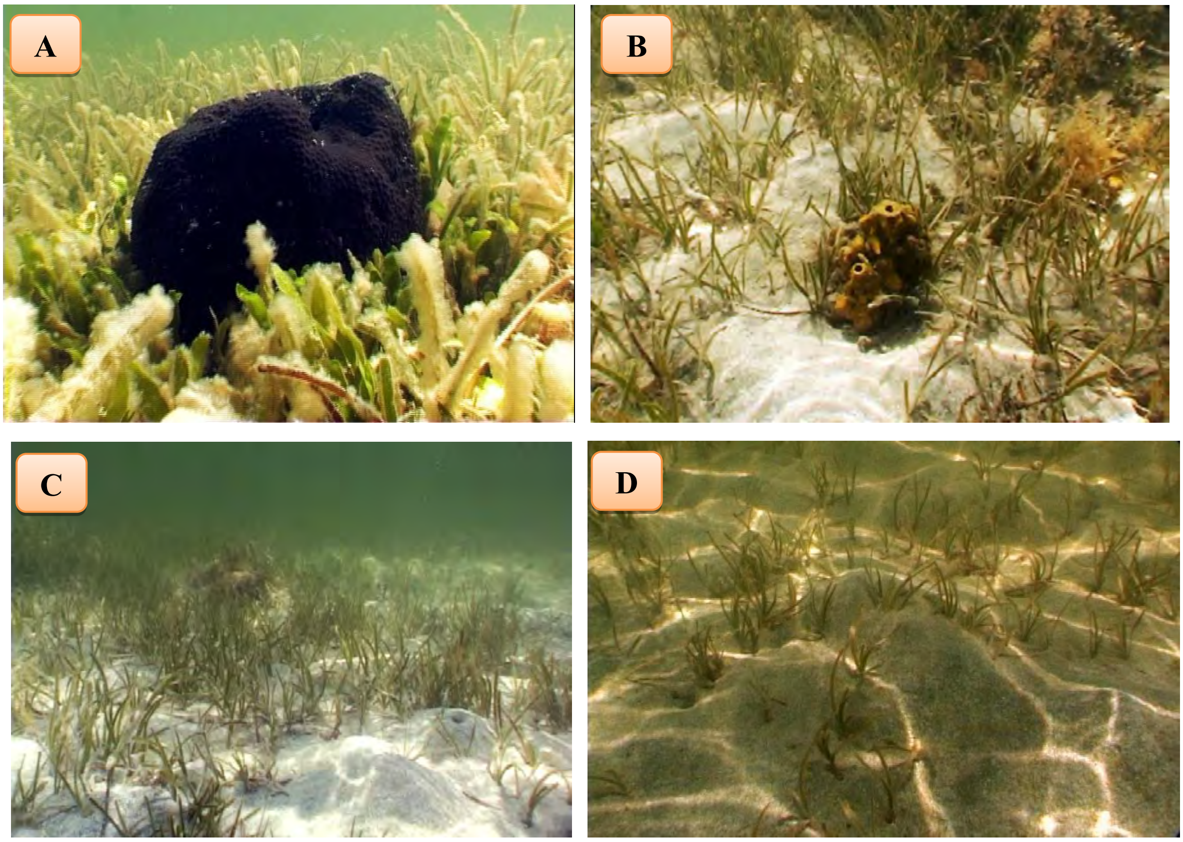


Fig. 21. (A) *Cymodocea nodosa* and *Caulerpa prolifera* prairie surrounding the sponge *Sarcotragus muscarum,* and (B) *Aplysina aerophoba*; (C) and (D) prairies with *Cymodocea nodosa* on sandy-silty bed.

2. *Posidonia oceanica* meadow

Biocenosis of *Posidonia oceanica* meadow

Posidonia oceanica is a marine phanerogam endemic to the Mediterranean. It constitutes characteristic formations called 'meadows' between the surface and 30-40 metres down. Its structure shows an epigeal part corresponding to the foliar fascicles and an endogean part, a veritable underwater terrace, the matte. These meadows, veritable underwater prairies, correspond to one of the main Mediterranean climaxes.

In the site of the study, the *Posidonia oceanica* meadow presents a particular morphology called the striped meadow ecomorphosis.

Striped meadow ecomorphosis

The striped meadow of the Kerkennah archipelago is deemed to be the most important in the Mediterranean (surface area, structure) (Burollet, 1983; Pergent *et al*., 2010). It is formed of strips of *Posidonia oceanica* several dozen metres long and nearly 2 metres wide separated by the 'dead matte' occupied by a population of *Cymodocea nodosa* and/or *Caulerpa prolifera* (Chlorobionta). The *Cymodocea nodosa* prairie is usually not very dense there (under 25% of cover), but may locally achieve cover of 100%.

The striped meadow is present in several configurations (Fig. 21).

- ‘Typical configuration’ (Fig. 22A): conforms to the description given by Boudouresque *et al*. (1990)
- ‘Circular configuration’ (Fig. 22B): strips of meadow arranged in a fairly regular circle. The inside of the circle is occupied by either a monospecific *Cymodocea nodosa* prairie (cover of 25-100%), or a mosaic of *Cymodocea nodosa*/*Caulerpa prolifera*. Strips of *Posidonia oceanica* can also occur within the circles. The size of the circles is very variable, from several dozen metres to over 150 m. in diameter. Certain small (a few metres) circular structures constitute ‘atolls’ (Pergent *et al*., 2007)
- ‘Belt configuration’ (Fig. 22C): strips of meadow arranged along a fairly straight line constituting a belt called a reef by Hattour and Ben Mustapha (2013). Those several kilometres long sometimes, in some places, are over thirty metres wide. The meadow there is usually just under the surface and the leaves reach the surface at low tide (Fig. 22D). These belts or *tsir* mark out vast stretches, *bhirats* (literally, ‘lagoons’) whose usually silty bed is up to 2 metres down; it is occupied by dense prairies of *Cymodocea nodosa* very often associated with *Caulerpa prolifera* (Fig. 23). Within these *bhirats* are found numerous strips of isolated *Posidonia oceanica* (Fig. 22E).

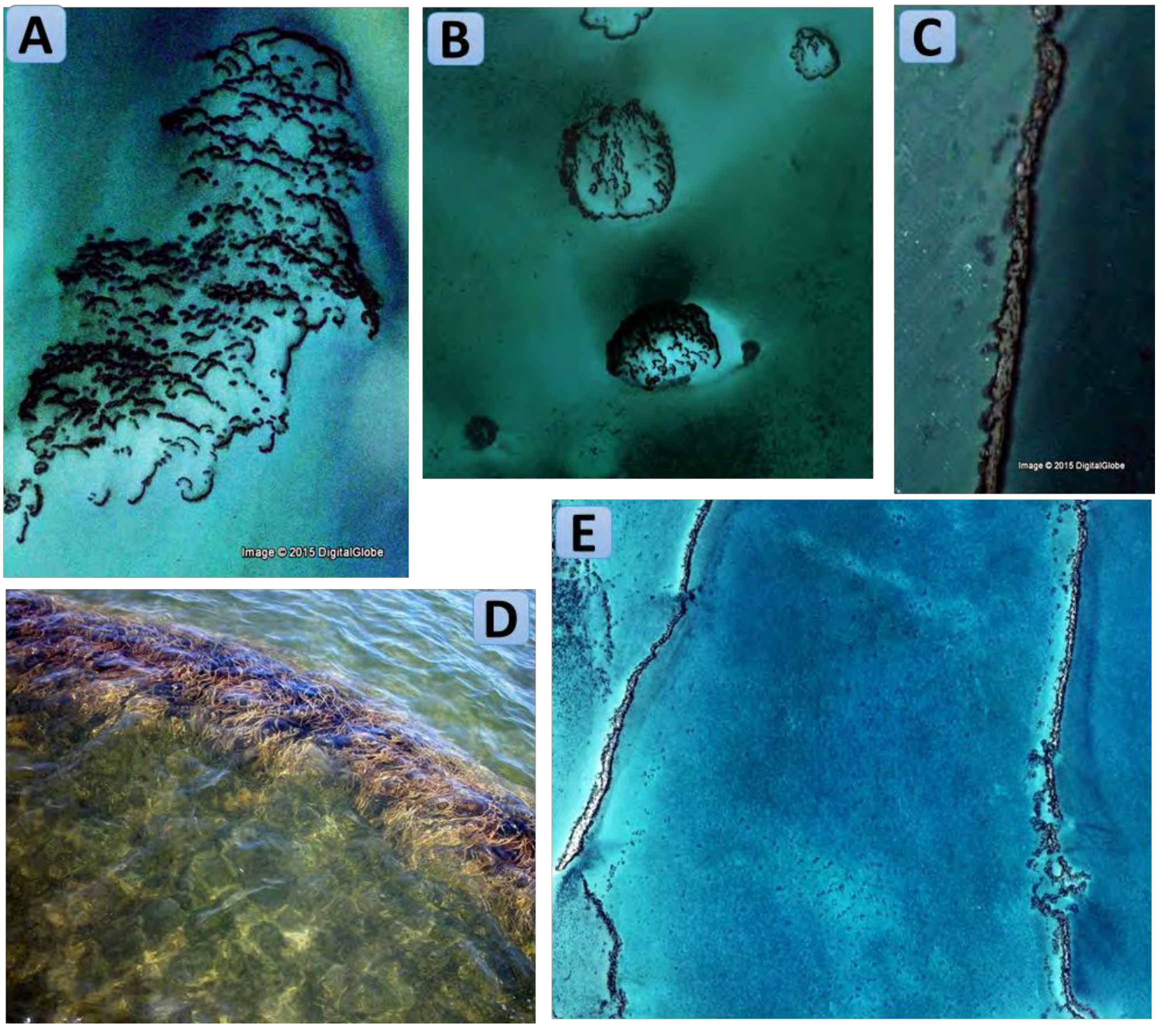


Fig. 22. Striped meadow: (A) typical configuration, (B) circular configuration, (C) belt configuration, (D) a strip of *Posidonia oceanica* near the surface interrupted by a mosaic of *Cymodocea nodosa* and (E) belts of striped meadows (*tsir*) marking out a *bhirat* where isolated strips of *Posidonia oceanica* are scattered

Fig. 23. Channel between strips of *Posidonia oceanica* carpeted by a lawn of *Cymodocea nodosa* and *Caulerpa prolifera*

Characterization of the *Posidonia oceanica* meadow

The average density of the *Posidonia oceanica* meadows is estimated *in situ* to be 717 ± 11 fascicles per sq. m. The meadow corresponds to a Type 1, or dense to very dense, meadow according to Giraud (1977) but, given the shallow, variable depth, its density is considered to be ‘normal’ to ‘middling’ according to the stations according to the Pergent-Martini and Pergent (2010) grid. This weak density is mostly due to the tide that increases the turbidity of the water in the shallows and the particular structure of the striped meadows.

A phenological study of the *Posidonia oceanica* fascicles (Annex 2) reveals a number of adult leaves that is always greater than that of intermediary leaves. The average number of leaves per fascicle (adult and intermediary) is 5.2. These values accord with those previously recorded for the southern Kerkennah Islands (APAL, 2012), where this number varies between 5 and 6 leaves per fascicle (Table 5). The low percentage of intermediary leaves in the samples studied is explained by the season when they were sampled; these leaves are especially present in the period of renewed foliar growth at the end of winter and in spring, whereas the number of adult leaves is at its highest in August (Pergent and Pergent-Martini, 1988).

The maximum length recorded for adult leaves is 831 mm. and the maximum width 11 mm. These values correspond to those recorded, in the same season, in several meadows in the Mediterranean.

The overall foliar index (adult and intermediary leaves) varies between 199.3 and 415.6 square centimetres per fascicle-1. These values are very high compared to those usually recorded in the Mediterranean (Pergent and Pergent-Martini, 1988; UNEP-MAP-RAC/SPA, 2009: Pergent-Martini and Pergent, 2010). The Leaf Area Index (LAI) per square metre is estimated as 21 sq. $m.^2$ $m.^{-2}$ for an average density of about 717 fascicles/sq. $m.^2$

The value of Weighting A is of the order of 58.4%. This high percentage is mainly explained by the strength of the hydrodynamics due to tidal currents, small depth, and *inter alia* the mechanical pressure exercised by maritime traffic in this zone. Epiphytism and grazing are secondary factors that increase the risk of loss of apex in this zone.

Table 5. Phenological parameters of the *Posidonia oceanica* meadow in the north-eastern part of the Kerkennah Islands archipelago in July 2015 (average ± 95% confidence interval). LAI=Leaf Area Index. Weighting A = (number of broken Ad+In leaves/total number of leaves) x 100

	Adult (Ad)	Intermediary (Int)	Total (Ad+Int)
Average number of leaves.fascicle-1	3,4 ± 0,4	1.8 ± 0,4	5.2 ± 0.6
Average length (mm.)	718,0 ± 44.3	294.0 ± 37,8	510,6 ± 104,6
Average width (mm.)	10,5 ± 0.2	10,3 ± 0.2	10,4 ± 0,2
Weighting A (%.fascicle^{-1})	84,1 ± 0,08	6,5 ± 0,07	58.4 ± 0.07
Foliar index (cm^2.fascicle^{-1})	255,6 ± 30.9	54.9 ± 12.2	308.1 ± 28.9
LAI (m^2.m^{-2})	18.3 ± 2.2	3.8 ± 0.9	21.1 ± 2.7

A lepidochronological analysis (Annex 3) confirms a very great vertical growth of the rhizome (16.4 ± 1.27 mm./year). These values are considered to be high compared to the average values measured in the Mediterranean (7.4 mm.year-1 in Pergent *et al*., 1995).

Average annual foliar production varies between 3.8 and 9.8 leaves for an overall average of 6.9 ± 0.01. This production is close to the average observed in various Mediterranean stations estimated by Pergent *et al*., 1995) at 7.5 scales per cycle.

In general, the meadows observed in the area under study present a good vitality and do not seem to be suffering from significant human-origin pressure.

Biocenosis of infralittoral algae

Since the study did not aim at establishing an exhaustive inventory of the macrophytobenthos, we are presenting here the species of conservation interest targeted by our samplings and a few accompanying species gathered at the same time.

Thus, 26 species of macrophyte were recorded in the area studied: 10 Chlorophyta, 5 Rhodophyta and 11 Ochrophyta (Table 6). The macrophytobenthos is mostly planted over an organogenic concretion (Fig. 24). It should be noted that the concretions are present both in the infralittoral and in the mediolittoral.

The order of Fucals (Ochrophyta) is the most representative, with 7 species (Plate 5) which appear on the List in Annex II to the SPA/BD Protocol.

The only species of conservation interest observed in the study area belong to the genus *Cystoseira*.

The Cystoseiras are species with high heritage value in the Mediterranean which build 'forests' like those found on land. These forests characterize habitats that are outstanding in terms of biodiversity and productivity. Among these species, *Cystoseira foeniculacea* f.

schiffneri, endemic to the Mediterranean, whose area of distribution is restricted in the Mediterranean, is the most abundant. It forms small forests, along with *C. susanensis* and *C. foeniculacea* and *C. foeniculacea* f. *tenuiramosa*. *Cystoseira compressa* and *C. spinosa* are also present, but sparsely. *C. compressa* was only found as an epiphyte on *Cystoseira foeniculacea* f. *schiffneri* or in association with *Padina pavonica*.

Table 6: List of macrophytobenthos species observed (excluding Magnoliophytes. *: species listed in Annex II (List of endangered or threatened species) of the Barcelona Convention (UNEP/MAP-RAC/SPA, 2007)

Phylum	Class	Order	Genus and species
Chlorophyta	***Ulvophyceae***	*Dasycladales*	*Acetabularia acetabulum*
			Dasycladus vermicularis
		Cladophorales	*Anadyomene stellata*
		Bryopsidales	*Caulerpa prolifera*
			Halimeda tuna
			Flabellia petiolata
			Codium vermilara
			Penicillus capitatus
		Siphonocladales	*Valonia aegagropila*
			Valonia sp.
Ochrophyta	***Phaeophyceae***	*Fucales*	*Cystoseira barbata* *
			Cystoseira compressa
			Cystoseira foeniculacea *
			Cystoseira foeniculacea f. *schiffneri* *
			Cystoseira foeniculacea f. *tenuiramosa* *
			Cystoseira sp.
			Cystoseira spinosa *
			Cystoseira susanensis *
		Dictyotales	*Dictyota linearis*
			Padina pavonica
		Sphacelariales	*Halopteris scoparia*
Rhodophyta	***Florideophyceae***	*Corallinales*	*Jania rubens*
			Lithophyllum sp.
		Nemaliales	*Liagora viscida*
		Ceramiales	*Laurencia obtusa*
		Peyssonneliales	*Peyssonnelia squamaria*

In the *Cystoseira* forests, the following were identified:

Flora made up of *Padina pavonica, Dasycladus vermicularis, Halimeda tuna, Laurencia obtusa* and sp. *Cladophora* sp. and *Anadyomene stellata*

Fauna made up of isopod crustaceans (*Spaeroma serratum, Eurydice pulchra*), juvenile holothurians, Echinoderms (*Amphipholis squamata* and *Ophioderma longicauda, Asterina gibbosa*), ascidians (*Didemnum* sp. and *Ectinascidia turbinata*) and the black-striped pipefish *Syngnathus abaster*.

Fig. 24 (A) Rocky veneer covered with photophilous algae essentially *Padina pavonica, Laurencia* and *Cystoseiras*; (B) Cluster of free-form Cystoseiras

Benthic fauna

Most of the benthic fauna of the shallows in the area prospected are malacological fauna and sponges. The noble pen shell *Pinna nobilis* and the bivalve *Pinctada radiata* are strongly present (Fig. 25). Several species of mollusc are also found: *Hexaplex trunculus, Chlamys glabra, Loripes lacteus* and *Cerithium vulgatum* and species of the family of *Vermetidae*. Echinoderms, mainly *Holothuria tubulosa, Paracentrotus lividus* and *Ophioderma longicauda* were identified. Ascidians (*Ectinascidia turbinata, Didemnum* sp.), sponges (*Aplysina, Cliona, Dysidea, Geodia, Ircinia* and *Sarcotragus*) and polychaetae worms were also in our samples.

It should be noted that the bryozoan *Zoobotryon verticillatum*, considered to be an invasive species in some parts of the world, was found in abundance in the area of study; big, arboraceous and brown, it can be confused with the *Cystoseiras*.


Fig. 25. *Pinna nobilis* in prairies with *Cymodocea nodosa* and *Caulerpa prolifera*

PLATE 4: ILLUSTRATION OF THE MAIN BIOCENOSES IN THE NORTH-EASTERN PART OF THE KERKENNAH ISLANDS

Supralittoral level

Biocenosis of Supralittoral sands

Biocenosis of slow-drying sea debris under salicornia

Facies of plantless sands, with dispersed debris

Mediolittoral level

Biocenoses of the crumbly beds of the mediolittoral

Biocenoses of silty sands and silts

Biocenoses of the mediolittoral rock

Infralittoral level

Biocenoses with *Cymodocea nodosa* on WCFS

Biocenoses of *Podsidonia oceanica*

Biocenoses of infralittoral algae

PLATE 5: SPECIES OF THE CYSTOSEIRA GENUS FOUND IN THE ZONE

***Cystoseira foeniculacea* f. *schiffneri* with *Halimeda tuna* epiphyte**

Cystoseira compressa

***Cystoseira spinosa* with *Laurencia obtusa* epiphyte**

***Cystoseira foeniculacea* f. *schiffneri* *C. compressa* epiphyte**

***Cystoseira foeniculacea* f. *schiffneri* free form**

Cystoseira barbata

***Cystoseira susanensis* after the branches' fall**

***Cystoseira* sp. with *Laurencia* and *Padina* epiphytes**

CHAPTER V. SUMMARY OF NATURAL AND CULTURAL POTENTIAL AND VULNERABILITIES IN THE AREA OF STUDY

I. Assessment of natural and cultural potential of the area north-east of the Kerkennah archipelago

1. Marine biodiversity

High biodiversity and an outstanding marine landscape

The data gathered during the investigation campaign confirms the presence of a great natural potential associated with a very high marine biological diversity. Moreover, the observations bear witness to a good state of conservation of the marine environment in general.

Outstanding flora

The underwater landscape in the area north-east of the Kerkennah archipelago is characterized by the presence of an immense *Posidonia oceanica* meadow, of high vitality, which carpets the shallows and appears on the surface at low tide. This natural heritage, considered to be one of the most outstanding in all the Mediterranean, is important in that: i) it occupies a very large surface area in the zone of study, ii) it presents a very rare 'striped meadow' structure because of tidal currents and thus constitutes a unique natural monument, iii) it has a primordial role at ecological level and in the maintaining of littoral balances: big primary production and high biological diversity, protecting the littoral from erosion, exporting organic matter to other ecosystems, it is a spawning and nursery area for many species of commercial interest, and has underwater landscapes with high aesthetic value.

The ecological importance of the shallows surrounding the archipelago are a result of not only the presence of the marine phanerogam *Posidonia oceanica* but also that of another phanerogam *Cymodocea nodosa* which helps to fashion the configuration of the marine vegetation of the zone, occupying a surface area of over 1,000 km.2. A mosaic of plant species characterized by mixed meadows of marine phanerogams (*Cymodocea nodosa* and *Posidonia oceanica*) and the Chlorobionta *Caulerpa prolifera* dominate the underwater landscape in the zone.

The prairies of *Cymodocea nodosa* and the meadows of *Posidonia oceanica* have a vital hydrodynamic role and help fix sediment. Whether by their rhizomes and roots (*Posidonia oceanica* and *Cymodocea nodosa*) or by their stolons (*Caulerpa prolifera*), they fix the crumbly bed and slow down the hydrodynamics, thus acting as sediment stabilisers.

These prairies and meadows also present a more direct ecological function, thanks to their high primary production and all the forms of support and shelter they offer. The meadows, especially that of *Posidonia oceanica*, the biggest ones, act as support and shelter for many other organisms which use them as their exclusive or preferred biotope. They allow the differentiation of many ecological niches (organisms that are fixed, sedentary or vagile on leaves and rhizomes, on the surface or in the sediment, in the water column between or near the plants), occupied by many species that come to spend at least a phase of their lives (reproduction or juvenile stage) there.

Also, species of the *Cystoseira* genus, listed, except for one of them, in Annex II to the SPA/BD Protocol, build marine habitats of great importance, taken into account in the selection of sites to be included in the National Inventory of Natural Sites of Interest for Conservation. Among these species, six are present in the area of study, *Cystoseira foeniculacea* f. *schiffneri* being the best represented.

Outstanding fauna

At benthic level, two species of bivalve mollusc are particularly well represented, the noble pen shell *Pinna nobilis*, which constitutes a good bio-indicator of the quality of the Mediterranean littoral environment, and *Pinctada radiata*, which is enfeoffed to the *Posidonia oceanica* meadow and on the palms of fixed fisheries.

The Kerkennah archipelago is also known for its importance in the Tunisian production of commercial sponges (Ben Mustapha, 1991). Several species were identified in the shallows: *Spongia officinalis, Petrosia ficiformis* and *Hippospongia communis*.

The presence of the marine turtle, the loggerhead *Caretta caretta*, is regularly signalled (APAL, 2001).

Varied avifauna

The Kerkennah archipelago is listed as an important zone for birds, an 'Important Bird and Biodiversity Areas (IBA) and an Important Zone for the Conservation of Waterbirds' (ZICO). The many *sebkhas* (one-third of the archipelago's total surface area) constitute a special wintering area (permanent presence of water) for many waterfowl that come to nest there, for example the great cormorant *Phalacrocorax carbo*, the gulls and terns, including *Larus genei, Larus fuscus, Larus cachinnans, Sterna caspia* and *Sterna sandvicensis*. Other species reproduce in the archipelago, especially the Eurasian kestrel *Falco tinnunculus*, the cream-coloured courser *Cursorius cursor*, the European bee-eater *Merops apiaster* and the grey shrike *Lanius excubitor*.

Also, the archipelago constitutes a major stopover in spring and autumn for hundreds of thousands of migrant passerines (BirdLife International, 2015). In times of migration, a lot of birds coming from Europe go there: limicolous birds and waterfowl like the common spoonbill *Platalea leucorodia* (Charmadiya and Gremdi), the grey herons *Ardea cinerea* (Charmadiya and Gremdi), the Caspian gull *Larus cachinnans* (Charmadiya), limicolous birds and terns. The archipelago shelters 1% of the population of the common spoonbill *Platalea leucorodia* (176 individuals recorded in January 2009) and 1% of the population of the slender-billed gull *Larus genei* (1,981 individuals recorded in January 2009).

A recent study confirms the importance of the Kerkennah archipelago for avifauna (Qninba & Ouni, 2014). According to this study, several outstanding species of waterfowl were identified in the north-eastern part of the archipelago: the Eurasian stone-curlew *Burhinus oedicnemus*, very abundant, the terns, relatively rare and very localised in the Maghreb, the ringed plover (*Haradrius alexandrinus*), the redshank (*Tringa totanus*) which only reproduces in Africa in Tunisia, the great cormorant (*Phalacrocorax carbo*) (1,000 to 10,000 present in winter) and the pipit *(Anthus campestris*).

2. Social and cultural values

Undeniable social and cultural values

Coastal fishing is the oldest activity of the Kerkennah archipelago and has for centuries been the main activity of the people of the region. The typical conditions of Kerkennah encouraged the system of fixed net fisheries that is Kerkennah's, the *Charfia*. These fisheries probably go back to the Phoenician age. This original and traditional fishing technique is used and is handed down from father to son. The *Charfia* uses palm branches planted in the bed to form a path at the end of which the fish are trapped. It can be described as a rectilinear 'wall' about 500 m. long made out of palm leaves that ends in a V-shaped wedge of two palm hedges (80-100 m.) whose tip faces onto to the sea. At the tip of the V is an entrance corridor that leads into a holding chamber giving access to several esparto grass (*Stipa tenacissima*) keepnets (or *Drinas*) and palm branches in which the fish are trapped at low tide. The *Charfias* form barriers that stud the coasts of the archipelago with zig-zag lines in the turquoise shimmer of the sea.

In the archipelago, there is another local activity, unfortunately declining – the valorizing of dates from the area's date palms.

Climate constraints and poor soil have led the farmers of Kerkennah to adapt and use specific cultural techniques for traditional farming practices, the most important being palm groves and gardens. Among these techniques is dry soil farming, regular and frequent ploughing, scraping of soil, pruning the vines and olives so that they retain the damp, improving the soil etc. (Kebaïli Tarchouna, 2013; Etienne, 2014).

Natural protection

The Kerkennah archipelago encompasses 161.6 km. of coast but, because of the existence of the *sebkhas*, only half of the shore is suited to tourist development. Also, the quality of the beaches, often covered at high tide, silty at low tide, with shallow water, does not attract tourists (UNESCO, 1981). The shallows that surround the islands make them hard of access, and only flat-bottomed boats can reach them. All these constraints plus the absence of development facilitating access to the islets in the north-eastern part of the archipelago afford natural protection against the many risks of crowding and exploitation.

II. Vulnerability and main risks and threats to the biotope

1. Human-origin threats

1.1. Threats to the Kerkennah archipelago as a whole

Trawling and over-use of living resources

The threats are mostly linked to traditional fishing being replaced by modern fishing. Illegal fishing threatens the Kerkennians' means of existence. Living off fishing has recently become even more difficult, since the trawlers worry the fishing communities by poaching in the area near the islands, reserved for traditional fishermen in small boats. Moreover, catching young small fishes threatens the halieutic stock in the short term.

It is clear that illegal fishing by trawlers to the detriment of traditional fishing with *Charfias* is increasing, as well as modernisation of the equipment. Modernisation, which has also affected fixed fisheries, involves replacing traditional materials by more modern ones that offer better resistance to bad weather and wear and tear.
For example, stretcher frames made of reworked palm nervures have been replaced by nets of 12-18 mm. mesh, and olive wood stakes replaced by PVC tubing; the fish traps, made from the stalks of dates, have been replaced by wire-netting fish traps, and the use of wire netting to protect the fish traps from dolphins is becoming increasingly frequent.

Such modifications, forced by a greater availability of new materials and their obvious positive effect on profitability, risk changing the traditional, aesthetic side of the fixed fisheries that give such charm to the marine landscapes in the Kerkennah archipelago. Use of plastic-based nets and products has become common and leads to the abandoning of an increasingly great part of the palm groves, where the branches are no longer cut off or maintained, and this speeds up the grove's degradation.

Trawling by fishing gear, locally known as the '*Kiss'*, threatens the halieutic resources, especially the *Posidonia oceanica* meadows in the north-eastern part of the Kerkennah Islands. According to Ben Hmida (2014), benthic trawling by *Kiss* nets puts strong pressure on the meadows and particularly affects the meadow cover. This destructive gear is strictly forbidden by the current laws but the number of users is constantly rising.

As well as the destruction of the *Posidonia oceanica* and *Cymodocea nodosa* meadows, *Kiss* (or small trawl) fishing implies catching a great number of immature, non-commercial smaller fishes, which are thrown back into the sea, especially small annular sea bream (*Diplodus annularis*), whose individual weight is no more than ten grammes. Fishermen in the Mellita region (north-west) have been able to preserve their *Charfias*, unlike the fisheries in the north and east of the archipelago, which are dwindling.

Using sea sand for building

Five quarries for the illicit mining of sands have now been abandoned (Fehri, 2011). The El-Kbour quarry, north of El-Abbassia, and that of Enf Errkik, have been opened into the *villafranchian* calcareous crust and have respectively served to build jetties in the fishing ports of El Attaya and Kraten. The same source states that several points of illicit mining of historic Holocene sands for the requirements of the building industry exist at the present time in the archipelago, and cause the exposure of the roots of many dozens of palms, and can even harm the salty phreatic sheet. Such consequences are irreversible; worse, these quarries have usually been transformed into unauthorized household rubbish tips. Worse still, in some cases, they have been opened up on archaeological sites, and these have been purely and simply ravaged.

1.2. Specific threats to the north-eastern part of the archipelago

Although the north-eastern part of the archipelago is still not much exploited or frequented, it is particularly threatened. Among the most important threats are the destruction of plant cover and certain acts of poaching.

Poaching and illegal fishing

The gathering of eggs of the Barbary partridge *Alectoris barbara* and the killing of marine turtles (*Caretta caretta*) for their flesh, eggs, hide, shell and fat are major reasons for the drastic decline of these populations in this region (Fig. 26).

A study done by Qninba & Ouni (2014) on nesting birds in the islands and islets north-east of the Kerkennah archipelago showed that poaching and robbery of nests (of all species, but mainly those of the Caspian gull and the Barbary partridge) constitute a potential threat hanging over the islands and islets north-east of the Kerkennah archipelago.

Fig. 26. Poaching *Caretta caretta* marine turtles in the Kerkennah archipelago

Destruction of plant cover

Cutting down vegetation is another threat; this activity has been confirmed, especially in Sefnou and Gremdi (Qninba & Ouni, 2014).

The natural vegetation is today suffering from overgrazing by flocks of sheep that exert significant pressure on clumps of *Lygeum spartum* esparto grass; this species constitutes the most common nesting support of the Caspian gull (Qninba & Ouni, 2014). This overgrazing also affects orchards (vines, fig trees, olive trees) especially in the islets of Gremdi, Roumadiya and Sefnoun (APAL, 2001).

Illegal uprootings and irregular cuttings of palms are two existing scourges that are behind the disappearance of individual palm trees and the concomitant genetic erosion.

Palm groves also suffer from the lack of ploughing (less and less barley is sown) and maintenance: no more pruning, no more pollinating of female palm trees.

Similarly, the very widespread practice of pollarding the palm trees to collect the sap or '*legmi'* has also become fatal for the trees. Formerly, the gathering of '*legmi'* respected the palm tree; a moderate incision enabled the tree to grow again later. Today, the makers of '*legmi'* take every last drop of sap from the trees, ensuring their death. (APAL, 2011).

Dwindling sponge stock

The Kerkennah archipelago is a renowned place for sponge fishing, although recently this activity has greatly declined. Over the past few years, the sponge stock has dropped drastically. According to the 2010 fishing statistics of the DGPA (General Fisheries and Fish

Farming Department), the stock has been constantly falling since 2006, from 101 tonnes in 2006 to only ten tonnes in 2009 and 2010, i.e. a drop of almost 90%.

According to a local fisherman in Attaya, sponge fishing is a very old tradition which used to be done standing up over beds of 1-1.5 metres; formerly very widespread, the activity has plummeted over the past few years; it is threatened with extinction, given the over-exploitation of the stock of commercialised sponges in the area.

2. Natural threats

Insularity

The insularity and small size of the islands of the Kerkennah archipelago is an important factor of vulnerability. Islands, especially the little islands and islets like those of Kerkennah, are more vulnerable to environmental change (climate change, rising sea level) than the continental masses (Etienne, 2014). Climate change is thought to be a powerful supplementary factor of the island territories' vulnerability (David, 2010).

Rise in sea level

According to Etienne (2014), in classical times the archipelago was 37 km. long and 18.5 wide; today it is 30 km. long by 14 km. wide, the result of the advancing sea. Slim *et al.* (2004) suppose that certain islets, now isolated, used to be joined to the main islands, particularly Gremdi islet, for the remains of classical roads have been discovered between the island of Chergui and the islets.

The Kerkennah archipelago is physically vulnerable and low-lying, with fragile lithostratigraphic layers. The sea level rises more quickly around the archipelago than elsewhere in Tunisia, because of the combination of subsidence and climate warming.

The arguments for this subsidence are based on the historical remains dating from Roman times that can be found covered by a strip of water of over two metres. Among other arguments are the immersion of a quarry used in classical times and a highway that, at the same date, linked At Attaya to Gremdi islet (APAL, 2001).

The combination of a warmer climate, rise in sea level, and the physical fragility of the islands of the archipelago plus the presence of economic stakes likely to degrade the environment enhance the vulnerability of the archipelago.

Coastal erosion and retreat of the coastline

Most of the coasts of the Kerkennah archipelago are retreating. According to Etienne (2014), the maximum value of erosion is 32.2 metres over 47 years, or 0.68 m./year on average and the significant average withdrawal is -11.8 m. between 1963 and 2010, or -0.25 m./year on average. The coasts most affected by this erosion are those that are sensitive to both erosion (coasts made up of fragile materials) and immersion (low-lying coasts). The geological structures are mostly fragile and can be easily eroded, which accentuates the risk of marine erosion; also, the low altitude of the littoral favours the extension of the *sebkhas* that already represent a great part of the archipelago's surface area (about 45% of the surface area)

(Etienne, 2014). The vulnerability of the coasts, already great, has worsened since the 1960s (Etienne, 2014).

The extension of urbanised littoral areas has led to a greater concentration of stakes in vulnerable zones. Increasingly numerous dwellings and activities that are very important for the archipelago are now very close to the sea.

Associated with coastal building, littoral development is heavy in certain zones and disturbs the littoral and sedimentary dynamics. This disturbance now leads to an increased vulnerability to erosion behind the sea walls or in spaces near the development. It also causes long-term vulnerability in the spaces developed; protective measures cannot stop, but only slow down, the erosion.

The retreat of the coastline is caused by the phenomenon of erosion due to both the mechanical and chemical action of the waves, the rise in sea level, and the subsidence of the soil. The retreat of the coast is bound up with lithology.

Heterogenous extension of the *sebkha* areas

The retreat of the coastline is not the only danger to the archipelago and its residents. The extension of the *sebkhas* and the increasing saltiness of the soil are another danger.

Since the 1950s and '60s, climate and societal change has brought about major modifications in the occupation of the soil of the archipelago; the soils become salty, the palm trees die, and the *sebkhas* grow bigger (Etienne, 2014). The occupation of the soil has been transformed, causing an urban expansion that is sometimes great, a marked retreat of the traditional palm groves, a displacement and growth of the irrigated areas and an extension of the *sebkha* areas (Etienne, 2014). So the pressure on the resources is increasing, which indicates a greater vulnerability. According to Etienne (2014), certain classical cultural features such as the traditional palm groves, which acted as a brake on the increased saltiness of the soil and maintained agriculture on the edges of the *sebkhas*, have been abandoned. It seems that nowadays the archipelago is more vulnerable to increasingly salty soil and extension of the *sebkhas* than it was before the 1960s.

The factors of vulnerability resulting from the moving coastline are linked to: i) the nature of the coasts (the lithology that informs about the coast's ability to undergo erosion and the height of the coast that informs about the vulnerability to immersion; ii) climate change; iii) stakes that accentuate vulnerability and impacts of development that can increase or decrease the rate of erosion. According to a study done by remote sensing (Etienne, 2014), which takes into consideration all the *sebkhas* of the archipelago, including the north-eastern part, the surface area of the *sebkhas* has gone from 4,164 hectares in 1984 to 4,900 hectares in 2011, or an increase of 736 hectares (15%) in 27 years (Fig. 27; Etienne, 2014).

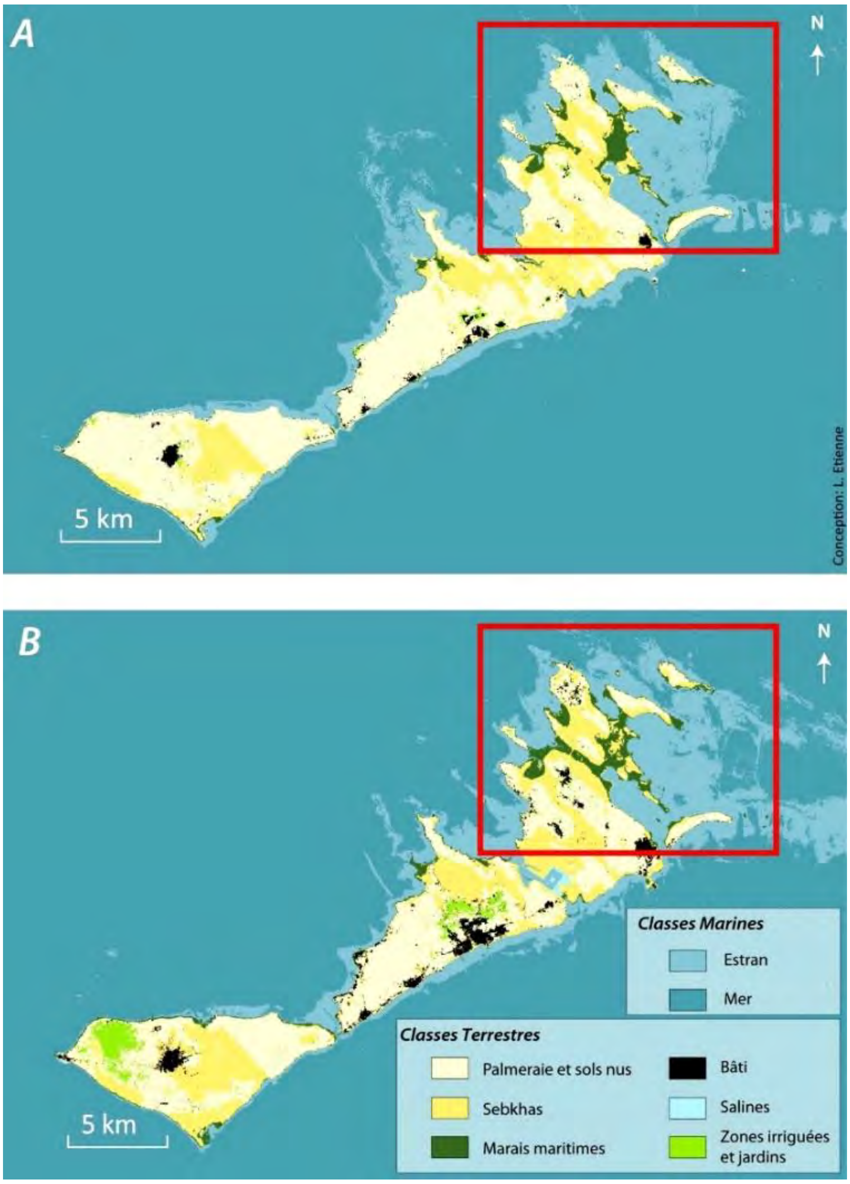


Fig. 27. Assessing the occupation of the soil and the *sebkha* areas in the archipelago between 1984 (A) and 2011 (B) (From Etienne, 2014, modified)

Social problems: a factor that amplifies threats

Ignorance about biological capital and over-exploitation of natural resources are bound up with social problems.

The worsening of poverty, the loss of traditional know-how and local craft activities, and the pressures exerted on natural resources have pushed young people to move away and abandon the land, and have increased illegal practices (poaching and other illegal removals). And human activities and infrastructure constitute threatened stakes and factors that worsen vulnerability. To protect the land from the advancing sea, which slowly erodes the coast right up to the buildings that are there, actions have been carried out by individuals (building walls, embankments, slopes etc.) and by the state (rip-rap). But these constructions are not suitable for they only slow down the marine erosion in the short term and cause littoral unbalance that can worsen the erosive processes (Etienne, 2014).

The rural exodus from the Kerkennah archipelago constitutes an index of how much its natural potential is being exhausted. The major factor of degradation is the growing demographic expansion associated to the shortage of economic resources in the region.

Reconciling the socio-economic development and the protection of the natural environment is a difficult task, explained by the demographic expansion on the one hand and the fragility of the ecosystems/ineffectiveness of management on the other.

SUMMARY OF THREATS AND VULNERABILITIES

Fishing	• Replacing traditional fishing by modern fishing • Non-selective fishing gear • Poaching and illegal fishing • Trawling, with over 40% of fishermen using the *Kiss* • Simultaneous fishing of reproductive fishes and juveniles; the 25 July-15 October close season is no longer respected • Over-exploitation and dwindling of the halieutic stock • Use of sea sand for building
Agriculture	• The illegal uprooting and irregular cutting of palm trees are two harmful practices that cause the disappearance of individual palm trees and genetic erosion • Lack of productivity of dry soil farming • Threats that the archipelago's phreatic sheets and soil will become more salty
Tourism and agriculture	• **Difficulty of access** to the archipelago, the main reason for the decline recorded in this sector • Kerkennah does not appear on maps as a destination, or on tourist circuits • There is no tourist information office in the sector working for tourism
Socio-economic aspects	• **Demographic stagnation** • Small proportion of young people (23.5%) and high proportion of 'over-60s', which encourages the **rural exodus** due to shortage of economic resources • Fishing sector is dominant, employing nearly 40% of the working population • **Difficulty of transport** between Kerkennah and the continent • **High cost of building materials** compared to Sfax • Only 5% of households connected to the wastewater network • Well water very rich in iron
Natural threats and climate change	• **Rise in sea level** • Coastal erosion and retreat of the coastline and growing risks of the sea's advance • **Heterogeneous extension of the *sebkhas*' surface areas** • **Death of vegetation in the littoral zone** seen as linked to the **soil's becoming excessively salty**

CONCLUSION

The area studied, lying north-east of the Kerkennah archipelago, possesses rich, diversified marine and coastal resources. The results obtained confirm that the area possesses an original landscape made up of species of fauna and flora and formations that are outstanding at national and regional level. The unique extension of the *Posidonia oceanica* striped meadow confirms the area's high value. This meadow seems to be in a good state of conservation, demonstrating the good quality of the littoral water in the area of study.

The outstanding marine flora is characterized not only by the abundance of the meadows of the marine phanerogam *Posidonia oceanica* but also the predominance of the phanerogam of heritage interest Cymodocea nodosa, which, mixed with the Chlorobionta *Caulerpa prolifera*, form prairies that have a vital role that is both ecological (important primary production, a spawning area and nursery for many species of fish and crustacean of economic interest) and hydrodynamic (fixing sediment, reducing hydrodynamics). There is undeniable biological richness due to the presence of species that are rare and/or threatened at Mediterranean level, i.e. *Pinna nobilis* and *Cystoseira* forests (*Cystoseira barbata, C. compressa, C. foeniculacea* f. *schiffneri, C. foeniculacea* f. *tenuiramosa*, *C. spinosa* and *C. susanensis*).

The floral-faunal inventory has highlighted outstanding benthic communities over the whole area of study. These communities have great heritage value in the Mediterranean, and are listed in Annex II to the SPA/BD Protocol of the Barcelona Convention.

The natural isolation of this north-eastern part of the Kerkennah Islands has naturally protected it from many human-origin degradations commonly seen on the rest of the archipelago's often more accessible coasts. The marine environment is thus well protected from all over-crowding and coastal pollution, and due to this, no significant degradation of the underwater environment was observed.

A Marine Protected Area groups the totality of the environments deemed to present heritage interest; the area studied possesses all the advantages that justify setting up a Marine and Coastal Protected Area (MCPA) that encompasses either part or all of this sector. Setting up a MCPA would help protect all the marine ecosystems of high heritage value that are present. It would also enable ecologically viable human activities to be pursued and developed, via encouraging the use of fixed fisheries and conserving the traditional and aesthetic side of this practice, which seems to be declining all around the Kerkennah archipelago.

REFERENCES

APAL, 2001. *Etude de gestion de la zone sensible littorale des îlots nord-est de Kerkennah. Phase 1. Caractérisation du milieu naturel. Rapport définitif*. République tunisienne, Ministère de l'Environnement et de l'aménagement du territoire, Agence de Protection et d'Aménagement du Littoral (APAL), Tunis : 40 p.

APAL, 2012. Etude de faisabilité pour la mise en place de récifs artificiels dans le sud des îles Kerkennah. Rapport de phase I. SERAH / ABARLOA 2. 145 pp. + Annexes.

APAL-WWF, 2006. Projet SMAP III : Etude d'impact de la ville de Sfax sur la biodiversité marine et côtière et promotion d'une pêche durable. Rapport définitif, Tunisie : 112p.

Ben Hmida A. 2014. Impact du mini-chalut benthique « Kiss » sur les herbiers à *Posidonia oceanica* dans la région des îles Kerkennah. Institut National Agronomique de Tunisie. 66 p.

Ben Mustapha K. 2007. Démosponges littorales des iles de Kerkennah (Tunisie). *Bull. lnst. nat. sci. techn. Océanogr. Pêche Salammbô*, 34 : 37-60.

Bernardie, N. et Taglioni, F. 2005. Les dynamiques contemporaines des petits espaces insulaires : De l'île-relais aux réseaux insulaires. *KARTHALA Editions*, 450 p.

BirdLife International (2015) Important Bird Areas factsheet: Kerkennah islands. Downloaded from http://www.birdlife.org on 12/09/2015.

Boudouresque C.F., Ballesteros E., Ben Maiz N., Boisset F., Bouladier E., Cinelli F., Cirik S., Cormaci M., Jeudy De Grissac A., Laborel J., Lanfranco E., Lundberg B., Mayhoub H., Meinesz A., Panayotidis P., Semroud R., Sinnassamy J.M., Span A., Vuignier G., 1990. Livre rouge "Gérard Vuignier" des végétaux, peuplements et paysages marins menacés de Méditerranée. Programme des Nations Unies pour l'Environnement publ.: 1-250.

BRANDHORST W., 1977.- Les conditions de milieu au large de la côte tunisienne. *Bull. lnst. nat. sci. techn. Océanogr. Pêche Salammbô,* Tunis, 1977, 4(2-4): 129-220.

Burollet P.F., Clairefond P. et Winnock E., 1979. La mer Pélagienne : étude sédimentologique et écologique du plateau tunisien et du golfe de Gabès. Ann. Univ. Provence, 6 (1 ; 1-345).

Dahech, S. 2007. Le vent à Sfax (Tunisie), impacts sur le climat et la pollution atmosphérique. Thèse de l'Université de Paris 7, 351 p.

Etienne Lucile.2014. Accentuation récente de la vulnérabilité liée à la mobilité du trait de côte et à la salinisation des sols dans l'archipel de Kerkennah (Tunisie). Geography. Université Paris Diderot (Paris 7) Sorbonne Paris Cité ; Université de Sfax (Faculté des Lettres et Sciences Humaines), Thèse de Doctorat. 326 pp.

Fehri Noômène, 2011. « La palmeraie des Îles Kerkennah (Tunisie), un paysage d'oasis maritime en dégradation : déterminisme naturel ou responsabilité anthropique ? », *Physio-Géo* [En ligne], Volume 5 | 2011, mis en ligne le 13 septembre 2011, Consulté le 20 août 2015. URL : http://physio-geo.revues.org/2011 ; DOI : 10.4000/physio-geo.2011.

Le Floc'H, E. & L. Boulos (2008). *Flore de Tunisie. Catalogue synonymique commenté.* Montpellier. 461pp. p.258.

Médail F., Pasta S. & Chaieb M., 2015. Flore et végétation des îles et îlots satellites de l'archipel des Kerkennah (Tunisie orientale). Bilan de la biodiversité végétale terrestre, impacts environnementaux et recommandations de gestion. Note naturaliste PIM, Aix-en-Provence : 66 p.

Oueslati, A. 1986. Jerba et Kerkna: îles de la côte orientale de la Tunisie. Leur évolution géomorphologique au cours du quaternaire. Faculté des lettres et sciences humaines de Tunis, Université de Tunis, 210 p.

Paskoff, R. et Sanlaville, P. 1983. Les côtes de la Tunisie. Variations du niveau marin depuis le Tyrrhénien,. Lyon : Maison de l'Orient et de la Méditerranée Collection de la Maison de l'Orient méditerranéen *Série géographique et préhistorique*, 192 p.

Pergent G., Calvo S., Cancemi G., Djellouli A., Dupuy de la Grandrive R., Langar H., Pergent-Martini C., Tomasello A., 2010. Nouvelles connaissances sur les herbiers tigrés de Méditerranée. Proceedings of the 4th Mediterranean symposium on marine vegetation (Hammamet, 2-4 December 2010). S. El Asmi, H. Langar& W. Belgacem edits., RAC/SPA publ., Tunis : 95-98.

Pergent G., Djellouli A., Hamza A.A., Ettayeb K.S., Alkekli A., Talha M., Alkunti E., 2007a. Structure of *Posidonia oceanica* meadows in the vicinity of ain al-ghazala lagoon (Libya): the « macroatoll » ecomorphosis. Proceedings of the third Mediterranean symposium on marine vegetation (Marseilles, 27-29 March 2007). C. Pergent-Martini, S. El Asmi, C. Le Ravallec edits., RAC/SPA publ., Tunis: 135-140.

Pergent G., Langar H., Pergent-Martini C., 2007. Surveillance de l'herbier des îles Kerkennah (Tunisie). Programme « MedPosidonia » / CAR/ASP - Fondation d'entreprise TOTAL pour la Biodiversité et la Mer ; Mémorandum d'Accord Nautilus - CAR/ASP N°21/2007 : 14p.

Pergent G., Pergent-Martini C., 1988. Phénologie de *Posidonia oceanica* dans le bassin méditerranéen. *Annales Institut océanographique, Paris*, N.S., 64(2) : 79-100.

Pergent G., Pergent-Martini C., Boudouresque C.F., 1995. Utilisation de l'herbier à *Posidoniaoceanica* comme indicateur biologique de la qualité du milieu littoral en Méditerranée : état des connaissances. Mésogée 54, 3-29.

Pergent, G. & Kempf, M. 1993. L'environnement marine côtier en Tunisie. . IFREMER, Brest, France I. Rapport de synthèse, 55pp. 2. Etude documentaire, 395 pp. 3 Annexes, 173 pp.

Pergent-Martini C., PergentG., 2010. Propositions de lignes directrices pour la standardisation des méthodes de cartographie et de surveillance des magnoliophytes Marines en Méditerranée. PNUE---PAM---CAR/ASP, Contrat N°72/2009, Tunis :1 - 70.

Qninba A. & Ouni R. 2014. Les oiseaux nicheurs sur les îles et îlots nord-est de l'archipel de Kerkennah, Tunisie. Initiative PIM. CdL (France)-APAL (Tunisie). 24 pp.

Ramos-Espla A., Ouergui A., Bayle J.T., Ben Mbarek N., Fernandeztorquemada Y., Guallouz S., Khidri R., Sanchez-Lizaso J.L., Yamak S. (2000) - Contribution à la caractérisation des herbiers à *Posidonia oceanica* (L) Delile aux iles kerkennah (Est de la Tunisie, méditerranée orientale. Actes du premier symposium méditerranéen sur la végétation marine (Ajaccio, 3-4 Octobre 2000), pp. 177.

Slim, H., Trousset, P., Paskoff, R. et Oueslati, A. 2004. Le littoral de la Tunisie, Etude Géoarchéologique et Historique. *CNRS Edition*, 308 p.

Trousset P., 2005. « Kerkena/Kerkennah », in *27 | Kairouan – Kifan Bel-Ghomari*, Aix-en-Provence, Edisud (« Volumes », no 27) , 2005 [En ligne], mis en ligne le 01 juin 2011, consulté le 26 juillet 2015. URL : http://encyclopedieberbere.revues.org/1338.

Verger, F. 1995. Slikkes et Schorres : milieux et aménagement. *Norois*. 165 (1), pp: 235-245.

ANNEXES

ANNEX 1 - POSITION OF OBSERVATION AND CLASSIFICATION POINTS *

*** Class 1 = *Cymodocea nodosa*; coverage <25% / Class 2 = *Cymodocea nodosa*; coverage between 25 and 75% / Class 3 = *Cymodocea nodosa*; coverage> 75% / Class 4 = *Posidonia oceanica* / Class 5 = Stands on photophilous biogenic concretions / Class 6 = coarse sand and fine gravel**

N	Class	Longitude X	Lattitude Y	N	Class	Longitude X	Lattitude Y
1	4	11,358211	34,764605	36	2	11,358841	34,766279
2	4	11,358109	34,764717	37	5	11,34806	34,766279
3	2	11,358587	34,764749	38	4	11,357706	34,76629
4	3	11,361794	34,764932	39	4	11,3579	34,766343
5	3	11,357251	34,76498	40	4	11,356963	34,766357
6	3	11,35702	34,76505	41	3	11,346432	34,76637
7	3	11,360995	34,765082	42	4	11,348377	34,766391
8	4	11,356409	34,76528	43	3	11,355357	34,766396
9	3	11,351294	34,765309	44	2	11,358222	34,766418
10	4	11,352001	34,765321	45	4	11,357509	34,766426
11	4	11,361719	34,765377	46	4	11,351757	34,766435
12	4	11,350882	34,765411	47	5	11,348234	34,766522
13	2	11,360131	34,765432	48	2	11,360904	34,76653
14	3	11,350217	34,765446	49	5	11,348156	34,766543
15	2	11,351582	34,765446	50	5	11,348189	34,766595
16	3	11,350494	34,765535	51	5	11,3483	34,766612
17	3	11,351193	34,765541	52	5	11,348366	34,766652
18	4	11,361302	34,765641	53	4	11,355101	34,766658
19	4	11,349938	34,765651	54	2	11,347664	34,766684
20	2	11,356146	34,765688	55	4	11,347817	34,766693
21	4	11,353637	34,765722	56	5	11,348367	34,766716
22	4	11,349304	34,765767	57	4	11,354644	34,766762
23	4	11,351572	34,765812	58	5	11,348311	34,766769
24	2	11,3513	34,765818	59	3	11,348393	34,766802
25	4	11,35798	34,765897	60	2	11,3579	34,766804
26	4	11,355267	34,765917	61	5	11,346132	34,766806
27	4	11,348856	34,765946	62	1	11,347718	34,766809
28	4	11,354509	34,76598	63	4	11,347803	34,766819
29	2	11,351431	34,76605	64	4	11,34746	34,766833
30	4	11,359213	34,766108	65	4	11,35144	34,766843
31	4	11,356006	34,766142	66	3	11,348099	34,766849
32	4	11,348271	34,766169	67	4	11,348378	34,766904
33	4	11,348036	34,766175	68	4	11,35761	34,766927
34	2	11,350863	34,766178	69	2	11,347685	34,766952
35	4	11,351793	34,766264	70	5	11,349747	34,766968

N	Class	Longitude X	Lattitude Y	N	Class	Longitude X	Lattitude Y
71	5	11,346533	34,767002	111	4	11,347032	34,768311
72	4	11,357599	34,767067	112	4	11,34738	34,768371
73	4	11,354122	34,767126	113	2	11,357539	34,76843
74	5	11,344197	34,767153	114	3	11,345363	34,768456
75	5	11,350647	34,767185	115	5	11,359686	34,768465
76	4	11,346922	34,767211	116	4	11,345577	34,768523
77	2	11,348678	34,767245	117	4	11,355551	34,768564
78	4	11,357362	34,767258	118	4	11,345432	34,768588
79	5	11,349061	34,767272	119	4	11,345449	34,768632
80	5	11,347019	34,767292	120	2	11,344552	34,768652
81	5	11,354021	34,767335	121	2	11,355108	34,768808
82	2	11,348528	34,767362	122	4	11,345485	34,768818
83	4	11,347966	34,76738	123	3	11,355552	34,768821
84	2	11,356181	34,767452	124	4	11,344737	34,768823
85	3	11,347714	34,767566	125	3	11,356239	34,768895
86	2	11,356927	34,767607	126	2	11,357308	34,768928
87	4	11,353292	34,767706	127	3	11,344457	34,769111
88	4	11,357211	34,767711	128	2	11,3548	34,769165
89	4	11,34766	34,767728	129	4	11,354566	34,769272
90	4	11,351204	34,767737	130	2	11,33008	34,769284
91	3	11,355752	34,767772	131	2	11,328202	34,769325
92	2	11,347957	34,767816	132	1	11,329347	34,769329
93	4	11,357026	34,767829	133	2	11,331101	34,769337
94	4	11,347675	34,767829	134	2	11,327125	34,769337
95	4	11,360362	34,767843	135	1	11,331834	34,769386
96	3	11,355466	34,767879	136	6	11,361512	34,7694
97	2	11,350916	34,767884	137	3	11,338234	34,769402
98	4	11,344895	34,76792	138	3	11,338764	34,769424
99	3	11,355345	34,768014	139	4	11,355904	34,769427
100	2	11,347464	34,768041	140	4	11,337574	34,769433
101	4	11,347199	34,768046	141	4	11,337171	34,769481
102	5	11,350261	34,768052	142	2	11,336369	34,769524
103	3	11,352214	34,76807	143	3	11,334213	34,769538
104	5	11,346172	34,768099	144	3	11,336932	34,769549
105	4	11,351059	34,768122	145	3	11,33559	34,76955
106	4	11,356232	34,768127	146	3	11,332972	34,76955
107	2	11,341063	34,768131	147	4	11,350018	34,76957
108	4	11,353163	34,768134	148	3	11,351248	34,76961
109	4	11,347764	34,768204	149	4	11,334881	34,769629
110	4	11,345036	34,768247	150	6	11,361198	34,769657

N	Class	Longitude X	Lattitude Y	N	Class	Longitude X	Lattitude Y
151	1	11,325021	34,769765	193	4	11,322675	34,771644
152	6	11,361155	34,769785	194	3	11,359418	34,77183
153	6	11,361077	34,769878	195	3	11,351473	34,771847
154	3	11,338275	34,769906	196	1	11,322334	34,771857
155	1	11,325434	34,769958	197	1	11,35842	34,771927
156	2	11,355612	34,770019	198	3	11,335197	34,771949
157	3	11,353662	34,770066	199	4	11,330664	34,77195
158	3	11,354731	34,77007	200	3	11,343829	34,772024
159	3	11,337515	34,770119	201	2	11,329311	34,772039
160	3	11,35503	34,770205	202	3	11,329769	34,772044
161	2	11,336755	34,770238	203	4	11,328831	34,772071
162	3	11,34266	34,770259	204	4	11,329121	34,772088
163	1	11,324716	34,770339	205	2	11,329161	34,772123
164	3	11,343073	34,770489	206	3	11,327637	34,772134
165	1	11,336372	34,770492	207	2	11,336136	34,772158
166	3	11,349429	34,770591	208	1	11,328389	34,772179
167	2	11,35904	34,770727	209	4	11,333921	34,772194
168	3	11,350014	34,770763	210	2	11,336636	34,772223
169	2	11,336229	34,770771	211	2	11,326891	34,77223
170	6	11,360249	34,770785	212	2	11,326094	34,772231
171	3	11,352857	34,770849	213	1	11,325296	34,772242
172	3	11,359109	34,770866	214	1	11,335992	34,772245
173	4	11,353986	34,770872	215	2	11,336971	34,772262
174	4	11,324024	34,77094	216	4	11,335879	34,772296
175	6	11,359953	34,770957	217	1	11,321728	34,772303
176	6	11,359807	34,770987	218	4	11,358129	34,772377
177	2	11,3587	34,771081	219	1	11,327202	34,772404
178	3	11,356247	34,7711	220	2	11,334911	34,77245
179	3	11,337871	34,771102	221	4	11,337557	34,772512
180	4	11,336028	34,771102	222	3	11,333051	34,772519
181	6	11,359439	34,771121	223	4	11,358715	34,772603
182	3	11,338674	34,771127	224	5	11,321437	34,77264
183	4	11,337328	34,771182	225	3	11,334202	34,772671
184	2	11,323262	34,771251	226	3	11,360405	34,772726
185	3	11,362787	34,771262	227	2	11,324852	34,772747
186	6	11,359264	34,771313	228	3	11,338249	34,772789
187	3	11,361715	34,771348	229	3	11,331789	34,77286
188	2	11,33677	34,771351	230	4	11,357814	34,772962
189	2	11,32302	34,771385	231	3	11,356586	34,772968
190	1	11,33611	34,771401	232	2	11,323711	34,772985
191	3	11,348619	34,771417	233	2	11,324023	34,772992
192	1	11,358773	34,771539	234	2	11,324264	34,773028

N	Class	Longitude X	Lattitude Y	N	Class	Longitude X	Lattitude Y
235	2	11,32286	34,773032	278	1	11,317521	34,774513
236	1	11,320671	34,773086	279	2	11,326454	34,774555
237	3	11,333607	34,773097	280	2	11,329781	34,774572
238	4	11,324179	34,773111	281	1	11,321023	34,774582
239	5	11,32187	34,773169	282	4	11,329422	34,774606
240	5	11,322379	34,77319	283	2	11,33188	34,774613
241	4	11,330819	34,773196	284	2	11,327355	34,774615
242	2	11,324171	34,773224	285	1	11,32906	34,774776
243	4	11,338622	34,773271	286	3	11,331613	34,774835
244	2	11,321557	34,77331	287	3	11,339854	34,774845
245	3	11,330157	34,77342	288	1	11,325162	34,774864
246	3	11,333158	34,773441	289	1	11,32382	34,774907
247	4	11,326841	34,773456	290	4	11,326246	34,774915
248	2	11,324124	34,773477	291	1	11,318033	34,775049
249	5	11,32145	34,773591	292	3	11,327752	34,775049
250	1	11,311782	34,77366	293	4	11,337214	34,775093
251	4	11,338412	34,773661	294	3	11,338733	34,775104
252	1	11,326824	34,773665	295	3	11,337751	34,775118
253	3	11,348233	34,773724	296	1	11,325033	34,775128
254	1	11,319952	34,773767	297	4	11,336762	34,775133
255	2	11,329546	34,773779	298	3	11,33219	34,775139
256	4	11,35908	34,773799	299	3	11,332954	34,775157
257	3	11,33779	34,773815	300	3	11,334452	34,775159
258	2	11,32126	34,773816	301	3	11,331174	34,775159
259	4	11,337033	34,773901	302	3	11,330408	34,775164
260	1	11,327046	34,773911	303	1	11,335448	34,775178
261	2	11,324044	34,773925	304	4	11,33519	34,775181
262	4	11,329644	34,773953	305	2	11,335505	34,775214
263	3	11,336597	34,774058	306	3	11,336263	34,775221
264	3	11,332364	34,774086	307	2	11,335909	34,775235
265	1	11,335859	34,774108	308	1	11,326135	34,775246
266	2	11,32707	34,774149	309	1	11,32083	34,775248
267	4	11,326711	34,774167	310	3	11,331265	34,775263
268	2	11,358206	34,774175	311	3	11,330329	34,775281
269	2	11,335923	34,774214	312	2	11,329791	34,775289
270	2	11,357975	34,774244	313	2	11,329796	34,775289
271	4	11,335583	34,774249	314	4	11,329016	34,775317
272	4	11,326353	34,774268	315	1	11,329267	34,775322
273	2	11,325561	34,774275	316	1	11,329396	34,775399
274	4	11,327146	34,77432	317	2	11,327999	34,775441
275	4	11,325391	34,774449	318	1	11,324988	34,775444
276	4	11,318991	34,774461	319	1	11,326086	34,775468
277	5	11,323923	34,774482	320	3	11,356006	34,775468

N	Class	Longitude X	Lattitude Y	N	Class	Longitude X	Lattitude Y
321	5	11,323837	34,775511	366	4	11,32889	34,77643
322	5	11,324867	34,775622	367	4	11,325224	34,776438
323	4	11,329132	34,77565	368	3	11,343384	34,776444
324	3	11,330974	34,775667	369	2	11,330009	34,776461
325	2	11,334303	34,775671	370	2	11,317222	34,776471
326	4	11,325885	34,775693	371	3	11,356001	34,776519
327	1	11,325558	34,775704	372	5	11,321386	34,776527
328	2	11,31793	34,775725	373	2	11,328916	34,77654
329	3	11,328219	34,775725	374	2	11,320878	34,776555
330	4	11,325722	34,775727	375	5	11,324253	34,77657
331	2	11,328759	34,77573	376	2	11,323217	34,776591
332	3	11,322166	34,775732	377	1	11,359349	34,776595
333	3	11,354665	34,775736	378	5	11,31989	34,776605
334	2	11,320707	34,775748	379	1	11,319078	34,776615
335	5	11,32333	34,775769	380	5	11,320246	34,776634
336	3	11,331285	34,77577	381	3	11,32252	34,77665
337	2	11,321692	34,7758	382	2	11,317023	34,776675
338	1	11,318391	34,775805	383	5	11,318957	34,776678
339	1	11,321366	34,775833	384	1	11,330054	34,776699
340	1	11,325255	34,77584	385	1	11,319104	34,776707
341	4	11,325299	34,775848	386	5	11,321331	34,776774
342	5	11,325032	34,775853	387	4	11,329122	34,7768
343	2	11,324979	34,775904	388	5	11,317991	34,776808
344	4	11,317558	34,775917	389	1	11,320627	34,776817
345	3	11,327918	34,775947	390	2	11,358549	34,776825
346	1	11,318333	34,775995	391	4	11,33384	34,776836
347	4	11,328576	34,776102	392	5	11,319658	34,77687
348	1	11,326222	34,776165	393	1	11,319967	34,776874
349	2	11,326752	34,776179	394	2	11,357284	34,776902
350	3	11,330591	34,776184	395	4	11,329288	34,777038
351	2	11,332056	34,776192	396	5	11,319373	34,777066
352	2	11,317267	34,776214	397	1	11,329614	34,777145
353	1	11,32577	34,776236	398	5	11,319507	34,777179
354	2	11,32861	34,776256	399	3	11,347836	34,7772
355	5	11,320717	34,776278	400	2	11,316342	34,777232
356	3	11,333549	34,776305	401	4	11,329535	34,777255
357	2	11,331863	34,776318	402	5	11,318024	34,77732
358	3	11,330219	34,776331	403	5	11,318873	34,777327
359	2	11,331252	34,776347	404	1	11,329614	34,777345
360	4	11,334049	34,776352	405	1	11,319956	34,777346
361	5	11,324888	34,776356	406	1	11,329833	34,777533
362	5	11,319099	34,776358	407	5	11,320893	34,77763
363	2	11,333864	34,776387	408	5	11,31802	34,777672
364	1	11,332149	34,776393	409	4	11,311071	34,777714
365	3	11,330795	34,776419	410	2	11,321572	34,777737

N	Class	Longitude X	Lattitude Y	N	Class	Longitude X	Lattitude Y
411	4	11,329321	34,777765	455	3	11,328818	34,779287
412	2	11,321953	34,777828	456	5	11,320247	34,779292
413	2	11,322452	34,777908	457	1	11,314984	34,779308
414	5	11,323353	34,777927	458	3	11,331802	34,779308
415	1	11,330627	34,777978	459	1	11,319323	34,779318
416	2	11,325185	34,777991	460	5	11,317911	34,77933
417	2	11,329287	34,778001	461	5	11,322221	34,779469
418	5	11,318683	34,778051	462	3	11,339119	34,779485
419	2	11,314759	34,778123	463	2	11,328641	34,779537
420	1	11,311031	34,778128	464	2	11,321894	34,779577
421	1	11,330751	34,77816	465	4	11,323324	34,779614
422	3	11,362014	34,778166	466	2	11,31794	34,779639
423	4	11,331491	34,778186	467	1	11,322881	34,779657
424	4	11,324636	34,778225	468	4	11,322793	34,779679
425	1	11,319554	34,778279	469	1	11,316553	34,779681
426	2	11,318043	34,778349	470	3	11,311814	34,779684
427	4	11,324501	34,778396	471	4	11,324388	34,779732
428	5	11,322575	34,778429	472	3	11,361027	34,779738
429	4	11,330988	34,778457	473	2	11,32489	34,779742
430	5	11,3212	34,778502	474	1	11,314356	34,779742
431	3	11,311498	34,778504	475	2	11,322516	34,779759
432	2	11,324319	34,778509	476	4	11,323914	34,77977
433	2	11,318186	34,77851	477	4	11,323018	34,779772
434	4	11,331279	34,778596	478	5	11,322162	34,77984
435	3	11,331105	34,778659	479	5	11,319295	34,77986
436	4	11,328966	34,778672	480	5	11,319017	34,779895
437	3	11,362374	34,778686	481	2	11,313174	34,779907
438	1	11,324259	34,778699	482	3	11,332414	34,779925
439	2	11,357925	34,77885	483	5	11,321765	34,779974
440	2	11,313504	34,778858	484	3	11,351779	34,779974
441	5	11,318785	34,778873	485	5	11,317837	34,779991
442	4	11,323984	34,778894	486	5	11,315043	34,779996
443	4	11,324394	34,778911	487	5	11,321663	34,780022
444	3	11,325653	34,778925	488	5	11,318337	34,780051
445	4	11,331541	34,779011	489	3	11,311069	34,780059
446	4	11,312041	34,779018	490	3	11,344612	34,780081
447	4	11,324387	34,779074	491	5	11,317501	34,78015
448	4	11,323723	34,779094	492	2	11,32139	34,780253
449	4	11,323601	34,779194	493	1	11,314076	34,780283
450	2	11,324897	34,779219	494	5	11,320896	34,780301
451	3	11,31278	34,779223	495	2	11,319945	34,780343
452	2	11,325386	34,779239	496	2	11,328294	34,780346
453	4	11,323432	34,77926	497	4	11,332858	34,780382
454	1	11,31581	34,779268	498	5	11,315962	34,780395

N	Class	Longitude X	Lattitude Y	N	Class	Longitude X	Lattitude Y
499	5	11,320616	34,780397	541	5	11,320027	34,781471
500	5	11,314876	34,780476	542	2	11,35752	34,781563
501	5	11,320295	34,780505	543	5	11,31394	34,781589
502	5	11,317935	34,780569	544	5	11,317149	34,781594
503	5	11,320164	34,780576	545	2	11,327726	34,781622
504	2	11,320006	34,780601	546	2	11,31347	34,781635
505	5	11,313776	34,780603	547	3	11,347327	34,781647
506	2	11,319184	34,780747	548	5	11,314598	34,781667
507	1	11,318634	34,780751	549	5	11,314926	34,781671
508	2	11,319469	34,780794	550	5	11,314942	34,781699
509	1	11,31322	34,780816	551	5	11,315699	34,781723
510	1	11,314458	34,780823	552	1	11,31433	34,78176
511	2	11,328063	34,780834	553	5	11,31811	34,781906
512	3	11,324375	34,780883	554	2	11,326838	34,782003
513	5	11,319756	34,780909	555	4	11,34931	34,782007
514	5	11,319132	34,78093	556	4	11,346702	34,782035
515	5	11,314829	34,780958	557	3	11,333937	34,782055
516	1	11,31586	34,780972	558	4	11,346326	34,782097
517	5	11,317109	34,781009	559	5	11,31821	34,782115
518	5	11,316894	34,781055	560	4	11,349062	34,782131
519	1	11,316277	34,781057	561	3	11,355604	34,782135
520	4	11,35841	34,781079	562	5	11,317779	34,782157
521	1	11,31301	34,7811	563	3	11,327389	34,782184
522	1	11,315929	34,781116	564	2	11,317699	34,782227
523	2	11,31767	34,781136	565	4	11,346264	34,782231
524	1	11,316446	34,781151	566	4	11,334268	34,782238
525	1	11,317275	34,781152	567	2	11,311058	34,782308
526	5	11,314199	34,781172	568	4	11,346421	34,782392
527	5	11,31587	34,78121	569	2	11,317377	34,782425
528	2	11,320834	34,781234	570	1	11,318632	34,782425
529	5	11,317617	34,781238	571	1	11,3172	34,782482
530	5	11,318671	34,781241	572	4	11,346164	34,782483
531	5	11,316737	34,781282	573	4	11,348148	34,782497
532	1	11,318949	34,781288	574	2	11,312534	34,782527
533	5	11,315634	34,781316	575	4	11,349386	34,782549
534	4	11,312539	34,781351	576	4	11,327077	34,782614
535	5	11,316524	34,781358	577	4	11,346373	34,782649
536	1	11,318718	34,781363	578	1	11,317107	34,782672
537	5	11,315302	34,781386	579	4	11,310873	34,782731
538	5	11,317237	34,781402	580	2	11,319754	34,782767
539	4	11,357659	34,78143	581	3	11,334436	34,782774
540	5	11,316331	34,78146	582	4	11,349043	34,782816

N	Class	Longitude X	Lattitude Y	N	Class	Longitude X	Lattitude Y
583	1	11,310678	34,782816	625	3	11,34208	34,784185
584	4	11,348691	34,782825	626	2	11,326318	34,784301
585	1	11,31654	34,782844	627	4	11,345859	34,78432
586	4	11,348001	34,782883	628	1	11,313122	34,784325
587	1	11,313118	34,782941	629	1	11,313955	34,78433
588	4	11,345403	34,782944	630	2	11,32596	34,78434
589	4	11,345588	34,782944	631	4	11,345407	34,784515
590	4	11,347515	34,782976	632	2	11,336206	34,784539
591	4	11,316304	34,782999	633	4	11,345731	34,784591
592	2	11,32688	34,783009	634	4	11,336511	34,784632
593	2	11,321706	34,783128	635	2	11,32102	34,784658
594	4	11,34718	34,783157	636	4	11,327135	34,784678
595	4	11,349376	34,78322	637	4	11,346116	34,784705
596	4	11,346708	34,783228	638	4	11,313238	34,78476
597	2	11,323214	34,783267	639	3	11,310784	34,784764
598	4	11,348991	34,783311	640	4	11,34743	34,784767
599	3	11,320656	34,783359	641	4	11,345398	34,7848
600	4	11,347694	34,783378	642	1	11,336832	34,784863
601	3	11,354177	34,783423	643	2	11,32841	34,784876
602	4	11,346304	34,783433	644	3	11,356881	34,784898
603	4	11,347458	34,783447	645	1	11,317441	34,784922
604	4	11,315752	34,783466	646	4	11,346383	34,784924
605	2	11,324217	34,783466	647	1	11,312828	34,784968
606	4	11,348629	34,783468	648	2	11,325726	34,785081
607	4	11,346787	34,783514	649	2	11,312554	34,785123
608	4	11,346304	34,783516	650	3	11,348217	34,785209
609	2	11,335446	34,783561	651	4	11,337153	34,785266
610	1	11,317299	34,783562	652	4	11,348881	34,785272
611	4	11,315519	34,783568	653	4	11,329211	34,785279
612	4	11,310871	34,783633	654	3	11,312351	34,78529
613	2	11,315172	34,783637	655	1	11,329809	34,785305
614	4	11,34644	34,783761	656	3	11,330361	34,785323
615	2	11,318833	34,783772	657	4	11,347049	34,785329
616	2	11,326559	34,783818	658	3	11,310988	34,785349
617	4	11,34723	34,783854	659	2	11,312254	34,785365
618	4	11,349462	34,783891	660	1	11,312206	34,785402
619	4	11,314721	34,783905	661	2	11,312179	34,785424
620	2	11,335713	34,783906	662	1	11,312148	34,785448
621	4	11,347877	34,78398	663	3	11,331292	34,785448
622	4	11,314506	34,784063	664	4	11,31925	34,785459
623	2	11,317323	34,784136	665	4	11,312093	34,785494
624	2	11,314344	34,784169	666	3	11,311035	34,785549

N	Class	Longitude X	Lattitude Y	N	Class	Longitude X	Lattitude Y
667	3	11,332628	34,785601	709	3	11,323489	34,786967
668	3	11,311932	34,785676	710	1	11,32237	34,786995
669	2	11,358984	34,785815	711	4	11,323383	34,787004
670	3	11,311079	34,78588	712	1	11,323192	34,787005
671	4	11,3254	34,785899	713	4	11,323615	34,787013
672	3	11,311546	34,785928	714	4	11,323222	34,787016
673	4	11,325256	34,78593	715	1	11,321974	34,787049
674	3	11,336791	34,785987	716	3	11,31794	34,787071
675	3	11,317373	34,786032	717	3	11,360936	34,787071
676	3	11,311272	34,786068	718	4	11,323368	34,787107
677	3	11,333562	34,786111	719	2	11,326859	34,787117
678	3	11,311015	34,786164	720	3	11,324757	34,787193
679	4	11,359804	34,786261	721	3	11,320936	34,787229
680	3	11,31072	34,786282	722	4	11,310677	34,787233
681	4	11,334035	34,786346	723	3	11,31727	34,787266
682	2	11,32127	34,786538	724	3	11,316106	34,78728
683	3	11,354381	34,786566	725	2	11,314529	34,787366
684	4	11,335428	34,786588	726	3	11,321356	34,787376
685	3	11,324033	34,786594	727	2	11,322715	34,787395
686	4	11,324176	34,786611	728	3	11,327263	34,787395
687	1	11,321915	34,78662	729	1	11,327886	34,787415
688	4	11,323843	34,786644	730	4	11,327638	34,787455
689	3	11,311058	34,786658	731	1	11,327817	34,787488
690	4	11,320848	34,786668	732	3	11,328516	34,787575
691	1	11,323586	34,78668	733	3	11,328574	34,787587
692	1	11,323147	34,786693	734	3	11,328139	34,787638
693	4	11,323907	34,786715	735	1	11,324569	34,787659
694	3	11,325032	34,786723	736	2	11,317013	34,78771
695	1	11,323312	34,786741	737	3	11,312009	34,787731
696	4	11,323762	34,786765	738	3	11,32198	34,787745
697	4	11,320196	34,786771	739	3	11,322322	34,787772
698	4	11,32385	34,786786	740	4	11,3277	34,787806
699	3	11,325472	34,786793	741	3	11,320624	34,78781
700	3	11,319925	34,786806	742	3	11,321593	34,787962
701	4	11,324105	34,786811	743	3	11,321909	34,788003
702	3	11,326141	34,786813	744	1	11,317797	34,788053
703	1	11,323004	34,786829	745	3	11,320871	34,788063
704	4	11,323741	34,786852	746	3	11,322113	34,788117
705	4	11,319616	34,786887	747	3	11,328401	34,788125
706	4	11,323862	34,78692	748	3	11,327869	34,788184
707	4	11,319074	34,786925	749	1	11,319307	34,788229
708	3	11,326567	34,786966	750	3	11,363259	34,788235

N	Class	Longitude X	Lattitude Y	N	Class	Longitude X	Lattitude Y
751	3	11,321864	34,788253	793	1	11,332108	34,792427
752	3	11,3108	34,78839	794	1	11,327773	34,792465
753	1	11,316614	34,788399	795	1	11,326745	34,792499
754	3	11,321576	34,788473	796	1	11,3326	34,792521
755	3	11,327439	34,788474	797	1	11,327085	34,792547
756	3	11,36306	34,788498	798	4	11,364562	34,792562
757	3	11,328158	34,788593	799	1	11,333249	34,792598
758	2	11,311299	34,788659	800	1	11,326764	34,792758
759	1	11,311165	34,788685	801	4	11,360427	34,7928
760	4	11,326995	34,788894	802	3	11,33369	34,792804
761	3	11,353421	34,788975	803	2	11,332077	34,79287
762	3	11,326737	34,788992	804	1	11,326193	34,792907
763	3	11,349548	34,789002	805	1	11,327277	34,792957
764	4	11,330251	34,789154	806	4	11,330944	34,792968
765	4	11,326587	34,789155	807	2	11,331572	34,792974
766	4	11,329898	34,789282	808	2	11,332794	34,793013
767	4	11,331679	34,789338	809	4	11,326005	34,793094
768	4	11,360239	34,789399	810	3	11,356409	34,7931
769	3	11,327904	34,789429	811	1	11,327522	34,793133
770	3	11,359499	34,789431	812	2	11,330063	34,793138
771	4	11,33258	34,789541	813	1	11,326507	34,793184
772	3	11,326054	34,789608	814	1	11,325883	34,793282
773	3	11,327634	34,789749	815	1	11,332347	34,793332
774	3	11,325608	34,78999	816	3	11,339918	34,79334
775	4	11,333174	34,790017	817	4	11,326842	34,793405
776	3	11,346055	34,790053	818	4	11,361269	34,793556
777	3	11,356752	34,790161	819	6	11,325762	34,793602
778	3	11,327083	34,790355	820	1	11,326339	34,793784
779	2	11,325134	34,79036	821	3	11,362975	34,793921
780	1	11,332883	34,790552	822	3	11,365018	34,793926
781	1	11,326954	34,790794	823	3	11,356741	34,793959
782	3	11,354772	34,790842	824	2	11,341625	34,79405
783	1	11,32691	34,791259	825	3	11,343228	34,794058
784	3	11,352246	34,791604	826	3	11,329615	34,794098
785	3	11,33069	34,791913	827	4	11,331583	34,794132
786	2	11,340604	34,791936	828	4	11,357085	34,794243
787	2	11,329216	34,792071	829	6	11,325781	34,794262
788	2	11,330964	34,792143	830	3	11,362481	34,794393
789	1	11,328354	34,792183	831	4	11,330976	34,794523
790	1	11,328664	34,792223	832	3	11,362765	34,794538
791	3	11,346602	34,792258	833	1	11,327198	34,794608
792	4	11,364777	34,792417	834	4	11,326851	34,794728

N	Class	Longitude X	Lattitude Y	N	Class	Longitude X	Lattitude Y
835	4	11,365376	34,794742	877	5	11,326458	34,797467
836	6	11,325607	34,794752	878	3	11,340046	34,797503
837	1	11,330525	34,794788	879	3	11,353263	34,797553
838	4	11,362308	34,794902	880	5	11,327019	34,797587
839	4	11,365515	34,794921	881	1	11,340636	34,797599
840	3	11,352214	34,794999	882	2	11,343675	34,797703
841	6	11,325723	34,795002	883	1	11,326149	34,797721
842	4	11,327352	34,795038	884	1	11,327724	34,797763
843	1	11,330245	34,795118	885	4	11,353388	34,797766
844	3	11,361811	34,795144	886	1	11,340126	34,797838
845	2	11,32888	34,79518	887	5	11,326841	34,797852
846	6	11,325376	34,795242	888	2	11,340604	34,797854
847	3	11,357616	34,795364	889	1	11,327438	34,797921
848	6	11,325273	34,795397	890	4	11,340548	34,797942
849	1	11,326354	34,795517	891	4	11,353474	34,797955
850	4	11,329835	34,795518	892	5	11,325949	34,798013
851	3	11,36085	34,795573	893	1	11,326813	34,798037
852	1	11,328608	34,795582	894	3	11,340373	34,798174
853	1	11,329693	34,795706	895	1	11,327095	34,798334
854	1	11,327431	34,795717	896	5	11,326604	34,798366
855	1	11,328457	34,795878	897	1	11,327784	34,798366
856	4	11,329405	34,795946	898	4	11,340213	34,798373
857	1	11,326729	34,796222	899	5	11,32796	34,798412
858	1	11,329004	34,796269	900	1	11,339966	34,79854
859	4	11,328212	34,79627	901	5	11,326858	34,798649
860	3	11,358184	34,796298	902	1	11,326203	34,798675
861	4	11,365724	34,796418	903	4	11,339966	34,798692
862	1	11,327992	34,796432	904	1	11,328012	34,798699
863	3	11,352434	34,796458	905	1	11,326717	34,798873
864	1	11,328755	34,796562	906	1	11,342949	34,798939
865	4	11,365765	34,7967	907	1	11,328108	34,798999
866	4	11,327601	34,796706	908	1	11,326579	34,799051
867	4	11,327762	34,796797	909	5	11,327898	34,799301
868	3	11,358501	34,796845	910	3	11,359547	34,799302
869	1	11,328356	34,796944	911	1	11,344178	34,799362
870	1	11,327601	34,79708	912	4	11,365974	34,799367
871	4	11,365821	34,797083	913	5	11,326319	34,799489
872	6	11,327034	34,797154	914	3	11,354987	34,799559
873	4	11,35312	34,797215	915	4	11,365844	34,799653
874	6	11,327362	34,797328	916	2	11,342375	34,799769
875	1	11,327834	34,797405	917	1	11,326168	34,799776
876	4	11,365947	34,797424	918	3	11,357777	34,799978

N	Class	Longitude X	Lattitude Y	N	Class	Longitude X	Lattitude Y
919	1	11,325935	34,800037	961	1	11,347469	34,801728
920	3	11,360732	34,800289	962	2	11,327076	34,801764
921	3	11,365812	34,80031	963	1	11,340697	34,801783
922	4	11,350726	34,800414	964	3	11,334361	34,801807
923	1	11,332443	34,800435	965	3	11,353227	34,801807
924	3	11,328465	34,800437	966	3	11,352128	34,801866
925	2	11,333755	34,80045	967	3	11,354949	34,801903
926	1	11,33008	34,800482	968	4	11,365851	34,801969
927	3	11,359402	34,800503	969	2	11,330981	34,801997
928	3	11,350371	34,800605	970	4	11,363485	34,801997
929	4	11,36154	34,800611	971	4	11,363657	34,802124
930	2	11,345917	34,800615	972	4	11,32939	34,802164
931	1	11,345087	34,800624	973	2	11,332274	34,802204
932	3	11,328604	34,800706	974	3	11,354397	34,802306
933	4	11,36166	34,800777	975	4	11,36527	34,802397
934	2	11,34453	34,800797	976	1	11,329655	34,802481
935	4	11,330439	34,800804	977	3	11,334811	34,802488
936	2	11,347998	34,800806	978	2	11,330246	34,802516
937	3	11,35658	34,800873	979	4	11,365365	34,80254
938	2	11,331872	34,800875	980	4	11,365227	34,802545
939	4	11,341071	34,800879	981	1	11,340725	34,802549
940	3	11,333969	34,8009	982	3	11,364294	34,802552
941	3	11,349332	34,800922	983	3	11,341528	34,802558
942	3	11,343481	34,800925	984	3	11,357299	34,802611
943	3	11,342869	34,800934	985	1	11,342431	34,802631
944	1	11,341327	34,801053	986	4	11,36607	34,802669
945	4	11,365812	34,801083	987	1	11,329886	34,80271
946	1	11,326656	34,801092	988	4	11,364899	34,802726
947	3	11,356237	34,801109	989	3	11,342614	34,80275
948	2	11,34223	34,801126	990	4	11,333401	34,802751
949	4	11,339593	34,801158	991	4	11,327611	34,802894
950	2	11,350936	34,801162	992	4	11,367688	34,802916
951	3	11,362385	34,801254	993	1	11,343106	34,802932
952	2	11,331568	34,80126	994	3	11,333835	34,802976
953	1	11,35119	34,801388	995	4	11,366803	34,802978
954	4	11,351801	34,801404	996	3	11,334828	34,803019
955	1	11,351046	34,801418	997	4	11,343444	34,803069
956	3	11,341738	34,801418	998	4	11,326153	34,803159
957	4	11,337713	34,801537	999	3	11,341865	34,803206
958	4	11,365865	34,801575	1000	1	11,325482	34,803275
959	2	11,329185	34,801592	1001	3	11,352426	34,803296
960	2	11,331518	34,801657	1002	4	11,364851	34,803321

N	Class	Longitude X	Lattitude Y	N	Class	Longitude X	Lattitude Y
1003	2	11,32765	34,803373	1045	1	11,359116	34,80451
1004	3	11,334157	34,803389	1046	4	11,356618	34,804521
1005	4	11,342376	34,803425	1047	2	11,345278	34,804529
1006	4	11,36497	34,803516	1048	2	11,360441	34,804537
1007	4	11,365851	34,803516	1049	4	11,36192	34,804566
1008	4	11,366198	34,803525	1050	2	11,348509	34,804566
1009	4	11,364323	34,803549	1051	3	11,351929	34,804575
1010	2	11,344092	34,80358	1052	4	11,366907	34,804591
1011	4	11,368035	34,803601	1053	4	11,357156	34,804601
1012	3	11,352375	34,803679	1054	1	11,347952	34,804612
1013	4	11,367654	34,80372	1055	3	11,350352	34,80463
1014	3	11,365888	34,803753	1056	4	11,352054	34,804641
1015	1	11,326124	34,803788	1057	4	11,365351	34,804644
1016	1	11,325858	34,803801	1058	4	11,366136	34,804648
1017	4	11,367131	34,80382	1059	1	11,358859	34,804651
1018	4	11,329972	34,803839	1060	4	11,355732	34,804653
1019	4	11,365513	34,803858	1061	3	11,362889	34,804661
1020	4	11,36803	34,803863	1062	1	11,345634	34,804694
1021	4	11,365223	34,803868	1063	1	11,340697	34,804739
1022	4	11,36696	34,803882	1064	4	11,367369	34,804786
1023	4	11,358104	34,803888	1065	4	11,361923	34,804794
1024	4	11,327822	34,804006	1066	1	11,328138	34,804886
1025	4	11,362434	34,804073	1067	3	11,3303	34,804886
1026	4	11,358273	34,804141	1068	4	11,330603	34,80492
1027	1	11,341181	34,804146	1069	4	11,367707	34,804953
1028	3	11,344612	34,804219	1070	4	11,361549	34,804991
1029	4	11,332013	34,804221	1071	3	11,331273	34,804992
1030	4	11,364928	34,804225	1072	4	11,362323	34,804998
1031	4	11,362137	34,804266	1073	4	11,36278	34,805008
1032	4	11,36735	34,804282	1074	4	11,36775	34,805048
1033	3	11,361601	34,804285	1075	1	11,358919	34,805101
1034	1	11,353948	34,80431	1076	4	11,345789	34,805104
1035	4	11,360196	34,804312	1077	2	11,331893	34,805106
1036	3	11,32651	34,80432	1078	1	11,32817	34,805143
1037	2	11,358789	34,804326	1079	4	11,360753	34,805151
1038	1	11,359386	34,80436	1080	2	11,342194	34,805159
1039	4	11,368211	34,804363	1081	3	11,344393	34,805177
1040	4	11,366331	34,80443	1082	2	11,343371	34,805177
1041	3	11,330654	34,804451	1083	1	11,341391	34,805177
1042	3	11,354672	34,804456	1084	4	11,332132	34,805185
1043	4	11,354701	34,804479	1085	3	11,344046	34,805187
1044	4	11,357455	34,804484	1086	3	11,345141	34,805196

N	Class	Longitude X	Lattitude Y	N	Class	Longitude X	Lattitude Y
1087	1	11,342522	34,805232	1101	1	11,326656	34,805772
1088	4	11,355482	34,805243	1102	4	11,336383	34,805825
1089	1	11,326649	34,805248	1103	1	11,328347	34,805846
1090	3	11,33287	34,805256	1104	4	11,337701	34,805879
1091	4	11,361417	34,805297	1105	2	11,326623	34,806323
1092	2	11,33339	34,805299	1106	4	11,328573	34,807241
1093	3	11,333889	34,805369	1107	1	11,326748	34,807402
1094	4	11,339259	34,80544	1108	2	11,326696	34,807841
1095	4	11,334256	34,805509	1109	2	11,32571	34,807842
1096	4	11,360246	34,805687	1110	2	11,328068	34,808266
1097	4	11,359152	34,805689	1111	4	11,326479	34,808591
1098	2	11,338025	34,805707	1112	1	11,326692	34,808651
1099	3	11,335235	34,805717	1113	4	11,32669	34,808826
1100	3	11,338187	34,805723				

ANNEX 2 - PHENOLOGIC ANALYSES

Kerstatekennah (-1m) : 23 July 2015

1	LT	B	l	state	Nb A c	4
A	745	58	10	c	Nb A	4
	817	59	10	c	Lg A	887,3
	1032	55	10	c	LB	54,5
	955	46	10	c	la A	10,0
					Coef A	100,0%
					LAI A	354,9
					LAA m²	25,1
I	129		9		Nb I c	0
					Nb I	1
					Lg I	129,0
					la I	9,0
					Coef I	0,0%
					LAI I	11,6
J	**22**		8		LAI m²	0,8
	3		4		Coef G	80,0%
					LAI G	366,5
					LAG m²	25,9

2	LT	B	l	state	Nb A c	3
A	290	60	11	c	Nb A	3
	462	58	11	c	Lg A	482,7
	696	49	11	c	LB	55,7
					la A	11,0
					Coef A	####
					LAI A	159,3
					LAA m²	11,3
I	330		11		Nb I c	0
	86		11		Nb I	2
					Lg I	208,0
					la I	11,0
					Coef I	0,0%
					LAI I	45,8
J	15		9		LAI m²	3,2
	2		5		Coef G	60,0%
					LAI G	205,0
					LAG m²	14,5

3	LT	B	l	state	Nb A c	4
A	596	58	10	c	Nb A	4
	910	59	10	c	Lg A	812,8
	786	55	10	c	LB	54,0
	959	44	10	c	la A	10,0
					Coef A	100,0%
					LAI A	325,1
					LAA m²	23,0
I					Nb I c	0
					Nb I	0
					Lg I	
					la I	
					Coef I	
					LAI I	
J	**23**		10		LAI m²	#####
	3		4		Coef G	100,0%
					LAI G	325,1
					LAG m²	#####

4	LT	B	l	state	Nb A c	4
A	766	56	10	c	Nb A	4
	596	57	10	c	Lg A	815,8
	910	55	10	c	LB	53,5
	991	46	10	c	la A	10,0
					Coef A	100,0%
					LAI A	326,3
					LAA m²	23,1
I	810		9		Nb I c	0
	216		10		Nb I	3
	41		9		Lg I	355,7
					la I	9,3
					Coef I	0,0%
					LAI I	99,6
J	**5**		6		LAI m²	7,1
					Coef G	57,1%
					LAI G	425,9
					LAG m²	30,2

5	LT	B	l	state	Nb A c	3
A	795	58	10	c	Nb A	3
	810	56	9	c	Lg A	837,0
	906	40	9	c	LB	51,3
					la A	9,3
					Coef A	####
					LAI A	234,4
					LAA m²	16,6
I	390		10		Nb I c	0
	119		10		Nb I	2
					Lg I	254,5
					la I	10,0
					Coef I	0,0%
					LAI I	50,9
J	**3**		4		LAI m²	3,6
					Coef G	60,0%
					LAI G	285,3
					LAG m²	20,2

6	LT	B	l	state	Nb A c	2
A	659	57	10	c	Nb A	3
	602	53	10	c	Lg A	691,0
	812	48	11		LB	52,7
					la A	10,3
					Coef A	66,7%
					LAI A	214,2
					LAA m²	15,2
I	594		10		Nb I c	0
	117		10		Nb I	2
					Lg I	355,5
					la I	10,0
					Coef I	0,0%
					LAI I	71,1
J	**7**		8		LAI m²	5,0
	3		5		Coef G	40,0%
					LAI G	285,3
					LAG m²	20,2

7	LT	B	l	state	Nb A c	2
A	540	57	11	c	Nb A	4
	698	55	11	c	Lg A	746,8
	931	53	11		LB	46,8
	818	22	10		la A	10,8
					Coef A	50,0%
					LAI A	321,1
					LAA m²	22,7
I	139		11		Nb I c	0
					Nb I	1
					Lg I	139,0
					la I	11,0
					Coef I	0,0%
					LAI I	15,3
J	7		9		LAI m²	1,1
	3		5		Coef G	40,0%
					LAI G	336,4
					LAG m²	23,8

8	LT	B	l	state	Nb A c	2
A	753	53	11	c	Nb A	3
	972	55	10	c	Lg A	898,0
	969	45	10		LB	51,0
					la A	10,3
					Coef A	66,7%
					LAI A	278,4
					LAA m²	19,7
I	376		10		Nb I c	0
					Nb I	1
					Lg I	376,0
					la I	10,0
					Coef I	0,0%
					LAI I	37,6
J	**35**		10		LAI m²	2,7
	2		4		Coef G	50,0%
					LAI G	316,0
					LAG m²	22,4

Kerkennah (-0,8m) : 27 July 2015

9	LT	B	l	state	Nb A c	2
A	656	55	11	c	Nb A	3
	414	54	11	c	Lg A	645,0
	865	50	11		LB	53,0
					la A	11,0
					Coef A	66,7%
					LAI A	212,9
					LAA m²	15,5
I	702		11		Nb I c	0
	158		10		Nb I	3
	100		10		Lg I	320,0
					la I	10,3
					Coef I	0,0%
					LAI I	99,2
J	**21**		10		LAI m²	7,2
	8		9		Coef G	33,3%
	8		9		LAI G	312,1
	3		4		LAG m²	22,8

10	LT	B	l	state	Nb A c	2
A	780	48	9	c	Nb A	2
	545	55	10	c	Lg A	662,5
					LB	51,5
					la A	9,5
					Coef A	####
					LAI A	125,9
					LAA m²	9,2
I	752		10	c	Nb I c	1
	76		10		Nb I	2
					Lg I	414,0
					la I	10,0
					Coef I	50,0%
					LAI I	82,8
J	3		6		LAI m²	6,0
					Coef G	75,0%
					LAI G	208,7
					LAG m²	15,2

11	LT	B	l	state	Nb A c	2
A	389	50	11	c	Nb A	2
	596	46	10	c	Lg A	492,5
					LB	48,0
					la A	10,5
					Coef A	100,0%
					LAI A	103,4
					LAA m²	7,6
I	959		10		Nb I c	0
					Nb I	1
					Lg I	959,0
					la I	10,0
					Coef I	0,0%
					LAI I	95,9
J	38		10		LAI m²	7,0
	4		5		Coef G	66,7%
					LAI G	199,3
					LAG m²	14,6

12	LT	B	l	state	Nb A c	3
A	642	58	10	c	Nb A	3
	832	56	10	c	Lg A	684,0
	578	35	10	c	LB	49,7
					la A	10,0
					Coef A	100,0%
					LAI A	205,2
					LAA m²	15,0
I	125		10		Nb I c	0
					Nb I	1
					Lg I	125,0
					la I	10,0
					Coef I	0,0%
					LAI I	12,5
J	18		9		LAI m²	0,9
	6		6		Coef G	75,0%
					LAI G	217,7
					LAG m²	15,9

13	LT	B	l	state	Nb A c	3
A	831	55	11	c	Nb A	4
	820	53	11	c	Lg A	812,0
	795	50	11	c	LB	49,8
	802	41	11		la A	11,0
					Coef A	75,0%
					LAI A	357,3
					LAA m²	26,1
I	318		11		Nb I c	0
	167		11		Nb I	2
					Lg I	242,5
					la I	11,0
					Coef I	0,0%
					LAI I	53,4
J	5		8		LAI m²	3,9
					Coef G	50,0%
					LAI G	410,6
					LAG m²	30,0

14	LT	B	l	state	Nb A c	4
A	539	54	11	c	Nb A	4
	705	54	11	c	Lg A	684,3
	720	47	11	c	LB	49,5
	773	43	11	c	la A	11,0
					Coef A	100,0%
					LAI A	301,1
					LAA m²	22,0
I	478		11		Nb I c	0
	195		11		Nb I	2
					Lg I	336,5
					la I	11,0
					Coef I	0,0%
					LAI I	74,0
J	5		9		LAI m²	5,4
					Coef G	66,7%
					LAI G	375,1
					LAG m²	27,4

15	LT	B	l	state	Nb A c	4
A	775	56	11		Nb A	5
	531	55	11	c	Lg A	559,2
	345	43	11	c	LB	47,0
	577	41	11	c	la A	11,0
	568	40	11	c	Coef A	80,0%
					LAI A	307,6
					LAA m²	22,5
I	225		11		Nb I c	0
	221		10		Nb I	4
	117		9		Lg I	166,3
	102		10		la I	10,0
					Coef I	0,0%
					LAI I	66,5
J	11		8		LAI m²	4,9
					Coef G	44,4%
					LAI G	374,1
					LAG m²	27,3

16	LT	B	l	state	Nb A c	3
A	827	55	10	c	Nb A	3
	838	52	11	c	Lg A	809,0
	762	42	10	c	LB	49,7
					la A	10,3
					Coef A	####
					LAI A	250,8
					LAA m²	18,3
I	447		10		Nb I c	0
	139		10		Nb I	2
					Lg I	293,0
					la I	10,0
					Coef I	0,0%
					LAI I	58,6
J	3		9		LAI m²	4,3
					Coef G	60,0%
					LAI G	309,4
					LAG m²	22,6

Kerkennah (-1,3m) : 28 July 2015

17	LT	B	l	state	Nb A c	1
A	460	59		c	Nb A	3
	900	58			Lg A	738,3
	855	43			LB	53,3
					la A	10,0
					Coef A	33,3%
					LAI A	221,5
					LAA m²	15,8
I	106				Nb I c	0
					Nb I	1
					Lg I	106,0
					la I	10,0
					Coef I	0,0%
					LAI I	10,6
J		8			LAI m²	0,8
					Coef G	25,0%
					LAI G	232,1
					LAG m²	16,5

18	LT	B	l	state	Nb A c	1
A	815	57	10	c	Nb A	2
	627	53	10		Lg A	721,0
					LB	55,0
					la A	10,0
					Coef A	50,0%
					LAI A	144,2
					LAA m²	10,3
I	395		10		Nb I c	0
					Nb I	1
					Lg I	395,0
					la I	10,0
					Coef I	0,0%
					LAI I	39,5
J	23		10		LAI m²	2,8
					Coef G	33,3%
					LAI G	183,7
					LAG m²	13,1

19	LT	B	l	state	Nb A c	3
A	654	52	11	c	Nb A	4
	640	54	11	c	Lg A	709,8
	745	48	11	c	LB	47,8
	800	37	11		la A	11,0
					Coef A	75,0%
					LAI A	312,3
					LAA m²	22,3
I	191		11		Nb I c	0
	51		11		Nb I	2
					Lg I	121,0
					la I	11,0
					Coef I	0,0%
					LAI I	26,6
J	3		7		LAI m²	1,9
					Coef G	50,0%
					LAI G	338,9
					LAG m²	24,2

20	LT	B	l	state	Nb A c	3
A	514	58	11	c	Nb A	4
	371	52	11	c	Lg A	595,3
	639	55	11	c	LB	53,8
	857	50	11		la A	11,0
					Coef A	75,0%
					LAI A	261,9
					LAA m²	18,7
I	360		11		Nb I c	0
	202		10		Nb I	3
	116		11		Lg I	226,0
					la I	10,7
					Coef I	0,0%
					LAI I	72,3
J	**25**		10		LAI m²	5,2
	5		7		Coef G	42,9%
					LAI G	334,2
					LAG m²	23,8

21	LT	B	l	state	Nb A c	4
A	600	54	11	c	Nb A	5
	761	55	11	c	Lg A	687,2
	611	54	11	c	LB	47,0
	870	50	11	c	la A	11,0
	594	22	11		Coef A	80,0%
					LAI A	378,0
					LAA m²	26,9
I	254		11		Nb I c	0
	88		11		Nb I	2
					Lg I	171,0
					la I	11,0
					Coef I	0,0%
					LAI I	37,6
J	3		6		LAI m²	2,7
					Coef G	57,1%
					LAI G	415,6
					LAG m²	29,6

22	LT	B	l	state	Nb A c	4
A	357	56	11	c	Nb A	4
	771	54	11	c	Lg A	687,8
	878	49	11	c	LB	47,0
	745	29	11	c	la A	11,0
					Coef A	100,0%
					LAI A	302,6
					LAA m²	21,6
I	157		11		Nb I c	0
					Nb I	1
					Lg I	157,0
					la I	11,0
					Coef I	0,0%
					LAI I	17,3
J	**9**		9		LAI m²	1,2
					Coef G	80,0%
					LAI G	319,9
					LAG m²	22,8

23	LT	B	l	state	Nb A c	3
A	828	53		c	Nb A	3
	771	52		c	Lg A	810,0
	831	48		c	LB	51,0
					la A	11,0
					Coef A	100,0%
					LAI A	267,3
					LAA m²	19,1
I	756				Nb I c	1
	195			c	Nb I	2
					Lg I	475,5
					la I	10,0
					Coef I	50,0%
					LAI I	95,1
J	24				LAI m²	6,8
	3				Coef G	80,0%
	2				LAI G	362,4
					LAG m²	25,8

24	LT	B	l	state	Nb A c	2
A	573	57	11	c	Nb A	2
	953	52	11	c	Lg A	763,0
					LB	54,5
					la A	11,0
					Coef A	####
					LAI A	167,9
					LAA m²	12,0
I	790		10		Nb I c	1
	89		10	c	Nb I	2
					Lg I	439,5
					la I	10,0
					Coef I	50,0%
					LAI I	87,9
J	5		8		LAI m²	6,3
					Coef G	75,0%
					LAI G	255,8
					LAG m²	18,2

Synthesis	Moy	EcT	IC
Nb A c	2,8	0,96	0,39
Nb A	3,4	0,88	0,35
Lg A	718,0	110,82	44,34
LB	51,1	2,88	1,15
la A	10,5	0,54	0,22
Coef A	84,1%	0,20	0,08
LAI A	255,6	77,25	30,91
LAA m²	18,3	5,50	2,20
Nb I c	0,1	0,34	0,14
Nb I	1,8	0,88	0,35
Lg I	294	184,55	73,83
la I	10,3	0,57	0,23
Coef I	6,5%	0,17	0,07

Synthesis	Moy	EcT	IC
LAI I	54,9	30,57	12,23
LAI m²	3,8	2,31	0,92
Nb G	5,2	1,40	0,56
Lg G	510,6	261,34	104,56
la G	10,4	0,56	0,23
Coef G	58,4%	0,18	0,07
LAI G	308,1	72,12	28,85
LAG m²	21,1	6,85	2,74
Nb G	5,2	1,40	0,56

ANNEX 3 - LEPIDOCHRONOLOGICAL ANALYSIS

Kerkennah (-1m) : 23 July 2015

	1	**Nb cycl. :**		4,0	**2**	**Nb cycl. :**		3,0	**3**	**Nb cycl. :**		3,0	**4**	**Nb cycl. :**		8,0		**5**	**Nb cycl. :**		3,0
Cy	**m**	**M**	**Nb**	**L R**	**m**	**M**	**Nb**	**L R**	**m**	**M**	**Nb**	**L R**	**m**	**M**	**Nb**	**L R**		**m**	**M**	**Nb**	**L R**
																			1		
1	4	8	4	4	5	8	5	28	4	7	4	10	4	7	4	20		5	9	5	31
2	11	15	7	10	13	17	8	24	10	14	6	11	10	13	6	23	F	14	17	9	21
3	18	21	7	8	21	24	8	15	17	21	7	8	16	19	6	22		20	25	6	25
4	25	28	7	14	27	30	6		24	28	7		23	25	7	26		29		9	
5	33		8										30	34	7	27					
6													37	41	7	20					
7													44	48	7	29					
8													54	57	10	20					
9													61	65	7						
10																					
11																					
12																					
13																					
14																					
15																					
S			33	36			27	67			24	29			61	187				29	77
m			8,3	9,0			9,0	22,3			8,0	9,7			7,6	23,4				9,7	25,7

	6	**Nb cycl. :**		- 1,0	**7**	**Nb cycl. :**		-1,0	**8**	**Nb cycl. :**		-1,0	**9**	**Nb cycl. :**		-1,0	**10**	**Nb cycl. :**		-1,0
Cy	**m**	**M**	**Nb**	**L R**	**m**	**M**	**Nb**	**L R**	**m**	**M**	**Nb**	**L R**	**m**	**M**	**Nb**	**L R**	**m**	**M**	**Nb**	**L R**
1			0				0				0				0				0	
2			0				0				0				0				0	
3			0				0				0				0				0	
4			0				0				0				0				0	
5			0				0				0				0				0	
6			0				0				0				0					
7																				
8																				
9																				
10																				
11																				
12																				
13																				
14																				
15																				
S			0	0			0	0			0	0			0	0			0	0
m			0,0	0,0			0,0	0,0			0,0	0,0			0,0	0,0			0,0	0,0

Synthesis	**Moy**	**EcT**	**IC**
Nb. beams	5		
Rank m1	4,4	1	1
Rank M1	7,8	0,8	0,7
Nb. scale	6,7	1,5	1,3
length of rhizome	18,9	8,0	7,0

Kerkennah (-1m) : 27 July 2015

	1	Nb cycl. :		4,0		2	Nb cycl. :		7,0		3	Nb cycl. :		7,0		4	Nb cycl. :		4,0		5	Nb cycl. :		7,0	
Cy	**m**	**M**	**Nb**	**L R**		**m**	**M**	**Nb**	**L R**		**m**	**M**	**Nb**	**L R**		**m**	**M**	**Nb**	**L R**		**m**	**M**	**Nb**	**L R**	
		1					2					1										2			
1	5	9	5	28		4	8	4	14		5	9	5	23		4	9	4	37	F	6	8	6	10	
2	13	17	8	28		12	15	8	8		12	15	7	20	F	13	16	9	25		11	14	5	12	F
3	23	27	10	26		18	21	6	7		18	22	6	30		20	23	7	23		19	22	8	14	
4	31	35	8	32	F	24	27	6	5		27	30	9	14		26	30	6	18		25	28	6	8	
5	39	43	8			29	32	5	6		33	38	6	13		33		7			31	35	6	12	
6						35	39	6	6		42	46	9	20							37	40	6	5	
7						42	46	7	7		51	55	9	24							43	45	6	5	
8						49	52	7	8		59		8								50		7		
9																									
10																									
11																									
12																									
13																									
14																									
15																									
S			39	114				49	61				59	144				33	103				50	66	
m			9,8	28,5				7,0	8,7				8,4	20,6				8,3	25,8				7,1	9,4	

Cy	**m**	**M**	**Nb**	**L R**	**m**	**M**	**Nb**	**L R**	**m**	**M**	**Nb**	**L R**	**m**	**M**	**Nb**	**L R**	**m**	**M**	**Nb**	**L R**
1			0				0				0				0				0	
2			0				0				0				0				0	
3			0				0				0				0				0	
4			0				0				0				0				0	
5			0				0				0				0				0	
6			0				0				0				0					
7																				
8																				
9																				
10																				
11																				
12																				
13																				
14																				
15																				
S			0	0			0	0			0	0			0	0			0	0
m			0,0	0,0			0,0	0,0			0,0	0,0			0,0	0,0			0,0	0,0

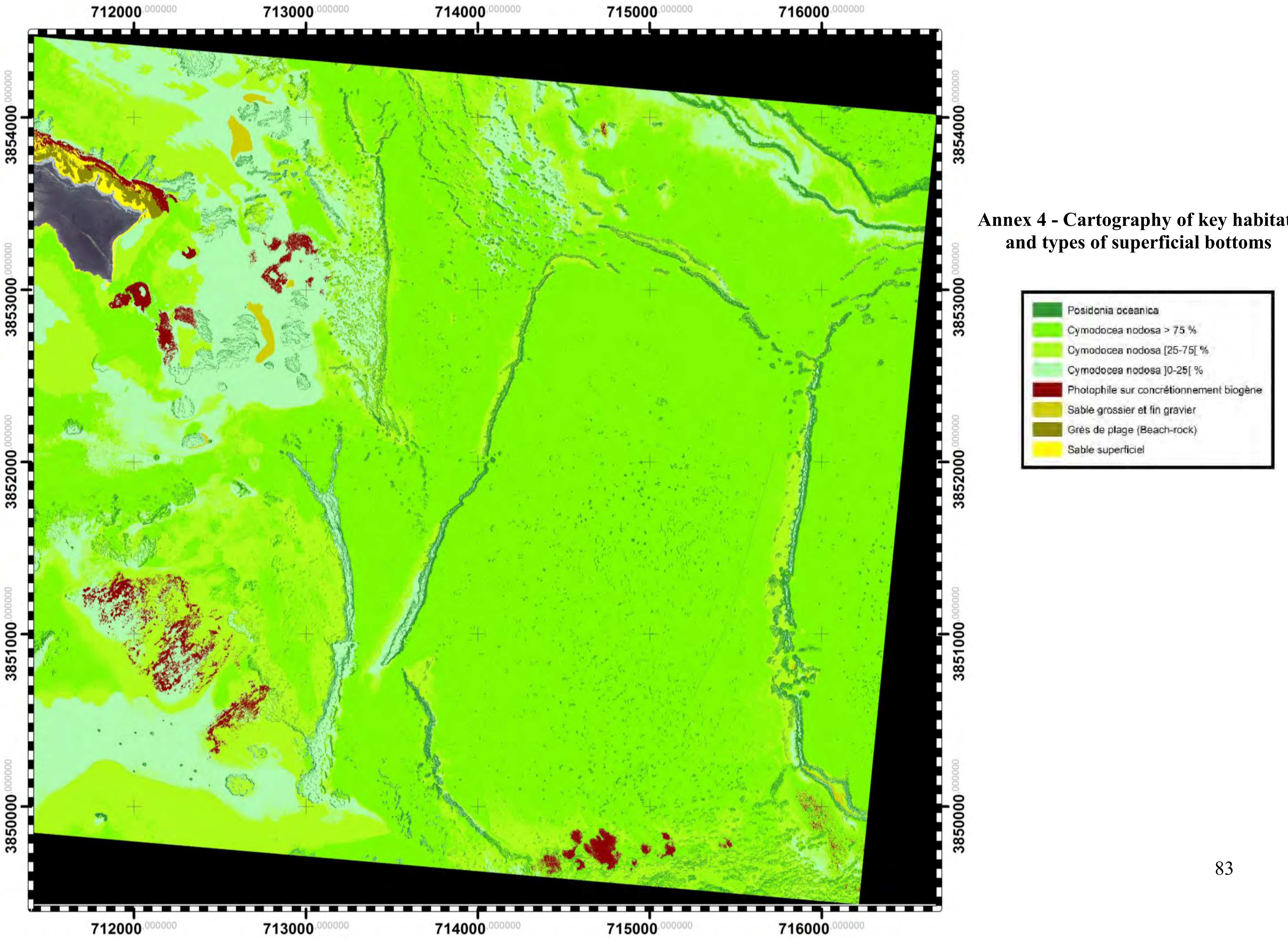
Synthesis	Moy	EcT	IC
Nb. beams	5		
Rank m1	4,8	1	1
Rank M1	8,6	0,5	0,5
Nb. scale	6,8	1,5	1,3
length of rhizome	16,3	9,4	8,2

Kerkennah (-1,3m) : 28 July 2015

	1	Nb cycl. :		9,0		2	Nb cycl. :		14,0		3	Nb cycl. :		11,0		4	Nb cycl. :		14,0		5	Nb cycl. :		13,0	
Cy	**m**	**M**	**Nb**	**L R**		**m**	**M**	**Nb**	**L R**		**m**	**M**	**Nb**	**L R**		**m**	**M**	**Nb**	**L R**		**m**	**M**	**Nb**	**L R**	
1	4	8	4	12	F	4	6	4	12		5	10	5	25		2	6	2	19		3	7	3	11	
2	11	15	7	11		9	13	5	11		15	21	10	17		10	13	8	11		12	16	9	10	
3	18	22	7	11		18	22	9	12		25	29	10	20		17	21	7	11		19	22	7	13	
4	26	30	8	15	F	25	29	7	17		35	40	10	16		25	29	8	10		25	28	6	11	
5	34	37	8	13		33	36	8	11		43	48	8	25		32	34	7	11		32	37	7	11	
6	41	45		11		40	43	7	13		52	55	9	20	F	38	42	6	19		40	44	8	13	
7	48	54		15		46	50	6	15		59	63	7	25		47	50	9	23		47	50	7	14	
8	57	60		14		54	58	8	18		67	71	8	14		55	59	8	13		54	59	7	16	
9	64	67		10	F	62	66	8	16		75	80	8	15	F	62	66	7	14		64	68	10	19	F
10	71	74				69	72	7	20		84	89	9	15	F	69	72	7	13		71	75	7	21	
11						76	80	7	21	F	93	97	9	15		76	86	7	9		79	83	8	13	
12						83	86	7	10		100	104	7			83	86	7	6		87	90	8	11	F
13						89	92	6	11							90	93	7	9	F	94	98	7	10	F
14						96	100	7	14							97	100	7	13		101	105	7		
15						103	107	7								104	108	7	7						
S			34	112				103	201				100	207				104	188				101	173	
m			3,8	12,4				7,4	14,4				9,1	18,8				7,4	13,4				7,8	13,3	

Cy	**m**	**M**	**Nb**	**L R**	**m**	**M**	**Nb**	**L R**	**m**	**M**	**Nb**	**L R**	**m**	**M**	**Nb**	**L R**	**m**	**M**	**Nb**	**L R**
1			0				0				0				0				0	
2			0				0				0				0				0	
3			0				0				0				0				0	
4			0				0				0				0				0	
5			0				0				0				0				0	
6			0				0				0				0					
7																				
8																				
9																				
10																				
11																				
12																				
13																				
14																				
15																				
S			0	0			0	0			0	0			0	0			0	0
m			0,0	0,0			0,0	0,0			0,0	0,0			0,0	0,0			0,0	0,0

Synthesis	Moy	EcT	IC
Nb. beams	5		
Rank m1	3,6	1	1
Rank M1	7,4	1,7	1,5
Nb. scale	7,2	1,5	1,3
length of rhizome	14,2	4,4	3,8

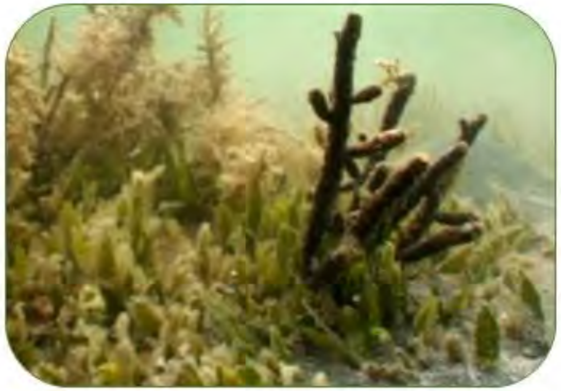


Annex 4 - Cartography of key habitats and types of superficial bottoms

THE MOST FREQUENT SPECIES OF THE BIOCENOSIS OF PHOTOPHILOUS ALGAE IN THE AREA OF STUDY

Heap of *Cystoseira foeniculacea* f. *schiffneri* in a freeform

Cystoseira foeniculacea



Cystoseira foeniculacea f. *schiffneri* surrounded by a meadow of *Caulerpa prolifera*

Concretions of *Neogoniolithon brassicaflorida*

Dasycladus vermicularis and *Anadyomene stellata* on concretions

Padina pavonica and *Laurencia obtusa*

BENTHIC FAUNA ASSOCIATED WITH PHOTOPHILOUS ALGAE IN THE AREA OF STUDY

Amphipholis squamata

Asterina gibbosa ~ Ventral and dorsal sides

Didemnum sp.

Sphaeroma serratum

Eurydice pulchra

Syngnathus abaster