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Regional Activity Centre For Specially Protected Areas

Integrated Coastal Area Management in Cyprus: Biodiversity Concerns

CYPRUS WILDLIFE SOCIETY

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COASTAL AREA MANAGEMENT PROGRAMME (CAMP) FOR CYPRUS.

ACTIVITY 6: BIODIVERSITY CONCERNS IN INTEGRATED COASTAL AREA MANAGEMENT (ICAM)

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Cover photograph: A. Demetropoulos

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1. INTRODUCTION

The coastal area of Cyprus is home to more than half of the population, and much of the economic output is related to activities taking place in coastal areas (such as coastal tourism, shipping, fishing etc). The presence of large and growing populations in the coastal area creates at the same time major problems. In Cyprus, as in other Mediterranean developed countries, needs are generated for even larger sewage treatment plants, expanded landfills for the disposal of solid waste, and increased recreational facilities, to name only a few.

On the other hand, the marine environment is completely different to the terrestrial one. Nonetheless much of the marine protection normative is still based on the terrestrial philosophy. In this context the application of the terrestrial protected areas philosophy to the marine areas is not adequate because the marine realm is characterised by:

- i) being open, with no physical barriers and no defined limits (water masses mobility by currents, free dispersal stage of many of the marine organisms);
- ii) small-scale complexity and interrelation of the ecological processes;
- iii) no ownership and more administrative complexity (various administrations; local, regional, national and supranational normative);
- iv) confluence of various uses (fishing, aquaculture, navigation, industry, leisure and tourism, etc.), which give rise to a variety of conflicts; and
- v) the large spread of the environmental impacts (pollution, beach regeneration, sediment dumping, sewage, etc.).

Therefore, coastal and marine areas are vulnerable in natural resource development and exploitation occurring in these areas, in particular overfishing, alteration and destruction of habitats and water pollution. Thus, protection and development of coastal and marine areas (of species, habitats, landscapes and seascapes) should be integrated into special development strategies for larger areas, under the umbrella of integrated marine and coastal area management (IMCAM)

The challenge is not to eliminate these activities but instead how to manage them in an appropriate and rational manner while preserving essential ecological processes, life support systems and biological diversity.

1.1 Justification and needs

To avoid these conflicts, Integrated Marine and Coastal Area Management (IMCAM) presents one of the most important tools for preserving marine biodiversity and ensuring a sustainable use of marine resources. In these areas, it is possible to reconcile the protection of marine life with a rational use of the marine resources (fishing, tourism, maritime traffic…).

IMCAM can be defined as “a continuous and dynamic process by which decisions are taken for the sustainable use, development and protection of coastal and marine areas and resources” (Cicin-Sain & Belfiore, 2005). The goals of ICZM are to attain sustainable development of coastal and marine areas; to reduce vulnerability of coastal areas and their inhabitants to natural hazards; and to maintain essential ecological processes, life support systems and biological diversity in coastal and marine areas.

The IMCAM must be a comprehensive strategy for the coastal area taking into account the ecological, biological, socioeconomic, and governance linkages between different portions of the coastal area, encompassing adjacent watersheds and offshore ocean areas. It integrates biodiversity conservation goals with the need to allow sustainable uses and socioeconomic development in coastal and marine areas under a planning and management framework.

The approach, combining nature conservation and sustainable exploitation, has been supported by several international programs and forums (such as the World Conservation Union (IUCN) in 1978; the United Nations Conference on Environment and Development, 1992 Summit; the Barcelona Convention and its 1995 Biodiversity Protocol, etc.) Some basic recommendations have been proposed: i) to preserve the biodiversity and the most essential ecological processes; ii) to protect environmental quality and to prevent any danger to the biological equilibrium of the marine and coastal communities; iii) to ensure a sustainable exploitation of species and ecosystems; and, iv) to keep pristine areas for research, training and educational purposes.

In this sense, the United Nations Conference on Environment and Development (The Rio 1992, World Summit) put forward some basic principles: the right to develop; intergenerational equity; environmental assessment; precautionary principle; polluter-pays principle; ecosystem approach; and openness and transparency in decision making. It is also guided by principles related to the special character of coasts and to the public nature of the oceans and to use of coastal marine resources:

- Coastal and ocean systems require special planning and management approaches due to their high productivity, great mobility and interdependence.
- The significant interactions across land-water boundary require recognising and managing the whole system.
- Activities well inland can significantly impact coastal resources.
- Land forms bordering the water’s edge (e.g. beaches, dunes) that help as buffers against erosion and sea level rise should be conserved.
- Interruptions of the natural long-shore drift system should be minimised.
- The biodiversity of fragile and/or rare ecosystems and endangered/threatened species.
- Since ocean resources are part of the public domain, management must be guided by a stewardship ethic, fairness and equity.

1.2 Marine-coastal biodiversity and IMCAM

The Convention on Biological Biodiversity (CBD) calls governments, communities and users to adopt integrated management measures to promote the conservation and sustainable use of marine and coastal biodiversity, including the adoption of tools and measures of IMCAM (Cicin-Sain & Belfiore, 2005):

a) Tools

- Carry out environmental impact assessment (EIA) of all of major marine and coastal development activities with special attention to marine and coastal

biological diversity, taking into account cumulative impacts (this is independent of any land use coastal zoning needed).
- Fulfil the requirements of the EU Directive on the assessment of the effects of certain plans and programmes on the environment (SEA Directive)
- Undertake systematic monitoring and evaluation of projects (as well as of plans and programmes) during implementation.
- Address socioeconomic needs of coastal communities in the planning and implementation of the marine and coastal area management.
- Promote rapid appraisal techniques to improve the conservation and management of marine and coastal biological diversity.
- Address impacts of land-based activities on marine and coastal biological diversity and identify methodologies and research to assess these impacts.
- Address impacts of deluging and pollution by maritime vessels on marine and coastal biological diversity, in particular in those countries which border international waterways.
- Adopt measures to mitigate adverse effects.

b) Measures

- Measures to prevent physical alteration, destruction and degradation of vital habitats and restore degraded habitats, including spawning areas, nurseries of stocks and living marine resources.
- The incorporation of coastal and marine protected areas under the umbrella of IMCAM, the identification of critical habitats for living marine resources as an important criterion for their selection, and conservation measures to protect ecosystem functioning in addition to the protection of specific stocks.
- The incorporation of mariculture into IMCAM plans, taking into account the vulnerability of areas of high biological value.
- The control/management of alien species as part of IMCAM.

1.3 Objectives

The main objectives of this report are the review of the national policy framework for the protection and improvement of biodiversity in Cyprus, the elaboration of the existing biodiversity concerns and threats to its quality and the development of guidelines for the incorporation of biodiversity concerns in IMCAM for Cyprus. The specific objectives are:

***1) Available information of coastal/marine biodiversity*:** Collection and codification of all available information from the relevant Ministries/Departments setting out the character and composition of coastal/marine Biodiversity in Cyprus, the main threats to this quality and the existing policy/legal framework in which protection is pursued and, based on that, the review of the main deficiencies, problems and concerns.

***2) Methodologies and practices of biodiversity protection*:** Elaboration of the established and evolving methodologies and practices of Biodiversity protection in the Cyprus coast and marine environments and their achievements and problems.

3) Pilot Application Case Study**:** Implementation of a Biodiversity protection/ /improvement Pilot Application Case Study in one of the selected locations (South Larnaca area).

4) Incorporation of the Biodiversity protection strategy**:** Within the framework of all the above, formulation of proposals for the incorporation of Biodiversity protection strategy within the Cyprus policy framework to support the sustainable use of coastal/marine resources in Cyprus.

2. MATERIAL AND METHODS

The IMCAM should be based on the best available knowledge and information about the abiotic and biotic environment and coastal uses (socio-economic activities)

The methodology employed has been based on the study and mapping of certain geo-morphologic, and biological/ecological features. The different thematic maps have been combined in the case study area to outline homogeneous environmental units, which have been evaluated for various types of activities.

2.1 Area of the study

The pilot area of the ICAM has been the Southern sector of the Larnaca area, from the fishing shelter to Cape Kiti (fig. 2-1), from the shore to 35m depth.

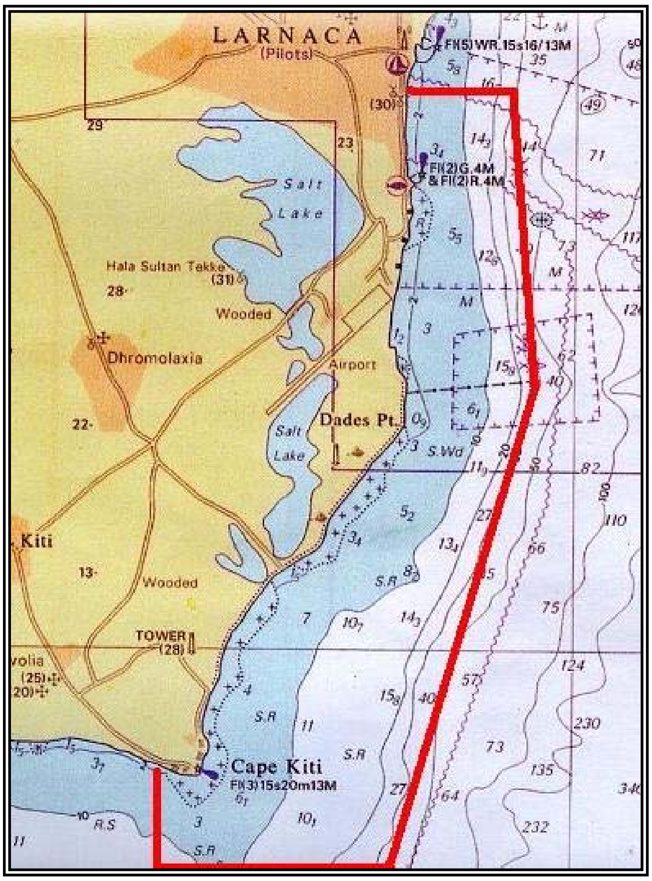


Figure 2-1. The observed marine area in the present study (from Maritime Chart 851: Cape Kiti to Dades Pt.

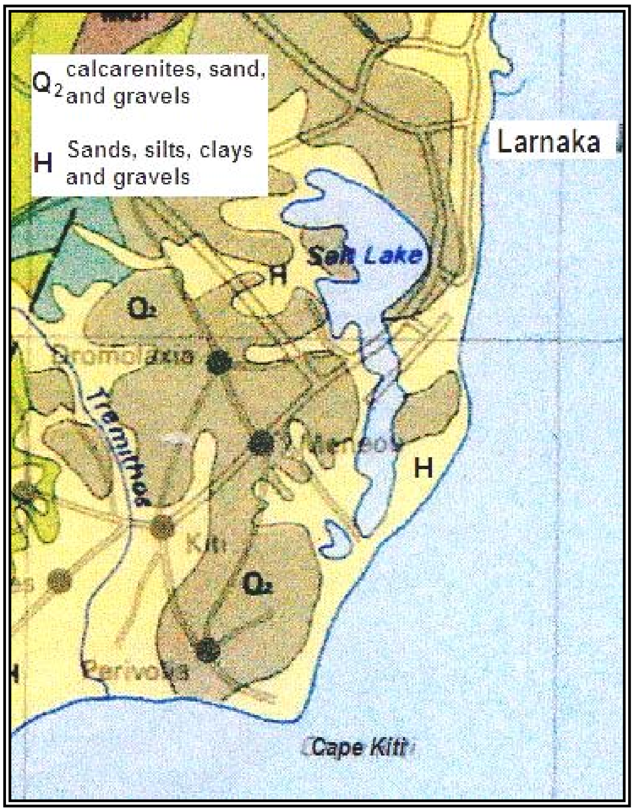


Figure 2-2. Geological map of the area south of Larnaca.

2.2 Geo-morphological features

The geo-morphological characteristics of the coast depend of the geologic materials (hardness, resistance, relief/slope, erosion/sedimentation…). In the studied area (South Larnaca to Cape Kiti), two kinds of geologic material (quaternary origin) form the coastal fringe (fig. 2-2): (Q_2): terrace deposits from Pleistocene (calcarenites, sands and gravels); and (H): alluvium and colluvium from Holocene (sands, silts, clays and gravels).

Figure 2-3. Sand beach north of the fishing shelter (note Posidonia leaves on beach).

Figure 2-4. Low rocky coast north of Cape Kiti.

That means a low profile shore with sand and cobles/pebbles beaches (South of Larnaca, fig. 2-3) and calcarenite rocky reefs (mainly in the Cape Kiti area, fig. 2-4). The rocky reefs are located underwater (between 0.5 to 6m depth), projecting at the surface in some places (fig. 2-5).

Figure 2-5. Interesting rocky reef south of the fishing shelter.

Unfortunately, any sand dunes protecting the shore have disappeared, by urbanization right on the seafront (fig. 2-3), or removal for building (fig. 2-6). These formations are particularly important as sand stock to avoid coastal erosion.

Figure 2-6. Rest of dunes from the Airport area.

Apart from the littoral geo-morphology, the sea bed has been considered as hard (rocky or blocks, *Posidonia* matte) and soft (cobles/pebbles, sand, muddy sand, mud) bottoms. That substratum division, with the depth, determine the settlement of different marine species and consequently the habitat.

2.3 Marine habitats and species

The mapping of the inshore marine habitats (0-50m depth) is essential if not critical to ICAM as some of the marine human uses (port constructions, mooring, sewage dumping, fishing, aquaculture, marine protected areas…) need this knowledge on the location of the benthic communities and associated organisms.

To acquire this knowledge of the marine habitats, we have realized two missions (December 2006 and April 2007) to cover the sea area south of Larnaca, in depths between 0 to 35m (fig. 2-1). The employed methods have been: snorkeling (0-5m depth), plot scuba dives and scuba hydroplane transects (5-35m depth).

With regard to the classification of the marine habitats we have following the classification of Pérès & Picard (1964), UNEP-MAP (1998) and the European Environment Agency (2002). Due to the sedimentary origin of the southern part of Larnaca, soft bottoms have been predominant, with some rocky reefs.

Particular attention has paid to the vulnerable/sensitive Mediterranean habitats and species of conservation interest which appear in the:

- Mediterranean 'Red Book' of the thread marine vegetation, associations and seascapes of the Mediterranean Sea (UNEP/IUCN/GIS, 1990).
- EU Habitat Directive (92/43) with the Annexes:
    - I (Natural Habitat Types of Community Interest)
    - II (Animal and Plant Species of Community Interest)
    - IV (Strictly protected species), and

    - V (species whose exploitation is regulated).
- The Barcelona Convention (1995) related to the Protocol concerning to the Specially Protected Areas and Biological Diversity in the Mediterranean with the Annexes:
    - II (endangered or threatened species), and
    - III (species whose exploitation is regulated).
- The Alghero Convention (1995) on coastal and marine biodiversity in the Mediterranean.
- The Bern Convention (1996) with the Annexes:
    - I (strictly protected flora species),
    - II (strictly protected fauna species), and
    - III (protected fauna species).

3. CYPRUS MARINE HABITATS AND SPECIES OF CONSERVATION INTEREST

The lists of the marine vulnerable/sensitive Mediterranean habitats and species observed in Cyprus appear in tables 3-1, 3-2 and 6-3. These lists are according to the IUCN (Mediterranean 'Red Book'), the European Union Habitats Directive 92/43, the COUNCIL REGULATION (EC) No 1967/2006 of 21 December 2006 concerning management measures for the sustainable exploitation of fishery resources in the Mediterranean Sea and International Conventions (Alguero, Barcelona, Bern).

3.1 Marine habitats

The table 3-1 lists the important and vulnerable marine biocoenosis present in the Cyprus waters which are object to conservation/protection. Those related to the European Union need to be protected under the Habitats Directive.

MARINE HABITATS	**RB**	**EU 1**	**EU 2**	**Ba C**	**AC**	**BeC**
Littoral organogenic concretions						
- *Dedropoma petraeum* (platforms, cushions)	+			+	+	+
- *Lithophyllum trochanter* + *Tenarea undulosa* (cushions)	+	+		+	+	+
Fucales forests						
- *Cystoseira spp.* exposed rock *(C.amentacea)*	+	+		+	+	+
- *Cystoseira spp.* sheltered rock *(C.humilis, C. spinosa)*	+				+	
- *Cystoseira spp.* deep forests (*C. spinosa, C. zosteroides*)	+			+		+
Maërl beds (rhodolithes)	+		+		+	+
Circalittoral biogenic formations ('coralligenous')	+		+		+	+
Submarine caves		+		+	+	+
Seagrass meadows						+
- *Posidonia oceanica*	+	+	+	+	+	+
- *Cymodocea nodosa*						+

Table 3-1. Mediterranean sensitive habitats observed in Cyprus. Legend: **(RB)** Mediterranean 'Red Book' UNEP/IUCN/GIS (1990); **(EU1)** Habitat Directive European Union (1992); (**EU2**) Mediterranean Marine Living Resources Directive (2006); **(BaC)** Barcelona Convention (1995); **(AC)** Alghero Convention (1995); **(BeC)** Bern Convention (1996). Table 3-1 does not list coastal habitats such as "Submerged or Partially Submerged Sea Caves" (8330)

Following this list, the next pages present the characteristics of the important marine habitats (description, location, Cyprus distribution, habitat importance, important associated species, threats, status and protection).

Association with *Lithophyllum trochanter* auct. and *Tenarea undulosa* (fig. 3-1)

Figure 3-1. Facies with Vermetids and *Lithophyllum trochanter* (white formations), and phaeophyta forest with *Cystoseira compressa, C. cf. humilis* and *Dictyota fasciola*. Agios Giorgios, -0.5m
(picture P. Sánchez-Jérez)

Description and location: White and pallid rose plates and cushions of the calcareous rhodophytes *Tenarea undulosa* and *Lithophyllum trochanter* on rocky exposed zones between 0-1m depth. In clean waters.

Cyprus distribution: Very local around the Cyprus coast (mainly Akamas peninsula).

Habitat importance: Hard and complex habitat (crevices); low growth (1mm/year); prevent erosion of the rock substrata. Typical habitat of the Eastern Mediterranean basin. Bio-indicator of high quality water.

Important species: *Lithophyllum trochanter*.

Threats: Coastal works (marinas, harbours); domestic and industrial sewage; hydrocarbons; trampling (over-frequentation); littoral urbanisations.

Status: Vulnerable habitat to the coastal development and organic pollution.

Protection: MRB (vulnerable habitat), EUHD (annex I, as reefs); AC (vulnerable habitat), BaC, BeC (annex I, threatened species).

Bioconcretions with vermetids (*Dendropoma petraeum*) (fig. 3-2)

Figure 3-2. Concretion of *Neogoniolithon brassica-marina* with *Dendropoma petraeum* in midlittoral rock. *Cystoseira amentacea* belt in lower part. In the north of the Larnaca study area (picture A.A. Ramos-Esplá).

Description and location: White plates, cushions and platforms structures with the vulnerable vermetid *Dendropoma petraeum* (black holes) and the calcareous algae *Neogoniolithon brassica-marina* and *Lithophyllum trochanter*. This important concretion is present at the rocky littoral fringe (0-1m depth).

Cyprus distribution: More or less abundant in rocky areas on the Cyprus coast (Akamas peninsula, Cape Greko, Moullia Rocks, Larnaca area).

Habitat importance: Hard and complex habitat (crevices); low growth (1mm/year); prevent erosion of the rock substrata. Bio-indicator of the water high quality

Important species: *Dendropoma petraeum*

Threats: Coastal works (marinas, harbours); domestic and industrial sewage; hydrocarbons; trampling (over-frequentation); littoral urbanisations.

Protection (*Dendropoma petraeum* biogenic formations) Mediterranean 'Red Book'; Habitat Directive 92/43 (Annex I, as reefs); Alghero Convention, Barcelona Convention (Annex II), Bern Convention (Annex II), IUCN (in danger).

Status: Very vulnerable habitat and species (*Dendropoma petraeum*) to the coastal development and organic pollution.

Association with *Cystoseira amentacea* (fig. 3-3)

Figure 3-3. Belt of the Cystoseira amentacea with Dendropoma formations (white spots). In the north of the Larnaca area (picture A.A. Ramos-Esplá)

Description and location: This characteristic belt has been observed on some rocky very exposed sites (0-1m depth), with the macroalgae *Laurencia obtusa, L. papillosa Anadyomene stellata, Dyctiota fasciola, Corallina elongata, Jania rubens, Spongites notarisii* and *Valonia utricularis*.

Cyprus distribution: More or less abundant around Cyprus coast (Akamas peninsula, Cape Greko, Moullia Rocks, Larnaca area).

Habitat importance: Highly complex habitat (arboreous stratum); structural and functional high biodiversity. Bio-indicator of the water high quality

Important species: *Cystoseira amentacea*.

Threats: Coastal works (marinas, harbours); domestic and industrial sewage; hydrocarbons; trampling (over-frequentation); littoral urbanisations.

Protection: Mediterranean 'Red Book'; Habitat Directive 92/43 (Annex I, as reefs); Alghero Convention, Barcelona Convention (Annex II), Bern Convention (Annex I, as strict protected flora).

Status: Very vulnerable habitat to the coastal development and organic pollution

Associations with shallow *Cystoseira* spp. forests (figs. 3-4)

Figure 3-4. Shallow *Cystoseira* forest (*C. compressa, C. cf. humilis*). South Larnaka (picture A.A. Ramos Esplá)

Description and location: Forests of the *Cystoseira* spp. (*C. cf. humilis, C. spinosa v. tenuior, C. compressa*) and *Sargassum vulgare*. The fauna is represented by: sponges *Sarcotragus muscaria*, *Cacospongia scalaris* and *Ircinia fasciculata*; gastropods *Cerithium rupestre*, *Strombus decorus* and *Fasciolaria lignaria*; polychaetes *Hermodice carunculata*; decapod *Clibanarius erythropus*; echinoderms *Paracentrotus lividus* and *Arbacia* lixula; fishes: *Sparisoma cretense*, *Siganus luridus*, *Diplodus vulgaris*, *D. sargus*, and *Serranus scriba*. The presence of *Charonia tritonis variegata* deserves to be mentioned here. These forests have been observed on rocky seabed (1-30m depth).

Cyprus distribution: Abundant around Cyprus coast (Akamas peninsula, Cape Greco, Moullia Rocks, Larnaca area, Amathus area).

Habitat importance: Highly complex habitat (arboreous stratum) with structural and functional biodiversity; nursery and shelter area. Bio-indicator of the water high quality

Important species: *Cystoseira* spp. (*C. cf. humilis*, *C. foeniculacea*, *C. spinosa v. tenuior*); triton shell (*Charonia tritonis*); nursery area to the juveniles of sea groupers (*Epinephelus*, *Mycteroperca*) and parrot fish (*Sparisoma*).

Threats: Coastal works; dredging; domestic and industrial sewage; desalination brine; mooring.

Protection: Mediterranean ‘Red Book’; Alghero Convention, Barcelona Convention (Annex II), Bern Convention (Annex I as strict protected flora).

Status: Vulnerable habitat to the coastal development and organic pollution

Association with deep Fucales forests (*Cystoseira* and *Sargassum* spp.)
(fig. 3-5)

Figure 3-5. Association with the brown algae *Cystoseira* spp. (*C. zosteroides*) and *Sargassum cf. trichocarpum*, with the sponge *Sarcotragus spinosula*. Cape Greco, -45m (picture P. Sánchez-Jérez)

Description and location: On horizontal surfaces with *C. spinosa, C. zosteroides, C. ercegovicii f. latiramosa* and *Sargassum cf. trichocarpum*. With the sponges *Axinella*, *Sarcotragus* and *Agelas* spp. Rocky substrata, from 30-45m depth.

Cyprus distribution: More or less developed in Eastern Cape Greco and at the North-eastern coast of Akamas.

Habitat importance: Highly complex habitat (arboreous stratum) with structural and functional biodiversity; nursery and shelter area. Bio-indicator of the water high quality.

Important species: Cystoseira spp. (*C. spinosa, C. zosteroides*), *Sargassum cf. trichocarpum*; sea groupers (*Epinephelus, Mycteroperca*).

Threats: Dredging; trawling; desalination brine; mooring; alien spp (*Caulerpa racemosa*).

Protection: Mediterranean 'Red Book'; Alghero Convention, Barcelona Convention (Annex II), Bern Convention (Annex I).

Status: Vulnerable habitat to the coastal development and trawling.

Circalittoral encrusting algae concretions or 'caralligenous' (fig. 3-6)

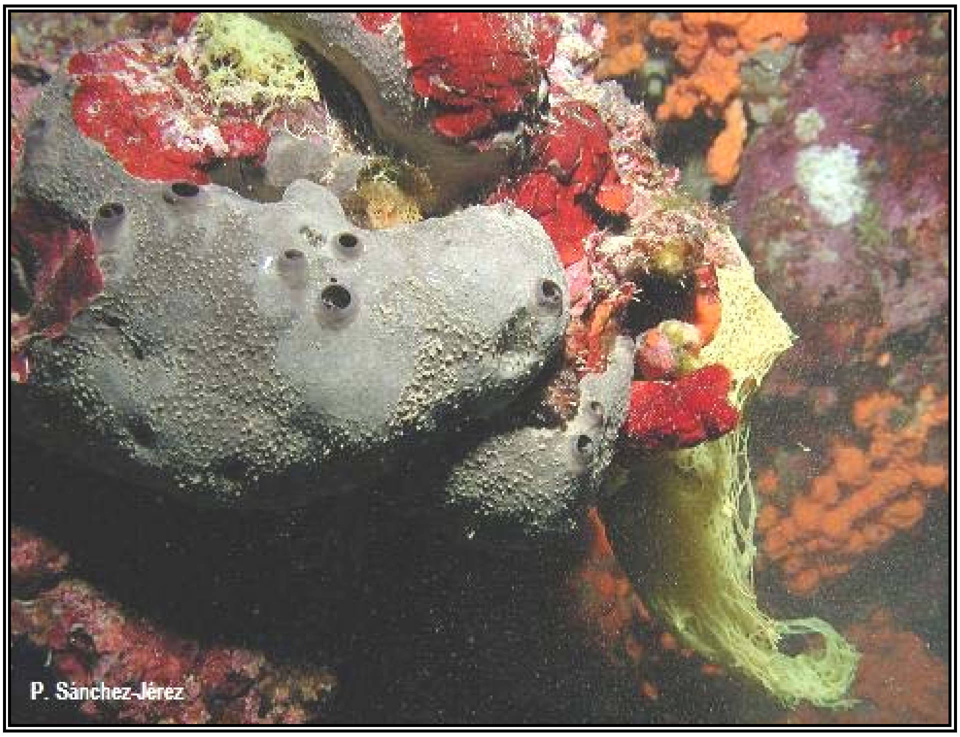


Figure 3-6. Coralligenous biocenosis with incrustant rhodophytes (*Mesophyllum alternans*, *Peyssonnelia* spp.) and the sponges *Ircinia oros* (grey), *Clathrina clathrus* (yellow) and *Agelas oroides* (orange). Cape Greco, -46m (picture P. Sánchez-Jérez).

Description and location: The calcareous macroalgae (*Lithophyllum*, *Mesophyllum*, *Peyssonnelia* spp.) form an encrusting substratum. Among the sessile fauna, poriferans (*Agelas*, *Clathrina*, *Axinella*, *Ircinia, Dysidea, Calyx*); the cnidarian *Madracis phaerensis*; polychaetes (*Protula, Serpula*); bryozoans (*Sertella, Adeonella*); and the ascidian *Halocynthia papillosa*. It is located in the infralittoral rocky enclaves (overhangs, cave entries, crevices) and horizontal surfaces between 0 at 50m depth. Mainly found below 35m depth.

Cyprus distribution: Developed in rocky reefs and cliff areas (Eastern Cape Greco, North-eastern of Akamas area, Moulia Rocks, from Cape Kiti).

Habitat importance: Complex habitat with calcareous organisms (algae and madreporarians); low growth (1-3mm/year); very high biodiversity. Habitat of reproductive groupers (*Epinephelus, Mycteroperca*).

Important species: Sponges (*Axinella* spp.), sea grouper shelters (*Epinephelus* spp.).

Threats: Dredging; scuba diving; overfishing (mainly spearfishing for groupers); losing of nets ('ghost fishing'); alien spp (*Caulerpa racemosa*).

Protection: Mediterranean 'Red Book'; Habitat Directive (Annex I as 'reefs'); Alghero Convention, Bern Conv. (Annex I).

Status: Very vulnerable habitat to the coastal development, dredging, and scuba diving.

Biocenosis of the semi-dark and dark caves (fig. 3-7)

Figure 3-7. Coralligenous enclave in the infralittoral stage with the incrustant red algae *Peyssonnelia* spp. (red-garnet) and *Mesophyllum alternans* (rose), and the serpulid *Protula intestinum* and the madreporarian *Madracis phaerensis* (brown). Cape Greco, -11m (picture P. Sánchez-Jérez).

Description and location: The entry of the caves is colonised by the coralligenous community with incrusting algae *Mesophyllum alternans*, *Lithophyllum stictaeforme*, and *Peyssonnelia* spp. In more sciaphylic surfaces the cnidarian *Madracis phaerensis*, characterise this habitat; also the poriferans are abundant (*Spirastrella*, *Phorbas, Hamigera*, *Agelas*, *Petrosia*, *Chondrosia*). In the rocky bottoms from 0 to 50m depth.

Cyprus distribution: They are present in rocky reefs and cliff areas (Eastern Cape Greco, Akamas Peninsula).

Habitat importance: Interesting habitat with deep organisms adapted to shallow waters; very low growth of organisms (1mm/year). Very sensitive habitat to human presence.

Important species: Sea grouper shelters (*Epinephelus* spp.) and brown meagre (*Sciaena umbra*); habitat of slipper lobster (*Scyllarides latus*).

Threats: Scuba diving; coastal works and domestic sewage (near the shore),

Protection: Mediterranean 'Red Book'; Habitat Directive (Annex I as sea caves); Alghero Convention.

Status: Vulnerable habitat to scuba diving and the coastal development.

Habitat of the infralittoral pebbles and small boulders (fig. 3-8)

Figure 3-8. Habitat of infralittoral pebbles and small boulders. Amathus area, 1m depth (picture A.A. Ramos-Esplá).

Description and location: Interesting mix (soft and hard substrata) and complex community forming by photophylic (*Cystoseira, Padina, Dictyota*) and sciaphylic algae (*Peyssonnelia, Plocamium*). An understone fauna: sponges, bryozoans, ascidians, crustacean, molluscs, polychaetes, echinoderms, and fishes (*Gouania, Lepadogaster*). On soft sediments, between 0 to 2m depth; usually off stream outlets.

Cyprus distribution: Very local around the Cyprus coast. (Amathus, Limni etc)

Habitat importance: Interesting and unknown habitat, mix of hard and soft bottoms, photophylic and sciaphylic environments, and spatially complex (holes, crevices).

Important species: Habitat of the abalone (*Haliotis tuberculata*) and the seastar (*Asterina gibbosa*); nursery area of juveniles of sea urchins (*Paracentrotus*) and sea breams (*Diplodus* spp.).

Threats: Coastal works, domestic and industrial sewage, beach replenishment; over-frequentation; and bait collection (turning over of boulders).

Protection: Mediterranean ‘Red Book’; Habitat Directive (Annex I: closed bays/creeks).

Status: Very vulnerable habitat to the coastal development, domestic and industrial sewages, and bait collection.

Posidonia oceanica meadows (fig. 3-9)

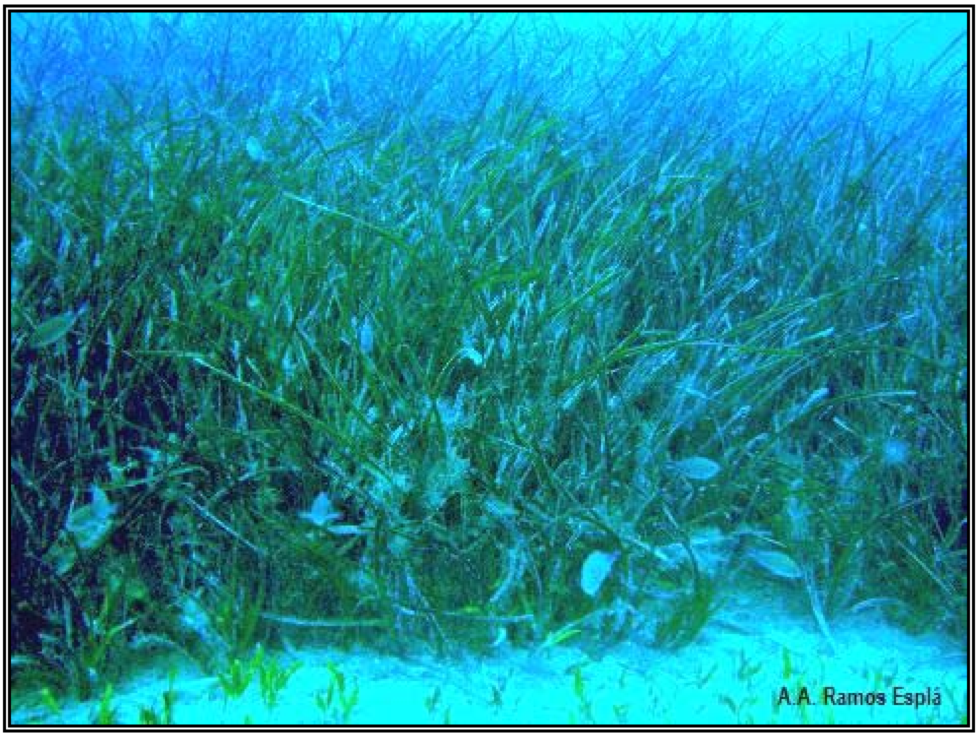


Figure 3-9. *Posidonia oceanica* meadow on sand bottom, with a shoal of the fish *Chromis chromis* and Sparidae. South-Larnaca, -23m (picture Alfonso A. Ramos-Esplá).

Description and location: This community, endemic in the Mediterranean Sea, represents the climax of the infralittoral soft bottoms. It presents one the highest biodiversity in the Mediterranean Sea (about 1000 macroalgae and invertebrate spp.) *Posidonia* colonises both rocky and sandy substrata, between 0 to 42m depth (in Akamas Peninsula, one of the deeper location in the Mediterranean). In some parts the *Posidonia* matte forms terraces or fronts with 1-2m high (15-32m depth).

Cyprus distribution: Well developed around much of the Cyprus coast

Habitat importance: Very complex habitat, mix of hard and soft bottoms, and photophylic and sciaphylic environments; low growth (1cm/year); nursery, spawning and shelter area; high O_2 production, and beach defense against the wave erosion.

Important species: Nacre (*Pinna nobilis*), triton shell (*Charonia variagata*), captain seastar (*Asterina panceri*), sea-horses (*Hippocampus* spp.).

Threats: Coastal works, domestic and industrial sewage, beach replenishment; littoral dynamic alterations (marinas, ports); trawl fishing, brine of desalination, inshore fish cage aquaculture, mooring; dredging and siltation.

Protection: Mediterranean ‘Red Book’; Habitat Directive (Annex I: * priority habitat); Barcelona Convention (Annex II), Bern Convention (Annex I).

Status: Very vulnerable habitat to the coastal development, domestic and industrial pollution, mechanical impacts (trawling, mooring).

Association with *Cymodocea nodosa* (fig. 3-10)

Figure 3-10. Sandy bottom with the seagrass *Cymodocea nodosa*. South Larnaca area, -4m (picture Alfonso A. Ramos-Esplá).

Description and location: This important phanerogame colonise the sand and muddy sand-bottoms, between 1-41m depth, preparing the seabed to later colonisation from Posidonia.

Cyprus distribution: Well developed around much of the Cyprus coast.

Habitat importance: Although the meadow structure is not complex, Cymodocea is the precursor of the *Posidonia* settlement. Spawning area from opisthobranch gastropods (*Aplysia* spp.); and important trophic area for commercial fish (eg. Sparidae) and cephalopods. Main foraging area for green turtles (*Chelonia mydas*) particularly for juveniles and sub-adults.

Important species: Nacre (*Pinna nobilis*), sea-horses (*Hippocampus* spp.).

Threats: Coastal works, domestic and industrial sewage, beach replenishment; brine of desalination, inshore fish cage aquaculture.

Protection: Mediterranean 'Red Book'; Convention of Bern (Annex I).

Status: Vulnerable habitat to the coastal development, domestic and industrial sewages, mechanical impacts (trawling, mooring).

Maërl facies of the biocenosis of the coastal detritic bottoms: (fig. 3-11)

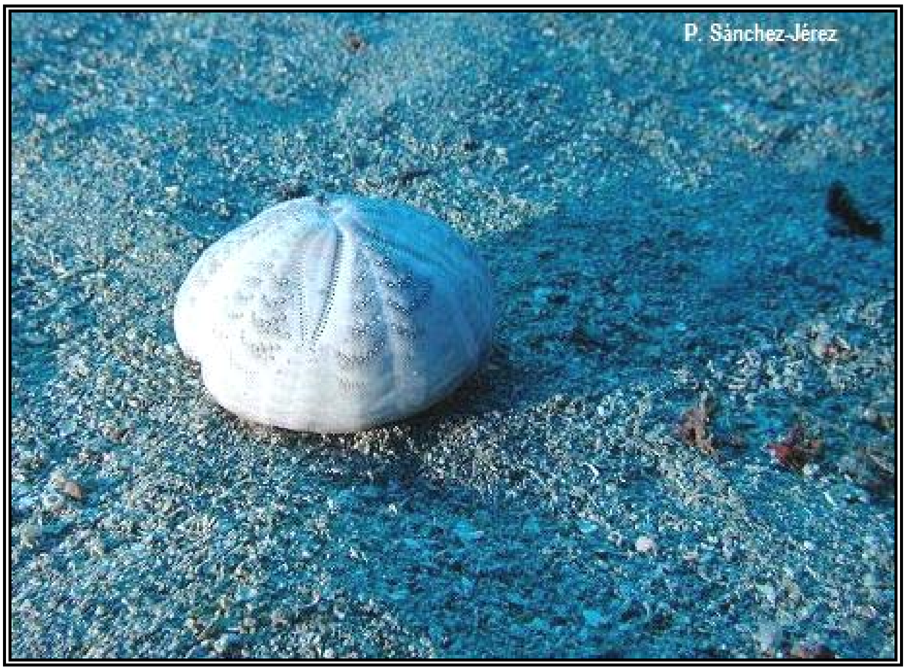


Figure 3-11. Maerl bed with some free calcareous rhodophytes and the skeleton of the purple-heard sea urchin (*Spatangus purpureus*). Cape Greko, -35m (picture Pablo Sánchez-Jérez)

Description and location: The maerl beds are forming by the free talus of calcareous rhodophytes (*Lithothamnion, Phymatolithon, Lithophyllum*). Usually well developed off capes, where a moderate hydrodynamism (currents) prevent siltation. In some places the detritic bottom is covered by the chlorophytes *Caulerpa prolifera* and *C. racemosa*, with *Flabellia petiolata* and some rhodophytes (*Osmundaria volubilis, Rhodymenia ardissonei,* and *Botryocladia botryoides*).

Cyprus distribution: Very local around the Cyprus coast, mainly off the capes (Arnauti, Greco, Kiti, Pyla).

Habitat importance: Very complex community, with small associated and diverse fauna. Important sink for carbon (calcareous algae). Nursery area for cephalopods (*Octopus*).

Important species: Free calcareous algae (Lithothamnion corallioides, Phymatolithon calcareum); habitat of the small spiny lobster (*Scyllarus pygmaeus*); the needle-spined urchin *Centrosptephanus longispinus.*

Threats: Dredging, offshore fish cage aquaculture, trawl fishing, brine from desalination plants.

Protection: Mediterranean 'Red Book'; EU Habitat Directive (Annex I - in four different habitat types - while Annex V covers some of the species found there), Bern Convention (Annex I).

Status: Very vulnerable habitat to the dredging and trawling, and brine from desalination plants.

3.2. Marine species

The Cyprus marine species of interest (EU, Barcelona Convention, Bern Convention) are indicated in the tables 3-2 and 3-4. We have distinguished among macrophyta (mainly habitat-forming species) and invertebrates. For vertebrates see Table 3-4.

PROTECTED SPECIES (CYPRUS)	MRB	EU	BaC	BeC
MACROPHYTA				
Magnoliophyta				
Cymodocea nodosa (Ucria) Ascherson				I
Posidonia oceanica (Linnaeus) Delile	+	I	II	I
Zostera noltii Hornemann			II	I
Fucophyta				
Cystoseira amentacea (C. Agardh) Bory	+		II	I
Cystoseira spinosa Sauvageau	+		II	I
Cystoseira zosteroides C. Agardh	+		II	I
Rhodophyta				
Lithophyllum trochanter (Bory) H. Huvé *ex*. Woelkerling	+		II	I
Lithothamnion corallioides Crouan		V		
Phymatolithon calcareum (Pallas) Adey & McKibbin		V		
Ptilophora mediterranea (H. Huvé) Norris	+		II	I
INVERTEBRATA				
Porifera				
Axinella cannabina (Esper, 1794)			II	
Axinella polypoides Schmidt, 1862			II	II
Spongidae spp. (*Hippospongia, Spongia*)			III	III
Mollusca				
Charonia lampas lampas (Linnaeus, 1758)			II	II
Charonia tritonis variegata (Lamarck, 1816)			II	II
Dendropoma petraeum (Monterosato, 1884)			II	II
Erosaria spurca (Linnaeus, 1758)			II	II
Lithophaga lithophaga (Linnaeus, 1758)		IV	II	II
Luria lurida (Linnaeus, 1758)			II	II
Pholas dactylus Linnaeus, 1758			II	II
Pinna nobilis (Linnaeus, 1758)		IV	II	
Pinna rudis (= P. pernula) Linnaeus, 1758			II	II
Tonna galea (Linnaeus, 1758)			II	II
Crustacea				
Maia squinado (Herbst, 1788)			III	III
Ocypode cursor (Linnaeus, 1758)			II	II
Palinurus elephas (Fabricius, 1787)			III	III
Scyllarides latus (Latreille, 1803)		V	III	III
Scyllarus arctus (Linnaeus, 1758)			III	III
Scyllarus pygmaeus (Bate, 1888)				
Bryozoa				
Hornera lichenoides (Linnaeus, 1758)			II	
Echinodermata				
Centrostephanus longispinus (Philippi, 1845)		IV	II	II
Ophidiaster ophidianus (Lamark, 1816)			II	II
Paracentrotus lividus (Lamarck, 1816)			III	III

Table 3-2. Marine species (macrophyte and invertebrates) of special interest and observed in Cyprus. Legend: **(MRB)** Mediterranean 'Red Book' UNEP/IUCN/GIS (1990); **(EU)** Habitat Directive European Union (1992); **(BaC)** Barcelona Convention (1995); **(BeC)** Bern Convention (1996-98).

3.2.1 Marine macrophyta

The majority of the macrophytes, as habitat forming species, have been considered in the preceding part (interesting habitats): *Posidonia oceanica*, *Cymodocea nodosa*, *Cystoseira* spp., *Lithophyllum* and *Lithothamnion* spp.

3.2.2 Marine invertebrates

There are sessile species (as poriferans, bivalvia and bryozoans) and sedentary ones (gastropods, echinoderms, crustaceans). The main important marine invertebrates observed in Cyprus for protection are indicated in the table 5-3.

a) Porifera

Axinella cannabina (Esper, 1794) (fig. 3-12)

- *Protection status*: Annex II, Barcelona Convention (1995).
- *Threats*: Sediment dumping, trawling, fixed bottom nets, collection by divers.
- *Cyprus areas distribution*: Rare. Western Akamas (r); observed by Demetropoulos (pers. comm.) in the North of Cyprus. (sector between Cape Kormatitis to Cape Andreas).

Figure 3-12. The ‘orange candlestick’ sponge *Axinella cannabina* (picture A. Demetropoulos).

Axinella polypoides Schmidt, 1862 (fig. 3-13)

Figure 3-13. *Axinella polyploides*. Eastern Cape Greco, -47m (picture P. Sánchez-Jérez)

- *Protection status*: Annex II, Barcelona Convention (1995); Annex II, Bern Convention (1996-98).
- *Threats*: Sediment dumping, trawling, fixed bottom nets, collection by divers.
- *Cyprus areas distribution*: Common. Cape Greco (cc), Moulia Rocks (r), Eastern Akamas (c), Western Akamas (c).

Spongiidae spp. (fig. 3-14)

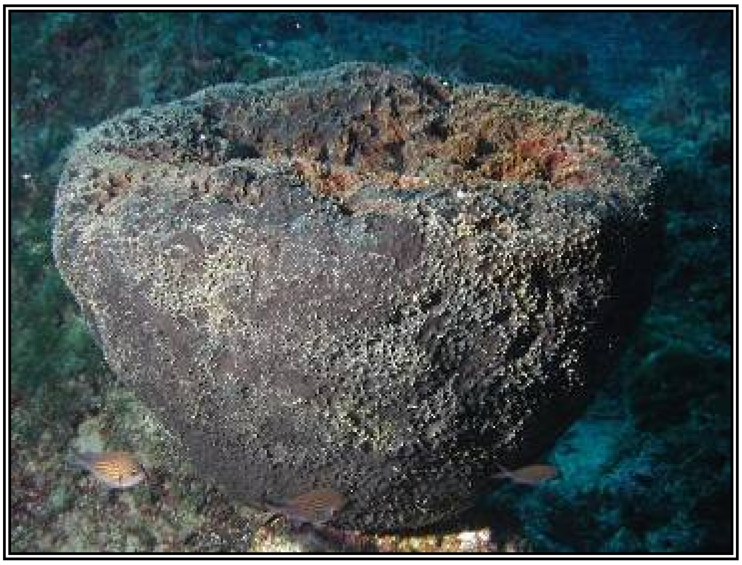


Figure 3-14. Specimen of the Spongiidae family. Cape Greco, -15m (picture P. Sánchez-Jérez).

With the species: *Spongia agaricina* Pallas, 1766; *S. officinalis* Linnaeus, 1759; *S. zimoca*; *Hippospongia communis* (Lamarck, 1813); *Ircinia foetida* and *I. pipetta* (Schmidt, 1868).

- *Observations*: Some species of this family have been observed, mainly of the genus *Ircinia, Sarcotragus* and *Cacospongia*. Certainly, species of the genus *Hippospongia* and *Spongia* are present but we have not identified them in the diving
- *Protection status*: Annex II (*I. foetida, I. pipetta*) of the Barcelona Convention (1995) and Bern Convention (1996-98), and Annex III (*S. agaricina, S. offininalis, S. zimoca, H. communis*) of Barcelona Convention (1995) and Bern Convention (1996-98).
- *Threats*: Non-regulated commercial collection, sediment dumping.
- *Cyprus areas distribution*: Cape Greco (cc), Moulia Rocks (r), Eastern Akamas (r), Western Akamas (cc), also present in several other usually rocky bottom areas.

b) Cnidaria

The inshore cnidarian spp. of conservation interest (*Astroides calycularis, Antipathes spp., Gerardia sevaglia, Corallium rubrum*) have not been observed in Cyprus in the depths covered (< 50m depth).

c) Mollusca

Charonia lampas lampas (Linnaeus, 1758) (= *C. nodifera*), 'trumpet shell' (fig. 3-15):

Figure 3-15. *Charonia lampas lampas* with the sea urchin *Spharaechinus granularis*. Alboran Marine Reserve (Spain), -39m (picture J. Planells).

- *Protection status*: Annex II, Barcelona Convention (1995); Annex II, Bern Convention (1996-98).
- *Threats*: Collection by divers, losing of habitat (pollution, sediment dumping).
- *Cyprus areas distribution*: Demetropoulos (1971) identified one example of this species coming from a particular collection (Mr. Takis Zambakides) who reported finding at Cape Andreas (Eastern part) at 8 fathoms.

Charonia tritonis variegata (Lamarck, 1816) (= *C. variegata*), 'trumpet shell' (fig. 3-16):

Figure 3-16. The protected grastropod *Charonia tritonis veriegata*. Agios Giorgios, -8m
(picture P. Sánchez-Jérez).

- *Protection status*: Annex II, Barcelona Convention (1995); Annex II, Bern Convention (1996-98).
- *Threats*: Collection by divers, losing of habitat (pollution, sediment dumping).
- *Cyprus areas distribution*: Common. Moulia Rocks (c); Eastern Akamas (cc). Demetropoulos (1969): common especially on the North coast, observed in shallow rocky grounds.

Dendropoma petraeum (Monterosato, 1884) , worm shell' (fig. 3-17):

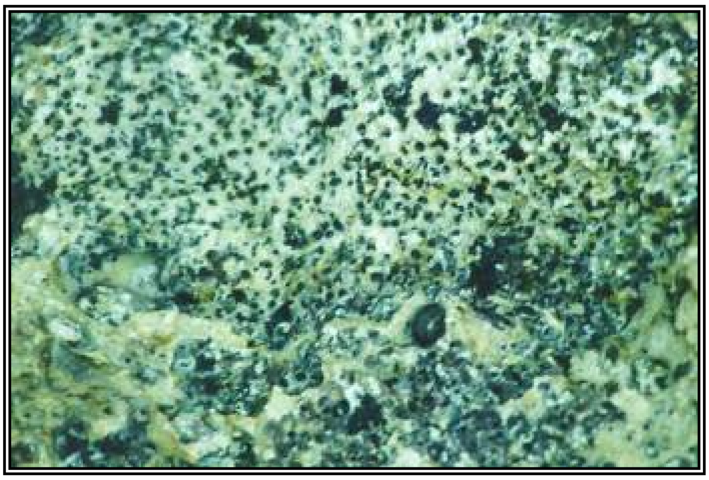


Figure 3-17: Incrustant plates of *Dendropoma petraeum* (black points) with the calcareous rhodophyte Neogolithon brassica-marina. Cape Greco, 0m (picture A.A. Ramos-Esplá) .

- *Protection status*: Annex II, Barcelona Convention (1995); Annex II, Bern Convention (1996-98).

- *Threats*: Organic pollution, littoral dynamic alterations (marinas, ports), trampling.
- *Cyprus areas distribution*: Common. Cape Greco (cc), Moulia Rocks (c), Eastern Akamas (cc), Western Akamas (c). As *Vermetus glomerulatus*: in Famagusta Bay (Demetropoulos, 1969),

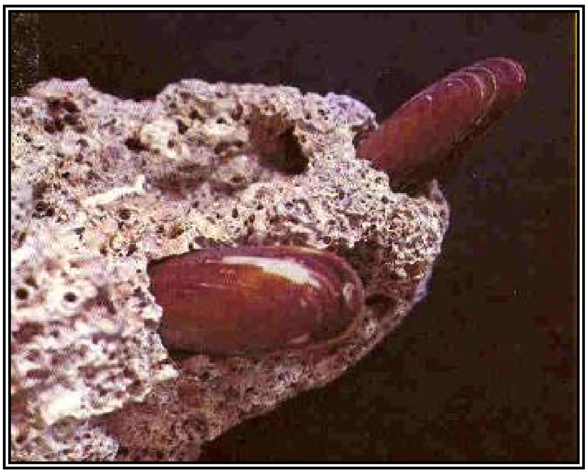
Erosaria spurca (Linnaeus, 1758) (= *Cypraea spurca*),'spotted cowry' (fig. 3-18)

Figure 3-18. Dead shell of *Erosaria spurca* (= *Cypraea* spurca) on coarse sand and fine gravel bottoms. Moulia Rocks, - 23m (picture P. Sánchez-Jérez).

- *Protection status*: Annex II, Barcelona Convention (1995); Annex II, Bern Convention (1996-98).
- *Threats*: Collection by divers (turning over of blocks and stones), loss of habitat (pollution, sediment dumping).
- *Cyprus areas distribution*: Common. Cape Greco (r), Moulia Rocks (c), Eastern Akamas (r), Western Akamas (c). Demetropoulos (1969), common in North coast and Famagusta Bay, frequent in other areas.

Lithophaga lithophaga (Linnaeus, 1758), 'date shell' (fig. 3-19):

Figure 3-19. The date shell (*Lithophaga lithophaga*) (photo A.A. Ramos-Esplá).



- *Protection status*: Annex II, Barcelona Convention (1995); Annex IV, EU Habitats Directive (1992); Annex II, Bern Convention (1996-98).
- *Threats*: Collection by divers (destruction of the rocky substratum), losing of habitat.
- *Cyprus areas distribution*: Common. Cape Greco (c), Moulia Rocks (cc), Eastern Akamas (c), Western Akamas (c). Demetropoulos (1971), as common in shallow grounds from the littoral zone down to 28m depth.

Luria lurida (Linnaeus, 1758) (= *Cypraea lurida*), ‘brown cowry’(fig. 3-20):

Figure 3-20. Dead shell of the cypraeid gastropod *Luria lurida* in *Posidonia oceanica* matte. Moullia Roks, -20m (picture P. Sánchez-Jérez).

- *Protection status*: Annex II, Barcelona Convention (1995); Annex II, Bern Convention (1996-98).
- *Threats*: Collection by divers (turning over of blocks and stones), loss of habitat (pollution, sediment dumping).
- *Cyprus areas distribution*: Common. Cape Greco (r), Moulia Rocks (c), Eastern Akamas (r), Western Akamas (c). Demetropoulos (1969), occasional, North coast (recorded in Akamas on 55m depth), Famagusta Bay, Ayia Napa; Hadjichristophorou et al. (1997), Southern part (Moni and Limassol areas, 10-30m)

Pinna species ('pen shell')***: P. nobilis*** Linnaeus, 1758 (= *P. squamosa*), and ***P. rudis*** Linnaeus, 1758 (= *P. pernula*), ((fig. 3-21)

Figure 3-21. Juvenile of *Pinna nobilis* inside the *Posidonia* meadow. Moullia Rock, -5m (picture P. Sánchez-Jérez).

- *Protection status*: Annex II, Barcelona Convention (1995); Annex IV, EU Habitats Directive (1992); Annex II, Bern Convention (1996-98).
- *Threats*: Collection by divers, loss of habitat (pollution, sediment dumping).
- *Cyprus areas distribution*: Common. Cape Greco (c), Moulia Rocks (cc), Eastern Akamas (c), Western Akamas (r); specimens with small and medium size (< 30cm). Demetropoulos (1971), very common in *Posidonia* beds, small specimens found in shallow grounds, distribution general; Hadjichristophorou *et al*. (1997): Moni, Episkopi, Morfou areas10-30m depth.

Pholas dactylus Linnaeus, 1758, 'piddock' (fig. 3-22):

Figure 3-22. Interesting bivalves inside hard bottoms: Piddock (*Pholas dactylus*) and date shell (*Lithophaga lithophaga*) (picture A.A. Ramos-Esplá).

- *Protection status*: Annex II, Barcelona Convention (1995); Annex II, Bern Convention (1996-98).
- *Threats*: Collection by divers, loss of habitat (pollution, sediment dumping).
- *Cyprus areas distribution*: Rare. Recorded by Demetropoulos & Hadjichristophorou (1976b) in a beach sample from Klapsides in Famagusta Bay.

Tonna galea (Linnaeus, 1758) (= *Dolium galea*), 'giant tun' (fig.3-23):

- *Protection status*: Annex II, Barcelona Convention (1995); Annex II, Bern Convention (1996-98).
- *Threats*: Collection by divers, losing of habitat (pollution, sediment dumping).
- *Cyprus areas distribution*: Common. It has been observed only by an empty shell in Moulia Rocks, and some small empty shells (< 15mm) by trawling in the eastern and southern part of Cyprus (35-75m depth), and western Akamas on the beach. Demetropoulos (1969) mentions it as "frequent to common" with large specimens (up to 220mm) mainly in Famagusta Bay and South Coast in deep waters (100-250m depth); smaller ones more shallow.

Figure 3-23. Dead shell of the giant tun (*Tonna galea*) in *Posidonia oceanica* matte. Moulia Rocks, -20m (picture P. Sánchez-Jérez)

d) Crustacea

The large decapods *Scyllarides latus*, *Scyllarus arctus*, *Maja squinado* and *Palinurus elephas,* have not been observed during the field survey. However, Hadjichristophorou *et al*. (1997) have sampled some spp. (*M. squinado, S. arctus*). *Scyllarides latus* ('karavida'). *Palinurus elephas* (= P. vulgaris) ('astakos') figures in the annual report of Cyprus commercial catches (Anonymous DFMR, 2002) and they are fished around the island, mainly in the northern part of Paphos (CPUE, table 3-3).

Vulnerable spp.	Eastern Area	Southern Area	Western Area	Northern Area	Total (kg)
Large crustaceans	100	2220	1190	1570	5080
Nº of boats	56	320	71	53	500
CPEU (kg/boat)	1.79	6.94	16.76	29.62	10.16

Table 3-3. Catch of large crustaceans (*Palinurus elephas, Scyllarides latus*) by area in Cyprus waters (Anonymous -DFMR, 2001) and catch per effort unit (CPEU). Areas: Eastern (C. Andreas to C. Greco); Southern (C. Greco to C. Zevgari); Western (C. Zevgari to C. Arnaouti); Northern (C. Arnaouti to Pyrgos).

Maia squinado (Herbst, 1788), 'great spider crab'

- *Protection status*: Annex III, Barcelona Convention (1995); Annex III, Bern Convention (1996-98).
- *Threats*: Collection by divers, loss of habitat (pollution, sediment dumping).
- *Cyprus areas distribution*: Rare. Hadjichristophorou *et al*. (1997) in the South coast of Cyprus (Moni and Episkopi, between 10-40m).The divers and fishermen indicate that is rare in Cape Greco area and Akamas Peninsula.

Ocypode cursor (Linnaeus, 1758), 'ghost crab' (fig.3-24):

Figure 3-24. The 'ghost crab'. Lara beach (picture A. Demetropoulos).

- *Protection status*: Annex II, Barcelona Convention (1995); Annex II, Bern Convention (1996-98).
- *Threats*: Poaching, Beach over-frequentation.
- *Cyprus areas distribution*: Common in Lara beach (c) also found on several other beaches.

Palinurus elephas (Fabricius, 1787), ‘spiny lobster’ (fig. 3-25)

Figure 3-25. Spiny lobster (*Palinurus elephas*) (picture A. A. Ramos Esplá)

- *Protection*: Annex III, Barcelona Convention (1995); Annex III, Bern Convention (1996-98).
- *Threats*: Collection by divers, loss of habitat (degradation of the caves), landings of undersized animals.
- *Cyprus areas distribution*: Rare. Mainly in the Northern part of Paphos (Akamas, fishermen pers. comm.).

Scyllarides latus (Latreille, 1803) ‘slipper lobster’ (fig. 3-26):

Figure 3-26: The slipper lobster (*Scyllarides latus*) (picture A. Demetropoulos).

- *Protection status*: Annex III, Barcelona Convention (1995); Annex III, Bern Convention (1996-98).
- *Threats*: Collection by divers, loss of habitat (degradation of the caves), landings of undersized animals.
- *Cyprus areas distribution*: Rare. Reported as rare by fishermen and divers in the Cape Greco and Akamas areas (where it is more common).

Scyllarus arctus (Linnaeus, 1758), 'little spiny lobster' (fig. 3-27)

Figure 3-27: The little slipper lobster (*Scyllarus arctus*). Tabarca Marine Reserve (Spain), -18m
(picture A.A. Ramos-Esplá)

- *Protection status*: Annex III, Barcelona Convention (1995); Annex III, Bern Convention (1996-98).
- *Threats*: Collection by divers, loss of habitat (pollution, sediment dumping).
- *Cyprus areas distribution*: Rare. Reported as rare by the fishermen and divers in the Cape Greco and Akamas areas. Hadjichristophorou *et al*. (1997) in the south coast of Cyprus (Moni and Episkopi, between 10-40m).

e) Bryozoa

Hornera cf. lichenoides (Linnaeus, 1758) (fig. 3-28):

- *Protection status*: Annex II, Barcelona Convention (1995).
- *Threats*: Collection and erosion by divers, losing of habitat (pollution, sediment dumping).
- *Cyprus areas distribution*: Very rare. Only observed in the Lara area (Western Akamas). Also North Coast (A. Demetropoulos, personal communication)

Figure 3-28. The bryozoan *Hornera lichenoides*. ASPIM Zembra (Tunisia), -45m (picture P. Sánchez-Jérez).

f) Echinodermata

Ophidiaster ophidianus (Lamark, 1816), purple starfish’ (fig. 3-29)

Figure 3-29. The purple starfish (*Ophidiaster ophidianus*) and a juvenile of *Pinna rudis* (picture A. Demetropoulos).

- *Protection status*: Annex II, Barcelona Convention (1995); Annex II, Bern Convention (1996-98).
- *Threats*: Collection by divers, loss of habitat (pollution, sediment dumping).
- *Cyprus areas distribution*: Rare. Reported by Demetropoulos & Hadjichristophorou (1976) on rocky grounds (5-40m depth) with coralligenous growths, mainly from the North coast.

Centrostephanus longispinus (Philippi, 1845), 'needle-spined urchin' (fig. 3-30)

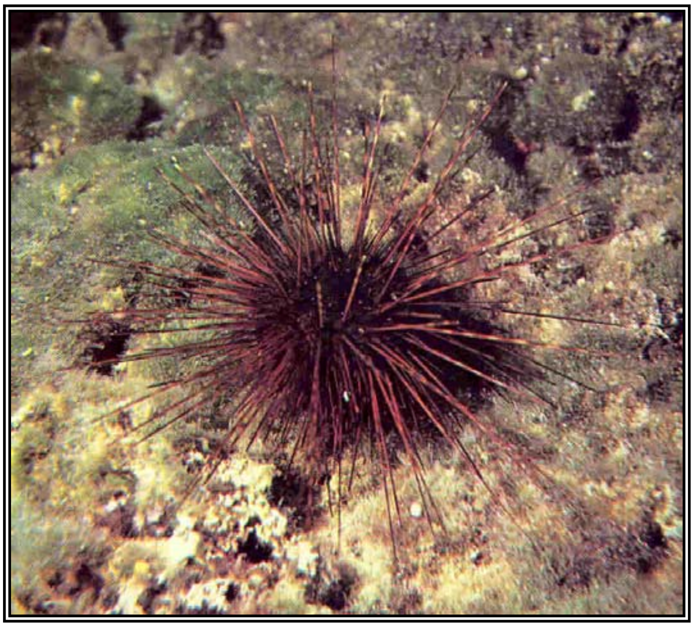


Figure 3-30. The needle spined urchin (*Centrostephanus longispinus*). Kyrenia -20m (picture A. Demetropoulos).

- *Protection*: Annex II, Barcelona Convention (1995); Annex IV EU Habitat Directive (1990); Annex II, Bern Convention (1996-98).
- *Threats*: Damage by divers, loss of habitat (sediment dumping), bottom trawling.
- *Cyprus areas distribution*: Common. Catch by trawl on coarse sand and fine gravels at the 35-85m depth in NE-Cape Greco area; observed in the Western Akamas. Demetropoulos & Hadjichristophorou (1976), as common in most areas and found often in trawl catches (20-120m depth); Hadjichristophorou et al. (1997) in the south coast (Larnaca and Limassol areas) at 60m depth.

Paracentrotus lividus (Lamarck, 1816), 'rock sea urchin' (fig. 3-31)

- *Protection status*: Annex III, Barcelona Convention (1995); Annex III, Bern Convention (1996-98).
- *Threats*: Collection by divers , losing of habitat (pollution, sediment dumping).
- *Cyprus areas distribution*: Very common. Cape Greco (cc), Moulia Rocks (cc), Akamas Peninsula (cc). Demetropoulos & Hadjichristophorou (1976), very common in all areas around the Island on shallow rocky grounds in the photophylic algae zone; Hadjichristophorou et al. (1997), Southern part (Limassol area, 5-10m)

Figure 3-31. The rock sea urchin (*Paracentrotus lividus*). Lara Point, -6m (picture P. Sánchez-Jérez).

3.2.3 Marine vertebrates (excluded cetaceans)

a) Fishes

The main important/protected marine vertebrates that have been recorded in Cyprus are indicated in table 3-4.

MARINE VERTEBRATA	MRB	EU	BaC	BeC
Fishes				
Epinephelus marginatus (Lowe, 1834)			III	III
Hippocampus spp.			II	II
Sciaena umbra Linnaeus, 1758			III	III
Sea turtles				
*Caretta caretta**		II&IV	II	II
*Chelonia mydas**		II&IV	II	II
Mammals (cetaceans excluded)				
*Monachus monachus**		II&IV	II	II

Table 3-4. Marine fishes of special interest observed in Cyprus. **(MRB)** Mediterranean 'Red Book' UNEP/IUCN/GIS (1990); **(EU)** Habitats Directive European Union (1992), * denotes a priority species; **(BaC)** Barcelona Convention (1995); **(BeC)** Bern Convention (1996-98).

- Serranidae

- *Protection status*: Annex III, Barcelona Convention (1995); Annex III, Bern Convention (1996-98).
- *Threats*: selective spearfishing on territorial males (large and solitary individuals).
- *Cyprus areas distribution*: Common. Cape Greco (c), juveniles (cc), Moulia Rocks (r), Akamas Peninsula (r).

Epinephelus marginatus (Lowe, 1834) (= *E. guaza*), 'dusky grouper' (fig. 3-32)

Figure 3-32. Juvenile of *Epinephelus marginatus*. Western-Cape Greco, -10m (picture P. Sánchez-Jérez).

- Syngnathidae

Hippocampus spp.*: *H. hippocampus (Linnaeus, 1758)***, H. ramulosus*** Leach, 1814; 'sea-horses' (fig. 3-33)

F**igure 3-33**. Sea-horse *Hippocampus ramulosus*, -2m (picture A.A. Ramos Esplá).

- *Protection status*: Annex II, Barcelona Convention (1995); Annex II, Bern Convention (1996-98).
- *Threats*: Collection by divers, loss of habitat (pollution, sediment dumping), bottom trawling.
- *Cyprus areas distribution*: Rare. Cape Greco (r) on coastal detritic (*H. hippocampus*), -60-70m. *Hippocampus ramulosus* is common in trawl catches (A. Demetropoulos - personal communication)

- Sciaenidae

Sciaena umbra Linnaeus, 1758 'brown meagre' (fig. 3-34)

Figure 3-34. Brown meagre (*Sciaena umbra*), ASPIM Zembra (Tunisia), -26m (picture A. Bouajina).

- *Protection status*: Annex III, Barcelona Convention (1995); Annex III, Bern Convention (1996-98).
- *Threats*: Spearfishing
- *Cyprus areas distribution*: Rare. The divers and fishermen indicate that is rare in Cape Greco area and Akamas Peninsula. However, the fishery statistics include this family (Sciaenidae).

Umbrina cirrosa (Linnaeus, 1758), 'shi drum'

- *Protection status*: Annex III, Barcelona Convention (1995); Annex III, Bern Convention (1996-98).
- *Threats*: Spearfishing
- *Cyprus areas distribution*: Rare. The divers and fishermen indicate that is rare in Cape Greco area and Akamas Peninsula. However, the fishery statistics include this family (Sciaenidae).

b) Marine Tetrapoda

- Sea turtles

Caretta caretta Linnaeus, 1758, 'loggerhead turtle' (figs. 3-35a and 3-37)

- *Protection status*: EU Habitat Directive (Annex II and IV) Priority species; Annex II, Barcelona Convention (1995); Annex II, Bern Convention (1996-98).
- *Threats*: Incidental catches in long-line and net fishing; loss/degradation of nesting beaches; tourism/urban pressure.

- *Cyprus areas distribution*: Moderate common. Main nesting beaches in Chrysochou Bay; western Akamas (Lara/Toxeftra Reserve beaches) and north and eastern coasts. Also minor or scattered nesting in several other areas (including some nesting on the South Larnaca beaches). (Demetropoulos and Hadjichristophorou 2005)

Figure 3-35a. Loggerhead turtle (*Caretta caretta*) (picture A. Demetropoulos).

Chelonia mydas Linnaeus, 1758; green turtle (fig.3-35b)

- *Protection status*: EU Habitat Directive (Annex II and IV) Priority species; Annex II, Barcelona Convention (1995); Annex II, Bern Convention (1996-98).
- *Threats*: Incidental catches in fishing nets and long-line fishing; loss and/or degradation of nesting beaches; tourism/urban pressure.
- *Cyprus areas distribution*: Moderate common - rare. Main nesting beaches in Western Akamas (Lara and Toxeftra beaches); foraging areas for green turtles the *Cymodocea nodosa* and *Posidonia oceanica* meadows.

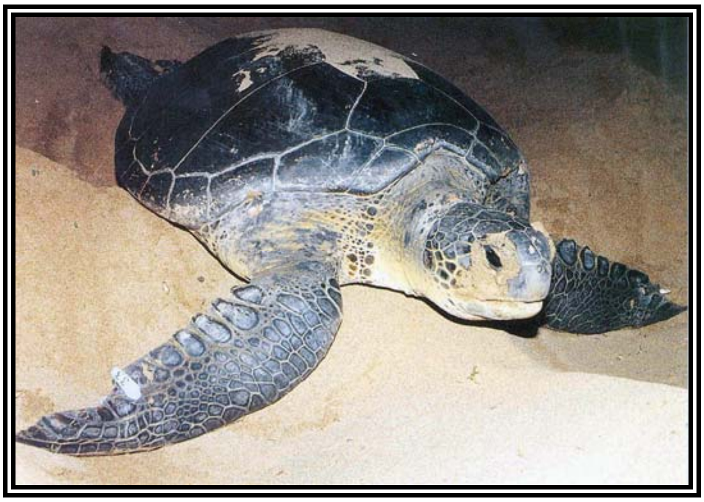


Figure 3-35b. Green turtle (*Chelonia mydas*) (picture M. Hadjichristophorou)

- Pinnipedia

Monachus monachus Linnaeus, 1758, 'monk seal'

Figure 3-36. Mediterranean monk seal (*Monachus monachus*) (picture D. Cebrian).

- *Protection status*: EU Habitat Directive (Annex II and IV, extinction endangered species); Annex II, Barcelona Convention (1995); Annex II, Bern Convention (1996-98).
- *Threats*: Losing of breeding places; fishing and tourism pressure.
- *Cyprus areas distribution*: Very rare. Breeding possibly still taking place in the north part of the island. Resting and/or breeding habitat in: Western Akamas, in sea caves complex of Thalassines Spilies near Ayios Georgios (Peyia) north of Paphos, Cape Yeronisos; Eastern Akamas, with two areas; Cape Gata at Akrotiri; Cape Pyla; Cape Andreas and Klidhes islands on the north-eastern tip of the Island; North coast, east of Yialousa.

Figure 3-37. Minor loggerhead nesting on the south Larnaca beaches (pictures: A. Demetropoulos)

4. CYPRUS COASTAL AND MARINE ACTIVITIES

The coastal zone is densely populated and environmentally vulnerable. It is subject to increasing pressures from a number of sources (e.g. industrial development, urban expansion, exploitation of marine resources, tourism…). There is thus an urgent need to integrate the many uses made of coastal resources so that they can be rationally developed in harmony with one another and with the environment

4.1 Uses and impacts

The potential uses and derived impacts/threats on the coastal and marine Cyprus areas are: tourism/recreation, fishing, aquaculture, urban development, industrial activities, maritime traffic, education, research and conservation.

4.1.1 Tourism and recreation/leisure

These represent the principal activity in the Cyprus coastal area, with significant increases. There are many activities or uses in this narrow strip:

- i) Beaching:
    - Uses: Sunbathing, bathing and swimming; nautical sports (surfing, nautical ski, towed parachuting, sea-scooters (jet-skis), …).
    - Impacts: Overfrequentation; habitat destruction (sand replenishment)
- ii) Nautical development:
    - Uses: Marinas, boating, mooring.
    - Impacts: hydrodynamic alterations and habitat destruction (marinas, dredging, mooring, silting); disturbance of turtle nesting and foraging places and monk seal resting/breeding shelters.
- iii) Living resources and marine biodiversity:
    - Uses: Diving (snorkelling, scuba); bait and another fauna collection.
    - Impacts: Habitat destruction (turn over the blocks, collection of sea dates and other species, 'souvenirs' as nacres); scuba erosion (mainly in the caves).

4.1.2 Fishing

The small-scale fisheries represent a necessary activity for the littoral settled people, and is localised mainly around the fishing shelters. Nevertheless, some fishing activities are destructive, such as illegal trawling at shallow depths (past practice) and some sport fishing (with nets, scuba spear fishing) on some vulnerable fishes (e.g., groupers).

i) Professional fishing
- Trawling:
    - Activity: Bottom trawl fishing on Smooth bottoms in off-shore areas (>50m depth).
    - Impacts: Habitat and nursery areas destruction by the illegal trawling (<50m depth), mainly on *Posidonia*, *Cymodocea* and maerl communities (); overfishing on juveniles

- Small-scale fisheries:
  - Activities: Long-lines, trammel and gill nets, pots.
  - Impacts: 'Ghost' fishing (lost nets), sea bed erosion (mainly on maerl beds), overfishing.

ii) Sport fishing

- Activities: hooks (rod, hand-line, long-line, trolling); nets, similar to professional small-scale fishery (trammel net); pots; spearfishing (skin and scuba)*
- Impacts: lost nets ('ghost fishing'); overfishing of vulnerable species, by sex (e.g., male groupers, due to their sequential hermaphroditic biology) or on juveniles.

(*) Some of the sport fishing activities (trammel nets and scuba spearfishing) must be forbidden at national level according to the recent European Union Regulation for the Mediterranean.

4.1.3 Coastal urban development

The increase of tourism and the demand of new buildings represent a potential coastal threat, if there is not a rational planning and management of this important resource.

- Building and roads
  - Activities: Land reclamation, littoral roads, promenades and villas too near the coast, lights, littoral overfrequentation.
  - Impacts: Destruction and degradation of sand dunes and other sensitive coastal and marine habitats;
- Waste treatment
  - Activities: liquid domestic sewage by treatment plants; overflows, disposal.
  - Impacts: organic pollution (domestic wastes); low quality of seawaters, degradation of coastal ecosystems.

4.1.4 Industrial activities

Through localised in some coastal areas (fish cages, desalination plants, power plants), their impact can be important.

- i) Aquaculture:
  - Uses: sea fish cages for the fish rearing.
  - Impacts: organic (incl. nutrient) and antibiotic pollution (habitat degradation), alien species.
- ii) Desalination plants:
  - Uses: desalination of seawater.
  - Impacts: brine impact (osmotic alterations, chemical pollution habitat and biodiversity degradation).
- iii) Power generation plants:
  - Uses: Electricity generation using the seawater for cooling.
  - Impacts: Increase seawater temperature (metabolism and biological alterations).

4.1.5 Maritime traffic/transport

This activity is centred mainly around the commercial ports (Larnaca and Limassol areas mainly):

- Uses: Traffic, mooring areas, pipelines for gas or oil.
- Impacts: Hydrodynamic alterations (enlargement of actual ports); habitat destruction (dredging, mooring, silting); non-indigenous species (ballast water, fouling); oil spills.

4.1.6 Educational, research and conservation uses

These uses represent positive activities which permit the protection of the coastal and marine areas. Some areas have been proposed as marine protected areas (Cape Greco, Moulia Rocks, Akamas Peninsula, Polis/Yialia etc).

4.2 Prevention, mitigation and/or restoration measures

The physical impacts are the more dangerous on marine/coastal biodiversity (destruction of habitats). In this sense, coastal impacts and dredging represent one of the most significant impacts on the coastal and marine environment. Also, the direct destruction of seagrass meadows and maerl beds was caused by trawling (extensively) and anchoring (locally, but accumulative).

Another problem is the increasing population in coastal areas that presents a potential (but localized) threat to the coastal seagrass resources caused by domestic sewage disposal degrading water quality. Poor coastal planning signifies the anarchical coastal urbanization and the loss of natural resources (water quality, degradation/destruction of the coastal communities, overfrequentation…). Potential impacts need to be studied and taken into account so as to minimize impacts (e.g., physical destruction of habitats, pollution, lights etc)

Apart from the ICAM, some impact mitigation measures could be applied to restore and/or to avoid negative effects on the marine habitats and biodiversity. It is the case of some of the main impacts on marine habitats (new marinas, dredging, breakwaters, desalination plants)

4.2.1 New ports/marinas

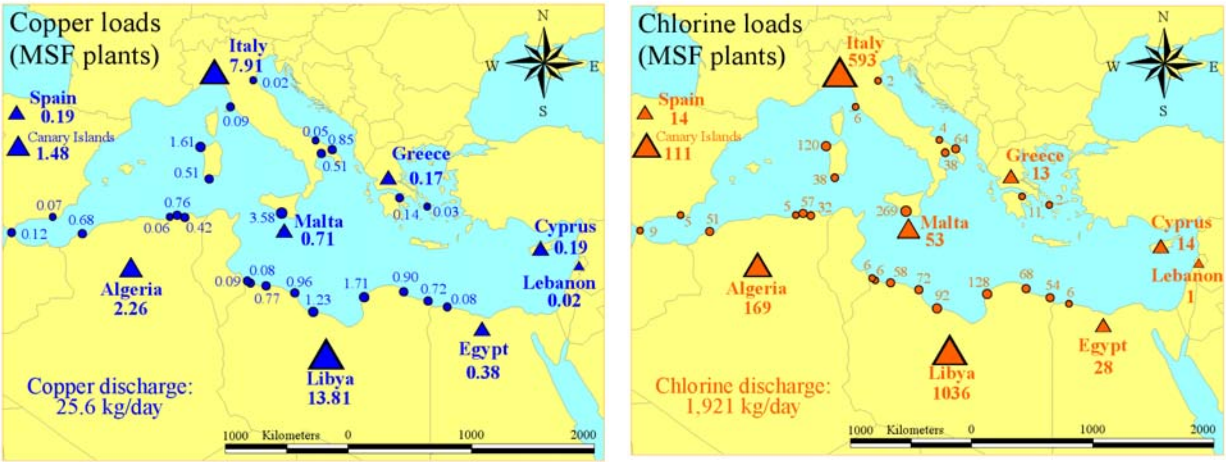
Due the important alteration of the hydrodynamic regime, the most rational solution will be the enlargement of the existing ports and/or marinas. Since the impact largely exists, the incremental impacts would be minor, compared with those of new constructions.

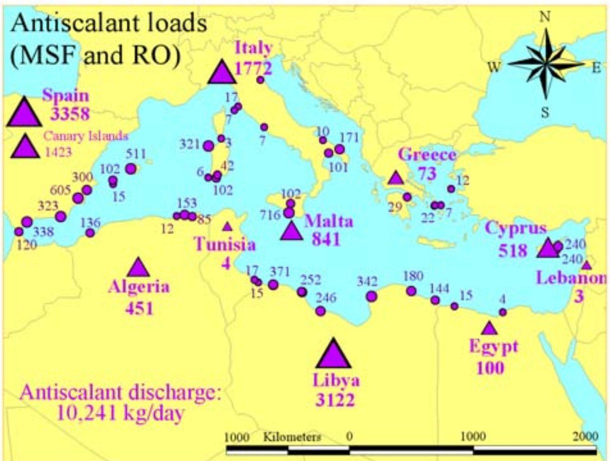
4.2.2 Dredging

Port dredging represents one of the main impacts on the marine habitats and biodiversity, not only by blanketing but also by silting (increase of the fine fraction => death of the structural filter-feeding fauna), the impacts of which can be spread over and affect large areas (depending on depth, location etc). The best solution for Cyprus is to establish permanent dumping sites at sea.

4.2.3 Desalination plants

The waste produced by desalination processes includes concentrated brine, antifouling chemicals, washing liquids containing antiscalants and corrosion salts. Such waste is discharged in most cases into the sea, provoking an increase in the surroundings in salinity, temperature, heavy metals and nutrients. Waste chemicals may include chlorine (as biocide), antifoam (mostly polyglycols), anti-corrosives, caustic soda, metal chlorides, calcium bicarbonate, sodium bicarbonate, phosphate and silicates. (ElHabr, in Chouikhi and Ismail (Eds) 2004; Abufayed, in opus cit.). Figure 4.1 shows some values regarding desalination-related discharges in the Mediterranean





From: Lattemann, S. 2003. Guidelines for the Environmental Sound Management of Seawater Desalination Plants in the Mediterranean Region. Ed. UNEP-MAP MEDPOL, Athens).

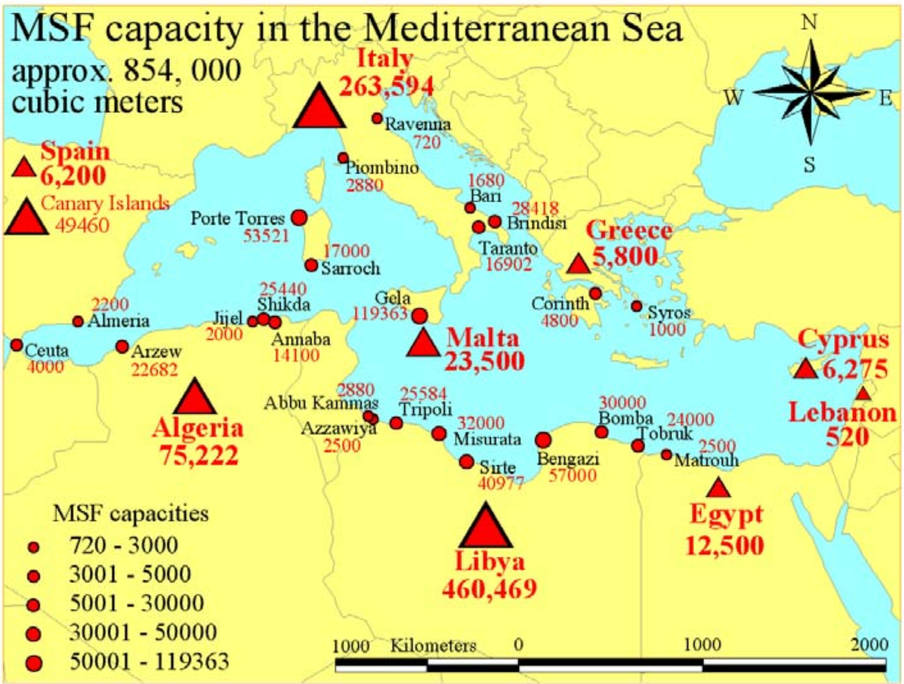
Figure 4.1: Estimated copper, chlorine and antiscalant discharges into the Mediterranean Sea in kg per day. Dots and triangles show discharge loads of single locations and cumulative national loads, respectively.
Copper and chlorine are present in discharges from multi-stage flash (MSF) distillation plants. The estimate is based on a brine copper level of 15µg/l, while residual chlorine levels of 0.25 mg/l were assumed for both brine and cooling water effluents.
Antiscalants are used in both multi-stage flash (MSF) distillation and RO plants. The figure shows the estimated discharge of both processes based on a dosage of 2 mg/l to the feedwater.

The brine impact on marine communities and biodiversity is high, due to the stenohaline feature of the majority of marine organisms. The brine has a salinity between 65-70 psu compared to 38-39 psu of Cyprus seawaters. That represents serious osmotic problems and the death of the benthic flora and fauna reached by it, because brines are denser than seawater and constitute very conservative water masses, difficult to mix. Temperature anomalies provoked by the waste mass affect organisms and water flux in the ecosystem.

Consequences for marine ecosystem in the vicinity of desalination plants include stress leading to death of sessile organisms, migration or bioaccumulation, destruction of habitat, breakage of food chains and changes in ecosystem, increases in competition, predation, disease and lethal stress of biological food sources. Oxygen depletion and temperature increases may have a greater effect than salinity alteration, causing large scale destruction of vegetation produced by temperatures exceeding 35 ^{o}C (Abufayed, 2004).

Driving Forces

Most riparian countries undergo a strong increase in services demand generated by tourism; and non EU countries are facing an increase in industry water demand. There is also a generalized feeling in public and policy makers which presents desalination as a panacea to water shortage, without ecological consequences faced through other activities such as damming or aquifers pumping. As a consequence, the water production by Mediterranean countries using sea water desalination systems becomes a physical and political necessity to address their total needs. Figure 4.2 shows the situation in 1999. Already in 2002, the production of several riparian countries had reached the following values (m^3/d): Algeria 301 134; Cyprus 120 000; France 11 262; Greece 39 220; Israel 352 000; Italy 439 131; Lebanon 17 083; Libya 750 198; Malta 146 313; Morocco 19 700; Spain 1 634 326; Tunisia 72 000; Turkey 13 000. Such production implied a total discharge of brine into the Mediterranean Sea amounting roughly 20 000 000 m^3/d (Abousamra, pers. com.). Desalination has as a consequence become an emerging pressure in the Mediterranean region with trends increasing fast.



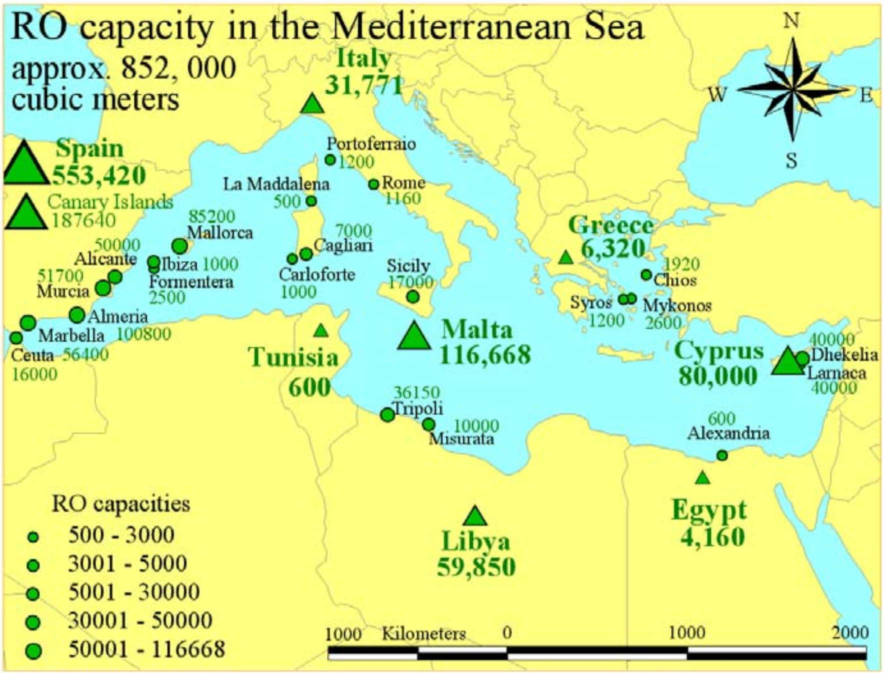


Figure 4.2. MSF and RO capacities in the Mediterranean Sea, with each process contributing about 0.85 million m^3/day. Triangles refer to national capacities, dots illustrate capacities of selected plant locations (data by Abousamra, F. based on Wangnick, 1999 In: Chouikhi and Ismail (Eds) 2004. Proc. On The Impact of Seawater Desalination Plants on Coastal Environment, Dubai 2003. Ed. INOC. Izmir. 333 pp.

Measures needed – Mitigation measures

Given the increasing importance that desalination is getting in the Mediterranean coasts it is important to consider the issue within any future coastal development plan.

Concerning chemical pollution, it is necessary to improve the use of safe chemicals and correct cleaning procedures of those chemicals before releasing discharging into the outfall.

With regard to the high concentration of the released waste itself, there are some feasible brine mitigation actions, to facilitate the rapid mixing with the seawater:

- i) To dilute the brine with seawater, previous to disposal into the sea (e.g. 1 part of brine with 2 ones of seawater => 49 psu). That permits a better mixing, due the lower salinity.
- ii) To facilitate the dilution into the sea. Unlike domestic liquid wastes (more or less freshwaters), the brine dilution is more difficult when the depth increases. That means that the shallower the better for brine dilution (keeping in mind the above).
- iii) Regarding the brine out-fall location, the best suitable areas are harbours/ports (degraded environments) and above the sea level. That permits a major dilution and oxygenation. Other suitable outfall areas are the hydrodynamic beaches (fine and coarse sands) with smooth slope and adequate wave action. That permits the brine spread in fan-shape (decreasing the brine thickness) and the action of the waves and ripple-marks in the dilution. The

latter solution is not applicable to ecologically sensitive beaches, such as turtle nesting beaches, where increased salinity etc will have detrimental effects.

- iv) To avoid other substances than brine, which could produce chemical pollution, it is necessary to previously treat the effluent of the osmosis membranes, cleaning against mineral and biological fouling (chloride, acids and alkaline substances, dispersants, flocculants…) and to eliminate them previous to disposing into the sea.

These brine mitigation actions have been applied and tested in desalination plants in the Alicante area (South-eastern Spain), with very positive results.

Regional Institutional Cooperation

Desalination plants are covered by the provisions of LBS Protocol of the Barcelona Convention: there is a need for discharge permits, an assessment on the basis of the Strategic Environmental Assessment (SEA) Directive, as well as obligations for the reduction of pollutant releases. MEDPOL has developed guidelines for the environmentally sound management of desalination plants (Guidelines for the Environmental Sound Management of Seawater Desalination Plants in the Mediterranean Region, Ed. UNEP-MEDPOL 2003)

A check list of aspects and a more general procedure to be considered in an EIA is provided in the guidelines. It takes the 1990 UNEP methodological approach into account, for an environmental impact assessment of projects affecting the coastal and marine environment, applied to seawater desalination. Impact of present and future installations in Cyprus should be revisited following the UNEP guidelines.

Furthermore, MAP will implement along 2008-09 through MEDPOL, in collaboration with several Regional Activity Centres, a capacity building and awareness programme focused on impact of desalination in the Mediterranean.

4.2.4 Trawling

The bottom fishing trawl represents one of the major threats on the benthic habitats (destruction, siltation, seabed smothering etc). One of the most effective actions to stop illegal trawling in some important areas is constructing deterrent artificial reefs. An artificial reef is planned for the Amathus area to enhance biodiversity and protect the sea bed. Concrete modules 2.6 tons weight will be used.

The VMS system implemented in Cyprus now safeguards that trawling does not take place in shallow waters (50m is the legal limit). Moreover Cyprus has recently reduced its trawler fleet fishing in local waters from 8 to 4 trawlers reducing significantly potential problems.

4.2.5 Sewage/pollution

Currently there is no regular disposal of treated effluents in the sea in Cyprus. Occasional disposal is however undertaken to mitigate temporal problems in treatment plants or in storage ponds. Even in such cases in the evaluation of the waste disposal sites (by submarine pipelines), knowledge of the current pattern is essential, as it is the main factor in controlling the diluting capacity of the waters. Also, knowledge of the slope and the habitats of the seabed are important, so as to locate the outfall at depths greater than 30-40m, without *Posidonia* and maerl habitats.

The Department of Fisheries and Marine Research is at the present time at the stage of preparing the monitoring programme for the implementation of the Water Framework Directive (2000/60/EC) in coastal waters. This is expected to cover the parameters foreseen in the Directive such as benthic invertebrates, phytoplankton (Chlorophyl a), angiosperms and macroalgae, as well the necessary physicochemical parameters (e.g., temperature, oxygen, nutrients etc). Cyprus is participating in the intercalibration process for this monitoring through the Working Group Med GIG.

The Department of Fisheries and Marine Research is also participating in the implementation of the Nitrate Directive (91/676/EC). The DFMR is monitoring the coastal waters in the Kokkinochoria area, as these are adjacent waters to the Kokkinochoria aquifer and are deemed to be vulnerable to episodic eutrophication phenomena with Cladophora outbreaks.

4.2.6 Control of marine invasive species

The removal of marine invasive species once they have invaded a sea is practically impossible and futile as has been proven by experience (as for example seen in the *Caulerpa taxifolia* case). The prevention of entry of alien species into a new aquatic environment is obviously indicated, through the control of activities/actions likely to allow the entry of such species in the sea. Lessepsian and/or tropical migrants, with global warming, are expected to increase in the coming years. Though removal is futile, nevertheless the impact of some dangerous species such as *Caulerpa taxifolia* and red tide forming species (as *Alexandrinum* and *Gymnodium* dinoflagellates) can be mitigated to a degree. The first (habitat danger) through public information (fig. 4-3), mainly directed at fishermen, and skin and scuba divers, albeit to record the advance of this alga; The red tide species and other alien species are mainly controlled with the control of ballast waters in the oil loading terminals and commercial ports as appropriate (though there is in fact no debalasting from tankers in Cyprus as this is an unloading terminal for oil - not a loading one). Control of ship cleaning operations (defouling) can help to reduce the incidence of accidental introduction of alien species

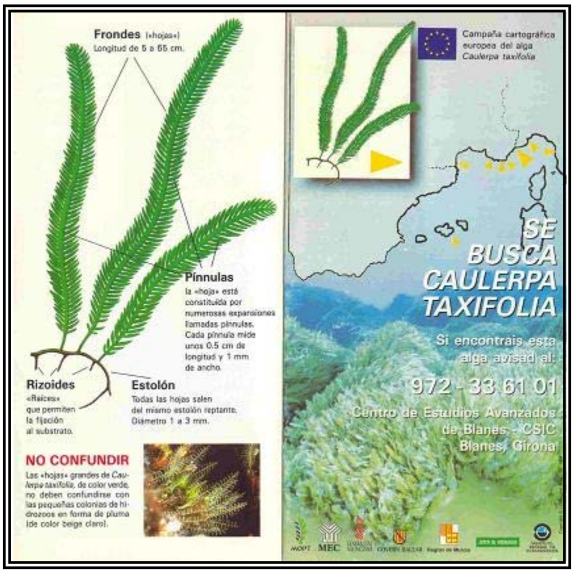


Figure 4-3. Leaflet in Spanish language with information about the characterisation and habitat danger of the Caulerpa taxifolia, with contact addresses to inform of its presence.

4.3 Climate change and sea level rise:

Due to global warming, the sea level will progressively rise in the coming years. The rise rate is based on climatic evolution models (conservatives and 'pessimists'), which consider three possible scenarios: 4, 10 or 15mm/year of the sea level rise (IPCC, 2002). According to these rates, the following increases were estimated in 2002:

- 10-20cm (year 2025)
- 20-40cm (year 2050)
- 50-135cm (year 2100)

Furthermore, satellite measurements calculate that sea level has been rising at a rate of 2.4-3.8 mm/yr since 1993, more than 50% faster than the rate that tide gauges estimate over the last century (Figure 4-4).So sea level appears to be rising about 50% faster than recent models suggest. Although not a proof of their lack of validity, given the uncertainty of the models, satellite measurements suggest that average sea level rise rate is being underestimated.

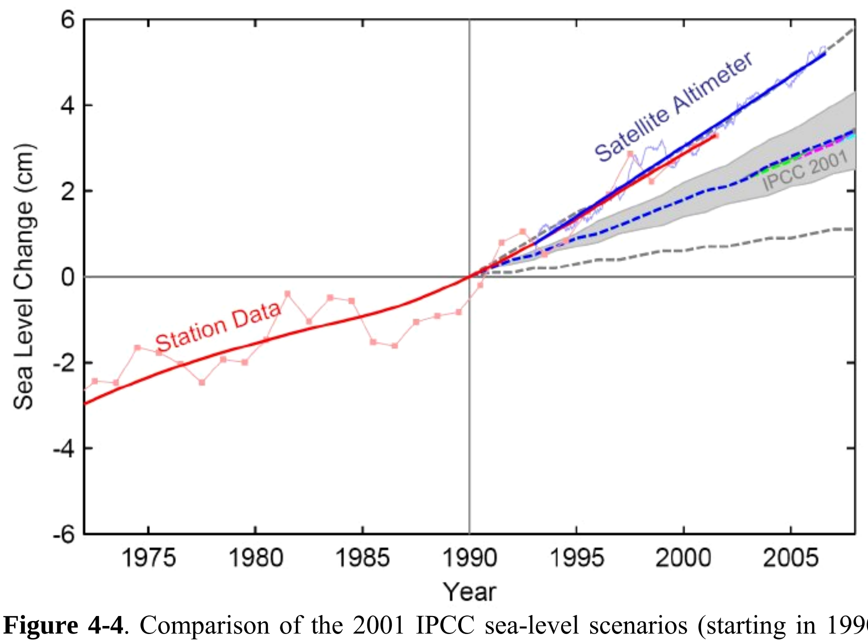


Figure 4-4. Comparison of the 2001 IPCC sea-level scenarios (starting in 1990) and observed data: the Church and White (2006) data based primarily on tide gauges (annual, red) and the satellite altimeter data (updated from Cazenave and Nerem 2004, 3-month data spacing, blue, up to mid-2006) are shown with their trend lines. Note that the observed sea level rise tends to follow the uppermost dashed line of the IPCC scenarios (update taken from www.realclimate.org)

In addition, sea level rise is presently mainly caused by thermal expansion, not ice melting, so a higher increase should be expected in areas where sea water temperature has more possibility to increase, such as in enclosed seas. The whole Mediterranean area is expected to have increased summer temperatures, according to the fourth (2007) IPCC assessment report, while the Eastern Mediterranean is expected to face some of the top world's highest increases in temperatures in the winter months.

That means for the case of the Mediterranean coasts, including Cyprus, the urgent necessity to establish a protection coastal zone to avoid urban development close to the present coastline, mainly in the tourist areas, since a coastline regression should be expected. The width of this protection zone will depend of the relief and slope: i) low profile coast at least 200m width; ii) moderate profile, at least 100m width. With regards to the South Larnaca, some constructions are quite near the shore (fig. 4-5) and they will endangered by sea level rise.

Figure 4-5. Southern Cape Kiti

In this sense, it is fundamental to take some prevention measures with regard to the protection of the sand dunes and seagrass meadows (*Posidonia, Cymodocea*), as elements against coastal erosion (sand stock, deadening wave effect, dead leaves stratum…). Figures 4-6 and 4-7 represent a well equilibrated beach and another when the shallow *Posidonia* meadows is degraded (by coastal works, organic pollution, anchoring…).

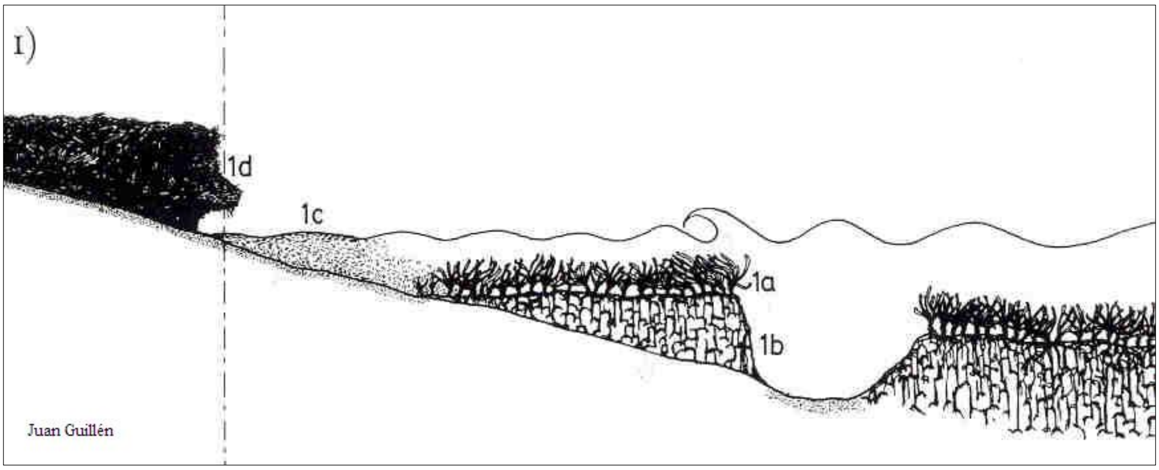


Figure 4-6. Littoral protection by the *Posidonia oceanica* meadows. Legend: 1a) wave deadening effect by the living leaves; 1b) growth of the matte to the surface (1cm/year); 1c) wave deadening effect by the dead leaves litter; 1d) avoid erosion effect by the littoral dead leave banks.

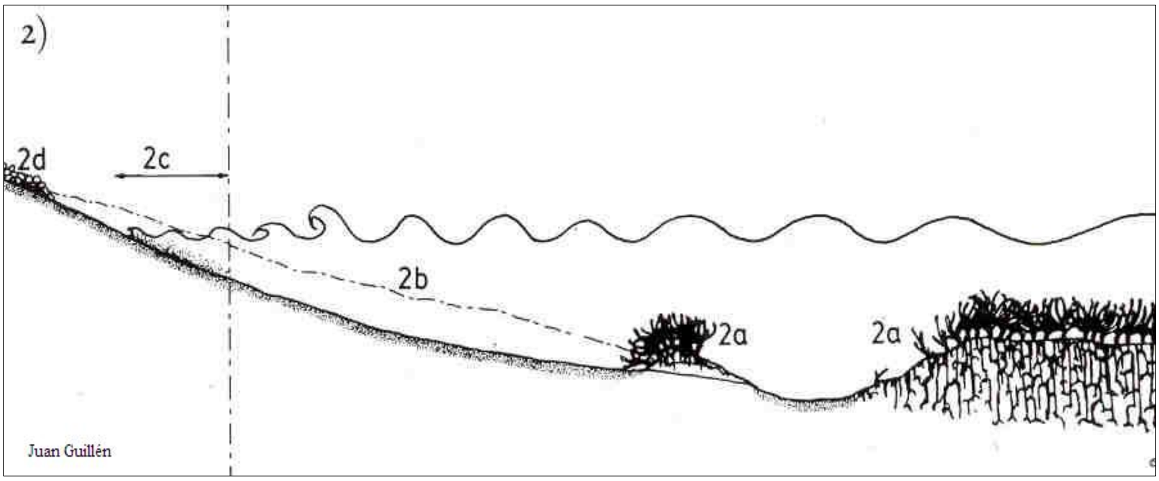


Figure 4-7. Littoral erosion when the Posidonia meadows are degraded or destroyed. Legend: 2a) degraded Posidonia matte; 2b) losing of sediment; 2c) losing of beaches; 2d) cobbles and pebbles.

Another mitigation measure against beach erosion is to conserve the dead leave stratum of Posidonia on the shore (fig. 4-8). Apart from the anti-erosion effect, the leaves are mixed with the sand, consolidating the sediment and increasing the beach. The problem is the 'cultural' impression of dirty beach by the tourists (the wrong idea, 'tropical clean and white beaches'). In this case two solutions are possible: i) tourist education, the presence of *Posidonia* leaves is a sign of high quality of waters and of a healthy sea (ecological beaches); or ii) to remove them only in the main tourist season (late May to late September), that permits the beach protection during the bad weather (fall, winter and spring). Nevertheless, the removal of the leaves also implies the removal of some important quantity of sand, which means losses to the beach.

Figure 4-8 . Dead leaf bank of Posidonia on the littoral of Southern Larnaca.

5. CASE STUDY: SOUTH LARNACA ZONE

The area comprises from South of Larnaca city to Cape Kiti (fig. 2-1). A preliminary marine study has been carried out to characterize the environmental units and mapping them (fig. 5-1).

5.1 Environmental units

According to the geo-morphological (substrata, topography, depth) features and the associated biocoenosis in the Southern Larnaca sector, the environmental units(or seascapes) have been (from shallower to deeper): i) littoral rock (fig. 5-2); ii) fine sand (fig. 5-4); iii) sand with *Cymodocea* (fig. 5-5); iv) *Posidonia* meadows (fig. 5-6); and v) muddy sand with *Caulerpa* (fig. 5-7). These environmental units have been represented in the figure 3-6.

5.1.1 Littoral rock

Figure 5-2. Littoral rocky environmental unit. Macroalgae spp. (*Cystoseira cf. humilis, Padina pavonica*), 1m depth (picture D. Cebrián).

Description: This environmental unit corresponds to the rocky substrata (calcarenites) between 0-6m depth. The associated biocoenosis belonging to the littoral and infralittoral photophylic (*Cystoseira* spp., *Padina pavonica*, *Laurencia* spp…) and sciaphylic (*Flabellia petiolata, Peyssonnelia* spp.) macroalgae (fig. 5-2).

Larnaca location: In the whole area (south of fishing shelter, in the Cape Kiti area), it is well represented with the *Dendropoma* biogenic formations and *Cystoseira* spp. associations (fig. 3-1).

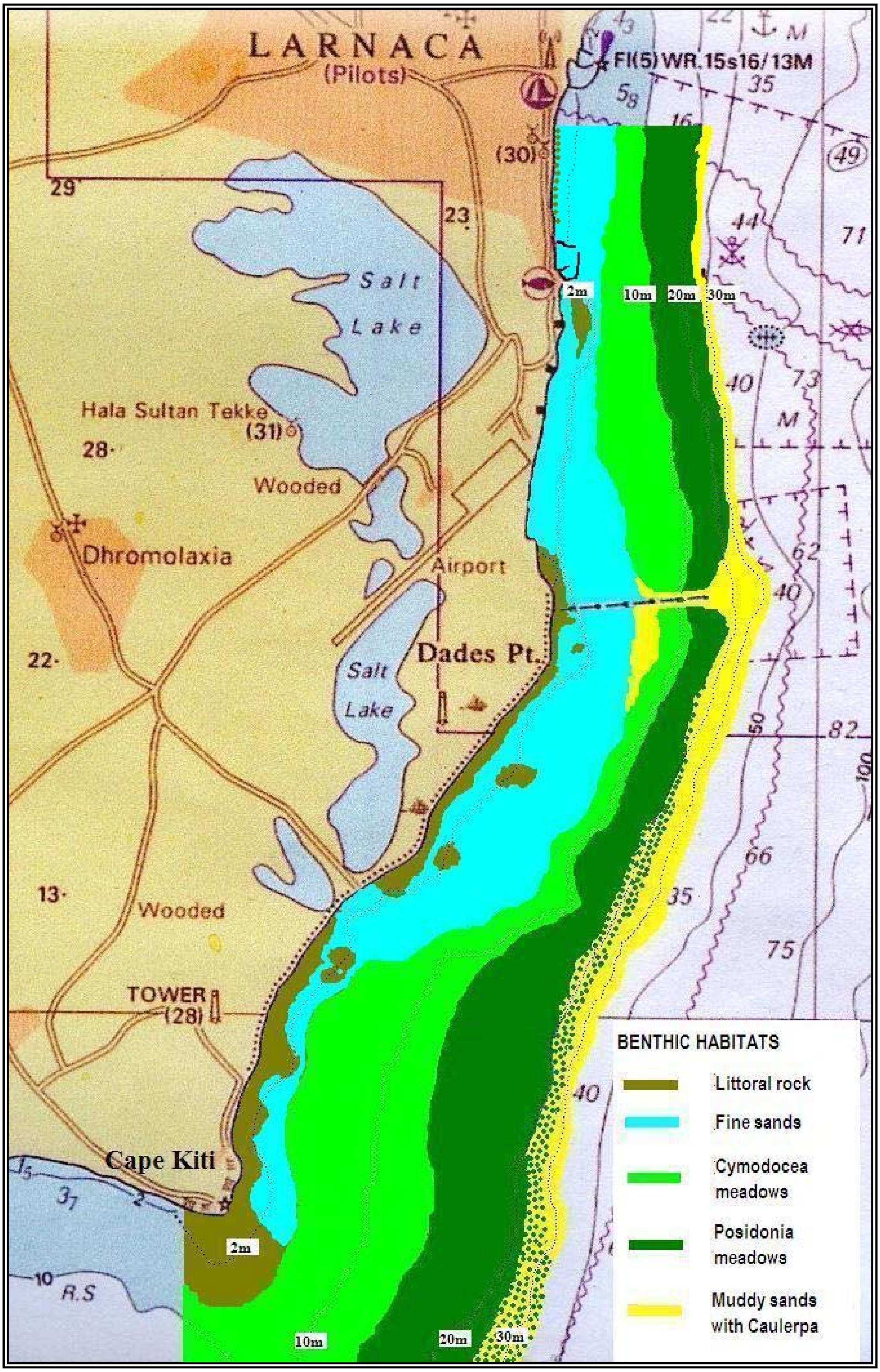


Figure 5-1. Marine habitat mapping (environmental units) of the South Larnaca sector.

Interesting habitats and species: Some of the vulnerable habitats are present: littoral biogenic constructions (*Dendropoma petraeum* and *Spongites rosa-florida*) and *Cystoseira* forests (*C. amentacea, C. compressa, C. cf. humilis, C. foeniculacea*). In some places, the *Posidonia oceanica* colonises the rocky substrata (fig. 5-3). Another interesting species: *Lithophaga lithophaga, Epinephelus marginatus, Sciaena umbra*.

Another functions: Nursery area (mainly commercial fishes: Sparidae, Serraridae, *Sparisoma cretense*…)

Figure 5-3. *Posidonia* shoots on the rocky substrata. Rocky reef at the Southern of Larnaca fishing shelter, 1m depth (picture D. Cebrián)

Threats: Harbours, marinas, land reclamation, coastal urbanisation, organic sewage, overfrequentation, dredging, bait collection.

Uses: diving (snorkelling, scuba), cane fishing, conservation measures (high biodiversity, nursery area)

5.1.2 Fine sand

Description: Habitat without vegetation or 'submarine 'deserts', only epifauna and infauna. From sand beaches to 9m depth (fig. 5-4).

Larnaka location: In the whole area, with tourist beaches (mainly at the south of the fishing shelter.

Interesting habitat and species: In spite of the 'lack' of macrorganisms, the fine sand harbours an interesting adapted fauna, as invertebrates (the hermit-crab *Diogenes pugilator*; the irregular sea urchin *Echinocardium mediterraneum*; the sea snails *Nassarius* spp.); the flatfishes (*Bothus podas*) and the 'cleaver wrasse' *Xyrichthys novacula*.

Figure 5-4. Fine sand seabed with ripple-marks, 2m depth (picture A.A. Ramos-Esplá).

Threats: Losing of the beaches by coastal works (harbours, marinas); destruction by land reclamation, dredging and coastal urbanisation; degradation by organic sewage.

Uses: Tourist/recreational uses (beaching, bathing, sunbathing); desalination brine outfall, without *Posidonia oceanica* meadows in a radius of 1km.

5.1.3 Sand with *Cymodocea nodosa*

Figure 5-5. Fine sand with Cymodocea nodosa, 4m depth (picture A.A. Ramos Esplá).

Description: Infralittoral fine sand and muddy sand seabed with the phanerogam *Cymodocea nodosa* (fig. 5-5).

Larnaka location: In the whole area, covering an important surface (3-18m depth), mainly in the Cape Kiti area.

Interesting habitat and species: Although the meadow structure is not complex, the *Cymodocea* is the precursor of the *Posidonia* settlement Spawning area from opisthobranch gastropods (*Aplisia* spp.); and important trophic area for commercial fish (eg. Sparidae) and cephalopods. Also harbours the nacre (*Pinna nobilis*) and sea-horses (*Hippocampus* spp.). Foraging area for juvenile to sub-adult (mainly) green turtles (*Chelonia mydas*)

Threats: Losing of the *Cymodocea* by coastal works (harbours, marinas, beach replenishment); destruction by land reclamation, dredging and coastal urbanisation; degradation by organic sewage; not diluted brine of desalination; inshore fish cage aquaculture.

Uses: Small-scale and sportive fisheries. Protection measures needed

5.1.4 *Posidonia* meadows

Figure 5-6. *Posidonia oceanica* meadow with the violet sea urchin (*Sphaerechinus granularis*, 12m depth (picture P. Sánchez-Jérez)

Description: Sandy bottoms with the phanerogam *Posidonia oceanica*, from 5 to 42m depth (fig. 5-6). In some parts the *Posidonia* matte forms terraces or fronts 1m high. Three subdivisions have been done: i) living *Posidonia* matte; ii) dead *Posidonia* matte; and iii) dispersed living shoots.

Larnaca location: In the whole area, covering a large area (10-25m depth), mainly in the Cape Kiti area. The signs of trawling are everywhere, mainly in the deeper meadows (20-32m depth). Nevertheless, some shoots have colonised the dead matte (27-32m depth), that means a slow recuperation is occurring (trawling has now stopped here).

Interesting habitat and species: Very complex habitat, mix of hard and soft bottoms, and photophylic and sciaphylic environments; low growth (1cm/year); nursery, spawning and shelter area; high O_2 production, and beach defence against the wave erosion. Interesting associated species: nacre (*Pinna nobilis*), triton shell (*Charonia tritonis*), captain seastar (*Asterina panceri*), sea-horses (*Hippocampus* spp.). Also harbours the nacre (*Pinna nobilis*), includes their nursery areas.

Other functions: Nursery area for many fish (includes some commercial fishes: Sparidae, Serraridae, *Sparisoma cretense*…); shore protection against the wave erosion and sediment stock.

Threats: Coastal works, beach replenishment; littoral dynamic alterations (marinas, ports); domestic and industrial sewage; trawl fishing; brine of desalination; inshore fish cage aquaculture, mooring; dredging and siltation.

Uses: Any human activities, excepting scuba diving and research. Total protection of the *Posidonia meadows*.

5.1.5 Muddy sand with *Caulerpa*

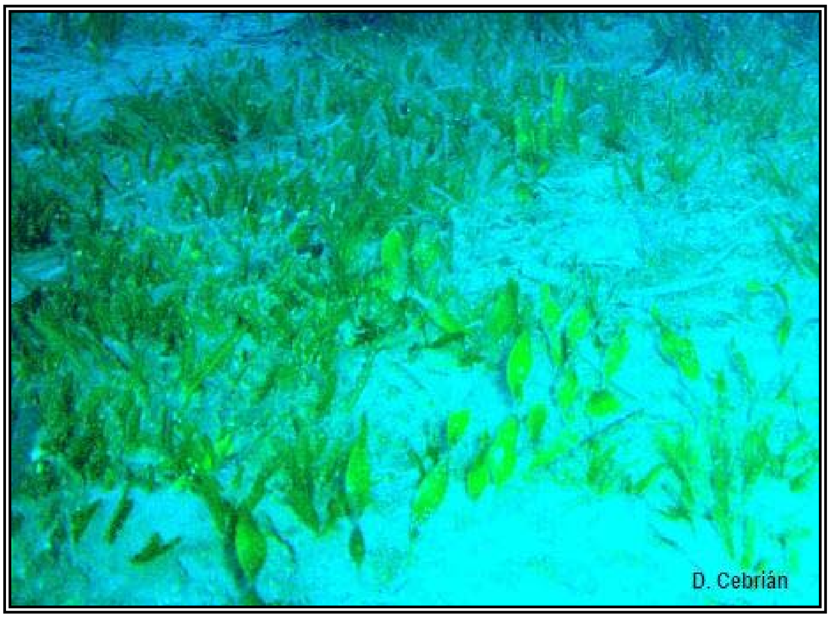


Figure 5-7. Muddy sand with *Caulerpa prolifera* (light green) and *Halophila stipulacea* (dark green), 24m depth (picture D. Cebrián).

Description: The *Caulerpa* spp (*C. prolifera* and the invasive *C. racemosa*) are abundant on muddy sand and sandy mud. The Lessepsian phanerogam *Halophila stipulacea*, it is also frequent (fig. 5-7).

Larnaca location: In the whole area, mainly on the degraded seabed (trawling and mooring impacts, desalination brine, organic sewage…). The depth range has varied between 5 to 35m (limit of the present study).

Interesting habitat and species: This environmental unit is represented by opportunistic species (*Caulerpa* spp.) and Lessepsians (*C. racemosa* and *Halophila*), and the associated species which have no conservation interest. Therefore the interest of this habitat is low.

Threats: Due to fast recover by the *Caulerpa* spp., any impact on this habitat should not be important.

Uses: Location of emergency treated domestic sewage out-fall; small-scale and sport fisheries; vessel mooring area; desalination brine dumping.

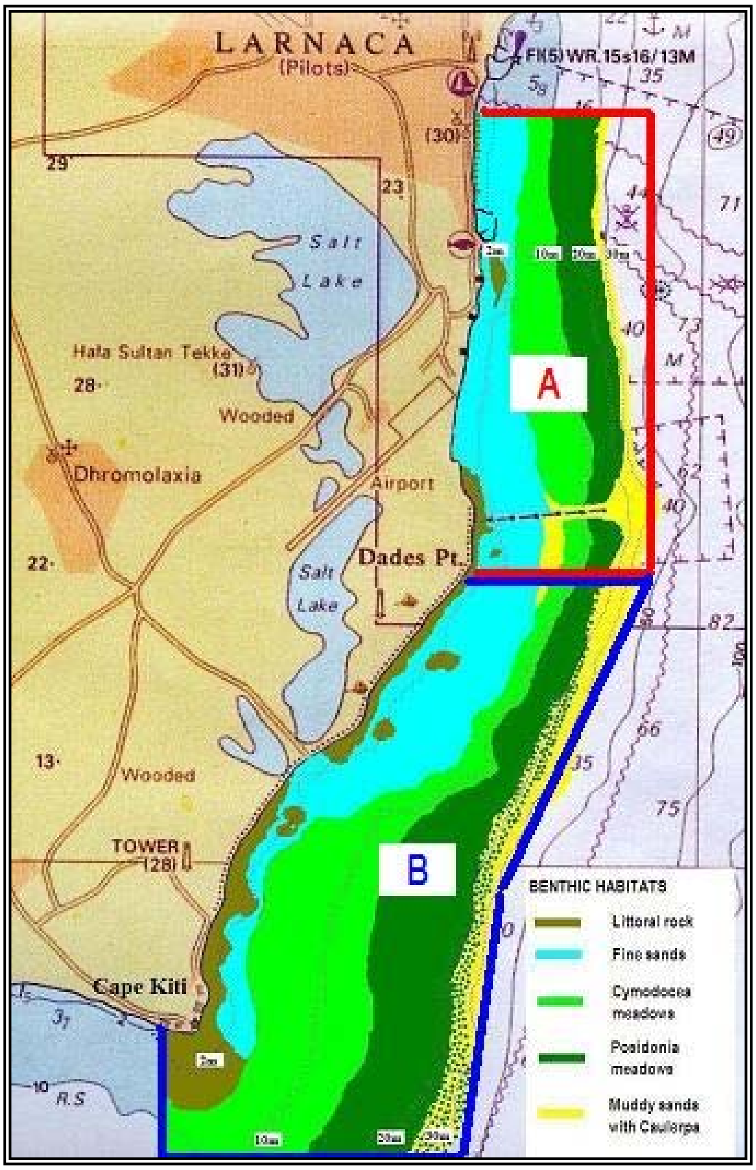


Figure 5-8. Subdivision in two sub-zones of the studied area: (A) Larnaka harbour to Dades Point; (B) Dades Point to Cape Kiti.

5.2 IMCAM of the South Larnaca area

According to the environmental units (see paragraph 5.1), we can establish two main subzones in the studied area (fig. 5-8): (A) Larnaca harbour to Dades Point; (B) Dades Point to Cape Kiti.

5.2.1 Subzone A

This corresponds to the marine and coastal area between Larnaca harbour and Dades Point. That represents the expansion area from Larnaca city with several uses (tourist, fisheries, industrial, urban development…) and high urban development.

a) Environmental units:

- Littoral rock: Rocky reefs at the South of the fishing shelter (0-2m depth).
- Fine sand (0-8m depth).
- C*ymodocea nodosa* meadows (3-11m depth)
- *Posidonia oceanica* meadows and dead matte (10-27m depth)
- Muddy sand with *Caulerpa* spp. (21-35m depth)

b) Uses: A variety of coastal and marine uses are developed in sub-zone A

- Tourist/recreation: beaching, sunbathing, bathing; scuba diving ('Zenobia' wreck)
- Fisheries: small-scale (trammel, long-lines) and sport fisheries.
- Coastal works: Larnaca port and marina, fishing shelter; breakwater against coastal erosion; littoral road.
- Urban development: spread area from the Larnaca city; important tourist place; sewage treatment.
- Industry and commercial activities: Maritime traffic and mooring area; airport; desalination plant.

c) Impacts

- Losing of dunes (coastal works and buildings); beach erosion;
- Losing of *Posidonia* meadows: desalination brine, mooring area, trawl fishing (past)
- Anarchical urban development, some buildings very near the shore

d) Prevention, mitigation and/or restoration measures

- Avoid building 100-200m from the shore, depending on the geomorphology of the coast. Take into account the sea level rise.
- Enhance the beach protection with the *Posidonia* dead leaves (do not pick up; if strictly necessary, only in the summer period and replace them afterwards).
- Emergency treated water overflow by submarine pipeline in this subzone (high slope ≈ 2.4% between 0 to 50m depth) and outfall located > 30m depth outside *Posidonia* meadows (on muddy sand with *Caulerpa* spp.). The length of the pipeline between 1500 to 2000m
- Desalination brine outfall situated at 0m level; dilution of the brine with 2 parts of seawater (the salinity lows to 48-50 psu) to enhance the mixing; previous treatment of the cleaning substances from osmosis membranes.
- Deterrent artificial reefs, if needed, against trawling, situated between 20-35m depth (now not needed due to measures taken). The recovery of *Posidonia* must be natural, by free shoots.

5.2.2 Subzone B

This corresponds to the marine and coastal area between Dades Point and Cape Kiti. This subzone presents moderate urbanization (possibly higher in the near future) and moderate-low impact.

a) Environmental units:

- Littoral rock: Rocky reefs in all of the subzone (0-6m depth).
- Fine sand (0-9m depth)
- C*ymodocea nodosa* meadows (4-18m depth)
- *Posidonia oceanica* meadows and dead matte (12-24m depth); free shoots (24-32m depth)

- Muddy sand with *Caulerpa* spp. (22-35m depth).

b) Uses: A variety of coastal and marine uses are developed in the sub-zone A

- Tourist/recreation: beaching, sunning, bathing; snorkelling.
- Fisheries: small-scale (trammel, long-lines) and sport fisheries; fishing trawl (now ceased).
- Coastal works: breakwater against coastal erosion; littoral road.
- Urban development: important tourist place; sewage treatment.

c) Impacts

- Loses of dunes (coastal works and buildings); beach erosion;
- Loses of *Posidonia* meadows: trawl fishing (damage from past trawling)
- Anarchical urban development, some buildings very near the shore

d) Prevention, mitigation and/or restoration measures

- Avoid building 100-200m from the shore, depending on geomorphology. Take into account the sea level rise.
- Enhance the beach protection with the *Posidonia* dead leaves (do not pick up; if it necessary, only in the summer period).
- Deterrent artificial reefs, if needed, against trawling, situated between 20-35m depth (now not needed due to measures taken). The recovery of *Posidonia* must be natural, by free shoots.

e) Marine protected Area in Cape Kiti

Cape Kiti represents an interesting area (rocky reefs, Cymodocea and Posidonia meadows) and in good health. It is also an important nursery area for many species including some commercial fish. According to that, it is recommended to create a marine protected area to enhance the fishery stocks and the small-scale fisheries in the Larnaca zone

Figure 5-9 shows the zone that could be a 'fisheries-refuge', with no fishing inside the zone. The shape could be rectangular, between 0 to 10m depth, and the area about 800hectares (fig. 5-9).

Figure 5-9. Subzone B with the possible location of a marine protected area in Cape Kiti, as "fisheries refuge".

5.3 The Larnaca Salt Lakes

The Larnaca Salt Lake Complex is one of the two main wetlands in Cyprus which are of international ecological significance. It consists of four main lakes, the main Salt Lake (Alyki), Orphani, Soros and the small Airport Lake. Smaller lakes also form near the coast to the east of Orphani. The wetland area also includes the extensive halophytic communities on the shores of the lakes and in the area between the lakes and the sea. Two small forests one by the Tekke and the other on the east bank of Alyki add diversity to the area.

The lakes of the Larnaca Salt Lake complex are inter-related lakes, which, however, vary significantly among them from an ecological point of view. Alyki, the main Salt Lake, has a very high salinity regime. The alga that forms the basis of the food chain here is *Dunaliella salina.* On this alga feeds *Artemia salina,* the Brine shrimp. This shrimp can withstand very large salinity fluctuations (from 15‰-300‰) but usually thrives at salinities of about 100‰. *Branchinella spinosa*, the Fairy shrimp, a close relative of *Artemia salina*, lives in the other Larnaca lakes, which are less salty. The brine shrimp cysts start hatching when the salinity of the lake drops to about 25‰. (Demetropoulos 1998 and Demetropoulos and Hadjichristophorou 2003)

These shrimps are the main food of the Flamingo and of other birds in these lakes. On average about 1,000-2,000 Flamingo overwinter here each year. In peak years, such as 1995 and 2005, there may be as many as 7,000.

The inflow of an adequate quantity of fresh water into the lakes is critical, as without this water the salinity of the lake will not drop enough for the *Artemia* cysts to hatch and the Flamingo and the other birds will not have food. The main source of water for the lakes is rainfall. It is important to safeguard that the hydrological balance of the lakes is not interfered with.

In 1997 the Council of Ministers approved the Programme for the Conservation and Management of the Larnaca Salt lakes and the adjacent area. Its aims are the protection and conservation of the salt lake ecosystem, including the protection of the area from pollution and degradation, as well as its wise use, for environmental education and environmentally friendly forms of recreation.

In 2001 Cyprus ratified the RAMSAR Convention for the Protection of Wetlands and the main Larnaca Salt Lake (Alyki) was included in the RAMSAR List as the 1081st Wetland of International Importance.

In 2005 the Larnaca Salt Lakes and the area surrounding them were proposed by government to the European Commission as one of the Natura 2000 SAC sites (pSCI) in Cyprus. It was also proposed as an SPA site with the same boundaries. This was on the basis of Laws 153(I) of 2003 and 152(I) of 2003 which are the two laws transposing the provisions of the Habitats and Bird Directives into national legislation.

The main threats and their sources and possible impacts are outlined in the table below:

Source	Threat	Impact/effect
Sewage treatment plant	Leakages of secondary treated effluent into the lakes (from split lining of storage ponds). Mainly to Orphani lake and Spyros coastal lagoons	eutrophication
Coastal development at the east of the lakes	Sewage from incomplete sewage systems enters Orphani and Glossa (Soros)	eutrophication
Airport	Oil etc from runway, parking storage area. Water balance	Contamination/ecosystem changes (oxygen transfer reduction). Salinity cycle impact
Access/nature trails	Disturbance of birds	Energy losses – birds move away from Larnaca lakes
Urban development in Kamares area, north and east of main lake mainly	Freshwater inflow reduction	Ecosystem cycle changes – hatching of Artemia etc
Agriculture west and north west of main lake and around Orphani and Soros	Inflow of fertilizers	Eutrophication
Driving in lakes	Impact on ecosystem – sediment disturbance	suspended solids increase (turbidity increases) filter feeders impacted
Tekke Picnic area (includes cross-country driving)	Too many people and driving in sensitive area for flora /vegetation	Trampling of halophytes - picking of flowers (Orchids in particular)
Inadequate management of area	Canal bringing water to Airport lake (feeding the main salt lake) partly blocked	Lakes deprived of freshwater needed for ecological cycles of brine shrimps

The above need to be taken into consideration in protecting and managing the lake ecosystem and need to be addressed in any spatial plan and/or EIA study relating to the area, as well as in the framework of the management plan of the salt lakes area.

Potential problems

1. The Airport extension, especially the new runway foreseen for the future (evidently not the immediate future) needs to be carefully evaluated as it can directly impact physically the wetland habitats as well as the water regime.
2. The planned expansion of the sewage treatment plant and the foreseen emergency outfall, need to be carefully planned as they could seriously impact the salt lakes and the marine biodiversity in the coastal water of the area.

6. ON STRATEGY AND GUIDELINES

- The Habitats Directive provides the criteria (priority habitats and species etc) that need to be used to adequately protect marine/coastal biodiversity in the member States. The issue of "How" the guidelines elaborated for the conservation of this biodiversity are to be implemented is addressed inter alia, through the ICAM procedures and the Cyprus CAMP project findings and recommendations. The SEA and the EIA Directives are also cornerstones in this.
- The provisions of the Barcelona Convention (SPA Protocol) and the Bern Convention also list the species/habitats that require protection
- Gaps in the existing knowledge of marine/coastal biodiversity (spatial etc) need to be addressed.
- The nature of the marine environment is such that it mandates stakeholder representation on a very diverse variety of bodies - and in institutional coordination.
- The strategy to be followed in the incorporation of marine/coastal biodiversity concerns in any plan (spatial or other) or programme in the coastal area, implies that all the available information and concerns need to be taken into consideration in the formulation stage of any such programme or plan.
- There is a pressing need, in an island with a limited and precious coastline which is under severe pressure, to have Biodiversity Evaluation as a key component of ICAM

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