

Establishing a bio-monitoring program of plant species and habitats of the Mesogaia area (Athens, Greece): baseline survey results

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Ever-increasing human activities in the Mesogaia area (prefecture of Attiki, Greece) have caused severe environmental disturbances and alteration of the area's natural ecosystems. The construction and operation of the new Athens International Airport "Eleftherios Venizelos" in the area is expected to amplify these disturbances directly or indirectly. Bio-monitoring of the remaining natural habitat types is of high importance; therefore, a research project was established in order to monitor any impacts induced by the construction and operation of the new International Airport and the prospective development of the surrounding area. A detailed survey of the flora and vegetation of the area and vegetation mapping enabled the authors to identify and record the habitat types, plant communities and the area's ecosystem dynamics, as well as to evaluate anticipated environmental impacts. Subsequently, a number of plant taxa connected with conservation references are presented here, along with several habitat types considered important for plants and animals.

Key words: bio-monitoring, Athens International Airport, vegetation mapping, conservation, floristics.

INTRODUCTION

The Athens International Airport (AIA) conceived a project entitled "Bio-monitoring project – monitoring plant species and habitats" which commenced in 1997 and was implemented by the Biology Department of Patras University. The project was aiming at assessing environmental impacts from the construction and operation of the new International Airport in the Mesogaia area.

The study area is delimited by the coordinates 23° 47' to 24° 05' E and 37° 49' to 38° 03' N (Fig. 1). The size and the shape of the study area were determined by AIA in a way that the airport site is in the

centre and the areas considered to be more affected by its operation, around that centre. High scale man-induced environmental disturbances, going back to ancient times, have had a negative impact on the Mesogaia natural ecosystems. Urban expansion is obviously the most important disturbance on the area, but trash and waste disposal, hunting, grazing, wildfires, quarries, vegetation clearing, road cutting etc. have almost equally detrimental effects.

Despite uncontrolled construction of new residences during the last decades, the area partly maintains its agricultural character, although the area covered by agricultural land has been reduced. Vineyards and olive groves mainly occupy the landscape. Grapes and olives have been cultivated here since the antiquity and constitute an important and characteristic feature of the Mediterranean landscape. Fur-

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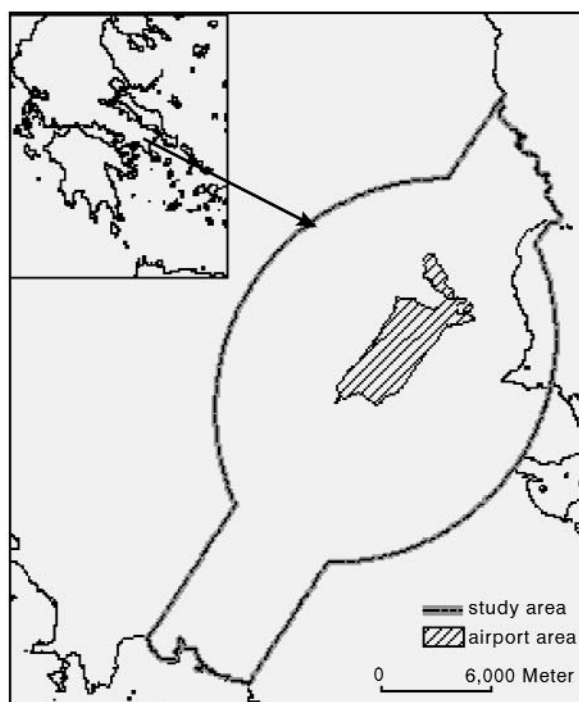


FIG. 1. Map of the study area.

thermore, they support an interesting variety of living organisms, a fact that makes their conservation essential.

The objectives of the current work include:

- Detailed recording of the presence and the distribution of the plant species within the study area. Special attention is given to species connected to official conservation references.
- Detailed recording and mapping of the habitat types of the study area.

Recorded data will constitute the baseline of the current situation from which monitoring will commence.

MATERIALS AND METHODS

An extensive fieldwork was undertaken in a number of selected sites within the study area. For a more accurate and systematic work, the study area was divided into 500×500 m grids. The selected sites represent the entire range of habitats and plant species occurring in the area. The fieldwork was carried out between 1997 and 1999, in two phases. During the first phase of the project, almost all areas covered by natural vegetation and supporting natural habitats were studied (Verroios *et al.*, 1998). In the second phase, priority was given to all habitats (natural ones and agroecosystems) within an 8 km radius from the

airport, areas considered important from a floristic and vegetation point of view (Dimitrellos *et al.*, 1999).

During the fieldwork, the flora and vegetation of the study sites were recorded. Plant species not identified *in situ* were collected and later identified in the Herbarium of Patras University. Species nomenclature followed Flora Hellenica (Strid & Tan, 1997-2002), Med-Checklist (Greuter *et al.*, 1984-1989) and Flora Europaea (Tutin *et al.*, 1968-1993). Vegetation samples (relevés) for the determination of the vegetation units were collected and their exact position was recorded by means of GPS (Global Positioning System). Habitat distinction and identification were based on the characteristic and diagnostic taxa referred to in Horvat *et al.* (1974), Barbero & Quezel (1976), Dimopoulos *et al.* (1995), Mucina (1997) and Dafis *et al.* (1999). Habitat types were described using the nomenclature of the NATURA 2000 project (Dafis *et al.*, 1999).

After fieldwork, all data collected were registered in a specially designed database, BIOMIS (Anagnostopoulos, 1997). This database divides the study area into squares of 25 hectares each (500×500 m) and has the ability of producing species and habitat maps that will constitute the baseline information that is necessary for future monitoring. At the same time, *in situ* confirmation and recording of the changes in the vegetation patterns (based on orthophotomaps of 1991) was undertaken in order to produce a vegetation map depicting the 1999 situation. GIS (Geographic Information System) was used for recording, analysing and presenting spatial information in the form of maps. The first vegetation map was based on aerial photographs and orthophotomaps of the 1991 period. This map was reviewed after extensive fieldwork in order to produce the vegetation map of the 1999 period. The maps were printed at a scale of 1:25000 (Lampada *et al.*, 2000).

RESULTS

The research work presented here is considered as unique for the flora and vegetation of the Mesogaia area. From the collection, identification and recording of the flora of the study area it is concluded that it consists of 604 taxa. A list of plant species considered as important from a conservation point of view (endemics, WCMC, Greek Presidential Decree 1981, CITES) is presented in Table 1.

The vegetation of the area is characterized by a high diversity of habitat types which reflects the nat-

TABLE 1. Plant species of the study area connected with conservation references

Conservation reference	Plant species name
Local endemics	<i>Campanula celsii</i> subsp. <i>celsii</i>
Greek endemics	<i>Campanula drabifolia</i> , <i>Centaurea orphanidea</i> subsp. <i>orphanidea</i> , <i>C. raphanina</i> subsp. <i>mixta</i> , <i>Chondrilla ramosissima</i> , <i>Crepis hellenica</i> , <i>Crocus cartwrightianus</i> , <i>Echinops graecus</i> , <i>Erysimum graecum</i> , <i>Fritillaria graeca</i> subsp. <i>graeca</i> , <i>Galium melanantherum</i> , <i>Goniolimon sartorii</i> , <i>Inula verbascifolia</i> subsp. <i>methanea</i> , <i>Leontodon graecus</i> , <i>Linum leucanthum</i> , <i>Limonium doerfleri</i> , <i>L. hyssopifolium</i> , <i>Malcolmia graeca</i> subsp. <i>graeca</i> , <i>Melilotus graecus</i> , <i>Onobrychis ebenoides</i> , <i>Ornithogalum atticum</i> , <i>Scorzonera crocifolia</i> , <i>Silene corinthiaca</i> , <i>S. spinescens</i> , <i>Tragopogon brevirostris</i> subsp. <i>longifolius</i> , <i>Veronica glauca</i> subsp. <i>peloponnesiaca</i>
CITES (European Commission DG XI, 1982)	<i>Barlia robertiana</i> , <i>Cyclamen graecum</i> , <i>C. hederifolium</i> , <i>Ophrys ferrum-equinum</i> subsp. <i>ferrum-equinum</i> , <i>O. fusca</i> subsp. <i>fusca</i> , <i>O. fusca</i> subsp. <i>iricolor</i> , <i>O. sicula</i> , <i>O. scolopax</i> subsp. <i>cornuta</i> , <i>O. scolopax</i> subsp. <i>heldreichii</i> , <i>O. sphegodes</i> subsp. <i>sphegodes</i> , <i>O. tenthredinifera</i> , <i>Orchis coriophora</i> subsp. <i>fragrans</i> , <i>O. lactea</i> , <i>O. quadripunctata</i> , <i>O. tridentata</i> , <i>Serapias bergonii</i> , <i>Spiranthes spiralis</i> , <i>Sternbergia lutea</i> subsp. <i>sicula</i>
Greek presidential decree 67/1981	<i>Noaea mucronata</i> , <i>Scorzonera crocifolia</i>
WCMC (IUCN) (Walter & Gillett, 1998)	<i>Ornithogalum atticum</i>

ural, semi-natural and man-induced environments. All habitat types of the study area are listed in Table 2.

Habitat types of the Mesogaia area were grouped into three main groups (Table 2) reflecting the natural, semi-natural and man-induced environments. The area covered by these three habitat type groups in 1991 and 1999 is shown in Figures 2 and 3. Detailed data for the size of the area occupied by habitat types are given in Table 3. Vegetation mapping showed that in 1999 man-induced habitat types occupied the largest part of the study area (78.9%). Semi-natural habitats occupied the smallest area (1.3%), whereas natural habitats occupied a noteworthy 19.8% of the area. Mapping the vegetation units for two different time periods (1991, 1999) showed that the greatest change in coverage (27% decrease) was observed in the semi-natural habitat types, whereas the man-induced and natural habitats presented the smallest change (1% increase and 1% decrease, respectively) (Fig. 4).

Natural habitat types can be grouped into five main groups (Table 2). Vegetation mapping for the time period 1991-1999 showed that the phrygana and the shrub habitat type areas increased by 1% and 6%, respectively, whereas the mixed shrub-pine and the pure pine forest habitat type areas decreased by 23% and 7%, respectively (Table 3, Fig. 5). In the coastal and wetland habitats there was no significant size change.

DISCUSSION

The survey of the study area's plant taxa indicated that Mesogaia is characterized by a rich flora with a high proportion of endemic or protected plants. The flora of the study area consists of more than 600 taxa. Floristic evaluation resulted in 45 taxa that belong to different conservation categories.

Despite the intensive human activity, a significant number of natural habitat types were recorded in the study area. These include phryganic vegetation, shrubs, pine forest, coastal and wetland vegetation. Vegetation mapping showed that natural habitats occupy almost 1/5 of the study area. Natural habitats exhibited a small decrease (1%) during the period 1991-1999. More than 50% of the natural vegetation is occupied by shrubby vegetation. The shrub area increased by 6% during the period 1991-1999. This increase is attributed to the respective decrease of the area covered by pure pine forest and mixed shrub-pine forest. Wildfires and housing development is the reason for this transition. Housing development also affects negatively semi-natural habitat types.

GIS spatial analysis showed an increase of the man-induced habitats at the expense of the natural and semi-natural habitat types. Semi-natural habitat area decreased the most, since it represents the transitional zone between man-induced and natural habitats. This tendency is more intense in the north-east-

TABLE 2. Habitat types of the study area

Habitat groups	Natural habitat type groups	Natural habitat type code	Description
natural habitats	coastal and wetland	1160	Large shallow inlets and bays
		1210	Annual vegetation of drift lines (<i>Cakiletea maritima</i>)
		1240	Vegetated sea cliffs of the Mediterranean coasts (with endemic <i>Limonium</i> spp.)
		1420	Mediterranean and thermo-atlantic halophilous scrubs (<i>Arthrocnemum fruticosum</i>)
		1420×92D0×72A0	Mediterranean and thermo-atlantic halophilous scrubs × East Mediterranean tamarisk thickets × common reed beds
		92D0 × 72A0	East Mediterranean tamarisk thickets × common reed beds
	phrygana	5420	<i>Sarcopoterium spinosum</i> phrygana
	shrubs	9320	<i>Olea</i> and <i>Ceratonia</i> forests
		9320 × 5212	<i>Olea</i> and <i>Ceratonia</i> forests × <i>Juniperus phoenicea</i> arborescent matorral
		5211	<i>Juniperus oxycedrus</i> arborescent matorral
		5212	<i>Juniperus phoenicea</i> arborescent matorral
		5212 × 5340	<i>Juniperus phoenicea</i> arborescent matorral × East Mediterranean garrigues
		5340	East Mediterranean garrigues
	shrubs and pines	9320 × 954010	<i>Olea</i> and <i>Ceratonia</i> forests × Greek aleppo pine forests
		5212 × 954010	<i>Juniperus phoenicea</i> arborescent matorral × Greek aleppo pine forests
		5340 × 954010	East Mediterranean garrigues × Greek aleppo pine forests
	pine forest	954010	Greek aleppo pine forests
	semi-natural habitats		Villages × Greek aleppo pine forests
			Villages × Greek aleppo pine forests × crops
			Fallow fields
		Greek aleppo pine forests × crops	
		East Mediterranean garrigues × Greek aleppo pine forests × villages	
		Villages × <i>Sarcopoterium spinosum</i> phrygana	
		Plantations of <i>Eucalyptus camaldulensis</i>	
man-induced habitats		Airport area	
		other uses	
		crops	
		crops × villages	
		villages	

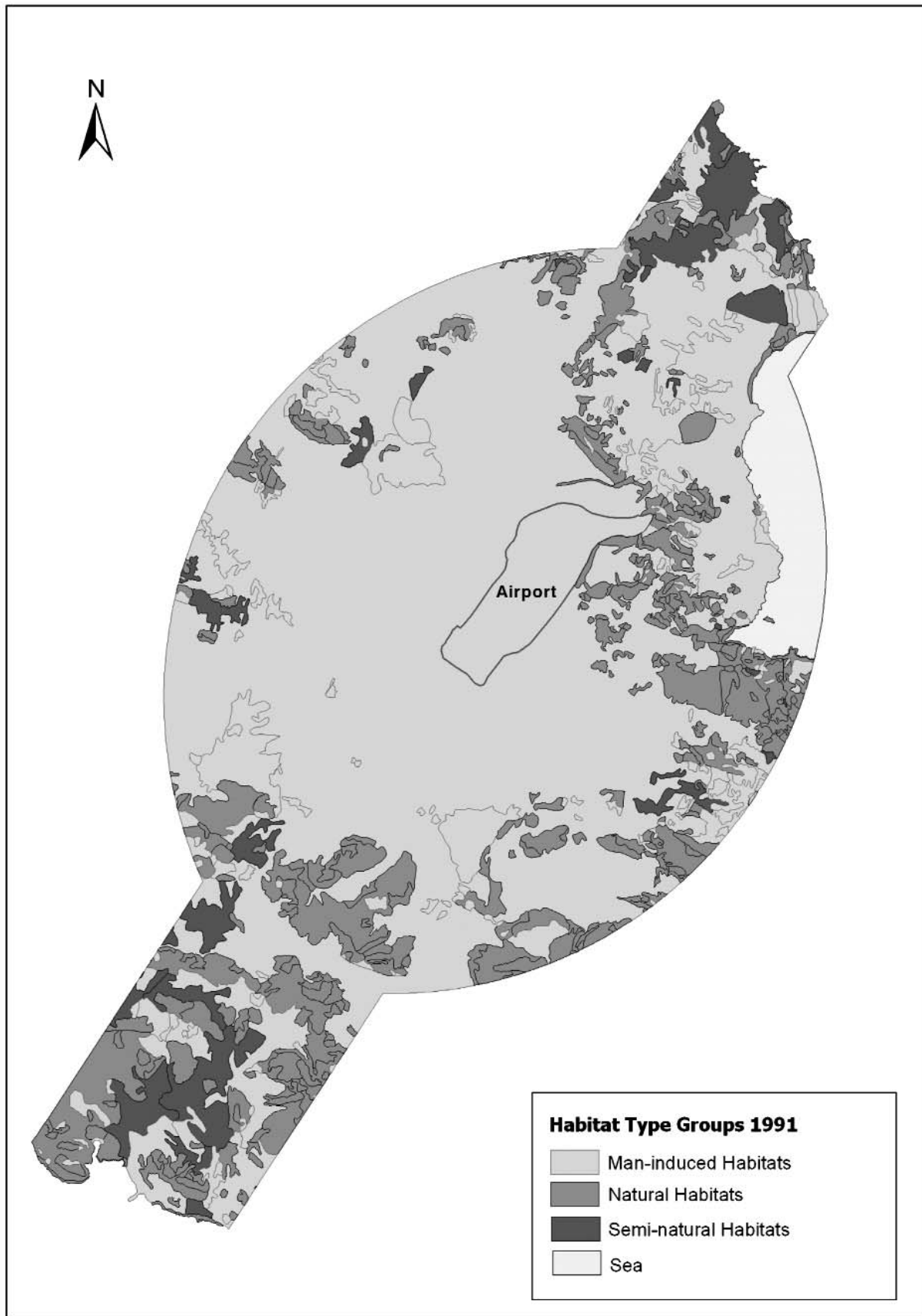


FIG. 2. Vegetation map of the three main habitat groups in 1991.



FIG. 3. Vegetation map of the three main habitat groups in 1999.

TABLE 3. Area covered by habitat types in two different time periods

Habitat type groups	1991 area (ha)	1999 area (ha)	Change (ha)
coastal and wetland	102.3	102.3	0.0
phrygana	791.1	797.5	+ 6.4
shrubs	2550.5	2702.0	+ 151.5
shrubs and pines	589.1	450.4	- 138.8
pine forest	914.2	846.8	- 67.4
Natural (total)	4947.2	4899.0	- 48.2
Semi-natural	422.9	309.9	- 113.0
Man-induced	19334.6	19495.8	+ 161.2

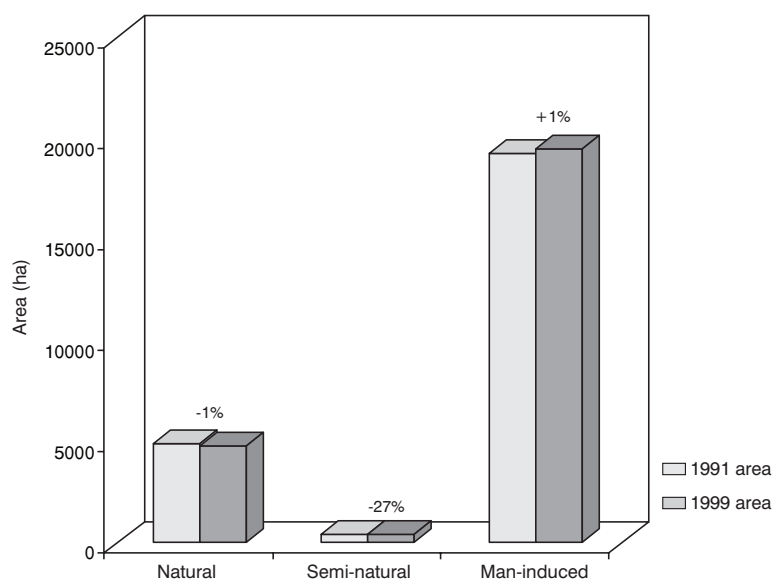


FIG. 4. Area covered by the three main habitat type groups.

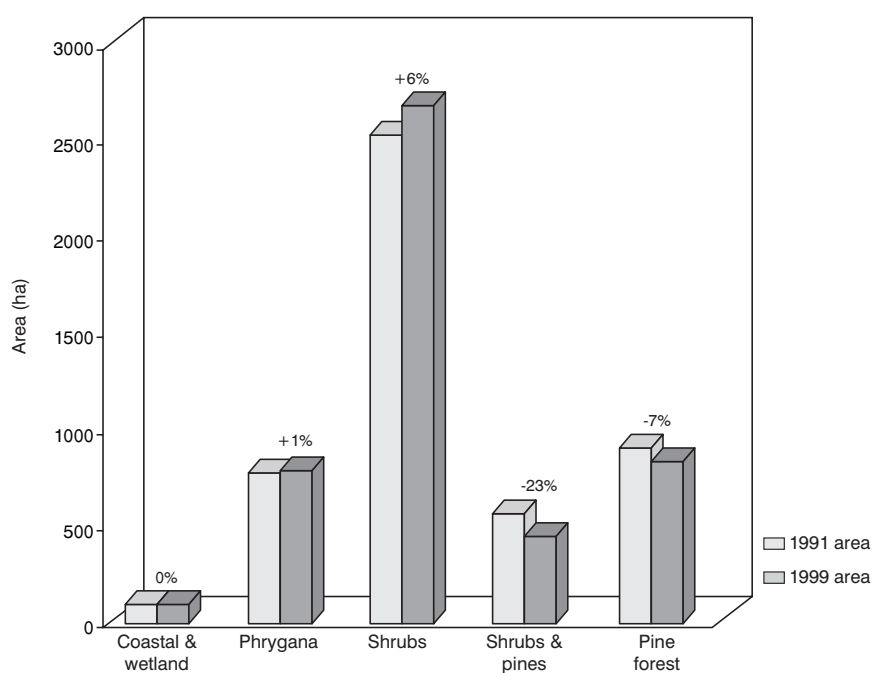


FIG. 5. Area covered by the five main natural habitat type groups.

ern side of the airport and is accompanied by the parallel increase of settlements. Pine stands are the most threatened natural habitat type because a big part of them is found in a radius of 200 m from the existing settlements. Vegetation mapping of the study area revealed the trend of changes and produced a baseline for future monitoring. This information is essential for the environmental protection and management of the Mesogaia area.

The construction of Athens International Airport begun in 1996 and the airport became operational in 2001. The establishment and operation of the airport in the Mesogaia area is expected to affect either directly or indirectly, through further changes in land uses, the various ecosystems of the area. A bio-monitoring program established since 1997 is monitoring for possible flora, and habitat deterioration within the zone of direct impact of the airport. In case such deterioration is detected, the appropriate resources will be studied in order to apply the proper mitigation and restoration measures. Based on the results obtained from the first survey (1997-1999) of the bio-monitoring process, a second survey is currently underway covering the period 2005-2007.

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