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Chapter 18
The Seascape as an Indicator of Environmental Interest and Quality of the Mediterranean Benthos: The *in Situ* Development of a Description Index: The LIMA

Sylvie Gobert, Aurélia Chéry, Alexandre Volpon, Corinne Pelaprat and Pierre Lejeune

Abstract The LIMA index conveys the environmental interest and quality of the landscape formed by the Mediterranean benthos, ranging from 0 to -40 m, in numerical format. The LIMA index allows a comparison spatially and temporarily between sites. It is a comprehensive index which is easy to implement and is composed of two factors: a topographical description (classification of 15 typologies) and a biological description (the presence or absence of some thirty species or groups of structuring, remarkable and invasive species). The LIMA index has been validated in the Bay of Calvi (Corsica-France) where it varies between 0.31 and 0.79 on a scale of 0.00–1.00.

Keywords Remarkable species · Invasive species · Benthos · Seagrass · Interest and quality index · Corsica

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18.1 Introduction

By definition, a landscape is the arrangement of features, characteristics, and forms of a limited space, it is a portion of territory with a marked identity, modeled by natural abiotic, biotic and anthropogenic factors. The ecology of the landscape studies the spatial and temporal variations, the communications, barriers and fragmentation of zones. Developed more than a century ago in the terrestrial environment, the ecology of landscapes makes it possible to contemplate the effect of planning and its consequences for pre-existing ecosystems.

In the marine environment, the coastal area has an ecological and economic importance which has been amply demonstrated (e.g. Costanza et al. 1997; Hughes et al. 2009), but it is subjected to important modifications due to human pressure (coastal development, urbanization, provision of excess nutrients, release of pollutants. . .) (Boudouresque 2004; Boudouresque et al. 2009).

Aware of this environmental pollution, the European Community is advocating sustainable exploitation of living resources and protection of biodiversity (www.agriculture.gov.lb/bio_div/tablebio.html, www1.environnement.gouv.fr/article; Aronson et al. 2002). Up to a certain threshold, biodiversity is in correlation with the richness of the environment (Gibson 1994): if this richness diminishes, mainly due to homogenization of the territory, scientists observe an erosion of the specific richness. It is therefore possible to link the environmental quality of an environment with its biological quality.

Corsica, with more than 1,000 km of coastline and a relatively moderate anthropization is a very favorable terrain for the implementation and creation of a reference tool whose aim is to assess the environmental richness and heritage species of the seabed.

The Lima is a regional program that was launched in 2000 by the Office of the Environment in Corsica, devoted to gaining knowledge of the nature and quality of the coastal areas of Corsica at depths of between 0–100 m (Guennoc et al. 2002). This is the context of the present study which was initiated by the agency Eau de Méditerranée Corse, the objective of which is the design of a simple rapid and easily reproducible methodology for the assessment of the attraction and rich heritage species of the Mediterranean benthos in the bathymetric zone from 0–40 m (Chery et al. 2006a, b).

18.2 Material and Methods

18.2.1 *Definition of the Sector to be Prospected*

Whether in the context of coastal management or the definition of the quality or temporal evolution of a site for scientific reasons, as soon as the sectors to be described have been determined, the bathymetry and sedimentology must be identified. This

Table 18.1 Color code and status of the sites according to the LIMA index

LIMA	Site status	Color code
0.800–1.000	Exceptional richness of species, exceptional site	Blue
0.600–0.799	High richness of species, rich site	Green
0.400–0.599	Average richness of species, attractive site	Yellow
0.200–0.399	Lower richness of species, site low in attraction	Orange
0.000–0.199	Low richness of species, unattractive site	Red

should make it possible to define the length and position (coordinates) of 3 radials to be analyzed in a homogenous zone that is representative of the sector to be explored.

The LIMA index makes it possible to describe sites in the bathymetric zone between the surface and 40 m in depth. However, the distance separating the coastline from the isobath -40 m varies from one site to another. Therefore all the radials that are in excess of 500 m are divided up into 4 transects of 150 m, distributed in such a way as to describe the deep area (from -40 m to the coastline), the area of -30 m (from the isobath to the coastline) the area of -20 m (from the isobath to the coastline), and the area of -10 m (from the isobath to the coastline). In the case where the distance separating the isobath -40 m from the coastline is less than 500 m, the totality of this distance is explored by the divers in order to define the LIMA index.

18.2.2 Data Recording and Calculation Procedures for the LIMA Index

The LIMA index is a comprehensive index calculated from topographical observations and observations on the presence or absence of some thirty species or groups of species of flora and fauna. These observations are carried out by 2 divers and do not involve counting or sample taking. The LIMA index is composed of two factors: a topographical description (TD) and a biological description (BD) of the radials carried out between the surface and 40 m in depth which is the area accessible to an autonomous diver.

$$\text{LIMA index} = (TD + BD)/2$$

All the data gathered during diving is then encoded in a file. The Topographical Description, the Biological Description and the overall LIMA index are then calculated. The LIMA index has values ranging from 0 to 1 and is divided into five classes (Table 18.1). From 0.000 to 0.199, the sector is described as "low in heritage species, unattractive site" (color red); from 0.200 to 0.399, the sector is described as "low in richness of heritage, low level of site attraction" (color orange); from 0.400 to 0.599, the sector is described as "average richness of heritage, attractive site (color yellow); from 0.600 to 0.799, the sector is described as "high in richness of heritage species, rich site (color green); from 0.800 to 1.000, is described as exceptional richness of heritage and exceptional site (Color blue).

Table 18.2 Notes attributed to the different typologies and associated numerical and color codes

Typology	Code	Note
Cavity, large overhang, cave	1	1.000
Sloping, rocky pinnacle, rocky peak	2	1.000
Mediterranean bio-constructed bottom (coralligenous)	3	0.900
Large rockfall	4	0.800
Wreck, artificial reef	5	0.750
Cave: small overhang, depression	6	0.750
Craggy rock colonized or not by macrophyta (magniolophyta, algae. . .)	7	0.700
Isolated rock	8	0.600
Small rockfall	9	0.500
Maerl	10	0.300
Extended sandy stretch colonized or not by macrophyta (magniolophyta, algae. . .)	11	0.250
Rock layer colonized or not by macrophyta (magniolophyta, algae. . .)	12	0.250
Dead matte	13	0.150
Sandy-muddy	14	0.100
Mud	15	0.000

18.2.2.1 Topographical Description (TD)

The diversity and nature of the seabed of a site have been classed and encoded into 15 different typologies; a value of 0 to 1 has been attributed to each typology according to its general structure on a synoptic scale (Table 18.2) (Pérès and Picard 1964; Palmisani 2002).

In a practical way, the TD of a site is calculated from the results of the observations of a diver carried out along the three radials. Each radial, which has a length L, graduated every 5 meters, is covered from a depth of 40 m to the surface and the diver notes the distance (d) while he observes the typology and the corresponding code (c). For each radial a TD is calcu[illegible]

$$\text{TDradial}=^{\Sigma} (\text{di}/\text{Lradial} * \text{ci})$$

The TD of a sector is the average of the TDs and the three radials explored in the zone:

$$\text{TDsector} = (\text{TDradial1} + \text{TDradial2} + \text{TDradial3})/3$$

18.2.2.2 Biological description (BD)

The biological description (BD) is based on 3 biological indicators: the R index: remarkable species, the I index: invasive species and the S index: structuring species.

$$\text{BD} = (\text{R} + \text{I} + 2\text{S})/4$$

Twenty-nine species or groups of species were taken into account to define the Biological Description. Some species or groups of species are rare or strictly limited

Table 18.3 Species or groups of species which are rare or limited to a particular bathymetric section

Macrophyta
Lithophyllum lichenoide
Magniolophytes
Cnidaria
Corallium rubrum
Mollusc
Patella ferruginea
Fish
Sciaena umbra
Labrus bimaculatus
Shoal
Particular seabed
Coralligenous habitat
Maërl

to a particular bathymetric section, the Biological Description of a sector is therefore directly correlated to their presence along a radial (Table 18.3). Other species or groups of species have a large bathymetric distribution, the Biological Description of the sector is directly proportional to the colonized surface and therefore to the number of times they are listed across the entire radial which is divided into portions [AQ1] of 50 m (Table 18.4).

For those species that are rare or strictly limited to a bathymetric section, the diver notes the presence (or absence) of species or groups of species across the entire radial. A value (v) of 0 or 2 which corresponds to the absence 0 or the presence (2) across the entire radial is attributed. On the other hand, for the species or groups of species which have a large bathymetric distribution, their presence or absence is noted for each portion of 50 m, a value of 0, 1, or 2 is attributed by comparing the frequency of their presence (Σ of presence for the portions i of 50 m/ the number i of the portion of 50 m) with the expected frequency (Table 18.4). This method is applied to all the species or groups of species for the indexes (R and S) in which they occur.

The remarkable species: the R index. The remarkable species considered for the biological description are, on one hand, those that benefit from local legal protection regionally or in the administrative departments, nationally by means of decrees or laws or internationally by means of conventions (Berne, Bonn, Barcelona); and on the other hand, species which are not protected but considered to be regressing or species considered to be vulnerable (Bellan-Santini et al. 1994; Harmelin 1991; Lejeusne et al. 2010; Malak et al. 2011) (Table 18.5). Eleven species or groups of species were considered.

For each radial, the value (v) attributed to each species or group of species is the same as that described above. These values are integrated into the following equation to calculate the R index for remarkable species:

$$R =_{\Sigma} \text{v}\textit{Cystoseira sp} + \text{v}\textit{L. byssoides} + \text{vMagnioliophytes} + \text{v}\textit{Corallium rubrum} + \text{v}\textit{Cladocora sp.} + \text{v}\textit{Patella ferruginea} + \text{vPinna sp.} + \text{n}\textit{Palinurus elephas} + \text{v}\textit{Epinephelus marginatus} + \text{v}\textit{Sciaena umbra} + \text{v}\textit{Labrus bimaculatus}/22$$

Table 18.4 Species or groups of species with a large bathymetric distribution. Expected presence levels

	Zero presence (%)	Average presence (%)	High frequency (%)
Macrophyta			
Cystoseira sp	0.00–0.99	1.00–32.99	≤ 33.00
Caulerpa prolifera	0.00–0.99	1.00–24.99	≤ 25.00
Caulerpa racemosa	0.00–0.99	1.00–32.99	≤ 33.00
Caulerpa taxifolia	0.00–0.99	1.00–32.99	≤ 33.00
Nematochrysopsis	0.00–0.99	1.00–32.99	≤ 33.00
Polysiphonia	0.00–0.99	1.00–32.99	≤ 33.00
Sponges			
Axinella sp	0.00–0.99	1.00–32.99	≤ 33.00
Other sponges	0.00–0.99	1.00–49.99	≤ 50.00
Bryozoa			
Erect bryozoan	0.00–0.99	1.00–32.99	≤ 33.00
Cnidaria			
Cladocora sp.	0.00–0.99	1.00–14.99	≤ 15.00
Eunicella cavolini	0.00–0.99	1.00–32.99	≤ 33.00
Eunicella singularis	0.00–0.99	1.00–14.99	≤ 15.00
Paramuricea clavata	0.00–0.99	1.00–24.99	≤ 25.00
Parazoanthus axinella	0.00–0.99	1.00–49.99	≤ 50.00
Pennatularia	0.00–0.99	1.00–09.99	≤ 10.00
Worms			
Salmacina sp or.Filograna sp.	0.00–0.99	1.00–24.99	≤ 25.00
Fan worms	0.00–0.99	1.00–66.99	≤ 67.00
Molluscs			
Pinna sp.	0.00–0.99	1.00–19.99	≤ 20.00
Crustaceans			
Palinurus elephas	0.00–0.99	1.00–24.99	≤ 25.00
Fishes			
Epinephelus sp.	0.00–0.99	1.00–32.99	≤ 33.00

The R index of a site is the average of the R indexes of the 3 radials carried out in the sector:

$$\text{Rsector} = (\text{Rradial1} + \text{Rradial2} + \text{Rradial3})/3$$

The invasive species index I, for the invasive species is calculated by noting the presence of Caulerpa (ex: *C. taxifolia*, *C. racemosa*) (Belsher and Meinesz 1995; Boudouresque and Verlaque 2002), filamentous algae (Nematochrysopsis sp. of the Chrysophyceae family): opportunistic and invasive species, and carpets of Polysiphonia sp: algae with a nitrophilous tendency which proliferate on all types of substratum for longer and longer periods and enter into competition with the benthic species present (Hoffman et al. 2000) (Table 18.6). The I index is calculated by integrating the values into the fol[illegible]g equ[illegible]

$$I = \Sigma\, v\mathit{Caulerpataxifolia} + v\mathit{Caulerparacemosa} + v\mathit{Nematochrysopsis} + v\mathit{Polysiphonia}/8$$

Table 18.5 List of species or groups of species taken into account for calculation of the R index: remarkable species.—: box to be ticked by the diver according to the presence P or absence A of the species or group of species observed overall or for a portion of the transect

	Total		Portion 1		Portion 2		Portion X	
	Transect		50 m		50 m		50 m	
	P	A	P	A	P	A	P	A
Macrophyta								
Cystoseira sp			–	–	–	–	–	–
Lithophyllum byssoides		–						
Magniolophyta		–						
Cnidaria								
Cladocora sp.			–	–	–	–	–	–
Corallium rubrum	–	–						
Molluscs								
Patella ferruginea	–	–						
Pinna sp.			–	–	–	–	–	–
Crustaceans								
Palinurus elephas			–	–	–	–	–	–
Fish								
Sciaena umbra	–	–						
Epinephelus sp.			–	–	–	–	–	–
Labrus bimaculatus	–	–						

Table 18.6 List of species or group of species taken into account for calculation of the I index: invasive species.—: box to be ticked by the diver according to the presence P or the absence A of the species or group of species observed over a portion of the transect

	Portion 1		Portion 2		Portion	
	50 m		50 m		X. . .	
	P	A	P	A		
Caulerpa taxifolia	–	–	–	–	–	–
Caulerpa racemosa	–	–	–	–	–	–
Nematochrysopsis	–	–	–	–	–	–
Polysiphonia	–	–	–	–	–	–

The I index of a sector is the average of the I indexes of the three radials carried out in the sector:

$$\text{Isector} = (\text{Rradial1} + \text{Rradial2} + \text{Rradial3})/3$$

The structuring species the S index.

The structuring species enrich the three-dimensional structure, supply a vast range of tints or fill the water column. Nineteen species or groups of species were considered, including plants, sponges, cnidaria, bryozoa, worms, molluscs, fish and particular seabed species like Maerl and corraligenous habitat (Table 18.7).

Table 18.7 List of species or group of species taken into account for calculation of the S index: structuring species.—: box to be ticked by the diver according to the presence P or the absence A of the species or group of species observed in total or for a portion of the transect

	Total Transect		Portion 1 50 m		Portion 2 50 m		Portion X 50 m	
	P	A	P	A	P	A	P	A
Macrophyta								
Cystoseira sp			–	–	–	–	–	–
Lithophyllum byssoides		–						
Caulerpa prolifera			–	–	–	–	–	–
Magniolophyta	–	–						
Sea sponges								
Axinella sp.			–	–	–	–	–	–
Large sponges			–	–	–	–	–	–
Cnidaria								
Cladocora sp.			–	–	–	–	–	–
Eunicella cavolini			–	–	–	–	–	–
Eunicella stricta			–	–	–	–	–	–
Paramuricea clavata			–	–	–	–	–	–
Parazoanthus axinella			–	–	–	–	–	–
Pennatularia			–	–	–	–	–	–
Bryozoa								
Erect bryozoa			–	–	–	–	–	–
Worms								
Salmacina sp. Filograna sp.			–	–	–	–	–	–
Fan worm			–	–	–	–	–	–
Molluscs								
Pinna sp.			–	–	–	–	–	–
Fish								
Shoal	–	–						
Particular seabeds								
Coralligeous habitat	–	–						
Maerl	–	–						

As well as the information gathered for these 19 species, the gorgonian populations of *Paramuricea clavata,* typical of the rocky mediterranean seabed, are described based on the presence of dead colonies.

The value v, calculated for *Paramuricea clavata* according to its presence/absence per zone of 50 m, is multiplied by 1 if the average number of colonies encountered is higher than 70 cm and if they carry small quantities of necrosis (estimated to be less than 10 %). The value v is multiplied by 0.5, if the average for the colonies encountered is smaller than 20 cm and if they have a large quantity of necrosis (estimated to be higher than 75 %). The value v is multiplied by 0.75 in intermediate cases.

The *Paramuricea clav*[illegible]alue, along a transect composed of the portion (i) of 50 m, $vParamuricea_{clavata}$ is equal to Σ (0 or 2 for each portion $i_{(50\,m)}$)/i 50 m * (1, 0.5 or 0.75).

The S index is calculated by integrating the values into the following equation:

$$S = \sum \begin{array}{l} n\textit{Cystoseira}\ \mathrm{sp} + n\textit{L. byssoides} + n\textit{Caulerpa prolifera} \\ + n\mathrm{Magniolophytes} + n\mathrm{Axinella}\ \textit{sp} + n\mathrm{large\ sponge} + n\textit{Cladocora sp}. \\ + n\textit{Eunicella stricta} + n\textit{Eunicella cavolini} + N\textit{Paramuricea clavata} + \\ n\textit{Parazoanthus axinella} + n\mathrm{Pennatul\ aires} + n\mathrm{erected\ Bryozoa} \\ + n\textit{Salmacina sp}\ \mathrm{and}\ \textit{Filograba sp} + n\mathrm{Fan\ worm} + n\ \textit{Pinna sp}. \\ + n\mathrm{shoalof\ fish} + n\mathrm{Coralligenous\ habitat} + n\mathrm{Maërl}/38 \end{array}$$

The S index for a sector is the average of the S indexes for the three radials explored in the zone:

$$\mathrm{Ssector} = (\mathrm{Sradial1} + \mathrm{Sradial2} + \mathrm{Sradial3})/3$$

18.2.3 Experimentation and Validation of the LIMA Index

The LIMA index was tested and validated in the Bay of Calvi (Corsica-France) (Fig. 18.1) between May and September 2005. This zone has been well studied since 1970 by numerous researchers for the abiotic parameters (e.g. salinity, temperature, nutritive salt content. . .) (Vrancken 1999; Gobert 2002; Lepoint et al. 2004) for the biotic parameters: the gorgonians (Weinbauer and Velimirov 1995; Weinbauer and Velimirov 1996), the seagrasses *Posidonia oceanica* (Gobert 2002), the algal populations (Coppejans and Boudouresque 1983; Demoulin et al. 1980; Demoulin 1987), and the fish populations (Bussers et al. 1976; Lejeune 1984; Pelaprat 2000). . .

Between Punta Revellata and Punta Spano, eight sectors were selected in the Bay of Calvi: Punta Revellata, STARESO, Bibliothèque, Pointe St François, Calvi beach, Punta Caldanu, Bay of Algajo and Punta Spano (Fig. 18.1) and 3 radials per sector representing 24 radials in total were positioned and their lengths were assessed (Table 18.7). The 24 radials were divided into two groups (Table 18.7): the radials lower than 500 m (10 radials) and the radials higher than 500 m in length (14 radials) were described in accordance with the protocol which allows for 4 sections of 150 m, distributed according to the bathymetry (cf. Definition of the sector to be prospected).

18.3 Results—Discussions

Table 18.8 presents the results of the topographical description (TD), the biological description (BD, I, R, and S) and the overall LIMA index for the eight sectors studied in the Bay of Calvi.

In the Bay of Calvi, the LIMA index varies between 0.31 and 0.79 corresponding to sites described as having a low level of richness of heritage species and as low attraction sites (orange) and sites described as having a high level of richness of

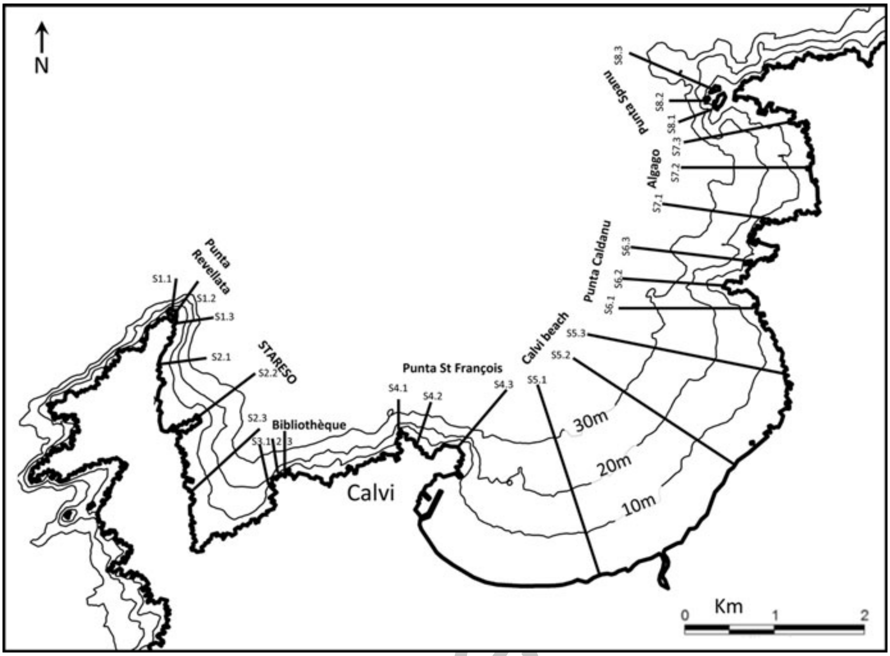

Fig. 18.1 Presentation of the eight sectors prospected in the Bay of Calvi (Corsica) for testing and validating the LIMA index: Punta Revellata (Sector 1), STARESO (Sector 2), Bibliothèque (Sector 3), Punta St François (Sector 4), Calvi beach (Sector 5), Punta Caldanu (Sector 6), Algajo of (Sector 7) and Punta Spano (Sector 8) (24 radials: 3 per sector)

heritage species and as rich sites (green) respectively. A sector is classed as having a high level of richness of heritage species and as a rich site (green class); 4 sites are classed as having an average level of richness of heritage species and as attractive sites (yellow class) and 3 sectors are classed as having low levels of richness of heritage species and as unattractive sites (orange class).

The topographical quality (Table 18.8) varies between 0.25 (Calvi beach sector, radial 1) and 0.92 (Punta Revellata sector, radial 1). The Calvi beach sector is a large covered sandy stretch covered by magniolophyta in certain places. On the other hand, the Punta Revellata sector is an uneven and rocky zone (presence of cavities, overhangs, slopes. . .). This sector of the bay is particularly frequented by sport divers. The detailed results of the Biological Description of radial 1 of the Punta Revellata sector are presented in Table 18.9. Species belonging to remarkable genuses like *Cystoseira, Epinephelus and Palinurus* are frequent there. The colonies of *Eunicella* and *Parazoanthus* colonise the slopes and overhangs and make this sector rich and attractive.

The biological quality varies between 0.21 (S), 0.09 ®, 0.50 (I) for the Calvi beach and STARESO sectors 0.67 (S), 0.81 ®, 1.00 (I) for the sectors of Punta Revellata, Bay of Algago and Punta Spano.

Table 18.8 Lengths, Topographical and biological descriptions (Structuring, remarkable and invasive species) for the 24 respective radials of the eight sectors of the Bay of Calvi. Values and color codes (*B: Blauw, O: Orange, Y: Yellow*) of the LIMA index for each radial and for each sector

Sector	Radial (m)	TD	BD		LIMA		
			S	R	E	Radial	Sector
Punta Revellata	1 (197)	0.86	0.61	0.72	1.00	0.78	
	2 (222)	0.92	0.67	0.81	1.00	0.83	*0.79*
	3 (250)	0.84	0.57	0.41	0.75	0.67	*B*
STARESO	1 (390)	0.28	0.24	0.27	1.00	0.36	
	2 (610)	0.33	0.47	0.32	0.63	0.40	*0.33*
	3 (1410)	0.21	0.16	0.15	0.50	0.22	*O*
Bibliothèque	1 (480)	0.32	0.39	0.23	0.75	0.38	
	2 (480)	0.33	0.39	0.36	0.75	0.40	*0.39*
	3 (440)	0.31	0.50	0.32	0.63	0.49	*O*
Pointe St François	1 (280)	0.43	0.58	0.32	0.75	0.44	
	2 (540)	0.35	0.49	0.41	0.63	0.43	*0.44*
	3 (770)	0.35	0.37	0.32	0.63	0.39	*Y*
Plage de	1 (2330)	0.25	0.21	0.09	0.75	0.28	
Calvi	2 (2440)	0.26	0.24	0.09	0.88	0.31	*0.31*
	3 (2520)	0.26	0.24	0.23	0.88	0.32	*O*
Punta	1 (1430)	0.32	0.34	0.23	0.75	0.37	
Caldanu	2 (1630)	0.40	0.47	0.32	0.88	0.47	*0.42*
	3 (1630)	0.36	0.45	0.36	0.75	0.43	*Y*
Baie d'Algago	1 (1160)	0.33	0.50	0.36	1.00	0.46	
	2 (1410)	0.33	0.36	0.27	0.88	0.40	*0.42*
	3 (1160)	0.43	0.47	0.18	0.88	0.46	*Y*
	1 (420)	0.34	0.47	0.32	1.00	0.45	
Punta Spano	2 (490)	0.60	0.47	0.23	0.88	0.55	*0.55*
	3 (1200)	0.63	0.63	0.45	0.88	0.64	*Y*

The classification of the eight sectors of Calvi bay given by the comprehensive LIMA index corresponds to the attraction represented by these sites for experienced sports divers with maximal frequentation at the Pointe de La Revellata and Spano, these same divers, who are used to the Mediterranean coastline, describe sites that are even more attractive in other zones like the area around the Scandola reserve. Access to this reserve would probably result in the highest LIMA classification: an exceptional level of richness of heritage and an exceptional site.

On the rocky substrates (Punta Revellata, Bibliothèque, Pointe St François, Punta Caldanu, Algago bay and Punta Spano sectors), the biological classification given by the BD index reflects the diversity of results obtained by the scientists of different disciplines: ichthyology, algology, zoology (Janssens et al. 1993). On the other hand, the 2 sectors like STARESO and Calvi beach are sandy and are largely colonized by seagrasses (*Oceanica, C. nodosa*). These grasses are, on first appearance monotonous and not very rich but they are recognized as having a high ecological and economic importance. The LIMA index does not make it possible to describe the magniolophyta. In this type of area, indexes such as PREI (Posidonia Rapid Easy

Table 18.9 Detailed results of radial 1 of sector 1 (L = 197 m) and radial 3 of sector 8 (L = 1200 m)

Punta Revellata Radial 1, Sector 1 (197 m)	Transect total P	A	Portion 1 50 m P	A	Portion 2 50 m P	A	Portion 3 50 m P	A	Portion 4 50 m P	A	Transect value
Cystoseira sp			X		X		X		X		2
Lithophyllum lichenoide	X										2
Magniolophytes		X									0
Cladocora sp.				X		X		X		X	0
Corallium rubrum	X										2
Centrostephanus longispinus		X									0
Patella ferruginea	X										2
Pinna sp.				X		X		X		X	0
Homarus gammarus		X									0
Palinurus elephas					X						2
Scyllarides latus		X									0
Sciaena umbra	X										2
Epinephelus sp.				X	X		X		X		2
Hippocampus sp.		X									0
Labrus bimaculatus		X									0
Caulerpa taxifolia				X		X		X		X	2
Caulerpa racemosa				X		X		X		X	2
Nematochrysopsis				X		X		X		X	2
Polysiphonia				X		X		X		X	2
Cystoseira sp			X			X	X		X		2
Lithophyllum lichenoide	X										2
Caulerpa prolifera				X		X		X		X	0
Magniolophytes		X									2
Axinella sp.			X		X			X		X	2
Large sponges			X			X		X		X	1
Cladocora sp.				X		X		X		X	0
Eunicella cavolini				X	X		X			X	2
Eunicella stricta											0
Paramuricea clavata			X		X		X			X	2
Parazoanthus axinella				X		X		X		X	0
Pennatularia				X		X		X		X	0
Bryozoria			X		X		X		X		2
Salmacina sp.Filograna sp.			X		X			X		X	2
Fab worm					X		X		X		2
Pinna sp.				X		X		X		X	0
Shoal	X										2
Coralligenous habitat		X									2
Maërl		X									2

Index) which describe the state of a given seagrass in a mass of water already exist (Gobert et al. 2009), and are more adapted to the task.

For some years, the accumulated consequences of climate change and anthropic activity have been visible in Corsica and the Bay of Calvi. The gorgonian populations died in massive numbers from 1989 to 2003 but the dynamics of the species has made it possible to recolonize the zone (Poulicek et al. 2007a, 2007b) and the degraded populations which appeared in 2005 are once again actively colonizing.

On the other hand, *Caulerpa racemosa*, which is an invasive species, has appeared in the bay since 2008 (Cariou et al. 2013). The processing of data which is still in progress shows that the LIMA index conveyed these developments between 2005 and 2011; the sector of La Revellata dropped one class to yellow (average level of richness of heritage species and attractive site) due to this species.

The LIMA index conveys the environmental attraction and the richness of heritage species in a defined zone of the Mediterrannean benthos between 0 and – 40 m. The LIMA index makes possible a spatial comparison of the sites and could even demonstrate the temporal evolution of these sites; it could therefore help not only scientists to characterize an ecosystem, but could also help management authorities in their decisions concerning the protection and management of the territory. This comprehensive index which has been validated in the Bay of Calvi, is easy to implement, it could be complemented by other indexes such as the "Fish" index (Payrot 2010) and the ICAR (*Caulerpa racemosa*) (Cariou et al. 2013).

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