

Coastal scenic assessment in northern France: a useful tool for characterization and conservation of most attractive sites following the Conservatoire du littoral management approach

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Abstract

“Buy to protect”: this may be the *Conservatoire du Littoral* philosophy. Since 1975, this unique public French institution endeavours to acquire vulnerable and threatened coastal areas of great natural relevance to ensure their permanent and sound management/protection by establishing conventions with local authorities. This paper is focused on (i) the research of remarkable attractive natural sites not (or only slightly) affected by human intrusions, (ii) the analysis of the *Conservatoire* policies related to landscape issues and (iii) the proposal of judicious measures to assess/maintain/enhance/monitor landscape quality. For such proposals, the Coastal Scenic Evaluation System (CSES) method was *in situ* applied along the northern French coast, from Belgium to the Seine estuary. This area, shaped in a macrotidal environment, was chosen as it exhibits a wide variety of scenery composed of majestic dunes complexes, estuaries, bays and impressive cliff formations, alongside a strong cultural heritage. It also includes some world-renowned sites such as Les Deux Caps (Gris-Nez and Blanc-Nez), the Somme Bay and the cliffs of Étretat. CSES is a strong accurate indicator of scenic quality based on 26 physical and human parameters, and fuzzy-logic mathematics to overcome subjectivity and quantify uncertainties. As a result, an evaluation index (D) is obtained, enabling to classify sites into five distinct classes, from Class I (outstanding quality) to Class V (very poor quality). In this paper, 16 sectors respectively located along the Côte d’Opale (8), Côte Picarde (4) and Côte d’Albâtre (4) were selected after a long process of field testing. Seven were included in Class I, five in Class II and four in Class III. Finally, suggestions were made to complete the remarkable labour done by the *Conservatoire*.

1. Introduction

During the last centuries, the coastal zone has represented an attractive and valuable settlement area for humans due to its strategic location, favourable climate and large quantity of resources (Rick and Fitzpatrick 2012; Ford 2011). Earliest coastal settlements were essentially devoted to agriculture and, therefore located on coastal plains and deltas, and secondarily to fishing and shellfish harvesting (Erlandson and Fitzpatrick 2006). As civilization advanced and population grew, coastal areas progressively became a strategic region essentially because of the development of maritime commerce that favoured port emplacement and associated infrastructures and settlements (Griggs 2017). In the 17th century, started the recreational use of the coastal environment (Corbin 1993), in France, as in the rest of Europe (Pranzini and Williams 2013), only a few well-established coastal localities existed (Anthony and Sabatier 2012). It was in the 20th century when a wider part of the European population reached an economic level that allowed people to travel for holidays far from their homes, and beaches came to be considered places of rest and relaxation (Rubio 2005). In France, a further enhancement of coastal tourism took place after the World War II (WWII), giving way to a new era that transformed coastal areas into places of strong economic value (Houston 2013).

The above brought an increase in coastal population and tourism, according to an incessant and unsustainable feedback process. High-rise hotels and apartments were built en masse to accommodate seasonal visitors and promenades often replaced areas occupied by traditional fishing boats and small fishing-related infrastructures (Griggs 2017). About 40% of the present global population is living within 100 km from the shoreline (CIESIN 2012). This trend is expected to rise as predictions suggest an increase of population living in low elevation coastal zones (< 10m) from 625 million (in 2000) up to 949 and 1388 million people in 2030 and 2060, respectively (Neuman et al. 2015). By 2040, the French coast is expected to increase its population by 4.5 million inhabitants (MTE 2022).

Travel and tourism represents one of the world’s biggest industries (UNWTO 2020). Before of the Sars-Covid-19 pandemic impact, which produced disruption globally to people, businesses and economies, tourist arrivals have been continuously growing on the world scale, e.g., in the 2009–2019 period, real growth in international tourism receipts (54%) exceeded growth in world Gross Domestic Product (GDP, 44%). In 2019, total tourist arrivals were 1.46 billion and international tourism receipts US\$ 1,481 billion, which respectively corresponded to an increase of +4% and +3% respect to 2018 (UNWTO 2020). In 2018, France was the world’s top tourism destination (with 89.4 million arrivals) and the third destination by international tourism incomes (US\$ 66 billion), which contributed to 7% of its GDP (UNWTO 2020). The coast is the first tourist destination in France (MEFR 2021). In 2018, 39% of overnight stays during summer were recorded at coastal destinations, i.e., 121.8 million nights, with the Mediterranean coast being the most popular (INSEE 2019). Tourism is also relevant along the southern Atlantic coast as well as the northern littoral and, particularly, the Bay of Somme (Gauche 2017). It constitutes 55% to the Blue economy jobs and 52% of the Gross Value Added (EC 2020).

Today, tourism industry represents a complex activity, which shows a diversity of cultural, social, environmental and physical aspects. Increased tourism favours economic development and activities that can give rise to negative impacts on coastal sustainability. Such impacts are often larger than the benefits that tourism brings (UNEP/MAP/PAP 2008; Holzner 2011; Zielinski et al. 2021): tourism developments are accompanied by decisions essentially based on financial criteria and no relevance is attributed to coastal environmental preservation and sustainability. According to Lenceck and Bosker (1998), Defeo et al. (2007), Hughes and Duchain (2011), Pilkey and Cooper (2014), actions on coastal areas are only carried out when it is mandatory to reduce adverse effects that threaten economic profit and, in most cases, actions are taken following an action/reaction criteria (Rangel-Buitrago and Anfuso 2015) and not on economic considerations based on a sound cost–benefit analysis approach (Cooper and McKenna 2008). Today, infrastructures and activities related to human developments affect an extremely strategic asset—coastal scenery. Coastal landscapes can be described as a littoral area, as perceived by humans, which is the result from the multiple natural and human factors interactions (Council of Europe 2000). Scenery, which is the focus of this paper, together with safety, facilities, water quality and no litter represent the five parameters of the greatest significance to coastal visitors (Williams 2011). The invaluable relevance of coastal scenery to society is reflected by the large number of existing protection status areas, e.g., National Parks, Heritage Coasts, Wilderness Areas, Protected Landscapes and Areas of Outstanding Natural Beauty. Unfortunately, despite the existence of the above-mentioned features, scenic degradation globally concerns many coasts as barely 15% of global coastlines remains ecologically undamaged/intact (Williams et al. 2021) and natural coastal sceneries can be recognised as critically endangered (Pilker and Cooper 2014).

This paper aims to i) identify the most attractive scenic sites of the northern French coast by analysing their physical and human components using the Coastal Scenic Evaluation System (CSES) method (Ergin et al. 2004, 2006, 2019), ii) analyse the role on coastal scenic beauty preservation of the *Conservatoire du Littoral* (CdL, Coastal Conservation Trust or Coastal Protection Agency in English), strongly present along the study area and, in general, in

undeveloped French coastal sectors, and iii) eventually suggest judicious measures to maintain/enhance/monitor scenic quality within determined areas. Emphasis was given to the *Conservatoire* as it is a unique public institution committed to protect vulnerable coastal (and lakeshore) areas of great environmental relevance by purchasing strategies. Its management approach is firmly devoted to preserve and enhance natural beauty of coastal sceneries and this is focus of this paper.

2. Study Area

The investigated coastline extends ca. 350 km in length from the France-Belgium border to the Seine estuary (INSEE 2015). This macrotidal coast (spring tidal range is 8–10 meters), bordered by the English Channel and North Sea, includes the Côte d'Albâtre (130 km in length), Côte Picarde (70 km) and Côte d'Opale (150 km) (INSEE 2015). It presents a remarkable variety of geomorphological features and coastal scenery varying from low-lying areas, dunes, cliffs, estuaries and bays, amongst others. Cliffs, essentially constituted by chalk, are mainly present along the Côte d'Albâtre and well symbolised by the world-famous geological features of Etretat (cf Results), which shows arches, stacks, etc. immortalised by many famous artists, e.g., Monet, Delacroix and Courbet (points 14–16; Fig. 1). The Côte d'Opale and Côte Picarde boast sand and pebble beaches, spectacular dunes system such as the Flanders dunes (point 1 in Fig. 1), Dunes d'Ecault (8) or Marquenterre (10), wetlands and estuaries, e.g., Platier d'Oye (2), Le Touquet (8) and Baie d'Authie (9), as well as cliffs sectors composed of marls, clays and limestones (points 3,5,12; Fig. 1). Two emblematic sites of international frame were labelled as *Grand Site de France*: Les Deux Caps, referring to Cap Blanc-Nez and Cap Gris-Nez (3–6); and the Bay of Somme (11, Fig. 1). Today, the *Conservatoire du Littoral* (CdL) protects 39 sites that occupy 8,000 ha, corresponding to 27% of the Hauts-de-France coastline (CdL 2021a).

Regarding human activities, this region is well-known for its strong shipping industry with its four major ports: Dunkirk (national port for rail freight), Calais (national passenger port), Le Havre (the second national largest seaport for goods), and Boulogne-sur-Mer (fishing and seafood processing) (MTE 2021). The tourism industry represents 4% of the Côte d'Opale economy (*Pôle Métropolitain de la Côte d'Opale* in French) and hosts more than 300,000 tourist beds, i.e., almost 50% of Hauts-de-France region capacity (INSEE Hauts-de-France 2021). Since the end of the 19th century, the Côte d'Opale and Côte Picarde have seen the establishment of numerous seaside towns benefiting due to their proximity to Paris. The successive widespread use of cars for traveling, the improvement of transport infrastructures, etc., moved tourism to the Mediterranean coast, slowing down tourism growth of northern coastal regions of France.

Actually, among the most famous northern French destinations are Le Touquet-Paris plage, Hardelot, Merlimont, Wissant, Le Crotoy or Mers les Bains. Seaside resorts along the Côte d'Albâtre frequently stand at the mouth of broad valleys, shaped between the chalk cliffs, e.g., Le Tréport, Dieppe, Fécamp and Etretat; most of them were ancient fishing village. At Côte d'Opale and Côte Picarde, tourism employs around 10,000 jobs per month, i.e., 3.9% of total employments (regional average is 2.4%); whilst, at Côte d'Albâtre, tourism generates nearly 5,000 jobs/month (INSEE 2015). With 10 million visits in summer, its high seasonality is associated with its climate categorised as “Temperate oceanic” (Cfb; Köppen classification) (Kottek et al. 2006). An incessant growth in popularity has been recorded in the past twenty years, i.e., an 8.9% rise between 2018 and 2019 in Haut-de-France (INSEE 2015, 2019).

Lastly, a strong cultural heritage, essentially linked to remains of the WWII, is observed along the coast of these two regions. Ruins of blockhouses, one time located on dunes, are nowadays on the shore, this clearly reflecting shoreline retreat in the last decades. Places such Baie de Wissant (point 4; Fig. 1) experienced > 100 m retreat between 1963 and 2000 (Aernouts and Héquette 2006; Chaverot 2006). At Bois de Cise (point 12; Fig. 1), cliffs are retreating at a rate > 0.50 m/yr (Pannet et al. 2014).

3. Method

Coastal scenic characteristics were field-tested at 16 sites by applying the well-known “Coastal Scenic Evaluation System” (CSES), published in British Council Reports (BCR 2003, 2004), Ergin et al. (2004, 2006) and Rangel-Buitrago (2019), formulated from a pilot idea by Morgan and Williams (1995). The CSES methodology was formulated by expert and trained groups on coastal geomorphology and management via a public survey evaluation process to establish the best/ugliest coastal scenery. In a preliminary step (BCR 2003), a large list of scenic parameters was selected by literature surveys, interviews and consultancy with coastal experts, professionals and academicians and > 1000 questionnaires to beach users, chosen by random number tables at selected 57 sites in Croatia, Malta, Turkey and UK. Assessment results allowed to select the number of times a parameter was marked, and the answers pointed out 26 “coastal scenic assessment parameters”, 18 physical and 8 human (Table 1). Successively, > 500 beach interviews were undertaken in the same countries to give a score to each one of the 26 parameters obtained during the first round of surveys. This enabled the establishment of a weight for each parameter, i.e., not all parameters had the same value. After that, each parameter was ranked from low (1), i.e., absence/poor quality, to high (5), i.e., excellent/outstanding quality.

A mathematical model based on Fuzzy Logic Approach (FLA) (Patel 2002) was developed to reduce the possibility of the scenic value assessor marking the wrong attribute box in the 26 parameters checklist, e.g., cliff slope can be < 45° (rated 1), 45–60° (rated 2), 60–75° (3), 75–85° (4) or *circa* vertical (5) (Table 1). The FLA allows overcoming the problem, e.g., a cliff slope being recorded in the 75–85° box (4) when, in reality, it is *circa* vertical (5). The method is explained in detail by Ergin (2019).

Once the checklist is filled, results are graphically shown as histograms, weighted average of attributes and membership degree of attributes (Ergin 2019). A visual summary of scores of physical and human parameters is represented by histogram figures that easily assess high/low rated attributes. Membership degree vs. attribute curve corresponds to overall scenic assessment over the attributes, and weighted averages of attributes define relative assessment of physical and human parameters. Based on summed parameter evaluations, a final “D” score is computed, which divides sites into five distinct classes, from Class I (extremely attractive natural sites) to Class V (very unattractive, intensively developed urban sites).

The CSES method was successfully tested in many field-studies carried out in numerous countries →30, see Anfuso et al. (2019) for a detailed description of > 1000 global study cases. It provides an evidence-based approach for sound coastal management decisions since it gives not only an objective evaluation

of the physical but also of human parameters (unattractive urbanization, intensive and not environmental friendly developments, presence of litter, etc.). Therefore, CSES also points out how scenic parameters may be improved by sound management actions – especially human parameters because it is not easy to improve natural ones.

The focus of this paper is research on the top scenic sites lying in Class I ($D \geq 0.85$) and Class II ($0.65 \leq D < 0.85$), with null or very low level of human influence, and essentially located in remote areas. For a few reasons (further discussed), this study also includes a few Class III sites. Selection of sites was realized according to the same standard applied in Bulgaria, the Balearic Islands and Andalusia, Spain (Mooser et al. 2018, 2021, 2022), detailed in the following lines:

- i. A first approximation of the most attractive coastal sectors was achieved via satellite images and land-cover viewers, e.g., Google Earth and Copernicus land viewer. This enabled elimination of urban and village areas, and to preselect natural areas (or rural) that appeared of great scenic value conforming to the 26 physical and human parameters (Table 1), and accessible by a walk < 1.5 h (from the nearest car park); for example, sites with extensive dunes system and/or showing singular coastal features (estuaries, bays, high biodiversity, etc.) or pocket beaches backed by outstanding cliff formations, and, at the same time recording a low visual impact of human activities. If doubts arose relating their attractiveness or access difficulty, locations were automatically preselected. Twenty-two sectors were chosen during this process irrespective as to whether they were located or not within lands belonging to the CdL.
- ii. After consultation with local coastal experts and investigation of preselected sectors, e.g., by consulting official webs of tourism, *Conservatoire* website, review of published papers, grey literature, etc., a total of 19 locations were selected for field visits. It should be noted that the criteria used to determine the distribution of preselected sites favour the coastal scenic variety. Selected sites presented the greatest spatial density along heterogeneous scenic coastlines, such as *Le Grand Site de France Les Deux Caps* (points 3–6; Fig. 1), whilst the opposite was true for homogenous scenic shorelines, e.g., Côte d'Albâtre (Fig. 1).
- iii. Field surveys were achieved in July 2021 between 10 a.m. and 6 p.m., during normal weather conditions, when stable conditions ruled, e.g., a storm may alter sand and water colour (points 6 and 16, Table 1), and over sectors 400–500 m in length; that is, when a long shoreline is estimated, it can be divided into different sectors if scenic quality varied. But when constant alongshore scenic conditions were observed, adjacent sectors were joined (Cristiano et al. 2016; Alcerreca-Huerta et al. 2021), giving finally a total of 16 coastal sites with different coastal lengths, e.g., Pisseuses de Valaine (350 m in length) or Marquenterre, the longest one (7.8 km). Regarding this latter, the sector close to the seaside resort of Quend Plage was not considered as its skyline quality was slightly lowered by the village buildings. Preselected site such as La Sirène (Audinghen, Cap Gris-Nez) was visited but, finally, not chosen because of its low scenic quality. Valleuse at Octeville-sur-Mer (Côte d'Albâtre) was finally not evaluated because of the lack of a proper pathway to reach the beach from the cliff top (a detour would have caused a walk > 1.5 h).

Table 1
Physical and human parameters for scenic beauty assessment (CSES method)

No	PHYSICAL PARAMETERS	Weight	RATING				
			1	2	3	4	5
1	Height (m)	0.02	Absent	$5 \leq H < 30$	$30 \leq H < 60$	$60 \leq H < 90$	$H \geq 90$
2	CLIFF Slope	0.02	$< 45^\circ$	$45^\circ - 60^\circ$	$60^\circ - 75^\circ$	$75^\circ - 85^\circ$	circa vertical
3	Features*	0.03	Absent	1	2	3	Many (>3)
4	Type	0.03	Absent	Mud	Cobble/Boulder	Pebble/Gravel	Sand
5	BEACH FACE Width (m)	0.03	Absent	$W < 5$ or $W > 100$	$5 \leq W < 25$	$25 \leq W < 50$	$50 \leq W \leq 100$
6	Colour	0.02	Absent	Dark	Dark tan	Light tan/bleached	White/gold
7	Slope	0.01	Absent	$< 5^\circ$	$5^\circ - 10^\circ$	$10^\circ - 20^\circ$	$20^\circ - 45^\circ$
8	ROCKY SHORE Extent	0.01	Absent	< 5 m	5–10 m	10–20 m	> 20 m
9	Roughness	0.02	Absent	Distinctly jagged	Deeply pitted and/or irregular	Shallow pitted	Smooth
10	DUNES	0.04	Absent	Remnants	Fore-dune	Secondary ridge	Several
11	VALLEY	0.08	Absent	Dry valley	(< 1 m) Stream	(1–4 m) Stream	River/limestone gorge
12	SKYLINE LANDFORM	0.08	Not visible	Flat	Undulating	Highly undulating	Mountainous
13	TIDES	0.04	Macro (>4 m)		Meso (2–4 m)		Micro (<2 m)
14	COASTAL LANDSCAPE FEATURES**	0.12	None	1	2	3	>3
15	VISTAS	0.09	Open on one side	Open on two sides		Open on three sides	Open on four sides
16	WATER COLOUR & CLARITY	0.14	Muddy brown/grey	Milky blue/green opaque	Green/grey/ blue	Clear blue/dark blue	Very clear turquoise
17	NATURAL VEGETATION COVER	0.12	Bare ($<10\%$ vegetation only)	Scrub/garigue (marram/gorse, bramble, etc.)	Wetlands/meadow	Coppices, maquis (\pm mature trees)	Variety of mature trees/mature natural cover
18	VEGETATION DEBRIS	0.09	Continuous (>50 cm high)	Full strand line	Single accumulation	Few scattered items	None
HUMAN PARAMETERS							
19	NOISE DISTURBANCE	0.14	Intolerable	Tolerable		Little	None
20	LITTER	0.15	Continuous accumulations	Full strand line	Single accumulation	Few scattered items	Virtually absent
21	SEWAGE DISCHARGE EVIDENCE	0.15	Sewage evidence		Same evidence (1–3 items)		No evidence of sewage
22	NON_BUILT ENVIRONMENT	0.06	None		Hedgerow/terracing/monoculture		Field mixed cultivation \pm trees/natural
23	BUILT ENVIRONMENT	0.14	Heavy Industry	Heavy tourism and/or urban	Light tourism and/or urban and/or sensitive	Sensitive tourism and/or urban	Historic and/or none
24	ACCESS TYPE	0.09	No buffer zone/ heavy traffic	No buffer zone/light traffic		Parking lot visible from coastal area	Parking lot not visible from coastal area

* Cliff special features: indentation, banding, folding, screes and irregular profile. ** Coastal landscape features: Peninsulas, rock ridges, irregular headlands, arches, windows, caves, waterfalls, deltas, lagoons, islands, stacks, estuaries, reefs, fauna, embayment, tombola, etc. *** Utilities: power lines, pipelines, street lamps, groins, seawalls, revetments, restaurants, etc.

No	PHYSICAL PARAMETERS	Weight	RATING					
			1	2	3	4	5	
25	SKYLINE	0.14	Very unattractive		Sensitively designed high/low		Very sensitively designed	Natural/historic features
26	UTILITIES***	0.14	>3	3	2		1	None

* Cliff special features: indentation, banding, folding, screens and irregular profile. ** Coastal landscape features: Peninsulas, rock ridges, irregular headlands, arches, windows, caves, waterfalls, deltas, lagoons, islands, stacks, estuaries, reefs, fauna, embayment, tombola, etc. *** Utilities: power lines, pipelines, street lamps, groins, seawalls, revetments, restaurants, etc.

4. Contextualisation

4.1 French national context

With nearly 11 million km² and almost 20,000 km of coastline, France has the second largest maritime space in the world after the United States (MTE 2017). Because of the wide distribution of its overseas territories, France jurisdiction is presented in all seas and oceans (except the Arctic) and this makes this country custodian of an extraordinary natural heritage, e.g., 10% of world coral reefs and 20% of atolls are located under French jurisdiction (MEDDE 2014).

Coastal management is basically under the responsibility of the national government. Nonetheless, a national level consultation on a new environment policy (*Grenelle de l'environnement* between 2007 and 2010) placed more emphasis on the decentralization and integrated management of the seas and coasts (Grenelle II Law 2010). This process has not yet been successfully achieved (Cudennec 2020) but certain services have been decentralised to NUTS 2 (*Région* in French) and NUTS 3 (*Département*) levels. A meaningful step is the National Strategy for the Sea and Coast adopted and launched in 2017 (MTE 2017), which fits with the Integrated Maritime Policy adopted by the European council in 2007 (EC 2007).

France was not one of the first countries aware of the necessity of preserving natural coastal sites. For example, British countries and The Netherlands were pioneers in adopting laws and taking measures on coastal issues (Meur Férec 1997). However, coastal protection and preservation in France became a priority as a result of a strong set of legal tools established over the 20th and 21st centuries. Below, the most relevant ones:

- i. Law of 2nd May 1930, to protect remarkable natural and cultural sites (*Site classé* and *Site inscrit* in French). These terms are widely used to protect coastal sites;
- ii. Decree no. 59-771 (1959), to establish "Sensitive perimeter" (*Périmètres sensibles*) within coastal areas, and particularly along the southern *Côte d'Azur* (extended in 1961 to the whole territory);
- iii. Law no. 60-1384 (1960) with the institution of the "Department green tax" (*Redevance Départementale d'Espaces Verts*) to intervene in favour of the protection of coastal sites;
- iv. Law no. 60-708 (1960) for the creation of National parks;
- v. Law no. 75-602 (1975), foundation of the *Conservatoire de l'Espace Littoral et des Rivages Lacustres*, generally called *Conservatoire du Littoral*, which is the focus of this paper;
- vi. Law no. 76-629 (1976), a fairly innovative nature protection Law for the conservation of natural habitats and wildlife that particularly enabled the creation of nature reserves;
- vii. Law no. 86-2 (1986) known as "The Coastal Law" (*Loi Littoral*, modified in 2018), relative to coastal management, protection and planning, which marks a turning point in coastal management, especially for natural coastal sites;
- viii. Decree no. 89-684 (1989), related to the Coastal Law, to specify "Special sites" of high ecological value (*Espaces remarquables*) to be delimited in the Land Use Plan (*Plan d'Occupation des Sols*) of the Communes within strict legal protection
- ix. Law no. 93-24 (1993), the *Landscape Law (Loi Paysage)*, which devoted a specific approach to the aesthetic and heritage value of sceneries;
- x. Law no. 2006-436 (2006) related to national and regional natural parks together with marine natural parks;
- xi. the "Grenelle Environment Round Table" commitments (2007), to define the key points of public policy on ecological and sustainable development issues, i.e., a "National strategy of sustainable development towards a green and equitable economy" entered in force in 2010;
- xii. Law no. 2016-1087 (2016) for the recovery of biodiversity, nature and landscape, establishing, amongst others, a national biodiversity committee and agency for Biodiversity (*Office français de la biodiversité*).

France also demonstrated its leadership role on climate change issues, e.g., by leading the Paris Agreement (2015) and the Global Pact for the Environment (2017). In recent years, a "National Protected Areas Strategy 2030" was launched with the aim of unifying, for the first time, all protected areas, natural land and marine heritage in metropolitan France and overseas territories (MTE/MM 2021). This new strategy included seven main objectives, which come with 18 measures, implemented by means of three successive three-year action plans terminating in 2030. Among the most significant measures, it expects to expand by 2022 the Protected Area network to, at least, 30% of the national territory and have 10% of it under any high protection feature.

4.2 Conservatoire du Littoral

Many British initiatives, like Heritage Coasts and the National Trust, have inspired French policy, notably in the foundation of the *Conservatoire du Littoral* (CdL). Likewise, France has endowed itself with a strong set of laws for the protection of the coastal zone, which has no equivalent in England and Wales. A

very detailed comparison between the French and British systems can be found in Meur Férec (1997). By means of the CdL, the French system places emphasis on land acquisition while British organizations mostly operate through specific agreements set up with private landowners (Williams 1990, Meur Férec 1997; AONB 2019; National Trust 2022).

Created in 1975 (Law No. 75–602), the *Conservatoire* is a public institution without any equivalent institution in Europe (Meur Férec 1997; Kalaora and Konits 2004; IUCN 2013; Joveniaux 2017) whose mission is to acquire vulnerable and threatened coastal and extensive lakeshore areas of great natural relevance to ensure their permanent protection. This marks a significant turning point in the history of management of French coastal areas. The aim is to protect the beauty of landscapes and their ecosystem diversity, by ensuring also a free and sustainable public access to them. Land-purchasing policy is guaranteed by State subventions —such is not the case of British organisations cited before— and by private donors, e.g., firms or individuals. Only in 2020, the CdL received 51.7M€ of which 37.5M€ came from a boat tax known as “Francisation” (*Droit Annuel de Francisation et de Navigation DAFN* in French). For the same period, private donations were estimated over 3,2M€ alongside the endowment of 15 parcels (89 ha), valued for ca. 1.35M€ (CdL 2021b). Since its creation, almost 3,000 ha have been acquired every year (> 8700 deeds of sale) and, today, nearly 14% of the French coastline is protected under this system (750 sites occupying 210,000 ha) (CdL/MTE 2021). In certain regions such as Nord-Pas de Calais and Corsica, circa 25% of the coastline already belongs to the *Conservatoire* (CdL/MTE 2015).

The above lead to the following question: how does the *Conservatoire* identify areas of intervention? Whilst, the sole criterion of UK Heritage Coasts is scenic beauty, the answer herein demands a holistic view of the following issues (CdL/MTE 2015):

- i. Ecological value,
- ii. Landscape and cultural heritage,
- iii. Land-sea interface,
- iv. Level of human pressure,
- v. Lack of management, and
- vi. risk of overcrowding scenarios.

Adopted by the French council, the “Intervention Strategy” on the horizon 2050 (*Stratégie d’intervention 2015–2050* in French) aims to:

- i. contribute to the “Third wild”, i.e., the protection of one-third of the French coastline, target set by the CdL in line with the National Protected Areas Strategy (MTE/MM 2021) —which also includes in its scheme the coastlines protected by national parks, nature reserves, public-owned forests and sensitive natural areas— and
- ii. create a network of natural sites in healthy conditions, valued as an integral part of the territories, with long-term management plans and adaptation strategies to climate change related processes.

To complete the first objective, a series of maps database/strategies (*Stratégies cartographiées* or *Carte d’enjeux et de pressions* in French) were initially established for the 146 French coastal units in 1995 and then updated in 2005 and 2015. This enabled to identify two different types of areas: i) priority areas for interventions and ii) surveillance areas, both detailed in territorial project at coastal units’ level. This information is frequently revised and shared with both territorial partners and the administration council of the CdL with the aim of establishing which surfaces (named “authorised perimeter”) have to be acquired within such areas. Often, the assignment of coastal lands belonging to the public domain is solicited by the CdL. Between 2005 and 2015, 93% of acquisitions were realised within these strategic areas declared in 2005 as “authorised perimeter” (CdL/MTE 2015). Therefore, to reach the first-mentioned objective (i.e., the “Third wild”), the “Intervention Strategy 2015–2050” expects to protect 320,000 hectares (nearly 1000 sites), by private acquisitions (200,000 ha) and public assignments (120,000 ha), i.e., about 20–25% of the French coastal length (CdL/MTE 2015).

The second objective aims to draw up durable management plans for all acquired sites. The openness and the quality of interventions have to contribute to restore/preserve their natural identity by conserving/encouraging traditional activities and allowing only very limited and supervised leisure facilities. Although the *Conservatoire* is guarantor of the smooth functioning of its properties, it does not carry out their day-to-day running: once a site or property is acquired, management partnerships are set up primarily with local authorities to cultivate a local sense of ownership. An agreement by conventions is thus reached on strategies to adopt according to the *Conservatoire* chart (further analysed) and diagnostics previously established. Competencies between CdL (owner) and managers are presented in Fig. 2.

Today, the CdL is associated with more than 330 managers, i.e., among them, 50% are *Communes* (Municipalities), 31% departments (and structures *intercommunales*) and 15% associations (NGOs) (CdL 2021b). Nearly 65% of sites (485 out of 750) are considered as “operational” or “working” sites because show full management plans with long-term adaptation strategies. By 2050, it expects to reach roughly 1000 “operational” sites. Otherwise, the fact that sites protected are totally excluded from the real estate market further contributes to increase the value of adjoining residential areas (Prunetti et al. 2011), as is the case with Heritage coasts in England and Wales. Surveys carried out in 2011 showed that almost 95% of French peoples considered the interventions of the *Conservatoire* to be necessary (CdL 2016).

5. Results

In order to achieve the objectives initially proposed, investigated sectors were classified and analysed in detail by coastal units (*unités littorales* in French) established by the CdL, to deal with management challenges at local scales. The metropolitan French territory is divided into a total of 93 coastal units, characterized by a certain geographical, historical or cultural homogeneity. In total, five were identified along the 350 km of the study area and investigated below:

- i. Coastal Plain of Flanders and Calais (*Plaine Maritime de Flandre et du Calais* in French)
- ii. Opal Cliffs (*Falaise d'Opale*)
- iii. Opal Dunes and Estuaries (*Dunes et Estuaires d'Opale*)
- iv. Bay and Valleys of Somme (*Baie et Vallées de la Somme*)
- v. Cliffs and Valleys of Pays de Caux (*Falaises et Valleuses du Pays de Caux*)

Sixteen sites, respectively located along these five units, were field tested during July (2021) by the itemised checklist method (Ergin et al. 2004, 2006) (Table 1). Their scenic attractiveness is reflected by the Evaluation index scores (D) presented in Fig. 3. Seven sites correspond to Class I ($D \geq 0.85$), five to Class II ($0.65 \leq D < 0.85$) and four to Class III ($0.40 \leq D < 0.65$). Certain sites clearly stand out from the rest with very high scenic values such as Valleuse d'Antifer (D: 1.01), Pisseuses de Valaine (0.92), Baie de Wissant (0.93) or Pointe du Touquet (0.88) (Fig. 3). Others showed medium or poor scores for human aspects and were consequently ranged in Class III. Regarding Baie d'Authie and Valleuse des Moutiers (Class III), both could be easily upgraded to Class II just by reducing beach litter amounts.

As shown in Table 2, all investigated sectors are located within protected areas under complementary designations features established at regional, national, European or international levels, working alongside the *Conservatoire*. The European project recently initiated by the CdL at Baie d'Authie (Life Adapto 2022), which marks the border between the Opal and Alabaster coasts, is a great symbol of cooperation. It gathers together numerous partners (department, Regional Natural Park, local communities, amongst others) in an attempt to reach a balance among traditional uses, conservation of biodiversity and ecotourism development.

Regarding the sites investigated, 10 out of 16 are under the control of the *Conservatoire* (Table 2). At various places, "authorised perimeters" have been set up to:

- i. Fully control the whole site by acquiring the little remaining surface; i.e., Marquenterre, Baie de Wissant, Platier d'Oye and Dunes d'Ecault,
- ii. Protect new sites such as Pointe du Hourdel or Bois de Cise (Table 2).

Places like Pointe du Touquet and Pisseuses de Valaine (both Class I) have not been placed within such priority perimeters. It is certainly because the former is already a *Site Classé* (with a strong protection feature) while the latter is backed, on its cliff top, by a golf course since 1908.

Table 2

Main site characteristics: municipalities, beach typologies, beach length, *Conservatoire* and other protected area features, D values and scenic classes

Site	Municipality	Typ.*	Length (m)	D value	Class	CdL (%)		Protected Areas
						Acq.**	Per.***	
(1) Dune Dewulf	Leffrinckoucke Ghyvelde	Re	2,280	0.49	III	100		SAC & SPA
(2) Platier d'Oye	Oye-Plage	Re	3,600	0.68	II	75	25	Réserve Naturelle Nationale SPA
(3) Cran d'Escalles	Escalles	Re	1,730	0.80	II	100		<i>Grand Site de France</i> (GSF) Les Deux Caps Regional Natural Park (RNP) Caps et Marais d'Opale APB Cap Blanc Nez SAC & SPA
(4) Baie de Wissant	Wissant	Re	1,790	0.93	I	70	30	GSF Les Deux Caps RNP Caps et Marais d'Opale SAC & SPA
(5) Cran Poulet	Audinghen	Re	720	0.85	I	100		GSF Les Deux Caps RNP Caps et Marais d'Opale SAC & SPA
(6) Dunes de la Slack	Wimereux	Ru	1,460	0.82	II	100		GSF Les Deux Caps RNP Caps et Marais d'Opale Marin Natural Park (MNP) Estuaires Picards et Mer d'Opale (MO.) SAC & SPA
(7) Dunes d'Écault	Saint Étienne au Mont	Re	2,250	0.80	II	70	30	RNP Caps et Marais d'Opale MNP Estuaires Picards et MO. SAC
(8) Pointe du Touquet	Le Touquet-Paris-Plage	Ru	1,450	0.88	I	No		<i>Site classé</i> MNP Estuaires Picards et MO. SAC & SPA (only marine)
(9) Baie d'Authie	Fort-Mahon-Plage	Re	2,170	0.61	III	100		Ramsar RNP Baie de Somme Picardie Maritime (PM.) MNP Estuaires Picards et MO. SAC & SPA
(10) Marquenterre	Saint-Quentin-en-Tourmont	Re	7,800	0.86	I	70	30	Ramsar National Natural Reserve RNP Baie de Somme PM. MNP Estuaires Picards et MO. SAC & SPA
(11) Pointe du Hourdel	Cayeux-sur-Mer	Ru	1,420	0.86	I		100	Ramsar APB RNP Baie de Somme PM. MNP Estuaires Picards et MO. SAC

* Beach typologies defined according to Williams et al. (2011); **surface acquired by the CdL;

*** surface declared as "authorised perimeter" by the CdL

Site	Municipality	Typ.*	Length (m)	D value	Class	CdL (%)		Protected Areas
						Acq.**	Per.***	
(12) Bois de Cise	Ault	Ru	950	0.57	III		80	Ramsar RNP Baie de Somme PM. MNP Estuaires Picards et MO. SAC
(13) Valleuse des Moutiers	Varangeville-sur-Mer	Re	810	0.56	III	No		OSPAR (marine) SAC
(14) Val de la Mer	Senneville-sur-Fécamp	Ru	490	0.80	II	No		OSPAR (marine) SAC & SPA
(15) Pisseuses de Valaine	Étretat	Re	350	0.92	I	No		OSPAR (marine) SAC & SPA
(16) Valleuse d'Antifer	Le Tilleul	Re	750	1.01	I	100		<i>Site Classé</i> OSPAR (coastal and marine area) SAC & SPA
* Beach typologies defined according to Williams et al. (2011); **surface acquired by the CdL;								
*** surface declared as "authorised perimeter" by the CdL								

5.1 Analysis of physical parameters by coastal units

These five coastal units stand out as having a large scenic variety that inspired and amazed countless recognised artists, poets and novelists, such as Delacroix, Boudin, Courbet, Pissarro, Matisse, Maupassant, Hugo and Verne. A land composed of estuaries, dunes, sand beaches and chalk cliffs, shaped in a macrotidal environment by strong winds prevailing from the SW, where lights and colour contrasts are continuously changing. The Côte d'Albâtre and Côte d'Opale owe their name to the stone opal colour, for its opalescence, fluorescence and iridescence, and the whiteness of the alabaster, which varies depending on weather conditions. Below, a description of physical scenic characteristics is given for each coastal unit and scores obtained from the CSES parameters are presented in Table 3.

Table 3
Site scores obtained for physical (1–18) and human parameters (19–26) (CSES parameters)

Parameter	1. Dunes Dewulf (0.49)	2. Platier d'Oye (0.68)	3. Cran d'Escalles (0.80)	4. Baie de Wissant (0.93)	5. Cran Poulet (0.85)	6. Dunes de la Slack (0.82)	7. Dunes d'Écault (0.80)	8. Pointe du Touquet (0.88)	9. Baie d'Authie (0.61)	10. Marquenterre (0.86)	11. Pointe du Hourdel (0.86)	12. Boise de Cise (0.57)
1–3 Cliff	Height	1	1	4	1	2	1	1	1	1	1	4
	Slope	1	1	4	1	4	1	1	1	1	1	5
	Features	1	1	4	1	5	1	1	1	1	1	4
4–6 Beach face	Type	5	5	4	5	4	4	5	5	5	5	4
	Width	3	1	1	3	3	3	4	2	2	3	3
	Colour	4	4	4	5	3	4	4	5	4	4	4
7–9 Rocky shore	Slope	1	1	1	1	1	1	1	1	1	1	3
	Extent	1	1	1	1	1	1	1	1	1	1	5
	Rough.	1	1	1	1	1	1	1	1	1	1	4
10. Dunes	5	3	1	4	1	5	5	5	5	5	3	1
11. Valley	1	1	2	1	2	1	4	5	5	1	5	1
12. Skyline landform	1	1	1	1	1	1	1	3	1	1	1	1
13. Tides	1	1	1	1	1	1	1	1	1	1	1	1
14. Landscape features	1	3	4	4	3	3	1	4	4	3	3	3
15. Vistas	4	5	4	4	4	4	4	4	4	4	4	4
16. Water colour	3	3	3	3	4	3	3	3	3	4	3	3
17. Vegetation cover	4	3	1	4	3	4	4	3	3	3	4	3
18. Vegetation debris	5	5	5	4	5	4	4	5	5	4	5	5
19. Noise disturbance	5	5	5	5	5	5	5	4	5	5	5	5
20. Litter	5	4	5	5	5	4	4	5	3	4	5	4
21. Sewage evidence	5	5	5	5	5	5	5	5	5	5	5	5
22. Non-Built Environment	5	5	5	5	5	5	5	5	5	5	5	5
23. Built environment	5	5	5	5	5	5	5	5	5	5	4	4
24. Access type	5	5	5	5	5	5	5	5	5	5	4	5
25. Skyline	2	4	4	4	4	4	4	4	3	5	4	4
26. Utilities	5	5	4	5	4	5	5	5	5	4	5	2

a) Coastal Plain of Flanders and Calais

From Calais to Belgium, along the coast of the North Sea, this long fringe of low-lying landforms spread over 10 to 15 km inland. It mainly consists of sand dunes, estuaries and “polders”. The latter is a Dutch word generally used to designate a piece of land reclaimed from the sea or from inland water bodies (Eisma 1982). This cultural landscape has been shaped over the centuries by local inhabitants for farming activities such as pasture or market gardening. Two sites owned by the CdL are part of this coastal unit (Fig. 4A): Platier d'Oye (D: 0.68; Class II) and Dunes Dewulf (0.49; Class III). Good scores, linked to the geomorphological setting, were observed at both sites, i.e., beach type/colour and presence of dunes (Table 3). The former is a nature reserve constituted by an extensive coastal lagoon (Fig. 4B) and one of the largest birds feeding area on the English Channel and North Sea, and more than 230 bird species have been observed (RNF 2022). This was reflected by good scores for “Landscape features” (point 14; Table 3). Situated close to the boarder with Belgium, the 275 ha occupied by the Dune Dewulf complex stretches along nearly 2.5 km of coastline and is part of a vast dune complex called “The Dunes of Flanders”. It represents a characteristic geomorphologic feature of the North Sea coast, formed by prevailing winds striking the shoreline obliquely from the SW and

presenting vast depressions (*blow outs*) in the heart of the dune complex (Fig. 4C). Scenic quality of the Dunes Dewulf complex is significantly lowered by the proximity of Dunkirk (cf discussion). Today, the *Conservatoire* holds eight protected areas in this coastal unit.

b) Opal Cliffs

West of Calais, dunes give way to the famous *Grand Site de France des Deux Caps*, a true natural setting recognised by a national label in 2011 (renewed in 2018) consisting of two capes. The geology of this site explains its landscape diversity. Four investigated sites fall within this coastal unit and all belong to the *Conservatoire*: Cran d'Escalles (D: 0.80), Dune d'Aval (0.91), Cran Poulet (0.85) and Dune de la Slack (0.65) (Fig. 5A). The "Two Caps" are made up of a succession of grey Jurassic cliffs, composed of marls and sandstones (Cap Gris-Nez) (Fig. 5D), and white chalky cliffs from the Cretaceous period (Cap Blanc-Nez) (Fig. 5B), and dune sequences alongside a wide opening bay bordered by two capes (Fig. 5C).

The grey cliffs of Cap Gris-Nez give the cape its name (Grey Nose in English). Cran Poulet, a pebble beach located southern of Gris-Nez, is a perfect place to collect fossils such bivalves, gastropods or ammonites of Jurassic age. These singular cliffs' characteristics were reflected by top scores for "Cliffs Special Features" (rated 5; Table 3). From Cran d'Escalles, it is possible to observe the well-known Cap Blanc-Nez (White Nose in English), reaching a height of 134 m and favouring top grade scores for "Cliff Height" (> 90 m, rated 5; Table 3). "Cran" is a local term, specific to the Opal coast, to designate "small cliff valley" shaped by water runoff ("Valley", rated 2; Table 3). South from the eponym village, Baie de Wissant is also known as Dunes d'Aval and backed by a 100–350 m dune width complex varying from 6 to 22 m in height (rated 5; Table 3). Critically exposed to erosion processes, this latter experienced a retreat > 100 m in the last decades (Aernouts and Héquette 2006; Chaverot 2006). At low tide, the beach foreshore is 400–500 m wide whilst the upper beach is nearly 20 m (rated 3; Table 3). It consists of fine homogeneous well-sorted sands, i.e., 0.25 mm (Ruz and Meur-Férec 2003), giving top scores at "Beach type" (fine sand, rated 5; Table 3) and "Beach colour" (gold, rated 5; Table 3). These three very attractive sites (two Class I and one Class II) are also located in the closest point to England (34 km). On a clear day, the emblematic white chalky cliffs of Dover can be seen, favouring good scores for "Landscape Special Features" (Table 3). Dune de la Slack is another great scenic site (D: 0.82), located at the south of the Slack River, surrounded by a remarkable 213 ha developed dune complex (rated 5) (Fig. 5E).

c) Opal Dunes and Estuaries

South of Boulogne, this coastal unit is characterized by sand beaches, immensely wide at low tide, outstanding dune systems and estuaries. These landscapes are well exemplified by the following investigated sites: Dune d'Ecault (D: 0.80), Pointe du Touquet (0.88) and Baie d'Authie (0.61) (Fig. 6A-D).

Mostly acquired by the CdL, the former is a patchwork of dunes systems. With nearly 5 km width (the largest dune massif in northern France), it shows embryo dunes, white dunes with European marram grass (*Ammophila arenaria*), gray dunes with mosses and lichens, shrubby dunes and wooden dunes (rated 5; Table 3) (Fig. 6B). Good ratings were generally observed for "Beach characteristics" as sand comes from the extensive Palaeocene and Eocene deposits (from the sea) rather than from rivers (Briquet 1930). At Pointe du Touquet, its gold/white tan colour gives top score for "Beach colour" (Table 3). Together with the Authie Bay, the Canche Bay is a typical "Picardy estuary": on one side, an accreting shore known as the *poulier* (sandspit), which corresponds with the Pointe du Touquet (Fig. 6D), and on the other side, a strong eroding sector (*musoir* in French). Both sites record complex sedimentary exchanges and offer a wide variety of ecosystems, i.e., dunes, polders, salt meadows, bocage, meadows and ponds hosting a great biodiversity of flora and fauna (Fig. 6C). This set of characteristics favours excellent scores for "Landscape Special Features" (both rated 4), "Dunes" and "Valleys" (both rated 5, Table 3). Besides, at Pointe du Touquet, the undulating landscape of the Canche Bay gives intermediate score for "Landform" (rated 3, Table 3). Labelled as *Site Classé* in 2001 (Classed Site), this latter is one the most aesthetic site of this paper, whilst Baie d'Authie only figures as a Class III site. This latter is further discussed in order to analyse the ways to upgrade it to Class II.

d) Bay and Valleys of Somme

This coastal unit is especially well known for its world famous *Baie de Somme* ("Somme Bay" or "Bay of the Somme"). But it is also one of the most varied in term of scenery. Once again, this diversity is perfectly represented by the investigated sites: Marquenterre (0.86, Class I), Pointe du Hourdel (0.86) and Bois de Cise (0.57, Class II) (Fig. 7A-D). North to the bay, Marquenterre is characterized by a remarkable mosaic of dune formations (rated 5, Table 3), i.e., white dunes, grey dunes, shrubs, dune clacks and pine forests, over a surface area up to 3,000 ha (3 km wide) and 14 km of unspoilt coastline. This highly protected complex (National Nature Reserve), known as "Picardy dunes", is typical of this region and characterized by wide dune formations due to the perpendicular prevailing winds (Fig. 7D). Most of the Marquenterre coastline is also owned by the CdL. The Somme Bay represents the largest estuary in northern France, with a surface of 7,200 ha, only 15% of which has been urbanised (World Bays 2022) (Fig. 7C). This *Grand Site de France* is also the refuge of a very rich fauna with 365 bird species identified and the largest French colony of harbour seals (RSIS 2022). Mainly composed of vast sand, mudflats and grassy areas, this complex presents the same sedimentary characteristics as previously described for the Canche and the Authie Bays. Maximum tides may exceed 10 meters (Michel et al. 2017). To the SW is Pointe du Hourdel (the *poulier*), a shingle "rounded" spit into the estuary with extensive sandbanks showing scour channels and megarripples. These scenic characteristics were reflected by good scores for "Beach type" (rated 4), "Landscape Special Features" (rated 3), "Valley" (rated 5), "Vegetation cover" (shrubs, rated 4) (Table 3). This site scored high (D: 0.86, Class I) despite some visual impact related to human activities (discussed latter). Finally, the southern part of this unit is the starting point of a cliffed sector consisting of chalk. At Boise de Cise, cliffs are incised by a small valley fronted by a strip pebble beach, dominated by flint modules from the eroding chalk, and by an intertidal shore platform. Good scores were therefore observed for "Shore characteristics" (points 9–11, Table 3) as well as "Cliffs", which reach up to 80 meters at the highest point (points 1–3, Table 3).

e) Cliffs and Valleys of Pays de Caux

This unit, also known as Côte d'Albâtre, corresponds to the North-western termination of the Paris sedimentary basin (Upper Normandy). The latter is characterized by the existence of more or less high, undulating and sometimes faulted plateaus, carved into cliffs, which explain the lithostratigraphic diversity of the outcrops (from the Upper Jurassic to Upper Cretaceous) (Costa et al. 2019). At Valleuse des Moutiers (D: 0.56), the chalk cliffs have a capping of Tertiary sand and clay containing silicified sandstone and characterized by brown stains. It is also one of the most sensitive areas to erosion processes of the Alabaster coast, i.e., retreat > 0.23m/year (Letortu et al. 2014). Toward Etretat, cliffs are vertical and cut in hard silicified and almost horizontally stratified

chalks (mainly from Coniacien-Santonian ages). The four sites, falling within this area, are composed of flint pebbles (rated 4, point 4, Table 3) with a dry beach width varying from 4 to 5 m (rated 2), i.e., Valleuse des Moutiers and Val de la Mer, to 35–45 m (rated 4) at Valleuse d'Antifer (Fig. 8A,B,D). *Val* or *Valleuse*, as previously stated for *Cran*, is another local term to designate a small valley mouth (rated 2, point 11, Table 3). Etretat area is a spectacular geologic pattern of international fame. Its unique shape, gathered in a 2.5 km coastal sector, gives rise to five bays, four capes, and includes elegant arches and high residual stacks. Obviously, these breath-taking scenes were reflected by high evaluation index scores (D) as observed for Valleuse d'Antifer (1.01) and Pisseuses de Valaine (0.92). At both sites, top scores were obtained for "Cliffs" parameters as the great wall reaches nearly 100 m in height (Fig. 8C,D). The uniqueness of its scenic characteristics also leads to high scores for "Landscape Special Features". For example, at Pisseuses de Valaine, the water stopped by the hard ground over the chalk rock (Southerham marl) give rise to a karst spring waterfall, which give the name of this site (Fig. 8C). Finally, it is noteworthy to mention that clear water (rated 4) was observed for both sites, whilst most of the study area were rated 3 (point 16; Table 3).

5.2 General anthropogenic characteristics vs coastal units

Site scores obtained for human parameters (CSES method), shown in Fig. 9, are presented by coastal units. Note in Fig. 9 the colour coding for the *Conservatoire*. Since this study is focused on the most attractive natural sectors, sites predominantly presented good scores, but some substantial differences between parameters and, to a lesser extent, coastal units, i.e., "Bay and Valleys of Somme" (unit 4; Fig. 9). Regarding this latter, Pointe du Hourdel and Bois de Cise were included as priority areas for future land acquisitions (orange colour). In general, parameters such as "Noise", "Sewage", "Non-built", "Built environment" and "Access type" show very high ratings. However, significant variances can be observed for "Skyline", "Litter" and "Utilities". The discussion focuses on those aspects according to the *Conservatoire* management approach regarding human pressure.

6. Discussion

6.1 Characterization of Class I, Class II and Class III sites

Three examples chosen from the same coastal unit "Cliffs and Valleys of Pays de Caux" were used to characterize the three scenic classes recorded in this study: Valleuse d'Antifer (D: 1.01, Class I), Val de la Mer (D: 0.80, Class II) and Valleuse des Moutiers (D: 0.56, Class III). Their ratings, averages and membership degree curves are presented in Fig. 10 to give an immediate visual state of their natural and human parameters.

1) Class I are extremely attractive sites with outstanding scenic characteristics ($D \geq 0.85$), reflected by top scores for both physical and human parameters (Fig. 10A–C). Fully owned by the CdL (since 1994) and managed by the department of Seine-Maritime through an operational management plan set up in 2007, Valleuse d'Antifer is the perfect illustration of a top scenic site (D: 1.01). Also known as *Plage du Tilleul*, it requires a 30-minute walk from the famous village of Etretat (remote typology). Top grades were observed for all human aspects apart from Skyline (rated 4). This low visual impact is linked to the port of Bruneval located few kilometres to the West. Histograms, weighted averages and attribute curves, skewed to the right, clearly reflect good scores obtained for attributes "4" and "5" (Fig. 10C). Regarding physical parameters, excellent scores were particularly observed for "Cliffs", "Beach face", "Landscape features", "Vistas" and "Water colour" (Fig. 10A). This site is part of a vast area (nearly 15 km of coastal length) in process of being awarded Grand Site de France (GSF 2022). In this paper, seven sites fell within this class.

2) Class II corresponds to attractive sites with high landscape value ($0.65 \leq D < 0.85$). These sites generally rated lower than Class I due to a lower scoring of the physical parameters or because of the influence of human activities. For example, at Val de la Mer (D: 0.80), good scores were observed relating human aspects but, comparing with the former, lesser ratings were noticed for physical characteristics; namely, "Cliff height" (nearly 60 m in height, rated 4), "Beach width" (4 m width at high-tide, rated 2), "Landscape features" (rock edges, rated 3), amongst others. These aspects are well reflected by Fig. 10A–C. In total, five sites were categorized as Class II.

3) Class III sites are frequently located in remote, rural or village areas with medium landscape values ($0.45 \leq D < 0.65$). With similar physical characteristics than Val de la Mer (Fig. 10A), Valleuse des Moutiers (D: 0.56) was rated as Class III essentially because of litter problems (rated 3), which significantly downgraded its attractiveness. Another case is Baie d'Authie (D: 0.61), which "D" value was lowered by the presence of litter associated with low skyline quality in spite of the very positive values showed by physical aspects. For Dunes Dewulf complex (D: 0.49), physical factors scored well but poor skyline quality (rated 2) lead the site to Class III. Despite the focus of this study, these sites were chosen either because of their potential to be upgraded to Class II or because of their singularity, i.e., the historic heritage of Dunes Dewulf complex.

6.2 Human parameters vs *Conservatoire du Littoral* policies

From a scenic approach, only a small number of changes can be made to improve physical parameters, e.g., formation of artificial dunes or beach nourishment. Thereby, attention should be essentially paid to work out ways of upgrading anthropogenic parameter scores (or keep them high), although certain scenic impacts are just irreversible as travel back in time is not feasible. This is particularly the case of "Skyline" and "Built environment". Therefore, it is of the utmost importance to maintain the natural character of the remaining undeveloped coast. With this regard, the focus of this paper is the research of remarkable attractive natural sites not (or only slightly) affected yet by human intrusions with a view to explore the following questions: what is the legacy of the *Conservatoire*? What are the benefits of its management approach on scenic beauty?

As stated, since its creation in 1975, the *Conservatoire* attempts to protect natural environments and coastal landscapes by acquiring non-urbanized sites in metropolitan France and overseas. If acquisitions are often justified by the quality of the scenery, it seeks to define the correct approach for conserving and enhancing the natural beauty of its sites through the application of local solutions to local challenges, respecting the following principles:

1. Preserve peace, tranquillity and essence of sceneries, avoiding their "banalisation",
2. Favour light and reversible interventions,

3. Involve local actors, e.g., stakeholders, association, guards, etc.,
4. Support cultural and traditional activities, e.g., sustainable agricultural practices,
5. Prioritise nature based-solutions with a long-term view.

In this regard, a detailed analysis of the eight human parameters scored at the 16 investigate sites (Fig. 9) is presented in following lines. Likewise, specific emphasis is given to the *Conservatoire* with the aim of explore its existing policies related to each aspect, enabling to interpret its effectiveness.

1) Noise disturbance is mainly linked to human activities carried out near the beach, e.g., playing loud music (bars), jet skis, heavy, traffic, overcrowding scenarios, etc., and was almost non-existent at all investigated sites during the field observations (rated 5; Fig. 9, Table 3). Only at Pointe du Touquet, little disturbances was perceived and associated with the presence of a small airport located 5 km apart from the beach (rated 4, Fig. 9). Usually, disturbance associated with visitors may increase in August, during the peak tourist season, especially at places of easy access. It is well-known that access difficulty is an essential component of the management approach to regulate visitors' pressure. Thus, it is interesting to highlight that all sites owned by the CdL required at least a 15-minute walk from the nearest car park. With this in mind, adequate access restrictions were implemented in the last decade at Cran d'Escalles and Cran Poulet by moving away the car park by 1 km from the beach (Fig. 11A,B). Both sites belong to the *Grand Site des Deux Caps*, the second most visited site belonging to the CdL in France after the famous Dune de Pilat, which receives ca. 2.5 million visits every year (CdL 2016). Other places such Marquenterre, demand at least a 45-minute walk. However, it has to be noted that places such as Pointe du Hourdel, Bois de Cise, Val de la Mer or Pointe du Touquet, which do not belong to the *Conservatoire*, were easily accessible by a walk <10 minutes.

2) Litter items were usually characterized by "few scattered items" (rated 4) or "virtually absent" (rated 5, Fig. 9). Only two places showed single accumulations of litter (rated 3); i.e., Baie d'Authie and Valleuse des Moutiers (Fig. 9). Items are usually not discharged by beach users but transported and stranded by waves and currents. Regarding the former place, its presence is quite unusual as it is part of a strong European project, previously described, involving many actors to increase the ecological quality of the estuary (Life Adapto 2022). It may have been a provisional temporal accumulation made by clean-up operators as litter was virtually absent along the remaining investigated sector. At Valleuse des Moutiers, accumulations were essentially attributed to marine and land sources (rivers) together with the absence of periodic cleaning operations (Fig. 11C). If their current litter scores (3) are improved to obtain a rate of 4, their index D would jump respectively from 0.61 to 0.74 (Baie d'Authie) and 0.56 to 0.68 (Val Moutier). These interventions would upgrade both sites to Class II. Since 2006, the *Conservatoire* claims manual cleaning operations rather than mechanical ones, to not remove seaweed, to protect sites from erosion and conserve their biodiversity (*Plan de réduction et gestion des macro déchets*) (CdL 2022). In this way, it is interesting to highlight that several "Tidal bins" (*Bac à Marée*) were implemented along the study area by different managers working together with the CdL, as part of the *Trait Bleu* program (BAM 2022). Such was the case at Dunes Dewulf, Dunes d'Écault, Platier d'Oye and Marquenterre (Fig. 11D,E).

3) Sewage was virtually absent at the investigated sites. Its presence is more usual in urban or village beach typologies (Anfuso et al. 2019), but unusual in remote areas.

4) Non-Built Environment is the environment perceived minus its artificial constructions, e.g., buildings, car parking, etc., i.e., it essentially involves cultivated areas. Here, all sites gave top scores (5) mostly because they were located on the back of dunes systems and cliffs, thus, were not visible from the beach. At few sites, pastures and meadows were slightly visible but did not have any scenic impact, e.g., Valleuse d'Antifer, Cran d'Escalles or Cran Poulet (Fig. 11F,G). It is noteworthy to mention that 90% of agricultural fields surrounding sites owned by the *Conservatoire* are permanent pasture fields (no-till farming) set up by means of conventions (CdL 2021c). Since coastal farming lands have decreased by 25% (period 1970-2010), essentially affecting small farms, supporting traditional and extensive practices together with small producers is one of the main CdL concerns. Today, agricultural leases for sustainable practices are about 30-60% cheaper within CdL lands (CdL 2021c).

5) Built Environment points out the visual impact of surrounding buildings. Most sites were characterized by top scores ("Historic or none", rated 5) as they were located in natural environments, except at Pointe du Hourdel and Bois de Cise (both rated 4), where a few buildings of a village settlement were visible from the beach (Fig. 11J). Located at a crossroads between several cultures, northern France has had a rich and tumultuous past from Roman times to wartime occupation, creating a broad-sweeping historical heritage along its coast. The strong heritage link to the Second World War is omnipresent as it was the epicentre of the Atlantic Wall. These military vestiges, mainly composed of bunkers were valued as "historical environment" (rated 5). The dunes of the Dewulf complex represent a great example as it was one of the boarding beaches of operation Dynamo, which allowed 340,000 soldiers to be evacuated to England (English Heritage 2022). Today, a shipwreck from this operation is still visible at low tide alongside an impressive fort battery near the back dune (Fig. 4C and 11H).

By buying land, the *Conservatoire* also inherits their history (archaeological remains, lock keepers' huts, lighthouses, castles, war vestiges, etc.) and, thus, their maintenance, surveillance and/or functioning. Buildings without cultural interest, which may have a role in the management, are also preserved and used as visitor centres, houses for guards, agricultural uses, etc. Otherwise, whilst urbanization is spreading everywhere, constructions with negative impacts on scenery and without interest are entirely "erased" with the aim of recovering the beauty and natural identity of sites; i.e., 92 buildings were demolished in 2013 (CdL 2016). This recently happened at Cap d'Alprech situated 3 km away from Dune d'Écault complex.

6) Access type is linked to the visual impact of car parking and/or roads. Herein, top scores were obtained apart from Pointe du Hourdel (not owed by the CdL), where an old road now closed to traffic and known as the "white road" can be seen along its southern sector. Redeveloped in 2018 for the exclusive use of bikes and pedestrians, due to its low scenic impact, obtained a rate of 4. Besides the scenic aspect, creating an adequate access is crucial from a management viewpoint as it partially determines the number of visitors. Make sites sustainably accessible and maintain their undeveloped character is clearly one of the *Conservatoire* priorities reflected within its management plan (Kalaora and Konits 2004; Joveniaux 2017; Freyret 2013). Camping, caravanning and

the entry of motor vehicles on the sites, except for service or security reasons, are systematically prohibited (Freytet 2013). Today, nearly 900 littoral guards are employed to inform, supervise and control public welcoming (CdL 2021b).

7) Skyline refers to the silhouettes of buildings or others artificial structures not in harmony with the environment. Even if it was mainly associated with village settlements sensitively designed without high buildings (rated 4), most sites were relatively affected by its impact (Fig. 9). At some places, such as Cran d'Escalles, Baie de Wissant or Cran Poulet, it was linked to the marine traffic of large ships sailing through the English Channel (hundreds every day). At Pointe du Touquet, the presence of several wind turbines was also considered and rated 4. Dunes Dewulf recorded the worst score (2) because of the Dunkirk industrial port (Fig. 11I), and Baie d'Authie obtained a rate of 3 due to the city of Berk. Lastly, the unspoiled coast of Marquenterre (14 km of length) achieved top score at Skyline (5).

8) Utilities covers a large variety of human items, e.g., lighting, powerlines, seawalls, pipelines, leisure facilities, aid stations, amongst others. Practically all sites had good scores (>4) apart from Bois de Cise (rated 2). This latter showed poor scores because of the presence of hard coastal protection structures emplaced to avoid cliff erosion caused by wave action (Fig. 11J). At Cran Poulet, soft interventions were carried out to protect the cliff foot from erosion, near the valley mouth, by means of local cobbles (Fig. 11K), which gave a rating of 4. Both cases can be hardly compared as the former is backed by a few houses while the second is located in a fully natural environment. Thanks to this soft approach (that has a low scenic impact) alongside the interventions relating car access (car park removed away), Cran Poulet is classified as a top scenic site (Class I). Otherwise, without those hard structures, Bois de Cise would have been a Class II site (D: 0.66). The most common impact was related to a public stairway for beach access, certainly indispensable for sites backed by cliffs (Fig. 9), i.e., Cran d'Escalles, Valleuse des Moutiers, Val de la Mer (rated 4, Fig. 9). Despite showing the same scores (4), the visual impact of the stairway observed at Cran d'Escalles was quite lower than the one observed at Val de la Mer (Fig. 11L). At Marquenterre, the presence of mussel cultivation was rated 4.

Commonly, conflicts of interest arise between conservation and recreation as management approaches are usually focused on the latter (like within protected areas) (Mooser et al. 2018, 2020, 2021, 2022). With this regard, it is interesting to highlight that no recreational impacts were perceived along this study area. The *Conservatoire* emphasis is devoted to social and economic development that conserves and enhances the natural and historic environment, e.g., agriculture, forestry, mussels farming and other social needs of local communities. Recreational activities are very limited as they are not consistent with the conservation of natural beauty, and can be summed up as pedestrian uses, e.g., *Grande Randonnée GR* footpath, and, to a lesser extent, cycling. Likewise, the CdL also possesses its own "Signage chart" (*Charte signalétique* in French), which favour minimal - but effective - interventions, limiting the number of panels in key areas as in the Heritage Coast approach in England and Wales (Freytet 2013). Its sensitive aesthetic approach is associated with the presence of littoral guards posted on sites with high number of visitants.

7. Final Considerations

To answer the objectives and distinct questions previously formulated, the following key points can be stark in evidence:

- i. The most important scenic diversity was observed along the Côte d'Opale and Côte Picarde in Haut-de-France region and, more specifically, along the coastal units "Opal cliffs", "Opal Dunes and Estuaries" and "Bay and Valleys of Somme" (Table 3, Fig. 9). This was clearly reflected by a high number of investigated sites exhibiting a patchwork of remarkable dunes complexes, a vast geodiversity of cliff formations, outstanding bays and estuaries, including the well-known *Baie de Somme*, which supports a rich wildlife flora and fauna, e.g., migratory birds, the French largest colony of harbour seals and some rare marine plants such as the sea cabbage, amongst others.
- ii. A notable influence of the *Conservatoire* in the investigated area, i.e., 10 out of 16 (and two in process) of the sites investigated belong to the *Conservatoire*. It is noteworthy to reiterate that sites were chosen for survey visits irrespective as to whether they were located or not within lands belonging to the CdL, as this paper was initially focused only on the research of top scenic sites. That said, it would be useful to add additional sites along the Côte d'Albâtre (see Fig. 8) and, specially, near the *Valleuses* of great scenic relevance. Today, places such as Valleuse des Moutiers and Val de la Mer do not benefit of a strong land protection, i.e., only Natura 2000 (Table 2).
- iii. Only a very few interventions can be suggested to improve scenic quality of investigated sites within CdL lands, i.e., beach litter at Baie d'Authie. This clearly reflects the *Conservatoire* sound and common-sense management devoted to conserve and enhance natural beauty. Many of its interventions and proposal are just not perceptible, at a first sight, but very effectiveness to maintain scenic quality of natural sites; i.e., manual beach cleaning, access regulation, convention for sustainable agricultural practises, demolition of buildings without scenic/cultural interest, soft approach to counteract erosion processes, signage chart with low presence of information panels counterbalanced by the presence of littoral guards.

It has been shown that the method used in this paper can deal with the heterogeneity of investigated scenes especially regarding physical and human aspects. This landscape quality assessment constitutes a useful tool to measure the ways of enhancement of scenic beauty as well as to provide a baseline information to managers for monitoring their evolution. Indeed, it can be used to evidence how the scenic quality of beaches varies over time, e.g., litter, built environment, etc. This method could be exploited by the *Conservatoire* for such proposals and also to identify areas of great scenic interest before land acquisitions. Lastly, top scenery, e.g., Class I sites, could be labelled by a "Scenic award" to recognise their quality to visitors, and secure their long-term future protection.

8. Conclusions

The landscape quality assessment presented in this paper, via the CSES method, and carried out in Northern France, along Côte d'Opale, Côte Picarde and Côte d'Albâtre, gave evidence of 16 investigated sites of great scenic value. The technique is based on 26 physical and natural parameters, and enables personnel to classify sites from Class I (outstanding quality) to Class V (very poor quality). Any area classified as Class I or II should be protected in any future development plans (if it is not protected yet) seeking the balance between economic activities, societal expectations and environmental conservation. In this

paper, seven sites correspond to Class I, five to Class II and four to Class III. Just by reducing beach litter, two Class III sites could be upgraded to Class II. These results show the outstanding scenic quality of the northern French coast despite a strong presence of human activities mainly concentrated along the Opal coast near Boulogne, Calais and Dunkirk. The most impressive result is surely the huge variety/diversity of natural landscapes recorded along the study area, which is only 350 km in length.

This legacy can clearly be associated with the work done by the *Conservatoire*, started almost 50 years ago, to preserve the undeveloped French coast. Today, nearly 25% of the Haut de France region belongs to the CdL, and every year, in France, its coverage is increased by > 3000 ha of coastal lands. Ten out of 16 sites were located within *Conservatoire* lands, even if a lesser presence was observed along the Côte d'Albâtre (1 out of 4 sites). Its management strategies, based on partnership essentially with local authorities, proved to be highly effective as shown by the quality of its interventions.

It has been demonstrated that the method used in this study could be useful and multipurpose for managers/*Conservatoire* to:

- i. identify and characterize sites of great scenic relevance before land acquisitions,
- ii. quantify scenic benefits of interventions through the evaluation index "D", i.e., with evaluation pre and post interventions,
- iii. label, promote, recognize sites of top scenic values keeping in mind the importance of their conservation under the umbrella of sustainable tourism, i.e., Class I, which could be benefit to local economies.

Finally, this paper raises the question why similar institutions as the *Conservatoire du Littoral*, funded by public and private subventions, have not spread at a greater scale to other countries —one of the only exceptions is the National Trust in Britain (which does not rely on public funding). It would be particularly interesting to reproduce this successful model of cooperation, based on the "buy to protect" philosophy, in developing countries where pristine coastal scenes are globally turning into emerging, crowded tourist destinations.

Declarations

Author Contributions

A.M. and G.A. designed the study and participated in all phases. V.H. provided specific information related to the study area, i.e., erosion rates, categories of protection and tourism trends at local scale. A.T.W. provided a global structural discussion and made English corrections. P.P.C.A. made contributions regarding the conceptual approach and literature review. All authors reviewed the manuscript.

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Conflicts of Interest

The authors declare no conflict of interest.

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Figures

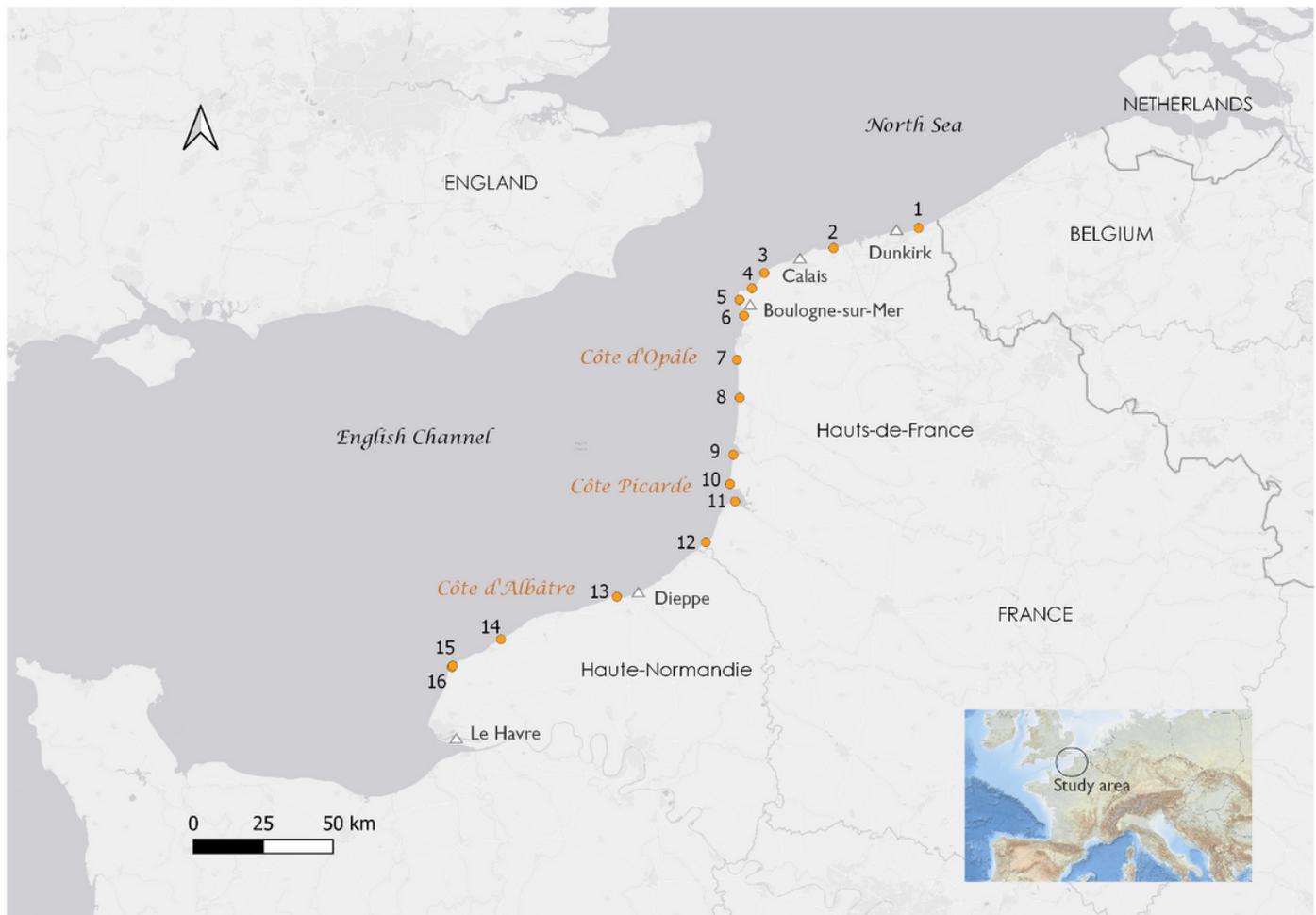


Figure 1

Location map of investigated sites: (1) Dunes Dewulf, (2) Platier d'Oye, (3) Cran d'Escalles, (4) Baie de Wissant, (5) Cran Poulet, (6) Dunes de la Slack, (7) Dunes d'Ecault, (8) Pointe du Touquet, (9) Baie d'Authie, (10) Marquenterre, (11) Pointe du Hourdel, (12) Bois de Cise, (13) Valleuse des Moutiers, (14) Val de la Mer, (15) Pisseuses de Valaine, (16) Valleuse d'Antifer

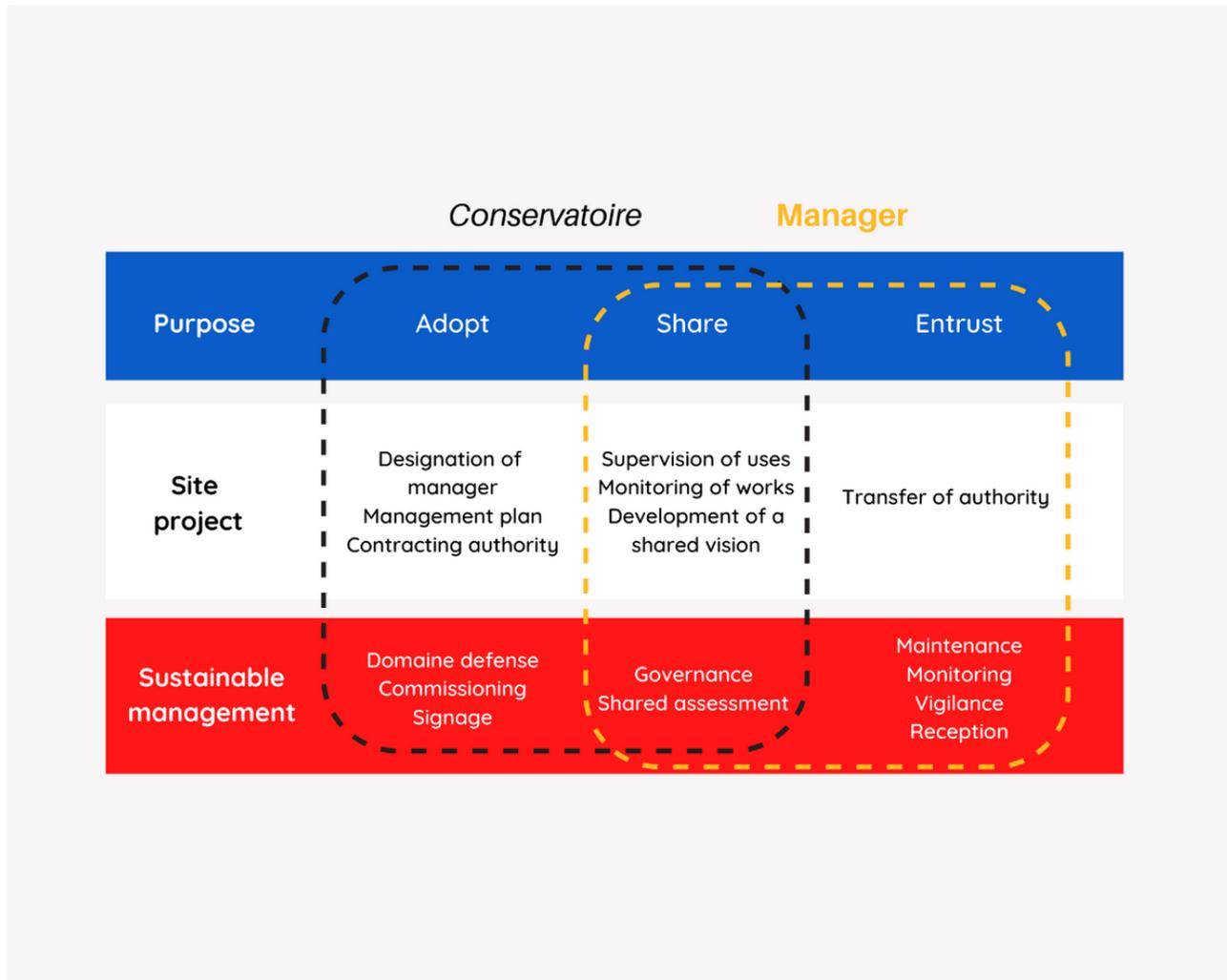


Figure 2

Conservatoire du Littoral (CdL) and managers: respective competencies

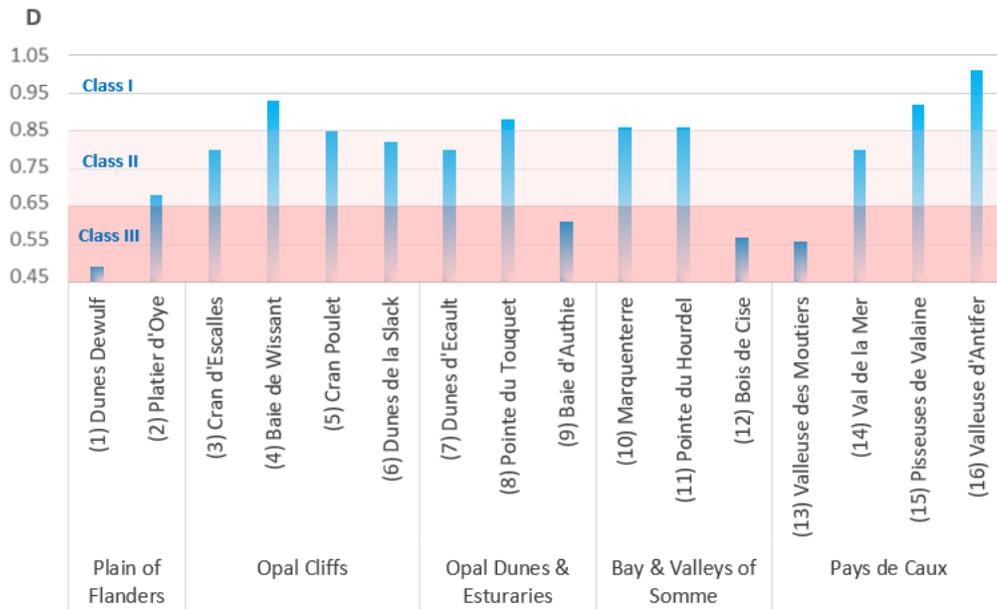


Figure 3

Sites aesthetic values (D) with their corresponding location map number

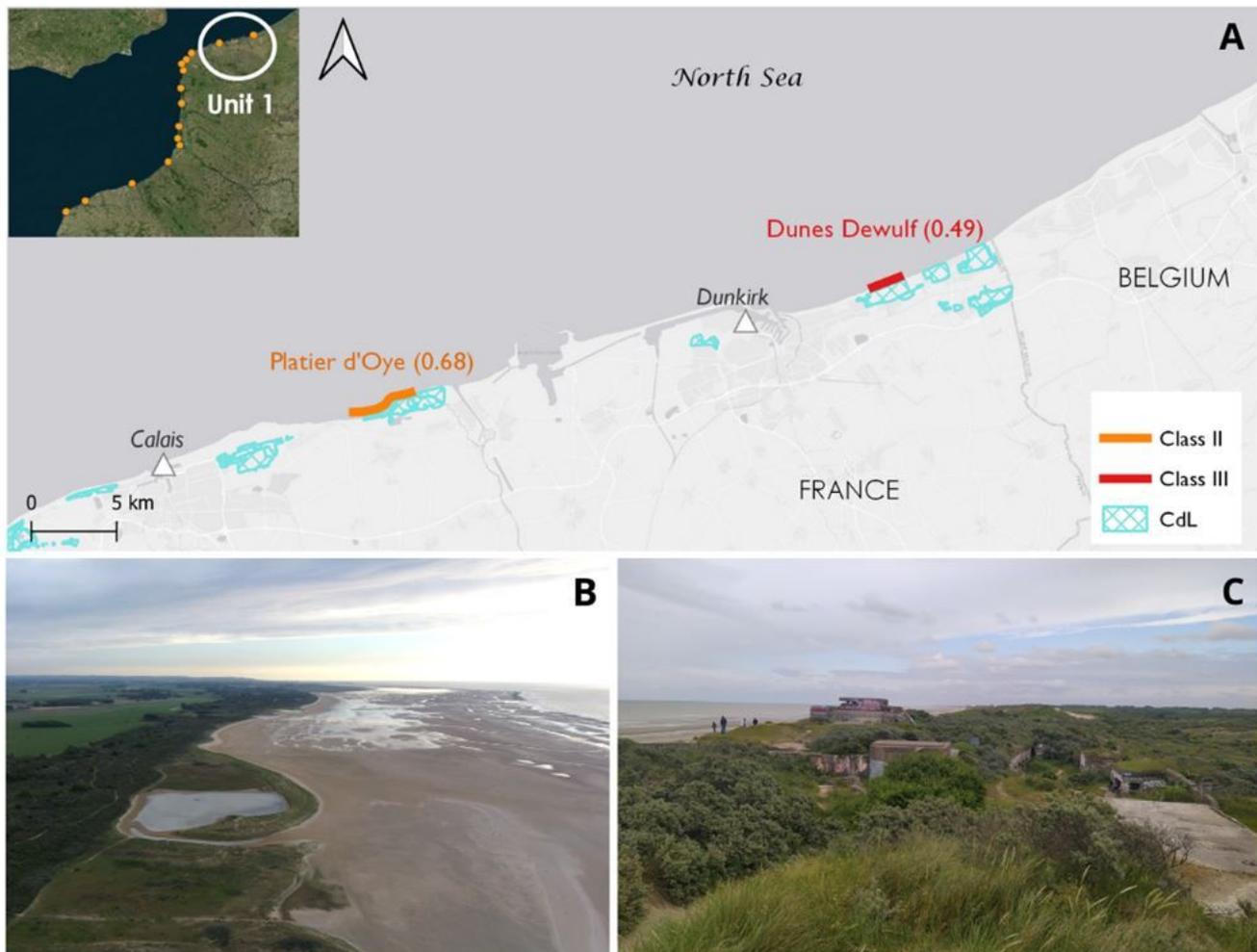


Figure 4

Location map of "Coastal Plain of Flanders and Calais" (A); Coastal lagoon observed at Platier d'Oye (B) and Dune Dewulf complex (C)

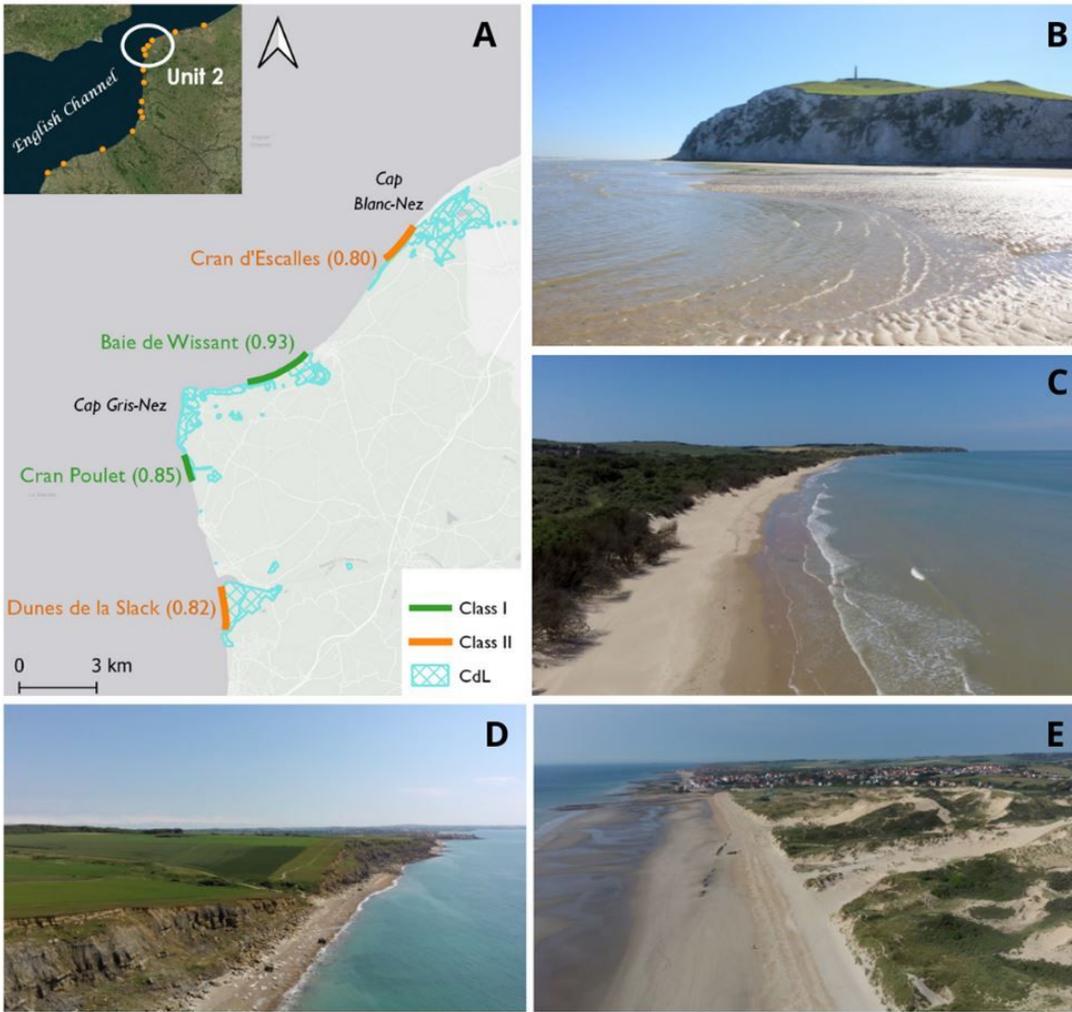


Figure 5

Location map of "Opal Cliffs" (A); chalk cliffs at Cap Blanc-Nez (B) and natural sector of the Wissant Bay (C); grey Jurassic cliffs at Gris-Nez (D) and Slack dune complex (E)

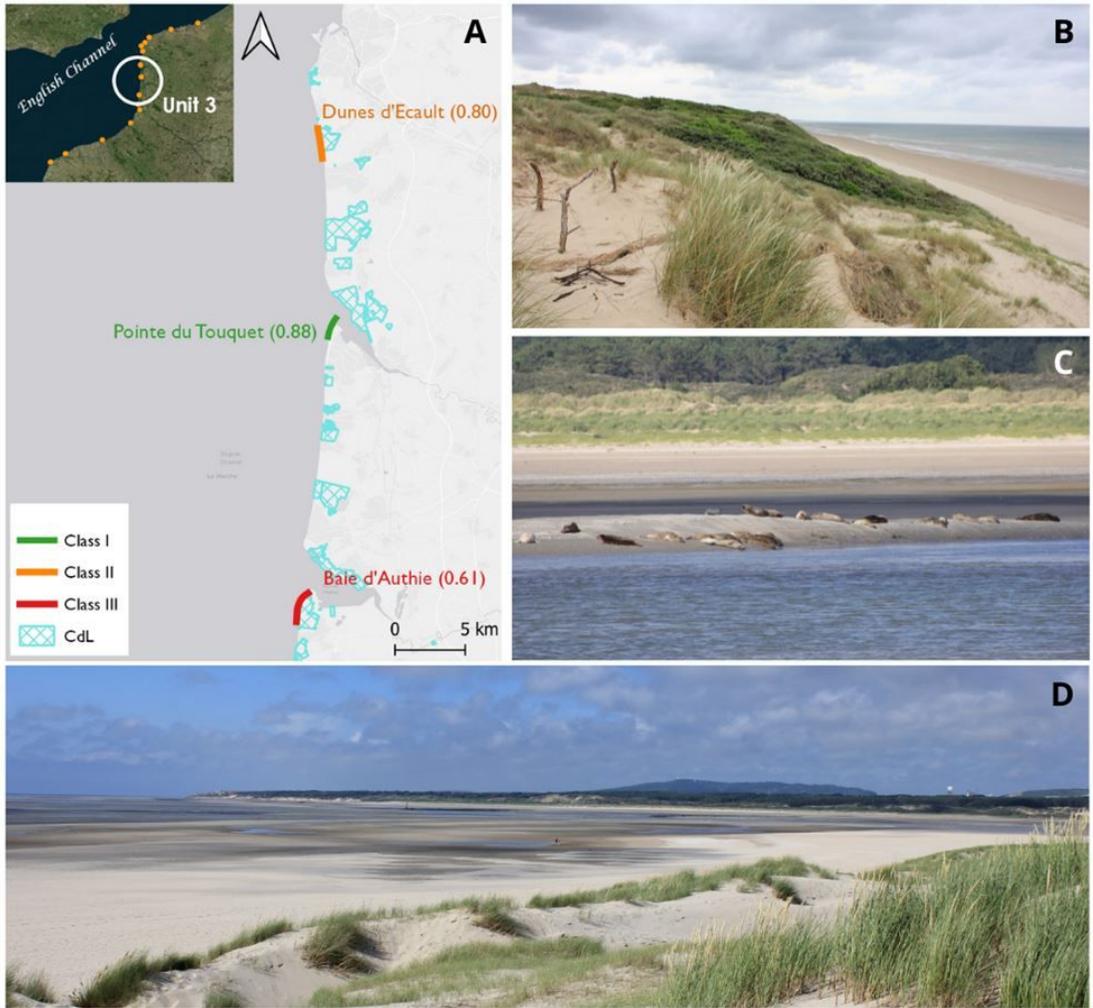


Figure 6

Location map of “Opal Dunes and Estuaries” (A); Dunes d’Ecault, the largest dune complex in northern France (B); harbour seals and grey seals seen in the Canche Bay (C), Pointe du Touquet also known as Banc du pilori (D)

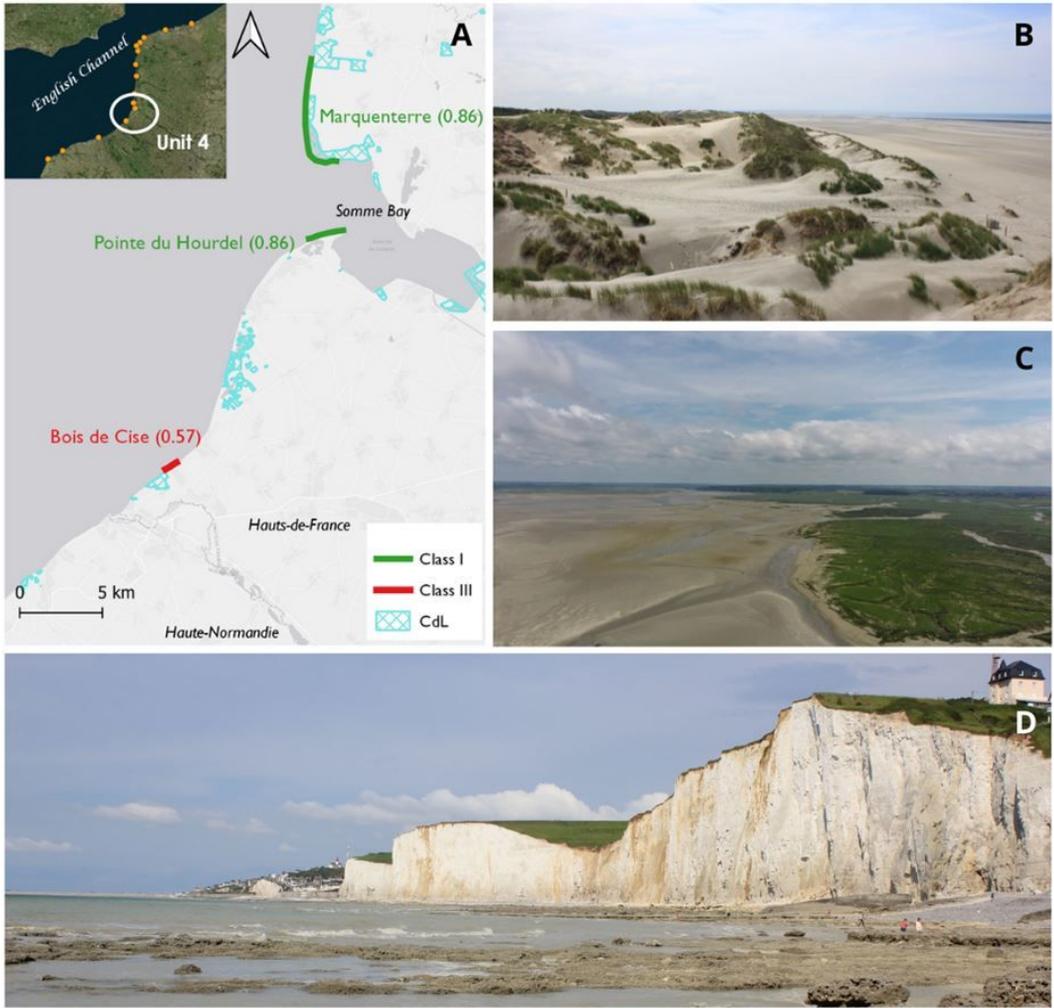


Figure 7

Location map of “Bay and Valleys of Somme” (A); typical dune system known as “Picardy dunes” at Marquenterre (B); Somme Bay (C) and chalk cliff at Bois de Cise (D)

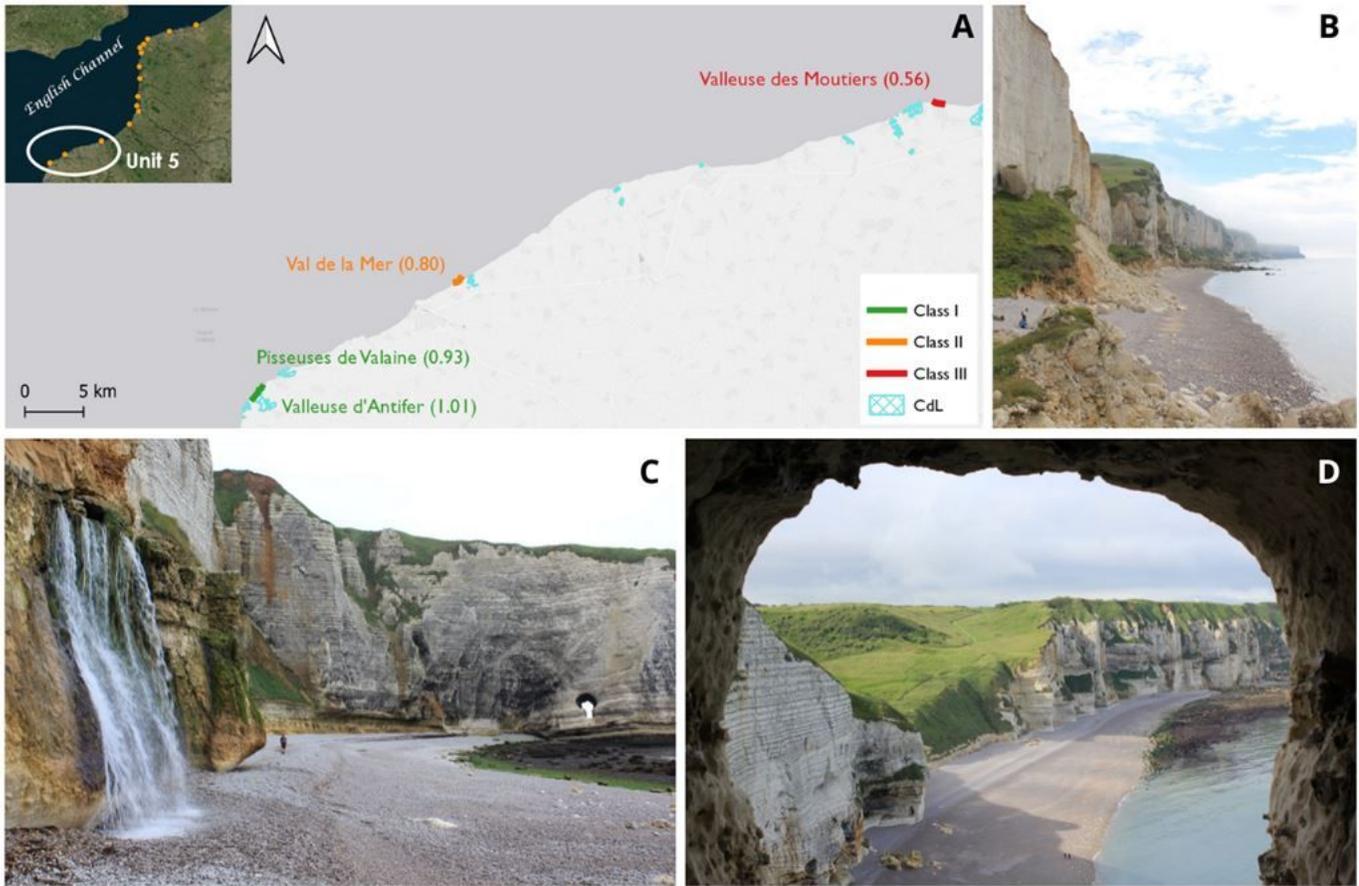


Figure 8
 Location map of “Cliffs and Valleys of Pays de Caux” (A); coastline of Val de la Mer (B); karst spring waterfall observed at Pisseuses de Valaine (C) and natural scenery of Valleuse d'Antifer (D), both sites located near Etretat



Figure 9
 Human parameter scores (CSES) by coastal units (values ≤ 3 in red); CdL areas (in blue) and authorised perimeter for future interventions (in orange)

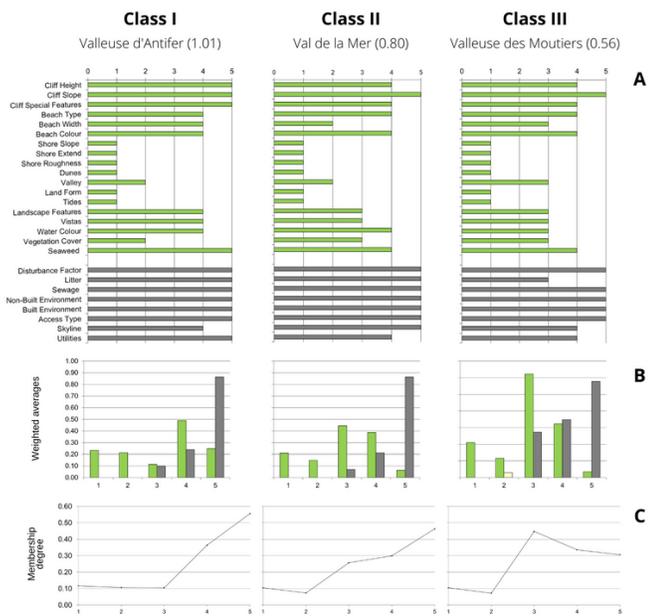


Figure 10

Scenic evaluation histograms (A), weighted averages (B) and membership degree curves (C) for Valleuse d'Antifer (D: 1.01, Class I), Val de la Mer (D: 0.80, Class II) and Valleuse des Moutiers (D: 0.56, Class III)



Figure 11

Cran d'Escalles; new parking moved away from the beach (A) and pathway freshly made with ephemeral exhibition of local artist (B); Litter amounts stranded by sea currents at Valleuse des Moutiers (C); example of *Bac à marée* placed at Dunes d'Ecault in the back dunes near the car park (D); inspiring good practise of local user at Valleuse d'Antifer (E); coastal farm fields from Cap Blanc-Nez to Wissant village (F) and sustainable agricultural practise at Cran Poulet (G), both owned by the CdL; shipwreck, from the well-known operation *Dynamo* carried out in May 1940 along the Flanders coast, and bunkers in background at Dunes Dewulf (H); port of Dunkirk observed from this latter (I); hard structures to protect cliffs from wave action and houses near the clifftop at Bois de Cise (J); soft interventions to protect Cran Poulet from erosion (K); stairways visible at Val de la Mer (L)