

Let's preserve the Mediterranean identity of our beaches!

Charter of Commitment for beaches with *Posidonia oceanica* banquettes

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Abstract. The seagrass *Posidonia oceanica* ecosystem, characteristic of the Mediterranean Sea, provides a number of ecosystem services, in particular the protection of beaches by reducing the wave and swell strength and *via* the exportation of dead leaves that constitute a *banquette* on beaches; both protect beaches against erosion. The removal of the *banquette*, practised by most municipalities to prepare beaches for the tourist season, is considered a costly case of mismanagement. At the same time, municipalities and beachgoers are worried about beach erosion and are willing to develop more sustainable and eco-friendly solutions for the management of beaches. In the framework of the European Union (EU) InterregMed programme, the POSBEMED2 project launched an innovative Charter of Commitment to enhance *P. oceanica* *banquette* friendly management practices. The Charter of Commitment initiative has been proposed by the French *Région Sud* and deployed by 9 project partners in 6 Mediterranean UE countries (Croatia, Cyprus, France, Greece, Italy and Spain). The charter fulfils several aims, e.g. (i) raising awareness, informing and educating beach stakeholders to achieve better understanding of the *banquettes* and coastal ecosystems, (ii) changing collective and individual representations and behaviours with regard to the *P. oceanica* *banquettes* on the beaches, so as to act in a manner that benefits their conservation, (iii) promoting and disseminating best management practices that respect the natural character of beaches and encourage the sharing of experiences, and (iv) supporting those who are starting out on this process and building a *Posidonia* beach friendly community of actors in the Mediterranean. The charter can be signed online by local and regional authorities, representatives of all levels of government, private enterprises and other business interests, NGOs, scientists, academic institutions and citizens. Overall, the message is that *banquettes* could represent a key asset for sustainable tourism in the 21st century, both as an efficient nature-based solution to preserve beaches and as a strong hallmark of our Mediterranean identity.

Keywords: *banquettes* of seagrass dead leaves, beach, beach erosion, coastline management, French Riviera, Mediterranean identity, nature-based solutions, *Posidonia oceanica*, Provence.

Résumé. Ensemble, préservons l'identité méditerranéenne de nos plages ! Charte d'engagement pour des plages de caractère en Méditerranée. La plante à fleurs (magnoliophyte) marine *Posidonia oceanica*, endémique de la Méditerranée, et l'écosystème dont elle est ingénieure, fournissent de nombreux services écosystémiques, en particulier la protection des plages contre l'érosion : réduction de la force des vagues et des houles et exportation de feuilles mortes qui constituent des

banquettes (accumulations de ces feuilles) sur les plages. L'enlèvement des banquettes, pratiqué par la plupart des communes, pour répondre aux demandes supposées des usagers et des touristes, constitue une grave erreur de gestion. Les communes et les usagers s'inquiètent de l'érosion des plages qui en résulte et sont demandeurs de solutions plus écologiques et durables pour la gestion des plages. Dans le cadre d'un programme de l'Union Européenne (UE), le projet InterregMed POSBEMED2, une Charte d'engagement innovante, destinée à promouvoir des pratiques écologiques et durables, a été proposée. Cette charte concerne 6 pays méditerranéens (Chypre, Croatie, Espagne, France, Grèce et Italie), dont la Région Sud (Provence-Alpes-Côte d'Azur, France), avec 9 partenaires. La charte répond à plusieurs objectifs, en particulier (i) développer la sensibilisation, l'éducation du public et la compréhension du rôle des banquettes par les gestionnaires ; (ii) changer les représentations collectives et individuelles, ainsi que les comportements, envers les banquettes, afin d'améliorer leur préservation ; (iii) favoriser et généraliser des pratiques de gestion des banquettes respectueuses de la naturalité des plages, et partager les expériences ; et enfin (iv) accompagner les gestionnaires qui s'engagent dans ce processus et créer une communauté d'acteurs engagés pour une gestion écologique et durable des plages méditerranéennes. La Charte peut être signée en ligne par des représentants des administrations locales et régionales, par des entreprises privées et autres acteurs économiques, par des associations et organisations non-gouvernementales (ONG), par des scientifiques et des instituts universitaires et par de simples citoyens. Au total, le message est que les banquettes représentent une base forte pour le tourisme durable du 21^{ème} siècle, une solution efficace, basée sur la nature, pour la préservation des plages, et enfin un signe fort de l'identité méditerranéenne.

Mots-clés: banquette de feuilles mortes, Côte d'Azur, érosion des plages, gestion côtière, identité méditerranéenne, plages, *Posidonia oceanica*, Provence, solutions basées sur la nature.

1. Introduction

The seagrass *Posidonia oceanica*, endemic to the Mediterranean Sea, is the engineer of an iconic ecosystem. It has become the symbol of the Mediterranean Sea, as are the olive tree and lavender for the lands around it (Boudouresque and Meinesz, 1982; Pergent *et al.*, 2012; Personnic *et al.*, 2014; Boudouresque *et al.*, 2016).

The *P. oceanica* ecosystem is of paramount importance for the functioning of the whole of the Mediterranean Sea and, less expectedly, for that of adjacent land areas. It provides a number of ecosystem services, including (i) as the basis for food webs supporting fish of economic interest, (ii) the production (sand factory) of a significant or a major part of the sand that constitutes the beaches, (iii) mitigation of climate warming by sequestering part of human-induced CO₂ emissions within the *matte*, (iv) the supply of carbon and nitrogen to coastal land ecosystems, (v) the protection of beaches from erosion by reducing the wave and swell strength, and (vi) the direct protection of beaches from erosion by a coat of dead leaves washed ashore during storms, the *banquette* (Mateo *et al.*, 2003; Cardona *et al.*, 2007; Cancemi and Buron, 2008; Cardona and García, 2008; Simeone, 2008; Pergent *et al.*, 2012; Simeone and De Falco, 2013; Pergent *et al.*, 2014; Boudouresque *et al.*, 2017; Roig-Munar *et al.*, 2019; Fontaine *et al.*, 2020; Cantasano, 2021; Pergent-Martini *et al.*, 2021; Boudouresque *et al.*, 2022; IUCN, 2022; Pikelj *et al.*, 2022; Vandarakis *et al.*, 2022).

The removal of the *banquette* from beaches, practised by most municipalities in France and in other Mediterranean countries, is now considered a costly case of mismanagement, from both an ecological and economic point of view (Boudouresque *et al.*, 2017; Otero *et al.*, 2018; IUCN, 2022; Otero *et al.*, 2022). There is an increasing demand among many coastal municipalities and stakeholders for more sustainable and economically viable solutions for the long-term management of *banquettes* (Blanfuné *et al.*, 2022; IUCN, 2022). Here, we present one of the deliverables of a European Union (EU) InterregMed project, POSBEMED2 (November 2019-June 2022), which associated 9 partners from 6 Mediterranean countries, namely the 'Charter of Commitment for Mediterranean *Posidonia* beaches'. This joint charter has been developed in collaboration with the Autonomous Region of Sardinia (Italy), the Natura-Jadera Public Institution for Management of Protected Areas in the County of Zadar (Croatia), Région Sud Provence-Alpes-Côte d'Azur (France), the Region of Central Macedonia (Greece), the Regional Ministry of the Environment of the Balearic Islands (Spain), the International Union for Conservation of Nature (IUCN), the Institute for the Study of Anthropogenic Impact and Sustainability in the Marine Environment of the National Research Council (Italy), the Hellenic Society for the Protection of Nature (Greece) and Enalia Physis Environmental Research Centre (Cyprus) (POSBEMED2, 2022a, 2022b).

2. Beach *banquettes* of *Posidonia oceanica* dead leaves

Leaves of *P. oceanica* are grazed by few herbivores, such as the sea urchin *Paracentrotus lividus* and the fish *Sarpa salpa* (Pergent *et al.*, 1994; Cebrian *et al.*, 1997; Personnic *et al.*, 2014; Boudouresque and Verlaque, 2020). Unconsumed leaves are shed year-round, but mainly in the autumn (Pergent *et al.*, 1994, 1997). They accumulate in the leaf litter, as in terrestrial forest ecosystems; but unlike the latter, a large part of this litter, together with other *P. oceanica* remains (broken rhizomes and sea balls – aegagropiles), is exported by currents and storms to other ecosystems, from the supralittoral zone (beaches) to the bathyal zone (up to more than 1 000 m depth). These dead leaves (and other *P. oceanica* remains) travel, following currents and storms, from one ecosystem to another; everywhere, they are actively consumed by detritus-feeders (e.g. crustaceans), until they are entirely re-mineralised (Fig. 1) (Boudouresque *et al.*, 2016). As far as the *banquette* is concerned, it is mainly made of dead leaves (on average: 73% of total mass), in addition to sea balls (2%) (aegagropiles) (Fig. 2), broken rhizomes (7%) and sand (10%) (Tomasello *et al.*, 2022). It is a rapidly changing structure: from one storm to another, and depending on the season, leaves arrive, are washed offshore, are washed back and/or move to another beach or ecosystem. Overall, the fate of most

of the *P. oceanica* remains of the *banquette* is to return to benthic ecosystems, where they constitute a major source of organic carbon and nutrients (Fig. 1). One cubic meter of *banquette*, once processed via food webs, roughly represents on average ~35 kg fish (Boudouresque, 2021).

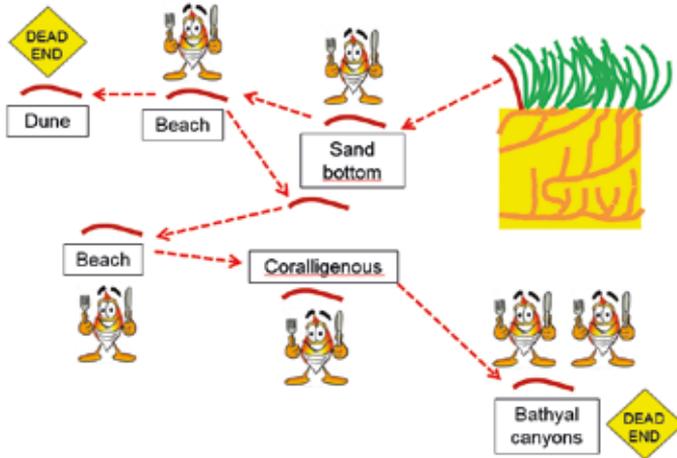


Figure 1. The possible voyage of a *Posidonia oceanica* dead leaf, from shedding (top right) to total consumption. In the final stage, via food webs, symbolized by a crustacean with a knife and fork, dead leaves are converted into fish to be caught by artisanal fishers. Drawing © Charles-François Boudouresque.



Figure 2. Sea balls (aegagropiles) of *Posidonia oceanica* at Is Traias beach (Sardinia, Italy). There, *banquettes* are not removed. Photo © Charles-François Boudouresque, June 2022.

Posidonia oceanica *banquettes* constitute a major compartment of the DBB ecosystem (Dune, Beach, *Banquette*) and a characteristic feature of Mediterranean beaches (Fig. 3); they have been there for at least 10 million years, long before modern humans colonized the Mediterranean shores. Modern humans coexisted with *banquettes* without any conflict of interest until the 1960s-1980s, including in the early days of seaside tourism (Boudouresque *et al.*, 2017).



Figure 3. L'Ostriconi beach, L'Agriate (Corsica). The DBB ecosystem (Dune, Beach, *Banquette*) and the location of *Posidonia oceanica* *banquette* in December 2018. Photo © Charles-François Boudouresque.

Then came tour operators, the development of mass tourism in the 1970s and 1980s, and certain ill-intentioned or ill-advised managers. The image of white sand beaches took over in the collective imagination. Local authorities considered that the *banquettes* smelt bad (which is sometimes true, although rarely), that they were uncomfortable to walk or lie on (which is pretty inaccurate), and so were a hindrance to tourism. They developed the habit of systematically cleaning beaches before the summer to satisfy the real or supposed demands of beachgoers and the leisure industry (see below). What began as an exotic fantasy became a habitual matter of convenience and finally turned into be a requirement and a quality standard: the habit had set in and became a model. Beach managers and local municipalities developed through time management practices corresponding to this model, and most beach managers have followed

and perpetuated this trend, even sometimes in breach of the mandatory management rules and laws.

In France, *P. oceanica*, in all its forms (live or dead, including *banquettes*) is protected by law (*Arrêté* of July 19th, 1988 and *Décret* of September 20th, 1989), so that its destruction is prohibited (Pergent, 1991; Boudouresque and Bianchi, 2013). However, exemptions are granted by the French Ministry of the Environment for the management of *banquettes*, subject to certain conditions and excluding destruction (i.e. landfilling), although these conditions are sometimes poorly respected (Blanfuné *et al.*, 2022). At the EU level, *P. oceanica* is included in Annex I (*Natural habitat types of Community interest whose conservation requires the designation of special areas of conservation*) of the Habitat Directive 92/43 of May 21st, 1992 (Lagier, 1995; Krämer, 2013). Finally, at international level, *P. oceanica* is featured in Annex II (list of endangered or threatened species) of the Barcelona Convention of 1976 and in Appendix I (strictly protected flora species) of the Bern Convention of 1979 (Boudouresque and Bianchi, 2013). It is worth noting that the inclusion of a species within the appendices of the Barcelona and Bern conventions is not indicative of its actual protection level in the member States, which depends upon national legislation. As far as *P. oceanica* is concerned, the French legislation is by far the strongest; failure to comply with the resulting obligation is punishable by criminal and administrative sanctions (article L415-3 of the *Code de l'environnement*, *Ordonnance* of January 11th, 2012, Law of August 1st, 2008).

While the role of the *P. oceanica* meadows in the functioning of coastal ecosystem, and the services they provide to humans, is relatively well known today by the public at large, the role of its dead leaf deposits (*banquettes*) is much less so. Tour operators and managers of seaside resorts generally claim that they remove *P. oceanica banquettes* for the convenience of beachgoers, and at their request. However, is it really true? There is growing evidence that, without *banquette* removal, the number of properly informed beachgoers does not decline, e.g. at Porquerolles Island beaches (Port-Cros National Park, eastern Provence) (Serantoni, 2015). Even without information provided by managers regarding the role of *banquettes*, it appears that the perception of *banquettes* by beachgoers is not as negative as it is claimed by tour operators and local government administrators (Table I); in fact, the level of negative perception increases strongly from users (beachgoers) to managers (e.g. Bergthold, 2017; Boudouresque *et al.*, 2017; Martin, 2017; Otero *et al.*, 2018; Mossone *et al.*, 2019; Réveillon, 2019; Boudouresque *et al.*, 2022).

Table 1. *Posidonia oceanica* banquettes on beaches: differences in perceptions and expectations between beachgoers and stakeholders. From 1 200 interviews (Cyprus, Greece, France, Italy and Spain). No information provided about the role of banquettes. Data from Mossone *et al.* (2019).

		Beachgoers	Tour operators	Local government administrators
Perception of the presence of <i>banquettes</i>	Negative	41%	75%	74%
	Indifferent	33%	18%	22%
	Positive	26%	7%	5%
Have <i>banquettes</i> an impact on tourism?	Yes (negatively)	43%	75%	74% ^a
	No	48%	12%	6%
	Yes (positively)	9%	13%	20%

^a An authors' typing error has been corrected (they wrote 80%).

Unfortunately, removal of the *banquette* triggers a cascade of consequences, a kind of vicious circle (erosion, sand replenishment, sand washed out to the sea, degradation of adjacent *P. oceanica* meadows *via* turbidity and burial, and finally acceleration of the erosive process), the result of which is the accelerated withdrawal of the beach, with negative ecological and economic consequences (e.g. De Falco *et al.*, 2002; Simeone, 2008; Simeone and Di Falco, 2013; Boudouresque *et al.*, 2017; Fontaine *et al.*, 2020).

It is very difficult to overcome a model and a mass aspiration (supposed or actual), here a model of beach, through pressure and constraints. But one of the ways is to try to make this model seem old-fashioned. This is one of the levers of action that was expected to be activated through the launching of the Charter of Commitment platform in the POSBEMED2 project.

As a result, in recent years, the concept of the 'ecological beach', i.e. beaches with soft, environment-friendly management, without any *banquette* removal, or with socially and ecologically acceptable partial removal, has been gaining ground (Boudouresque *et al.*, 2017; Borrello *et al.*, 2019; Astier *et al.*, 2020; Rotini *et al.*, 2020; Scarpato *et al.*, 2020; IUCN, 2022). The concept of ecological beaches is typical for Nature-based Solutions (NbS) (IUCN, 2022). The European program POSBEMED2, based on the above considerations, offers managers and the public at large an attractive solution to facilitate the social acceptability of a new type of beach management, respectful of the environment and economically cost effective.

3. An innovative approach to address the issue of the social acceptability of *banquette* on the beach

3.1. The goals and tools

The original intention was to use Nudge theory, an innovative method for helping virtuous decision-making issued from behavioural economics, as an innovative form of communication to gain in efficiency (Leonard, 2008; Thaler and Sunstein, 2008). ‘To nudge’ means ‘to give a boost’¹; the aim is to encourage individuals or an entire human group to change their behaviours or to make certain choices without putting them under pressure, obligation or threat of sanction. In addition to the Nudge approach, the POSBEMED2 project aimed to use commitment theory (Joule and Beauvois, 1987) and more generally the whole corpus of behavioural sciences (Tagliabue and Simon, 2018) to help broaden and mainstream the lessons learned from the social sciences in public policy implementation.

The issue is as follows: even if well-informed, when faced with a choice, humans are often irrational to the point of making a decision that goes against their own interests. As a general rule, they are all driven by good intentions – but they struggle to transform these intentions into virtuous actions. Everyone knows, for example, that dropping your cigarette butt onto the beach is not a good behaviour! But our favourite decision mode (Cognitive system #1, fast and intuitive), as well as external stimuli, mean that the cigarette butt does not systematically end up in an ashtray. To make the right decision, we need help: in the right place and at the right time to bring about a lasting change in behaviour. That is to say that the boost must be provided in the context of the decision and at the precise moment when the decision is made.

At the start of the project, the intention was therefore to see whether the Nudge approach could be useful in promoting the social acceptability of *P. oceanica banquettes* on the beaches. Two scenarios are to be considered: **(i)** The receiver of the message already knows the reason for the requested behaviour (such as not dropping a cigarette butt on the beach, etc.). A Nudge action can be implemented to promote virtuous action at the time of the action. **(ii)** The receiver of the message is unaware of the reason for the behaviour requested: such as ignorance of the usefulness of *P. oceanica banquettes* to fight against beach erosion; an awareness-raising action prior to the use of Nudge is therefore essential.

In the case of the implementation of the POSBEMED2 project, it was not actually possible to set up Nudges insofar as the beach stakeholders are still too unfamiliar with the role of the *banquettes*. It is

¹ To nudge: in French, ‘*donner un coup de pouce*’.

only when the various users have become aware of its usefulness that a Nudge approach could be implemented. In addition, it should be kept in mind that the use of the Nudge approach only makes sense if it requires modifying a very specific behaviour at the time “t” when it will be accomplished. It is therefore ultimately ill-suited in our case to a problem that relates more to changes in perceptions than changes in behaviour. The project deployed on the *Région Sud* (Provence, Alps and French Riviera) coastline area was therefore focused towards awareness-raising actions using specific psycho-sociological levers.

Prior to the implementation of awareness-raising actions, an exploratory study was carried out to determine what were the curbs and therefore the motivational levers that must be solicited to effectively modify the behaviours and feelings of the target audiences. The qualitative exploratory study involved obtaining information on the criteria, habits and motivations of these target audiences. It focused on a limited sample of people (due to its taking place in the midst of the COVID-19 health crisis) and for this reason made not claim to presenting a representative panel of target audiences. The study took the form of semi-structured individual interviews with a sample of around twenty beach stakeholders (elected officials, actors of the local economy, technicians working for municipalities, NGOs, beachgoers). The answers obtained were processed in order to identify cognitive biases and psychological levers, the interpretation of which served as a theoretical basis for the design of communication tools.

The exploratory study made it possible to bring out various biases and levers of action specific to the issue of the social acceptability of the *banquettes* on the beaches. The biases are: **(i)** ignorance of *banquettes* and their role, **(ii)** negative perception of the *banquette*, **(iii)** the fantasy of an ideal ‘paradise’ beach (in the sense of the white sand postcard), and **(iv)** difficulty projecting into the distant future. The levers to be used are: **(i)** enhance the standing of a more natural beach (beaches as a hallmark of Mediterranean identity), **(ii)** make the issues readable, visible (challenge), **(iii)** promote the understanding of beach erosion issues, **(iv)** make people understand the ecological functions of the *banquette*, **(v)** appeal to emotions to create empathy towards the *banquette*, and **(vi)** demonstrate to elected officials and managers that the effort made is economically useful.

Finally, for these awareness-raising actions to be effective, we have ensured that they comply with the following rules: **(i)** display a benevolent attitude, i.e. do not make people feel guilty, do not give lessons, do not give orders; **(ii)** be attention-grabbing, i.e. have high visibility related to the context of speaking, attractive graphically; **(iii)** be meaningful, i.e. give meaning to the requested action to make it durable; **(iv)** rely on specific psychological levers, i.e. to be able to

counter the biases identified, and adapted to the profile of the people targeted; and **(v)** address the ‘right system of the brain’, either the reflective system to inform upstream, or the intuitive system to trigger downstream action.

3.2. A prerequisite: a public awareness campaign with tailored made tools

Based on this work and these findings (§ 3.1), the first step in the process of a new approach in *banquette* management was to develop innovative communication and awareness-raising tools, with a specific tone (Table II). The choice was to combine humour and instruction (Fig. 4, 5, 6, 7) (Nudge Me *et al.*, 2022a, 2022b; Anonymous, 2022). Here, for instance, when the sea ball (aegagropile) says ‘I stink’, it anticipates the reaction of the public, almost always unfounded, because in most cases, the *banquette* does not stink.



Figure 4. Table set designed to be distributed to beach restaurants and bars in France. Design: Nudge Me and *Région Sud*. POSBEMED2 EU Project.

Table II. How to develop innovative communication and awareness-raising tools with a specific tone: some examples related to *Posidonia oceanica* banquettes on beaches.

Tone	Examples
Personification	The <i>banquette</i> of <i>Posidonia oceanica</i> takes the floor
Turning drawbacks into assets	'I'm ugly and I stink. Maybe, but without me, no beach!' (see Fig. 5)
Convincing	29% of Mediterranean beach habitat in Europe has been lost in the last 50 years
Protesting	'So there, and that's that' (see Fig. 5)
Didactic, while being simple	'Just like land plants, I shed my leaves in winter'
Reassuring	'I am not harmful, nor toxic, nor polluting'
Touching	'I'm ugly and I stink' (see Fig. 5)
Partner	'Just call me Posidonia'. 'I've been a star for millennia'
Valuing the work of public authorities	'I have been protected for 50 years'
Ambitious	A Charter of Commitment for outstanding beaches which preserve their Mediterranean identity (In French: ' <i>Plages de caractère</i> ' ^a)

^a We are talking about *caractère* for a remarkable person, as for a good wine (a *cru*) that stands out among world-famous good standard wines.

Other specific tools and fun products have been developed, including an interactive *Posidonia* quiz, which is particularly appreciated when played at camp sites for evening entertainment (Fig. 8) (Lanier, 2021-2022).



Figure 5. First page of a leaflet edited by the French *Région Sud*, in the framework of the UE POSBEMED2 programme (Nudge Me *et al.*, 2022a). The sea ball says: 'I'm ugly and I stink. Maybe, but without me, no beach!' And it adds: 'So there, and that's that' - I am *Posidonia* in person'. At the bottom, note the chosen slogan: '*Nos plages ont du caractère*' (our beaches have class).



Figure 6. From a cartoon made with and for school students. People say: *'How nice to take advantage of the softness of the banquettes for sunbathing!'*. Drawing Julie Borgese in Rossi et al. (2022).



Figure 7. Post card published by the French *Région Sud*, in the framework of the UE POSBEMED2 program (Nudge Me et al., 2022a). The sea ball says: *'I'm not a diva'* (unlike the famous singer Beyoncé), *'But without me, it's hopeless'*.



Figure 8. The interactive Posidonia quiz. The text says: 'Ready for the Big Challenge? The quiz that's all about me!'

Awareness-raising actions aimed at beach users and stakeholders have been designed as a prerequisite in a three-step process. **(i)** First step: carrying out awareness-raising actions with beach users and economic players (stakeholders). **(ii)** Second step: convincing elected officials and managers to change their practices, by having them sign the Charter of Commitment and choose the first practical actions to implement. **(iii)** Third step: creating a virtuous dynamic that has a snowball effect by promoting the spread and visibility of the commitment of municipalities and users to make people want to join the movement and get involved. The idea is also to show, via the Mobilization Platform, that the public is more favourable to the *banquettes* than it seems and that therefore less risk-taking may be involved for managers than they think. The Charter of Commitment and the Mobilization Platform are tools that should help to generate this expected virtuous circle dynamic (Fig 9).

3.3. A Charter of Commitment for beaches which preserve their Mediterranean identity.

The second step in the process of a new kind of approach to *banquette* management concerns a joint Charter of Commitment, aiming to create a lasting collaboration between national governments and beach stakeholders (POSBEMED2, 2022b).

The goals in creating a Charter of Commitment were the following: **(i)** To raise awareness among all beach stakeholders on the importance of preserving the *Posidonia banquette* from an ecological point of view and for preventing erosion. **(ii)** To enhance the Mediterranean character of our shores and give it an identity in its own right, as a basis for the development of an alternative model of seaside tourism. And **(iii)** to contribute to the emergence of a network of committed Mediterranean beach stakeholders.

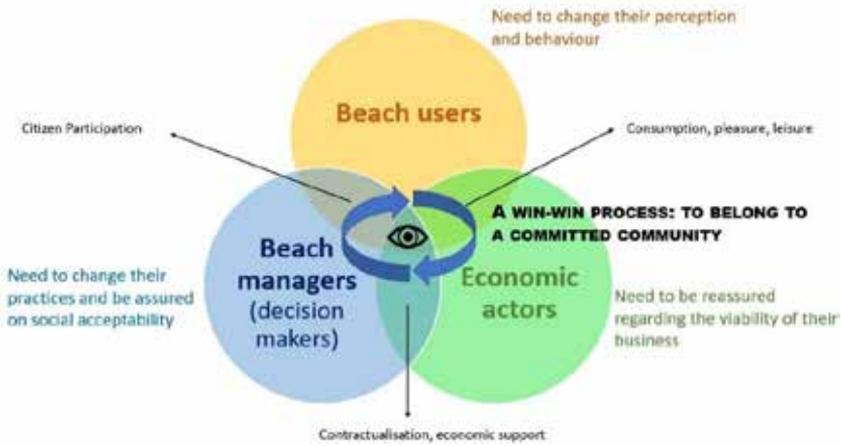


Figure 9. Beach stakeholder relationships and needs. Drawing © Stéphanie Oudin.

The Charter of Commitment (Fig. 10) can be signed by all beach stakeholders: **(i)** National governments, **local authorities**, and beach managers, at any administrative level. **(ii) Economic actors**, private enterprises, tourism organizations and NGOs. **(iii) Citizens** (local inhabitants or tourists) and all other actors, e.g. academic institutions, scientists, cultural actors, etc. The signature can be done through the Mobilization Platform at the following website: <https://www.act4posidonia.eu/>. The Charter of Commitment has been drafted jointly by all POSBEMED2 partners representing six countries and is therefore available in 6 languages (Croatian, English, French, Italian, Greek and Spanish) (POSBEMED2, 2022b). The charter highlights the values and goals common to all the partners of the POSBEMED2 project, to reflect another way of enjoying the beach and preserving its Mediterranean identity.

The charter is based on a comprehensive approach and shared values that seek to:

1. Recognise Mediterranean beaches for their unique, natural and authentic character.
2. Manage Mediterranean beaches with respect, paying particular attention to the fauna and flora that inhabit them.
3. Enhance the cultural identity of Mediterranean beaches.
4. Develop seaside economies in a manner that takes into account the benefits of *Posidonia oceanica* in sustaining the quality of the coast.
5. Promote healthy beaches that reflect the good quality of bathing waters and marine ecosystems.
6. Promote biodiversity and the preservation of these beaches for future generations.
7. Preserve the beauty and uniqueness of Mediterranean coastal landscapes.
8. Provide clean, waste-free beaches that are accessible to all.
9. Conserve the ecological features of beaches to increase the resilience of Mediterranean coasts to climate change.



Figure 10. What the Charter of commitment looks like. Versions in other languages (e.g. French and Italian) are available.

Moreover, the signatories of the charter agree to commit to (POSBEMED2, 2022b):

1. Promote the commitment to this charter among stakeholders.
2. Participate in the development of knowledge concerning the ecosystem of the beach and the *banquette* and more generally of Mediterranean coastal ecosystems.
3. Raise awareness, inform, educate and enhance the capacity-building of beach stakeholders, in order to better understand and protect the *banquettes* and Mediterranean coastal ecosystems.
4. Change collective and individual behaviours and practices with regard to the *P. oceanica banquettes* on the beaches, so as to act in a manner that benefits their conservation.
5. Promote and disseminate best management practices for beaches that respect their naturalness and encourage the sharing of experiences.
6. Participate in mainstream nature-based solutions and ecosystem-based approaches in Mediterranean coastal management.
7. Comply with existing regional, national and EU regulations concerning *P. oceanica* meadows and *banquettes* or promote the application of regulations in countries or regions where they do not exist.

3.4. A Mobilization Platform to preserve *Posidonia oceanica banquettes* on beaches and sign the Charter of Commitment

The third step in the process of a new approach to *banquette* management concerns the creation of the Mobilization Platform to facilitate the signature of the charter and to enhance the expected 'snowball effect' and virtuous circle.

The challenge here is that targeting many different sectors of the public enhances the chance of getting more people involved in *Posidonia banquettes* preservation and generating emulation between stakeholders. Each signatory can choose their own feasible, practical and relevant options to engage commit to. It is a tailor-made and step-by-step commitment. This point is a crucial one with regard to the spirit of commitment, especially for local authorities that have the responsibility for beach management. They can try new practices step-by-step, and gradually adapt to the constraints of the site and the reactions of beach users.

In the case of administrations and other entities responsible for beach management, the Charter proposes the following commitment focal areas, in addition to which signatories are invited to propose and develop additional, actor-specific commitments as indicated previously (POSBEMED2, 2022b):

1. Provide the resources to finance and/or use management techniques that promote the sustainable management of *P. oceanica banquettes* and Mediterranean ecosystems overall.
2. Avoid the use of heavy machinery, especially in sensitive areas.
3. Where *P. oceanica banquette* removal is authorized, use only soft methods (manual collection, sifting) that allow the removal of waste only while preserving *P. oceanica banquettes*.
4. Before deciding on which management technique to implement, develop a baseline study to discover and understand management methods that promote the preservation of *P. oceanica banquettes* and coastal ecosystems. For example: leaving *P. oceanica banquettes* untouched; temporarily removing *banquettes* during the summer season, storing the *banquette* on-site and returning it to the shoreline after the tourist season.
5. Develop and implement awareness-raising and outreach activities related to *P. oceanica banquettes* and meadows addressed to all beach users.
6. Promote and/or finance research activities to improve existing knowledge on the relationships between *P. oceanica* and coastal ecosystems.
7. Include in calls for tenders for beach concessions a specific clause promoting the sustainable management of *P. oceanica banquettes*.
8. Other actions that target the common goals and support the enabling actions for *P. oceanica* banquette management (e.g. the support and promotion of local legislation that drives the protection of *P. oceanica banquettes*).

The creation of the Mobilization Platform was driven by the need to have a communication tool for the Charter of Commitment that can be disseminated throughout the Mediterranean. The idea was to create a tool as: **(i)** A tool of mobilization for a cause. **(ii)** A tool to disseminate and promote the tailor-made actions to which the signatories have committed themselves. And **(iii)** a unifying tool promoting a Mediterranean identity and belonging to a community of committed actors. We present an illustration of the process of commitment on the Mobilization Platform (Fig. 11).

The first 6 months following the launch of the Mobilization Platform have shown that this type of tool can be powerful provided it is accompanied by a field promotion campaign. There is a crucial need for promotion to fully scale up a 'community of committed beach stakeholders' in addition to the platform. The platform cannot be seen as self-sufficient. The role of associations in that regard is essential to accompany public policies. Moreover, the commitment of decision makers requires spending time with them and their beach managers for in-depth discussion of the details and to help them identify actions to be implemented to further build a real action plan for *Posidonia* beaches

sustainable management. The step-by-step approach appears to be appreciated by decision makers willing to commit but still concerned about the potential reactions of tourists and local inhabitants. The key to the success of the ‘Charter of Commitment for *Posidonia* Beaches in the Mediterranean’ will be the capacity to create a long-term regional campaign, using all the tools developed in the POSBEMED2 project to help beach users to change their perception, to further integrate and engage economic actors and accompany beach managers to gradually implement new practices. Such campaigns should be accompanied by sociological surveys in order to assess the changes in perception and the obstacles to and levers of the social acceptability of change as new *banquette* management practices are implemented.

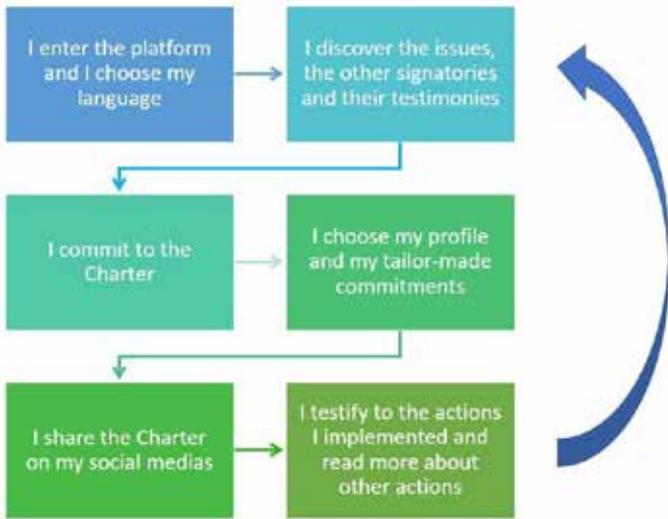


Figure 11. The commitment process on the Mobilization Platform on: <https://www.act4posidonia.eu/>

Conclusions

The *banquettes* of dead leaves of *Posidonia oceanica* have been a major feature of Mediterranean beaches, for millions of years. Humans have always accepted their presence, as part of their familiar and unthreatening landscape, and this continued to be the case until the first decades of the era of tourism (i.e. until the 1970s-1980s).

Today, most beach managers throughout the Mediterranean consider *banquettes* as waste and eliminate them methodically, often brutally, using heavy machinery. However, these practices are no

longer sustainable; a considerable body of scientific data shows that the removal of the *banquettes* has disastrous consequences, not only for the ecosystem of the beaches (the DBB ecosystem), but also for the very existence of the beaches, and therefore for the economy of tourism.

The voices of the scientists are increasingly making themselves heard and practices are changing gradually in European Mediterranean countries, mostly when regulation is strong and properly enforced. But climate change is intensifying the need to go further and faster to preserve beaches from erosion and preserve their biodiversity and ecosystem services.

In addition, all the surveys show that, contrary to what some managers claim, it is less the users than the managers and tour operators who demand beaches without *banquettes*. In a way, tour operators still try to 'sell' Polynesian-style beaches to beachgoers and managers².

The new deal today is to 'change the software'. The aim is to propose a sustainable form of seaside tourism. Beaches with *banquettes* represent not only a pivotal emblem of Mediterranean cultural identity, but also a realistic approach to economic profitability. The term 'beaches of character', a mirroring 'wines of character' or 'a village of character', which are the pride of the Mediterranean regions, constitutes a specific feature of the *Région Sud* part of the UE programme. It is time to promote the real Mediterranean identity, and to highlight this, rather than an ersatz version of French Polynesia. This is a key asset for sustainable tourism in the 21st century.

This Charter of Commitments is a step forward towards this objective. It is important for the reader to understand that it is aimed at voluntary membership and does not involve binding regulatory constraints (apart from regional, national and EU laws). It constitutes a projection towards the future, a future that will be beneficial to users, to the economy and to biodiversity.

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² Alain Barcelo (*in* Boudouresque *et al.*, 2017) and Gérard Pergent (reviewer's comment) mischievously note that the beaches of Polynesia are often strewn with coral debris, much sharper and bothersome than the leaves of *P. oceanica*, and that these beaches may not be as heavenly as our managers and tour operators imagine.

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References

- ANONYMOUS, 2022. *Posidonia oceanica*. [storia] di una pianta aquatica molto antica e preziosa. Area Marina Protetta Penisola del Sinis Isola di Mal di Ventre publ., Cabras (Sardinia): 1-16.
- ASTIER J.M., BOUDOURESQUE C.F., PERGENT G., PERGENT-MARTINI C., 2020. Non-removal of the *Posidonia oceanica* 'banquette' on a beach very popular with tourists: lessons from Tunisia. *Sci. Rep. Port-Cros Natl. Park*, 34: 15-21.
- BERGTHOLD V., 2017. *POSBEMED, gestion des banquettes de posidonie en Méditerranée française*. Mémoire master 'Environnement marin', Aix-Marseille Université, Marseille : 1-58.
- BLANFUNÉ A., BOUDOURESQUE C.F., SCHOHN T., ASTRUCH P., BELLONI B., CASSETTI O., L.C. DZIEGALA L.C., MIRLEAU P., THIBAUT T., 2022. *Synthèse cartographique et analyse biométrique des banquettes de posidonies de la Région Sud*. Fabrique de connaissance – Région Sud – Action N° 11. Contrat Aix-Marseille Université – Région Sud Provence-Alpes-Côte d'Azur, GIS Posidonie publ., Marseille : 1-75.
- BORRELLO P., CHIESA S., MALTESE S., SILVESTRI C., SCARPATO A., 2019. Management of *Posidonia oceanica* beached accumulations and the 'ecological beach' model. *Rapp. Comm. Intl. Mer Méditerr.*, 42: 218.
- BOUDOURESQUE C.F., 2021. La biodiversité à Marseille: les herbiers à *Posidonia oceanica*, leur statut et les services qu'ils rendent. *Marseille, la revue culturelle de la ville de Marseille*, 270 : 49-51.
- BOUDOURESQUE C.F., BIANCHI C.N., 2013. Une idée neuve: la protection des espèces marines. In: *GIS Posidonie: plus de 30 ans au service de la protection et de la gestion du milieu marin*. Le Diréach L., Boudouresque C.F. (eds.), GIS Posidonie publ., Marseille : 85-91.
- BOUDOURESQUE C.F., MEINESZ A., 1982. Découverte de l'herbier de Posidonie. *Cah. Parc Natl. Port-Cros, Hyères.*, 4 : 1-79.
- BOUDOURESQUE C.F., VERLAQUE M., 2020. *Paracentrotus lividus*. In: *Sea Urchins: Biology and Ecology*, Fourth Edition. Lawrence J.M. (ed.), Elsevier, Academic Press, Publ.: 447-485.
- BOUDOURESQUE C.F., PERGENT G., PERGENT-MARTINI C., RUITTON S., THIBAUT T., VERLAQUE M., 2016. The necromass of the *Posidonia oceanica* seagrass meadow: fate, role, ecosystem services and vulnerability. *Hydrobiologia*, 781: 25-42.
- BOUDOURESQUE C.F., PONEL P., ASTRUCH A., BARCELO A., BLANFUNÉ A., GEOFFROY D., THIBAUT T., 2017. The high heritage value of the Mediterranean sandy beaches, with a particular focus on the *Posidonia oceanica* 'banquettes': a review. *Sci. Rep. Port-Cros Natl. Park*, 31: 23-70.
- BOUDOURESQUE C.F., BĂNARU D., CHANGEUX T., 2022. Fleuves, inondations, plages et milieu marin: pour une approche intégrée en Méditerranée. *Sci. Rep. Port-Cros Natl. Park*, 36: 43-57.
- CANCEMI G., BURON K., 2008. *Érosion du littoral et suivi des banquettes de posidonie sur les plages de Corse*. DIREN Corse et EVEMar, Porto-Vecchio : 1-45.
- CANTASANO N., 2021. Deposition dynamics of *Posidonia oceanica* 'banquettes' on Calabrian sandy beaches (Southern Italy). *Coasts*, 1: 25-30.
- CARDONA L., GARCÍA M., 2008. Beach-cast seagrass material fertilizes the foredune vegetation of Mediterranean coastal dunes. *Acta Oecologica*, 34: 97-103.
- CARDONA L., REVELLES M., SALES M., AGUILAR A., BORRELL A., 2007. Meadows of the seagrass *Posidonia oceanica* are a significant source of organic matter for adjoining ecosystems. *Mar. Ecol. Prog. Ser.*, 335: 123-131.
- CEBRIÁN J., DUARTE C.M., MARBÀ N., ENRÍQUEZ S., 1997. Magnitude and fate of the production of four co-occurring Western Mediterranean seagrass species. *Mar. Ecol. Prog. Ser.*, 155: 29-44.
- DE FALCO G., BAROLI M., SIMEONE S., PIERGALLINI G., 2002. La rimozione della *Posidonia* dalle spiagge: conseguenze sulla stabilità dei litorali. Fondazione IMC – Centro Marino Internazionale - ONLUS publ., Torregrande Oristano, Italy: 1-17.
- DREAL, 2019. *Améliorer la gestion de la posidonie sur les plages*. DREAL Provence-Alpes-Côte d'Azur publ. : 1-8.
- FONTAINE Q., FULLGRABE L., PARADIS G., SORBA V., POZZO DI BORGIO M.L., CANCEMI G., LEJEUNE P., 2020. *Étude des communautés végétales présentes sur les plages de Rondinara et Balistra et caractérisation des dépôts de banquettes de posidonie*. Contrat Stareso-OEC E07-19, Stareso publ., Calvi : 1-108.
- IUCN, 2022. *Enhancing Mediterranean coastal resilience with Posidonia oceanica and Nature-based Solutions*. IUCN Centre for Mediterranean Cooperation and Enalia Physis Environmental Research Centre publ., Cyprus: 1-8.

- JOULE R.V., BEAUVOIS J.L., 1987. *Petit traité de manipulation à l'usage des honnêtes gens*. Presses universitaires de Grenoble, Grenoble.
- KRÄMER L., 2013. De l'intérêt général, de l'Union Européenne et de l'environnement. In: *Pour un droit économique de l'environnement. Mélanges en l'honneur de Gilles J. Martin*. Éditions Frison-Roche, Paris : 249-259.
- LAGIER C., 1995. L'Europe et l'environnement: la Directive 92/43/CEE du 21 mai 1992 sur la conservation des habitats naturels de la faune et de la flore sauvages. *La Gazette du Palais*, 1-2 février 1995 : 14-21.
- LANIER J.F., 2021-2022. Campagne Écoattitude : le quiz Posidonie. ADEE (Association pour le Développement de l'Éducation à l'Environnement), Fréjus.
- LEONARD T.C., 2008. Richard H. Thaler, Cass R. Sunstein, Nudge: Improving decisions about health, wealth, and happiness. Yale University Press, New Haven, CT, 2008, 293 pp, \$36.00. *Const. Polit. Econ.*, 19: 356-360.
- MARTIN A., 2017. *Analyse socio-économique de la gestion des plages : cas des banquettes de posidonies sur les communes du littoral méditerranéen français*. Mémoire Ingénieur agronome, Supagro, Montpellier : 1-65.
- MATEO M.A., SÁNCHEZ-LIZASO J.L., ROMERO J., 2003. *Posidonia oceanica* 'banquettes': a preliminary assessment of the relevance for meadow carbon and nutrient budget. *Estuar. Coast. Shelf Sci.*, 56: 85-90.
- MOSSONE P., GUALA I., SIMEONE S., 2019. *Posidonia* banquettes on the Mediterranean beaches: to what extent do local administrators' and users' perceptions correspond? In: *Planning, nature and ecosystem services*, Gargiulo C., Zoppi C. (eds.), FedOAPress, Naples: 225-234.
- NUDGE ME, BUSTAMANTE B., BADAROUX J.M., 2022a. - *Je suis moche et je pue, peut-être... Mais sans moi, pas de plage!* / Plaque de vulgarisation, Région Sud publ., Marseille : 1-4.
- NUDGE ME, BUSTAMANTE B., BADAROUX J.M., 2022b. Rapport d'activité POSBEMED2. Comment favoriser l'acceptabilité sociale des banquettes de posidonie. Nudge Me publ., Lyon : 1-50 + annexes.
- OTERO M.M., SIMEONE S., ALJINOVIC B., SALOMIDI M., MOSSONE P., GERAKARIS V., GIUNTA FORNASIN M.E., MILANO P., HEURTEFEUX H., ISSARIS Y., GUIDO M., ADAMOPOULOU M., 2018. *POSBEMED: gouvernance et gestion des systèmes plages/dunes à posidonie*. Rapport final. IUCN publ., Málaga : 1-66 + Annexes.
- OTERO M.M., SIMEONE S., LINDQVIST E., AGAOGLOU C., PALOMBO L., HADJIOANNOU L., SAVVIDES P., PETROU N., 2022. *A manual for conserving Mediterranean beaches with Posidonia oceanica and assessing progress of management actions*. POSBEMED2 Interreg Med Project, IUCN publ., Málaga : 1-106 + Annexes.
- PERGENT G., 1991. La protection légale de la Posidonie en France: un outil efficace. Nécessité de son extension à d'autres pays méditerranéens. In: *Les espèces marines à protéger en Méditerranée*, Boudouresque C.F., Avon M., Gravez V. (eds.), GIS Posidonie publ., Marseille : 29-33.
- PERGENT G., ROMERO J., PERGENT-MARTINI C., MATEO M.A., BOUDOURESQUE C.F., 1994. Primary production, stocks and fluxes in the Mediterranean seagrass *Posidonia oceanica*. *Mar. Ecol. Prog. Ser.*, 106: 139-146.
- PERGENT G., RICO-RAIMONDINO V., PERGENT-MARTINI C., 1997. Fate of primary production in *Posidonia oceanica* meadows of the Mediterranean. *Aquatic Botany*, 59: 307-321.
- PERGENT G., BAZAIRI H., BIANCHI C.N., BOUDOURESQUE C.F., BUIA M.C., CLABAUT P., HARMELIN-VIVIEN M., MATEO M.A., MONTEFALCONE M., MORRI C., ORFANIDIS S., PERGENT-MARTINI C., SEMROUD R., SERRANO O., VERLAQUE M., 2012. *Les herbiers de Magnoliophytes marines de Méditerranée. Résilience et contribution à l'atténuation des changements climatiques*. IUCN publ., Gland, Málaga : 1-79.
- PERGENT P., BAZAIRI H., BIANCHI C.N., BOUDOURESQUE C.F., BUIA M.C., CALVO S., CLABAUT P., HARMELIN-VIVIEN M., MATEO M.A., MONTEFALCONE M., MORRI C., ORFANIDIS S., PERGENT-MARTINI C., SEMROUD R., SERRANO O., THIBAUT T., TOMASELLO A., VERLAQUE M., 2014. Climate change and Mediterranean seagrass meadows: a synopsis for environmental managers. *Mediterr. Mar. Sci.*, 15 (2): 462-473.
- PERGENT-MARTINI C., PERGENT G., MONNIER B., BOUDOURESQUE C.F., MORI C., VALETTE-SANSEVIN A., 2021. Contribution of *Posidonia oceanica* meadows in the context of climate change mitigation in the Mediterranean Sea. *Mar. Environ. Res.*, 165 (105236): 1-10.
- PERSONNIC S., BOUDOURESQUE C.F., ASTRUCH P., BALLESTEROS E., BLOUET S., BELLAN-SANTINI D., BONHOMME P., THIBAUT-BOTHA D., FEUNTEUN E., HARMELIN-VIVIEN M., PERGENT G., PERGENT-MARTINI C., PASTOR J., POGGIALE J.C., RENAUD F., THIBAUT T., RUITTON S., 2014. An ecosystem-based approach to assess the status of a Mediterranean ecosystem, the *Posidonia oceanica* seagrass meadow. *PlosOne*, 9 (6): 1-17 (e98994).
- PIKELJ K., GODEC P., CVETKO TEŠOVIĆ B., 2022. Sedimentological consequences of *Posidonia oceanica* banquette removal: Sakarun beach case study (Dugi Otok, Croatia). In: *Monitoring of Mediterranean coastal areas: problems and measurement techniques*, Livorno (Italy), Ninth International Symposium, Bonora L., Carboni D., De Vincenzi M., Matteucci G. (eds.), Firenze University Press, Firenze: 83-92.

- POSBEMED2, 2022a. www.act4posidonia.eu. Accessed on July 9th, 2022.
- POSBEMED2, 2022b. *A joint charter of commitments for Mediterranean beaches with Posidonia*. IUCN Center for Mediterranean cooperation publ., Malaga: 1-26.
- RÉVEILLON É., 2019. *Tourisme de masse et atteintes environnementales du milieu marin. Golfe de Saint-Tropez (1955-1985)*. Mémoire Master 2 Histoire et humanités, Aix-Marseille Université : 1-179.
- ROIG-MUNAR F.X., RODRÍGUEZ-PEREA A., MARTÍN PRIETO J.Á., GALABER FERRER B., 2019. Cuantificación de la pérdida de sedimento por la retirada mecánica de bermas (*banquettes*) de *Posidonia oceanica* en las playas de las Islas Baleares: consecuencias geomorfológicas. *Rev. Soc. Geol. Esp.*, 32 (2): 73-86.
- ROSSI F., BUSSOTTI S., BORGESE J., 2022. *En route ! Les secrets de la plage avec Sidonie*. Région Sud and Université Côte d'Azur publ., Nice : 1-8.
- ROTINI A., CHIESA S., MANFRA L., BORELLO P., PIERMARINI R., SILVESTRI C., CAPPUCCI S., PARLAGRECO L., DEVOTI S., PISAPIA M., CREO C., MEZZETTI T., SCARPATO A., MIGNORE L., 2020. Effectiveness of the 'ecological beach' model: beneficial management of *Posidonia* beach casts and *banquette*. *Water*, 12 (3238): 1-16.
- SCARPATO A., BORRELLO P., CHIESA S., DEVOTI S., MAGALETTI E., MANFRA L., MUGNAI C., PARLAGRECO L., PIERMARINI R., ROTINI A., SILVESTRI C., CAPPUCCI S., CREO C., MIGLIORE L., MAZZARELLI G., 2020. La spiaggia ecologica: gestione sostenibile della *banquette* di *Posidonia oceanica* sugli arenili del Lazio. ISPRA publ., Roma : 1-52.
- SERANTONI É., 2015. La gestion des dépôts marins sur les plages sur l'île de Porquerolles, située en cœur du parc national de Port-Cros (Provence, France). *Sci. Rep. Port-Cros Natl. Park*, 29: 223-235.
- SIMEONE S., 2008. *Posidonia oceanica banquettes removal: sedimentological, geomorphological and ecological implications*. PhD Thesis, Università degli Studi della Tuscia di Viterbo, Viterbo: 1-127.
- SIMEONE S., DE FALCO G., 2013. *Posidonia oceanica banquettes removal: sedimentological, geomorphological and ecological implications*. *J. Coast. Res.*, special issue, 65: 1045-1050.
- TAGLIABUE M., SIMON C., 2018. Feeding the behavioral revolution: contributions of behavior analysis to nudging and vice versa. *J. Behav. Econom. Pol.* 2 (1): 91-97.
- THALER R., SUNSTEIN C., 2008. *Nudge: improving decisions about health, wealth and happiness*. Yale University Press, New Haven: 1-293.
- TOMASELLO A., BOSMAN A., SIGNA G., RENDE S.F., ANDOLINA C., CILLUFFO G., CASSETTI F.P., MAZZOLA A., CALVO S., RANDAZZO G., SCARPATO A., VIZZINI S., 2022. 3-D Reconstruction of a giant *Posidonia oceanica* beach wrack (*banquette*): sizing biomass, carbon and nutrient stocks by combining field data with high-resolution UAV photogrammetry. *Front. Mar. Sci.*, 9 (903138): 1-16.
- VANDARAKIS D., KOURLIAFTIS I., SALOMIDI M., GERAKARIS V., ISSARIS Y., AGAOGLOU Ch., KAPSIMALIS V., PANAGIOTOPOULOS I., 2022. Geomorphological approaches to study *Posidonia* banquettes and their effects on the coastal front of Schinias-Marathon national Park. In: *Monitoring of Mediterranean coastal areas: problems and measurement techniques*, Livorno (Italy), Ninth International Symposium. Bonora L., Carboni D., De Vincenzi M., Matteucci G. (eds.), Firenze University Press, Firenze: 93-103.