

Management Plan for the Beach-Cast Seagrass in Calabria

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Abstract

The wracks of *Posidonia oceanica* leaves and the “banquette” formation on the sandy beaches of Calabria are one of the most important defence against the erosion processes. The management of the beach-cast sea-grass in Italy has been, generally, realized through the mechanical removal and the transport in dumping of the beach-cast material. This system, apparently simple and fast, produces, instead, a net loss of sediments from the sandy beaches and, therefore, a deficit in the sedimentary budget of coastline leading the coastal system to possible shore erosions. The ideal solution is to keep these vegetable deposits on spot so to warrant a positive sedimentary budget, the protection of coastline and the tourist value of the regional beaches to improve tourism in the seaside resorts with bathing vocation.

1 Introduction

The Mediterranean endemic sea-grass *Posidonia oceanica* (Linnaeus) Delile, forms extensive beds, named “prairies”, in the infra-littoral bottom of the basin, according to favourable environmental conditions. A long time ago, the prairies of *Posidonia oceanica* surrounded a large part of the Mediterranean seashore forming an almost continuous belt along the coasts of the basin. Nowadays, we attend to a widespread regression and/or to the complete disappearance of these natural barriers along the Mediterranean coasts. Healthy meadows have been replaced, in the damaged areas, with deserts of dead “mattes” or have been colonized again by algal populations of *Caulerpa prolifera* (Forsskål) J.V. Lamouroux or by the other common Mediterranean sea-grass *Cymodocea nodosa* (Ucria) Ascherson. In these last decades, this trend has been reported

in many areas of the Italian coasts where the 72% of the prairies have deteriorated, as shown by the partial data, related to five regions, produced by the “National Program of characterization and development of *Posidonia oceanica*” started up on 1989 by Ministero dell’Ambiente e della Tutela del Territorio e del Mare [20].

The problem of the reduction of Mediterranean meadows takes place also in Calabria and, in particular, along the calabrian Tyrrhenian coasts where the 62% of the prairies is in regression [6]. The phenological data and, in detail, the trend of the density shoots of these prairies point out the bad conditions of the Mediterranean meadows as reported in literature [2, 1, 19, 22].

The widespread deterioration of the coastal environments, in the Mediterranean basin, implies a global vision of the problem. The critical state of the Italian coasts has become in these last years a serious problem along our coastal boundary where

the 42% is in erosion [10]. These negative conditions are particularly severe in the calabrian coastal boundary where the 43% of the beaches are in erosion [21]. The particular position of this region, surrounded by the Tyrrhenian and the Ionian seas, for a coastal boundary of 725 km, as 1/5 of the national coastal perimeter, suggests the solution of some problems linked to the protection and the improvement of its coastal line, transition area between the terrestrial and the marine environments. So, the coastal defence must become the main appointment for the national and the regional authorities.

The dynamic environmental balance of sandy beaches comes from two different processes: from one side, the transport of solid materials through the sedimentary supply of rivers flowing into the sea; from the other side, the losses of sands and littoral pebbles due to hydrodynamic forces. In ideal conditions of a stable balance these processes are equal and the beach keeps stable its profile. In real conditions, instead, it takes place advancing or, more frequently, erosion of the coastline. The coastal advancing happens if the value of the supplies exceeds the losses while in the opposite case, much more common, we can observe the erosion processes. The sedimentary budget of sandy beaches is made by three basic elements: the shoreface, the shoreline and the coastal dune amongst which take place exchanges so to grant the littoral sedimentary equilibrium and the right working of coastal system. The sedimentary loop between the underwater and the terrestrial shore begins at the end of the vegetative period when leaves senesce and detach off the rhizomes [16]. This leaf loss can reach values of 10-20 tons of vegetable fragments for hectare of meadow [18] of which 5% is exported out-

side, 70% remains in the “intermattes” of the meadow and 25% is washed by wave action on adjacent shorelines, forming deposits known as “banquettes” [4]. Indeed, during their life, the plants lose a lot of leaves that are carried by hydrodynamic pressure onto the beach on clumps and are accumulated on sandy beaches where form very conspicuous wedge-shaped deposits up to 2 m height [18]. The “banquettes” play, also, a leading role trapping high amounts of sediment inside the overlapping layers of the deposits. The leaf piles and their sediment store carry out an important functional and structural task by attenuating wave and stream energy and limiting coastal erosion.

2 The coastal trophic system

The meadows of *Posidonia oceanica* play a basic function in the sensitive biological balance of the Mediterranean Sea even though they cover only the 0,2% of its floor for a surface area of about 20.000 square miles. The prairie, climax community on mobile substrates in the infralittoral bottom of the basin [15], produces a big amount of organic substances that may reach a high primary production as $20 \text{ g} \cdot \text{C} \cdot \text{m}^{-2} \cdot \text{d}^{-1}$ in the summer season. A large part of this energy and material inputs come into the trophic loop through the detritus chain formed by the dead leaves of the plants that settle inside the channels and in the “intermattes” of the meadow. A lot of studies, indeed, indicate the central role played in the overall structure of the food web by the leaf detritus [25]. The 50% of this amount of organic substances produced by the meadow is consumed inside

it, the 30% is exported towards the open sea and the remaining 20% is carried by hydrodynamic pressure towards the line-coast [5]. The ecosystems of *Posidonia oceanica* (PP) play, therefore, an important role for the primary productivity of the coastal system where they carry out a central task in the handling of energy and materials between coastal, pelagic and terrestrial systems (Figure 1).

3 Functions, dynamics and structures of “banquettes”

The “banquettes” are a potential nutrient sinks for the coastal trophic net and, consequently, for its whole productivity. The organic material in these leaf deposits consisted of about 95% by *Posidonia oceanica* brown leaf blades and of about 5% by rhizomes and seaweeds [7]. Leaf litter biomass in the banquettes ranges from 18 to 500 kg dry wt m⁻¹ of shoreline [17]. This big amount of organic supply sinks temporarily in the banquettes where is partially consumed by terrestrial detritus feeders, such as amphipods, isopods, coleoptera and diptera, and partly constitutes an important and temporary C, N and P sink for *Posidonia oceanica* meadows. Therefore, the sea-grass wrack is an intermediate and important product in the life cycle of the plant that should end into the sea. These wedge-shaped accumulations all along the Mediterranean coasts are, indeed, the final result of a dynamic process of formation/accretion/destruction arranged in the following temporal sequence:

A) Formation

- October: First equinoctial storms and beginning of wave action - detach of

leaf blades – suspension of dead leaves of *Posidonia oceanica* and their transport towards underwater shore.

- November: Transport of dead leaves of *Posidonia oceanica* from underwater shore to terrestrial one.

B) Accretion

- December: Accumulation and deposit of *Posidonia oceanica* leaf litter on the shoreline.
- January: Severe winter storms and increasing of wave action > vertical and horizontal increases of “banquettes” – hydrodynamic reduction.

C) Erosion

- February: Beginning of erosion at the base of “banquette”.
- March: Increase of erosion and formation of a step at the base of the “banquette” – reduction in height of the deposit.

D) Collapse

- March: Breaking in blocks and collapse into the sea of the “banquette”.

The “banquettes” are solid and elastic structures and provide a very remarkable level of compactness because, during their formation, the air spaces amongst the leaves are eliminated and the hydraulic conductivity of the structure is reduced [17]. These conditions allow the “banquette” to offer a considerable resistance against wave action so to oppose coastal erosion (Figure 2).

The wedge-shaped deposits of *Posidonia oceanica* leaf litter, that pile up on the sandy beaches of the Mediterranean basin, are a temporary sink of organic matter made up of detached leaves of the plants but include, also, inorganic materials as sands and water. The amount of sediments in the “banquettes” depends on their grain size. The quantity of sand trapped in the “banquettes” is very high in the beaches

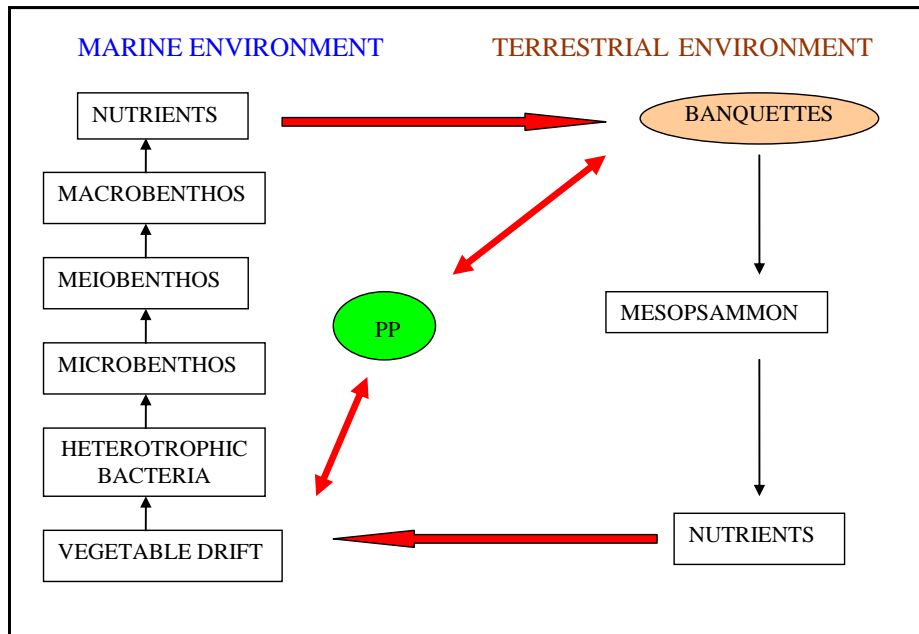


Figure 1: Conceptual scheme of trophic and energy transfers between terrestrial and marine environments.

of coarse – grained while it decreases in those of medium and thin – grained. The results of Arena Project, carried out along the Sardinian coasts, prove that the removal of 100 m³ of “banquettes” from beaches of coarse texture causes a loss of sediment of 11,2 tons like a loss of 11,2 kg from the beach [9]. These conditions produce a negative beach sediment budget and, consequently, possible shore erosions following storm events. Therefore, it is necessary to value the percent in weight and in volume of the organic and inorganic fractions contained in these deposits so to establish the physic function of “banquettes” in the coastal dynamics. The first results of this method, held by the Environmental Department of Livorno Province [12], prove that the sandy fraction of the deposits is very

high, ranging from 37% (percent in volume) to 56% (percent in weight) and, consequently, these wedge – shaped deposits of *Posidonia oceanica* leaf litter can be considered basic for the hydrodynamic equilibrium of littorals.

4 Problems and solutions

The cleaning operations of the beaches and the whole removal of these beach – cast litter produce a subtraction of sediments from the beaches and may lead to possible shore erosions. These conditions produce, also, the deterioration of coastline and the loss of dune vegetation. The desertification of sandy beaches gives raise, long-term, to substantial changes in beach



Figure 2: The “banquette” of Punta Santa Litterata (Cs.).

morphology. From a biological point of view, the “banquettes” are an important and potential sink of biogenic elements for the sea-grass ecosystems [17]. These vegetable biomasses accumulate, indeed, a large amount of organic carbon valuable from 18 to 500 kg of dry wt m⁻¹ of shoreline [13]. The complete removal of the “banquettes” causes a nutrient depletion for the trophic chain of coastal ecosystem and, in particular, a permanent loss of C, N and P. The N and P losses are respectively 5,4% and 1,2% of the annual requirement of the plant [23, 16, 14].

The removal operations, made by coastal municipalities, using heavy machinery such as bulldozers and excavators, are carried out to keep the tourist value of sandy beaches. The following loss of sediments from the shoreline impacts upon the littoral stability and may support erosive processes

on the beaches exposed to high hydrodynamic pressure. Therefore, it’s reasonable to avoid this kind of procedure or to carry out late actions of displacement in the months of May or June, at the beginning of steady anti-cyclonical conditions, to minimize the impacts of removal. It’s necessary, in these circumstances, to avoid the mechanical handling of the deposits while it’s right to work manually so to avoid the direct removal of sandy materials.

The solution to the problem should be to leave these vegetable deposits to their natural process of maturation keeping the “banquettes” on the spot or to stock them on the ground in the highly tourist areas and to move them inside the coastal dune or in retired belts close to the shoring events within the point of maximum wave expansion. It is necessary, in this instance, to proceed by hand so to avoid health

risks. This kind of operations may contribute to the protection of the coastline against erosion processes and to the stability of substrates behind the fore-dunes allowing, at last, a real saving of financial resources. These suggestions have been recently ratified by a ministerial memorandum of Ministero Ambiente dated 17 March 2006 (DPN/VD/2006/08123) concerning the management of beach-cast litter found in coastal areas. This provision states three alternative solutions: the removing and dumping of beach-cast litter, the moving of the deposits or the maintenance on spot of the “banquettes”. The first solution is to avoid because it produces a great loss of sediments from the sandy beaches and a deficit in the sedimentary budget of coastal system leading the shoreline to possible erosions. The second one is suggested only in case of problems with the touristic development of some seaside resorts with bathing vocation. In this particular situation, the removal operations must be carefully executed with late actions of displacement, avoiding the use of heavy machineries. The third one is the ideal solution to the problem and in this event the coastal municipalities have to inform the public opinion and, particularly, the tourists through posters and placards to improve the presence of *Posidonia oceanica* meadows in that areas as pattern of ecological shore like the “bio-beaches” of French coasts [3]. In this sense the joined presence of meadows and “banquettes” could become the main factor of wildness of the coastal area. The final result will be a steady and tourist attending of the beaches.

5 The new outlooks: the G.I.P.O.S. project

The project, held by C.N.R. – I.S.A.Fo.M. Rende Department (Prot. n.131 AXIII/I), aims to evaluate the beaching processes of these conspicuous wedge-shaped accumulations all along the coasts of “Riviera dei Cedri” Marine Regional Park. This is the first trial, in Calabria, to tackle the problem of a correct management of leaf litter on the grounds of previous scientific researches carried out in some Italian regions as Lazio, Tuscany and Sardinia. The research line, named G.I.P.O.S., aims to share into the knowledge of the process of banquette storing along the regional sandy beaches and to study their structures so to evaluate their physical and biological functions in the erosive process, still going on the calabrian Tyrrhenian coasts.

The “Riviera dei Cedri” Marine Regional Park (Figure 3) is an area of high environmental value and is marked out by the presence of four Sites of Community Interest (S.I.C.) in the sea-beds of Isola di Dino, Capo Scalea, Isola di Cirella and Diamante where are located some of the most important regional prairies of *Posidonia oceanica*. The coastline of the Park, between the marine villages of Praia a Mare (CS) and Acquappesa (CS), spreads over 55 kilometres. The eleven coastal municipalities of this area have been interested in the implementation of the project through the compilations of a set of questions concerning the reports of *Posidonia oceanica* beaching in the period 1998 – 2007.

The scientific program consists of three stages. The first step aims to identify the coastal areas where have been reported events of beaching of *Posidonia oceanica* in the decade 1998-2007 and the related



Figure 3: Map of “Riviera dei Cedri” Marine Regional Park.

managements methods realized by coastal municipalities of the Park. The second step regards the study of the chemical and structural pattern of “banquettes” in order to evaluate its functional role in the sedimentary budget of coastline. In the third step, at last, are sieved the different methods of moving these massive deposits of leaf litter of *Posidonia oceanica* and are suggested the best solutions for a correct management of the beach-cast sea-grass.

Recently, the wracks of dead sea-grass

have been collected and transformed into compost in the Mediterranean coastal countries for agricultural purposes. The use of compost as soil enrichment enhances plant growth and increases crop productivity. The addition of seaweeds into the compost can increase pore volumes, aggregate stability, cationic exchange capacity, microbial mass and biological activity of the soil for horticultural species and for the farming.

Nowadays in our country have been tested

some technologies for the use of vegetable biomasses in composting as biological fertilizer [24, 11], but also as covering dumping grounds, as agricultural drainage and as mulching of the soils to remove weeds. The problem arises from our national laws that forbids the use of *Posidonia oceanica* as composting matrix for agricultural purposes (D.Lgs.217/2006). In this lawgiving national contest the Italian Composting Pool has sent to U.E. an application for the review of this ministerial decree. Therefore, after the passage of the new law, it will be allowed to compost the marine vegetable wastes as long as they don't exceed the 20% of total weight compost [8]. So, it will be possible to obtain a mixture of Mediterranean sea-grass with shredded municipal yard and landscape green wastes after a composting period of 150 days and several rinsing to eliminate all chlorides and heavy metal compounds. The composting material will be rich in carbon, phosphorus and nitrogen and will improve the physical conditions and the microbial biomass of soil so to stimulate plant growth and increase crop productivity.

6 Conclusions

The vegetable biomasses known as “banquettes” are an excellent indicator of the

quality of marine coastal environment for the presence of extensive *Posidonia oceanica* meadows on the marine sea-beds. Therefore, the presence of these massive supra-littoral deposits of leaf litter along the coastal areas of the “Riviera dei Cedri” Marine Regional Park is a clear sign of a sea in a good environmental health. The wedge-shaped deposits, placed on some stretches of the protected coastline, perform an important mechanical and biological role in the trophic and sedimentary budget of coastal system. Therefore, these deposits cannot be considered a simple waste material but, instead, a natural resource for the sensitive balance of coastal ecosystems. The actual technologies and the current management practices about “banquettes” must change from the simple beach wrack removal to their maintenance on spot providing a protection to the foreshore and reducing erosion processes. At last, it is necessary to revalue the ecological function of *Posidonia oceanica* “banquettes”, natural elements of some calabrian coasts, that could become the “bio-beaches” of the coastal regional boundary so to improve the tourism in the seaside resorts with bathing vocation.

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