A shoreline stabilization system and method are provided, comprising one or more base layers of a non-woven plastic matrix positioned on a shoreline, wherein the base layer is at least partially submerged in the water. A second layer of non-woven plastic matrix positioned on top of the base layer, wherein the second layer is at least partially submerged in the water, and wherein the second layer is pre-planted with one or more selected plants such as smooth cord grass (*Spartina alterniflora*), seashore paspalum (*Paspalum vaginatum*), torpedo grass (*Panicum repens*), and/or bull rush (*genus Scirpus*). Other selected plants are inserted into holes in the base layer such as bunchgrass, tussock, and/or sunshine vetivergrass (*Chrysopogon zicanicoides*). The base layer and the second layer are anchored to the shoreline by a plurality of anchors sufficient to cause the base layer to conform to the shoreline. The assembled system provides protection from wave energies, while allowing for plant and root growth to further reinforce the shoreline.
SHORELINE STABILIZATION SYSTEM AND
METHOD
CROSS-REFERENCE TO RELATED
APPLICATIONS
[0001] Not applicable.

STATEMENT REGARDING FEDERALLY
SPONSORED RESEARCH OR DEVELOPMENT
[0002] Not applicable.

THE NAMES OF THE PARTIES TO A JOINT
RESEARCH AGREEMENT
[0003] Not applicable.

BACKGROUND OF THE INVENTION
[0004] 1. Field of the Invention
[0005] The invention relates generally to devices and methods used in the stabilization of shorelines and levees, and more particularly to those devices and methods which promote plant growth and establish a riparian edge for aquatic and wildlife habitat.

[0006] 2. Description of Related Art
[0007] Erosion of coastal areas and shorelines due to erosion, either through natural causes or caused by human activities, is a serious problem for many areas around the world. Many attempts have been made over the years to prevent or control such erosion, resulting in the development of various devices and methods which attenuate wave action and reinforce the shoreline using bulkheads, concrete structures, mats, and similar means.

[0008] Natural occurrences such as waves, hurricanes, and floods may destroy ecosystems, as well as wave action attributable to boat traffic and other vehicles. Over time, those ecosystems often recover and mature into diverse healthy environments. Without outside interference, the processes of recovery are normal and inevitable. They include microbial colonization followed by the invasion of plant species and eventually aquatic and wildlife species. In many areas, time is usually the only requirement for such recovery. However, the conditions, both naturally occurring and man-made, that are impacting the Louisiana coastline and similar regions do not allow for this spontaneous recovery. To meet the challenges posed by the constant high-energy environment and human impact, intentional effort must be directed toward environmental restoration.

[0009] While such efforts have been successful to some degree, a primary goal in many areas is reformation and restoration of the shoreline to include native vegetation. In those instances, the objective is to reinforce the areas subject to erosion with plants which are typically native to the region. Consequently, an organic ecosystem can eventually be established that is resistant to erosive forces, but using means which do not detract from the natural beauty of the shoreline. These methods are sometimes referred to as “living shorelines”, and they provide additional ecological habitat for aquatic as well as terrestrial biology. Living shorelines refer to management practices that use strategic placement of plants, stone, sand fill and other structural organic materials, such as oyster reefs, to provide shoreline stabilization and protection of marsh vegetation and habitat viability. Living shorelines may be used in appropriate areas as alternatives to bulkheads, rip-rap and other hard structures.

[0010] Because shoreline topography and conditions are so diverse, living shorelines must often be custom-designed for each location to be successful. According to most researchers, site-specific living shorelines must employ principles from each of the fields of ecology, geology, oceanography and engineering to develop effective projects.

[0011] To meet these needs, the present invention provides the one of the most environmentally efficient and systematic efforts to harness the natural processes of the South Louisiana coastal ecosystem. The invention, in its preferred and alternative embodiments, protects the existing shoreline, while promoting plant growth and establishing a riparian edge for aquatic and wildlife habitat.

SUMMARY OF THE INVENTION
[0012] A shoreline stabilization system and method are provided, comprising one or more base layers of a non-woven plastic matrix positioned on a shoreline, wherein the base layer is at least partially submerged in the water; a second layer of non-woven plastic matrix positioned on top of the base layer, wherein the second layer is at least partially submerged in the water, wherein the second layer is pre-planted with one or more selected plants, and wherein the selected plants in the second layer have rooting and propagation characteristics sufficient to establish growth of the selected plants into the base layer and toward the water.

[0013] The base layer includes selected plants inserted through holes formed into the base layer, wherein the selected plants in the base layer have rooting and propagation characteristics sufficient to establish a natural anchor for the base layer into the shoreline; and wherein the base layer and the second layer are anchored to the shoreline by a plurality of anchors sufficient to cause the base layer to conform to the shoreline.

[0014] Preferably, the non-woven plastic matrix is a recycled polyethylene terephthalate (PET) plastic containing no phenol-formaldehyde resins.

[0015] In a preferred embodiment, the selected plants in the second layer are selected from the group consisting of smooth cord grass (Spartina alterniflora), seashore paspalum (Paspalum vaginatum), torpedo grass (Panicum repens), bull rush (genus Scirpus), and their variants having equivalent rooting characteristics.

[0016] More preferably, the seashore paspalum or torpedo grass are positioned on the second layer above a mean tide level, while the smooth cord grass or bull rush are positioned on the second layer below a mean tide level.

[0017] In a preferred embodiment, the selected plants inserted into the base layer are selected from the group consisting of bunchgrass, tussock, sunshine vetivergrass (Chrysopogon zizanioides), and their variants having equivalent rooting and propagation characteristics.

[0018] In an alternate embodiment, the base layer includes two layers of the plastic matrix, wherein the layers are positioned in at least a partially overlapping position.

[0019] In a further alternate embodiment, the base layer includes three layers of the plastic matrix, wherein the layers are positioned in at least a partially overlapping position.

[0020] In a more preferred embodiment, the layers are positioned progressively toward the water such that a portion of each of the layers is in contact with and caused to conform to the shoreline, and the selected plants in the base layer are inserted only on the layer farthest from the waterline.
In most embodiments, the shoreline is shaped and graded to a predetermined condition prior to installation of the base layer. In a more preferred embodiment, the base layer is about 8-12 feet wide in a direction substantially perpendicular to the shoreline, and is positioned on the shoreline in strips 30-100 feet long in a direction substantially parallel to the shoreline. Also, the second layer is about 24-36 inches wide in a direction substantially perpendicular to the shoreline, and is positioned on the base layer in strips 10-20 feet long in a direction substantially parallel to the shoreline.

The anchors comprise an anchor plate having a plurality of holes formed therein, and an elongated reinforcement bar staple inserted through the anchor plate and driven into the shoreline.

The above and other objects and features of the present invention will become apparent from the drawings, the description given herein, and the appended claims.

**BRIEF DESCRIPTION OF THE DRAWINGS**

For a further understanding of the nature, objects, and advantages of the present invention, reference should be had to the following detailed description, read in conjunction with the following drawings, wherein like reference numerals denote like elements.

**FIG. 1** illustrates a simple embodiment of a shoreline stabilization system of the present invention depicting a single base layer.

**FIG. 2** illustrates a layout view of the system of FIG. 1.

**FIG. 3** illustrates an alternative embodiment of the system depicting two base layers and additional vegetation inserted into the base layers.

**FIG. 4** illustrates a more preferred embodiment depicting three base layers in a progressively overlapping configuration.

**FIG. 5A** illustrates another embodiment depicting three base layers conforming to the shoreline.

**FIG. 5B** illustrates the embodiment of FIG. 5A depicting growth of the plants in the base layer and second layer.

**FIG. 6** illustrates another view of the embodiment of FIG. 5 depicting typical dimensions for an installed shoreline stabilization system.

**FIG. 7** illustrates a layout view of the embodiment of FIG. 6.

**FIG. 8** illustrates a layout view of the embodiment of FIG. 6 showing the seam construction.

**FIG. 9** illustrates a view of the anchoring systems depicting the anchor staples and the anchor plates.

**DETAILED DESCRIPTION OF THE INVENTION**

Before the subject invention is further described, it is to be understood that the invention is not limited to the particular embodiments of the invention described below, as variations of the particular embodiments may be made and still fall within the scope of the appended claims. It is also to be understood that the terminology employed is for the purpose of describing particular embodiments, and is not intended to be limiting. Instead, the scope of the present invention will be established by the appended claims.

In this specification and the appended claims, the singular forms “a,” “an,” and “the” include plural reference unless the context clearly dictates otherwise. Unless defined otherwise, all technical and scientific terms used herein have the same meaning as commonly understood to one of ordinary skill in the art to which this invention belongs.

Referring now to FIG. 1, a simple embodiment of a shoreline stabilization system 1 of the present invention is depicted as having a single base layer 2. The base layer 2 is preferentially a non-woven plastic matrix positioned on a shoreline, wherein the base layer 2 is at least partially submerged in the water 3. A second layer 4 of non-woven plastic matrix is positioned on top of the base layer 2, wherein the second layer 4 is at least partially submerged in the water 3. Preferably, the non-woven plastic matrix is a recycled polyethylene terephthalate (PET) plastic containing no phenol-formaldehyde resins. The base layer 2 and the second layer 4 are anchored to the shoreline 5 by a plurality of anchors 6 sufficient to cause the base layer 2 to conform to the shoreline 5.

One example of a non-woven plastic matrix used in the present invention is the JCII Island Brown product manufactured by Americo Manufacturing Company, Inc., which employs only water-based latex resins and is constructed entirely from post-consumer products such as recycled water and soda bottles. The material is non-toxic to fish and other aquaculture, and it can easily be applied from rolls onto the shoreline.

In a preferred embodiment, the second layer is pre- planted with one or more selected plants 7, such as smooth cord grass (Spartina alterniflora), seashore paspalum (Paspalum vaginatum), torpedo grass (Panicum repens), and bull rush (genus Scirpus). The pre-grown vegetation 7 requires approximately 45 days to become established and ready for installation. It will be appreciated that a variety of other plants may also be suitable, including vegetation having equivalent rooting and propagation characteristics. Importantly, the second layer 4 and its pre- planted grasses 7 are positioned roughly at the mean tide level 3, such that the high and low tide range reaches the front and rear of the pre- planted grasses of the second layer. It is also important that the selected plants 7 in the second layer 4 have rooting and propagation characteristics sufficient to establish growth of the selected plants 7 into the base layer 2 and toward the water 3. When such growth occurs, the expansion of the plants 7 toward the water 3 has a number of beneficial effects. First, as the base layer 2 and second layer 4 become covered with plants, the plants serve to protect the underlying matrix from ultraviolet (UV) radiation and consequent degradation, prolonging the structural integrity of the matrix. Furthermore, plant growth into the water greatly enhances wave attenuation and reduces the surrounding erosion of the shoreline 5.

FIG. 2 is a layout view of an installed system of FIG. 1, wherein the base layer 2 is about 7-8 feet wide in a direction substantially perpendicular to the shoreline 5, and is positioned on the shoreline 5 in strips about 90 feet long in a direction substantially parallel to the shoreline 5. Also, the second layer 4 is about 30 inches wide in a direction substantially perpendicular to the shoreline 5, and is positioned on the base layer 2 in strips about 15 feet long in a direction substantially parallel to the shoreline 5. Anchor rods 6 are driven through the base layer 2 and second layer 4 into the shoreline 5 at predetermined locations to secure the layers 2, 4 and conform them to the shoreline 5.

Another embodiment is shown in FIG. 3, wherein two base layers 2 are employed in at least a partially overlapping configuration so that a thicker matrix is available for
rooting of ground cover and other grasses. The base layers 2
include selected plants 8 inserted through holes 9 formed into
the base layers 2, such as bunchgrass, tussock, and sunshine
veitchergass (Chrysochop zizanioides) (collectively the
“Veitver”). As with the vegetation in the second layer 4, it will
be appreciated that a variety of other plants may also be
suitable, including vegetation having equivalent rooting and
propagation characteristics. The selected plants in the base
layer should have rooting and propagation characteristics
sufficient to establish a natural anchor for the base layer into
the shoreline. The Veitver is planted in three or more rows,
and advantageously provides a substantial root mass which
grows through the base layer matrix and eventually into the
shoreline itself. The Veitver’s deep massive fibrous root sys-
tem can reach down 6-9 feet in the first year, improving soil
shear strength by as much as 39%, making Veitver an ideal
plant for stabilizing steep and unstable slopes. The Veitver
ystem when applied to such slopes significantly reduces the
probability of land slippage and reduces the need for “hard
solutions”. It is also a way to mitigate the potential damage
to the plastic matrix from UV rays until the vegetation com-
tpletely covers the base layers in 4-6 months.

For shoreline areas which are subject to more high
energy wave action, FIG. 4 illustrates a more preferred
embodiment depicting three base layers 2 in a progressive
overlapping configuration. The three base layers 2 are posi-
tioned progressively toward the water 3 such that a portion
of each of the base layers 2 is in contact with and caused to
conform to the shoreline 5. In this embodiment, the selected
plants 8 in the base layer 2 are inserted only on the base layer
2farthest from the waterline. As with the previous embed-
ments, anchors 6 are employed to secure the system to the
shoreline 5.

FIG. 5A is a similar embodiment to that of FIG. 4, shown
immediately after installation, wherein the base layers
2 are more closely conformed to the shoreline 5. Note the
placement of the anchors 6 such that all layers are securely
attached to the shoreline 5, and that the second pre-planted
vegetation layer 4 is positioned between the levels of low
and high tide 3. FIG. 5B depicts the system as it might appear after
about one year from installation. Note particularly the growth
of the selected plants 8 on the rear portion of the base layer
2, and the manner in which the roots are extending further into
the shoreline 5 to create a natural anchor. Note also that the
selected plants 7 on the second layer 4 are establishing deeper
roots into the base layers 2 and into the shoreline 5, and they are
propagating rearward and further into the water 3. This
natural growth and propagation is essential to strengthening
the soil against further erosion, attenuating wave energies,
and reestablishing a “living shoreline”.

FIG. 6, typical dimensions for an installed shore-
line stabilization system of FIGS. 5A and 5B are also shown.
However, it should be understood that such dimensions are
only one example of a wide range of dimensions and scale
which are determined to be best suited to a particular shore-
line. Variations in dimension and scale may be made to adapt
the system to unique shoreline conditions, all without depart-
ing from the spirit and scope of the present invention.

For such high energy areas and the embodiments shown
in FIGS. 4, 5A, and 5B, improved anchoring systems
are typically required, such as those depicted in FIG. 9. In
these anchoring systems, a base plate 10 having a plurality
of holes is positioned on top of the layer to be anchored, follow-
ing by insertion of an elongated reinforcement bar anchor
staple 6 inserted through the anchor plate 10 and driven into
the shoreline 5. Using this arrangement, the anchor staple 6
forces a larger bearing surface of the base plate 10 down on
the layers 2, 4, resulting in a stronger anchoring to the shore-
line 5.

FIG. 7 further illustrates a layout view of the system of
FIGS. 5A, 5B, and 6, depicting the manner of use and
placement of the anchoring systems. Note that the anchor
plates 10 are positioned on the corners and terminal ends
of the base layer 2, as well as in predetermined locations along
the edges running parallel to the shoreline 5. The plants 8
which are installed into the base layers 2 are also archived in
a manner to establish a hedgerow at the rear of the installed
stabilization system, while the pre-planted vegetation layer 4,
7 extends completely across the base layers 2 over a typical 90
foot segment.

FIG. 8 illustrates another layout view of the embed-
diment of FIGS. 5A, 5B, and 6 showing the seam construc-
tion, wherein two 90 foot segments are joined. Anchor plates 10 are
used to overlap the abutting edges of the base layers 2 and
second layer 4, creating a smooth and continuous structure.

In a more preferred arrangement, the seashore
paspalum or torpedo grass of the selected plants 7 are posi-
tioned on the second layer 4 above a mean tide level 3, while
the smooth cord grass or bull rush of the selected plants 7 are
positioned on the second layer 4 below a mean tide level 3.
Such arrangement is intended to keep the various vegetation
within conditions most suitable for rooting and growth. In all
of the embodiments described herein, it is preferable that the
shoreline 5 be shaped and graded to a predetermined con-
tion prior to installation of the base layers 2.

The present invention, also referred to as a “veget-
eted ecomatrix”, is cost-effective when compared to tradi-
tional forms of shoreline protection and levee stabilization.
For years, levees and terraces have relied on seeding or
manual re-vegetation to provide protection from erosive
waves. Traditional methods of seeding and planting could
take as much as two years to properly root in and protect the
base. During that time, daily waves continue to erode the
newly constructed levee or terrace, thus never allowing for
the vegetation to establish, root in, and grow.

The vegetated ecomatrix of the present invention provides
immediate protection, because the plants are pre-
grown with a minimum of 45 days of growth, providing an
instant barrier to erosive waves. The material provides ero-
sion protection while also creating vegetative edge for wave
dampening.

The present invention is porous and lightweight
allowing for ease of timely installation. Heavy equipment
is rarely required which also minimizes the installation foot-
print on existing critical areas. Very little maintenance is
required as the self-propagating nature results in new seed-
lings being dispersed. As vegetation grows, spreads, and multi-
plies, the surface area of the vegetated ecomatrix increases,
providing increased wave and wind shearing capabilities.
This improves the outcomes of vegetation and vegetation
plantings, as well as saves time by not having to replant again.
All references cited in this specification are herein incorporated by reference as though each reference was specifically and individually indicated to be incorporated by reference. The citation of any reference is for its disclosure prior to the filing date and should not be construed as an admission that the present invention is not entitled to antedate such reference by virtue of prior invention.

It will be understood that each of the elements described above, or two or more together may also find a useful application in other types of methods differing from the type described above. Without further analysis, the foregoing will so fully reveal the gist of the present invention that others can, by applying current knowledge, readily adapt it for various applications without omitting features that, from the standpoint of prior art, fairly constitute essential characteristics of the generic or specific aspects of this invention set forth in the appended claims. The foregoing embodiments are presented by way of example only; the scope of the present invention is to be limited only by the following claims.

The invention claimed is:

1. A shoreline stabilization system, comprising:
   one or more base layers of a non-woven plastic matrix positioned on a shoreline, wherein the base layer is at least partially submerged in the water;
   a second layer of non-woven plastic matrix positioned on top of the base layer, wherein the second layer is at least partially submerged in the water, wherein the second layer is pre-planted with one or more selected plants, and wherein the selected plants in the second layer have rooting and propagation characteristics sufficient to establish growth of the selected plants into the base layer and toward the water;
   wherein the base layer includes selected plants inserted through holes formed into the base layer, wherein the selected plants in the base layer have rooting and propagation characteristics sufficient to establish a natural anchor for the base layer into the shoreline; and
   wherein the base layer and the second layer are anchored to the shoreline by a plurality of anchors sufficient to cause the base layer to conform to the shoreline.

2. The system of claim 1, wherein the non-woven plastic matrix is a recycled polyethylene terephthalate (PET) plastic.

3. The system of claim 2, wherein the plastic matrix includes no phenol-formaldehyde resins.

4. The system of claim 1, wherein the selected plants in the second layer are selected from the group consisting of smooth cord grass (Spartina alterniflora), seashore paspalum (Paspalum vaginatum), torpedo grass (Panicum repens), bull rush (genus Scirpus), and their variants having equivalent rooting and propagation characteristics.

5. The system of claim 4, wherein the seashore paspalum or torpedo grass are positioned on the second layer above a mean tide level.

6. The system of claim 4, wherein the smooth cord grass or bull rush are positioned on the second layer below a mean tide level.

7. The system of claim 1, wherein the selected plants inserted into the base layer are selected from the group consisting of bunchgrass, tussock, sunshine vetivergrass (Chrysopogon zizanioides), and their variants having equivalent rooting and propagation characteristics.

8. The system of claim 1, wherein the base layer includes two layers of the plastic matrix, wherein the layers are positioned in at least a partially overlapping position.

9. The system of claim 1, wherein the base layer includes three layers of the plastic matrix, wherein the layers are positioned in at least a partially overlapping position.

10. The system of claim 9, wherein the layers are positioned progressively toward the water such that a portion of each of the layers is in contact with and caused to conform to the shoreline.

11. The system of claim 10, wherein the selected plants in the base layer are inserted only on the layer furthest from the waterline.

12. The system of claim 1, wherein the shoreline is shaped and graded to a predetermined condition prior to installation of the base layer.

13. The system of claim 1, wherein the base layer is about 8-12 feet wide in a direction substantially perpendicular to the shoreline, and is positioned on the shoreline in strips 30-100 feet long in a direction substantially parallel to the shoreline.

14. The system of claim 1, wherein the second layer is about 24-36 inches wide in a direction substantially perpendicular to the shoreline, and is positioned on the base layer in strips 10-20 feet long in a direction substantially parallel to the shoreline.

15. The system of claim 1, wherein the anchors comprise an anchor plate having a plurality of holes formed therein, and an elongated reinforcement bar staple inserted through the anchor plate and driven into the shoreline.

16. A method of stabilizing a shoreline, comprising:
   positioning one or more base layers of a non-woven plastic matrix positioned on a shoreline, wherein the base layer is at least partially submerged in the water;
   positioning a second layer of non-woven plastic matrix positioned on top of the base layer, wherein the second layer is at least partially submerged in the water, wherein the second layer is pre-planted with one or more selected plants, and wherein the selected plants in the second layer have rooting and propagation characteristics sufficient to establish growth of the selected plants into the base layer and toward the water;
   inserting selected plants into holes formed through the base layer to form a hedgerow, wherein the selected plants in the base layer have rooting and propagation characteristics sufficient to establish a natural anchor for the base layer into the shoreline; and
   anchoring the base layer and the second layer to the shoreline by a plurality of anchors sufficient to cause the base layer to conform to the shoreline.

17. The method of claim 16, wherein the non-woven plastic matrix is a recycled polyethylene terephthalate (PET) plastic.

18. The method of claim 17, wherein the plastic matrix includes no phenol-formaldehyde resins.

19. The method of claim 16, wherein the selected plants in the second layer are selected from the group consisting of smooth cord grass (Spartina alterniflora), seashore paspalum (Paspalum vaginatum), torpedo grass (Panicum repens), bull rush (genus Scirpus), and their variants having equivalent rooting and propagation characteristics.

20. The method of claim 19, wherein the seashore paspalum or torpedo grass are positioned on the second layer above a mean tide level.

21. The method of claim 19, wherein the smooth cord grass or bull rush are positioned on the second layer below a mean tide level.

22. The method of claim 16, wherein the selected plants inserted into the base layer are selected from the group con-
sisting of bunchgrass, tussock, sunshine vetivergrass (*Chrysopgon zizanioides*), and their variants having equivalent rooting and propagation characteristics.

23. The method of claim 16, wherein the base layer includes two layers of the plastic matrix, wherein the layers are positioned in at least a partially overlapping position.

24. The method of claim 16, wherein the base layer includes three layers of the plastic matrix, wherein the layers are positioned in at least a partially overlapping position.

25. The method of claim 24, wherein the layers are positioned progressively toward the water such that a portion of each of the layers is in contact with and caused to conform to the shoreline.

26. The method of claim 25, wherein the selected plants in the base layer are inserted only on the layer farthest from the waterline.

27. The method of claim 16, further comprising shaping and grading the shoreline to a predetermined condition prior to installation of the base layer.

28. The method of claim 16, wherein the base layer is about 8-12 feet wide in a direction substantially perpendicular to the shoreline, and is positioned on the shoreline in strips 30-100 feet long in a direction substantially parallel to the shoreline.

29. The method of claim 16, wherein the second layer is about 24-36 inches wide in a direction substantially perpendicular to the shoreline, and is positioned on the base layer in strips 10-20 feet long in a direction substantially parallel to the shoreline.

30. The method of claim 16, wherein the anchors comprise an anchor plate having a plurality of holes formed therein, and an elongated reinforcement bar staple inserted therein, and an elongated reinforcement bar staple inserted through the anchor plate and driven into the shoreline.

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