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HABITAT RESTORATION  
ENVIRONMENTAL MANAGEMENT

**Biomimicry Strategy and Techniques: Making Land from Air**  
USING WIND ENERGY TO RESTORE DUNES, By Gordon Peabody, Safe Harbor  
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**Biomimicry is an innovative random matrix coastal restoration system** that harvests sand from storm winds. Safe Harbor Environmental developed this minimal profile system during a [barrier dune](#) restoration in Truro, Cape Cod, MA following 5 failed attempts. The broken dune had over washed into a freshwater marsh for 19 years. Safe Harbor's restoration systems collected 18-22 vertical feet of new sand in 26 months. The cross-section profile of the restored barrier dune was 600 square feet.

**“Biomimicry”** refers to our minimal profile, random matrix, coastal restoration system. Biomimicry imitates the performance of native coastal vegetation to stabilize and collect windblown sand. Biomimicry uses 14-inch-long, narrow cedar shims which are randomly inserted several inches into the sand. The shims are placed 10-14 inches apart, in a random matrix, along the upper beach. This matrix stabilizes existing sand while also collecting new sand, by generating turbulence in laminar ocean storm winds. Turbulence reduces velocity, which then reduces transport, causing sand to collect. As sand levels rise, the shims are pulled up higher, to continue collecting. Additional shims can be added to widen the profile. How the shims are adjusted controls the profile of the sand collection platform. As elevations of the dune increase, beachgrass can be planted side by side with Biomimicry. The performance of Biomimicry is inversely proportional to its minimal profile, see pages 9-14 for more information. Permitting should require minimal, AR or RDA. Biomimicry is not a fence, is not a structure, and is fully removable.

**Barrier Dunes:** Barrier dunes over wash as part of the coastal process. Biomimicry was developed in response to chronic anthropogenic impacts that can create high frequency over wash, as was the case for 19 years on the barrier beach in Truro.

**Biomimicry Shims:** One pack of cedar shims covers approximately 10'x10'. Five packages of shims and one hour of time will create a 100' X 5' matrix to begin dune creation. On ocean beaches with good sand supply, dunes are created when the matrix minimally interacts with storm winds transporting sand. The resulting turbulence generates sand collection. The shims may require adjustment after significant winter storms.

Four Rivers Charter School students from Greenfield MA, adjust shims.



Erosion brings exponential volumes of sand into the coastal process.



Storm winds create laminar flow, moving eroded sand down the beach.



Native vegetation creates minimal turbulence in the laminar flow, reducing the wind velocity and reducing sand transport. Our Biomimicry system replicates this process.



**IMAGE BELOW** from 1978, showing healthy barrier dune between two coastal banks; **BELOW RIGHT**, over wash risks created by chronically eroding anthropogenic access paths.



**IMAGE BELOW** 1991 “PERFECT STORM” waves over wash into freshwater marsh at the headwaters of Truro’s Pamet River and travel 1 mile down river.



**IMAGE BELOW** Shows a more recent open breach, common to this dune system after 19 years of sand collection systems and pedestrian traffic control failed.



Following an entire year of unsuccessful attempts to secure permitting, in December of 2010, Safe Harbor was finally allowed to experiment with an innovative system: collecting sand using multiple lines of short fences.



Within two weeks the system began collecting sand from ocean storms.



The restoration area too would over wash, destroying the fencing.



Safe Harbor began experimenting with reduced collection profiles at the toe.



Five different ideas were tried but nothing seemed to collect sand successfully.



Finally, only the individual slats remained, so we tried using them.



We tried using only bare slats in a random matrix, as seen below.



Within a week, something very unusual began happening; sand kept collecting with no losses. We realized we were onto something.



By continually reducing effort and reducing profile we had stumbled upon the inversely proportional balance point, between minimal profile turbulence and maximum collection performance.



We discovered when the slats were pulled up, they kept on performing.



**IMAGE BELOW PRE-HURRICANE.** The 2<sup>nd</sup> year we were only using cedar shims.



**IMAGE BELOW DAY AFTER HURRICANE;** setting shims for predicted Nor'easter. We were favoring the back-dune restoration area, as this is the most resilient area of a dune, where we wanted to collect a lot of sand.



**IMAGE BELOW** 1 DAY AFTER THE BIG NOR'EASTER. Major sand collection.



**IMAGE BELOW** EARLY WINTER. Sand continued to collect. Signpost from above image is nearly obscured, so we marked a new signpost on the dune crest.



We began planting beachgrass in late winter. The dune was now collecting sand and performing on its own.



Another dune restoration using imported geomass as a base. Using Biomimicry to stabilize raw sand and collect new sand.



Biomimicry shims being placed in random, linear matrices.



One storm later the shims were ready to be readjusted.



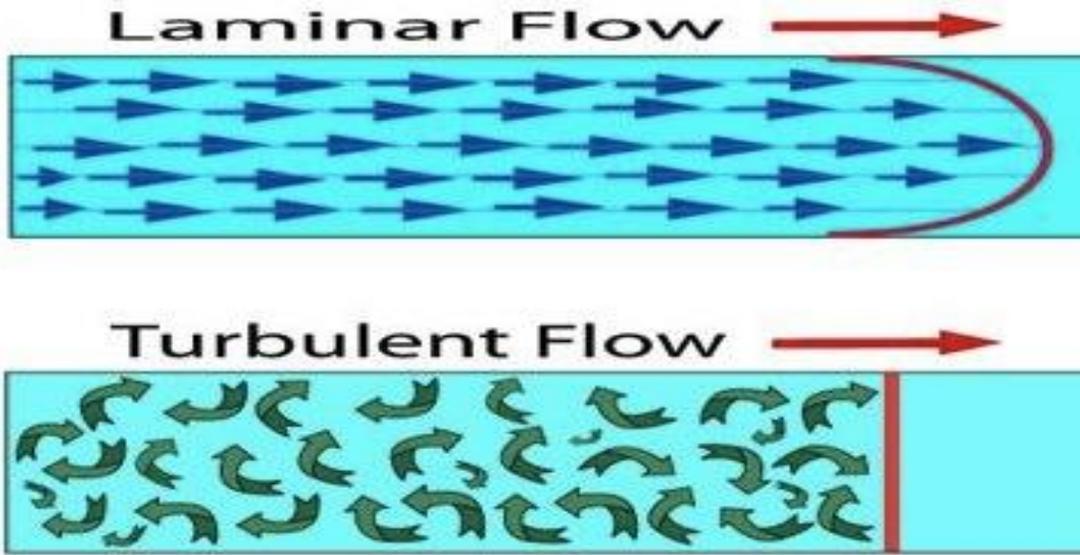
This system created linear dunes, when shim supply was limited.



The same site, two years later after planting beachgrass.



THE CORE PERFORMANCE OF SAND COLLECTION BY BIOMIMICRY OR BEACH GRASS



Biomimicry has limited performance on the toe of a coastal bank.



At toe of nourishment, Biomimicry creates bi-directional sand collection.



**IMAGES BELOW** document small-scale Biomimicry being used on eroded beach access paths to restore sand during the low use period in winter.



## **CONTINUED EXPERIMENTATION, IN HIGH RISK, OVER WASH SITES**

Image below shows *High Risk Biomimicry Configuration*: A significant portion of shims have been installed with 90-degree offset, further reducing cross section.



Image below documents Biomimicry sand collection from storm wave over wash.



We are still studying the potential of Biomimicry to perform in limited, high risk areas. The system has demonstrated the potential to interact with the fluid characteristics of both wind and water. The use of Biomimicry and wave over wash, have been described in our newest publication "[MAKING LAND FROM WAVES: USING BIOMIMICRY TO RESTORE DUNES FROM STORM OVER WASH](#)" Gordon Peabody, 2020. [www.SafeHarborEnv.com](http://www.SafeHarborEnv.com)

## **Review of Biomimicry: Information and Installation Instructions**

- Safe Harbor’s Biomimicry system is an innovative “Green Technology”.
- Biomimicry is an adjustable, low profile sand restoration system.
- This system is designed for use on coastal beaches during winter storms.
- This system mimics the performance of native beach vegetation to collect and stabilize sand being transported by ocean storm energy.
- Storm wind energy is part of the coastal-ocean resource system.
- This system has also collected sand from limited surf line wash over.
- Storm winds transporting sand are partially interrupted by Biomimicry.
- Collected sand is completely compatible for dune restoration projects.
- Thin wooden shims, 14 inches long, are available at building supply places.
- The shims should be inserted 3-4 inches into the sand, spaced randomly 10-14 inches on center (facing the water), leaving 10 inches exposed.
- Linear matrix pattern is between 4-6 feet wide, parallel to the shoreline.
- Linear matrices can be spaced 15 feet apart to restore beach elevations.
- When sand collects around the Biomimicry system, the shims can be adjusted easily (pulled up by hand) to continue sand collection.
- We recommend making certain the shims are dry before installation.
- It takes about one hour to create a 100-foot-long x 6-foot-wide matrix.
- This pattern can be installed where a dune is being restored or created.
- This system may be considered for restoring the toe of a coastal bank.
- This pattern can also be installed to restore the eroded toe of a dune.
- This system can perform as a stand-alone or in conjunction with newly planted beach grass, contributing to performance, pending plant maturity.
- The performance of this restoration system is linked to available sand.
- Collection rates vary due to uncertainties in storm tracks.
- The system may be seasonally removed to facilitate seasonal beach access.



*A few final words...Biomimicry was developed and tested under some of the most intense conditions imaginable. It is challenging to explain the counter-intuitive simplicity and often extraordinary performance of such a humble system. I believe Coastal Resources are best protected by the people who live there. Coastal Communities and Natural Resources, need each other to survive.*

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<https://www.safeharborenv.com/safeharborblog/2017/2/21/making-land-from-air-innovative-biomimicry-sand-collection-system> **Link to NOAA Webinar on our Biomimicry System.**

**Proprietary interest:** Safe Harbor is relinquishing proprietary interest in "Biomimicry sand collection systems" as of January 14, 2013. **You are free to Share** — to copy, distribute and transmit this Safe Harbor publication **under the following conditions: Attribution** — You must attribute the work but not in any way that suggests that Safe Harbor endorses you or your use of the work.