****

**Protecting Coastal Communities with Innovative Engineering:**

**A Concept Paper to Establish a R&D “Engineering with Nature” Partnership on the Use of Seaweed Erosion Mitigation Systems (SEMS) in Saco Bay, Maine**

# **Introduction**

During the Civil War a pair of rip rap jetties was constructed at the mouth of the Saco River in Maine to stabilize the inlet and to increase the import and export capabilities to America’s most important textile industries located at Factory Island in Saco, Maine. These enormous structures were lengthened multiple times until they became one of the largest navigational structures on the eastern seaboard of the United States. Indeed, over half of the inlets in this region over 100 meters in width are similarly stabilized by hard infrastructure (FitzGerald et al., 2005). Construction of such large scale coastal jetties were common at this time of rapid industrialization; today these structures are blamed for the widespread alteration of coastal geologies and ecosystems resulting in billions of dollars of shoreline changes and lost tourist incomes. The jetties in Saco have forever altered the sediment dynamics within the region, home to the most visited stretch of coastal beaches north of Massachusetts. The jetties severed the riverine sediment supply which arrives from the foothills of the White Mountains in New Hampshire, causing Maine’s precious beaches to be starved of sediment.

Scientists at UNE’s Marine Science Center have been discussing internally and with potential partners the concept of developing an innovative, and potentially economically viable “soft” biotechnical complements to the proposed methods of erosion mitigation via jetties, “hard” stabilization and expensive beach renorishment within Saco Bay. We propose to work in partnership with the many concerned groups to establish experimental seaweed aquaculture structures placed specifically to provide erosion mitigation but also multiple benefits. We believe applied ocean research we can conduct will provide a unique opportunity to involve the private sector, scientists and students plus leverage the unique facilities and logistics of the Marine Science Center at the UNE. We feel that our strategy has the potential to benefit the current strategies of both the United States Army Corps of Engineers (USACOE) and Saco.

# **Current Situation**

Erosion caused by the interruption of transport of riverine sands to form beaches has led to the loss of multiple properties at Camp Ellis, and still more are threatened. An estimated 20-30% of the total tax revenue from the city of Saco, Maine is in this area, and is in danger. Historical shoreline positions show a significant loss of material at the southern end of the bay, with continued erosion (Figure 1) (Woods Hole Group/Aubrey Consultants, 2006). The entire area is now a Section 111 project under the US Army Corps of Engineers (USACE) which is required to mitigate the damage caused by its structures. The USACE is attempting to mitigate the wave action which is directed at Camp Ellis which transports sands to the north, eroding the shoreline.

Currently, sand that resides on the beaches of Saco Bay is utilized for a large and economically important recreational tourism industry. The sandy beach also provides a vital buffer from ocean energy to property owners. Sand resources are being eroded, particularly in the southern reaches of the bay due to waves and storms. The presence of the riprap jetties at the mouth of the river disrupts the input of sand and sediments from the Saco River, creating a net deficit, resulting in a loss of the beach. A detailed model of wave action has been completed by the Woods Hole Oceanographic Group (WHOG) and Aubrey Consulting Inc. which determined that the best alternative for dealing with this situation is to break incident wave action and the resulting, refracted, or along-jetty wave action - known as “Mach-Stem waves” - through the proposed development of a 750’ “spur jetty” parallel to the coastline.

# **Our View**

The current strategy of reducing wave action is appropriate to reduce the amount of energy reaching Camp Ellis. Trapping sediment before its transport north is also an important aspect. The building of additional structures over and above the perpendicular jetty to protect more of the coast line is limited by the high costs and the suitability of the Saco Bay’s substrates to support such structures. Beds of seaweed are known to dampen wave action. Our proposal is to use seaweed structures (Seaweed Erosion Mitigation System, SEMS) to alter the movement of sands north of Camp Ellis.

This concept would allow for thick vegetation structures to be oriented to absorb the maximum amount of wave energy and slow the movement of sediment along the beach. Slowing the transport of sediment along the beach could increase the amount of time in between future replenishments, and potentially give dune grasses and vegetation additional time to take hold. By breaking down the structure of the wave energy onshore while also being a permeable structure, these SEMS could allow large quantities of sediment to be moved onshore and deposited.

# **Benefits: Use of Ecological Engineering in Coastal Processes**

Coastal commercial and residential infrastructure is likely to be increasingly susceptible to storm damage due to a changing climate; and intensifying coastal developments will increase the risk and value of such losses. This project has the potential to benefit a wide range of individuals and organizations through economic, engineering, ecological, and education services. From an economic standpoint, the concept stems from a “for profit” seaweed industry, with financial models already in existence to create capital. An existing business (Ocean Approved, Portland, Maine) with an expanding market demand for seaweed products could be a method to provide recurring income, jobs, and taxes. Ecological services provided by SEMS could benefit everyone who utilizes the bay. Kelp would increase water quality through filtering and extraction of nutrients. When kelps are harvested, nutrients are removed from the system, potentially reducing the likelihood of Harmful Algal Blooms (HABs). In addition, kelps grow rapidly in the winter when storms cause most of the problems; plus, there would be less user conflicts with summer tourism.

# **Proposed Cooperative Marine Science Research**

In an effort to assist in the efforts of the USACE and Saco to protect its invaluable coastal communities, we propose to study the impacts of this unique “soft engineering” concept by deploying SEMS (e.g. seaweed kelp farming structures) between Ram Island and Eagle Island, and to study their impacts over the winter storm periods. Instrumentation will be deployed to examine the physical oceanography, movements of sand deposition, and the marine ecology of the Camp Ellis area. We propose to form a working group comprised of all affected parties, including local officials, fishing community interests, federal and state agencies, and University of Maine, USM, and UNE professionals. We intend to convene workshops of all important technical parties to the issues to share findings.

# **Funding Needs**

We propose that funding will be required for a PhD student; for undergraduate research fellows; for oceanographers from UNE and the University of Maine; for a UNE expert in participatory strategies and environmental communication; for seaweed experts from Ocean Approved, Inc. and for equipment, supplies and marine operations.UNE will provide significant match from its large ocean buoys and its staff. Funding needs are estimated to be required over a five year project period at approximately $250,000 per year, for a total estimated cost of $1 million

The University of New England is a partner of the North Atlantic Coast Cooperative Ecosystems Study Unit (CESU) Network which could be a funding portal for this work.

The North Atlantic Coast CESU is a network of programs established to provide research, technical assistance and education to federal land management, environmental and research agencies. If funded, the UNE would be the coordinator of a statewide partnership to work on marine/coastal issues of direct interest to Maine, New England, the Department of the Army, NOAA, Department of the Interior, and the Department of Agriculture.

# **UNE Marine Science Center Background to this Concept Paper**

The Marine Science Center at the University of New England has undergone a leadership change and has a new strategic plan that emphasizes our intention to seek more actively opportunities to contribute to developing increased understanding of our local marine/ocean/coastal, environmental resource and ocean issues important to Southern Maine, and especially to the communities of Saco, Biddeford, and Portland.

**References**

FitzGerald, D.M., Buynevich, I.V., Fenster, M.S., Kelley, J.T., Belknap, D.F. 2005. Coarse-grained sediment transport in northern New England estuaries: A synthesis. *High Resolution Morphodynamics and Sedimentary Evolution of Estuaries*. **8**: 195-213. DOI: 10.1007/1-4020-3296-X\_10

Woods Hole Group, Aubrey Consultants. 2006. Historical Shoreline positions in the vicinity of the Jetty system. (Final Draft Report: Section 111 Erosion Mitigation Project; Woods Hole Group, Aubrey Consultants)

**Figure 1**