Benthic Barriers

U.S. ARMY CORPS OF ENGINEERS **Building Strong®**

ANS Control: Benthic Barriers – textile or plastics and silt.

Bottom screening material being prepared prior to installation around a boat dock

Targeted Species: Species controlled by this technology include, fish, macroinvertebrates, and rooted aquatic plants, both submersed and emergent. Specifically, ANS of Concern – CAWS[1] species including Cuban bulrush (*Oxycaryum cubense*), marsh dewflower *(Murdannia keisak)*, reed sweetgrass *(Glyceria maxima)*, and swamp sedge *(Carex acutiformis)*.

Selectivity: Benthic barriers are not selective. Benthic barriers will impact all target and non-target organisms dependent on or living in sediment.

Developer/Manufacturer/Researcher: Manufacturers and installers of benthic barriers are readily available throughout the United States.

Brief Description: A benthic barrier is a system designed to prevent the establishment of plants, control existing plants, and to interfere with respiration in fish and macroinvertebrates. The method is applicable in water bodies of all types, but water bodies with higher velocity flows, such as rivers, streams, and canals, present additional challenges in implementation. There are two general types of benthic barriers:

Textile or plastic – Benthic barriers to control invasive plant consist of an anchored textile or plastic material, which is placed over existing vegetation, or in a location to prevent the establishment of aquatic vegetation. These barrier systems range from simple designs (such as a nylon tarp with cinderblocks for anchors and PVC poles for markers), to more complex nylon or fiberglass materials, with anchors built into the edges of the fabric, and buoys for navigational markers. Any number of materials and anchors can be utilized to effectively implement the system, however, materials and markers should be chosen to match the environmental and hydrologic conditions in a given water body.

Silt – Benthic barriers can also be created by applying excessive silt or sand to smother bottom-dwelling organisms. Biotic impacts may result directly from sediment in suspension or through the deposition of fine sediment either on, or within, the river bed. Some organisms are very sensitive to excessive sediment during early life stages. A range of factors influence the impacts of sediments on

[1] For a complete list of the 39 specific ANS of Concern – CAWS, please see Table 1 of the main report.

aquatic biota, including concentration, duration of exposure, composition and particle size (Collins et al. 2011).

Prior Applications:

Textile or plastic – Benthic barriers are used worldwide to control aquatic plants in many ways, including creating open “swimming” areas in lakes, preventing the establishment of submersed aquatic plants, and allowing for habitat restoration (Gettys et al. 2009). Benthic barriers are primarily used in lake settings, but have been placed in river systems and canals in South Florida to control submersed aquatic vegetation. Subject to the availability of funding, the U.S. Army Corps of Engineers’ (USACE) Pilot Swales Project within the Comprehensive Everglades Restoration Project is considering a study to construct benthic barriers in the swales between Water Conservation Area 3 and Everglades National Park, with the intent of controlling and preventing the establishment of rooted vegetation in these areas (Angie Huebner & Sue Wilcox, USACE, Personal communication, 2011).

Silt – Erosion from anthropogenic sources (i.e. construction, timber harvest and farming) is regulated and its effects on native aquatic organisms are well known; however, the application of silt to control invasive species has not been widely studied. Silt was proposed as a physical strategy for controlling invasive lake trout (*Salvelinus namaycush*) in Yellowstone Lake, Wyoming to smother eggs and early life stages of fish at the redd (nest) site (Gross et al. 2010). Other applications have not been identified.

General Effectiveness:

Textile or plastic – Benthic barriers may be extremely effective at limiting plant growth and establishment, and are often used as a low cost rapid response tool to control establishment of new species (Gettys et al. 2009). When implemented and properly maintained, textile and plastic benthic barriers can provide 100% control of existing covered vegetation. The barrier effectively starves plants of sunlight, blocking the ability to photosynthesize (Gettys et al. 2009).

A benefit of benthic barriers is that the area where the barrier is installed will not harbor floating vegetation, and the lack of emergent and submersed vegetation will prevent floating vegetation from collecting. One negative consequence of benthic barriers is that they do not allow establishment of native vegetation in the area of the barrier.

Though textile or plastic benthic barriers are primarily used to control submersed aquatic vegetation, the University of California, Davis’ Tahoe Environmental Research Center and the University of Nevada, Reno’s Aquatic Ecosystem Analysis Laboratory are researching the use of benthic barriers to control invasive mollusks. At this time, researchers have not concluded whether benthic barriers are an effective ANS Control for certain mollusk species (Marion Wittman, Personal communication, 2011).

Silt – The effectiveness of silt for controlling invasive species in the CAWS depends upon if the invasive species is susceptible to suspended sediment or siltation and could be contained within a treatment area. If applied in an open flowing system, exposure time is greater for upstream movement as compared with downstream movement. Many species can tolerate inhospitable environments for short periods of time. The reaction of an organism to suspended silt can range from feeding inhibition, reduced metabolism, avoidance, or mortality (Table 1). Since many invasive species are silt-tolerant, it is unlikely that increasing suspended sediment concentrations would greatly reduce their abundance.

Table 1. Examples of the Results of Sediment Dose–Response Experiments for Fish and Macroinvertebrates (adapted from Collins et al. 2011)

Organism	Suspended sediment concentration (mg l^{-1})	Duration (h)	Impact	Reference
Fish - Chinook salmon	207 000	1	100% mortality of juveniles	Newcomb & Flagg 1983
Fish - cyprinids	100 000	168	Some survival	Wallen 1951
Copepod - Cladocera	25 000	unknown	Feeding inhibition	Alabaster & Lloyd 1982
Mollusk - Bivalvia	600	unknown	Feeding inhibition and reduced metabolism	Aldridge et al. 1987
Various benthic invertebrates	743	unknown	Reduced population (85%)	Wagener & LaPerriere 1985

Application of high concentrations of silt in an open, flowing system may be difficult to control.

Operating Constraints: Benthic barriers have operating constraints, including a barrier's impact on non-target organisms that live in or depend on sediment, the scale of the ANS infestation, barrier maintenance, and barrier location.

Textile or plastic – Because textile or plastic benthic barriers completely separate the water column from the sediment, plants dependent on sediment and other non-target organisms living in or dependent on sediment may be adversely impacted.

Because the material used to construct a barrier and the means of anchoring the system become extremely cumbersome as the barrier grows in size, benthic barriers are more suitable for small-scale applications. Current consensus on best design and construction practices notes that barriers should be held to a size of less than one acre to be effectively managed, however, even a barrier one acre in size may be very difficult to maintain (Gettys et al. 2009).

Additional constraints are related to ensuring that a barrier is properly anchored for site-specific conditions, to ensure that it remains in place. Barriers need to be sufficiently weighted to withstand high flow in waterways; additionally, barriers in water bodies that are highly susceptible to seiche[2] effects must be properly anchored (Bellaud 2009). Not only will a barrier be ineffective if it is not properly anchored, but if the barrier is freed from its anchorage, it may become detrimental to desired aquatic vegetation or a hazard to boats. Breakdown of vegetative material may produce significant quantities of methane gas beneath the barrier; commonly, barriers must be 'burped' to allow for the release of gases trapped beneath the barrier.

[2] A seiche is the process of water being drawn from one side of the lake and 'stacked' on the other side due to wind; when winds subside, the water rushes back, creating violent waves.

Benthic barriers must be removed, cleaned and inspected, and reset in order to maintain effectiveness over time. The time required to complete this cycle for maintenance varies greatly, and is highly dependent on site-specific environmental conditions, as well as the size and material type of a barrier. A barrier will become completely ineffective if silt and soil buildup occurs on its upper surface. Vegetation will establish in the accumulated material and compromise the intended purpose. Holes in the barrier would also allow vegetation to establish.

Silt – In a flowing system, maintaining an effective concentration and exposure time for silt would be constrained by the system's non static conditions such as fluctuations in volume and flow velocity during dry and wet weather conditions, inconsistent flow direction, variability in water density throughout channel depth, removal of water by users, addition of effluent from dischargers to the waterway, and the variability of sediment conditions along the targeted area.

Cost Considerations:

Textile or plastic –

Implementation: Implementation costs would include planning, design, and materials and installation for each barrier and anchoring system. Planning and design activities in this phase may include research and development of this Control, modeling, site selection, site-specific regulatory approval, plans and specifications, and real estate acquisition. Design will also include analysis of this Control's impact to existing waterway uses including, but not limited to, flood risk management, natural resources, navigation, recreation, water users and dischargers, and required mitigation measures.

Operation and Maintenance: Cost considerations include the maintenance of the barriers such as monitoring to ensure they are properly anchored, repair of torn or ripped barrier material, monitoring for and release of methane build up beneath the barrier, and removal of accumulated soil, sediment and debris from the barrier.

Mitigation: Design and cost for mitigation measures required to address impacts as a result of implementation of this Control cannot be determined at this time. Mitigation factors will be based on site-specific and project-specific requirements that will be addressed in subsequent, more detailed, evaluations.

Silt –

Implementation: Implementation costs would include planning, design, and materials and installation for each silt barrier. Planning and design activities in the implementation phase may include research and development of this Control (regarding such items as coverage requirements and effectiveness for specific species), modeling, site selection, site-specific regulatory approval, development of plans and specifications, and real estate acquisition. Design will also include analysis of this Control's impact to existing waterway uses including, but not limited to, flood risk management, natural resources, navigation, recreation, water users and dischargers, and required mitigation measures.

Operations and Maintenance: Operations and maintenance would include application of the silt and monitoring to ensure effectiveness of application in open flowing systems.

Mitigation: Design and cost for mitigation measures required to address impacts as a result of implementation of this Control cannot be determined at this time. Mitigation factors will be based on site-specific and project-specific requirements that will be addressed in subsequent, more detailed, evaluations.

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