USA: Maryland: Potomac River Eelgrass Restoration

Overview

As part of a larger effort to restore vital submerged aquatic vegetation (SAV) habitat in Chesapeake Bay--primarily eelgrass (Zostera marina)--three sites in the Potomac River were chosen for replanting. After initial attempts to manually gather reproductive shoots from donor beds, project practitioners decided to employ a mechanical harvesting boat in order to improve efficiency and viable seed yields. Shoots were gathered and stored at an aquaculture facility, and seeding was subsequently conducted using a variety of techniques. Seed bags were utilized at the sites to mimic natural reproductive processes, and manual and automatic seed dispersal techniques were later employed as well. Despite a large quantity of distributed seeds and initial indicators of success, long-term survival rates for newly established seedlings proved disappointing. Poor water quality and ineffective seed storage procedures are thought to be the primary factors in the low success rate.

Project Details

Lead Entity:

The Chesapeake Bay Program

Lead entity types:

- Other

Adaptive management

Describe adaptive management processes and mid-course corrections taken to address unforeseen challenges and improve outcomes in each of the following categories:

Other:

Despite some advantages to using adult plants (e.g. successful adult plants yield reproductive shoots during the following year's reproductive season, Orth, 2003), seed broadcasting appears to be a more efficient and cost effective restoration technique with the added benefit of having less impact on donor beds (Orth, 2000). Evaluation of the cost effectiveness of the different seeding methods used showed that spring seed bags were by far the most cost effective restoration technique, with a cost per seedling of $1.70 (compared to $4.70 for planting an adult plant and $363.89 per seedling for fall seed broadcasting).

State of Progress:

- Implementation

Project Start:

2003-10-11

Project End:

2003-10-11

Global Regions:

- Northern America
- Americas
- World

Countries:

- United States of America

Ecosystem Functional Groups / Biomes:

- Brackish tidal biome

Ecosystems:

- Coastal saltmarshes and reedbeds

Extent of project:

- Other

Extent of restoration:

- Other

Degradations:

- Other industrial and urban development

Description:

In Chesapeake Bay, deforestation, population growth, and the subsequent sedimentation and nutrient enrichment caused declines in all species of submerged aquatic vegetation (SAV) beginning in the 17th century (Brush and Davis, 1984). However, those changes were relatively minor compared to the catastrophic declines that occurred in the late 1960's and early 1970's (Orth and Moore, 1983). Researchers suggest a combination of factors resulted in these losses. Kemp et al. (1983) and Twilley et al. (1985) postulated that increased nutrient loadings of the Chesapeake Bay in the 1970's enhanced growth of planktonic and periphytic algal species which compete with SAV for light. SAV productivity was shown to be reduced further when suspended sediment increases in the water column, exacerbating light attenuation problems (Wetzel and Penhale, 1983; Kemp et al., 1983). These studies demonstrated that SAV growth and abundance were inextricably linked to water quality. In addition to the combined effects of degraded water quality, the flooding that accompanied Hurricane Agnes in 1972 resulted in a prolonged period of high suspended sediment loads at a critical time of year for SAV growth. The combination of stressors had devastating effects on the SAV acreage baywide, and few areas have recovered to their 1930's- 1950's levels.

Planning and Review

Goals and Objectives

Was a baseline assessment conducted:

UNSURE

Was a reference model used:

UNSURE

were_goals_identified:

YES

Goals and objectives:

- Other

Goals Description::

To identify and strategically plant or reseed SAV beds in regions of the Chesapeake Bay where habitat conditions are suitable for SAV growth. The establishment of dense, protected beds will afford both a source of seeds to accelerate natural revegetation and the self-protection necessary to ensure the longevity of newly established beds.

Stakeholder Engagement

Were Stakeholders engaged?:

unsure

Description of Stakeholder Involvement:

The primary stakeholders in this project are the many partners comprising the Chesapeake Bay Program and the signatories to the Chesapeake Bay Agreement. These include, among others: the Chesapeake Bay Commission, Commonwealth of Pennsylvania, Commonwealth of Virginia, District of Columbia, State of Maryland, State of Delaware, State of West Virginia, New York State, and the U.S. Environmental Protection Agency. Federal partners also include the Chesapeake Bay Environmental Enforcement Coalition, U.S. Department of Agriculture, U.S. Department of Commerce, U.S. Department of the Interior, U.S. Department of Transportation, and the U.S. Department of Education. A number of academic institutions are associated with the restoration effort, including: the Academy of Natural Sciences, Chesapeake Research Consortium (CRC), College of William and Mary, Cornell Cooperative Extension, Smithsonian Institute, University of Maryland, University of Pennsylvania, University of Virginia, and the Virginia Cooperative Extension Office. Other stakeholder institutions include: the Alliance for the Chesapeake Bay (ACB), American Forests, Anacostia Watershed Society, Center for Chesapeake Communities (CCC), Center for Watershed Protection (CWP), Chesapeake Bay Foundation (CBF), Chesapeake Bay Trust, Ducks Unlimited, Consortium for International Earth Science

Information Network (CIESIN), National Fish and Wildlife Foundation, Potomac Conservancy, Susquehanna River Basin Commission (SRBC), and Interstate Commission on the Potomac River Basin (ICPRB).

Ecosystem Activities and Approaches

General Activities: *Site Selection* Locations for large-scale restoration activity were determined using a Geographic Information System (GIS) based SAV restoration targeting model (Parham and Karrh 1998). The model uses six layers of key habitat information to evaluate the suitability, ability and potential of a particular habitat to support SAV populations. Five sites in the lower Potomac River were identified as suitable for eelgrass recolonization based on the DNR SAV targeting model: - Cherryfield Point (N38Â° 07.819' W76Â° 27.574') - Piney Point (N38Â° 08.279' W76Â° 30.159') - Sage Point (N38Â° 07 53.2' W076Â° 26 10.5') - St. George Island (N38Â° 08 07.6' W076Â° 29 41.4') - Kitt's Point (N36Â° 06.628' W76Â° 25.471') *Test plantings* To determine the best planting sites within the areas identified by the SAV restoration targeting model, adult plants raised in the laboratory and harvested from existing beds in the bay were transplanted into three, one square meter plots in areas adjacent to seed broadcast and seed bag areas. Sixty-four adult plants were planted in each plot, anchored by wooden skewers (Davis, 1997). These test plantings were monitored for percent survival at 1 week, 4 weeks and 16 weeks after initial planting. *Seed Collection* To begin the project, DNR staff concentrated efforts on finding the most productive donor beds from which to harvest. In May 2003, eelgrass reproductive shoots were collected manually from donor beds in Sinepuxent Bay and Tangier Sound. For approximately 3 weeks, DNR staff and volunteers snorkeled and used scuba equipment to manually remove the reproductive shoots of eelgrass. This method yielded a total of 2.3 million seeds, 250,000 of which were viable for broadcast. This was a very expensive and inefficient process in terms of man-hours involved, so over the winter, alternative methods of harvesting were investigated. It was found that very little work had to be done to adapt a mechanical harvesting boat, previously used to harvest water chestnut (Trapa natans), to collect eelgrass reproductive shoots. The reproductive shoots stand above a majority of the plant biomass and could be harvested with little or no impact on the eelgrass beds. During subsequent harvests in 2004 and 2005 in the Little Annemessex River and Tangier Sound (N37Â° 58.479' W75Â° 52.255' and N37Â° 59.073' W75Â° 59.206', respectively), a mechanical harvest boat was utilized (M J McCook & Associates, La Plata MD) to increase the volume of reproductive material collected. The harvester would run systematic transects within the beds, adjusting the cutting blades to account for changes in depth. As the boat moved slowly through the water, the cutting blades clipped the eelgrass reproductive shoots at approximately one foot above the sediment. This method yielded 15.12 million seeds in 2004, of which 1,058,400 seeds were viable for broadcast. *Seed Processing and Storage* Once the bags of harvested eelgrass reproductive shoots arrived at Piney Point Aquaculture Facility, they were placed in one of eight, 20,000 gallon (32'x32'x4') or one of sixteen 9,800 gallon (20'x20'x4') greenhouse basins. The water in each basin was replaced daily with local St. Georges Creek water and augmented with aquaculture grade sea salt to match conditions at the harvesting areas (~14ppt). In addition, each basin was aerated to prevent anoxia. Typical basin dissolved oxygen levels averaged 5-6 mg/l. Water quality was monitored twice daily in order to ensure adequate conditions. While in the basins, the eelgrass seeds slowly dropped from the reproductive shoots over the following month. After all the seeds were released and settled to the bottom of the basins, the seed/reproductive shoot slurry was pumped into a series of stacked settling trays to allow the passive accumulation of seeds while discarding the non-seed material. *Seeding* As the bags of harvested material arrived at Piney Point, about 15,000 L were used to fill seed bags for deployment. DNR used a modified version of the buoy deployed seeding system, (BuDSS), created by Chris Pickerell at Cornell University Extension Service (Pickerell et al., 2003). Four gallons of collected reproductive shoots were placed in a mesh bag, divided into three sections by cable ties, and supported on each end with a small buoy. At one end, 2.1 m of polypropylene rope was attached to a cinderblock to anchor the seed bag. The mesh bags remain suspended above the sediment allowing the seeds to mature and drop over a period of weeks, thus mimicking the floating and rafting of reproductive shoots during natural seeding events (Pickerel et al. 2003). Although not proven, it has been suggested that this method may also reduce predation by spreading out seed dispersal over time and through a combination of time and natural forces yield a more even distribution of seeds. Two types of seed bags were constructed and deployed: single (50,000 seeds) and double (100,000 seeds). Seed bags were deployed at the restoration sites by watermen and DNR staff for approximately one month. Eelgrass seeds were also hand broadcast using methods employed by Orth (Orth, Personal Communication) during the fall of 2003. The restoration site was divided into seven 25 m radius plots 1963.4 m2, or 0.485 acres. The plots were then divided into 5m concentric circles from a central point. The concentric areas at 5m increments were chosen to evenly allocate the seeds across the plot by broadcasting while walking around the plot in concentric circles. To distribute at a density of 100,000 seeds/acre, 50,000 seeds or 660 ml, were broadcast with the appropriate proportions going to each concentric section. For example, 237mL of seeds (36% of the total 660mL) went into the outer ring. This method was slow and did not guarantee an even distribution of seeds. Subsequent seed broadcasts in the fall 2004 were achieved mechanically using a specially designed seed broadcast apparatus developed by C & K Lord and Associates and DNR staff. All seed broadcasts took place before ambient water temperatures dropped to 15Â°C, the temperature at which eelgrass seeds begin germination. In Maryland, seeds were mechanically dispersed using a newly developed seed-sprayer from C& K Lord, Inc capable of evenly dispersing seeds at suitable densities (200,000 seeds/acre) at the rate of 10 minutes/acre. *Assessment* Germination rates, seedling survival, and growth in each seeding density replicate were assessed annually at approximately 1 month, 6 months and 12 months after seeding following methods similar to that of Orth et al. (2003).

Categories of ecosystem restoration activities and approaches utilized:

- Ecological restoration

Specific type of rehabilitation and/or restoration approach implemented:

- Assisted natural recovery without planting, seeding, or faunal introductions (e.g. weeding, pruning, thinning, prescribed fire)

Project Outcomes

Eliminate existing threats to the ecosystem: *St. George Island* In spring 2004, seed bags containing 605,000 seeds were dispersed in a 5 acre plot. The site was monitored for the first time on May 12, 2005 and there were 567 eelgrass plants observed per acre, with an estimated 2,835 eelgrass plants in the entire plot. In the fall of 2004, 75,000 seeds were dispersed by machine broadcast in a 0.3 acre plot. The fall seeding area had 586 eelgrass plants per acre on May 12,, 2005 for an estimated 147 plants in the plot. Test plantings placed at each site in November 2004 were monitored on the same dates. In May 2005, an average of 55 plants were observed among the three test plots at St. George Island, yielding an 86% initial planting success rate. In August, 6% of the plants remained, half of which survived through November 2005. *Sage Point* In 2004, there was only spring seed bag dispersal at this site. There were two sites, each with 605,000 seeds spread over 5 acre plots. Field observations made by biologists identified large amounts of widgeon grass, snails, and live oysters on the bottom. Test plantings placed at this site in November 2004 were monitored on the same dates. In May 2005, an average of 52 plants was observed among the three test plots at Sage Point, yielding an 81% initial planting success rate. In August and November of 2005, no plants were observed. *Cherryfield Point* In 2004, there was a spring seed bag and fall seed broadcast at this site. In the spring, two adjacent 2.5 acre plots were seeded with seed bags with 275,000 seeds dispersed in each plot (550,000 total). Test plantings placed at this site in November 2004 were monitored on the same dates. In May 2005, an average of 11 plants was observed among the three test plots at Cherryfield Point, yielding a 17% initial planting success rate. In August and November, no plants were observed. *Seed Bags* The spring seed bag method yielded 7,193 seedlings across all spring seed bag site locations out of 2.4 million seeds broadcast, a recruitment success rate of 0.3%. The fall seed broadcast method yielded 147 seedlings across all fall seed broadcast locations out of 262,000 seeds dispersed, a recruitment success rate of 0.06%. Factors limiting recovery of the ecosystem: Eelgrass seed distributions in 2004 resulted in the successful establishment of seedlings at each site in May 2005. However, almost all adult test plot plants and seedlings completely disappeared in the summer of 2005. To determine the cause for the near complete loss of adult plants, water quality data from the continuous monitoring stations, mainstem stations, and the water quality mapping cruises were analyzed to detect trends or spikes in water temperature and turbidity data that may explain these results. A number of studies have shown that decreased light availability affects eelgrass survival (Philips et al. 1978; Kemp et al. 1983; Dennison and Albert 1986; Twilley et al. 1985). Eelgrass requires between 6 and 8 hours of photosynthetic saturating irradiance per day to survive (Dennison and Alberte, 1985). Although it is not well documented how many days healthy plants can survive elevated turbidity and decreased light availability, it is not likely that the recruited seedlings or adult plants could survive the prolonged periods of high turbidity such as those reflected by the continuous monitor data (see figures). When water clarity data for 2003, 2004 and 2005 are compared to the 20-year record, the values are below the mean each year, with 2003 being the year with the worst water clarity. Water temperature was another major factor in the low recovery rate observed at the project sites. Eelgrass in the Chesapeake Bay is near the southernmost extent of its distribution on the east coast of the United States. Although it is not well documented how many days healthy plants can tolerate elevated temperatures like those recorded during monitoring activities in 2005, the fact that instances of elevated turbidity coincide with elevated temperatures are the likely reason that most recruited seedlings and adult plants did not survive the summer of 2005. The last significant factor in the recovery rate of SAV observed during the project period is the long-term storage of spring-harvested seeds. Regardless of other factors that may have played a role in the variance observed, spring seeding clearly was the most effective method for seed distribution in 2004. Recruitment was much lower for fall seed broadcast due to poor seed survival during storage. Although attempts have been made to improve current storage techniques, and thus increase the number of viable seeds, the care of seeds through the summer has proven to be one of the most difficult aspects of this project.

Monitoring and Data Sharing

Does the project have a defined monitoring plan?:

NO

Open Access URL:

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Long Term Management

STAPER