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Nature-Based Nutrient Reduction for Seagrass Restoration

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The National Academies of SCIENCES ENGINEERING MEDICINE

Abstract

Seagrass Restoration

- Non-Point Source Nutrients Cause a Decline and Loss of Seagrasses Worldwide at an Accelerating Pace
- Target Moderate Nitrogen Impairment to Lower the Total Nitrogen Concentration for Seeding in 1 to 2 Years
- Seeding Done in September of the Year Nitrogen Concentration Goals are Met
- Seagrass would Appear the Following Year and Become Mature in 5 to 10 Years
- Major Impact Objective is ability to scale into Projects that could Seed Hundreds of Hectares

Solution Built Upon 3 Pillars

- **Impact**
- **Timing**
- **Cost**

- Solution directly addresses a natural process bottleneck in shallow waters (< 80 meters) where seagrasses live
- Eutrophication exacerbated by higher temperatures due to climate change impair the naturally occurring coupled nitrification-denitrification (CND) process by reducing availability of dissolved oxygen in bottom water
- Process supplies dissolved oxygen to the sediment surface by delivering nanoscale oxygen bubbles mixed with recirculated bottom water
- Since this is a sediment-based process larger areal coverage means a consequently larger bioreactor for nitrogen removal
- Growth of seagrass meadow requires a continuing program of nitrogen reduction to clear a healthy path for new seedings

Natural Capital

- Current seagrass valuation methods combine both transactional information with ecological to estimate ecosystem service value
- Average seagrass income values at $34,000 per hectare per year
- Converting income, growth rate, and a discount rate we estimate the value for seagrass as a natural capital asset at $1,000,000 per hectare

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Coastal Problems

Coastal Nutrient Pollution

- Eutrophication
- Low Dissolved Oxygen in Bottom Water
- Impaired Ecosystems
- Loss of Seagrasses and Related Services
- Loss of Marine Life
- Loss of Economic Opportunities in Coastal Areas
- Food Insecurity
- Erosion
- Ocean Plastics

Quantified Loss

- Seagrass Loss Worldwide: 7 % per year, 21,000 square kilometers per year, $2.1 Trillion per year
- Nutrient Caused Seagrass Loss Worldwide: 7 % per year, 7,000 square kilometers per year, $700 Billion per year
- Total Seagrass Lost Worldwide Since 1879: 29 %, 125,000 square kilometers, $12.5 Trillion
- Total Nutrient Caused Seagrass Lost Since 1879: 29%, 41,700 square kilometers, $4.2 Trillion
- Fish Loss Worldwide: 168 Billion per year
- Nutrient Caused Fish Loss Worldwide: 56 Billion per year
- Total Fish Loss Worldwide Since 1879: 1 Trillion
- Total Nutrient Caused Fish Loss Since 1879: 330 Billion

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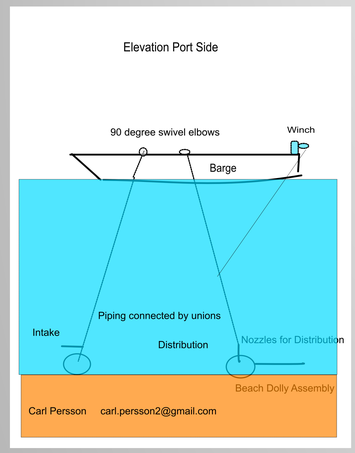
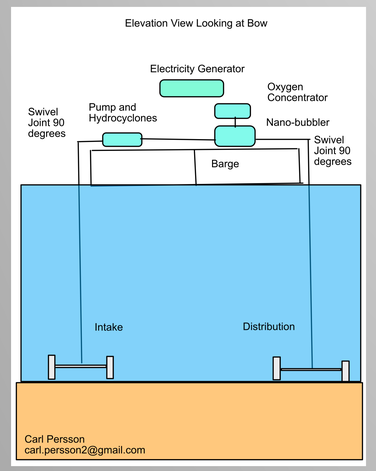
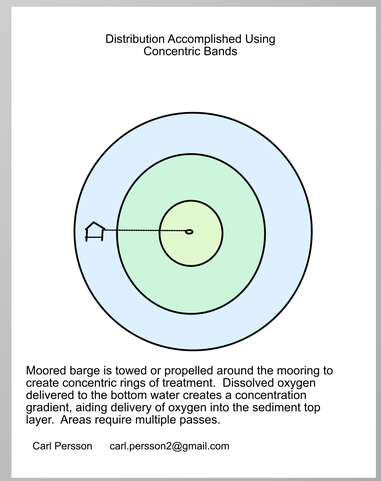
Solutions

Seagrass Restoration





- Restoration of seagrass due to nutrient impairment is a three-step process:
    1. Lower total nitrogen concentration in the bottom water/sediment
    2. Seed or transplant treated areas using best practices
    3. Growth of the seagrass meadow is provided by also lowering total nitrogen in adjacent areas
- Our approach solves the classic non-point source nutrient problem by using a nature-based process using biogeochemistry (coupled nitrification-denitrification) for shallow waters (< 80 meters deep)
- Nutrient impairment bottlenecks natural processes, especially in warmer waters, with a critical lack of dissolved oxygen at the heart of the problem
- Bottleneck is removed with external supply of dissolved oxygen produced by mixing bottom water (temperature) with oxygen sourced from the atmosphere and delivered with bubble diameters of 100 to 200 nanometers using newly available equipment
- Most of the oxygen nanobubbles dissolve in microseconds
- We expect that nutrient removal will take 1 to 2 years with seeding done in September of the year nutrient reduction is achieved at acceptable levels
- The following season should see early growth of seagrass with a mature bed in 5 to 10 years



Other Solutions

- Nitrogen Reduction and Phosphorous Control in water bodies across salinities
- Relief from Hypoxia Regardless of Cause
- Improving Water Quality for Farmed Shrimp

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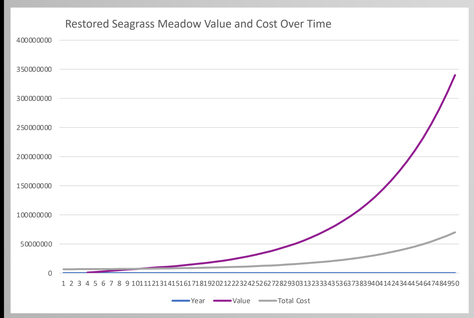
Abstract | Problems | Solutions | Benefits

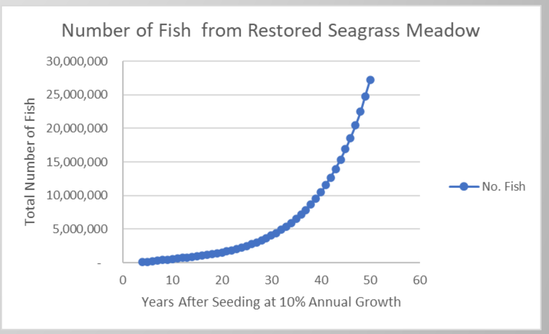
Benefits of Seagrass Restoration

Better Ecological Services

- Habitat for Marine Life
- Nursery for Juvenile Fish
- Food
- Biodiversity
- Carbon Storage
- Ocean Acidification Control
- Oxygen Production
- Sediment Erosion Control
- Nutrient Cycling
- Containment of Particles, Improving Water Clarity
- Containment of Ocean Plastics



Forecast Seagrass Asset Values and Accumulated Cost for Restored 10 ha Seagrass Bed Growing at 10 % per yea for 50 years.



1hectare of Healthy Seagrass can Support 80,000 Fish. Forecast Fish Population Resulting from Restored 10 ha Start Growing at 10 % per Year for 50 Years

Natural Capital

- Blended transactional/ecological economics yields “average” income for seagrass at $34,000 per hectare per year
- Using the Income Model, we can capitalize income, growth rate and a discounting interest rate to an asset value for natural capital. For seagrass we estimate a Natural Capital value of $1,000,000 per hectare.