Defining Protocols for Replanting as an Oil Spill Response Tactic in Coastal Marshes: Preliminary Results

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Abstract

Coastal marshlands are ecologically critical areas that provide essential food, refuge, and nursery habitat. They are highly sensitive to oil spills and exceedingly difficult to clean up. Many of the techniques used to clean oiled shorelines can cause additional damage in marshlands and are not viable treatment options in these sensitive environments. During the *Deepwater Horizon* oil spill, NOAA and the unified response investigated a wide variety of clean-up tactics in the most heavily impacted coastal marshes in Louisiana. Subsequent monitoring in coordination with Tulane University revealed that one of the most beneficial tactics employed was to replant native grasses in the impacted areas. The objective of this study is to determine the best combination of replanting factors associated with marsh grass (*Spartina alterniflora*) during a simulated diesel fuel oil spill in a controlled coastal marsh setting. The study is currently underway and utilizes a set of oiled mesocosms. Selected replanting tactics (nursery plants vs. field transplants as well as containerized/plug plantings vs. bare-root plantings) and their recovery will be followed over an extended period (12-18 months). Preliminary findings presented here include initial oil effects on the original marsh prior to replanting, hydrocarbon residues in water and sediments over time, and early observations of the replanted grasses.

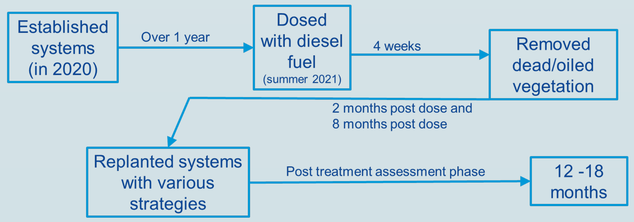
Introduction

- A number of response and restoration tactics have been implemented in actual spills
- While several replanting approaches show potential, replanting methods following oil spills have not been defined or optimized formally
- The purpose of the research is to provide scientific context to formalize replanting methodologies
- Overarching Objective:
  - To determine the combination of marsh grass (*Spartina alterniflora*) restoration tactics that produces the best outcome for a marsh oiled with marine diesel
- Primary goal:
  - To produce a field manual addendum (planting SOP or guidance document) to inform decision making in the aftermath of an oil spill

Methodology

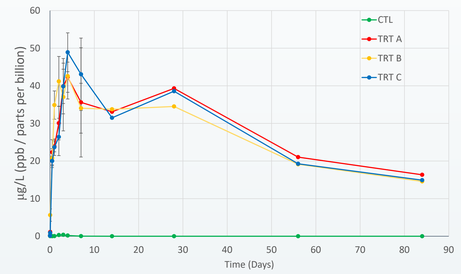
- Experiments performed in 20 modular estuarine mesocosms established with:
  - Natural seawater (25 psu)
  - Intertidal sediments
  - *Spartina alterniflora* (tall form)
- Systems are housed in a greenhouse and are engineered to have simulated tidal cycles
- Systems were dosed with marine diesel fuel (aka 'red diesel')
  - 3 mm slick (~3 L/m^2)
  - Complete vegetation kill
- Four Treatments (5 replicates each)
  - Control (no fuel oil)
  - TRT A - Oiled system – no replanting
  - TRT B - Oiled system – local 'wild' transplants
  - TRT C - Oiled system – nursery plants (grown from seed sourced in Maryland)
- Post oiling:
  - Controls and TRT A were not disturbed
  - Dead above ground biomass (AGB) of *S. alterniflora* was removed from TRTs B & C using vegetation cutting
  - Two replanting events occurred
    - 2 months post oiling
    - 8 months post oiling
  - The replanting events consisted of both plugs and bare-root planting (split plot design) within each replicate mesocosm

- Oil weathering and degradation characterized chemically using GC/MS
  - Sum of 50 targeted PAHs (TPAH50)
  - Total Extractable Hydrocarbons (TEH)
- Water column salinity, pH, dissolved oxygen, nutrients, and chlorophyll *a* are being monitored over time.
- Water column and benthic microbial communities are being characterized using metagenomic techniques.
- Growth of replanted *S. alterniflora*

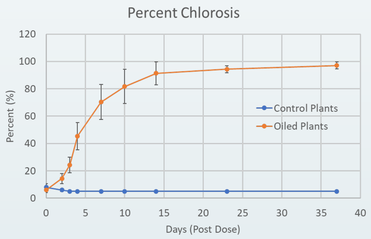


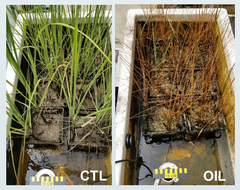
Results of dosing with diesel

Pre-dose

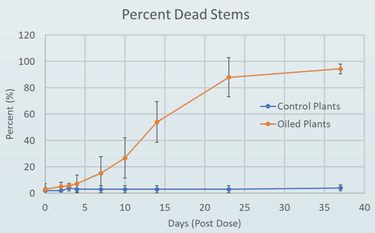


Chlorosis (yellowing) – 72 hours





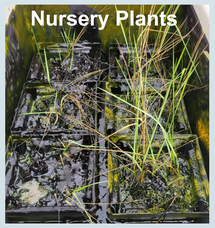
23 days post spill



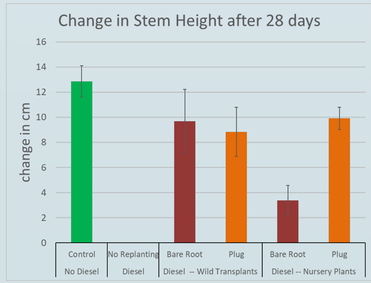
Preliminary results of replanting

First attempt at replanting (2 months post spill):
- All re-plantings were killed within 3-4 weeks in the oiled systems

Second attempt at replanting (8 months post spill):



Bare Root Plantings Plug Plantings



Research in still progress

Water column
- Hydrocarbon chemistry (PAH / TEH)
- Nutrients (NH3, NO2/NO3, and PO4)
- Chlorophyll a
- Microbial community (metagenomics)

Sediment
- Hydrocarbon chemistry (PAH / TEH)
- Microbial community (metagenomics)

Spartina (growth of replantings)
- Stem height
- Stem density
- Biomass (above and below ground biomass)
- Plant cover
- % Chlorosis / live vs. dead
- Seed production
- Hydrocarbon chemistry (PAH / TEH)
- Time-lapse videos of grow-in

Preliminary Conclusion

- By design, this spill represented a worst-case scenario
- Simulated spill:
  - Hydrocarbon levels (TPAH50) remained elevated in the mesocosm systems >12 weeks after the simulated spill
  - Chlorosis of above ground biomass (ABG) began within 2-3 days
  - By 14 days, greater than 95% of oiled plants were showing chlorosis
  - Approximately, 50% of oiled plants were dead (AGB) at 14 days
  - Greater than 95% of oiled plants were dead by 37 days
- Replanting (first attempt @ 2 months) – conditions were still too toxic for plant growth
- Replanting (second attempt @ 8 months) – After 28 days:
  - Wild transplants and nursery plugs are out-performing nursery bare root plantings

Acknowledgements

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