NANTUCKET CONSERVATION FOUNDATION, INC.

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March 15, 2021

Mr. Jeff Carlson, Administrator
Nantucket Conservation Commission
2 Bathing Beach Road
Nantucket, MA 02554

Re: Monitoring Progress Report Submission
DEP File Number SE48-3190
Salt Marsh Dieback Restoration
Nantucket Conservation Foundation

Dear Jeff:

As per the Order of Conditions issued on May 1 2019, in regards to DEP File Number SE48-3190, please accept the enclosed annual monitoring report detailing the results of permitted salt marsh management and restoration work by the Nantucket Conservation Foundation.

Any questions regarding this project can be addressed to me at the contact information below.

Thank you very much for your support of our wetland restoration efforts.

Sincerely,

Jennifer M. Karberg
Research Program Supervisor

Nantucket Conservation Foundation
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Enclosure

Salt Marsh Dieback – Marsh Restoration Research Project
Progress Report: 2020 Field Season

Dr. Jennifer M. Karberg, Nantucket Conservation Foundation

Background and Purpose

In 2019 and 2020, the Nantucket Conservation Foundation conducted a project to actively reduce populations of the native purple marsh crab (*Sesarma reticulata*) in two locations in Polpis Harbor. Increased grazing pressure from these crabs has dramatically reduced the health of Polpis Harbor salt marshes, leading directly to salt marsh die back. This project was designed to actively reduce crab populations to allow the salt marsh to recover from grazing pressure and revegetate. Active crab management occurred in 2019 and 2020, additionally in 2020, the project incorporated out-planting of the native Spartina alterniflora into the dieback areas.

Salt marsh dieback in New England, driven by intensive herbivory by the native purple marsh crab (*Sesarma reticulata*), is the complete loss of stabilizing low marsh vegetation, particularly smooth cordgrass (*Spartina alterniflora*), leading to large expanses of exposed marsh soil sediment bordering harbors and marsh creeks. The loss of low marsh vegetation severely impacts salt marsh stability and function leading to increases in soil erosion, sediment softening/subsidence and exposure of a salt marsh to increased impacts associated with climate change and sea level rise. Research currently suggests that recreational fishing pressures decrease fish predator populations, allowing purple marsh crab populations to explode and without control, the marsh vegetation is overgrazed. Exposed marsh sediments can quickly experience subsidence, losing elevation to the oxidation and decomposition of organic soils, as well as erosion from normal wave and storm events. Once lost; marsh elevation and sediment structure are exceedingly difficult to rebuild, leaving salt marshes vulnerable to increased impacts from sea level rise.

Salt marsh dieback in New England was first observed on Cape Cod in 2004 and now, after over a decade and a half, marshes appear to be recovering as crab populations naturally decrease. The recovery of these marshes is a positive sign that, with the reduction of crabs, salt marsh vegetation will naturally recolonize. Unfortunately, due to sediment erosion and softening, even though these marshes are revegetating and serving valuable salt marsh habitat functions, they are less stable and more at risk to erosion and sea level rise than prior to the dieback event.

Salt marsh dieback was not observed on Nantucket until around 2012, almost a decade behind the rest of Cape Cod. So, while salt marshes on the mainland are beginning to recover, our marshes are just now experiencing active overgrazing and dieback. This gives us a unique opportunity to potentially control the purple marsh crab and facilitate salt marsh revegetation before losing valuable soil sediments.

This project was designed as a pilot study (a smaller-scale study intended to facilitate the design of larger scale research and restoration projects) to examine potential methods for actively reducing current, overabundant purple marsh crab populations while reestablishing smooth cordgrass within recently exposed soils. As a pilot study, this project attempted to reduce crab populations through active trapping and reestablish smooth cordgrass in two impacted salt marshes in Polpis Harbor. As a reference, we also tracked smooth cordgrass dieback and crab populations in an adjacent marsh just outside of Polpis Harbor that has been used as a reference marsh in previous research conducted by the Nantucket Conservation Foundation's Science and Stewardship Department.

Although very staff time intensive, the potential success of this pilot project will inform the feasibility of larger scale salt marsh dieback restoration on Nantucket and even other areas of Cape Cod that are still in recovery.

As far as we can determine, no other organizations are studying how anthropogenic manipulation of the crab populations influences the trajectory of dieback and recovery in salt marshes.

Objectives: Restoration of sediment stability and function to salt marshes experiencing dieback of smooth cordgrass resulting from increased populations and resultant herbivory by the native purple marsh crab. To achieve these objectives, we aggressively reduced the grazing population of purple marsh crabs from two salt marsh locations in Polpis Harbor. Populations were reduced through bi/tri-weekly trapping and removal of purple marsh crabs. In 2020, to begin stabilizing marsh soils, we outplanted plugs of smooth cordgrass within the dieback regions at both marsh locations.

Field Methods:
Field methods in 2020 followed protocols established in 2019 with some additional trap locations and am outplanting management. Protocols and results of the 2019 field season are reported in an internal report available from the Nantucket Conservation Foundation (Karberg 2019).

Crab Population Reduction
In May 2020, we placed crab traps at two marshes in Polpis Harbor: Medouie Creek (n=31) and 5QPR (n=9). This doubled the traps initially used in 2019 but did not significantly increase trapping time. Traps were placed along the dieback fringe (the transition zone between bare soil and vegetation), utilizing some of the holes used in 2019. Traps consisted of empty tennis ball cans, sunk into the soil until the can rim sat flush with the soil surface. As nocturnal purple marsh crabs move across the marsh surface at night, they encounter the can and fall in and the smooth can sides prevent the crabs from crawling back out.

Traps were deployed and open in the two research areas over the entire field season (May 11, 2020 – October 27, 2020). Traps were visited 2 times a week with all crabs removed and counted in each trap. In addition to the purple marsh crab, we also captured the invasive Asian green crab and the native fiddler crab in our traps. Both purple and green crabs were euthanized and removed from the wetland area; fiddler crabs were released alive back to the wetland.

Smooth Cordgrass Revegetation
In 2020 we outplanted *Spartina alterniflora* plugs at both Medouie and QPR5. 900 plugs were obtained from an off-island nursery, New England Wetland Plants, Inc. Unfortunately, the plugs were shipped from Amherst, MA using UPS during a time of high delay in UPS shipping due to COVID-19. The plants arrived in extremely poor condition and ~30% of the plugs were dead on arrival.

We outplanted all plugs except the obviously dead ones and tracked recruitment. Plugs at Medouie were planted in $1m^2$ plots of 13 plants each. 40 of these plots were spread over the dieback area on both sides of the Medouie Creek (Figure 4). Plots were flagged and revisited twice over the growing season to track survival and potential rhizome spread. At QPR5, we outplanted 300 plants covering as much exposed soil as possible. The dieback area was revisited once, and stems counted for survivorship.

Individual Marsh Physical Characteristics
To document seasonal changes in dieback status, we GPSed the dieback fringe at the two research marshes and the reference marsh at the beginning and end of the field season. We also examined the fringe edge for visual evidence of browse and documented counts of incidence of browse.

Results and Discussion:
Crab Population Reduction
From May-October 2020, we captured a total of 659 purple marsh crabs and 144 Asian green crabs combined between the two research locations (Figure 1). Purple marsh crab numbers increased by 66% compared to

2019, while Asian green crab numbers were similar between 2019 and 2020. The increase in captured purple crabs in 2020 resulted primarily from an increase in crabs captured at Medouie, population numbers remained the similar at QPR5 compared to 2019. This increase in population number could be due to the doubling of traps placed out at Medouie in 2020 or other, unmeasured changes to the population. One year of trapping did not negatively impact purple marsh crab populations, rather it reduced their potential to graze on plants during the growing season.

In 2019, number of crabs captured at both sites followed a similar pattern with capture numbers slowly increasing starting in May to the highest capture density in September and then decreasing almost completely by the end of October. 2020 crab trapping numbers did not follow this trend and the trend in numbers differed between the two sites (Figure 2). At Medouie, we trapped the highest number of crabs over the year with significantly higher crabs trapped compared to 2019. In 2020, the highest crab capture occurred in June instead of September with the following months staying relatively steady until a decrease to almost not crabs by the end of October (Figure 2). At QPR5, purple crab numbers fluctuated up and down over the course of the season with no set pattern in density.

The reasons for the difference in timing of peak crab trapping between 2019 and 2020 is not clear. The weather was much warmer in the spring of 2020, potentially leading to an increase in successful reproduction and survivorship.

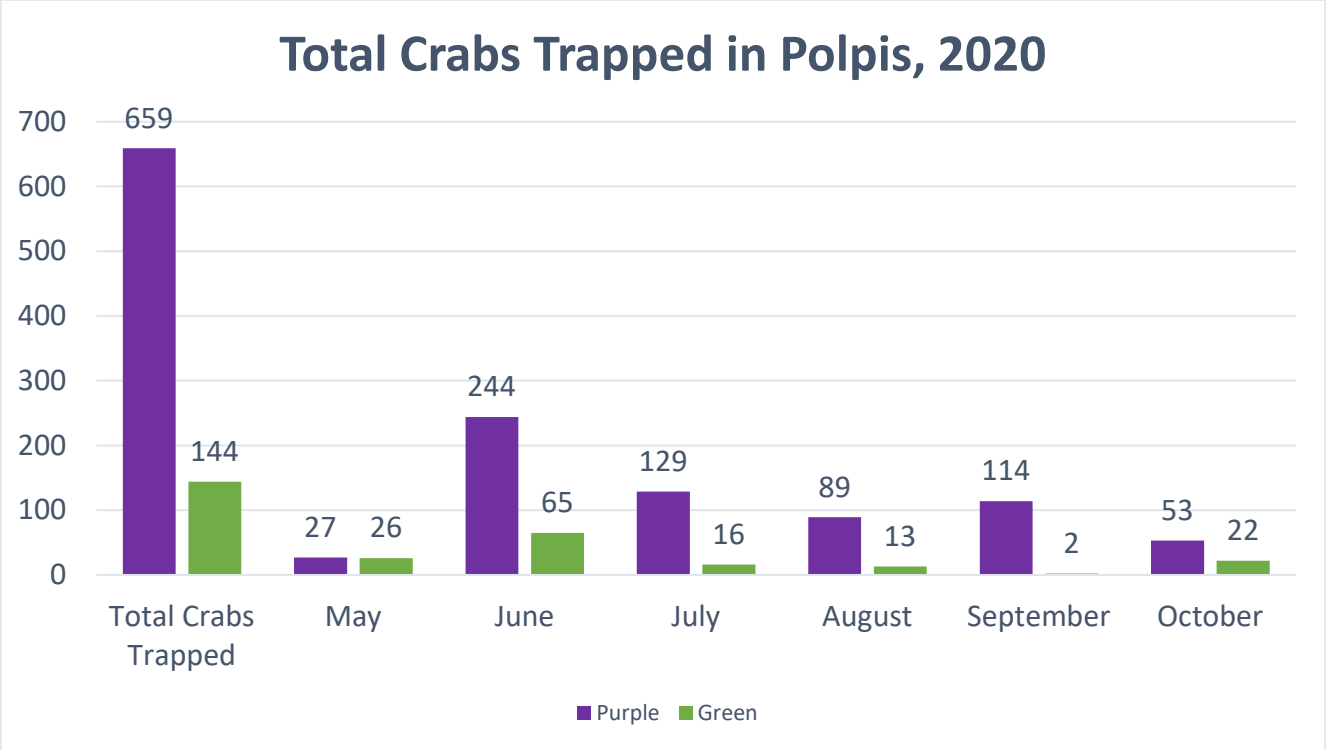

Figure 1: Total Crabs of each species captured over the course of this study as well as within each month.

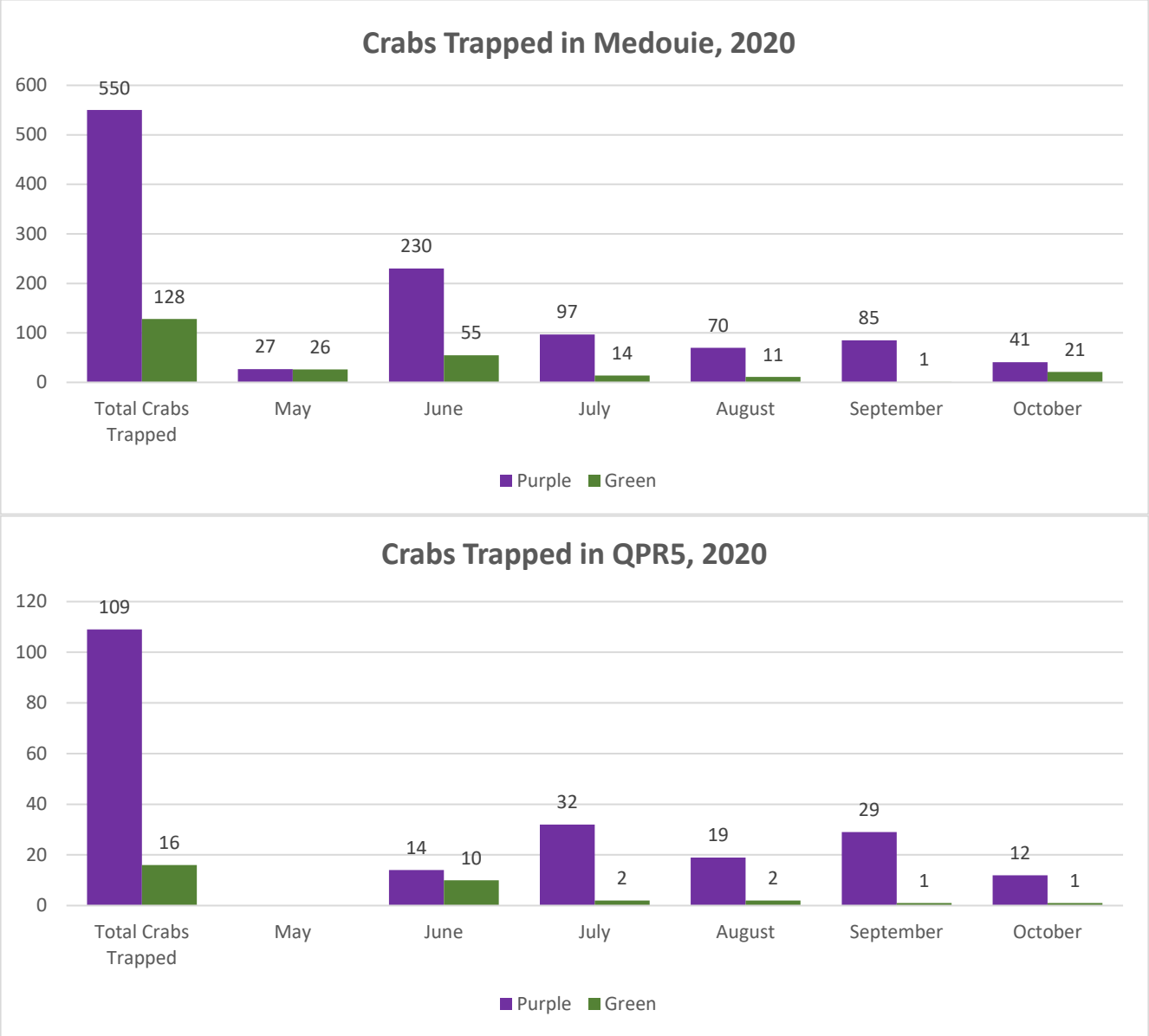

Figure 2: Total crabs trapped at each sample site over the course of the study and within each month.

Smooth Cordgrass Regrowth and outplanting

Even though crab numbers increased significantly in 2020, continuous trapping still benefited *Spartina alterniflora* populations. Active reduction of the crab populations did appear to allow Smooth cordgrass to natural begin revegetation on the dieback surfaces of the marshes, which we could document directly at Medouie Creek. In August of 2015 and 2018 - 2020 we used handheld GPS units to document the area extent of dieback at Medouie Creek. Between 2015 and 2018 we observed steady increases in the size of the dieback area, progressively moving back from the main ditch area with a dieback area of 0.24 acres in 2018, prior to the initiation or crab control. In 2019, crab control allowed the colonization of dieback areas by *Spartina alterniflora* which decreased the dieback from 0.24 acres to 0.17 acres. This trend continued in 2020 with the dieback area decreasing to 0.13 acres within Medouie Creek (Figure 4).

This decrease in dieback area in 2020 was attributable both to natural recolonization by *Spartina alterniflora* but also, unfortunately to calving and loss of the salt marsh creek bank to erosion.

The dieback area at QPR5 was documented in 2019 and in 2020. The dieback area at QPR5 decreased significantly in 2020 and a significant reduction in crab browse activity was observed in both 2019 and 2020. Due to the dispersed nature of *Spartina alterniflora* at QPR5, it was impossible to document the regrowth using a GPS unit. Grass regrowth was observed across the dieback area and large swaths of exposed soil were not observed in 2020.

Figure 4: Extent of dieback along Medouie Creek measured in 2019 and 2020. Dieback area decreased in 2020 (0.13 acres) compared to 2019 (0.1667 acres) with smooth cordgrass recruiting into the dieback area as seen in the photo. Pink circles represent the plot locations for outplanting of *Spartina alterniflora* in 2020.

To accelerate the recovering of the dieback area and reduce future marsh loss to erosion, NCF outplanted *Spartina alterniflora* plugs at both Medouie Creek (Figure 4) and QPR5. At Medouie Creek, plants were placed within $1m^2$ plots and monitored throughout the season.

Survivorship of *Spartina alterniflora* plugs was mixed. Coverage of the plots increased in almost all plots, only 4 plots out of 40 experience a complete loss of outplanted plugs (Figure 5). Spartina coverage ranged from 1-14% compared to 0% coverage prior to outplanting.

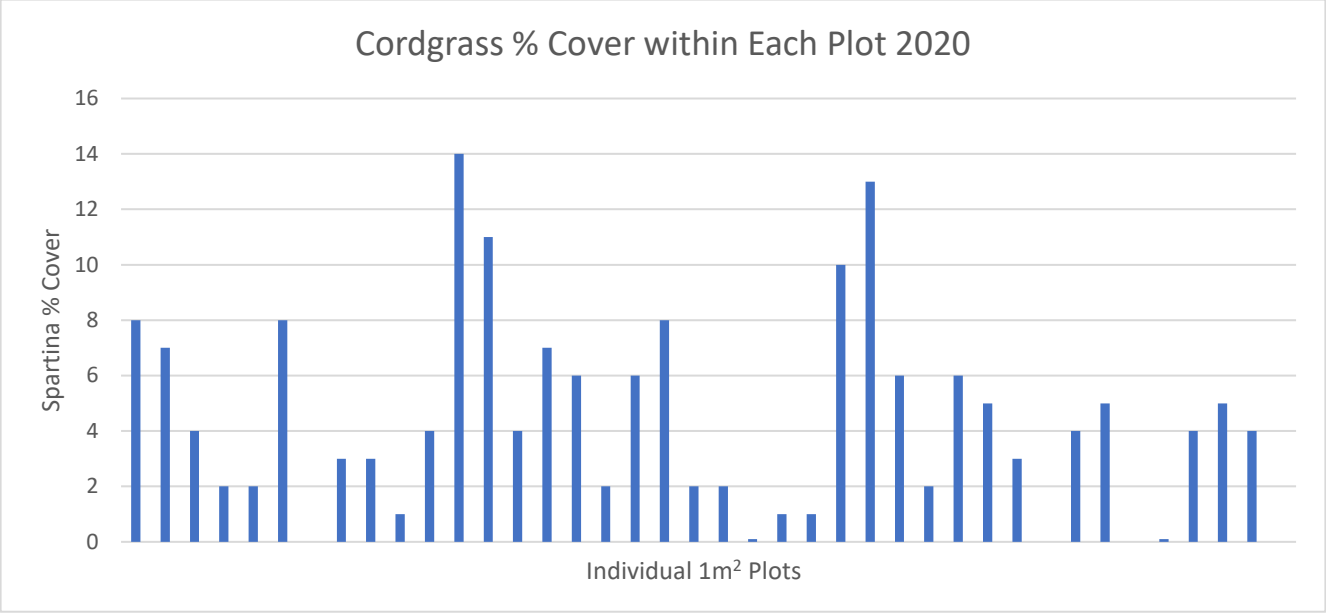

Figure 5: Measured Percent Coverage within each outplanted Plot at the end of the growing season, October 2020.

Plant survivorship varied among the planted plots. Each plot was planted with 13 individual plants, some died, some survived and some sent out runners and colonized more area of the plot. While the percent coverage of the plots remained low, the number of plants within some plots increased dramatically (Figure 6).

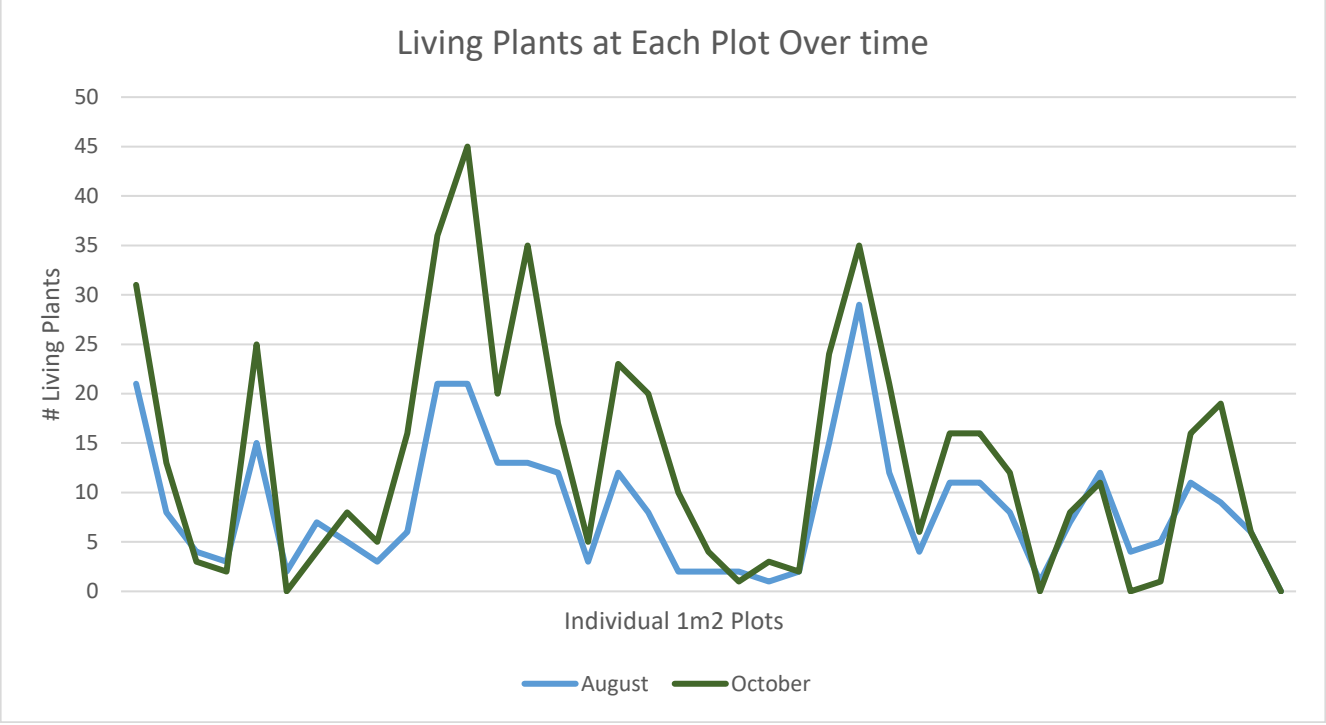

Figure 6: Number of Living plants within each plot sampled in August and in October 2020.

The highest number of plants was 45 and plots with plants at the end of the season ranged from 45 to 1. These plots will be revisited after marsh green up in 2021 to determine survivorship of seedlings through the winter.

At QPR5, plants were not planted within plots but were outplanted to cover the entire dieback area. Visual surveys indicated at 50% survivorship of individual seedlings in October 2020. Seedlings will be resurveyed in 2021 to determine survivorship through the winter season.

Conclusions

Purple marsh crab control and removal at dieback impacted salt marshes in Polpis Harbor has proven successful over two years of management. The crab population was not negative impacted over two years of trapping with crab numbers increasing in 2020. This is likely due to the small area of trapping within a large salt marsh area.

Trapping instead occurred at a time of year that reduced crab grazing pressure and allowed *Spartina alterniflora* to recolonize into the dieback area. Natural recolonization was documented in both 2019 and 2020.

Outplanting of *Spartina alterniflora* in both sites saw mixed results although at least one plant survived in 36 out of 40 planted plots at Medouie Creek. One of the reasons for moderate seedling survivorship was the condition of the plants on arrival to Nantucket. The COVID pandemic dramatically impacted shipping during the week the plants were sent out which impacted survivorship negatively. Retaining a credit in plant replacement from the nursery, we plan to conduct additional outplanting in 2021 at both sites to further augment *Spartina* coverage within the marshes.

In 2021, we plan to continue crab trapping and removal from both sites as well as population monitoring at our control which did not occur in 2020 due to COVID-19 and staff restraints. We will outplant Spartina alterniflora to augment 2020 plantings. We have also applied to the Nantucket Conservation Commission and received permission to install an oyster reef in front of Medouie Creek in 2021. This reef will likely reduce the impacts of storm waves and tide on the exposed creek banks and help limit salt marsh erosion while the dieback mitigation occurs.