QUARTERLY PROGRESS REPORT
As of June 30, 2018 DRAFT

Date: July 24, 2018 Dates Covered by this Report: April 1, 2018 – June 30, 2018
Agreement No.: P1496011 00 Grant Term: March 1, 2020
Project Title: Initiation of Thin-Layer Sediment Augmentation on the Pacific Coast
Grantee: U.S. Fish and Wildlife Service, San Diego NWRC

FISCAL REPORT

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¹ This amount includes invoices through the period 04/30/2018.
² The Conservancy’s expenditures were revised in 6/2018, to exclude expenditures that occurred prior to 6/2015.
³ Cost share agreements have been achieved and exceeded; therefore these amounts are not included in this total.

Invoice Submitted this Quarter: ☑ Yes (under separate cover) ☐ No

PROGRAM/TECHNICAL REPORT

Activities Performed from April 1 – June 30, 2018:

Monitoring
- Spring sampling was conducted by CSULB in April 2018 and involved collecting invertebrate cores, recording plant coverage, conducting plant measurements, and analyzing cordgrass photosynthesis rates.
- Those developing creek channels that were notched in February were monitored by UCLA in mid-May to determine what, if any, changes had occurred.
- Eelgrass surveys, two years post augmentation, were conducted on May 14 and 15.
- USGS took surface elevation table measurements and feldspar readings in May.
- Rick Nye, the Refuge Manager, conducted general site evaluations and volunteers conducted bird surveys.
- Chapman University conducted greenhouse gas measurements in April.
Site Observations

- During visits to the site in May, researchers and the Refuge Manager noted that vegetation regrowth remains slow, but cordgrass continues to expand into the site from the edges and is now occurring in some low-lying areas. Recent photos of the site are provided as Attachment A.

- The presence of annual pickleweed (*Salicornia bigelovii*) on the site has increased over last year and for the first time, perennial pickleweed (*Sarcocornia pacifica*) has reestablished on the site. We were also encouraged to find that saltwort (*Batis maritima*), a species present on the site prior to augmentation, is also now present on the site.

  *Batis maritima* was identified on the augmentation site in April 2018. Photo: C. Whitcraft

- The cyanobacteria observed all over the site earlier in the year continue to be present.

  Cyanobacteria continue to occupy the surface of the site. Photo: J. Torres
Project Coordination

- A team conference call was held on June 26, 2018. Discussion topics included:
  
  o The effects of notching on tidal creek formation - Based on observations made by Dr. Ambrose in May the effects appear to be minimal with little change to the configuration and depth of the creeks observed. As a result, additional photomosaics were not conducted. Creek formation will be reevaluated in July, when the team will determine if more significant notching should be implemented. The ultimate goal is to remove all of the barriers, but it was agreed that this should be done in a manner that allows for monitoring of the effects, as well as to ensure that sediment does not move off the site and impact adjacent eelgrass beds.
  
  o Sediment depth in subtidal channels adjacent to the augmentation site - Rick Nye is interested in determining the depth of applied sediment that has accumulated in subtidal channels located beyond the original sediment barriers. Within the site there is a clear marker between the original sediment and the applied sediment, if that is the case outside the site, the depth of that applied sediment could be measured. However, because the sediment is located within the tidal waters, consolidation may or may not have occurred. A number of potential corers were discussed that enable the collection of unconsolidated sediments, including a Mini Glew-corer and a Wildco hand corer. It was agreed that USGS would assist in core collection during their July visit to the site.
  
  o Experimental Planting of Cordgrass - The team’s proposal to implement an experimental planting program for cordgrass on the site was not selected for further consideration through the Proposition 84 USC SeaGrant program. The reviewers determined that testing active planting “seems to be more directly tied to addressing how adaptation measures (sediment augmentation) should be used to increase the resilience of a habitat to sea level rise.” The team will continue to pursue funding for an experimental planting program.
  
  o The question of whether low or the lack of nutrients in the sediments applied to the site is a factor in the very limited recolonization of cordgrass was once again addressed by the team. It was determined that understanding all the potential factors (e.g., elevation, grain size, low or the lack of nutrients) inhibiting cordgrass should be explored. Dr. Whitcraft and Dr. Keller have stored sediment samples, pore water, and vegetation samples that can be analyzed for nutrient content. Dr. Whitcraft prepared a proposal and cost estimate for conducting the analysis. The proposal is provided as Attachment B. (The Coastal Conservancy subsequently agreed to fund the proposal using the remaining funds in their grant for the augmentation project.)
  
  o Monitors presented the results of their monitoring efforts in April and May (addressed below).
Project Outreach/Information Dissemination

- The Refuge webpage (https://www.fws.gov/refuge/seal_beach/what_we_do/resource_management/Sediment_Pilot_Project.html) was updated to include this quarterly report.
- Elizabeth Murray (US Army Corps of Engineers) will be presenting at the National Conference on Ecosystem Restoration in New Orleans, 26-30 Aug 2018.
- Rick Nye will address the augmentation process during a tour for 20 participants on Sunday 9 Dec 2018 in association with the Restore America’s Estuaries, 9th National Summit on Coastal and Estuarine Restoration and Management in Long Beach, CA 08-13 Dec 2018.
- Christine Whitcraft and Karen Thorne are preparing a peer-reviewed report for publication on the first phase of the augmentation project.

Status of Ongoing Research:

Tidal Creek Formation

UCLA, under the direction of Richard Ambrose, continues to monitor creek formation. April monitoring indicated little change in the configuration and depth of the creeks on the site, including those where existing barriers were notched to allow for better tidal flows.

Surface Elevation Monitoring

USGS conducted monitoring in April and early July 2018. The quarterly report is provided as Attachment C. Overall results from elevation pin measurements indicate that the augmentation site experienced a gradual increase in elevation of 1.43 mm averaged across all fifteen SETs over the period April through July 13 (Figure 1); while the control site showed a slightly larger increase of 3.97 mm across its six SETs (Figure 2). The original SETs (n=4), located elsewhere on the Refuge also showed an increase of 3.53 mm.

![Figure 1](image)

After sediment application completion, initial decrease in elevation averaged -46.60 mm (April-June 2016), however the rate of decrease in elevation then slowed averaging -16.56 mm (June-October 2016). Between October 2016 and July 2017 elevation change continued to gradually decrease, -14.37 mm, and again between July 2017 and April 2018 -13.49 mm. However, during the most recent interval (April - July 2018), elevation increased (1.43 mm).
The feldspar readings showed a decrease in sediment above the feldspar layer during this quarterly time period for the augmentation site with a decrease of -5.97 mm. However, overall post monitoring indicates little overall change in depth of the feldspar layer with a small decrease of -18.21 mm averaged across all 15 SETs. The majority of elevation decreases shown in the elevation pin measurements is most likely due to the original marsh surface compacting below the feldspar marker horizon, while the rest could be due to the compaction and/or loss of the applied sediment.
Plant and Invertebrate Studies
CSULB conducted their spring assessments (two years post sediment augmentation) of invertebrates, plant, and photosynthesis in April 2018. Cordgrass appeared in one of the monitoring plots for the first time, and several new species were present in low cover including *Sarcocornia pacifica* and *Batis maritima*. Also noted was an increase in the overall abundance, species richness, and diversity of infaunal invertebrates. The community composition of invertebrates shifted from a dominance of oligochaetes and polychaetes to insects and insect larvae initially, but at eighteen months following augmentation, we saw an increase in oligochaetes on the augmentation site although not to pre-augmentation levels. Insect larvae still dominate at the augmentation site.

During this quarter, CSULB also completed invertebrate sorting and identification for the top 2 cm samples for all samples collected including fall 2017. Processing for spring 2018 samples is ongoing with 17 of 39 samples sorted to date. Invertebrate vouchers are in process for identification to lowest taxonomic level. In addition, the bottom 4 cm samples for all prior time points continue to be sorted.

CSULB also prepared a pre-proposal to USC SeaGrant related to a grant for future experimental planting work within the project site. Unfortunately, we were not invited to prepare a full proposal. We are considering submission to SeaGrant rapid response, as well as the National Coastal Resilience grant from the National Fish and Wildlife Foundation.

Gas Flux
Jason Keller (Chapman University) and his team conducted sampling in April 2018. Gas samples were collected from both the control and augmentation sites and analyzed for carbon dioxide, methane, and nitrous oxide. Surface porewater was also collected and redox in surface water was measured in the field. Measurements indicate that greenhouse gas fluxes at the augmentation site are no higher than those at the control site, with no releases of methane or nitrogen oxide identified.

Nutrient Analysis and Monitoring
With funding provided by the California State Coastal Conservancy, CSULB will be conducting nutrient monitoring at the augmentation site using porewater samples from Dr. Keller’s lab, which will be analyzed for dissolved nitrate and ammonium; frozen sediment samples from Dr. Whitcraft’s lab that were taken throughout the site during augmentation as well as pre-augmentation, which will be analyzed for total nitrogen (and carbon) as well as extractable nitrate and ammonium; and frozen plant tissue samples from Dr. Whitcraft’s lab taken pre- and post-augmentation, which will be analyzed for total nitrogen (and carbon). The intent of these actions is to understand the nutrient profile in the porewater and sediment prior to, during, and after augmentation to help understand and predict the recovery process.

Eelgrass Survey
MTS performed side-scan and SCUBA eelgrass surveys of the study area and reference area on May 14 and 15, 2018, respectively. The goals of the survey were to provide two-years post sediment augmentation eelgrass maps, eelgrass cover estimates, and eelgrass density estimates within each survey area. The report is still under review and will be finalized in July. Once final, the results of the surveys will be shared with NOAA. The final report will be included with our next report to CDFW (mid-October 2018).
Bird Surveys

No birds were identified on the site during the monthly high and low tide surveys. This is due to the timing of the surveys which are occurring when the site is completely submerged or totally exposed. Rick Nye, the Refuge Manager, continues to observe a variety of shorebirds on the site when the tides are more favorable for foraging and loafing. To better capture bird use on the site, Rick will be initiating site specific surveys for the augmentation site in the coming quarter. These surveys will continue throughout the remainder of the monitoring program. No light-footed Ridgway’s rails were observed on the site.

Percentage of Task Completed as of March 31, 2018:

| Task 1 – Project Management and Administration | 60% |
| Task 2 – Sediment Augmentation | 100% |
| Task 3 – Project Monitoring (overall) | 76% |
| 1) Carbon Storage/Sequestration Benefits | 90% |
| 2) Plant and Invertebrate Monitoring | 63% |
| 3) Pacific Cordgrass Analysis | 63% |
| 4) Site Elevations | 63% |
| 5) Sediment Analysis (compaction, movement, bulk density) | 63% |
| 6) Turbidity Levels | 100% |
| 7) Bird monitoring | 63% |
| 8) Eelgrass | 100% |

Task 4 – Engineering Design/Environmental Documentation (overall) | 100%

1) Engineering Plans for Sediment Augmentation Site | 100%
2) Environmental Documentation* | 100%

*CEQA/NEPA has been completed by SCC/USFWS

Task 5 – Public Participation/Presentations (overall) | 75%

1) Oral/Poster Presentations | 65%
2) Workshops and/or Webinars | 85%

Overall Project | 87%

Deliverables Completed for Each Task:

Task 1 – Project Management and Administration

1) Quarterly Progress Report | 12 reports
2) Monthly Invoices | 23 monthly invoices
3) Subcontractor Selection | Orange County Parks & SWIA selected
4) Data Management | preliminary data for monitoring locations
5) Acknowledgement of Credit | ongoing

Task 2 – Sediment Augmentation

...
1) Sediment Application completed
2) Adaptive Management on going
3) Reporting Results/Lessons Learned in process

Task 3 – Project Monitoring

1) Carbon Storage/Sequestration Benefits pre-augmentation monitoring complete; long core data processing complete; long core data final report complete, but to be updated to include belowground biomass data analysis; post-augmentation monitoring of carbon storage/sequestration continues

2) Plant and Invertebrate Monitoring pre-augmentation work completed; post-augmentation monitoring underway

3) Pacific Cordgrass Analysis pre-augmentation work completed; post-augmentation monitoring underway

4) Site Elevations pre-augmentation RTK survey conducted; initial post-augmentation photogrammetry conducted; SETs data downloads continue; monitoring of feldspar plots continue; one USACOE funded photogrammetry survey completed, next scheduled for August 2018

5) Sediment Analysis initial core samples retrieved; data processing completed; grain size analysis of new sediment nearing completion

6) Turbidity Levels monitoring completed in August 2017; final report completed 2017

7) Bird Monitoring pre-augmentation work completed; post-augmentation monitoring ongoing

8) Eelgrass pre-augmentation, post-augmentation and one and two-years post-augmentation surveys completed, year two post-augmentation survey report currently under review

Task 4 – Engineering Design/Environmental Documentation

1) Engineering Plans for Augmentation Site 100% engineering plans completed

2) Environmental Documentation* CEQA/NEPA documents final; ND recorded
Task 5 – Public Participation/Presentations

1) Oral/Poster Presentations
   Presentations ongoing

2) Workshops and/or Webinars
   Participated in USACOE webinar;
   Thorne/Sloane presented the lessons
   learned in a webinar on March 15, 2018,
   part of the Restoration Webinar Series

Problems/Delays Proposed Resolution:
No delays have been identified for post-augmentation monitoring. The year-two eelgrass survey was completed and review is underway. Consultation with NOAA will occur as soon as the report is final.

Revegetation of the site by Pacific cordgrass continues to be slow, but growth of annual pickleweed is expanding and additional salt marsh plant species are now present. We continue to consult with other wetland ecologists in the region who have experience with Pacific cordgrass restoration projects. In addition, researchers on the project team are continuing to discuss the implementation of an experimental cordgrass planting program. The objective of the proposal is to determine which planting regime will best facilitate colonization of the site with Pacific cordgrass: polycultures with Pacific cordgrass included, polycultures where other plants will facilitate conditions for eventual Pacific cordgrass colonization, or just Pacific cordgrass plantings. The purpose is to experimentally test the best planting strategy (polycultures versus monocultures) to restore Pacific cordgrass over the long term while also monitoring non-planted passive recovery at the augmentation site. We will continue to discuss potential funding sources for this proposal.

Project Benefits and Results:
Although we have not yet achieved our primary project goals, we have compiled a considerable amount of information regarding the sediment augmentation process and pre- and post-monitoring protocols. This information is being disseminated via conference presentations, poster sessions, and most recently a very well attended webinar. There is considerable interest about the project and the project team willingly provides background and details that have benefited other land managers who are considering similar actions both on the east and west coasts of the U.S. Information related to long-term carbon sequestration at Seal Beach will also benefit other land managers and those interested in carbon storage and protecting the carbon stock in southern California’s coastal salt marshes as sea levels rise.

Summarize Benefits to Disadvantaged Communities (if applicable):
Not applicable to this project.

List of Proposed Activities and Tasks for the Next Quarter:

Task 1 – Project Management and Administration
Tasks include coordination of final pre-project monitoring reports; completion of the “lessons learned” document; assisting researchers with site access; preparing invoices and the
upcoming annual report; providing other agencies with information about the project, and all other responsibilities needed to successfully complete the project.

**Task 2 – Sediment Augmentation**
The sediment augmentation process has been completed.

**Task 3 – Project Monitoring**
Refuge staff will be photographing and recording the locations (GPS) of cordgrass regrowth within the augmentation site during the next quarter. The research team will continue to evaluate the progress of cordgrass reestablishment on the site. Photo documentation of changes on the augmentation site over time will also continue.

USGS will continue collecting data from the SETs and feldspar plots.

Richard Ambrose and his team at UCLA will be conducting full field sampling during the next quarter. This will include sediment cores, sampling sediment heights at sediment stakes, and tidal creek cross sections.

With funding from the US Army Corps of Engineers, another photogrammetry survey will be conducted in August 2018. This survey will provide updated information regarding site elevations, including tidal creek formation, which can be compared to the previous survey taken immediately following completion of the augmentation process.

Evaluation of the creek notching process will continue in the next quarter.

Due to the need to focus on California least tern breeding at the Refuge, gathering volunteers to help remove twine left from deteriorated hay bales and other trash from the site had to be postponed. That work will begin in the next quarter.

Christine Whitcraft and her team at CSULB will continue invertebrate sampling and identification. In addition, they will continue surveying the site one to two times during the quarter to determine how plants are recovering and will continue taking photosynthetic measurements.

Dr. Keller and his team will be completing their evaluation of greenhouse gas fluxes from the control and augmentation sites and preparing a final report.

**Task 4 – Engineering Design/Environmental Documentation**
This task has been completed.

**Task 5 – Public Participation/Presentations**
Several research papers are currently underway by members of the research team. The Refuge webpage will continue to be updated, and we will participate in conferences and webinars as opportunities arise.

**Description of Amendments and Modifications to Grant:**
No amendments or modifications were made this quarter. We previously made a minor modification to the existing grant by redirecting $4,950 of unallocated research funds to additional eelgrass survey work, which was approved by CDFW on June 10, 2016.
Attachments:

A. Recent Photographs of the Augmentation Site
B. Seal Beach NWR Sediment Augmentation Nutrient Proposal
C. USGS Quarterly Report (July 2018)
D. Itemized In-Kind Cost Share Accounting

References:

Attachment A
Photographs from the Period
April through June 2018
Seal Beach NWR
Sediment Augmentation Project

Photo 1 – USGS staff conducting monitoring at one of the study plots on the augmentation site.

Photo 2 – Pacific cordgrass moving into the site from the buffer area.

Photo 3 – Augmentation site following a high tide.
Need: Sediment nutrient cycling is influenced by a range of environmental parameters including light, temperature, pH, salinity, O$_2$, inorganic nitrogen, and organic substrates. As we alter the inundation regime and abiotic parameters of the marsh plain and change the grain size of the sediment present, we would predict alterations to the available nitrogen on site. These changes will have potential impacts and vegetation recovery and productivity as well as on the greenhouse gas flux from the site.

Changes in plant and macroalgae cover can potentially have major consequences for the soil environment, for microalgae growth and for infaunal invertebrates. These in turn will affect how the marsh recovers so we should understand the current nutrient profile in the porewater and sediment to help predict and accelerate the recovery process.

To dos: Jason and Christine both have samples saved from various stages of the restoration process (to be catalogued soon). We proposed running the nitrate and ammonium concentrations from each of the sample types on an autoanalyzer (either at partner institution or CSULB) for a processing fee (to be determined as we move forward). Samples for total nitrogen can be analyzed on a CHN elemental analyzer at Chapman University.

Sample types:
1) Porewater (Keller lab samples). To be analyzed for dissolved nitrate and ammonium.
2) Sediment (Whitcraft lab samples, frozen from sampling throughout the site during augmentation as well as pre-augmentation). To be analyzed for total nitrogen (and carbon) as well as extractable nitrate and ammonium.
   a. Could also run on some of Ambrose lab samples if available
3) Plant tissue (Whitcraft lab samples, frozen from sampling pre and post augmentation). To be analyzed for total nitrogen (and carbon).
Attachment C
Thin-Layer Sediment Application Pilot Project at Seal Beach National Wildlife Refuge:
April 10- July 16, 2018
QUARTERLY PROGRESS REPORT
July 16, 2018

Principle Contact: Dr. Karen M. Thorne¹, 916-502-2996, kthorne@usgs.gov

Team: Chase Freeman¹, Karen Backe¹, Tesia Forstner¹, and Arianna Goodman¹

¹USGS, Western Ecological Research Center, 505 Azuar Dr. Vallejo, CA, 94592

Pickleweed growing into the SBA1 SET plot Area
Summary

- Monitoring of surface elevations continued at the augmentation site and the control site, while monitoring of sediment fluxes was ended in August of 2017 at both the deep channel site and the eelgrass site near the augmentation study area.

- Using Surface Elevation Tables (SETs) an initial surface elevation loss has been documented at the Augmentation SETs, presumably from a combination of compaction of the marsh platform and sediment being suspended during high tides and leaving the marsh.

- Surface elevation tables were measured during a July 13th 2018 site visit for this quarterly report time period.

- Elevation pin measurements showed that the augmentation site showed a gradual increase in elevation of 1.43 mm averaged across all fifteen SETs over this quarterly time period; while the control site showed a slightly larger increase of 3.97 mm across its six SETs. The original SETs (n=4) also showed an increase of 3.53 mm (Figure 1).

- Control SETs have had gains and losses of elevation since installation, but have a mean cumulative increase of 3.52 mm from the date of installation (Figure 2). Augmentation SETs had a mean increase in elevation of 216 mm with sediment application, but had a decrease in elevation of -89.47 mm post sediment application (April 2016-July 2018; Figure 1) and therefore a mean cumulative increase in elevation of 127.20 mm.
- The feldspar readings showed a decrease in sediment above the feldspar layer during this quarterly time period for the augmentation site with a decrease of -5.97 mm. However, overall post monitoring has showed little overall change in depth of the feldspar layer with a small decrease of -18.21 mm averaged across all 15 SETs. This finding shows that the majority of elevation decreases shown in the elevation pin measurements is most likely due to the original marsh surface compacting below the feldspar marker horizon, while the rest could be due to the compaction or loss of the applied sediment.

- Feldspar readings at the control site showed a small increase of 4.49 mm over this quarterly time period, whereas the original SETs feldspar readings showed an average decrease of -1.54 mm.

- Taking into account the entire time period for the SET installations we can look at this raw data as a rate of change over time to better see the trends in the data. Currently the augmentation marsh has 34.27 mm/yr rate of change due to the sediment application. However, due to subsidence or sediment leaving the marsh the post augmentation time period has a -30.70 mm/yr rate of change. Whereas, the control site has a 0.91 mm/yr rate of change and the original SETs have a 1.47 mm/yr rate of change (Figures 2-4). These trends are similar for the feldspar data.
**Figure 1.** Mean surface elevation change at control site (above) and augmentation site (below).
Figure 2. Sediment augmentation site rates of change in millimeter per year (mm/yr) calculated from pin measurements (elevation change) and feldspar measurements (feldspar accretion) for different time periods of the augmentation project.
Figure 3. Control site rates of change in millimeter per year (mm/yr) calculated from pin measurements (elevation change) and feldspar measurements (feldspar accretion) for different time periods of the augmentation project.
**Figure 4.** Original Seal Beach SETs rates of change in millimeter per year (mm/yr) calculated from pin measurements (elevation change) and feldspar measurements (feldspar accretion).
**Attachment D**

**Itemized Cost Share Accounting**

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$^1$ Costs associated with bird surveys and light-footed Ridgway's rail monitoring are not included.

$^2$ This does not include staff time accounted for on monthly invoices.

$^3$ The bids for sediment augmentation came is much higher than estimated by the project engineer, therefore, some of the cost for sediment augmentation was covered by the Orange County Parks.

$^4$ As of September 30, 2017, all USFWS CRI Grant funds have been expended and the grant is closed.

$^5$ All Coastal Conservancy costs were revised in March, 2018 to reflect the full amount expended rather than showing the cost less the 10% held by the Conservancy during each billing (this will avoid confusion in the future).