PROJECT INFORMATION

Project Director's Name*	Susan S. Bell
Organization*	University of South Florida
Project Title*	Using past seagrass restoration projects to inform research and improve the monitoring of future restoration efforts.
Reporting Period*	12/2017-09/2021

Note to Grantees: In sections 1 to 5, we ask you to highlight your accomplishments (including outputs and outcomes) through this grant award. These sections of the final grant report will be made available to the public.

1. GOALS AND ACCOMPLISHMENTS

1.1 Please restate the goals and objectives of your project.*

Our multifaceted study to use past efforts to inform current development of effective seagrass monitoring had three main objectives: 1) assemble a database that provides unprecedented information on over 300 seagrass planting projects initiated from 1987-2021 and conducted in Florida. The database represents an invaluable source of information for researchers, practitioners, and the public in that it codifies monitoring conducted in past restoration efforts and summarizes methodology and results of such efforts; 2) Extract information on the time scale required for effective monitoring using information from the database by constructing chronosequences based upon metrics used to measure seagrass restoration success and also revisiting 30 selected seagrass restoration projects from the database to compare seagrass cover from both restored and natural sites from each of the selected projects; and 3) convene a workshop of researchers, agency personnel and practitioners experienced in seagrass restoration to suggest the next set of efforts needed to improve restoration monitoring. Workshop participants will be asked to make recommendations, collectively, to identify most appropriate methodology for monitoring seagrass restoration projects and produce a consensus design of a monitoring program to be used in evaluating success of seagrass restoration efforts.

1.2 Describe the accomplishments of your project. You should include both the anticipated accomplishments that you outlined in your project proposal as well as any *unanticipated* accomplishments that have since occurred. Describe any activities you have conducted, programmatic progress made, or project benchmarks and milestones met.*

Among the accomplishments of this project are the following:

1. This study represents the largest and most comprehensive effort to revisit and evaluate historic seagrass restoration projects to date. By implementing standardized sampling methodologies and benchmarking restoration performance against references, we were able to characterize structural attributes of restored seagrass beds and evaluate the magnitude of difference in these attributes from natural equivalency. While previous literature-based studies provide a critical perspective on restoration outcomes over broad geographical ranges the ability of these analyses to describe performance of restored seagrass beds quantitatively has been limited by short-term monitoring durations, frequent lack of natural reference monitoring, and highly variable data formats provided in project reports. Our findings provide a unique perspective on seagrass restoration particularly with regard to community structure in restored seagrass beds and long-term restoration performance. Our findings are promising, in that they demonstrate the long-term stability of seagrass restorations that survive beyond an initial establishment period and confirm the effectiveness of seagrass restoration as a tool for supporting the recovery of lost or degraded habitats.

2. We compiled information for 336 seagrass restoration projects in the database. We met all milestones outlined in the project proposal except we were unable to do a data analyses to construct a chronosequence and utilize a meta-analyses on project outcomes. This was due to the poor quality of data reporting and inconsistent methodologies across projects. However we were able to conduct extensive analyses on the data collected from our revisits to seagrass restoration projects of varying ages (see #1 above).

3. After reviewing the database and following discussions during the workshop, participants designed a standardized reporting form for data for all seagrass restoration projects. Uniform use of the form across agencies would allow for better sharing of information of project performance and comparison among projects.

4. Training of graduate student and post doctoral researcher. Both individuals were able to increase their familiarity with the governmental permitting process for restoration efforts and project maintenance. The postdoctoral scholar who conducted database compilation, data analyses and field sampling of historic seagrass projects has finished his work on our project and recently was hired as an Assistant Professor at Coastal Carolina University.

2. Outputs

Before the form is completed, you may click "Save & Continue Editing" at the bottom of the page at any time to save your work or "Next" to move onto the next page of this form.

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2. OUTPUTS

Outputs are tangible or measurable deliverables, products, data, or publications produced during the project period.

2.1. Please indicate the number of students (K-12, undergraduate, or graduate), postdoctoral scholars, citizen scientists, or other trainees involved in the project. *

Please enter 0 if none were involved.

K-12 students	0
Undergraduate students	0
Graduate students	1
Postdoctoral scholars	1
Citizen Scientists	0
Other Trainees	0

2.2. Has your project generated any data and/or information products? *

Generation of data includes transformations of existing data sets and generation of data from existing resources (e.g., maps and images). Information products include publications, models, software, code, curricula, and digital resources.

(Check all that apply.)

Responses Selected:

Data
Information Products

2.3. Briefly describe how you fulfilled the approved Data Management Plan and, if applicable, any changes from the approved plan. *

We have submitted data collected in 2018 from field surveys during revisit to sites selected from the data base to GRIIDC.

If your project has generated data, please download the Excel worksheet entitled GRP Data Management Reporting. Use the "Data Report" tab in the worksheet to create an inventory of data sets that you produced and to verify deposit in a curation facility. Upon completion, please upload the worksheet to your task list. If you need guidance on how to complete the Data Report, please e-mail gulfgrants@nas.edu. A member of GRP's data management staff will reach out to you.

If your project has produced publications, websites or data portals, GIS applications, models or simulations, software packages or digital tools, code, curricula, or other interactive media, please download the Excel worksheet entitled GRP Information Management Reporting. Use the "Information Products Report" tab in the worksheet to create an inventory of these products and to verify deposit in a curation facility. Upon completion, please upload the worksheet to your task list. If you need guidance on how to complete the Information Products Report, please e-mail gulfgrants@nas.edu. A member of GRP's data management staff will reach out to you.

2.4. Aside from data and information products, what other tangible or measurable deliverables or products (e.g., workshops, trainings, and outreach events) were produced during the project period? *

Upon completion of this form, you may upload supplemental material that represent the tangible or measurable deliverables or products to complement this narrative report.

We conducted a workshop in June 2019. Appended is a list of workshop participants and the workshop agenda. The standardized reporting form designed by participants is also included.

3. Data Management

Before the form is completed, you may click "Save & Continue Editing" at the bottom of the page at any time to save your work or "Next" to move onto the next page of this form.

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3. DATA MANAGEMENT

In this section, please provide a response to each question to complement the **Data Report** in the GRP Data Reporting Excel worksheet.

3.1 If you listed multiple data sets in the data reporting table, please briefly describe how these data sets relate to one another. *

Only one data set used in published paper (Rezek et al. 2019). However we selected sites for our field surveys from the data base that was updated as part of our objectives.

3.2. Please provide a list of additional documentation to describe the data listed in the reporting table (e.g., code books, lab manuals, workflow procedures). Enter none if you did not produce any additional documentation to describe the data. *

none

3.3. Beyond depositing data and metadata in a repository, what other activities have you undertaken or will undertake to ensure that others (e.g., researchers, decision makers, and the public) can easily discover project data? What other activities have you undertaken to ensure that others can access and re-use these data in the future? *

Published work in scientific journals (one paper publsihed in 2019, one to be submitted to Restoration Ecology). Database is available from FWC as indicated in information management sheet. PI continues working with agency personnel and practitioners (e.g. second manuscript) on with a goal to improve seagrass monitoring.

3.4. Are any data products you produced sensitive, confidential, and/or proprietary? *

No

4. Information Products

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4. INFORMATION PRODUCTS

In this section, please provide a response to each question to complement the **Information Products Report** in the **GRP Information Products Management** Excel worksheet.

4.1. Please select the type(s) of information products that your project produced. *

Responses Selected:

1. Scholarly publications, reports or monographs, workshop summaries, or conference proceedings

2. Websites or data portals

Scholarly publications, reports or monographs, workshop summaries, or conference proceedings *

Please provide a list of citations for project publication, reports and monographs, workshop summaries, and conference proceedings.

l,Rezek, R.J., BT. Furman, R.P Jung, M.O. Hall, and S.S. Bell. 2019. Long-term performance of seagrass restoration projects in Florida, USA. Scientific Reports 9:15514; https:doi.org/10.1038/s41598-019-51856-9

Bell, S.S. M.O. Hall, BT. Furman, and H.S.Greening.Opinion: Grey literature as the repository of seagrass restoration projects: an ongoing dilemma and a call for standardization of reporting. (to be submitted to Restoration Ecology)

Websites or data portals *

Please provide a list of project websites and data portals (including the website URL).

Database: available upon request from Dr. Bradley Furman, FWC
https://www.dropbox.com/sh/opfuw37fpafxv8v/AADJ0ESZT4cnn8l4Ghhh5dgWa?dl=0

How long beyond the grant period will you maintain the project website/data portal and its contents? Please describe plans to archive the website/data portal and its contents after regular maintenance concludes.*

We will maintain the database availability through FWC personnel in the short term (2 years) as we look for other permanent locations for archiving this.

4.2. Beyond depositing information products in a repository, what other activities have you undertaken or will undertake to ensure that others (e.g., researchers, decision makers, and the public) can easily discover and access the listed information products? *

We conducted a workshop in 2019 to discuss products and findings. We distributed copies of the database to all participants and anyone who has requested it.

Publications are (will be) in peer reviewed scientific journals.

4.3. Are any of the information products you produced confidential, proprietary, or subject to special license agreements? *

No

5. Project Outcomes

Before the form is completed, you may click "Save & Continue Editing" at the bottom of the page at any time to save your work or "Next" to move onto the next page of this form.

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5. PROJECT OUTCOMES

Outcomes refer to the **impact(s), consequence(s), result(s), or effect(s)** that occur from carrying out the activities or outputs of the project. Outcomes may be environmental, behavioral, health-related, or programmatic. Example outcomes include, but are not limited to: increased learning, knowledge, skills, and motivation; policy changes; actions taken by a group as a result of information generated by your project.

5.1. Please describe the outcomes achieved during your project and how they were assessed. For this question, we are interested in learning about the immediate short-term outcomes that have already occurred during or as a result of your project. Do not include long-term outcomes you foresee your work contributing to beyond the end of the project. *

Numerous reviews of seagrass restoration projects have highlighted a low rate of successful outcomes. This is concerning given that over 300 seagrass restoration projects have been conducted in Florida, USA, alone. However, few projects in Florida have been included in reviews of seagrass restoration mainly because the outcomes of such studies are contained in permit documentation and monitoring reports for governmental agencies which are typically not accessed by researchers. We reviewed historic permitting documents, monitoring reports, and studies conducted in Florida and extracted information to evaluate the performance of seagrass restoration with the goal of using the information to guide future efforts. We found that the majority of seagrass restoration projects were monitored for 5 years and 85% reported “success”. But careful review revealed problems with a lack of standardization in the reporting of critical information including: 1) methods of restoring seagrass, 2) the exact location of restoration and 3) the criteria used to judge success. Therefore, we conducted a set of field “revisits” to a subset of projects that were deemed successful by initial investigators. By comparing the abundance of seagrass in restoration sites of various ages with that in current day natural seagrass beds we evaluated whether seagrass was similar in restored and natural sites. A major finding was that many of the restoration projects in Florida have been successful in creating seagrass beds that persist for years but the finding of success often emerged decades after the end of monitoring required by agencies, thereby challenging idea about monitoring duration.

We also updated the database that contained information on each of the seagrass projects conducted in Florida, making it available for other users. We compiled a database of public and private projects permitted in Florida from 1980 through 2020. We then convened a workshop of academic researchers, agency personnel and practitioners - all user groups who had experience working with seagrass restoration- to discuss the database and how it could be useful for improving restoration efforts. A lack of standardization in results reporting emerged as a major issue for our analysis. All three user-groups agreed for the need to standardize reporting of results of seagrass restoration projects. Together participants composed a template form that could address many of the identified data quality and quantity issues. Overall, interaction and discussion at the workshop among the three user-groups fostered enhanced understanding of needs and challenges that each sector may have in implementing and reporting results of seagrass restoration projects. Workshop participants agreed that having the database as an historical resource along with standardized results information would improve communication of project success and support future management decisions. We note that the outcome of such seagrass restoration projects is likely to remain poorly represented in peer-reviewed literature and the challenge to restoration ecologists will be to work alongside agencies and practitioners to improve the quality of reporting.

5.2. We're interested in hearing not just the results of your project but what are their implications for or contributions to:

- **offshore energy system safety,**
- **environmental protection and stewardship, and/or**
- **health and community resilience**

Please describe what you consider to be the most remarkable accomplishment or finding of your project. What can others learn from your accomplishment and finding? How do you see it fitting in with your greater field of study or community of practice? *

Most remarkable finding of the project: high percentage (88%) of restoration projects that supported seagrass past the date of the original monitoring duration. Our study highlights the benefit of identifying and surveying historic restorations to address knowledge gaps related to the performance and long-term fate of restored seagrass beds and ecosystem resilience.

Other persons considering seagrass restoration efforts an use this information as they design monitoring programs and set expectations....the concept that a 3 year study post restoration is adequate for evaluating performance of other restoration efforts is challenged by our findings.

6. Communication

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Note to Grantees: In Section 6, we seek input from you to help us evaluate the Gulf Research Program's funding strategy. This section will not be made available to the public.

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6. Information to Inform GRP Evaluations

6.1. Sharing the difficulties you encountered helps us learn from your experience. Describe any challenges you encountered in your project and how you addressed or overcame them. Challenges are inherent to conducting any complex project. These may include (but are not limited to): unexpected staffing changes, changes in the community you are working in, appearance of a new technology or dataset in the field you are working in, challenges accessing a field site, policy or regulatory changes that affect the issue you are addressing, low recruitment rates, delays in setting up services, or other problems in implementing and conducting your project. *

The impediments to conducting research on this grant were mainly related to two factors: COVID which essentially curtailed ongoing collaborations in March 2020 through to April 2021 because of medical issues/restricted access to group meetings/increased time demand to direct efforts to assisting student to their degree completing because of COVID impacts. A second factor was that the co-investigator (Dr. Margaret Hall retired in October 2020 and she was restricted for one year from any involvement in state related work with her former agency (Florida Wildlife Commission). Our workshop time table was shifted to later date because our efforts in the field and database updating required a bit more time than we had anticipated but all our main objectives, except the last updating of the database and writing up of workshop outcomes (funding was provided to finish this in June 2021-September 2021), was completed within the three year period. One big disappointment was that a standardized reporting form for seagrass restoration monitoring overseen by agencies was not quickly adopted by agencies in Florida- as the agencies which will be overseeing some aspects of permitting is being reconsidered. Once this is resolved we intend to engage in future discussions.

6.2. We like to hear about what you learned from your work and how you feel it affects future work or the work of others. Think back on your project strategies, methods, and activities, what worked and what did not? Is there anything you would do differently in the future? If so, tell us what and why. *

I think the idea for researchers to revisit restoration sites to collect information on projects carried out by agencies/practitioners will be attractive to others. This is especially true in the USA where seagrass restoration is regulated by state agencies and the permitting process. One of the lessons our research team gleaned from our efforts was that given governmental agency control of permitting as the main pathway by which seagrass restoration will likely be implemented in the future, valuable information can be extracted if researchers, practitioners and agency personnel work as a team. We were most pleased with the discussions in our workshop, the response to the database and the suggested “standardized reporting form” which was composed by the participants and suggest a focused workshop as a most worthwhile research component.

6.3. What are the next steps for this work, either for you and your project team or other researchers? Has this project led to other opportunities to work in this area? *

Revisting of restoration sites could become a new active approach to extracting information from restoration efforts across other habitats as well. The next steps for or research team will be to continue with seagrass restoration efforts, especially seeking to work alongside permitters and practitioners. We expect that these opportunities will arise in the future. However our team has changed…Dr. Ryan Rezek has taken a job as an Assistant Professor at Coastal Carolina University and Dr. Margaret Hall has retired from FWC so our research team may look for new members to join..perhaps from Texas where other seagrass restoration efforts are ongoing.

6.4. Have you developed new collaborations or partnerships (formal or informal) as a result of this work? If yes, please describe the new collaborations or partnerships. *

No new formal or informal partnerships have developed during this project. Dr. Bell and Dr. Hall joined a state of Florida advisory team on seagrass monitoring SEACAR DDI and continue to exchange ideas with state officials on this topic.

The research team collaborated with Ms. Holly Greening, a practitioner who has led agencies within Tampa Bay in the past, to formulate the second manuscript.

6.5. What, if any, positive changes in policy or practice do you foresee as a result of your work? *

The changes in policy can only be implemented by the governmental agencies. In our discussions they have responded positively to our standardized reporting form and we hope this will be adopted, given the nature of the feedback we have received.

6.6. If you could make one recommendation to the Gulf Research Program for how best to build on the work you conducted in this project, what would it be? *

I would suggest that GRP look favorably on projects that can examine restoration projects that have existed for more than 3-4 years….as we found that successful restoration often requires longer time periods for establishment. Also, efforts to fund projects that work on increasing data transparency/quality/accessibility may be extremely valuable.

7. Communication and Dissemination

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Note to Grantees: In Section 7, we ask you to help us communicate the importance, progress, and accomplishments of your work. Information provided in this section will be used by the Gulf Research Program to highlight its funded projects in print and electronic informational and promotional materials. The intended audience for the information provided in this section is different and should be thought of as a general audience. When you return to the dashboard, you may upload images that represent and illustrate the work of your project.

7.1. Please describe the most exciting or surprising thing you have learned while working on this project in a way that is understandable by a general audience. *

We were surprised by the number of permitted seagrass restoration projects that were permitted by the State of Florida since 1980 (0ver 300). This is largely due to the amount of coastal modification by humans that impacts seagrass abundance.
What was most exciting was that some of the restoration projects showed expansion of seagrass cover over time that matched levels of natural unimpacted areas....so there are a variety of examples where restoration is successful. We need to continue to examine these case studies to learn why they performed so well.

7.2. Do you have any stories that capture the impact of this project? (optional)

If so, please share one or two. Examples of what we are interested in include stories of people/communities that the project has helped; lives that have changed; work that led to policy change, such as legislation or regulation; and research breakthroughs.

Findings in Rezek et al. (2019) dispel the idea that long term seagrass restoration is largely unsuccessful as we found evidence for seagrass to persist in 85% of seagrass restoration projects when we revisited them.

7.3. Have any communications, outreach, or dissemination activities occurred in relation to your project?*

Please describe:

- Any press releases issued (other than that issued by the National Academies of Sciences, Engineering, and Medicine) about the project.
- Any media coverage or news stories about the project.
- Any social media accounts, websites, listservs, or other communication vehicles used to communicate information about this project. Please include relevant web addresses if available.

none