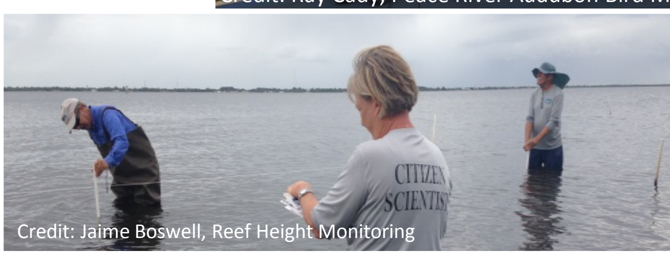
CHNEP Volunteer Oyster Habitat Monitoring Program

- **Volunteer Coordinator Manual**
- **Volunteer Manual**
- **Standard Operating Procedures**


Credit: Ray Cady, Peace River Audubon Bird Monitoring Volunteers


Credit: Jaime Boswell, Reef Height Monitoring


Credit: Jaime Boswell

Charlotte Harbor National Estuary Program

January 2017

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The Charlotte Harbor National Estuary Program is a partnership of citizens, elected officials, resource managers and commercial and recreational resource users working to improve the water quality and ecological integrity of the greater Charlotte Harbor watershed. A cooperative decision-making process is used within the Program to address diverse resource management concerns in the 4,700-square-mile study area. Many of these partners also financially support the Program, which, in turn, affords the Program opportunities to fund projects. The entities that have financially supported the Program include the following:

U.S. Environmental Protection Agency
Southwest Florida Water Management District
South Florida Water Management District
Florida Department of Environmental Protection
Peace River/Manasota Regional Water Supply Authority
Polk, Sarasota, Manatee, Lee, Charlotte, DeSoto, and Hardee Counties
Cities and Towns of Sanibel, Cape Coral, Fort Myers, Punta Gorda, North Port, Venice, Fort Myers Beach, Winter Haven, and Bonita Springs.

Acknowledgements:
This project has benefited from the generous contributions of numerous agencies and individuals that have provided information, time, and expertise to the development of these materials.

The Charlotte Harbor National Estuary Program and the City of Punta Gorda have provided the venue and support for the entire project. The Charlotte Harbor Aquatic Preserves staff conducted seagrass monitoring and assisted with equipment needs and laboratory space.

The Nature Conservancy's participation in this project was invaluable. The Nature Conservancy established the underlying oyster habitat restoration pilot project at Trabue Harborwalk upon which this project was based. Their staff provided technical assistance with monitoring procedures, assistance with recruiting and training citizen scientists, and review of documents.

Technical assistance was also provided by members of the Southwest Florida Oyster Working Group with particular expertise in oyster habitat monitoring and restoration. The citizen scientists provided valuable insight into how to make the program a success through their thoughtful questions and suggestions.

This project was funded in part through a grant agreement from the Florida Department of Environmental Protection's Florida Coastal Management Program, by a grant provided by the Office of Ocean and Coastal Resource Management under the Coastal Zone Management Act of 1972, as amended, National Oceanic and Atmospheric Administration Award No. NA15NOS90096. The views, statements, findings, conclusions and recommendations expressed herein are those of the author(s) and do not necessarily reflect the views of the State of Florida, NOAA or any of their subagencies.

January 2017.

Charlotte Harbor National Estuary Program

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Volunteer Oyster Habitat Monitoring Volunteer Coordinator Manual

Purpose

The Charlotte Harbor National Estuary Program (CHNEP) Volunteer Oyster Habitat Monitoring (VOHM) program is intended to enable the collection of meaningful long-term monitoring data from oyster habitat restoration sites throughout the CHNEP region by trained citizen scientists. The need for a consistent set of protocols amongst CHNEP partners, and the need for more long-term monitoring data to inform larger scale restoration were identified within the CHNEP Oyster Habitat Restoration Plan (2012). The VOHM program provides monitoring protocols that can be utilized by all partner organizations.

The program was developed through hands-on-experience working with volunteers to assist in monitoring The Nature Conservancy's Trabue Harborwalk oyster habitat restoration pilot project in Punta Gorda. The protocols were vetted through both a Scientific Steering Committee and a Volunteer Steering Committee to ensure the protocols were both appropriate for volunteers and would result in data that is usable by the scientific community. The protocols are also in line with the monitoring guidance provided in the *Oyster Habitat Restoration Monitoring and Assessment Handbook* (Baggett et al 2014) and will therefore result in data that can be compared to data from oyster habitat restoration projects in other regions.

By recruiting and training volunteers to conduct the majority of the monitoring using scientifically vetted protocols this program will:

- Enable long-term monitoring data to be collected, and at a lower cost to CHNEP partners while providing the data needed to answer scientific questions.
- Reduce the staff time needed to complete monitoring, while providing a source of leverage for grant funding through volunteer hours.
- Increase community support for habitat restoration projects through community engagement and stewardship of natural resources.
- Result in greater understanding in the community about oyster habitat degradation, restoration and ecosystem benefits from restoration.
- Provide meaningful volunteer opportunities for community members.

Volunteer Coordinator Roles

Each project partner wishing to implement the VOHM program will need to have a designated Volunteer Coordinator. The Volunteer Coordinator may be a paid or volunteer position. The Volunteer Coordinator could be the project lead/scientist or could work cooperatively with the project scientist. The coordinator should be well-organized, familiar with data management and comfortable working with computers, knowledgeable on the monitoring protocols, and experienced in organizing, conducting and leading all fieldwork. The responsibilities of the Volunteer Coordinator, described in more detail below, include:

1. Develop Project Specific Protocols
2. Recruit Volunteers
3. Train Volunteers
4. Schedule Monitoring Events
5. Obtain and Organize Monitoring Equipment
6. Prepare Datasheets
7. Manage Data
8. Track Volunteer Hours
9. Compile Data and Share

Develop Project Specific Protocols

The exact design of each oyster habitat restoration project will vary and the parameters being monitored may also vary, while the general protocols will remain the same. The Volunteer Manual (Section 2) should be edited to include project specific details, such as the parameters to be monitored and frequency of monitoring, the reef types being monitored, a map of the project site, and Volunteer Coordinator contact information. Additionally, some protocols allow for the specific methods to be adjusted based on availability of equipment or project design, but the resulting data should remain comparable between projects with consistent units of measure, timing of monitoring and general protocols.

The Volunteer Coordinator and/or the project lead/scientist will determine which parameters will be monitored, and at what frequency. This may in part be determined by the ability to recruit volunteers, the logistics of accessing the site, the time available for staff to coordinate the efforts, and the data that is relevant to answering scientific questions specific to the project or to regional efforts. The standard operating procedures (SOPs or protocols) developed for the VOHM program include monitoring protocols for reef area, reef height, live oyster density and size frequency, water quality monitoring, waterbird utilization, crown conch abundance, and shoreline location.

The *Oyster Habitat Restoration Monitoring and Assessment Handbook* (Baggett et al 2014) suggests that at a minimum reef area, reef height, live oyster density and live oyster size frequency should be monitored. In addition to these “Universal Metrics”, the handbook identifies “Universal Environmental Variables” which should be monitored if possible. For intertidal reefs these include water temperature and water salinity; dissolved oxygen is an added consideration for subtidal reefs. Additional parameters should be monitored dependent on the goals of the project, time and resource availability, and contribution to answering regional scientific questions. The table below outlines the considerations for each metric included in the VOHM protocols.

The CHNEP Oyster Habitat Restoration Plan (Boswell et al 2012) provides a table of success criteria that was developed by the Southwest Florida Oyster Working Group. Those success criteria may be used in conjunction with the parameters being monitored to evaluate project success. If live oyster density metrics are only monitored once per year, for consistency between locations and for the ability to evaluate success following the wet season/growing season, the monitoring should occur during the fall.

Table 1: Volunteer Oyster Habitat Monitoring Parameters

Metric	Frequency/timing	Purpose
Reef Area	Once per year – fall	Determine if reef area is increasing, decreasing or remaining the same over time.
Reef Height	Once per year – fall	Determine if reef height is increasing, decreasing or remaining the same over time.
Live Oyster Density	Once or twice per year – fall/spring	Evaluate the success of the restoration project based on the live oyster density.
Live Oyster Size Frequency	Once or twice per year – fall/spring	Evaluate the success of the restoration project based on the number of size categories.
Water Quality (temp. & salinity)	At least weekly, or more frequently	If localized water quality data is not available this will enable evaluating if water quality is appropriate for supporting oyster health.
Waterbird Utilization	Twice per month	Waterbird utilization is an easily observed indication that the restoration site is providing habitat to other animals.
Crown Conch Abundance	Quarterly	Crown conchs can limit oyster restoration success if overly abundant. Regional monitoring may assist in determining if crown conchs are affecting success in the CHNEP region.
Shoreline Location	Once per year – fall	If a project goal is to stabilize the shoreline it is important to document the location of the shoreline in relation to the reef over time.

Guidance in the *Oyster Habitat Restoration Monitoring and Assessment Handbook* (Baggett et al. 2012) provides that random sampling is ideal for assessing live oyster density and size frequency. The Volunteer Coordinator will need to work with the project lead/scientist to determine how random samples will be identified. The exact method may depend on the size and shapes of the reefs, the number of samples to be taken, and any stratification that is part of the project design (e.g. different reef types or elevations). Random sample locations may be used to identify a specific reef unit to be sampled, such as a bag or a mat, or may be used to identify the location for placement of a quadrat for sampling reef materials. The quadrat size can vary dependent on how dense the live oysters are on the particular reef site, the Handbook (Baggett et al. 2012) can be referenced for additional information.

In the Trabue Harborwalk pilot project random samples are identified by generating random numbers that can be used to identify a general location on the reef. Two numbers are generated for each sample, one that represents the location along the width of the reef and one that represents the location along the length of the reef. The range of potential numbers is based roughly on the length and width of the reefs in meters, so that if the reefs are approximately 11 meters long by 5 meters wide the range of numbers would be 1-11 for length and 1-5 for width. Sample locations can be identified in the field then by pacing off the length and width based on the random numbers. A survey flag with the sample ID number is placed in the reef at the random location, and then the sample can be collected.

Recruit Volunteers

The Volunteer Coordinator should have a preliminary project schedule developed prior to recruiting volunteers including which parameters will be monitored and the frequency of monitoring each metric (based on considerations outlined above). This information will assist the Volunteer Coordinator in estimating the number of volunteer hours needed to accomplish the identified tasks. In addition, this will allow the Volunteer Coordinator to provide descriptions of the tasks to potential volunteers. Potential volunteers will want to know how much time is expected of them and what types of activities they will be involved in. Understanding the time requirements of each task is the first step to being able to organize and recruit the volunteers needed to get the jobs done.

Table 2, below, provides an example matrix depicting a method to calculate the volunteer time needed for each monitoring metric. These time estimates are based on the Trabue Harborwalk pilot project. This project included easy site access directly from land with areas on land available for setting up to conduct live oyster monitoring in very close proximity to the oyster reefs. Additional time may be required depending on the number and size of the restored reef(s) and if site access is more complicated, especially if monitoring is to be conducted by boat.

Table 2: Volunteer Oyster Habitat Monitoring Metric Time Estimates

Metric	# of Reefs per Site	# of Samples per Reef	# of People	Time per Reef/Site (minutes)	Volunteer Time per Monitoring (minutes)	Time to Complete Metric (minutes)	Time to Complete Metric per Monitoring (hours)
Reef Area	9	1	3	10	270	90	1.5
Reef Height	9	1	4	10	360	90	1.5
Live Oyster Density & Frequency	9	3	3	30-60	2430-4860	810-1620	13.5 – 27*
Water Quality	3	1	1	20	60	60	1
Waterbirds	1	1	2	60	120	60	1
Crown Conchs	9	1	2	10	180	90	1.5
Shoreline	9	2	2	5	180	90	1.5

* Could be reduced with additional teams of volunteers

Volunteers for monitoring the pilot project were recruited through various sources, although many had been originally involved in the construction and deployment of reef materials managed by the Charlotte Harbor Aquatic Preserves and The Nature Conservancy. Volunteers were additionally recruited through the Peace River Audubon Society, Team Punta Gorda, articles in the CHNEP Harbor Happenings publication, and presentations within the community. Local community boating, fishing and environmental groups should be contacted to determine if they are interested in assisting with volunteer recruitment by hosting presentations about the project, or by providing contact information of people interested in volunteer opportunities whom the Volunteer Coordinator can contact directly. The CHNEP hosts a list of people interested in Citizen Scientist opportunities and is available to assist in spreading the word and posting volunteer monitoring opportunities on its website and online Water Atlas.

Other opportunities may be available to recruit volunteers through posting a flier for Citizen Scientist recruitment along with a sign-up sheet, at the municipality/county in which the project is located, festivals, visitor centers, libraries or other community locations. Once volunteers are actively monitoring they may also assist in spreading the word to engage additional volunteers. The CHNEP volunteers are provided with a Citizen Scientist t-shirt (see pictures on the cover) and are asked to wear them when conducting monitoring. When in areas visible to the public people will often stop to inquire about the project. Volunteers are provided with small business card sized handouts to give to anyone interested in the project; the cards include the information needed for interested individuals to find out more and get involved. An example flier, sign-up sheet and informational card are provided in Appendix A.

Once volunteers have expressed an interest in participating, it is critical for the Volunteer Coordinator to make direct contact with the volunteers as soon as possible (within 1 week is recommended) to welcome them and let them know what to expect next. This contact is best done through an individual personalized email or phone call. Many group emails are identified as junk mail and may be deleted without being read, especially if the recipient has not previously corresponded with the sender. The individualized contact also increases the likelihood that the volunteer will feel personally connected to the project and will remain interested when the time comes to attend a training event or participate in a monitoring event.

As volunteers are recruited, the Volunteer Coordinator should maintain an electronic database that includes contact information (name, email, phone, at a minimum), source of contact, and any other additional pertinent information collected. Some useful information to collect from the volunteers may be which parameters they are interested in monitoring, how frequently they are able to/interested in assisting, how many hours they are able to volunteer in one day, if they are comfortable/interested in doing work in the water and if they have any restrictions such as daily or seasonal availability or limited mobility, and t-shirt size.

Train Volunteers

Interested volunteers should be required to participate in a training session to ensure that they understand the purpose of the project, their role in the project, and the protocols that they will need to follow. The training should combine a presentation about the project details, the parameters to be measured, the role the volunteers will play and the general protocols, and hands on learning experiences. Try to schedule the training with plenty of advanced notice so interested individuals can plan accordingly. Requiring volunteers to sign-up in advance for the training is a good idea to enable appropriate planning.

As volunteers arrive the Volunteer Coordinator should greet them and get them oriented with how the training will be organized. Some things that can be done prior to the start of the training include, 1) have volunteers complete any necessary liability and media/photo release forms required by the sponsoring entity, 2) provide volunteers with copies of the Volunteer Manual and any additional handouts being used for the training, 3) if the sponsoring entity is providing Citizen Scientist t-shirts assist each volunteer in getting the appropriate size, and 4) if live oyster materials will be handled provide gloves to each volunteer.

Since the majority of volunteer time will be spent on identifying and measuring live oysters, this should also be the primary focus of the general training, although the other monitoring components should be introduced in the presentation. The hands on training experience should include using calipers or metric rulers to measure sample items. One exercise that can be used to compare measurements between participants is to provide items of a standard size, such as coins, to be measured by all participants. The participants can each be asked to measure, for example, a penny, a dime and a nickel, and then compare results with each other. A sample training exercise handout is provided on the next page, and provides a visualization of how to measure live oysters, the location of the umbo and the distal margin of the oysters, and how to read calipers. The diagram shows reading calipers to a tenth of a millimeter, however the protocols do not require this level of precision, so be sure volunteers know they should round to the nearest millimeter.

The next step in the process is to have the volunteers measure oyster shells. The oyster shells can be labeled with a number so that results can be compared between participants. Handling and measuring oyster shells will provide participants with the understanding that oyster shell shapes will vary considerably between individual oysters. It is important for the volunteers to be consistent in identifying the location of the umbo and the distal margin. See illustration, below.

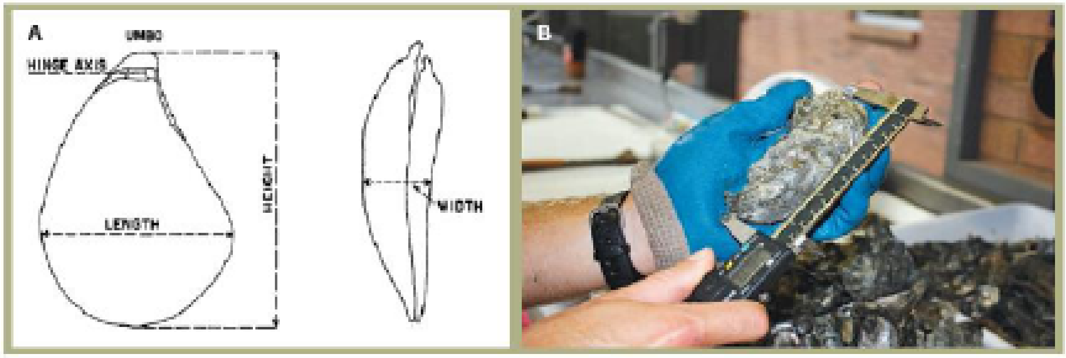
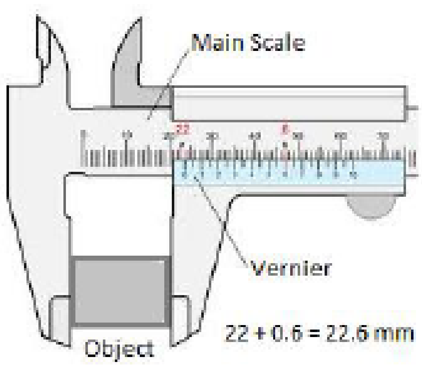


Figure 20. (a) Diagram of the height, length and width measurements of an oyster shell, from Galtsoff 1964, Chapter 2. (b) An example of shell height measurement in a lab.



<u>Step 1:</u> Grip the object gently using the outside jaws of the calipers.
<u>Step 2:</u> Read the main scale directly opposite the zero. In the example picture, the reading on the main scale is 22 mm.
<u>Step 3:</u> Record your measurement to the nearest mm, we will not be using the Vernier scale.

Practice Measurement Exercise: Measure the large shell in picture above, the small shell where the arrow is pointing, a penny, a nickel, and a dime. Compare with others at your table.

Large shell ________mm Nickel ________mm

Small Shell ________mm Dime ________mm

Penny ________mm

Lastly, the volunteers should be given the opportunity to handle freshly collected shell material, sort through the shell, identify live oysters including spat, and practice measuring live oysters. This step can either be done by taking the volunteers to the site, or the Volunteer Coordinator can collect samples ahead of time and bring them to the training site. It will be beneficial to have someone experienced with identifying live oysters stationed with a small group of 3-4 new volunteers. Inviting experienced volunteers from other existing VOHM programs to assist in the training would be a helpful addition to the training experience.

Training volunteers to assist in conducting the reef area, reef height, crown conch and shoreline measurements can be done during the monitoring event, either directly by the Volunteer Coordinator, project staff, or with the assistance of an experienced volunteer.

If volunteers will be collecting water quality data or conducting waterbird surveys, these groups of volunteers should be trained on site and specifically for these tasks utilizing the protocols provided. Anyone volunteering to conduct waterbird surveys should already be competent at waterbird identification. Local Audubon groups are a great source of potential volunteers that may be both willing and able to conduct this monitoring.

Schedule Monitoring Events

The annual and bi-annual monitoring events should be conducted around the same time every year in the fall and spring, respectively. The monitoring events should also be planned based on the tide predictions, selecting for days when tides are the lowest to allow for optimal accessibility to intertidal reefs. In order to utilize the days with the best tides, and stay within a consistent time frame every year, it is best to identify and schedule the monitoring events far in advance to ensure that willing volunteers can participate by planning their schedules accordingly. Sending out a "save the date" email announcement a few months in advance should guarantee good availability of volunteers. As the date gets closer, the Volunteer Coordinator can schedule specific time slots for each task and schedule with the volunteers.

Consider volunteer time slots of 2-4 hours each, some volunteers may choose to sign up for a full day, but many volunteers will appreciate the ability to participate for shorter periods of time and this will likely result in greater retention of volunteers. Consider for each time slot the tasks that should be completed by the volunteers and commit to completing those tasks. Volunteers can always leave early if the tasks are completed. This ensures that for each time slot, for which volunteers have been recruited, significant work will be completed. Another option is to schedule a few time slots that are identified to be "as needed". With any fieldwork there is always a potential that weather or other circumstances may result in work not being completed as scheduled, planning ahead of time for this possibility is easier than having to figure out what to do at the last minute.

If monitoring of other optional parameters is being conducted throughout the year, scheduling could occur for these events at the beginning of the year, quarterly or monthly, dependent on site conditions, weather, volunteer availability and Volunteer Coordinator workload. For the Trabue Harborwalk VOHM monitoring, water quality volunteers were scheduled to conduct monitoring on a rotating weekly basis.

The volunteers are provided with a schedule for approximately six months at a time and were encouraged to contact a replacement volunteer if they were not able to conduct their scheduled monitoring. The volunteers were asked to monitor within a 3-day window of time – for example they are scheduled for Monday, but can conduct the monitoring on Sunday, Monday or Tuesday. The quarterly crown conch monitoring and semi-monthly waterbird monitoring was scheduled approximately one month in advance. In the Trabue Harborwalk VOHM monitoring, a volunteer has taken on the responsibility of scheduling the waterbird monitoring, with the decision of when to monitor based on the two lowest low tides in the morning daylight hours per month.

Specific time slots for each volunteer and for each monitoring task can be organized using a free online program, such as SignUp.com. During the development of the Trabue Harborwalk VOHM monitoring, the free website SignUp.com was used to organize the scheduling of volunteers; there may be other free or fee programs that have similar capabilities. The SignUp.com website tools enabled the Volunteer Coordinator to create various monitoring events, and within the monitoring events to specify how many people are needed for each time slot. A link can be sent out to all trained volunteers requesting that they sign up for the timeslots for which they would like to volunteer.

Alternatively, the Volunteer Coordinator can assign specific monitoring days for tasks such as water quality monitoring. Once a volunteer is scheduled the program will automatically send reminders in advance of the scheduled monitoring event. The Volunteer Coordinator can also send messages through the program to provide updates to volunteers that are scheduled for specific time slots or events, for example if the monitoring location changes. Volunteers should be made aware in advance that details may change and that they should check their email the evening before their scheduled monitoring for any updates.

It is extremely helpful to print out the list of volunteers signed up for each time slot prior to the monitoring event, by doing so the Volunteer Coordinator will know who to expect to show up and will also have a record of those that participated in each event. It is useful to know that once the event takes place the free SignUp.com version does not allow users to go back to those events, so printing the roster ahead of time is the only way to have a permanent record of the event.

Obtain and Organize Monitoring Equipment

The monitoring equipment needed to conduct the monitoring tasks described in the SOPs is provided in Appendix B. Most of the monitoring equipment can be easily obtained and does not require much upkeep or maintenance. The Volunteer Coordinator needs to consider and plan ahead for the transportation, rinsing, drying and storing of monitoring equipment. Any equipment with metal components should be rinsed daily with freshwater and sprayed with WD40 prior to long-term storage. The logistics of each project will be different, but it may be appropriate to engage the volunteers in the preparation, transportation and clean-up of equipment.

Prepare Datasheets

Templates of datasheets for the parameters discussed are provided in Appendix C, and are available as editable excel spreadsheet electronic files from the CHNEP. The datasheets include the space to record all of the components described in the VOHM Protocols.

The Volunteer Coordinator should ensure sufficient numbers of datasheets are printed and available for all monitoring events, including some extras. If project budget allows, it is recommended that datasheets be printed on waterproof paper and be completed with pencil. As volunteers complete the data collection during the live oyster monitoring, datasheets should be collected by the Volunteer Coordinator. The Volunteer Coordinator can perform a quick in field quality control review of each datasheet to make sure all pertinent data is filled in, if data is missing, rather than not available, the field check will allow for collection of the missing data.

If volunteers will be entering the live oyster data into the project database or other data repository, the Volunteer Coordinator should digitally scan all datasheets, and then provide the digital files or hard copies of the datasheets to the volunteers for entry. This way the data is backed up and there is a greatly reduced chance of large amounts of data being lost accidentally. For those parameters for which volunteers are collecting data on a regular basis, including waterbird and water quality monitoring, the volunteers can submit the data electronically, shortly after data collection, using the **CHNEP Water Atlas Data Forms** (data forms can be accessed at http://www.chnep.wateratlas.usf.edu/oyster-habitat-restoration/).

Manage Data

Data entry forms were created using **Google Forms** to allow for online data entry by volunteers for water quality data, waterbird utilization data, crown conch data, and live oyster density data. These data forms have been password protected so that only those volunteers trained to collect and enter data have access. **Google Sheets** is a better format for data entry of size frequency data. The **Google Sheet** can be created by the Volunteer Coordinator and then a link to access the sheet can be provided to those volunteers assisting with data entry. Data entry from one sample for size frequency was estimated to take on average 5 to 15 minutes, including time needed for the volunteers to review all entered data.

The Volunteer Coordinator should regularly download data from the submitted **Google Forms** and **Google Sheets**. The data can be exported into Excel for further QA/QC and data management. The Volunteer Coordinator should review all data to make sure that the data entered makes sense, and a QA/QC process to randomly check data against actual data sheets should be implemented. The QA/QC process for the water quality data includes checking the hydrometer tables to ensure the temperature/specific conductance translation to salinity is correct. The data should also be examined for any extreme outliers and volunteers contacted if there is any data that stands out. Volunteers should be encouraged to submit comments, including site conditions, equipment trouble, ideas to facilitate monitoring etc., and these comments should be reviewed regularly so that any follow-up can occur in a timely manner.

Track Volunteer Hours

The Volunteer Coordinator should maintain a system for recording volunteer hours by person and by monitoring event. For the Trabue Harborwalk VOHM pilot project using a simple EXCEL spreadsheet to track the information worked best. This information is easily gathered when the data entry forms are downloaded and reviewed for parameters collected outside of the larger monitoring events. For the larger events it is useful to have a roster of volunteers that had signed up for each time slot, and then to enter that information into the volunteer hour spreadsheet. Many funding entities have their own volunteer hour tracking forms, some of which are compatible with EXCEL. Accurate tracking of the number of volunteer and hours is valuable for providing match to project grants. It is essential to set-up an easy to manage, workable system at the outset of a project, otherwise what first appears to be a simple tracking of hours and number of volunteers can quickly become cumbersome and confusing. It is recommended that the Volunteer Coordinator enter this data into the tracking system on a daily, or at least weekly basis, in order to effectively manage the information.

Compile Data and Share

An important component of a volunteer Citizen Scientist program is ensuring that the data is compiled and made available in some way for the volunteers and others to benefit from the data. The CHNEP Water Atlas Oyster Restoration page (http://www.chnep.wateratlas.usf.edu/oyster-habitat-restoration/) provides a place that data results can be shared, and where volunteers can easily view data results. Data results from the Trabue Harborwalk VOHM pilot project water quality and waterbird monitoring were made available and updated regularly with new data on this site. Reports and presentations may also be posted to the site and volunteers can be alerted to the availability of the information. The Volunteer Coordinator can work with the CHNEP to provide information via the CHNEP Water Atlas.

<The following sections provide the Volunteer Manual (VM) and Standard Operating Procedures (SOPs) as developed for the Trabue Harborwalk pilot project. When using the VM and the SOPs, the text should be revised to include project specific details, reformatted, and provided to volunteers during project specific trainings. Electronic copies of the VM and SOPs are available from the CHNEP.>

Volunteer Oyster Habitat Monitoring Volunteer Manual

Welcome! The scientists and resource managers in the Charlotte Harbor watershed appreciate your interest in becoming a volunteer citizen scientist by monitoring oyster habitat restoration in our estuary. Through the use of the data that you help to collect we will be able to measure the success of our restoration projects and learn valuable information about how to make future projects successful.

What is Citizen Science?

The involvement of the public in scientific research – whether community-driven research or global investigation. – Citizen Science Association

Citizen Science: Scientific work undertaken by members of the general public, often in collaboration with or under the direction of professional scientists and scientific institutions. – Oxford English Dictionary

The collection and analysis of data relating to the natural world by members of the general public, typically as part of a collaborative project with professional scientists. – Oxford British and World English Dictionary

What is the difference between Crowdsourcing and Citizen Science?

Crowdsourcing is a process of obtaining needed services, ideas, or content by soliciting contributions from a large group of people, and especially from an online community.

Example: Annual Coastal Clean-up Day. Trash and debris are collected by a large cohort of volunteers at multiple locations. For the past 30 years, data has been gathered and managed by the Ocean Conservancy about the type and quantity of trash and debris collected.

Citizen science mobilizes the public to participate in the scientific process to address real-world problems, in ways that include identifying research questions, collecting and analyzing data, interpreting results, making new discoveries, developing technologies and applications, and solving complex problems.

Example: Charlotte Harbor Estuary Volunteer Water Quality Monitoring Network. Trained volunteers go out on the first Monday of each month at sunrise to collect water samples and take specific measurements with equipment. Volunteers undergo training and periodic re-training.

The oldest citizen science project is the Audubon Society's Christmas Bird Count, which has been on-going since 1900.

Read more about Citizen Science…

Investing in Citizen Science Can Improve Natural Resource Management and Environmental Protection:
http://www.esa.org/esa/wp-content/uploads/2015/09/Issue19.pdf
Citizen Science:
http://guides.library.illinois.edu/c.php?g=348340&p=2347192
Citizen Science Blog:
http://blogs.plos.org/citizensci/
Federal Crowdsourcing and Citizen Science Toolkit:
https://crowdsourcing-toolkit.sites.usa.gov/
https://www.citizenscience.gov/

Volunteer Citizen Scientists

As a volunteer citizen scientist you will be trained to conduct basic scientific research on oyster habitat restoration projects. Your Volunteer Coordinator will work with you to schedule training and establish a calendar for the monitoring tasks. The monitoring that you will perform has been chosen by the project scientists and is based on best-available science. The monitoring will not only establish the success of your restoration project, but it may also be used to modify future projects or future monitoring protocols. The data you collect will be made available to scientists, resource managers, and the general public through an on-line data webpage.

The data will be analyzed and will inform the scientists and resource managers about multiple characteristics (parameters) of the project over time and may also be used to design or re-design future oyster habitat restoration projects in our region, and possibly other regions of Florida, the Gulf of Mexico and beyond.

In addition, the data you collect may be used in scientific research and be published in technical papers, presented at scientific conferences or poster sessions. The Volunteer Coordinator will be able to provide information about any scientific publications that utilize the data generated from your collective efforts as Volunteer Citizen Scientists.

Oyster Habitat Restoration and Monitoring

Oysters, oyster reefs and oyster bars are critical components of our healthy Charlotte Harbor waters. Since the mid-1800s it is estimated that we have lost over 90% of oyster habitat in the Charlotte Harbor estuaries, making oyster restoration a priority for improving the estuaries. The combination of oyster, mangrove and seagrass habitat provides a mosaic of habitat types that work in concert to make up a healthy estuarine system.

> *Oysters are unique in that they are a species that can attach to one another to form a reef structure (habitat) and individually are a valued fishery (think oysters on the half shell). Oyster reefs are the ecosystem engineers of bays and estuaries. They provide important services to people and nature by:*
>
> - *cleaning water – a single adult oyster can filter as much as 50 gallons per day;*
> - *providing food and habitat for a diversity of plants and animals, including fish, crabs and birds; and*
> - *serving as natural coastal buffers from boat wakes, sea-level rise and storms.*
>
> *from The Nature Conservancy website: nature.org*

Long term monitoring of oyster habitat restoration sites provides data that can inform future projects and provide insight not otherwise available to scientists and resource managers. Most current project budgets do not provide sufficient funds to support multi-year pre or post-restoration monitoring by paid staff.

The Southwest Florida Oyster Restoration Working Group identified locations suitable for oyster habitat restoration and creation in the Charlotte Harbor National Estuary Program's study area. In 2013, The Nature Conservancy (TNC) implemented the Created Oyster Reef at Trabue Harborwalk, Charlotte Harbor, Florida, a project developed in collaboration with the Charlotte Harbor Aquatic Preserves (CHAP). The project goal is to test three different oyster reef restoration methods – oyster mats, oyster bags and loose fossilized shell - for application in future projects in the Charlotte Harbor estuary.

In 2014, TNC contracted with CHAP to develop a community outreach program to create the oyster restoration materials that were used for this Trabue Harborwalk project. The CHAP's involvement of the community was very successful, with more than 1,200 citizens in the region volunteering their time for the project. Volunteers assisted in making oyster mats, bagging oyster shells and then deploying the mats, bags and loose shell at the restoration sites. The community's involvement in and support for this project generated a cadre of volunteers eager to participate in the implementation and monitoring of this project as well as future restoration projects.

The Volunteer Oyster Habitat Monitoring (VOHM) project was developed to provide volunteer Citizen Scientists with the skills, training and expertise to conduct hands-on long-term monitoring and data collection. The volunteer Citizen Scientists will capture long-term monitoring data of the Trabue

Harborwalk project that will be invaluable to shellfish scientists as they refine the techniques used for future restorations and for evaluating site suitability. The VOHM project is designed to continue engaging the volunteers in on-going and future oyster restoration projects they are designed and funded.

Read More about Oyster Restoration…

CHNEP Oyster Habitat Restoration WaterAtlas Page:
http://www.chnep.wateratlas.usf.edu/oyster-habitat-restoration/
CHNEP Oyster Habitat Restoration Plan:
http://www.chnep.wateratlas.usf.edu/upload/documents/134_CHNEP-Oyster-Restoration-Plan-12Dec2012-lowres.pdf
Oyster Restoration Workgroup:
http://www.oyster-restoration.org/
Oyster Reef Restoration:
http://www.nature.org/ourinitiatives/regions/northamerica/unitedstates/southcarolina/howwework/oyster-reef-restoration-southern-solutions-for-a-global-problem-1.xml

What will you do as a volunteer Citizen Scientist?

You will be taking measurements, collecting data and filling in data sheets about the growth of oysters at the site, about ambient conditions such as water temperature and salinity, about changes in the oyster reefs such as size and height, about the use of the reefs by other animals, or about changes in the shoreline. Before doing any monitoring you will be trained so that you are confident in your abilities and capable of collecting scientifically defensible data.

Each training and monitoring session will last anywhere from two to four hours. Your Volunteer Coordinator will establish schedules for the training and monitoring. During the training session you will be given an overview of the restoration project including the project's restoration goals established by the scientists or resource managers. In addition you will learn the types of monitoring that are going to be conducted, the frequency, and the various tasks associated with the monitoring. As an example: when measuring reef height and reef area you will need to be comfortable walking in the water, but to measure oyster density and water quality you can stay on dry land.

During the training you will be introduced to all the equipment that will be required to conduct the monitoring, you will learn to use the equipment, and you may be assigned a set of equipment for your use with your monitoring team. You will also be introduced to the potential challenges involved with the monitoring. Some of the tasks can be physically challenging, so be aware of the challenges associated with each task prior to signing up. Some tasks include going into the water, if you have open wounds or are uncomfortable walking on unstable ground these tasks should be avoided. When working with the oyster materials there is the possibility of getting small cuts on hands, but gloves are provided to help avoid this from happening. Some heavy lifting is involved, but not everyone is required to do this, just let your Volunteer Coordinator know what you are comfortable with doing.

If your assignment includes online data entry, you will be provided with website links and passwords (if required) to facilitate entering the collected data into the **Google Forms**, **Google Sheets** or directly into the **CHNEP WaterAtlas**.

The "fine print"

<this will vary depending on organization>

Each Volunteer Citizen Scientist will be required to complete a Liability Release Form prior to the first training session. In addition, we ask that everyone complete a photo release form also so we can post photographs of you.

Equipment and Supplies

The project Volunteer Coordinator will provide the required equipment (hydrometers, thermometers, tables, etc.) and supplies (buckets, survey tape, calipers, rulers, zip ties, rulers, calipers, data sheets, etc.) necessary to conduct the monitoring. The specific supplies needed for each metric is listed in the respective SOP.

You will be given a "Citizen Science" long sleeve shirt to wear when conducting monitoring to identify you and to protect you from the sun. You will have access to gloves to protect your hands from the sharp oysters, and a snorkel and mask (if you are conducting Crown Conch monitoring). Volunteers will need to bring their own shoes or water booties, head covering, water to drink, snacks and chairs.

Potential Hazards

As with all outdoor activities in Florida, lightening and heat are always a threat when conducting oyster monitoring. The majority of all outdoor trainings and monitoring events will be scheduled for the earlier/cooler hours of the day. Because of the life cycle of oysters in our region, the periodic six-month and annual monitoring will be scheduled for non-summer months when the threat of bad and dangerous weather is low.

Most monitoring events will be scheduled for low tides, so you will be able to see the location of oysters, and avoid walking on them or injuring yourself on the shells. Because our estuary waters are sometimes dark with tannin, it may be difficult to see where you are stepping, the bottom can be uneven, and the sediment soft in some places. Also, depending on the location, you may wish to gently shuffle your feet to avoid stepping on stingrays.

Your Volunteer Coordinator will provide you with emergency contact information, the location of the nearest emergency room, and a small first aid kit will be on-site to treat small cuts and abrasions.

Project Details - Trabue Harborwalk Oyster Habitat Restoration Project

<Insert Your Project Info>

The Trabue Harborwalk Oyster Reef Creation Project is a small pilot project in the Peace River along the City of Punta Gorda shoreline that is testing the efficacy of three different methods of oyster reef restoration – loose shell, bagged shell and recycled shell on mats. The project consists of nine reefs, three of each material type. The location of the site is shown on the figure below and a detailed site map is provided in Appendix D.

The Nature Conservancy planned to perform one year of monitoring consisting of two monitoring events six months apart. With the assistance of volunteers additional monitoring was added to include weekly water quality monitoring which began in May 2016 and bi-monthly waterbird monitoring which has been ongoing since prior to the reef deployment in October 2015. The VOHM program will help The Nature Conservancy to continue to collect data on these reefs for a longer period of time.

Trabue Harborwalk Oyster Habitat Restoration - Location Map

Created for: The Nature Conservancy
Created by: Jaime Boswell MS LLC 5/10/2013

The goal of the Volunteer Oyster Habitat Monitoring (VOHM) project is to continue monitoring of the created oyster reefs for at least an additional 12 months while also developing, implementing and sustaining a volunteer oyster habitat monitoring program that is scalable and transferrable throughout the Charlotte Harbor estuary. The VOHM will collect data that will be used to assess and compare the relative success of each construction method. Volunteers will be recruited and trained to monitor the constructed reefs over time; collecting data on a number of key parameters related to oyster recruitment and reef formation, subsequent colonization by reef associated organisms, protection of adjacent shorelines from erosion, and water quality. Volunteers will be given access to an online interface for data entry that will accommodate real-time data entry.

Funding Sources: The Nature Conservancy, the Florida Department of Environmental Protection, National Oceanic and Atmospheric Administration, the Charlotte Harbor National Estuary Program

Partners: The Nature Conservancy, City of Punta Gorda, The Charlotte Harbor Aquatic Preserve, the Charlotte Harbor National Estuary Program, The Friends of the Charlotte Harbor Aquatic Preserves, the Southwest Florida Oyster Working Group.

Permit Holder: The Nature Conservancy

Project Point of Contact: Jaime Boswell, Environmental Scientist, Charlotte Harbor National Estuary Program, jboswell@chnep.org

Project Staff: Charlotte Harbor National Estuary Program, The Nature Conservancy, Charlotte Harbor Aquatic Preserves, Friends of the Charlotte Harbor Aquatic Preserves, volunteer Citizen Scientists

Project Timeline:
Reef Deployment Completion – October 2015
Waterbird Utilization Monitoring Begins – October 2015
Volunteer Recruiting and Training – January – April 2016
Six-month Monitoring – May 2016
Water Quality Monitoring Begins – May 2016
Volunteer Training – October 2016
One-year Monitoring – November 2016

Project Parameters

For the Trabue Harborwalk project the project scientists have chosen 9 different parameters to be monitored by Citizen Scientists, including: Reef Area, Reef Height, Live Oyster Density, Live Oyster Size Frequency, Shell Volume, Water Quality, Waterbird Utilization, Crown Conch Abundance and Shoreline Location. Standard Operating Procedures (SOPs) have been developed for each of these parameters describing the equipment and supplies used, the number of volunteers needed, the techniques utilized to conduct the monitoring and the data collected for each parameter. The SOPs can be found at the end of this manual.

Read More about Parameters…

Guidelines for evaluating performance of oyster habitat restoration
http://www.disl.org/assets/uploads/publications/Baggett15RestorEco.pdf

What does each parameter tell us?

- Reef Area – measures annual change in reef size following the oyster growing season
- Reef Height - measures annual change following the oyster growing season, results may indicate increases in height over time as a result of new growth, or a decrease in height over time as a result of loss of living oysters and/or reef materials sinking into the sediment
- Live Oyster Density – indicates the success of the reef to provide both a good settling place for oyster and a good environment for survival
- Size Frequency – provides information about survival and settlement of different age classes or cohorts of oysters
- Shell Volume – indicates how much structural material was sampled, including both live and dead oysters
- Water Quality – measures fluctuations in water quality over time, and may be used to understand reef success or failure
- Waterbird Utilization – documents use of the restored oyster habitat by birds, and indication that the oyster reef is providing habitat for other animals
- Crown Conch – captures the abundance of crown conchs (an oyster predator) near the oyster reef
- Shoreline Location – documents whether the shoreline adjacent to the oyster reef is changing through sediment deposition or loss.

What special equipment is used?

Most of the monitoring is conducted using simple equipment, most of which can be purchased at the local hardware store. Only a few scientific instruments are used.

<u>Haglof DME</u> – A device that is capable of precisely measuring distance through the use of ultrasound. The use of the Haglof DME provides a quick, accurate way to measure reef length and width for calculating reef area, and can also be used to assess shoreline location. The unit consists of a transmitter and a receiver; the distance between the two units is measured at the push of a button and displayed on a screen. Sound and temperature can affect how the unit reads distance, so when using be sure the environment is relatively quiet (no talking or splashing in the water), and calibrate close to the time of use and regularly if the temperature changes significantly during the monitoring period.

<u>Hydrometer</u> – A hydrometer is an instrument that measures the specific gravity (relative density) of liquids—the ratio of the density of the liquid to the density of water. The hydrometer you will be using s made of glass and consists of a cylindrical stem and a bulb weighted with lead shot to make it float upright. The water you will test is poured into a tall graduated cylinder, and the hydrometer is gently lowered into the liquid until it floats freely. The point at which the surface of the liquid touches the stem of the hydrometer correlates to specific gravity. The hydrometers contain a scale inside the stem, so that the person using it can read specific gravity.

Thermometer - A thermometer is a device that measures temperature or a temperature gradient. You will be using a thermometer in conjunction with the hydrometer to assist in determining the salinity of the water at the site of the project. All measurements are taken in degrees Celsius.

Common Phrases Used When Monitoring (from various sources)

Location: name of the project area, for example Trabue Harborwalk

Site/Reef ID: dependent upon the project design there might be a either a site ID or a reef ID, or both – some projects may have several sites within one larger location, and then several reefs within a site, the IDs allow identification of the individual reefs and the sites that they are located within

Sample ID: this will typically include the site/reef ID and a unique number to identify unique samples taken from the reefs

Station: this is a spot that is monitored on the reef for reef height; this phrase could also be used to identify spots monitored for other parameters such as shoreline location

Metric: a standard for measuring or evaluating something, especially one that uses figures or statistics

Parameter: a characteristic, factor or variable

Permit holder: the organization that applied to conduct the project and received the permit. Permits are necessary for any work in the Nation's navigable waters.

Quadrat: a plot used in ecology and geography to isolate a standard unit of area for study of the distribution of an item over a large area.

Salinity: Sea water salinity is expressed as a ratio of salt (in grams) to liter of water. In sea water there is typically close to 35 grams of dissolved salts in each liter. It is written as 35ppt. The mixture of seawater and fresh water in estuaries is called brackish water and its salinity can range from 0.5 to 35 ppt.

Spat: once oyster larvae permanently attach to a surface, they are known as spat

Specific Gravity: the ratio of the density of a substance to the density of a reference substance; the reference substance is nearly always water at its densest (4°C) for liquids. Specific gravity varies with temperature and pressure; reference and sample must be compared at the same temperature and pressure or be corrected to a standard reference temperature and pressure. Substances with a specific gravity of 1 are neutrally buoyant in water. Those with specific gravity greater than 1 are denser than water and will, disregarding surface tension effects, sink in it. Those with a specific gravity of less than 1 are less dense than water and will float on it.

Organizations in our Region Involved in Oyster Restoration

Charlotte Harbor Aquatic Preserves
Melynda Brown, Preserve Manager, Melynda.A.Brown@fdep.state.fl.us, (941) 575-5861

Estero Bay Aquatic Preserve
Stephanie Erickson, Stephanie.Erickson@dep.state.fl.us, (239) 530-1001

Florida Gulf Coast University
Joëlle Richard, Assistant Professor of Marine Science, jrichard@fgcu.edu, (239) 745-4413

Lee County
Michael Campbell, Marine Project Manager, mcampbell@leegov.com, (239) 533-8133

Sanibel-Captiva Conservation Foundation Marine Laboratory
Eric Milbrandt, Marine Laboratory Director, emilbran@sccf.org, (239) 395-4617

Sarasota County
John Ryan, Environmental Supervisor, jryan@scgov.net, (941) 650-2159

The Nature Conservancy Florida Chapter
Anne Birch, Marine Conservation Director, abirch@tnc.org, (321) 610-3892

Standard Operating Procedures (SOPs)

Reef Area

Definition: Reef area is the actual area of patches of living and non-living oyster shell within the project footprint. (Baggett et al. 2012)

Reef area monitoring is conducted annually during the fall/winter (October-December) to measure any annual change in reef size following the oyster growing season. The monitoring dates and times will be coordinated by the Volunteer Coordinator; monitoring will occur at low tide to enable ease in identifying reef edges.

Personnel Needs: Observer and Recorder

Equipment Needs: Transect tape, Haglof DME Ultrasound Measuring Device (optional), datasheet, clipboard, pencil and pencil sharpener.

Enter the General Datasheet Information: Site name (e.g. Trabue), date, recorder name, and observer name.

Measuring Reef Area:

1. If using the Haglof DME calibrate the unit on dry land as close to the monitoring time as possible (calibration is dependent on ambient temperature and should be done close to the time that measurements will be taken to ensure greatest accuracy). To calibrate, use the transect tape to measure out 10 meters, place the transponder at one end of the tape and the receiving unit at the other end. With the receiving unit turned on, select the calibrate function on the Haglof DME, the unit is automatically set to calibrate to 10 meters when this function is selected. To test that calibration was accurate use the unit to measure a given distance along the transect tape. Note that the Haglof DME is sensitive to noise, so when taking measurements there should be no talking, walking through the water, boat noise etc.
2. Measure the length on both sides and width on both sides of the reef by positioning one person at a corner of the reef with one end of the transect tape, or with the Haglof DME receiver. A second person will extend the transect tape out the length or width of the reef to the opposite corner, or move to that corner with the Haglof DME transponder.
3. If using a transect tape measure to the nearest 0.5 meter and record on the datasheet next to the correct reef ID, and in the column for the correct position on the reef (e.g upstream, downstream, onshore or offshore – these descriptors may vary by project, dependent of reef location). If using the Haglof DME record the measurement in meters to level of accuracy as provided by the unit.
4. Repeat the process to measure all four sides of each reef.

5. At each reef take notes of any changes in reef shape and size. PVC poles or rebar should already be inserted at each corner of the reef. Use the PVC poles/rebar as reference points to note any changes. Refer to each PVC pole with respect to its position, for example upstream or downstream, and onshore or offshore.
6. Rinse all equipment with tap water following monitoring, leave out to dry completely. The Haglof DME should be wiped down, the batteries removed for storage. If the Haglof DME gets submerged in the field, immediately remove the batteries, rinse with freshwater and place in a container of rice.

Reef Height

Definition: Reef height is a measure of the mean height of the reef above the surrounding substrate (in relation to the substrate immediately adjacent to the reef, not the shoreline). (Baggett et al. 2012)

Reef height monitoring is conducted annually during the fall/winter (October – December) to measure any annual change following the oyster growing season. Monitoring results may indicate increases in height over time as a result of new growth, or a decrease in height over time as a result of loss of living oysters and/or reef materials sinking into the sediment. The monitoring dates and times will be coordinated by the Volunteer Coordinator; monitoring can occur at any tide height.

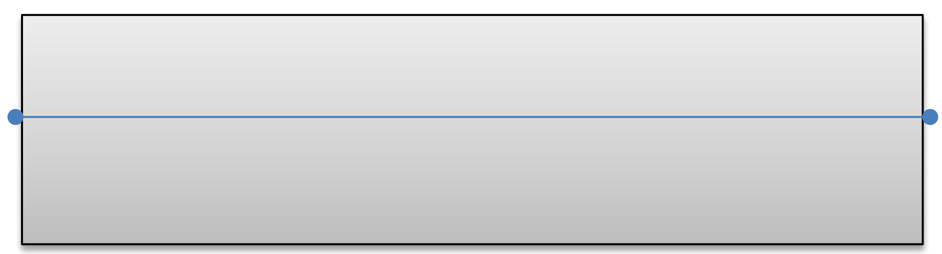
Personnel Needs: Observer, Recorder and two assistants

Equipment Needs: Three one-meter lengths of PVC marked with centimeter measurements, lightweight line, datasheet, clipboard, pencil and pencil sharpener.

Enter the General Datasheet Information: Site name (e.g. Trabue), date, recorder name, observer name, and reef ID for each individual reef.

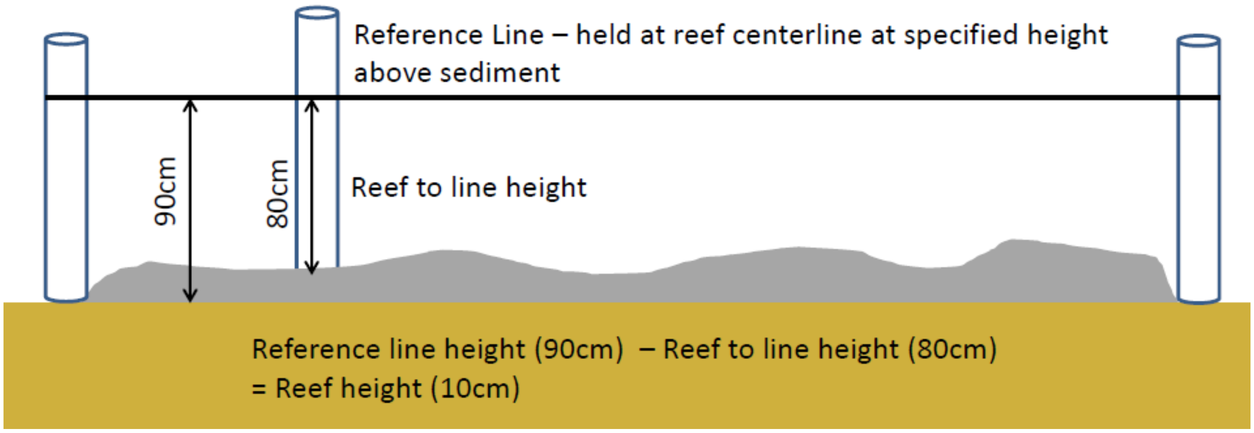
Measuring Reef Height:

1. Each assistant will have a PVC measuring stick. The lightweight line will be tied to one of the measuring sticks, and then will be extended out the length of the reef and wrapped around the other PVC measuring stick. The assistants will then walk the PVC poles to the approximate center of each side of the reef, so that the line extends over the length of the reef along the centerline. In the illustration below the rectangle represents the reef, the blue circles on either side indicate the locations where the assistants will hold the PVC sticks, and the blue line indicates the centerline of the reef where the lightweight string will be extended at a specified height above the sediment.



2. The PVCs are held right at the sediment level, not anchored into the sediment, and the line is placed at the same designated height on both PVCs, for example 90 cm. This provides a reference height above the sediment elevation. To ensure readings are as accurate as possible the line should be pulled and held taut.

3. The observer will begin to take measurements at the upstream end (note the use of the descriptor "upstream" may change dependent on project location) of the reef with the third PVC measuring stick. The first measurement will be identified as location "0" and should measure the distance between the shell at the very edge of the reef and the reference line (the line being held across the centerline of the reef) to the nearest centimeter. Subtracting the "reef to line height" from the "reference line height" provides a reef height estimate for each station along the centerline of the reef.



4. At each meter along the reef the observer will continue to take measurements of the distance between the reef and reference line. The observer and data recorder should check to make sure that the line is remaining tight across the reef. The PVC measuring stick can be used to measure the one-meter sampling increments.
5. A final measurement should be taken at the far edge of the reef and labeled as "Edge".
6. The recorder will record all measurements to the nearest centimeter.
7. Rinse all equipment with tap water following monitoring, leave out to dry completely.

Live Oyster Density, Size Frequency, and Shell Volume

Definitions: Live oyster density is the number of live oysters, including recruits, per square meter. Recruits are live oysters that have settled on the substrate and have grown to 10mm or greater. Spat are live oysters that have settled on the substrate, but are less than 10mm in size and therefore susceptible to higher mortality, spat density is considered separate from live oyster density.

Size frequency distribution is a measure of how the oyster population is distributed across various size classes and provides information about oyster growth and the survivorship and mortality of cohorts (groups of oysters around the same size/age). (Baggett et al. 2012)

Shell volume is a measure of the amount of all reef material sampled, this includes both live and dead shell and provides a metric for comparing samples of different sizes and material types.

Live oyster density, size frequency, and shell volume are measured either annually or bi-annually (twice annually) during the fall/winter monitoring (October – December) to capture the growing season, and during the spring monitoring (optional; April-May) to capture survival and growth over winter. The monitoring dates and times will be coordinated by the Volunteer Coordinator.

When preparing to conduct live oyster density, size frequency, and shell volume monitoring it is important to know which reef types will be monitored (e.g. mat reefs, bag reefs, or loose shell reefs) as the personnel and equipment needs and protocols vary slightly in consideration of different material types, as described below.

Personnel Needs (per team): Recorder and 1-3 Observers; mat samples are done with 1 observer, bag and loose shell samples can be done with up to 3 Observers.

Equipment Needs (numbered items are per team): Table (if possible use a table that adjusts to standing height), chairs (1 per person, volunteers can be asked to supply their own), 2 sorting bins, 1-3 oyster knives, 1-3 calipers or rulers, 4 5-gallon buckets (2 with volume measurements on the outside – a bin for measuring volume will be needed for mats), magnifying glass, Kevlar and lightweight gloves, large zip ties (for mats and bags), scissors/tin snips (for mats and bags), flagging tape, survey flags, sharpies, mask and snorkel, datasheets, clipboards, pencils, pencil sharpener, and mesh bag material. In addition, a bucket of freshwater with soap can be prepared to allow for rinsing hands. A first aid kit should also be on hand.

Enter the General Datasheet Information: Site name (e.g. Trabue), date, recorder name, and observer names.

Preparing the work area:

1. Set up a work space with a table, chairs, sorting bins, oyster knives, two buckets of water for rinsing shells (only one needed for mat samples), two partially full buckets of water for measuring shell volume (a bin will be used for mat samples). For bag and loose shell samples indicate on the datasheet the starting level of water in each bucket.

2. Work in teams of 2-4 for loose shell and bagged shell, with 1-3 sorter/measurers and 1 data recorder. Work in teams of 2 for mats, 1 sorter/measurer and 1 data recorder.
3. Wear gloves anytime you are working with the shell material, there will likely be sharp edges on the oysters and encrusting barnacles. Cuts from oysters and barnacles can easily become infected so use caution when working with these materials.

Collect samples from the reef:

1. The Volunteer Coordinator will provide project specific direction on sample collection from the reefs. Locations from which samples are taken should be marked with a survey flag that includes a unique sample ID, so that the sample can be placed back in the location from which it was removed.
2. Before going out to the reef, mark a piece of flagging tape with the reef ID and sample ID for each sample being collected.
3. Take a sorting bin (1 per sample), marked flagging tape, tin snips (if collecting mats), gloves, mask and snorkel (dependent on water height), and quadrat (if collecting loose shell or shell from bag reefs where individual bags are not identifiable).
4. Wear gloves while pulling samples. Use tin snips to cut and remove any zip ties that are anchoring mats or other materials down.
5. If invertebrate samples are not being collected as part of the monitoring program, thoroughly rinse the samples while in the water, being careful not to lose any loose shell material.
6. Place the survey flag at the corner of the "plot" being monitored, make sure the matching marked flagging tape is placed in the sorting bin.
7. Place sample material into a sorting bin with the appropriately marked flagging tape, make sure flagging tape marker stays with the sample at all times.
8. Float or carry the sample back to land for sorting (generally the sorting bins will float, but some samples may be too heavy for the bins, a kayak or small boat can also be used to aid in sample collection).

Measuring Live Oyster Density, Size Frequency, and Shell Volume:

1. **Mats** – one person will work on the mat sample along with a data recorder either at the table or with a sorting bin. Flagging tape can be used to section off certain areas of the mat to indicate areas that have been sorted/measured. For these samples identify the number of bridges per mat. Bridges are where original recycled shells (zip tied to the mats) have been connected to each other by new oyster growth. The picture below shows an oyster mat where new oyster growth has resulted in bridging between the original recycled shell. If necessary, use oyster knives to separate oysters in order to count and measure all live oysters.

Photo Credit: Jaime Boswell, Trabue Harborwalk Monitoring 2016

2. **Bag shell -** first empty shells out of the bag into the sorting bin, cutting bags open with scissors.
3. **Bag shell and loose shell -** Spread the shell out in the bin, and place the bin between two people. To eliminate bias in sampling, start sorting the shells closest to the end of the bin and work towards the center.
4. Carefully sort through all shell material, checking all shell surfaces for small oysters. A magnifying glass can be used to examine more closely. If the sample is not sufficiently clean, scrub the shells using scrub brushes and bucket of water to clean surfaces. Samples from older reefs will require the use of oyster knives to separate larger oysters from each other. While working with the shell, be careful to not damage the living oysters. Small oysters will often be found growing in between larger shells.
5. While sorting, identify all live oysters, measuring shell height of up to 84 live oysters per sample, then counting all additional live oysters. Dependent on the number of people working on the sample, those sorting can also measure, or any shells with live oysters can be placed into a separate bin for others to measure. All loose and bagged shell that has been sorted can be placed in the pre-measured volumetric buckets.
6. Use calipers or rulers to measure shell height from the umbo (the narrow hinge end of the oyster) to the furthest edge away from the umbo, known as the distal margin. Read the measurement to the nearest millimeter (mm) to the data recorder. Any live oysters with a shell height of less than 10 mm can be counted and recorded separately as spat.

Photo Credit: Jaime Boswell,
Trabue Harborwalk Monitoring 2016

7. The data recorder will record all shell height measurements in whole numbers. For those oysters less than 10mm, the number identified will be tracked in the spat count box on the datasheet. Always be sure the communication between the data recorder and the sorters is clear.
8. If/when 84 measurements are recorded for one sample, the data recorder will let the sorters know to start simply counting all live oysters. Sorters can count and report numbers to the recorder in small increments. For each number reported the recorder will write the numbers in the Live Oyster Counts box (e.g. +5 +10 + 20). Counts for oysters larger than 10mm should be kept separate from those smaller than 10mm (spat).
9. When all shell material has been sorted and all live oysters have been counted, the shell volume will be estimated.
   9a. Bag shell and loose shell: make sure all shell material is in the pre-filled bucket, and then estimate the water level to the nearest 0.25 liter. Record the no-shell water volume, record the with shell water volume, then subtract the no-shell volume from the with shell volume for the total shell volume estimate. For large samples, two buckets can be used, add the shell volume together from the two buckets for total shell volume.
   9b. For mat samples: Shell volume is more easily measured in a rectangular bin. The bin should have a hole near the top with a spout to allow water to easily flow out. The bin will be filled with water up to the spout, allow some water to flow out, when water flow stops place a volumetric bucket under the spout. Then place the mat sample into the bin, capture and measure all water that is displaced and record to the nearest 0.25 L the shell volume.

Photo Credit: Maran Hilgendorf, Measuring Mat Shell Volume 2016

10. Fill in the total live oyster count, if there were 84 or less live oysters the total count will be the same as the number measured. If there were more than 84 live oysters add the number measured plus all counts and fill in the Total Live Oysters box. Spat numbers are not included here.
11. Preparing samples to return back to reefs:
    Loose shell and mats – Place all materials back into a bin, along with the sample ID tag, for transport back to the reefs.
    Bag shell – Transfer the contents of the bucket into a new mesh bag, sealing both ends by tying a knot in the material, then trim off any excess. Place the new bag into a bin with the sample ID tag. When bag reefs have developed to the point where individual bags are not identifiable, materials may be placed directly back onto the reef without re-bagging.
12. Return the samples to the reef into the same location that they were removed from, remove the marker survey flag, and reattach mats with zip ties to donut weights.
13. Repeat until all samples have been processed.
14. Rinse all equipment with tap water following monitoring, leave out to dry completely.

Water Quality

Two water quality parameters that influence the success of intertidal oyster habitat restoration projects the most are water temperature and water salinity, the measure of how much salt is in the water. High water temperatures and high salinity levels can lead to increased prevalence of disease and predation. Prolonged low salinity levels can result in oyster mortality. Both factors also influence reproduction.

Monitoring of temperature and salinity is conducted at the designated location(s) (see Site Map; Appendix D) once per week, during the three-day window of Sunday-Tuesday, at a tide stage of greater than 0.5 feet. Monitoring at this tide stage will allow easier collection of water. A volunteer schedule will be established by the Volunteer Coordinator, if changes need to be made, volunteers are encouraged to work together to find a substitute to ensure the water quality monitoring occurs within the three-day window.

Equipment Needs: Small bucket with line, hydrometer, thermometer, datasheet (see Appendix C), clipboard, pencil and pencil sharpener.

Personnel Needs: 1-2 people

Tide Stage:

1. Plan the time of your water quality sampling based on the tide stage. The tide should be sufficiently high enough to allow for easy collection of water, this will vary dependent on the sampling location, but generally a tide of +0.5 feet should be sufficient. Local tide predictions for the Punta Gorda area can be found at http://www.localtides.net/punta-gorda-tide.php.
2. Note on the datasheet the predicted tide elevation, to the nearest half foot, for the time you will sample.
3. Note on the datasheet the predicted tide stage as incoming (when the tide is rising), high slack (when the tide is at its highest), outgoing (when the tide is receding), or low slack (when the tide is at its lowest).

Enter the General Datasheet Information:

1. Site Name
2. Location Name
3. Record the date, time and observer name(s)
4. Observe and provide comment on any extreme weather events, such as prolonged heavy rain, and on any visible changes to the water quality, such as turbidity plumes, change in color (darker or clearer), and algae blooms.

Collect the Water Sample:

1. Rinse the sampling bucket twice with estuary water being sure to discard the water several yards away from the water sample site.
2. In an undisturbed area of the water, lower the bucket into the water on its side to allow water to flow gently into the bucket. This is the water to be sampled.

Measure Salinity:

1. Rinse the hydrometer cylinder with sample water twice and discard.
2. Fill the hydrometer cylinder up to an inch below the top with sample water.
3. Place the thermometer into the cylinder, submerging it completely and holding in place.
4. Place the hydrometer into the cylinder, avoiding touching the thermometer and avoiding getting water on the hydrometer higher than where it naturally falls. You can gently spin the hydrometer to prevent it from clinging to the side.
5. Once the hydrometer settles observe from eye level where the water level falls on the hydrometer scale, do not measure at the top of the meniscus, the reading should be taken where the water level would cross the scale (see Diagram 1, Appendix E). Record the hydrometer reading (specific gravity) on the data sheet, all values start with 1.0 followed by the readings on the scale, for example if the scale reads 05, the specific gravity is 1.0**05**.
6. Use the thermometer to measure the water temperature in the cylinder at the same time as the specific gravity reading. Record the water temperature in the cylinder in °C.
7. Use the salinity table provided (see Appendix E) to calculate the salinity based on the hydrometer (specific gravity) and temperature measurements. Record the salinity in parts per thousand (ppt) on the data sheet.

Clean sampling equipment:

1. Rinse the bucket thoroughly with tap water twice.
2. Rinse the hydrometer, and cylinder twice with tap water, then distilled water. Air dry and store in cool, clean, dry place.

Enter Data: Following the monitoring event, enter all data into the online Water Quality data form, available at www.chnep.wateratlas.usf.edu/oyster-habitat-restoration/. A data form should be submitted for each of the sites monitored. The Volunteer Coordinator will provide a password to allow for data entry. Save datasheets in case the Volunteer Coordinator has any questions regarding the data entered.

Waterbird Utilization

Utilization of the restored reefs by waterbirds is an indicator of a successful reef restoration, and of the availability of food sources on the reefs. Waterbird utilization will be observed at the designated location (see Appendix D & F) at least six times within each of the three birding seasons, as identified by the International Shorebird Survey (ISS) and as outlined in the table below. Monitoring will occur on each monitoring date at the lowest low tide of the day. The monitoring dates and times will be coordinated by the Waterbird Monitoring Volunteer Coordinator; sampling dates will be selected based on when the lowest tide occurs early in the morning. Local tide predictions for the Punta Gorda area can be found at http://www.localtides.net/punta-gorda-tide.php .

Waterbird Survey Observation Schedule.	
Spring Season	**Number of Field Observation Days**
March 15 to April 6	2
April 7 to April 29	2*
April 30 to May 22	2*
Summer/Fall Season	
July 15 to August 15	2
August 16 to September 15	2*
September 16 to October 15	2
Winter Season	
Dec 1 to February 28	2 times per month with 14-day interval

***Include additional observation dates if possible.**

Personnel Needs: Observer and Recorder

Equipment Needs: Binoculars and/or spotting scope, field/bird guide(s), monitoring map, camera, pen/pencil, paper, and clipboard.

Enter the General Datasheet Information: Site name (e.g. Trabue), date, recorder name, and observer names.

Observing Waterbird Utilization:

1. Arrive at the site ready to begin monitoring one-half hour prior to low tide, continue monitoring until one-half hour past low tide.
2. Surveys should only be conducted under environmental conditions that permit identification of waterbirds with good binoculars or spotting scope (generally only up to light rain and moderate winds). If weather does not permit for monitoring, contact the Waterbird Monitoring Volunteer Coordinator to schedule an alternative monitoring date.
3. During the one-hour monitoring window continuously scan the site, recording observations of birds within the 75-yard monitoring area (see Appendix F). Also observe whether each type of reef (loose shell, bagged shell and mat reefs) was exposed during part, all, or none of the monitoring period.

4. Identify all waterbirds to the species level if possible; however, if shorebirds flush or are unidentifiable, record them to the nearest species group (e.g., yellowlegs, dowitchers, sandpipers). If the species is unknown, take notes on any conspicuous field marks such as size, color, shape, bill shape, leg color and length, and behavior.
5. For each observation, whether an individual or a group of individuals of the same species, categorize the waterbird behavior as feeding, roosting, or nesting.
6. For each observation, whether an individual or a group of individuals of the same species, characterize the location of the waterbird(s) (e.g. reef, sand flats, mangroves) and the distance from the reefs, using the monitoring map to estimate distance.

Enter Data: Following the monitoring event, enter all data into the online Waterbird Monitoring data form. Waterbird Form 1 should be filled out once for each monitoring event. Monitoring Form 2 should be filled out for each unique observation. Save datasheets in case the Volunteer Coordinator should have any questions regarding the data entered.

Crown Conch

Crown conchs are a natural, native predator of oysters. When present in high abundance crown conchs may affect reef success, for this reason it is important to monitor the abundance of crown conch. Crown conch monitoring will occur quarterly at low tide, monitoring dates and times will be coordinated by the Volunteer Coordinator.

Photo Credit: Jaime Boswell, Trabue Harborwalk 2016

Personnel Needs: Observer and Recorder

Equipment Needs: Transect tape, 1-meter length of PVC, gloves, mask and snorkel, datasheet, clipboard, pencil and pencil sharpener.

Enter the General Datasheet Information: Site name (e.g. Trabue), date, recorder name, and observer name.

Crown Conch Density per Reef:

1. Being careful not to disturb the area that will be observed, so as not to reduce visibility by stirring up sediment, position the transect tape parallel to the onshore side of the reef, approximately 1.0 meter away from the reef. Use the PVC pole to measure the spacing away from the reef. Measure out one meter from the downstream corner of the reef. The data recorder can then hold the end of the tape as the observer pulls the transect tape out 10 meters and anchors the end 1.0 meter from the reef, measuring the distance with the PVC pole, then using the PVC to anchor second end. The data recorder can then step on the end of the tape, so that the tape lies flat on the bottom.

2. The observer will then walk or swim the transect line, counting all crown conch located between the measuring tape and the reef. At really low tides crown conchs may be visible from the surface, but in most conditions swimming with a mask and snorkel will be necessary. Due to poor visibility it may also be necessary to wear gloves and feel for crown conchs between the tape and the reef. If the observer cannot clearly see the bottom, they should sweep their hands gently across the bottom from side to side for the length of the transect tape, counting all live crown conch encountered. When a shell is encountered it should be picked up to observe if the conch is alive.
3. Next to the appropriate Reef ID, record the number of crown conch observed within the $10m^2$ area.
4. At each reef, note any observations of identifiable reef residents, presence and general abundance of drift algae or attached algae, seagrass adjacent to the reef, and sedimentation on the reef.
5. Repeat at the designated control site, starting from the downstream, onshore corner of the site and moving 10 meters upstream, parallel to the shore.
6. Rinse all equipment with tap water following monitoring, leave out to dry completely.

Enter Data: Following the monitoring event, enter all data into the online Crown Conch data form, available at www.chnep.wateratlas.usf.edu/oyster-habitat-restoration/ . The Volunteer Coordinator will provide a password to allow for data entry. Save datasheets in case the Volunteer Coordinator should have any questions regarding the data entered.

Shoreline Location

Shoreline location monitoring will occur annually during the fall/winter (October – December) to capture any changes that have occurred throughout the year as a result of erosion or accretion. The monitoring dates and times will be coordinated by the Volunteer Coordinator; monitoring will occur at low tide. Monitoring will occur at fixed locations every year such as from the corners of the reefs directly to the shoreline. Shoreline indicators should be described for each project and if possible photographed . At the Trabue Harborwalk pilot project the most waterward red mangrove prop root firmly attached to the sediment (or tree trunk in some cases) was used as the indicator of shoreline location and was marked with a ziptie and flagging tape.

Personnel Needs: Observer and Recorder

Equipment Needs: Transect tape, Haglof DME Ultrasound Measuring Device (optional), camera (optional), datasheet, clipboard, pencil and pencil sharpener, flagging tape and zipties.

Enter the General Datasheet Information: Site name (e.g. Trabue), date, recorder name, and observer name.

Measuring Shoreline Location:

1. If using the Haglof DME calibrate the unit on land and as close to the monitoring time as possible (calibration is dependent on ambient temperature and should be done close to the time that measurements will be taken to ensure greatest accuracy). To calibrate use the transect tape to measure out 10 meters, place the transponder at one end of the tape and the receiving unit at the other end. With the receiving unit turned on, select the calibrate function on the Haglof DME, the unit will automatically calibrate to 10 meters. To test that calibration was accurate use the unit to measure a given distance along the transect tape. Note, the Haglof DME is sensitive to noise when taking measurements there should be no talking, walking through the water, boat noise etc.
2. Go to the first fixed monitoring location, these should be marked by a rebar or PVC pole. The data recorder should hold the Haglof DME receiving unit or the reel end of a transect tape and remain stationary at the fixed site.
3. The observer will walk straight to the shoreline and look for the previously marked shoreline indicator. If the shoreline indicator has not changed, for example at Trabue Harborwalk if the marked vegetation is still the most waterward attached vegetation, then the recorder should write down that there was no change. The observer will freshly mark, using a zip tie and flagging tape, the shoreline indicator.
4. If the observer finds that the shoreline indicator has changed the new indicator should be marked by the observer, and the recorder should note the change.
5. If the observer cannot find the shoreline indicator a new indicator should be identified and marked, and a note should be made that the previous indicator was not found.

6. In all cases a distance will be measured between the indicator and the fixed monitoring location. The distance should be measured in meters using either the Haglof DME or the measuring tape. If the measuring tape is used be sure to pull the tape as tight as possible. If the Haglof DME is used be sure to have the transmitter and the receiver approximately level with each other.
7. The observer will take a picture of the shoreline indicator at each site if photos are requested by the project scientist.
8. Continue the monitoring for all fixed locations.
9. Rinse all equipment with tap water following monitoring, leave out to dry completely. The Haglof DME should be wiped down, the batteries removed for storage. If the Haglof DME gets submerged in the field, immediately remove the batteries, rinse with freshwater and place in a container of rice.
10. Data sheets and picture files should be submitted to the Volunteer Coordinator or the Project Scientist.


Photo Credit: Maran Hilgendorf, Trabue Harborwalk
Shoreline Location Monitoring 2016

Appendix A: Sample Volunteer Recruiting Materials

Interested in being a Citizen Scientist?

Sign up to receive information from the **Charlotte Harbor National Estuary Program** about future Citizen Scientist opportunities, learn how you can help researchers study the natural environment.

Name	E-mail Address	Phone Number

Want to be a Citizen Scientist?

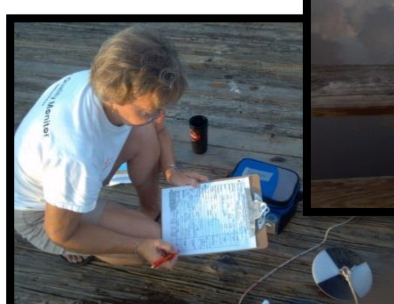
The Charlotte Harbor National Estuary Program (CHNEP) and the Charlotte Harbor Aquatic Preserves (CHAP) value the contribution that Citizen Scientists make in helping to study the local environment and answer scientific questions.

What is a Citizen Scientist?

A scientist is someone that studies the natural and physical world through observation and experiments. Scientists are not only those who make a living studying science, but can also come in the form of people who are passionate about studying the world around them and are willing to give of their free time to assist in the scientific process – these are "Citizen Scientists".

What types of projects can Citizen Scientists do?

- Water Quality Monitoring
- Shoreline Surveys
- Bird Surveys
- Vegetation Surveys
- Oyster Habitat Monitoring



How to become a Citizen Scientist

If you are passionate about the local environment and are interested in hearing about future Citizen Scientist opportunities please provide us with your contact information so we can add you to our contact list. Training and guidance is provided, and all data is used to better manage and conserve the natural environment.

OYSTER HABITAT MONITORING

Citizen Scientists are volunteering to assist in monitoring oyster restoration. The information they collect will help to make oyster restoration a success throughout the Charlotte Harbor estuaries.

For more information about local oyster habitat restoration, visit *www.chnep.wateratlas.usf.edu/oyster-habitat-restoration/*.

Charlotte Harbor National Estuary Program

CHNEP: A partnership to protect the natural environment
from Venice to Bonita Springs to Winter Haven
www.CHNEP.org

WHY RESTORE OYSTER HABITAT?

- Oyster habitat is the most degraded marine habitat world wide.
- An estimated 90% of oyster habitat in the Charlotte Harbor estuaries has been lost; much of the loss was a result of dredging.
- Oyster reefs provide habitat to fish and invertebrates, feeding grounds for birds, help stabilize shorelines, and help with water quality.
- One oyster can filter up to 50 gallons of water per day, imagine what a whole reef can do!

Appendix B: Monitoring Equipment List

Suggested Equipment	Explanation	Metrics
Waterproof Paper	All data sheets should be printer on waterproof paper.	All
Clipboards	1 per team monitoring during the annual and biannual monitoring events.	All
Storage Clipboards	Provide to any volunteers conducting monitoring for tasks outside of the annual and biannual monitoring, include datasheets, pencils, pencil sharpener and protocols. The volunteer coordinator should also have a few for organizing data sheets for the larger monitoring events.	All
Pencils	5 per storage clipboard plus extras for larger moniotring events.	All
Pencil Sharpener	1 per storage clipboard	All
Citizen Scientis Tshirts	1 per volunteer	All
Rectangular Bins	Use for storage of other equipment, and for measuring shell volume of mats	All
WD-40	After sampling use to maintain scissors, tin snips, tables etc.	Live Oyster
5-gallon bucket	3 per team, plus a few extras	Live Oyster
Sorting Trays (medium concrete	1-2 per team, plus a few extras	Live Oyster
Kevlar Gloves	Should be worn by anyone collecting materials off of the reefs, or when breaking up larger oyster clusters etc.	Live Oyster
Lightweight Gloves	Can be worn for sorting and measuring oysters	Live Oyster
Oyster Knives	1-2 per team needed once oysters are large and clustered	Live Oyster
All plastic Vernier Calipers or Scientific Rulers (150mm)	2-3 per team	Live Oyster
Adjustable Height Tables	1 per team - If the location of monitoring allows for use of tables, tables that allow volunteers to choose either a standing or sitting position are optimal	Live Oyster
Cable Ties	Needed if samples will include mats or bags	Live Oyster
Umbrellas/shade tents	Optional dependent on location of site	Live Oyster
Survey Flags	One for each sample to be collected	Live Oyster
Flagging Tape	Used to label all samples collected	Live Oyster
Sharpies	Used to label all samples collected	Live Oyster
Tin Snips	Needed if samples will include mats	Live Oyster
Scissors	Needed if samples will include bags	Live Oyster
Bag Mesh Material	Needed if samples will include bags	Live Oyster
Quadrats (size determined by	Used to collect samples from loose shell reefs	Live Oyster
Haglof DME (optional)	Can optionally be used for more accurate and quicker measurements	Reef Area, Shoreline Location
Metric Measuring Tape	At least 1 needed for measuring distances and for calibrating Haglof DME (if using)	Reef Area, Shoreline Location, Crown Conch
PVC - cut to 1 meter lengths	3 - 1-meter lengths marked with cm increments	Reef Height, Crown Conch
Lightweight String	Length of reefs	Reef Height
Mask and Snorkel	1-2 sets	Crown Conch
Thermometer	1 per water quality monitor	Water Quality
Hydrometer (range 1 - 1.0700 SG) with jar	1 per water quality monitor have replacements available as these break frequently	Water Quality
Small bucket with long line	1 per water quality monitor	Water Quality

Appendix C: Datasheets

Charlotte Harbor National Estuary Program
Volunteer Oyster Habitat Monitoring - Reef Area

Site Name:			Recorder:		
Date:			Observers:		
Reef ID	Reef Length (m ± 0.5m)		Reef Width (m ± 0.5m)		Observations*
	on-shore	off-shore	up-stream	down-stream	
1					
2					
3					
4					
5					
6					
7					
8					
9					

*Please make note of any changes in reef shape and size, use PVC poles marking the reef corners as a reference point.

Charlotte Harbor National Estuary Program
Volunteer Oyster Habitat Monitoring - Reef Height

Page ___ of ___

Site Name:				**Recorder:**			
Date:				**Observers:**			
Reef ID:				**Reef ID:**			
Station (m)	**Line Height (cm)**	**Line to Top of Reef (cm)**	**Reef Height (cm)**	**Station (m)**	**Line Height (cm)**	**Line to Top of Reef (cm)**	**Reef Height (cm)**
0				**0**			
1				**1**			
2				**2**			
3				**3**			
4				**4**			
5				**5**			
6				**6**			
7				**7**			
8				**8**			
9				**9**			
10				**10**			

Charlotte Harbor National Estuary Program

Volunteer Oyster Habitat Monitoring - Live Oyster/Size Frequency - Bags/loose

Site Name:		Recorder:	No-shell Volume: ________L_______L
Date:	Observers:		
Reef ID:	Sample ID:	Total Live Oysters:	With-shell Volume: ________L________L
Live Oyster Counts:			Shell Volume (SV): ________L ________L Total SV: _________L
Spat Count (<10):			

Number	Shell Height (mm)	Number	Shell Height (mm)	Number	Shell Height (mm)	Number	Shell Height (mm)
1		22		43		64	
2		23		44		65	
3		24		45		66	
4		25		46		67	
5		26		47		68	
6		27		48		69	
7		28		49		70	
8		29		50		71	
9		30		51		72	
10		31		52		73	
11		32		53		74	
12		33		54		75	
13		34		55		76	
14		35		56		77	
15		36		57		78	
16		37		58		79	
17		38		59		80	
18		39		60		81	
19		40		61		82	
20		41		62		83	
21		42		63		84	

Charlotte Harbor National Estuary Program
Volunteer Oyster Habitat Monitoring - Live Oyster/Size Frequency - Mats

Site Name:		**Recorder:**	**Shell Volume:** ________L
Date:	**Observers:**		
Reef ID:	**Sample ID:**	**Total Live Oysters:**	**Mat Bridges:**
Live Oyster Counts:			
Spat Count (<10):			

Number	Shell Height (mm)	Number	Shell Height (mm)	Number	Shell Height (mm)	Number	Shell Height (mm)
1		22		43		64	
2		23		44		65	
3		24		45		66	
4		25		46		67	
5		26		47		68	
6		27		48		69	
7		28		49		70	
8		29		50		71	
9		30		51		72	
10		31		52		73	
11		32		53		74	
12		33		54		75	
13		34		55		76	
14		35		56		77	
15		36		57		78	
16		37		58		79	
17		38		59		80	
18		39		60		81	
19		40		61		82	
20		41		62		83	
21		42		63		84	

Charlotte Harbor National Estuary Program
Volunteer Oyster Habitat Monitoring - Water Quality

Site Name: Trabue		**Location Name:** C (MLK) B (Mary) D (Adri.)		
Date: ___/____/___	**Time:** ___:___AM/PM	**Recorder:**		
Temperature: ____°C		**Specific Gravity: 1.0____**	**Salinity: ______ppt**	
Predicted Tide Height: 0.5 ft 1.0 ft 1.5ft 2.0 ft		**Tide Stage:** Incoming, High Slack, Outgoing, Low Slack		
Observations*:				

Date Entered: ____/____/_____

Site Name: Trabue		**Location Name:** C (MLK) B (Mary) D (Adri.)		
Date: ___/____/___	**Time:** ___:___AM/PM	**Recorder:**		
Temperature: ____°C		**Specific Gravity: 1.0____**	**Salinity: ______ppt**	
Predicted Tide Height: 0.5 ft 1.0 ft 1.5ft 2.0 ft		**Tide Stage:** Incoming, High Slack, Outgoing, Low Slack		
Observations*:				

Date Entered: ____/____/_____

Site Name: Trabue		**Location Name:** C (MLK) B (Mary) D (Adri.)		
Date: ___/____/___	**Time:** ___:___AM/PM	**Recorder:**		
Temperature: ____°C		**Specific Gravity: 1.0____**	**Salinity: ______ppt**	
Predicted Tide Height: 0.5 ft 1.0 ft 1.5ft 2.0 ft		**Tide Stage:** Incoming, High Slack, Outgoing, Low Slack		
Observations*:				

Date Entered: ____/____/_____

*Please make note of any visible changes in water quality (e.g. turbidity plume, dark color, algae bloom) or extreme weather conditions.

Charlotte Harbor National Estuary Program
Volunteer Oyster Habitat Monitoring - Crown Conch

Site Name:		Recorder:
Date:		Observers:
Reef ID	**Crown Conch per $10m^2$**	**Observations***
1		
2		
3		
4		
5		
6		
7		
8		
9		
Control		

*Please make note of any other identifiable reef residents, presence and abundance of drift algae or attached algae, seagrass adjacent to the reef, and sedimentation on the reef.

Charlotte Harbor National Estuary Program
Volunteer Oyster Habitat Monitoring - Waterbirds

Site Name: Trabue		**Location Name:** Martin Luther King	
Observers:			
Date: ___/____/___	**Start Time:** ___:___AM/PM	**End Time:** ___:___AM/PM	**Time of Low Tide:** ___:___AM/PM
Predicted Tide Height (ft):			

Relative Waterlevels	Exposed Entire Time	Exposed Part of Time	Not Exposed
Loose Shell Areas			
Bagged Shell Areas			
Mat Areas			

Observations (include notes on weather or other possible sources of bird disturbances)**:**

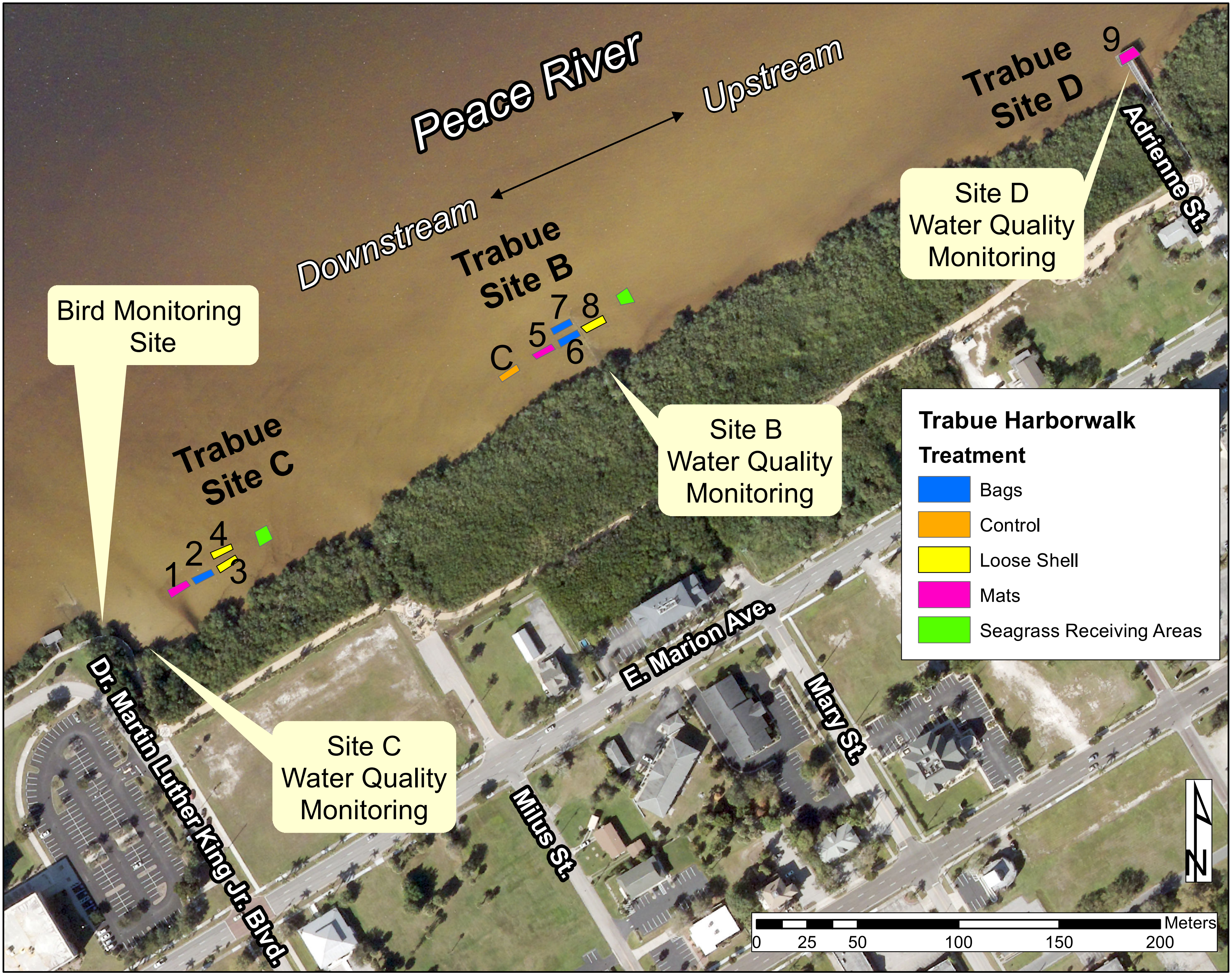
Species	**Count**	**Activity** (circle*)	**Location** (circle*)	**Distance**** (yards)	**Notes**
		F, N, R, O	R, M, S, P, O		
		F, N, R, O	R, M, S, P, O		
		F, N, R, O	R, M, S, P, O		
		F, N, R, O	R, M, S, P, O		
		F, N, R, O	R, M, S, P, O		
		F, N, R, O	R, M, S, P, O		
		F, N, R, O	R, M, S, P, O		
		F, N, R, O	R, M, S, P, O		
		F, N, R, O	R, M, S, P, O		

*F=Feeding, N=Nesting, R=Roosting, O=Other, R=Reef, M=Mangrove, S=Sandflat, P=Posts, O=Other
**Distance from Reef - On Reef, <10 yds, <25 yds, <50 yds, <75 yds

Charlotte Harbor National Estuary Program
Volunteer Oyster Habitat Monitoring - Shoreline Location

Site Name:			Recorder:	
Date:			Observers:	
Location	Compass Heading	Distance to shore (m)	Picture Number	Description of shoreline
C1-Down				
C1-Up				
C2-Down				
C2-Up				
C3-Down				
C3-Up				
CSAV-Down				
CSAV-Up				
Bcont-Down				
Bcont-Up				
B5-Down				
B5-Up				
B6-Down				
B6-Up				
B8-Down				
B8-Up				
BSAV-Down				
BSAV-Up				

Appendix D: Trabue Harborwalk Site Map



Peace River
Upstream
Downstream
Trabue Site D
9
Adrienne St.
Site D Water Quality Monitoring
Trabue Site B
C
5
6
7
8
Bird Monitoring Site
Site B Water Quality Monitoring
Trabue Site C
1
2
3
4
Site C Water Quality Monitoring
Dr. Martin Luther King Jr. Blvd.
E. Marion Ave.
Milus St.
Mary St.
Trabue Harborwalk
Treatment
Bags
Control
Loose Shell
Mats
Seagrass Receiving Areas
N
Meters
0 25 50 100 150 200

Appendix E: Hydrometer Tables

60°/60°F HYDROMETER

instructions

3-0011

60°/60°F Hydrometer

Salinity is the concentration of dissolved salts in water, usually expressed in "parts per thousand" (ppt or 0/00) units (parts of salts per 1000 parts of water). Freshwater contains few salts; drinking water usually has a salinity of less than 0.5 ppt. Seawater salinity averages 35 ppt.

The tables that are widely used to convert hydrometer readings (specific gravity) at any temperature to density at 15°C were designed to be used with a hydrometer calibrated on a 15°C/4°C basis.

Most hydrometers used for salinity measurements are calibrated on a 60°/60°F basis. The calibration basis for a hydrometer is printed on the paper scale inside each hydrometer.

If a 60°/60°F hydrometer is used with conversion tables designed for 15°C/4°C hydrometer, a value is obtained which is 0.001 higher than it should be. When converted to salinity, this error produces a salinity reading that averages 1.3 parts per thousand (ppt) higher than it should be.

The tables included in this manual are designed to be used with a hydrometer calibrated on a 60°/60°F basis. Check the hydrometer you are using and be sure to use the correct conversion table for that type of hydrometer.

Salinity may be calculated by measuring the actual specific gravity (Sp Gr) with a 60°/60°F hydrometer and temperature of the water simultaneously, then finding the corresponding salinity on Table 1.

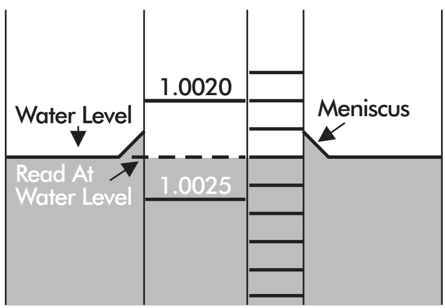
WARNING: contains LEAD. A product in this kit contains a LEAD (Pb) weight. Weights should not be handled by children under 14 without adult supervision.

Procedure

1. Fill a hydrometer jar (3-0024) about ¾ full with water to be tested.
2. Hang the thermometer (3-1066) in the jar so that it is totally submerged.

   NOTE: Make sure that the thermometer does not interfere with the hydrometer—the hydrometer must float freely.
3. Lower the hydrometer (3-0011) carefully into the jar. Allow it to float freely in the jar. Avoid splashing drops onto hydrometer stem above water level.
4. Viewing the thermometer through the clear jar, read and record the temperature.
5. Read the specific gravity from the scale in the hydrometer stem at the point where the scale crosses the surface of the water sample in the jar. Note that the water seems to creep up the glass stem of the hydrometer. The correct reading is obtained at the water level, not at the higher point called the meniscus. See Diagram 1.

Diagram 1
Correctly Reading The Hydrometer



NOTE: Be sure your eye is even with the water level in the hydrometer jar. Viewing down or up at an angle can give an incorrect reading.

6. The specific gravity may be read to the fourth decimal place using the lines printed between the labeled graduations. Use the illustration in diagram 2 to help identify the values on the scale.
7. Use Table 1 to convert the hydrometer reading and temperature to SALINITY in parts per thousand (ppt).

Example:

The observed hydrometer specific gravity (S.G.) reading is 1.0110 and water temperature in the hydrometer jar is 25°C.

Using Table 1, locate the observed reading of 1.0110 in the left-hand column. Move across the chart row horizontally to the 25° column. The number found, 16.9, is the SALINITY in parts per thousand (ppt).

Diagram 2
Reading The Hydrometer Specific Gravity Scale

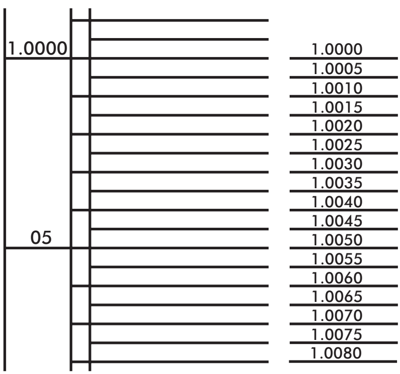


Table 1 · Salinity in parts per thousand (ppt)

Note: For use with 60°/60°F hydrometer

Observed Reading (SpGr)	Temperature of Water (°C)									
	-1.0	0.0	1.0	2.0	3.0	4.0	5.0	6.0	7.0	8.0
1.0000										
1.0010	0.6	0.6	0.5	0.5	0.2	0.2	0.2	0.2	0.2	0.2
1.0020	1.9	1.9	1.8	1.6	1.6	1.6	1.5	1.5	1.6	1.6
1.0030	3.2	3.1	2.9	2.9	2.8	2.8	2.8	2.8	2.8	2.9
1.0040	4.4	4.2	4.2	4.1	4.1	4.1	4.1	4.1	4.1	4.2
1.0050	5.7	5.5	5.4	5.4	5.4	5.3	5.3	5.4	5.4	5.4
1.0060	6.8	6.8	6.7	6.6	6.6	6.6	6.6	6.6	6.7	6.7
1.0070	8.1	8.0	7.9	7.9	7.9	7.9	7.9	7.9	7.9	8.0
1.0080	9.3	9.2	9.2	9.2	9.2	9.2	9.2	9.2	9.2	9.3
1.0090	10.5	10.5	10.4	10.4	10.4	10.4	10.4	10.5	10.5	10.6
1.0100	11.8	11.7	11.7	11.7	11.7	11.7	11.7	11.7	11.8	11.8
1.0110	13.0	13.0	12.8	12.8	12.8	12.8	13.0	13.0	13.0	13.1
1.0120	14.3	14.1	14.1	14.1	14.1	14.1	14.1	14.3	14.3	14.4
1.0130	15.4	15.4	15.4	15.4	15.4	15.4	15.4	15.4	15.6	15.7
1.0140	16.7	16.6	16.6	16.6	16.6	16.6	16.7	16.7	16.9	17.0
1.0150	17.9	17.9	17.9	17.9	17.9	17.9	17.9	18.0	18.0	18.2
1.0160	19.2	19.1	19.1	19.1	19.1	19.2	19.2	19.3	19.3	19.5
1.0170	20.4	20.4	20.4	20.4	20.4	20.4	20.5	20.5	20.6	20.8
1.0180	21.7	21.7	21.6	21.6	21.7	21.7	21.7	21.8	22.0	22.1
1.0190	22.9	22.9	22.9	22.9	22.9	23.0	23.0	23.1	23.3	23.4
1.0200	24.2	24.2	24.0	24.2	24.2	24.2	24.3	24.3	24.4	24.6
1.0210	25.3	25.3	25.3	25.3	25.5	25.5	25.6	25.6	25.7	25.9
1.0220	26.6	26.6	26.6	26.6	26.6	26.8	26.8	26.9	27.0	27.2
1.0230	27.8	27.8	27.8	27.8	27.9	27.9	28.1	28.2	28.3	28.5
1.0240	29.1	29.1	29.1	29.1	29.1	29.4	29.4	29.5	29.5	29.8
1.0250	30.3	30.3	30.3	30.4	30.4	30.6	30.6	30.7	30.8	30.9
1.0260	31.6	31.6	31.6	31.6	31.7	31.7	31.9	32.0	32.1	32.2
1.0270	32.8	32.8	32.9	32.9	32.9	33.0	33.2	33.3	33.4	33.5
1.0280	34.1	34.1	34.1	34.1	34.2	34.5	34.5	34.5	34.7	34.8
1.0290	35.2	35.2	35.4	35.4	335.5	35.6	35.6	35.8	35.9	36.2
1.0300	36.5	36.5	36.5	36.7	36.7	36.9	36.9	37.1	37.2	37.3
1.0310	37.7	37.7	37.8	37.8	38.0	38.1	38.2	38.4	38.5	38.6

Table 1 · Salinity in parts per thousand (ppt)

Note: For use with 60°/60°F hydrometer

Observed Reading (Sp Gr)	Temperature of Water (°C)									
	9.0	10.0	11.0	12.0	13.0	14.0	15.0	16.0	17.0	18.0
1.0000								0.0	0.2	0.3
1.0010	0.5	0.5	0.6	0.6	0.7	0.8	1.0	1.2	1.5	1.6
1.0020	1.6	1.8	1.9	2.0	2.1	2.3	2.4	2.5	2.8	2.9
1.0030	2.9	3.1	3.2	3.3	3.4	3.6	3.7	3.8	4.1	4.2
1.0040	4.2	4.4	4.5	4.6	4.8	4.9	5.0	5.1	5.4	5.5
1.0050	5.5	5.5	5.7	5.8	5.9	6.2	6.3	6.6	6.7	7.0
1.0060	6.8	6.8	7.0	7.1	7.2	7.5	7.6	7.9	8.0	8.3
1.0070	8.1	8.1	8.3	8.4	8.5	8.8	8.9	9.2	9.3	9.6
1.0080	9.3	9.4	9.6	9.7	9.8	10.0	10.2	10.5	10.6	10.9
1.0090	10.6	10.7	10.9	11.0	11.1	11.3	11.5	11.8	11.9	12.2
1.0100	11.9	12.0	12.2	12.3	12.4	12.6	12.8	13.1	13.2	13.5
1.0110	13.2	13.4	13.5	13.6	13.7	13.9	14.1	14.4	14.5	14.8
1.0120	14.5	14.7	14.8	14.9	15.0	15.2	15.4	15.7	15.8	16.1
1.0130	15.8	15.8	16.0	16.2	16.3	16.5	16.7	17.0	17.1	17.4
1.0140	17.0	17.1	17.3	17.5	17.7	17.8	18.0	18.3	18.6	18.7
1.0150	18.3	18.4	18.6	18.8	19.0	19.1	19.3	19.6	19.9	20.0
1.0160	19.6	19.7	19.9	20.1	20.3	20.4	20.6	20.9	21.2	21.3
1.0170	20.9	21.0	21.2	21.3	21.6	21.7	22.0	22.2	22.5	22.7
1.0180	22.2	22.3	22.5	22.6	22.9	23.0	23.3	23.5	23.8	24.0
1.0190	23.5	23.6	23.8	23.9	24.2	24.3	24.6	24.8	25.1	25.3
1.0200	24.7	24.8	25.1	25.2	25.5	25.6	25.9	26.1	26.4	26.6
1.0210	26.0	26.1	26.4	26.5	26.8	26.9	27.2	27.4	27.7	27.9
1.0220	27.3	27.4	27.7	27.8	28.1	28.2	28.5	28.7	29.0	29.2
1.0230	28.6	28.7	28.9	29.1	29.4	29.5	29.8	30.0	30.3	30.6
1.0240	29.9	30.0	30.2	30.4	30.6	30.8	31.1	31.3	31.6	31.9
1.0250	31.1	31.3	31.5	31.7	31.9	32.1	32.4	32.6	32.9	33.2
1.0260	32.4	32.6	32.8	33.0	33.2	33.4	33.7	33.9	34.2	34.5
1.0270	33.7	33.9	34.1	34.3	34.5	34.7	35.0	35.2	35.5	35.8
1.0280	35.0	35.1	35.4	35.6	35.8	36.0	36.3	36.5	36.8	37.1
1.0290	36.3	36.4	36.7	36.8	37.1	37.3	37.6	37.8	38.1	38.4
1.0300	37.6	37.7	38.0	38.1	38.4	38.6	38.9	39.1	39.4	39.7
1.0310	38.9	39.0	39.3	39.4	39.7	39.9	40.2	40.5	40.7	41.0

Table 1 · Salinity in parts per thousand (ppt)

Note: For use with 60°/60°F hydrometer

Observed Reading (Sp Gr)	Temperature of Water (°C)									
	18.5	19.0	19.5	20.0	20.5	21.0	21.5	22.0	22.5	23.0
0.9990							0.0	0.1	0.2	0.3
1.0000	0.5	0.6	0.7	0.8	1.0	1.1	1.2	1.4	1.5	1.6
1.0010	1.8	1.9	2.0	2.1	2.3	2.4	2.5	2.5	2.7	2.8
1.0020	3.1	3.2	3.3	3.4	3.6	3.7	3.8	4.0	4.1	4.2
1.0030	4.4	4.5	4.6	4.8	4.9	5.0	5.1	5.3	5.4	5.5
1.0040	5.7	5.8	5.9	6.1	6.2	6.3	6.4	6.6	6.7	7.0
1.0050	7.1	7.1	7.2	7.4	7.5	7.6	7.7	7.9	8.1	8.3
1.0060	8.4	8.5	8.7	8.8	8.9	9.1	9.2	9.3	9.4	9.6
1.0070	9.7	9.8	10.0	10.1	10.2	10.4	10.5	10.6	10.7	10.9
1.0080	11.0	11.1	11.3	11.4	11.5	11.7	11.8	11.9	12.0	12.2
1.0090	12.3	12.4	12.6	12.7	12.8	13.0	13.1	13.2	13.4	13.6
1.0100	13.6	13.7	13.9	14.0	14.1	14.3	14.4	14.5	14.8	14.9
1.0110	14.9	15.0	15.2	15.3	15.4	15.6	15.7	16.0	16.1	16.2
1.0120	16.2	16.3	16.5	16.6	16.7	17.0	17.1	17.3	17.4	17.5
1.0130	17.5	17.7	17.8	17.9	18.0	18.3	18.4	18.6	18.7	18.8
1.0140	18.8	19.0	19.1	19.3	19.5	19.6	19.7	19.9	20.0	20.1
1.0150	20.1	20.4	20.5	20.6	20.8	20.9	21.0	21.2	21.3	21.6
1.0160	21.4	21.7	21.8	22.0	22.1	22.2	22.3	22.5	22.7	22.9
1.0170	22.9	23.0	23.1	23.3	23.4	23.5	23.6	23.8	24.0	24.2
1.0180	24.2	24.3	24.4	24.6	24.7	24.8	24.9	25.2	25.3	25.5
1.0190	25.5	25.6	25.7	25.9	26.0	26.1	26.4	26.5	26.6	26.8
1.0200	26.8	26.9	27.0	27.2	27.3	27.4	27.7	27.8	27.9	28.2
1.0210	28.1	28.2	28.3	28.5	28.6	28.9	29.0	29.1	29.2	29.5
1.0220	29.4	29.5	29.6	29.8	30.0	30.2	30.3	30.4	30.7	30.8
1.0230	30.7	30.8	30.9	31.2	31.3	31.5	31.6	31.7	32.0	32.1
1.0240	32.0	32.1	32.2	32.5	32.6	32.8	32.9	33.2	33.3	33.4
1.0250	33.3	33.4	33.7	33.8	33.9	34.1	34.2	34.5	34.6	34.7
1.0260	34.6	34.7	35.0	35.1	35.2	35.4	35.6	35.8	35.9	36.0
1.0270	35.9	36.2	36.3	36.4	36.5	36.7	36.9	37.1	37.2	37.5
1.0280	37.2	37.5	37.6	37.7	37.8	38.1	38.2	38.4	38.5	38.8
1.0290	38.6	38.8	38.9	39.0	39.1	39.4	39.5	39.7	39.9	40.1
1.0300	39.9	40.1	40.2	40.3	40.6	40.7	40.8	41.0	41.2	41.4
1.0310	41.2	41.4	41.5	41.8	41.9	42.0	42.1	42.3	42.5	

Table 1 · Salinity in parts per thousand (ppt)

Note: For use with 60°/60°F hydrometer

Observed Reading (Sp Gr)	Temperature of Water (°C)									
	23.5	24.0	24.5	25.0	25.5	26.0	26.5	27.0	27.5	28.0
0.9980							0.1	0.2	0.3	0.6
0.9990	0.5	0.6	0.7	0.8	1.0	1.2	1.4	1.5	1.8	1.9
1.0000	1.8	1.9	2.0	2.1	2.4	2.5	2.7	2.9	3.1	3.2
1.0010	2.9	3.1	3.2	3.4	3.6	3.8	4.0	4.2	4.4	4.5
1.0020	4.4	4.6	4.8	4.9	5.0	5.1	5.4	5.5	5.7	5.9
1.0030	5.8	5.9	6.1	6.2	6.3	6.6	6.7	6.8	7.1	7.2
1.0040	7.1	7.2	7.4	7.5	7.7	7.9	8.0	8.3	8.4	8.5
1.0050	8.4	8.5	8.7	8.9	9.1	9.2	9.3	9.6	9.7	10.0
1.0060	9.7	9.8	10.1	10.2	10.4	10.5	10.7	10.9	11.0	11.3
1.0070	11.0	11.3	11.4	11.5	11.7	11.9	12.0	12.2	12.4	12.6
1.0080	12.4	12.6	12.7	12.8	13.0	13.2	13.4	13.6	13.7	13.9
1.0090	13.7	13.9	14.0	14.1	14.4	14.5	14.7	14.9	15.0	15.3
1.0100	15.0	15.2	15.3	15.6	15.7	15.8	16.1	16.2	16.5	16.6
1.0110	16.3	16.5	16.7	16.9	17.0	17.3	17.4	17.5	17.8	17.9
1.0120	17.7	17.9	18.0	18.2	18.3	18.6	18.7	19.0	19.1	19.3
1.0130	19.1	19.2	19.3	19.5	19.7	19.9	20.0	20.3	20.4	20.6
1.0140	20.4	20.5	20.6	20.9	21.0	21.2	21.4	21.6	21.8	22.0
1.0150	21.7	21.8	22.0	22.2	22.3	22.5	22.7	22.9	23.1	23.3
1.0160	23.0	23.3	23.4	23.5	23.6	23.9	24.0	24.3	24.4	24.7
1.0170	24.3	24.6	24.7	24.8	25.1	25.2	25.3	25.6	25.7	26.0
1.0180	25.6	25.9	26.0	26.1	26.4	26.5	26.8	26.9	27.2	27.3
1.0190	27.0	27.2	27.3	27.6	27.7	27.8	28.1	28.2	28.5	28.6
1.0200	28.3	28.5	28.6	28.9	29.0	29.2	29.4	29.6	29.8	30.0
1.0210	29.6	29.8	30.0	30.2	30.3	30.6	30.7	30.9	31.1	31.3
1.0220	30.9	31.2	31.3	31.5	31.7	31.9	32.0	32.2	32.5	32.6
1.0230	32.2	32.5	32.6	32.8	33.0	33.2	33.4	33.5	33.8	33.9
1.0240	33.7	33.8	33.9	34.2	34.3	34.5	34.7	35.0	35.1	35.4
1.0250	35.0	35.1	35.2	35.5	35.6	35.9	36.0	36.3	36.4	36.7
1.0260	36.3	36.4	36.7	36.8	36.9	37.2	37.3	37.6	37.7	38.0
1.0270	37.6	37.8	38.0	38.1	38.4	38.5	38.8	38.9	39.1	39.3
1.0280	38.9	39.1	39.3	39.4	39.7	39.8	40.1	40.2	40.5	40.7
1.0290	40.2	40.5	40.6	40.8	41.0	41.2	41.4	41.6	41.8	
1.0300	41.6	41.8	41.9							
1.0310										

Table 1. Salinity in parts per thousand (ppt)

Note: For use with 60°/60°F hydrometer.

Observed Reading (Sp Gr)	Temperature of Water in Graduated Cylinder (°C)									
	28.5	29.0	29.5	30.0	30.5	31.5	31.5	32.0	32.5	33.0
0.9980	0.7	0.8	1.1	1.2	1.5	1.6	1.9	2.0	2.3	2.4
0.9990	2.0	2.3	2.4	2.5	2.8	2.9	3.2	3.4	3.6	3.8
1.000	3.4	3.6	3.7	4.0	4.1	4.4	4.5	4.8	4.9	5.1
1.0010	4.8	4.9	5.1	5.1	5.4	5.5	5.8	5.9	6.2	6.4
1.0020	6.1	6.3	6.4	6.6	6.8	7.0	7.2	7.5	7.6	7.9
1.0030	7.4	7.6	7.7	8.0	8.1	8.4	8.5	8.8	9.1	9.2
1.0040	8.8	8.9	9.2	9.3	9.6	9.7	10.0	10.1	10.4	10.5
1.0050	10.1	10.2	10.5	10.6	10.9	11.0	11.3	11.5	11.7	11.9
1.0060	11.4	11.7	11.8	12.0	12.2	12.4	12.6	12.8	13.1	13.2
1.0070	12.8	13.0	13.1	13.4	13.6	13.7	14.0	14.1	14.4	14.7
1.0080	14.1	14.3	14.5	14.7	14.9	15.2	15.3	15.6	15.7	16.0
1.0090	15.4	15.7	15.8	16.1	16.2	16.5	16.6	16.9	17.1	17.3
1.0100	16.7	17.0	17.1	17.4	17.5	17.8	18.0	18.2	18.4	18.7
1.0110	18.2	18.3	18.6	18.7	19.0	19.1	19.3	19.6	19.7	20.0
1.0120	19.5	19.6	19.9	20.1	20.3	20.5	20.6	20.9	21.2	21.3
1.0130	20.8	21.0	21.2	21.4	21.6	21.8	22.1	22.2	22.5	22.7
1.0140	22.2	22.3	22.6	22.7	23.0	23.1	23.4	23.6	23.8	24.0
1.0150	23.5	23.6	23.9	24.0	24.3	24.6	24.7	24.9	25.2	25.3
1.0160	24.8	25.1	25.2	25.5	25.6	25.9	26.1	26.3	26.5	26.8
1.0170	26.1	26.4	26.5	26.8	27.0	27.2	27.4	27.7	27.8	28.1
1.0180	27.6	27.7	27.9	28.1	28.3	28.5	28.7	29.0	29.2	29.4
1.0190	28.9	29.0	29.2	29.5	29.6	29.9	30.0	30.3	30.6	30.8
1.0200	30.2	30.4	30.6	30.8	30.9	31.20	31.5	31.6	31.9	32.1
1.0210	31.5	31.7	32.0	32.1	32.4	32.5	32.8	33.0	33.3	33.4
1.0220	32.9	33.0	33.3	33.4	33.7	33.9	34.1	34.3	34.6	34.8
1.0230	34.2	34.5	34.6	34.8	35.0	35.2	35.5	35.6	35.9	36.2
1.0240	35.5	35.8	35.9	36.2	36.4	36.5	36.8	37.1	37.2	37.5
1.0250	36.8	37.1	37.2	37.5	37.7	37.8	38.1	38.4	38.6	38.8
1.0260	38.2	38.4	38.6	38.8	39.0	39.3	39.4	39.7	39.9	40.2
1.0270	39.5	39.8	39.9	40.2	40.3	40.6	40.8	41.0	41.2	41.5
1.0280	40.8	41.1	41.2	41.5						

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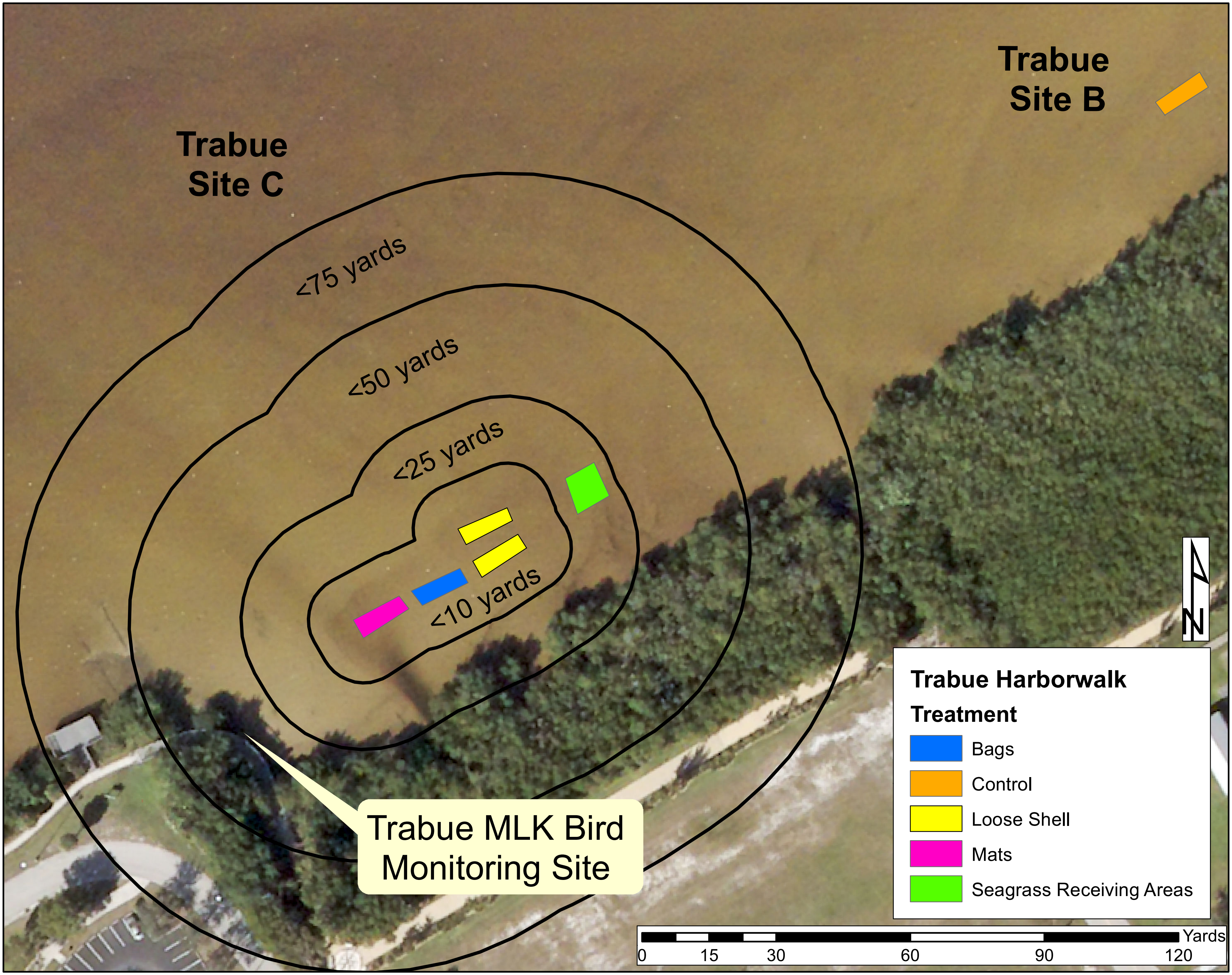
Appendix F: Waterbird Monitoring Map



Trabue
Site B
Trabue
Site C
<75 yards
<50 yards
<25 yards
<10 yards
Trabue MLK Bird
Monitoring Site
N
Trabue Harborwalk
Treatment
Bags
Control
Loose Shell
Mats
Seagrass Receiving Areas
Yards
0
15
30
60
90
120