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Update on Geospatial Data Products and Survey Methodologies Conducted at Little St. George Island, FL

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Report

Update on Geospatial Data Products and Survey Methodologies Conducted at Little St. George Island, FL

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Acknowledgement

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Brief Background, Scope of Project, and Funding

Grant: Regional Geospatial Modeling

Brief description of the project:

The Regional Geospatial Modeling initiative enhances the National Spatial Reference System adjacent to the northern coast of the Gulf of Mexico. This project provides the foundation for geospatial modeling along that part of the nation's coast which provides the largest economic return on investment and which is most exposed to inundation from tropical storm surge. The regions unique low-lying coastal topography shows a high risk of inundation by long-term effects of climate change and subsidence.

Work tasks conducted under Activity 5 below support the data collects at the ANERR/LSGI and provide the opportunity to perform data collections at other areas of interest along the Northern Gulf of Mexico.

Objectives (Activities) as stated in the statement of work for TAMU-CC:

1. To extend Global Navigation Satellite System (GNSS) multi-station height modernization network observations along the northern Gulf of Mexico from Texas to Florida filling in network observations in Louisiana, Mississippi, and Alabama, incorporating tide gauge benchmarks, existing coastal Continuously Operating Reference Stations (CORS), and stable National Geodetic Survey (NGS) vertical control benchmarks.

2. To provide these accurate geodetic 3D positions in the common, National Spatial Reference System that is well connected to the global terrestrial reference frame, and forms a long-term basis for the ongoing monitoring of the relative sea-level change along the northern Gulf of Mexico in the coming decades

3. Expand the number of CORS stations on tide gauges along the northern Gulf of Mexico to assist in accurate 3D positioning and to monitor subsidence rates adjacent to accurate sea level observations.

4. Southern United States Subsidence Mapping will carry out a comprehensive study of vertical motion from archived CORS data along the Gulf of Mexico states. The result will be a detailed map of vertical land motion relative to the ellipsoid measured by existing CORS stations

5. To develop and apply advanced geodetic imaging techniques to monitor surface elevation trends and vegetation cover at existing NERRS Sentinel Sites across the northern Gulf of Mexico and expand coastal topographic mapping capabilities using emergent remote sensing approaches. Current efforts target repeat observations at the Mission-Aransas

NERR and Apalachicola NERR and seek to extend observations to other low-lying coastal locations here regionally and along the northern Gulf Coast.

6. Support education, capacity building, and technology transfer through regional forums and meetings. Workshops will be coordinated with participants from NOAA, NGS, and other National Height Modernization Program (NHMP) partners. Professional development units and/or continuing education credits will be awarded to event participants. Project will also support the presentation of results for the work performed under this project at workshops and/or conferences where possible.

7. Texas Spatial Reference Center (TSRC) investigators will serve as liaisons between geodetic resource consumers and NGS in support of NHMP activities and goals throughout the region. By leveraging the technical leadership and resources provided by the TSRC, investigators can best coordinate and collaborate with local and regional entities to develop a needs assessment and strategic plan for regional implementation of NHMP goals.

Research conducted by this project is supported by federal funds under award NA18NOS400198 from the National Oceanic and Atmospheric Administration, U.S. Department of Commerce through the University of Southern Mississippi.

Methods

In order to establish a baseline to monitor changes at the Apalachicola National Estuarine Research Reserve (ANERR) of Florida, Little Saint George Island (LSGI) and some of the surrounding areas have been surveyed using a variety of geodetic scanning and imaging techniques with high spatial resolution and accuracy to measure elevation and land cover changes. This survey equipment includes a Terrestrial Laser Scanner (TLS), Unmanned Aircraft Systems (UASs) equipped with RGB digital cameras, a UAS equipped with RGB digital camera and a survey-grade lidar sensor, Mobile Lidar Scanning (MLS), and real-time kinematic (RTK) GPS to provide geodetic control. All RTK GPS surveys were set to collect data for the horizontal coordinates in NAD83 (2011) State Plane 0903 Florida North (meters), and the vertical datum was set to NAVD88 (meters). This equipment and the procedures to generate the deliverables used to monitor changes are discussed in the sections below.

TLS

The Riegl VZ 400 TLS is an active sensor that emits near-infrared laser pulses at a pulse repetition rate (PRR) of 300kHz while recording the angle of incidence, angle of return (the laser pulse rebounds when it encounters solid objects), and two way travel time of each pulse to compute the location of a point within the scene and quickly generate a high spatial resolution 3D point cloud of a scene (most study sites are ~10,000 m^2 and have point densities of ~100 points/m^2 or average point spacings of 3 cm throughout the scene). When paired with an RTK

GPS survey, these points are generally within ±1-4 cm of their true horizontal and vertical positions on earth. Absolute accuracy of TLS derived GIS products will depend highly on the quality of the RTK survey used to georeference the TLS data and post-processing methods.

The TLS survey technique employed is known as free stationing (sometimes referred to as resection). This technique relies on determining the precise locations of several points (referred to as targets or tie points) distributed uniformly throughout the study area surveyed to high accuracy using RTK GPS. The targets used are 10 cm cylindrical reflectors affixed to a level tribrach atop a tripod (see Figure 1a). The TLS is also affixed to a leveled tribrach atop a tripod and, depending on the occlusion provided by the objects in the scene (see Figure 1c), the scanner may be moved to several different scan positions throughout the scene to thoroughly capture all aspects of the study area because objects not facing the TLS will not be reached by the laser pulses. Typically, the scanner is set to “high speed” mode with stepping angles of 0.02 degrees in both the horizontal (φ) and vertical (θ) directions. The TLS horizontal range is a full 360-degree field of view as it rotates, and the vertical range is 60 degrees above the horizon and 40 degrees below the horizon as the internal mirror oscillates (see Figure 1b). Once the scan is complete, the targets/tie points in the scene are labeled and fine scanned to be used for merging the of the scan positions later. Once all of the scans are complete (the scene may require multiple scan positions as mentioned above), all the targets are surveyed using an RTK GPS to be used for georeferencing later.

In the lab, the TLS 3D point clouds are merged and georeferenced in RiSCAN Pro (software provided by the scanner manufacturer) and targets and other transient objects are manually removed from the scene. If the clouds are going to be used to generate a raster surface, the clouds are typically octree filtered to a uniform point spacing of 2 cm before they are exported. Once exported as an LAS 1.2 or 1.4 file type, the clouds are assigned projection information and filtered for noise using LAStools point cloud processing software. Then, ArcGIS is used to generate a raster surface with a cell size of 10 cm using inverse distance weighting (IDW) as the interpolation technique for producing the Digital Surface Model (DSM). It is important to mention that the DSMs produced are technically Digital Elevation Models (DEMs) because the raster cell values (z-values) are referenced to a vertical datum, in this case NAVD88. Therefore, the DSM cell values represent elevation of the exposed ground and land cover. Filtering of non-ground points can be applied to the TLS point cloud to try and generate a bare-earth DEM from points classified as ground, similar to what is commonly done with airborne lidar point cloud data. However, occlusion of the ground from vegetation and the oblique viewing perspective of TLS make this more challenging than traditional airborne lidar.

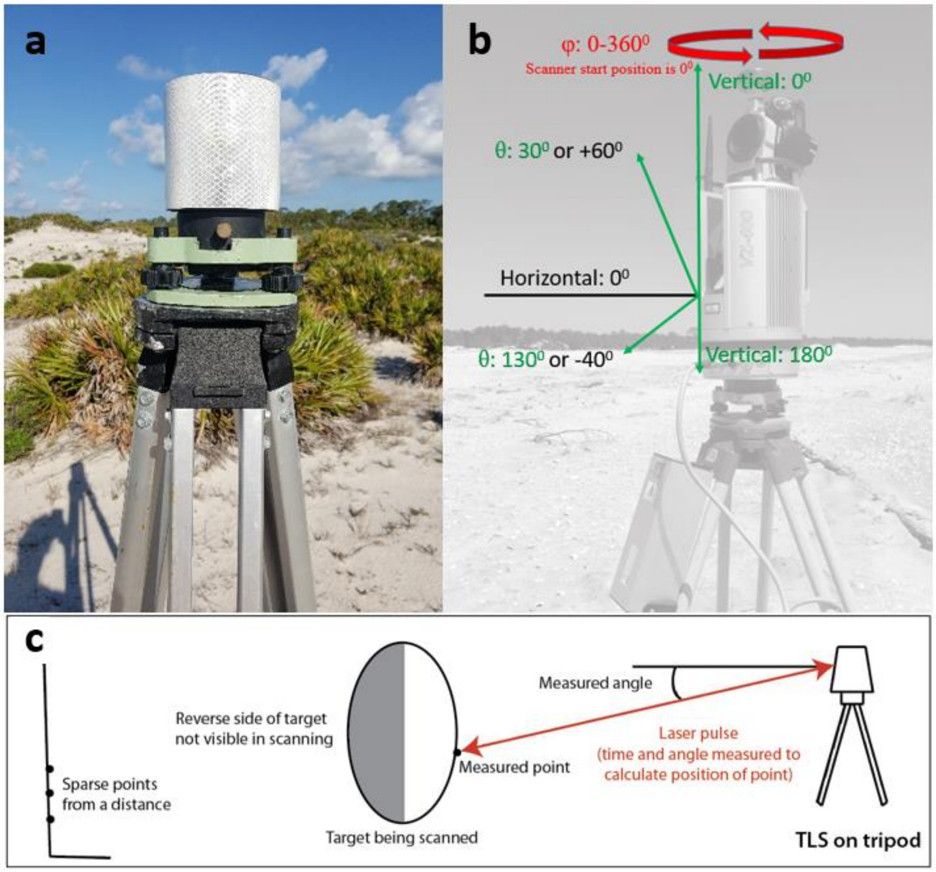


Figure 1: (a) Targets used in a field set up for the TLS, (b) Scan angles obtained by the Riegl VZ 400 TLS, and (c)illustration of occlusion and operation of the TLS.

UAS Photogrammetry

UASs equipped with RGB digital cameras can be used to acquire overlapping imagery to derive 2D and 3D geospatial data through photogrammetric processing. MANTIS Lab and CBI have used a variety of systems over the past 4 years, which include: DJI Phantom 4 Pro, SenseFly eBee Plus, DJI Mavic, and the Wingtra WingtraOne (see Figure 2). The DJI Phantom 4 Pro is a quadcopter equipped with a 20-megapixel camera. The SenseFly eBee Plus is a fixed-wing UAS equipped with a 20-megapixel photogrammetric camera called (S.O.D.A.). The DJI Mavic is a quadcopter with 4K video recording capabilities and is used primarily for videography. The WingtraOne is a tail-sitting vertical take-off and landing (VTOL) UAS. This means that it takes off and lands vertically like a helicopter, but the aerodynamic fixed-wing body allows it to conserve battery life and fly as a fixed-wing system during the survey. The WingtraOne is equipped with a 42-megapixel RGB camera to provide sub-cm image resolution.

Field setup for all the UAS mapping flights includes a pre-flight approval process to ensure all flights are conducted under FAA guidelines and within airspace approved for small UAS operations. 24-48 hours before the flight, a Notice to Airmen (NOTAM) is filed with the

FAA. In the field, ground control targets are laid out uniformly throughout the study site. For beach surveys, targets are laid out at a linear spacing no greater than 300 m of separation although corridor surveys often have much tighter control spacing dependent on the size of the area. Ground control targets are used to improve georeferencing of the derived data products. Next, the UAS is assembled for flight, and, if not already planned, the flight is planned in flight control software such as Ground Station Pro or eMotion by outlining the survey area and setting flight lines to minimize turns made by the UAS. Sidelap and endlap of collected images is adjusted to ensure sufficient overlap for photogrammetric post-processing. A target of 80% sidelap and a minimum of 70% endlap is desired although overlap amounts can vary dependent on platform and geometry of the survey area. Camera shutter speed is typically set to 1/2000 seconds, and the flying height of the UAS above ground level is adjusted to define the image resolution based on sensor frame resolution and focal length. For example, the DJI Phantom 4 Pro flights target a resolution of 1cm/pixel. For VTOL UASs, plywood is placed on the ground to be used as a launch pad. The UAS battery life is monitored and the UAS is returned to the launch point to replace the battery when 30% is reached. Typically, at the conclusion of the survey, all the ground control targets are surveyed in using an RTK GPS on a rover pole set to a height of 2 m. Similarly, for those UAS equipped with onboard differential GPS receivers (Wingtra and eBee Plus), the UAS image geotags are differentially corrected using post-processed kinematics (PPK) to provide high accuracy geolocations. In the latter case, the ground control targets are used as check points to validate reconstruction accuracy.

In the lab, the flight images are imported into either Pix4D or Agisoft PhotoScan, which are commercial photogrammetry software specifically used to process UAS imagery. Photogrammetry is the science of making measurements of objects from photographs, specifically to derive the exact position of a surface point. Input to photogrammetry are image sequences, and common outputs include seamless “orthorectified” image mosaics that have been corrected for distortion to allow accurate planimetric mapping and 3D models of real-world objects or scenes. Traditional airborne photogrammetry utilizes large-format metric cameras precisely calibrated such that their interior properties, like focal length, are accurately known. However, metric cameras are expensive and not conducive for widespread use of small UAS for mapping applications. In contrast, UAS mapping is typically performed with low-cost consumer grade digital cameras using Structure-from-Motion (SfM) photogrammetry. SfM exploits information from multiple overlapping images to extract 3D object information (i.e. create point clouds) and negate the need for precise camera calibration. Similar to airborne lidar, UAS-SfM can be used to perform aerial mapping of topography and land cover. Although each technique has pros and cons, UAS-SfM represents a powerful new alternative to lidar for collecting geospatial data. Dependent on the number and size of images, SfM photogrammetry can be computationally intensive. The main stages of SfM processing are summarized below:

1. Image sequences are input into the software and a feature detection algorithm is used to automatically extract and correspond features (called keypoints) between overlapping images.

2. A technique called a bundle block adjustment is then performed to minimize the errors in the correspondences by simultaneously solving for the camera's position and orientation at the time of each photograph. Based on this reconstruction, the matching points are verified and their 3D coordinates calculated to generate what is termed a "sparse point cloud". At this stage, the ground control points can be ingested into the software to optimize reconstruction and improve georeferencing accuracy.
3. Finally, the interior and exterior orientation for each image are used with a technique called multi-view stereo-photogrammetry to densify the point cloud by projecting every image pixel onto the surface.

The base data product output from UAS-SfM image processing is a densified 3D point cloud of the scene colored by the RGB values of the camera. UAS-SfM point clouds can be considered hyperspatial (easily exceeding 1000 pts/m^2) due to the high camera resolution (e.g. 20 MP+) and typical low altitudes at which data are collected. The 3D point cloud can then be used by the software to interpolate a DSM of the terrain, which can subsequently be used to orthorectify the images and produce a seamless orthomosaic from the image sequence. To summarize, the GIS data products output from a UAS-SfM survey are the following: textured 3D point cloud, DSM, and orthomosaic. 3D textured meshes can also be output. Figure 3 summarizes the UAS-SfM processing workflow, and Figure 4 shows an example of UAS-SfM survey products at LSGI.

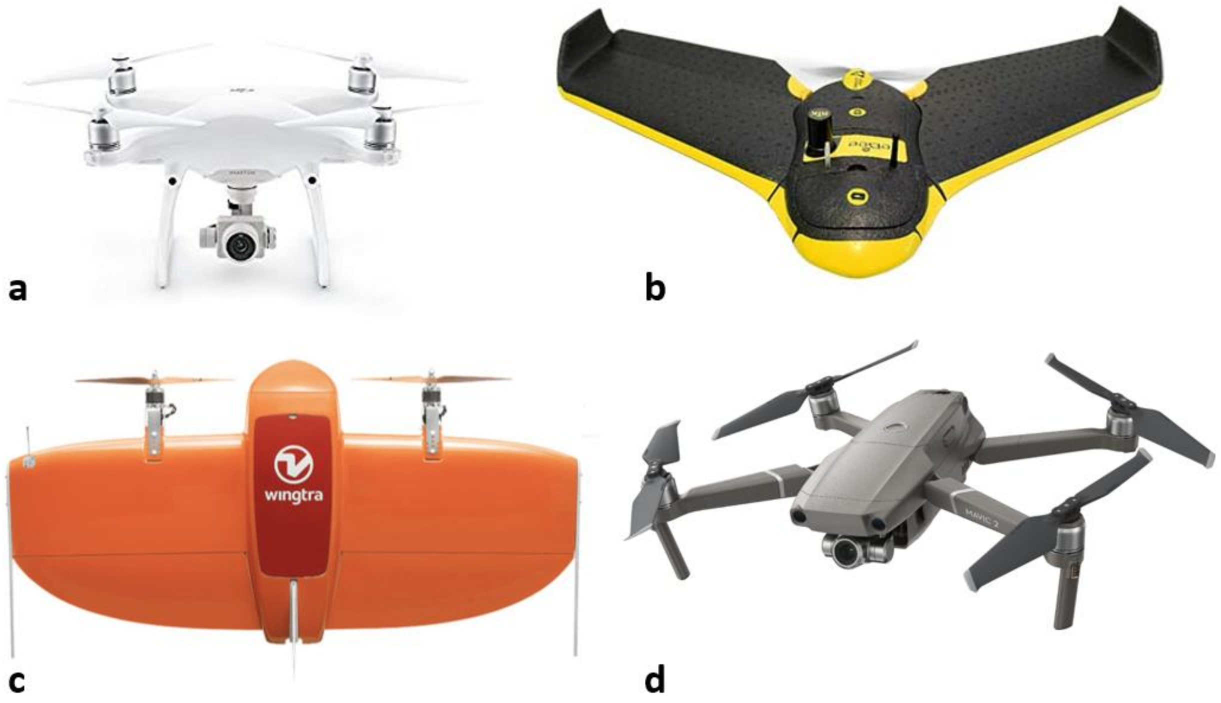


Figure 2: UASs with only RGB digital cameras used to survey LSGI: (a) DJI Phantom 4, (b) SenseFly eBee Plus, (c) Wingtra WingtraOne, and (d) DJI Mavic.

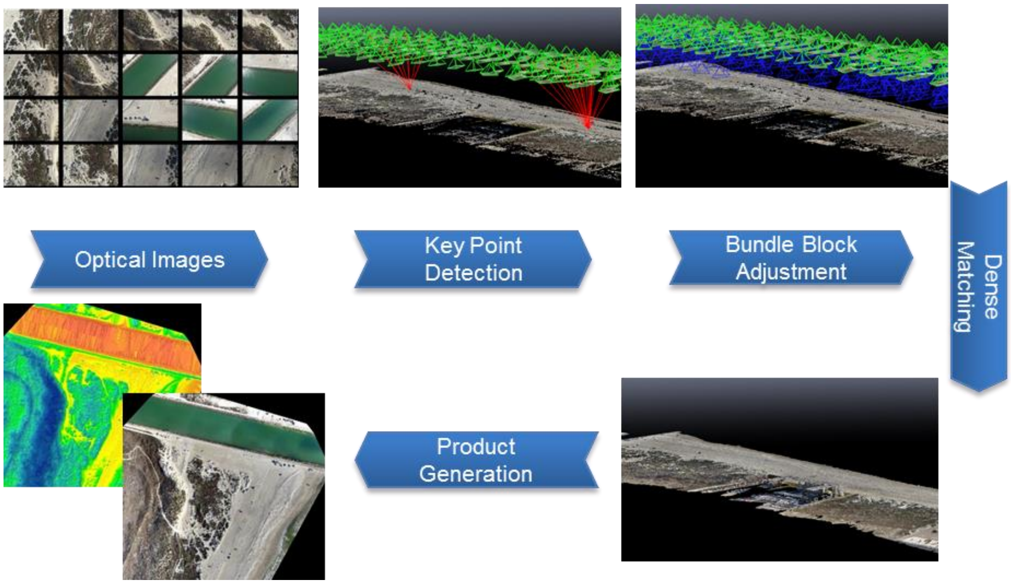


Figure 3: SfM workflow to process UAS image sequences into densified 3D point cloud, DSM, and orthomosaic. Example here is from Packery Channel on North Padre Island, TX.

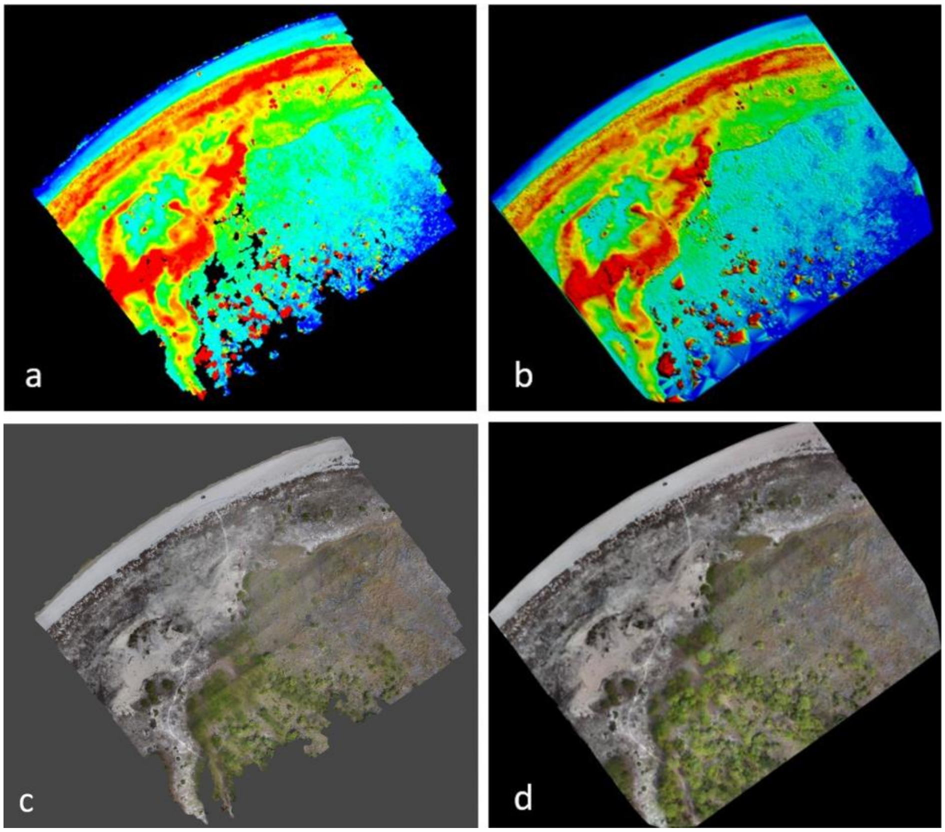


Figure 3: Example of UAS-SfM geospatial data products created for a section of LSGI. (a) false-colored (by height) 3D point cloud, (b) false-colored (by height) DSM, (c) RGB 3D textured mesh, and (d) RGB orthomosaic.

UAS Lidar

Airborne lidar datasets were collected at LSGI as part of the 2019 field campaign using a Vapor 55 single rotary UAS equipped with a Riegl VUX-1LR lidar sensor, Sony A6000 camera, and an integrated navigation system for high accuracy direct georeferencing of the lidar points and imagery (Figures 5-6). The combined weight of the UAS with sensor payload is less than 55 lbs, which is the FAA max weight requirement for small UAS operations. Various software are used for flight planning, flight control, data collection, and data post-processing. The Riegl VUX-1LR sensor provides a maximum range of 1,350 m, a pulse rate of up to 820 kHz taking up to 750,000 measurements a second, and can operate at heights up to 1,740 m AGL. This system also uses online waveform processing to provide multi-echo detection and is capable of recording upwards of 15 returns (echoes) per a transmitted laser pulse. However, recording of multiple returns is highly dependent on the underlying land cover (e.g. forest versus exposed beach). A three-man survey team consisting of a PIC (Pilot in Command), VO (Visual Observer), and SO (Sensor Operator) operates the equipment. Upon arrival to the selected survey sites, the crew assesses the site for risk and obstructions and creates a unique flight plan for the given area based on desired scan line overlap and point density. Flight plans for UAS lidar typically consist of a series of flight maneuvers for sensor calibration, and a series of transects flown at calculated intervals to attain optimal point density on the ground. A GNSS reference station is setup to record GPS and GLONASS observations during flight. The GNSS data is used in post-processing to derive a more accurate aircraft trajectory. The base geospatial data product output from a UAS lidar survey is a multiple-return 3D point cloud of the surveyed environment. From the multiple-return point cloud, DSMs and bare-earth DEMs are produced through accompanying software. Additionally, orthomosaics using imagery collected from the onboard camera can be generated, and the imagery is also used to colorize the lidar point cloud.

Aerial lidar datasets differ in respect to TLS datasets in that they are not as limited in scan angle, providing a more nadir (top-down perspective), which makes these datasets advantageous when it comes to mapping of vegetation and the underlying surface below (e.g. wetlands), mapping narrow edge features, determining canopy heights, biomass estimation, and for penetrating dense vegetation to create bare ground surface models. Similarly, the active scanning and multi-echo detection capabilities of the UAS lidar system are advantages for mapping over dense canopy compared to UAS-SfM photogrammetry, which produces a single-return point cloud. Currently, processing of the UAS lidar data collected during the 2019 field campaign at LGSI is in progress. MANTIS Lab is developing a series of workflows for post-processing and calibration of the data to provide high accuracy 3D point clouds and DSMs/DEMs of the survey sites.

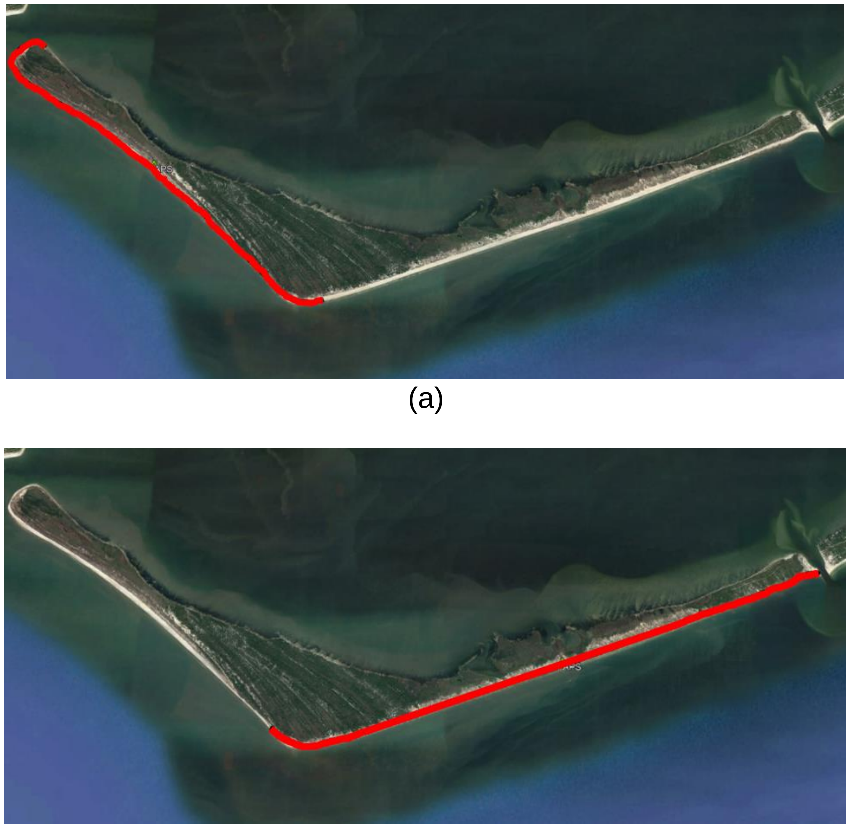
Figure 5: Riegl VUX-1LR lidar sensor and Sony A6000 camera integrated on a Pulse Aerospace Vapor 55 UAS platform. The picture here shows the platform without its cover.

Figure 6: UAS lidar system being operated by the pilot. Location is a wetland study site within the Apalachicola NERR.

Mobile Lidar Scanning (MLS)

During the 2018 field campaign, two mobile lidar surveys of the entire Gulf-facing shoreline at LSGI were conducted as detailed below:

- A 6650 m stretch along the west portion of the beach on Little St. George Island at Apalachicola National Estuarine Research Reserve (NERR), FL, on July 9, 2018 (Figure 7a).
- An 8760 m stretch along the east portion of the beach on Little St. George Island at Apalachicola NERR, FL, on July 10, 2018 (Figure 7b).


(a)

(b)

Figure 7. Google Earth images of the ground truth trajectories of the two mobile lidar surveys conducted at LSGI; (a) in red, the west portion of the beach on LSGI, (b) in red, the east portion of the beach at LSGI.

The mechanisms of mobile lidar scanning are similar to aerial/UAS lidar except the sensor is mounted onto a ground-based vehicle. MLS provides a more oblique scanning perspective of the imaged scene as opposed to a top-down perspective from aerial lidar; similar to TLS. This is beneficial for mapping the sides of structures such as buildings, trees, etc. Along a beach, the oblique scanning perspective is useful for mapping the structure of the foredunes. The surveys conducted at LSGI were performed using a Velodyne HDL-32E lidar sensor integrated with an inertial measurement unit (IMU) and GPS mounted onto an ATV (Figure 8). The Velodyne HDL-32E lidar sensor was originally developed for auto-navigation and robotics applications.

This unit provides a significantly lower-cost solution to traditional mobile lidar sensors with decent measurement performance. It is a 32 channel lidar system that provides dual return capabilities, +/- 2 cm ranging accuracy, 80 m – 100 m effective range, 360 degree horizontal FOV, +10 to -30 degree vertical FOV, and an effective measurement rate up to 1.39 million points per second. The MLS data collected during the 2018 field campaign is being used by a student to examine impacts of Hurricane Michael. Furthermore, mobile lidar data is being explored for its ability to be fused with airborne lidar data and provide a more complete 3D model of an imaged scene.

Figure 8. Example of the mobile lidar scanning system being mounted on an ATV near Packery Channel Jetty, Corpus Christi, TX. A similar setup was used at LSGI during the Summer 2019 field campaign by mounting the sensor on one of the ANERR's ATVs.

Surveys by Year

Little Saint George Island and some of the surrounding areas have been surveyed by CBI field crew and MANTIS lab members since 2016. Since 2016, additional survey sites and survey types have been added and explored. In 2016, only the TLS was used to survey 6 sites. In 2017, both UAS and the TLS were employed to survey 7 sites. In 2018, UAS and TLS were used to survey 8 sites, and mobile lidar was used to survey the beach as described above. In 2019, UAS, TLS, and the Vapor 55 (UAS lidar), were used to survey 9 sites. It should be mentioned that static GPS and RTK GPS data were collected across all survey campaigns.

Table 1: Years and equipment used to perform surveys on LSGI.

Year	Survey Equipment
2016	*Riegl* VZ 400 TLS
2017	*Riegl* VZ 400 TLS *DJI* Phantom 4 *SenseFly* eBee Plus (S.O.D.A.)
2018	*Riegl* VZ 400 TLS *SenseFly* eBee Plus (S.O.D.A.)

2019	*Riegl* VZ 400 TLS *DJI* Phantom 4 *DJI* Mavic *Wingtra* WingtraOne *Pulse Aerospace* Vapor 55

Table 2: Survey equipment and products that can be produced from them.

Survey Equipment	Deliverables
RTK GPS	Georeferenced: Points (typically >100 points)
TLS	Georeferenced: Point Cloud DSM
UAS-SfM	Georeferenced: Orthomosaic Point Cloud 3D Textured Mesh DSM DEM
Vapor 55 (UAS Lidar/camera)	Georeferenced: Orthomosaic Point Cloud DSM DEM

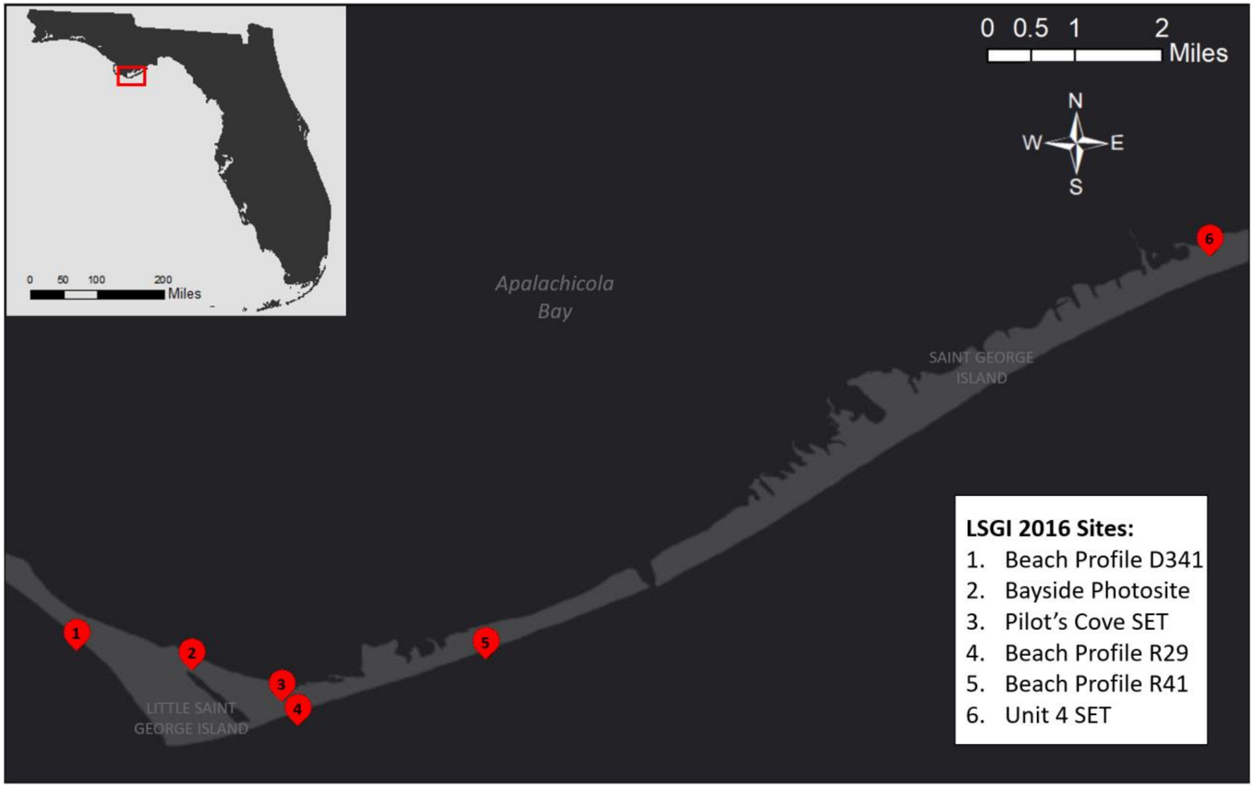
2016 Survey Summary

In 2016, there was only one survey technology utilized excluding RTK GPS. A Riegl VZ 400 Terrestrial Laser Scanner (TLS) was used to gather high-resolution 3D point cloud data for five survey sites on Little Saint George: Bayside Photosite, Beach Profile R29, Pilots Cove SET, Beach Profile R41, and Beach Profile D341. On Saint George Island, the Unit 4 SET was also surveyed.

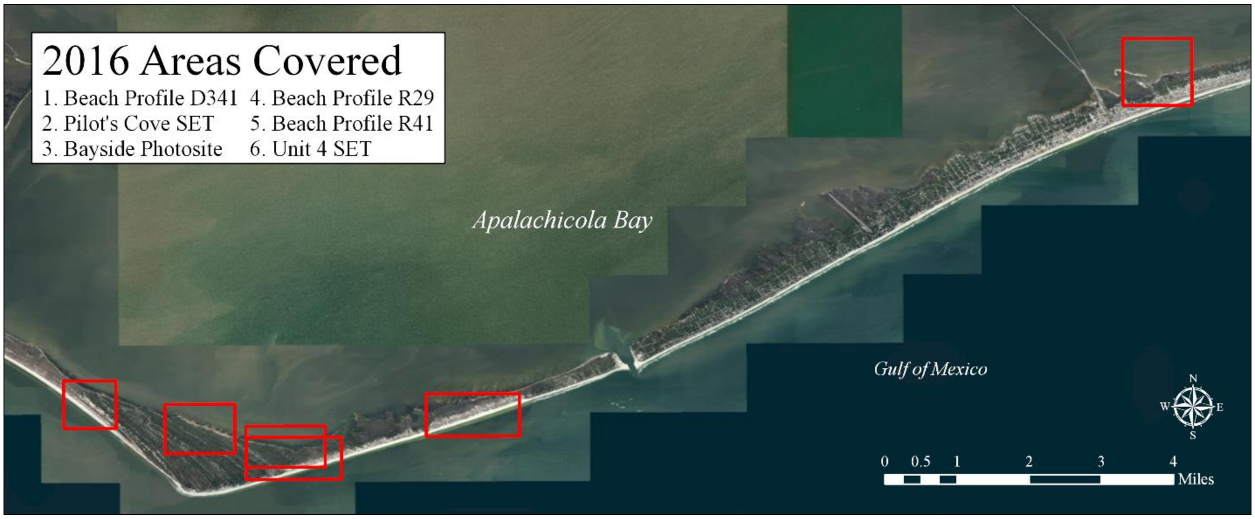
Table 3: Dates, locations, sites, and survey types for surveys performed in 2016.

Survey Date	Location	Site Description	Survey Type
3/15/2016	Little Saint George Island	Bayside Photosite	TLS
3/15/2016	Little Saint George Island	Beach Profile R29	TLS
3/16/2016	Little Saint George Island	Pilot's Cove SET	TLS
3/16/2016	Little Saint George Island	Beach Profile R41	TLS
3/17/2016	Little Saint George Island	Beach Profile D341	TLS
3/18/2016	Saint George Island	Unit 4 SET	TLS

2016 Survey Sites



2016 Areas Covered



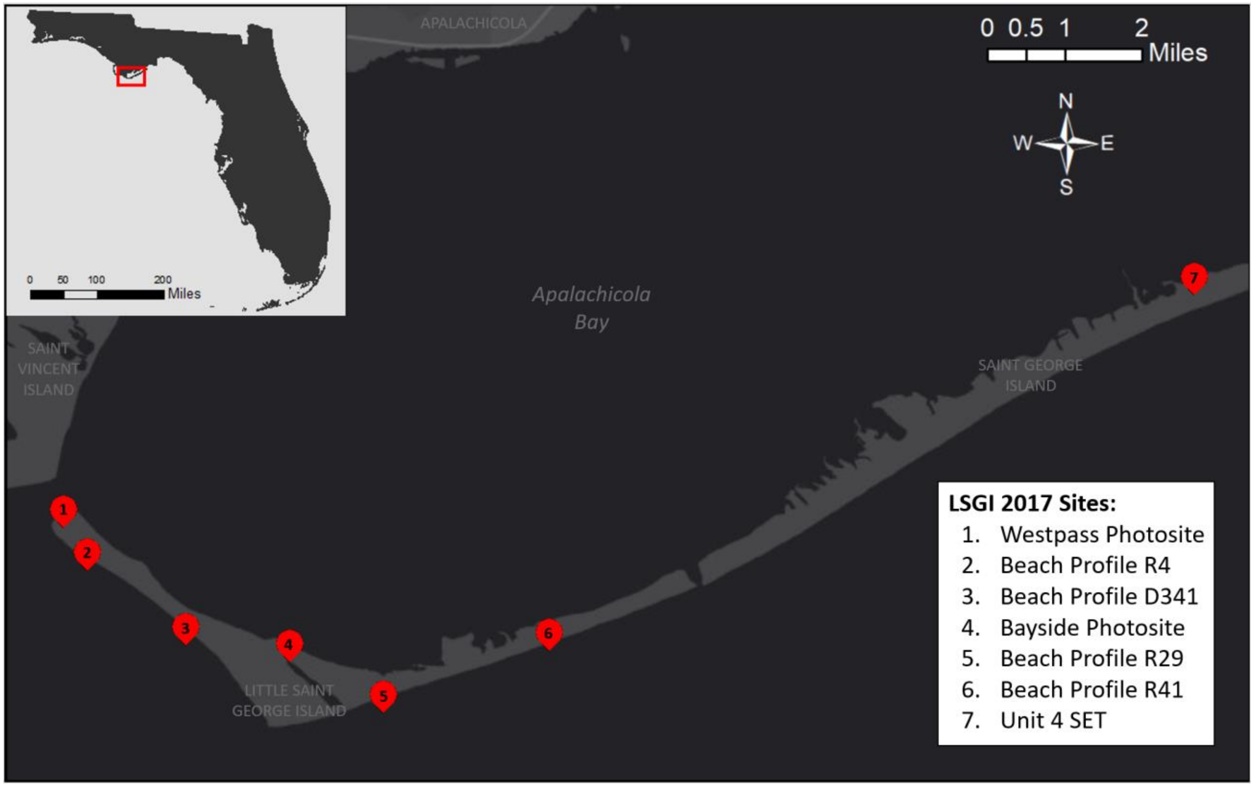
2017 Survey Summary

In 2017, there were two survey technologies employed: Unmanned Aircraft Systems (UAS) photogrammetry and TLS. The UAS platforms used were the DJI Phantom 4 and the SenseFly eBee. The TLS used was the Riegl VZ 400.

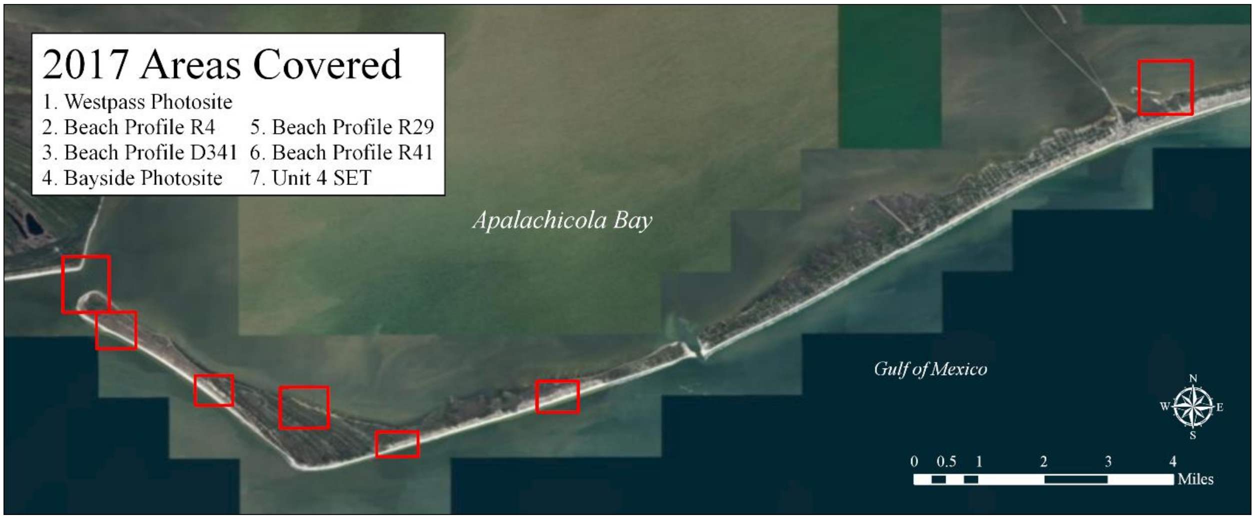
Table 4: Dates, locations, sites, and survey types for surveys performed in 2017.

Survey Date	Location	Site Description	Survey Type
3/20/2017	Little Saint George Island	Bayside Photosite	TLS
3/20/2017	Little Saint George Island	Beach Profile R29	TLS
3/20/2017	Little Saint George Island	Unit 4 SET	UAS
3/21/2017	Little Saint George Island	Beach Profile D341	TLS
3/21/2017	Little Saint George Island	Beach Profile R4	TLS
3/22/2017	Little Saint George Island	Beach Profile R41	TLS
3/22/2017	Little Saint George Island	Westpass Photosite	TLS
3/23/2017	Little Saint George Island	Westpass Photosite	UAS
3/23/2017	Little Saint George Island	Beach	UAS
3/24/2017	Little Saint George Island	Beach	UAS
3/25/2017	Saint George Island	Unit 4 SET	TLS
3/25/2017	Saint George Island	Unit 4 SET	UAS

2017 Survey Sites



2017 Areas Covered



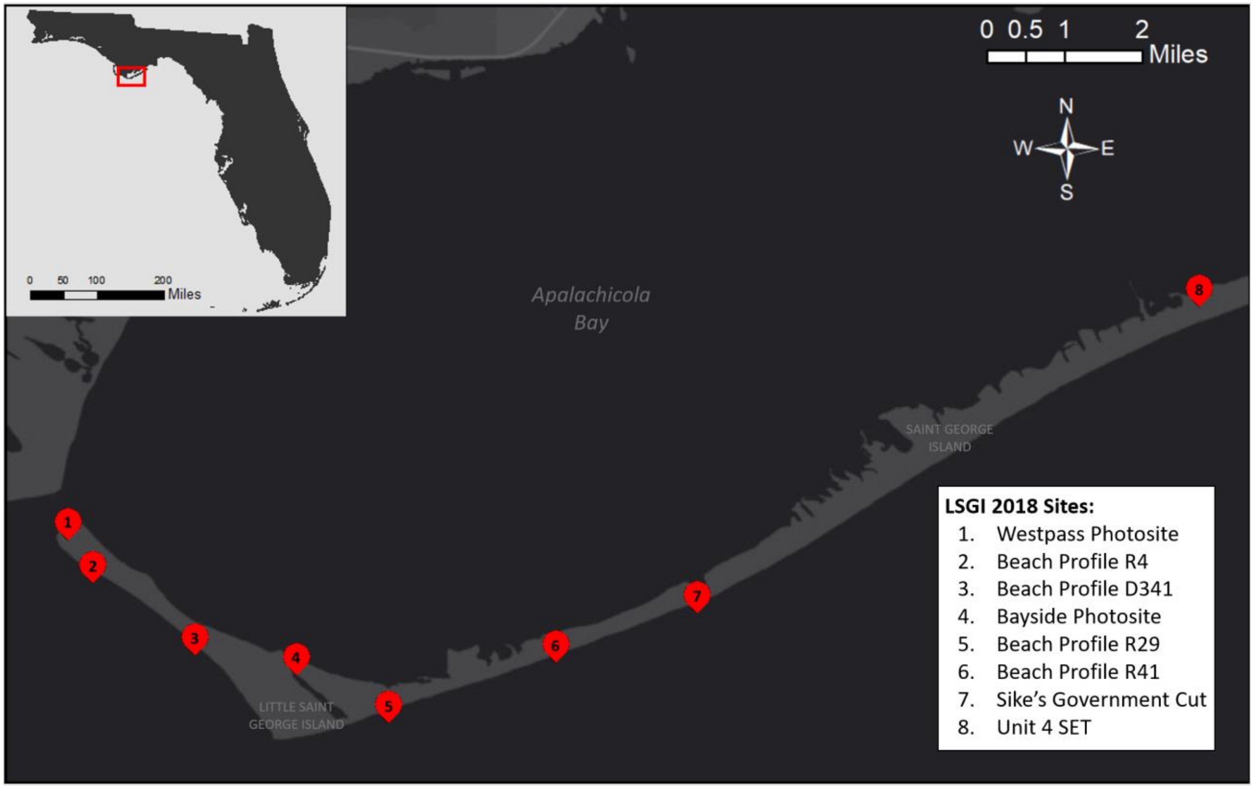
2018 Survey Summary

In 2018, there were three survey technologies employed: UAS photogrammetry, TLS, and Mobile Laser Scanning (MLS). The UAS platform used was the SenseFly eBee Plus. The TLS used was the Riegl VZ 400. The mobile lidar sensor used was the Velodyne HDL-32E.

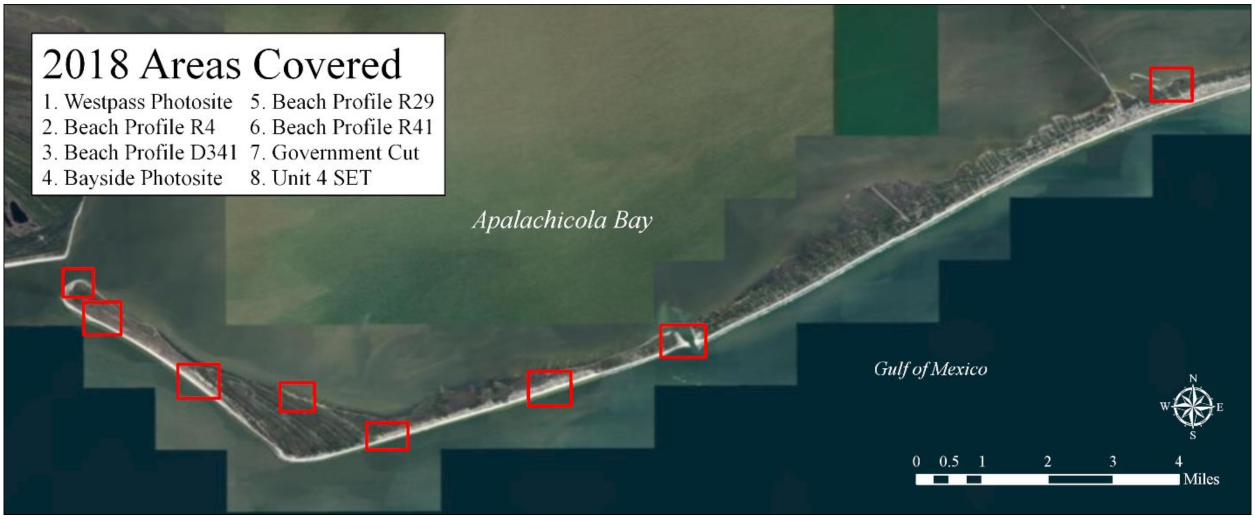
Table 5: Dates, locations, sites, and survey types for surveys performed in 2018.

Survey Date	Location	Site Description	Survey Type
7/9/2018	Little Saint George Island	Beach Profile D341	TLS
7/9/2018	Little Saint George Island	Beach Profile R4	TLS
7/9/2018	Little Saint George Island	West LSGI	UAS
7/9/2018	Little Saint George Island	West Portion of Beach	MLS
7/10/2018	Little Saint George Island	Beach Profile R29	TLS
7/10/2018	Little Saint George Island	Beach Profile R41	TLS
7/10/2018	Little Saint George Island	East LSGI	UAS
7/10/2018	Little Saint George Island	East Portion of Beach	MLS
7/11/2018	Saint George Island	Unit 4 SET	TLS
7/11/2018	Saint George Island	Unit 4 SET	UAS
7/12/2018	Little Saint George Island	Bayside Photosite	TLS
7/12/2018	Little Saint George Island	Westpass Photosite	TLS
7/13/2018	Little Saint George Island	Government Cut	TLS

2018 Survey Sites



2018 Areas Covered



2019 Survey Summary

In 2019, there were three survey technologies employed: UAS photogrammetry, TLS, and airborne lidar (via a UAS). The UAS platforms used were the WingtraOne, the DJI Phantom

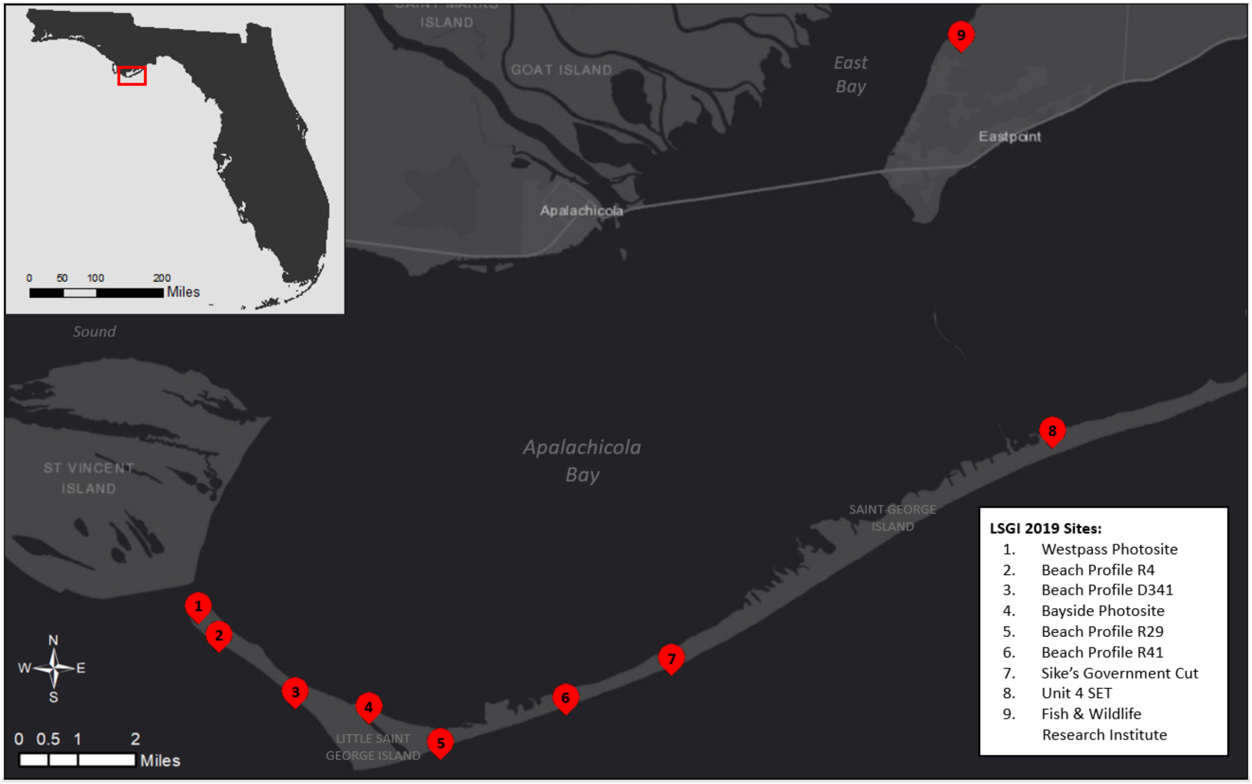
4, and the DJI Mavic. The TLS used was the Riegl VZ 400. The airborne lidar scanner used was a Riegl VUX-1LR integrated onto a Pulse Aerospace Vapor 55 UAS.

Table 6: Dates, locations, sites, and survey types for surveys performed in 2019.

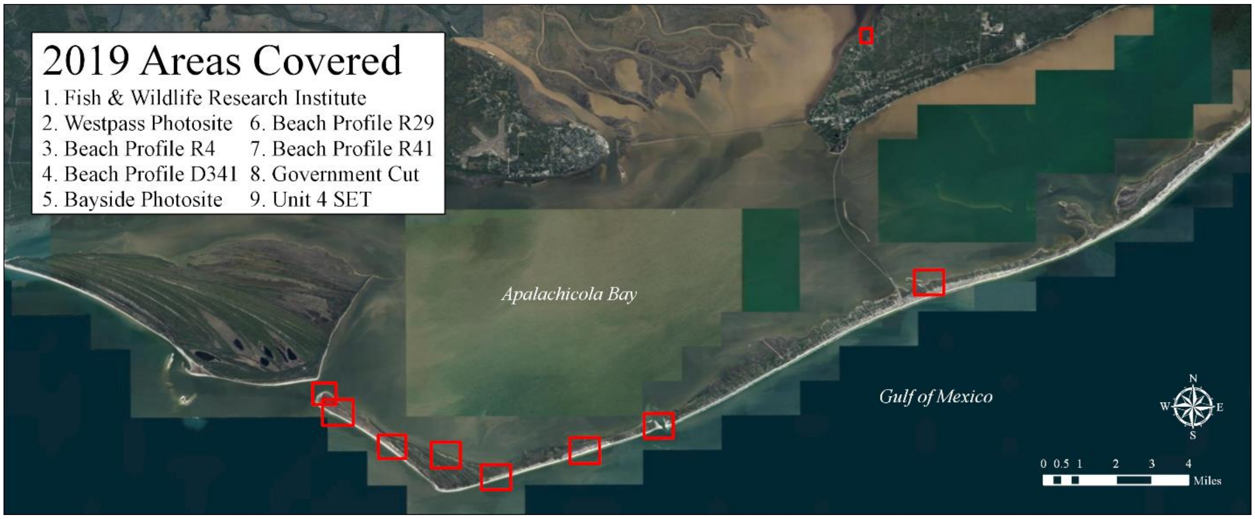
Survey Date	Location	Site Description	Survey Type
5/20/2019	Little Saint George Island	Westpass Photosite to R4 (Gulf side)	UAS
5/20/2019	Little Saint George Island	R4 to D341 (Gulf side)	UAS
5/20/2019	Little Saint George Island	Bayside Photosite (Gulf side)	UAS
5/20/2019	Little Saint George Island	Beach Profile R4	Vapor 55
5/21/2019	Little Saint George Island	Beach Profile D341	TLS
5/21/2019	Little Saint George Island	Beach Profile R4	TLS
5/21/2019	Little Saint George Island	Southern Tip to R29	UAS
5/21/2019	Little Saint George Island	R29-R41 (Gulf side)	UAS
5/21/2019	Little Saint George Island	R41 to Government Cut	UAS
5/21/2019	Little Saint George Island	Beach Profile D341	Vapor 55
5/21/2019	Little Saint George Island	Southern Tip to R29	Vapor 55
5/22/2019	Little Saint George Island	Bayside Photosite	TLS
5/22/2019	Little Saint George Island	Beach Profile R29	TLS
5/22/2019	Little Saint George Island	Beach Profile R41	TLS
5/22/2019	Little Saint George Island	Government Cut	UAS
5/22/2019	Little Saint George Island	Government Cut	UAS
5/22/2019	Little Saint George Island	Westpass Photosite to R4 (Gulf side)	UAS
5/22/2019	Little Saint George Island	Beach Profile R41	Vapor 55
5/22/2019	Little Saint George Island	Pilot's Cove SET	Vapor 55
5/23/2019	Little Saint George Island	Government Cut	TLS
5/23/2019	Little Saint George Island	Westpass Photosite	TLS
5/23/2019	Little Saint George Island	Bayside Photosite	UAS

5/23/2019	Little Saint George Island	R29 to R41 (bayside)	UAS
5/23/2019	Little Saint George Island	Government Cut	Vapor 55
5/23/2019	Little Saint George Island	Government Cut	Vapor 55
5/24/2019	Saint George Island	Unit 4 SET	TLS
5/24/2019	Saint George Island	Unit 4 SET (bayside)	UAS
5/24/2019	Saint George Island	Unit 4 SET (Gulf side)	UAS
5/24/2019	Eastpoint	Fish & Wildlife Research Institute SET	Vapor 55

2019 Survey Sites



2019 Areas Covered

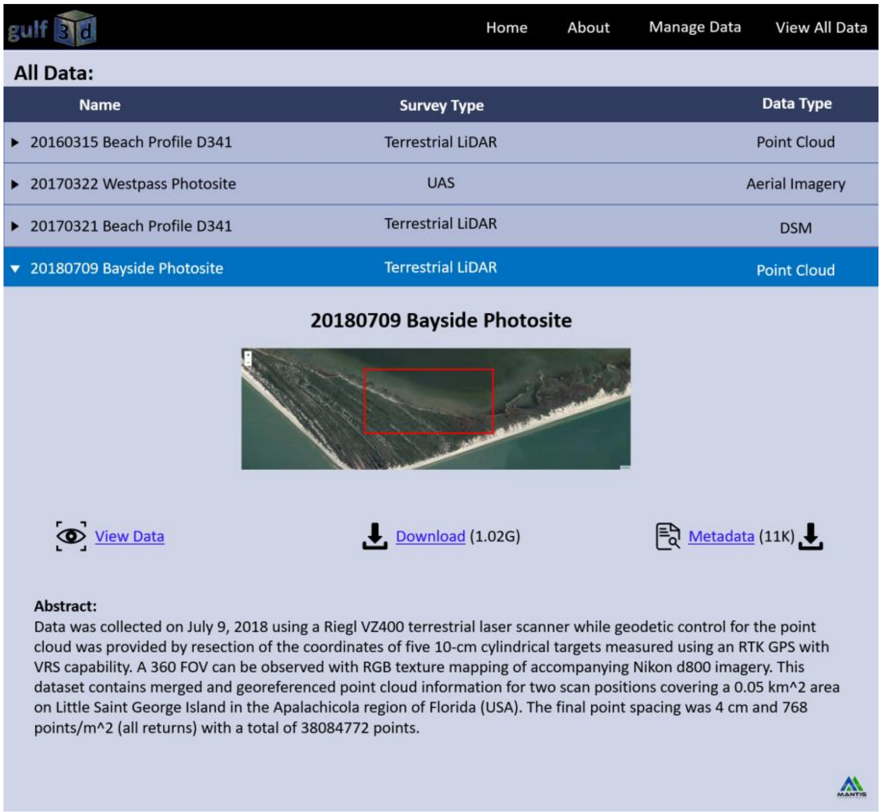


Results

MANTIS Coastal and Marine System Science PhD student, Kelsi Schwind, is using the collected datasets over the past four years as part of her dissertation research, which explores the geomorphological changes at LSGI (Gulf and bayside) . In 2019 she presented *Utilizing a Terrestrial Laser Scanner to Assess the Evolution of an Undeveloped Beach* at the ASBPA Texas Symposium. The presentation explored the changes detected by the TLS using the data collected at the R29, D341, and R41 sites between 2016 and 2017. She has also conducted a project for a class that explores some of the changes at LSGI following Hurricane Michael, *Utilizing UAS Photogrammetry and Airborne LiDAR for Surface Change Detection of an Undeveloped Beach After Hurricane Michael*. This paper compares UAS-SfM topography data collected in July 2018 by MANTIS before Hurricane Michael to U.S. Army Corps of Engineers (USACE) topo-bathymetric lidar data collected in October 2018 after Hurricane Michael. Her assessment examined volumetric changes and erosion to the exposed beach and dunes on the western portion of LSGI by computing differences in DEMs generated from each survey. It is important to mention that analysis of the collected data sets is ongoing, and the aforementioned results are preliminary. Some correction of biases between the UAS and the airborne lidar DEMs and removal of the vegetation signal are needed to improve volumetric change estimates following Michael. More detailed analysis on the impact of Michael at LSGI and historical evolution are forthcoming.

Gulf 3D Website Repository

The Gulf 3D website is a centralized geospatial data repository for the Regional Geospatial Modeling project. Gulf 3D will provide project partners with a cloud-based option to upload, download, and visualize geospatial data products generated from this project including all data sets at the ANERR. Gulf 3D is currently under development at CBI and Figure 5 shows a sample of Gulf 3D's user interface.



All Data:

Name	Survey Type	Data Type
▸ 20160315 Beach Profile D341	Terrestrial LiDAR	Point Cloud
▸ 20170322 Westpass Photosite	UAS	Aerial Imagery
▸ 20170321 Beach Profile D341	Terrestrial LiDAR	DSM
▾ 20180709 Bayside Photosite	Terrestrial LiDAR	Point Cloud

20180709 Bayside Photosite

View Data   Download (1.02G)   Metadata (11K)

Abstract:
Data was collected on July 9, 2018 using a Riegl VZ400 terrestrial laser scanner while geodetic control for the point cloud was provided by resection of the coordinates of five 10-cm cylindrical targets measured using an RTK GPS with VRS capability. A 360 FOV can be observed with RGB texture mapping of accompanying Nikon d800 imagery. This dataset contains merged and georeferenced point cloud information for two scan positions covering a 0.05 km^2 area on Little Saint George Island in the Apalachicola region of Florida (USA). The final point spacing was 4 cm and 768 points/m^2 (all returns) with a total of 38084772 points.

Figure 9: Gulf 3D user interface being designed by CBI.