Vol. 1

SargAdapt Good Practice Guide Series

Sargassum Monitoring Protocol Drones

Monitoring Sargassum Abundance using Drones

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MARINE SPATIAL INFORMATION SOLUTIONS

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Issue 2

Preface

Large mats of floating sargassum have been stranding along shorelines of the Caribbean and West Africa since 2011, resulting in significant damage to coastal ecosystems and their valuable services. These inundations have resulted in significant costs to coastal livelihoods and national economies, affecting fisheries, tourism, recreation, human health and coastal businesses.

The SargAdapt Good Practice Guide Series has been launched to provide easy-to-read, straightforward, technical advice to Caribbean stakeholders facing this 'sargassum crisis'. This first volume in the series provides a simple, rapid method of measuring the amount of sargassum stranding along shorelines.

Efforts to mitigate damage and adapt to this new hazard, by clearing beaches and developing uses for sargassum are still being hampered because we do not know how much sargassum is stranding on the vast majority of beaches. This sargassum monitoring protocol is intended to fill this knowledge gap by encouraging stakeholders across the Caribbean to begin monitoring the amount of sargassum that is stranding on multiple beaches. Such information, especially if collected using a standard method, could really help coastal managers and business entrepreneurs by showing them how much sargassum is stranding, when and where.

How to Cite

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Contents

Graphic design by: Jeanelle Irvine

This Sargassum Monitoring Protocol (SMP-Drones) is supplemented by a host of visual aids, webpages and help guides for your convenience.

Click any icon or information box with a coloured outline to explore the online resources that we've curated!
For example, check out a blog post about the early development of the SMP-Drones by clicking the adjacent icon.

Introduction

This Sargassum Monitoring Protocol (SMP-Drones) provides the basis for a standardised protocol for visualising and estimating the abundance of freshly beached sargassum. This simple protocol uses a combination of ‘off-the-shelf’ drone technology, rapid field measurements and automated geospatial analysis tools, developed specifically for use within the Caribbean context, recognising the low level of resources typically available.

It is anticipated that widespread application of this rapid monitoring protocol, will allow for the standardised collection of regional sargassum beaching data across the Caribbean. This will fill a critical gap in current knowledge, and has important implications for:

potential investors and entrepreneurs looking to valorise sargassum

managers and stakeholders involved in mitigating and clearing beached sargassum

improving sargassum forecast models by providing validation through quantitative monitoring of beaching events

improving scientific understanding of sargassum blooms and associated issues

We anticipate that this SMP-Drones will be dynamic, and will be upgraded as technology continues to improve, and with the addition of 'sub-protocols' for collecting additional site information as needs arise.

The main steps of this SMP-Drones are outlined in the following sections.

Required Resources

Previous Training

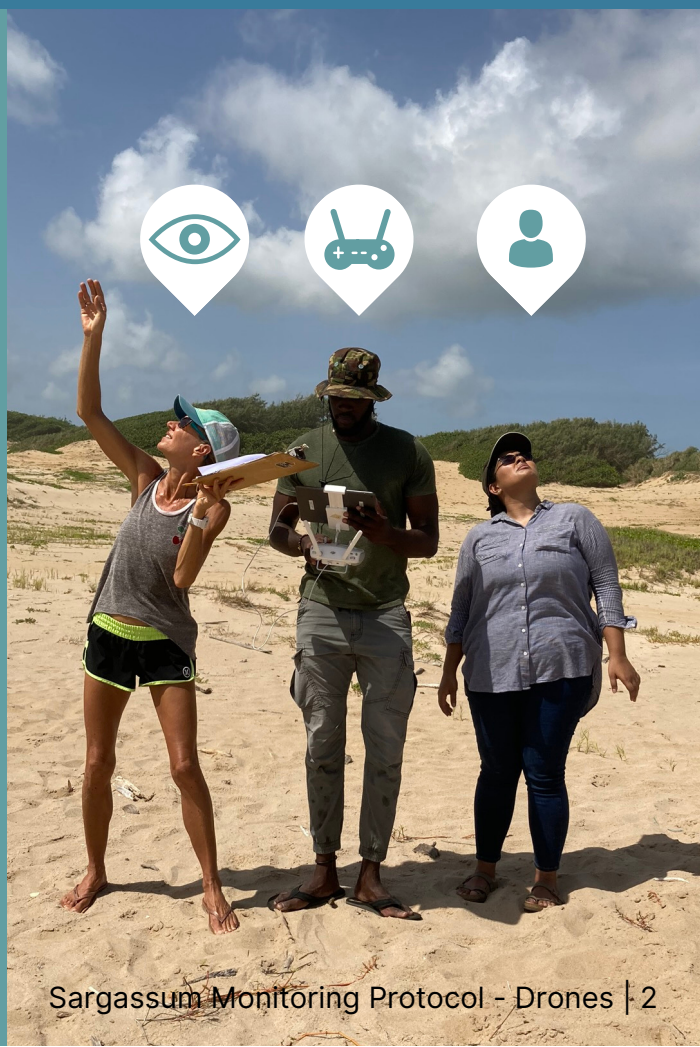
The following SMP-Drones assumes that

- At least one member of the team is legally licensed to fly drones and has been previously trained to fly safely and to conduct automated mapping flight surveys
- A commercial Drone Policy and Operations Manual has been developed and Standard Operating Procedures (SOPs) are strictly followed at all times
- All required Government flight approvals have been obtained and the drone team will abide by all national drone policies, safety guidelines and regulations

Manpower / Time

- **Drone Pilot**
- **Observer**
- **Field assistant**
  for ground measurements of sargassum

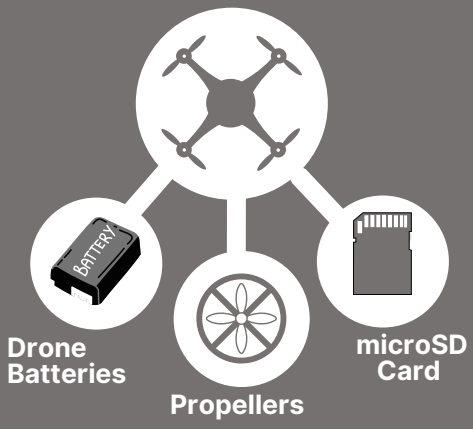
The entire beach survey is designed to take <u>less than one hour</u>, regardless of the severity of the sargassum influx



Drone Hardware and Software

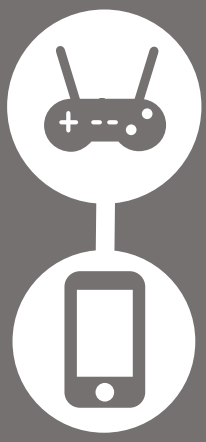
UAS Components

1. Drone Components



Mapping-Grade Drone (DJI Phantom 4 Pro or Mavic Pro)

2. Remote Controller



iOS Mobile Device (tablet or phone)

3. System Software

DJI

DroneDeploy

For Flight Control

Check the Appendix for the full shopping list!

Data Processing & Analysis

1.

A DroneDeploy user account

(Any subscription level)

2.

A laptop or desktop personal computer

(Windows 10, 64 bit with 8 GB RAM Intel Core i7 Processor)

3.

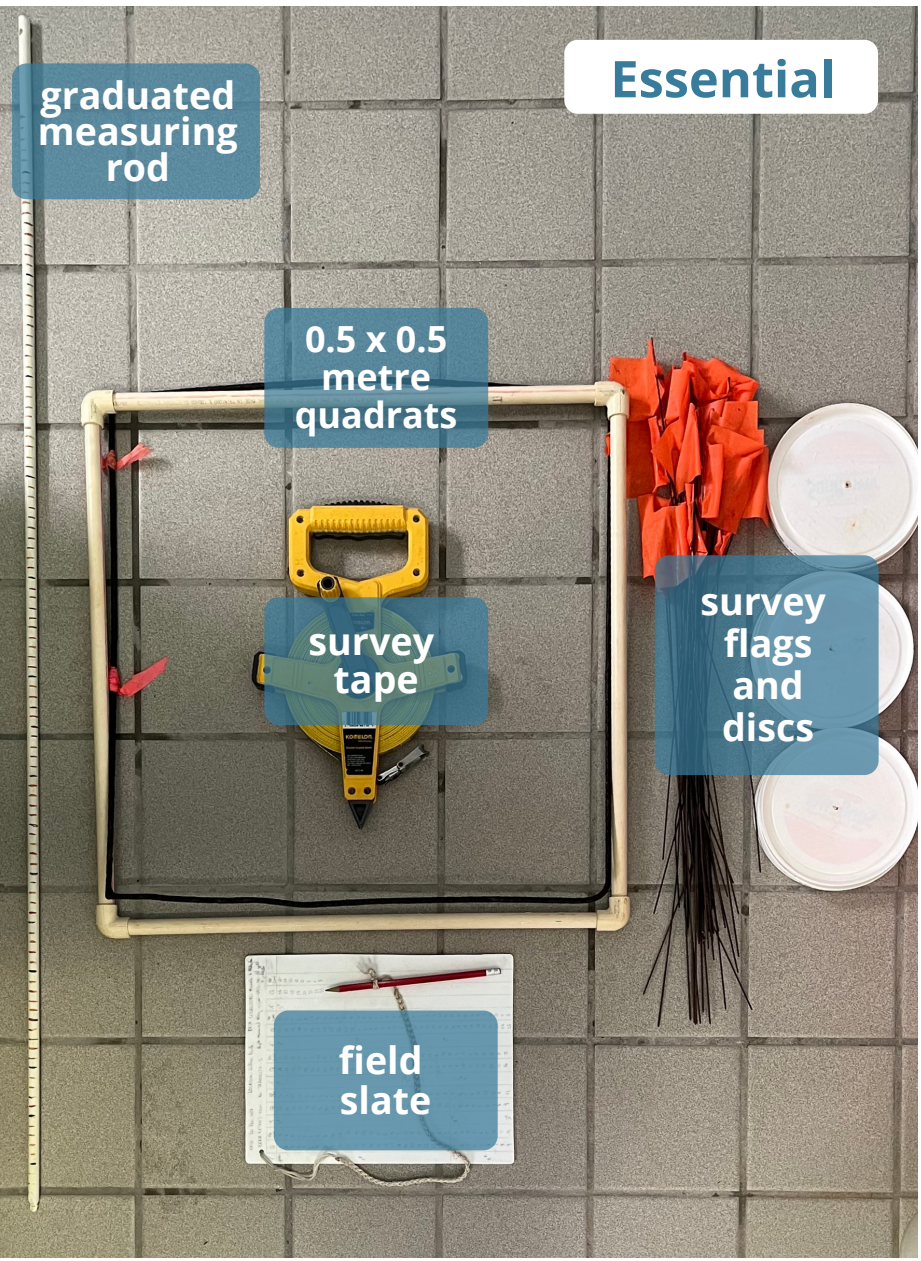
An internet connection

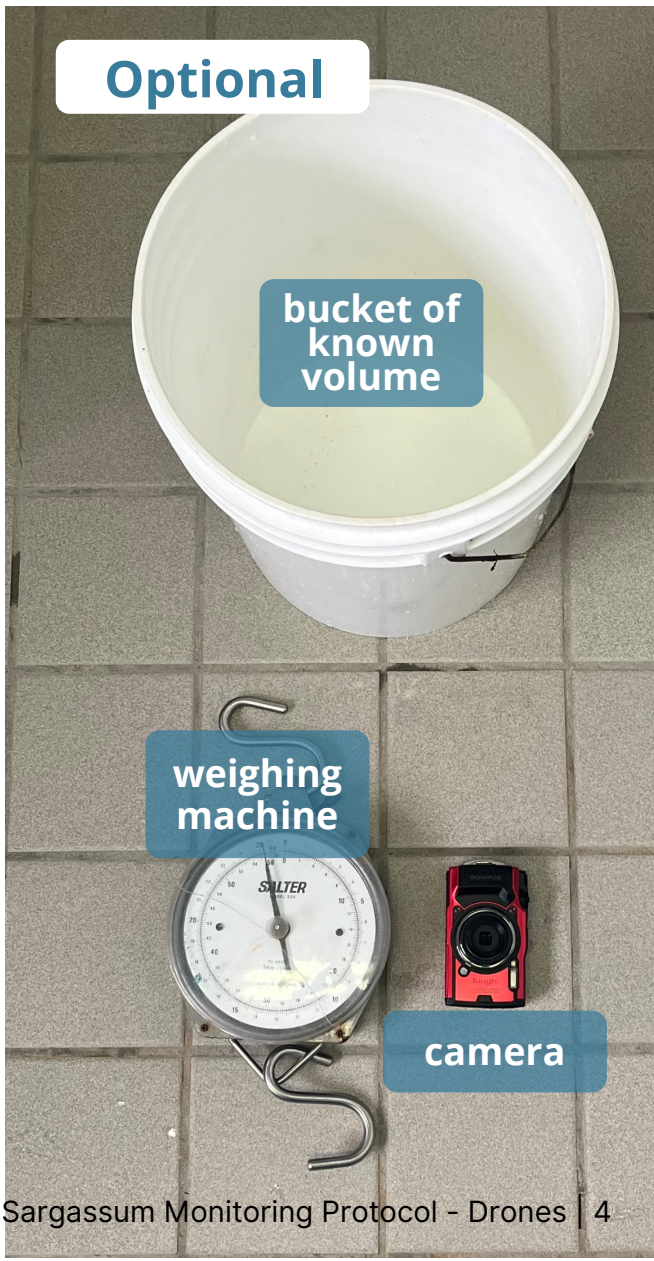
(ideally high-speed)

4.

Microsoft© Office Excel application

Ground Measurement Equipment





SAFETY FIRST!

Before undertaking the SMP drone surveys, be sure to conduct all preflight safety checks before every flight!

Click the icon to learn about pre-flight safety checks.

Drone Surveys

STEP #1

Conduct Initial Site Assessment

STEP #2

Execute Monitoring Flight Plans

All drone-related methodologies and flight plans were formulated based on DroneDeploy Version 2.150.0

All of the recommended SMP-Drones flight survey plans are created using the DroneDeploy platform (using either the desktop or mobile version).

Note that flight plans may be slightly adjusted according to site conditions at each monitoring beach.

Online Resources

DroneDeploy

Learn more about...

- Desktop Flight Planning
- Mobile App Flight Planning

DroneDeploy offers several flight plan templates that can be customised to suit your needs.

DroneDeploy Flight Plans

Maps & Models

- Standard
- Corridor

Media

- Panorama
- Photo Report
- Video

STEP #1
Conduct Initial Site Assessment

A.

The first step of the SMP-Drones is to conduct a preliminary site assessment at each beach where sargassum monitoring is to occur.

The preliminary site assessment first involves a 'desk-based' review of existing aerial imagery and secondary data for the monitoring site. (e.g. Google Earth, ArcGIS Earth, DroneDeploy and DJI Fly Safe applications, topographic maps, aerial photos).

This preparatory exercise is undertaken just once to:

Identify any potential obstacles / sources of interference and to determine appropriate technical flight parameters for each site

Allow for supplementary, site-specific contextual information to be collected to identify the associated biophysical features, resources, activities, livelihoods and spatial interactions occurring within the site to be mapped and monitored

B. **Using the imagery and secondary data acquired from the desk review, the beach monitoring site should be assessed and described using the list below**

Beach Monitoring Site - Description Features

Site type: Pocket beach, beach, bay, lagoon etc.

Location: E, SE, S, SW, W, NW, N, NE coast

Predominant Wind Direction: Offshore / Longshore / Onshore

Beach Wave Exposure: Full / Semi-exposed / Sheltered

Beach Width & Slope: Wide / Medium / Narrow; Flat Sloping / Steep

Shoreline Type: Sandy, Rocky, etc.

Coastal Vegetation: Dune, Shrubs, Trees, Coastal Strand etc.

Sargassum Management: Cleaned, Undisturbed, etc.

Main Uses: Conservation, Fishing, Tourism & Recreation, None

Coastal Infrastructure: None, Hotels, Landing Site, Jetties, Groynes

Examples - Beach Monitoring Site Descriptions

Site Type: Bay

Location: East coast

Wind Direction: Onshore

Wave Exposure: Semi-exposed

Beach Width & Slope: Narrow / flat

Shoreline Type: Sand / some rocks

Coastal Vegetation: Coconut trees

Management: Mechanical cleaning

Main Uses: Fishing / landing Site

Infrastructure: Jetty, boat ramp, fish market, residential properties

Site Type: Beach / lagoon

Location: South West coast

Wind Direction: Offshore

Wave Exposure: Semi-exposed

Beach Width/Slope: Medium / sloping

Shoreline Type: Sand

Coastal Vegetation: trees, coastal strand

Management: Manual cleaning

Main Uses: Beach recreation, surfing, tourism, turtle nesting

Infrastructure: Hotel either end, groynes

Site type: Beach

Location: E coast

Wind Direction: Onshore

Wave Exposure: Exposed

Beach Width/Slope: Wide / sloping

Shoreline Type: Sand

Coastal Vegetation: Dune, coastal strand

Management: Undisturbed

Main Uses: Wilderness tourism, beach fishing, turtle nesting, research

Infrastructure: None

C.

Finally, an initial 'baseline' mapping survey should be planned and flown to create a site basemap for each monitoring beach.

This one-time flight should encompass the entire coastal ecosytem (i.e. length of the beach or bay, the adjacent coastal community inshore and should also extend a short distance out to sea).

Standard (Maps & Models) Flight Plan

Flight Plan (purpose): Standard Map (used for site assessment and basemap)

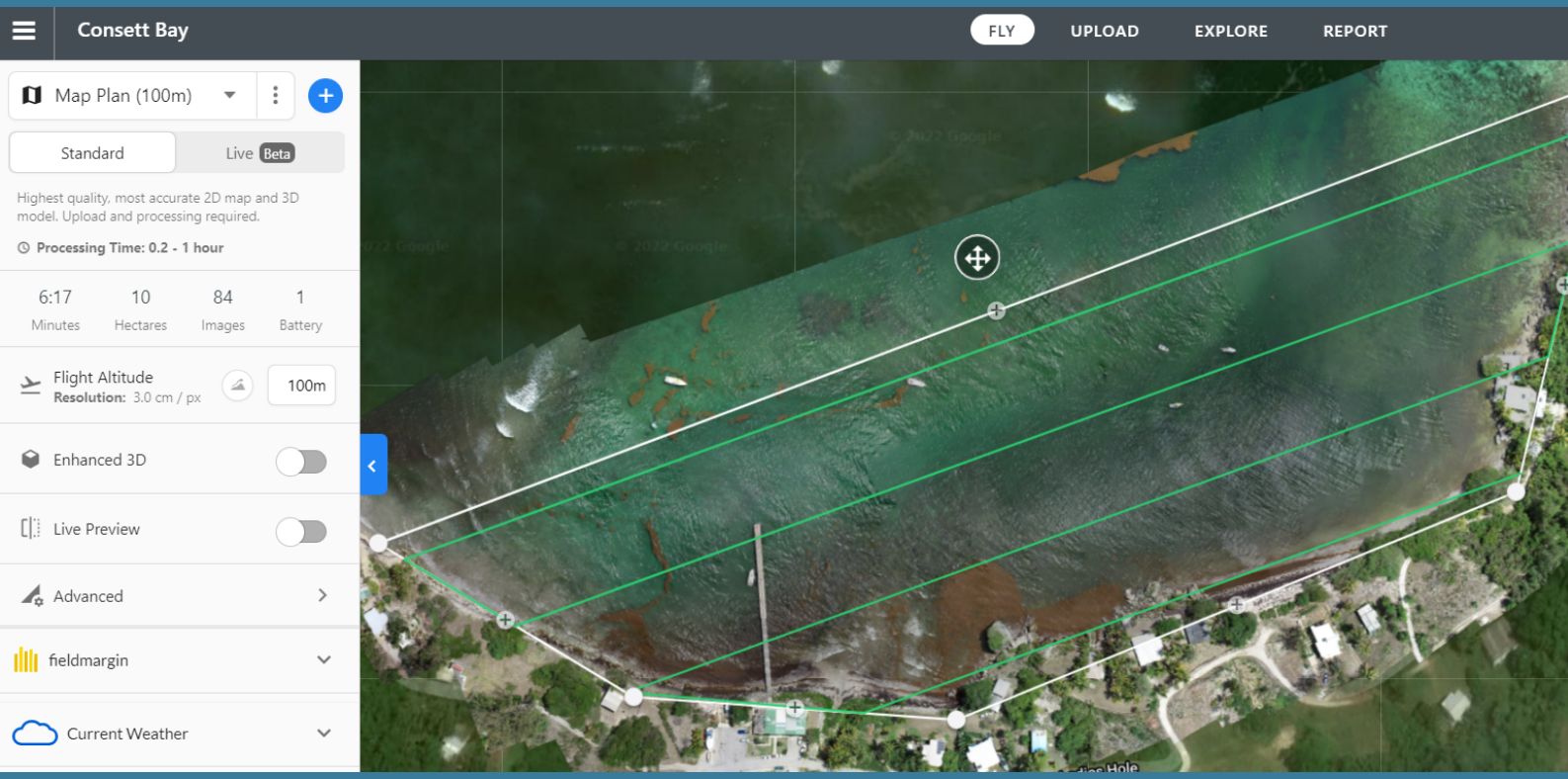
Extent: Length of monitoring beach, approximately 50 m offshore and 50-100 m onshore; variable based on site features identified in preliminary assessment.

Flying height: typically 80-120m Above Ground Level (AGL); Variable based on extent

Overlap: Standard (typically 75% front, 65% side; variable based on flying height)

Flight time: < 10 minutes; variable based on site extent and flying height

Time of day: Morning light is typical best (when sun glare and wind are minimal)



Screenshot of the basemap flight plan, showing the location and direction of the flight path in green and extent in white.

STEP #2
Execute Monitoring Flight Plans

The Sargassum Monitoring Protocol comprises four drone flight plans, each serving its own purpose.

Corridor: used for sargassum beach monitoring survey

Panorama: generates an interactive spherical 360° view

Photo: used for lower altitude landscape perspective of site

Video: used to capture lower altitude footage of site

All four flight survey plans can be 'queued' and flown consecutively, in less than 15 minutes, using a single drone battery.

To ensure the utmost safety, please conduct all necessary pre-flight checks for executing any drone flight plan!

Click the icon for another useful document about pre-flight checks.

Corridor (Maps & Models) Flight Plan

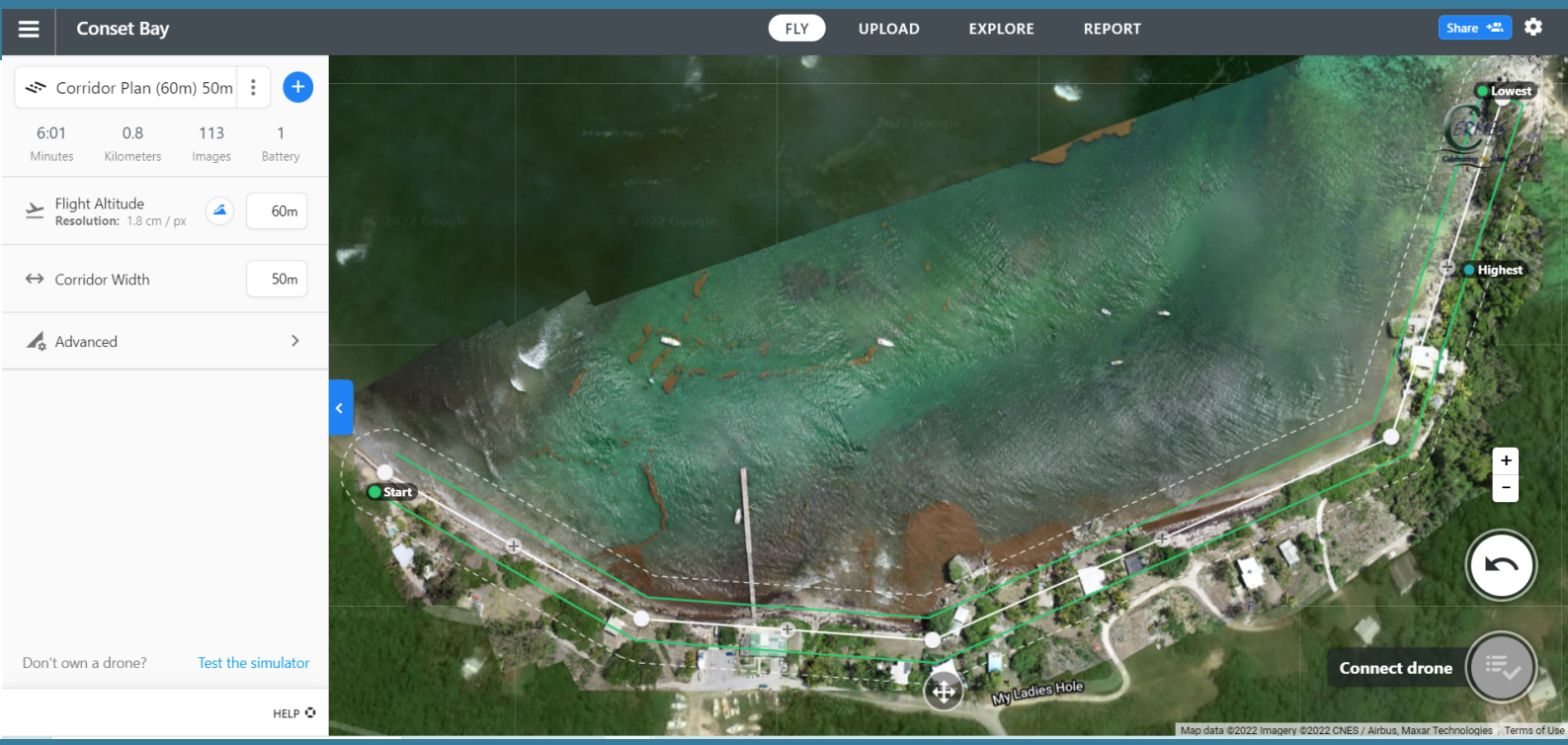
Extent: Length of beach to be monitored; extending just offshore and inshore to cover area where sargassum typically beaches; variable based on beach dynamics

Flying height: Variable; typically 45-60m Above Ground Level (AGL);
Corridor width: Variable based on beach characteristics; typically 50-10o m

Overlap: Standard (typically 75% front, 65% side; variable based on flying height)

Expected flight time: variable based on length of site/extent; typically < 8 minutes

Time of day: Minimum of three hours after high tide, but before low tide



Screenshot of the corridor mapping flight plan, showing the location and direction of the flight path in green and extent in white.

Ensure you can maintain visual line of sight at all times!

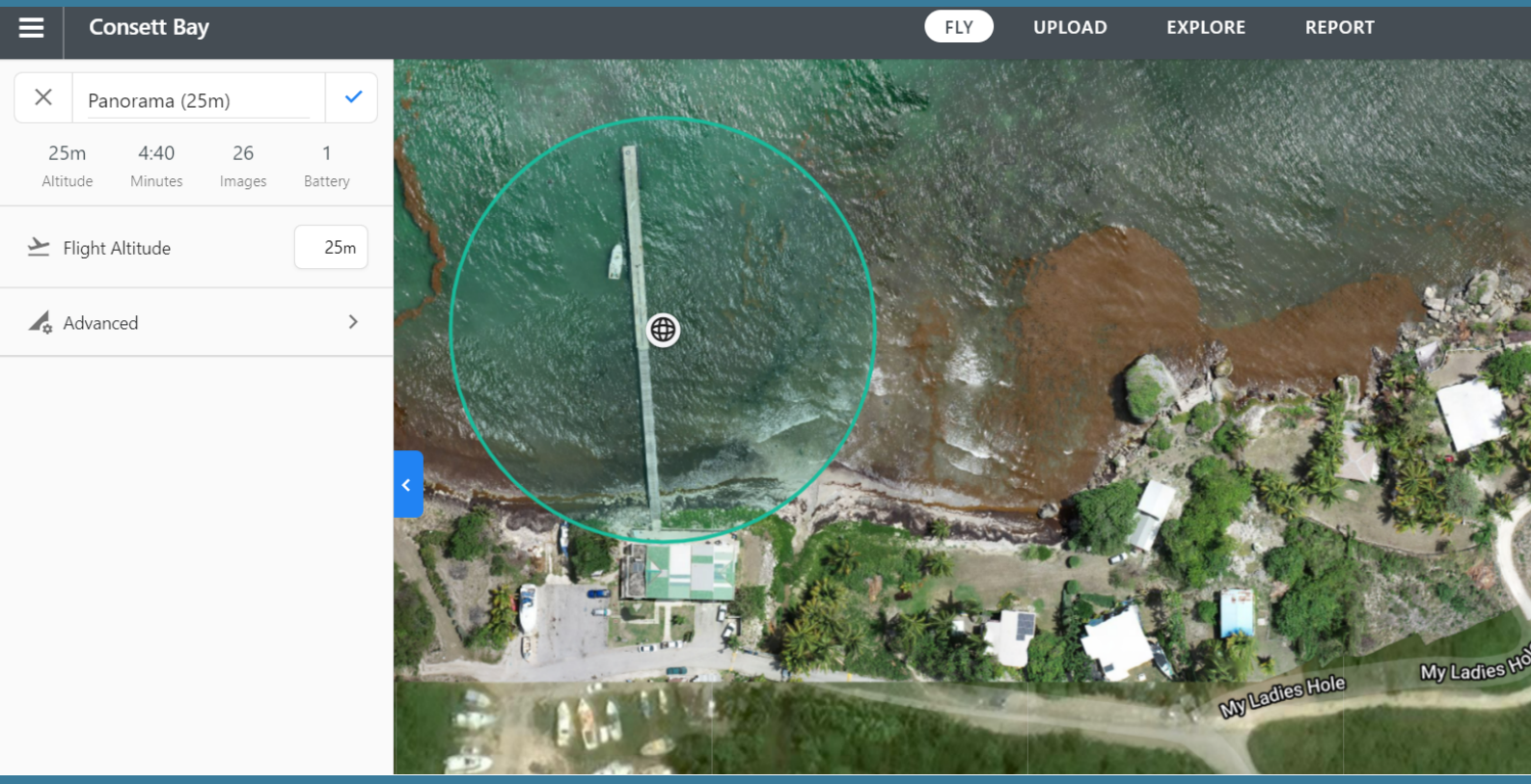
- *Carefully check the length of your survey plan pre-flight.*
- *Position take-off as central to start & end point as possible, so distance from pilot is no more than 1 km in either direction.*

Panorama (Media) Flight Plan

Flying height: approximately 25 m Above Ground Level (AGL)

Location: Center of monitoring site extent, typically slightly offshore of the beach; or based on the site's main features of interest / critical infrastructure.

Expected flight time: < 5 minutes



Screenshot of the location and extent of the 360 degree panorama flight plan.

Online Resources
DroneDeploy

Interact with a live 360° panoramic of Silver Sands Hotel, Barbados!

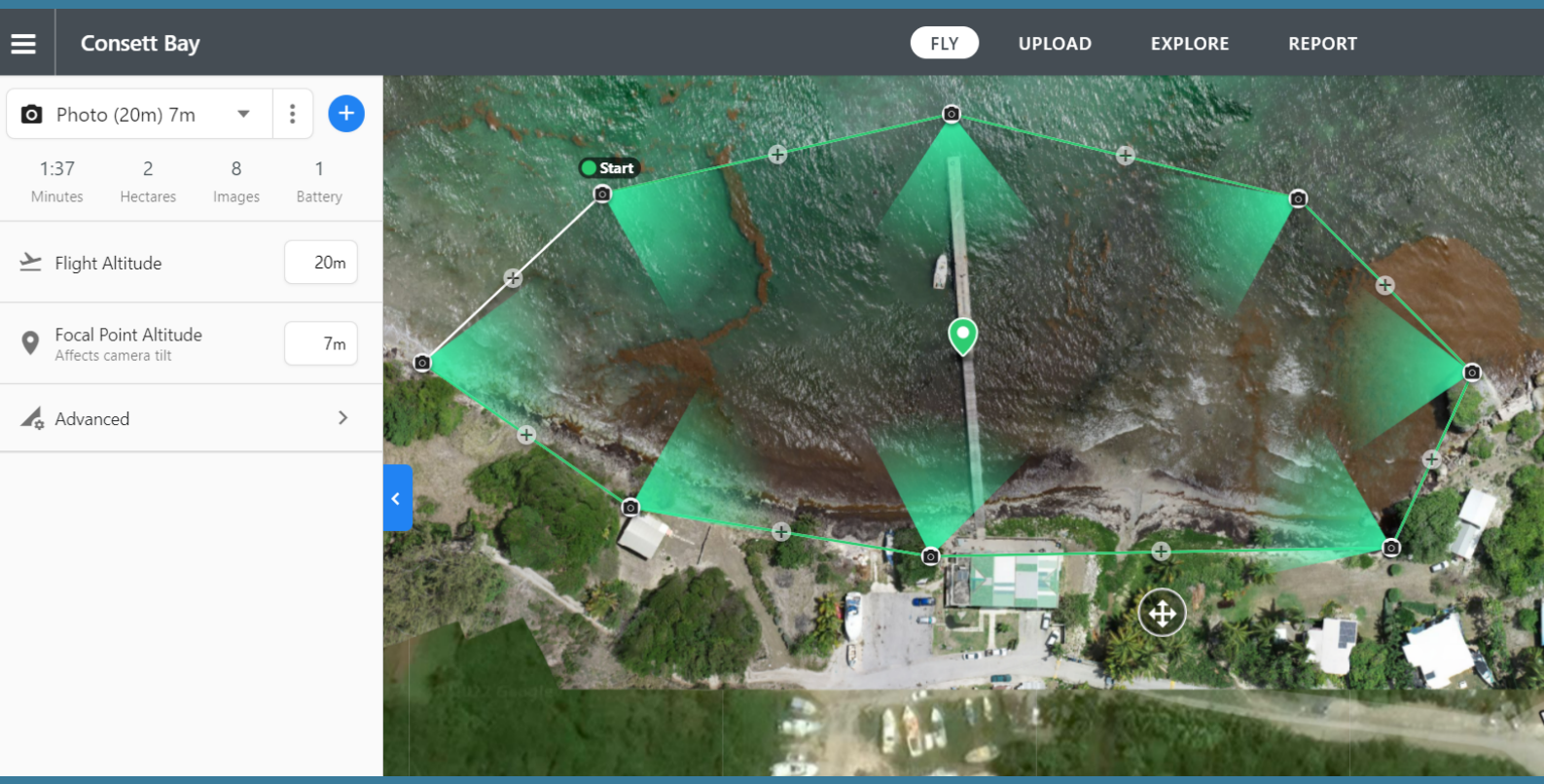
Photo (Media) Flight Plan

Extent: Length of beach to be monitored; extending just offshore and inshore to cover area where sargassum typically beaches; variable based on beach dynamics

Flying height: 10-30 m Above Ground Level (AGL); applying 1/3 ratio for the Focal Point Altitude (~3-10 m)

Photos: approximately 7-10 photos, spread evenly along the extent of mapping boundaries

Expected flight time: < 2 minutes



Screenshot of photo flight plan showing the location and direction of each (low-altitude) landscape photo

Online Resources
DroneDeploy

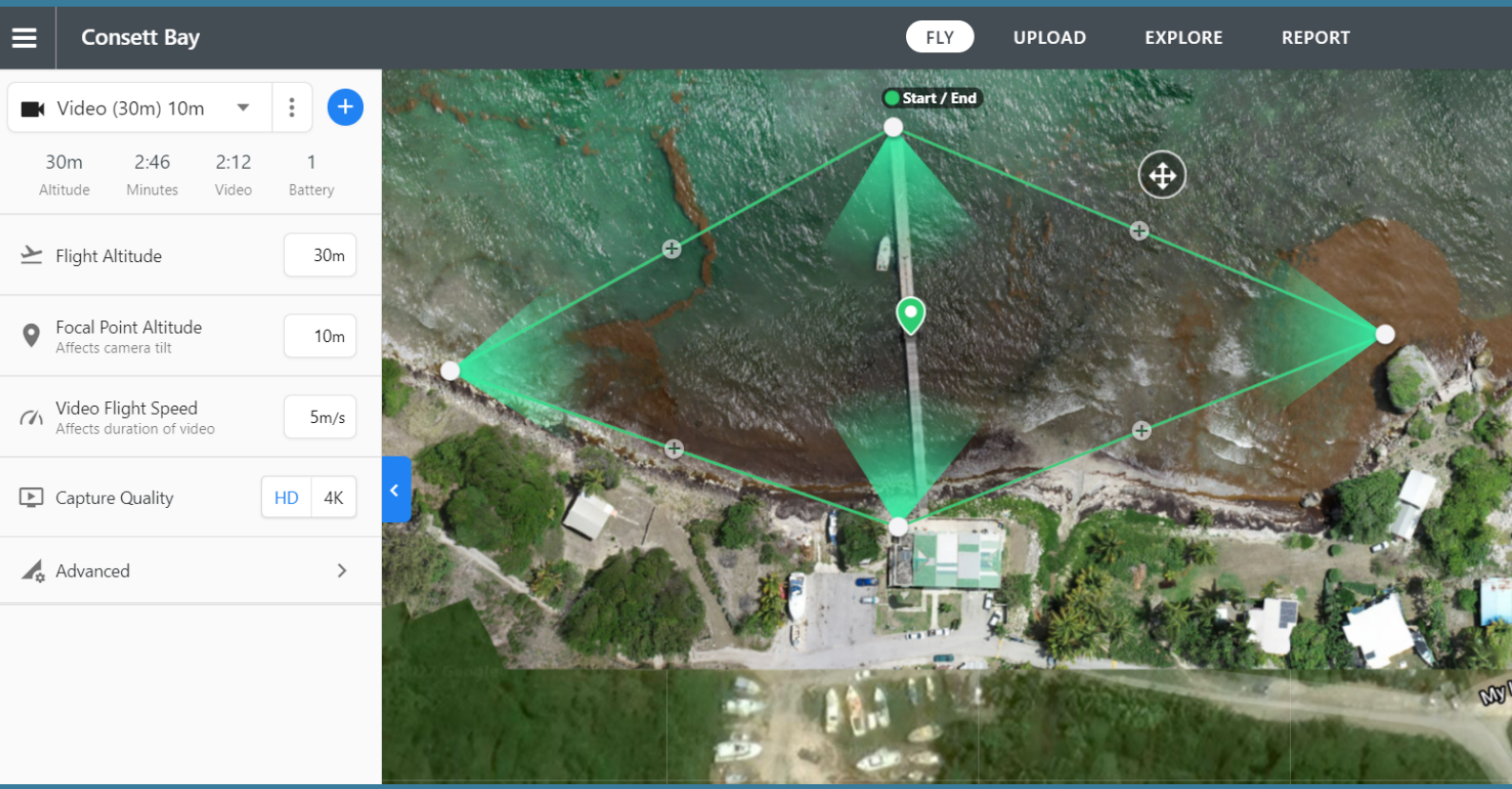
Check out an example output of a Photo flight plan!

Video (Media) Flight Plan

Extent: Along the length of the mapping survey boundaries (i.e. down the beach and extending slightly offshore and onshore of mapping extent) to produce < 60 second video clip

Flying height: 20 m Above Ground Level (AGL); applying 1/3 ratio for the Focal Point Altitude (~7 m)

Expected flight time: < 3 minutes



Screenshot of the video flight plan, showing the focal point and flight path direction in green

Online Resources

Check out this 60-second video clip of Walkers, Barbados produced from a Video flight plan!

Classifying Beached Sargassum

As beached sargassum dries, it quickly loses volume and weight, darkens, and gets pushed landward. This creates three distinct colours or 'classes' of beached sargassum that can be categorized based on 'age', or the length of time since it was on to the beach.

These three classes of sargassum are illustrated below.

Fresh Gold

freshly beached or 'wet' sargassum that was washed up during the most recent high tide

Old Gold

sargassum that was beached during the previous tides within the day and still remains 'wet'

Crispy

sargassum that has been beached for more than 24 hours and up to many weeks, and is therefore dry, brittle and lightweight

Ground Measurements

Using this protocol will give you a sargassum stranding rate per high tide.

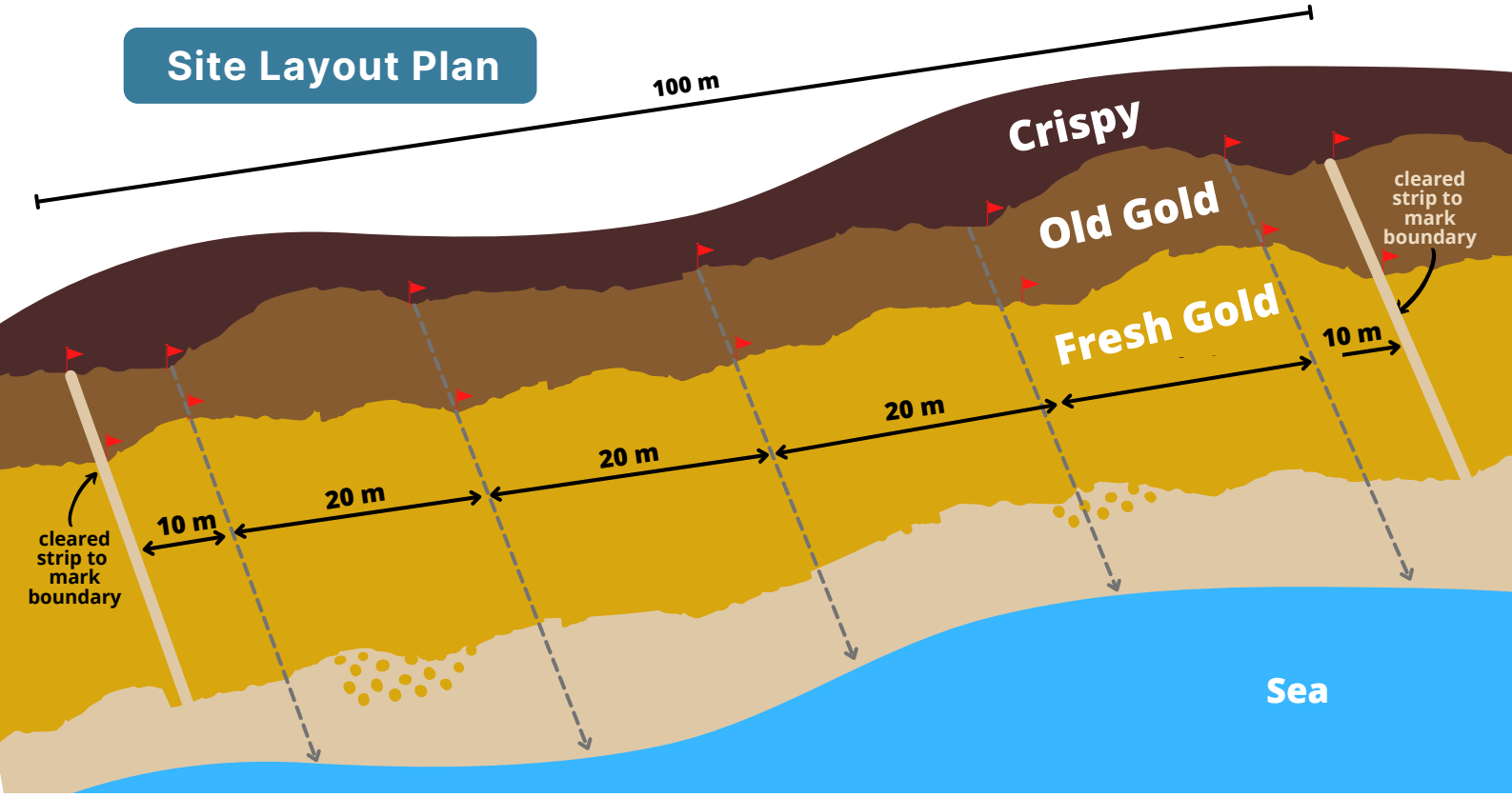
Using a standard volume unit of m^3/100 m shoreline as recommended will allow easy comparison across other studies using this SMP.

STEP #1
Marking the Site

Before you fly - it is important to clearly mark out your site!

- This ensures that ground features can be easily seen & interpreted from the aerial images and mapping products.

Site Layout Plan



Graphic showing the site layout for taking ground measurements.

The different classes of beached sargassum are illustrated (Fresh Gold, Old Gold and Crispy) and details of temporary marks for a 100 m survey extent.

Parallel lines indicate the position and orientation of the five (depth) line transects.

Red flags show the start of each transect & the transition point between the classes (Old Gold to Fresh Gold) of beached sargassum.

Marking the Site {cont'd}

A.

Use the measuring tape (or standard strides) to mark out the exact location of the desired extent of the survey.

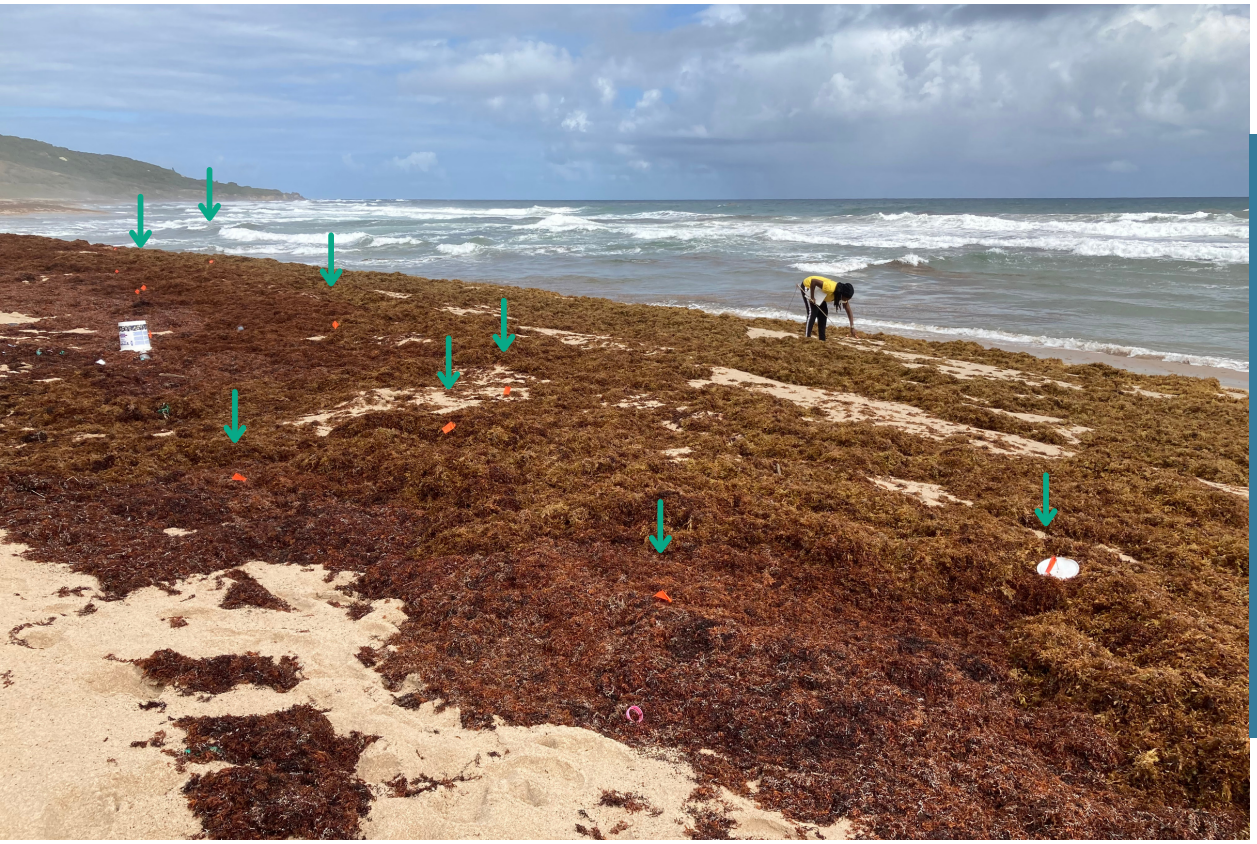
- Ensure that the desired extent is marked at each end by clearing a path through the sargassum perpendicular to the waterline
- If there is very little or no sargassum, mark the ends with the small coloured discs/lids, flags or foot tracks in the sand

B.

Use the measuring tape (or standard strides) to mark out the start locations of each of your straight-line depth transects.

- A maximum distance of 20 m between transects is recommended, or a minimum of 5 transects. Feel free to increase this if the shoreline stranding rate is highly variable along the 100 m extent.
- Line up the transect start locations exactly with the landward extent of the freshly beached sargassum, carefully marking the locations with the discs or flags that can be seen easily in the drone imagery.

Marking out the survey extent using survey flags and discs



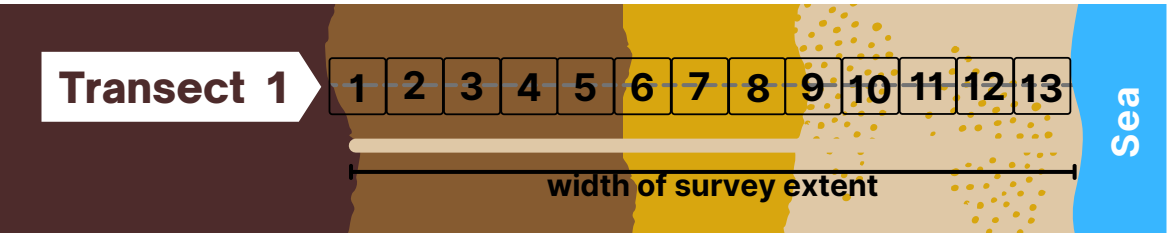
The landward extent of Fresh Gold is carefully marked with survey flags (arrows indicate location of flags/border between Fresh Gold and Old Gold)

STEP #2
Depth Transects

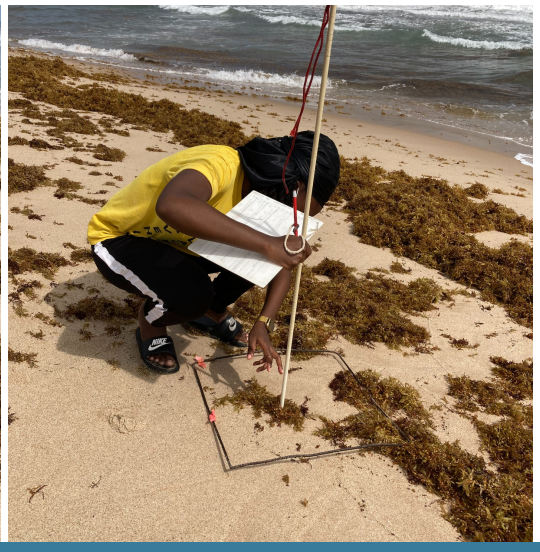
The average depth of beached sargassum can be adequately estimated by measuring the depth along your fixed grid pattern (straight-line transects).

A. Run straight-line transects down the beach, across the sargassum from marked starting points (see site layout diagram)

- Use a measuring tape (or flip your 0.5 m quadrat over and over) to determine the depth measurement locations every 0.5 m from transect start to water line.
- Depth measurements are taken by pushing the graduated pole through the sargassum to the sand base and recording the depth (to the nearest cm) on the field data slate.



Graphic showing site layout for depth transects



Keep flipping the quadrat over and over along the transect, until you reach the water line!

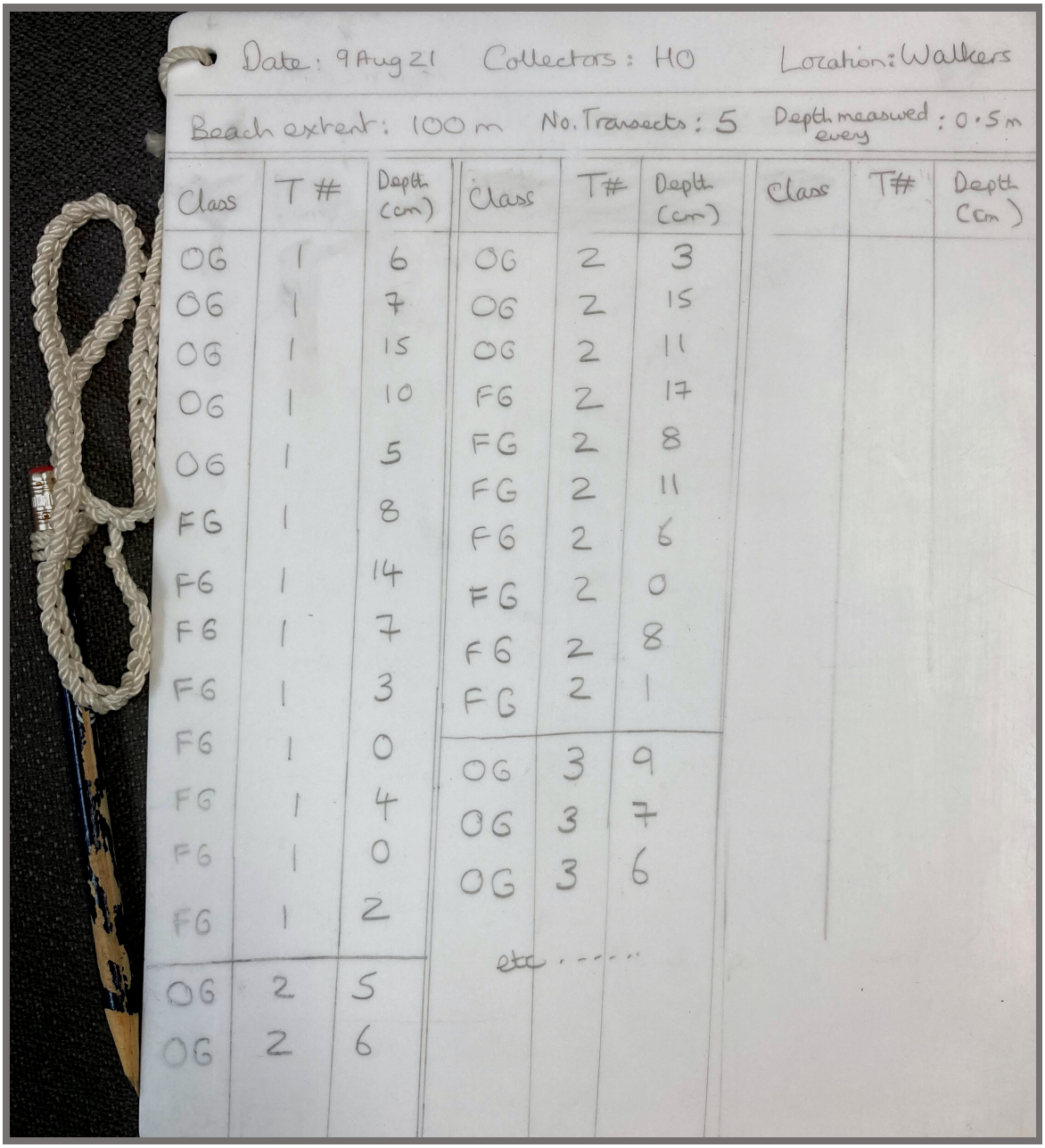
Some quadrats may have little or no sargassum as you move seaward, but continue the method as outlined, recording zeros.

B.

Each transect should start exactly on the landward border of the sargassum class of interest and run to the seaward border.

- In the case of Fresh Gold, the seaward edge is likely to be the water line, where pieces of sargassum may be widely strewn apart. As such, most of the depth measurements in this zone will be zero - but it is important to record them.
- Make sure that the class of sargassum (Old Gold or Fresh Gold) being measured is clearly marked on your field data slate (see example of field slate)

Field Slate for Depth Data



Date: 9 Aug 21 Collectors: HO Location: Walkers

Beach extent: 100 m No. Transects: 5 Depth measured every: 0.5 m

Class	T #	Depth (cm)	Class	T#	Depth (cm)	Class	T#	Depth (cm)
OG	1	6	OG	2	3			
OG	1	7	OG	2	15			
OG	1	15	OG	2	11			
OG	1	10	FG	2	17			
OG	1	5	FG	2	8			
FG	1	8	FG	2	11			
FG	1	14	FG	2	6			
FG	1	7	FG	2	0			
FG	1	3	FG	2	8			
FG	1	0	FG	2	1			
FG	1	4	OG	3	9			
FG	1	0	OG	3	7			
FG	1	2	OG	3	6			
OG	2	5	etc.....					
OG	2	6						

Key: OG = Old Gold, FG = Fresh Gold, T# = transect number

Data Management

Handling and Storage

Data management protocols should be included in your UAS Policy and outline how data are collected, stored and processed.

If an internal data server (in-house network or cloud-based drive) is not available, a dedicated portable hard drive is highly recommended to store copies of all data collected.

STEP #1
Download Drone Survey Data

Upon return from the field, remove the microSD card from the drone, and download the media files using a desktop or laptop computer.

For each site survey conducted, it is recommended that a new 'folder' is created containing digital copies of the following documents:

- *Government approval letters, drone license, registration & insurance;*
- *Flight plans, checklists, drone mission and field survey datasheets*
- *Drone survey data, including all 'raw' drone media in subfolders, with corresponding subfolders for each of the flight survey results.*

Naming conventions should also be applied to all corresponding subfolders, data and supporting documents.

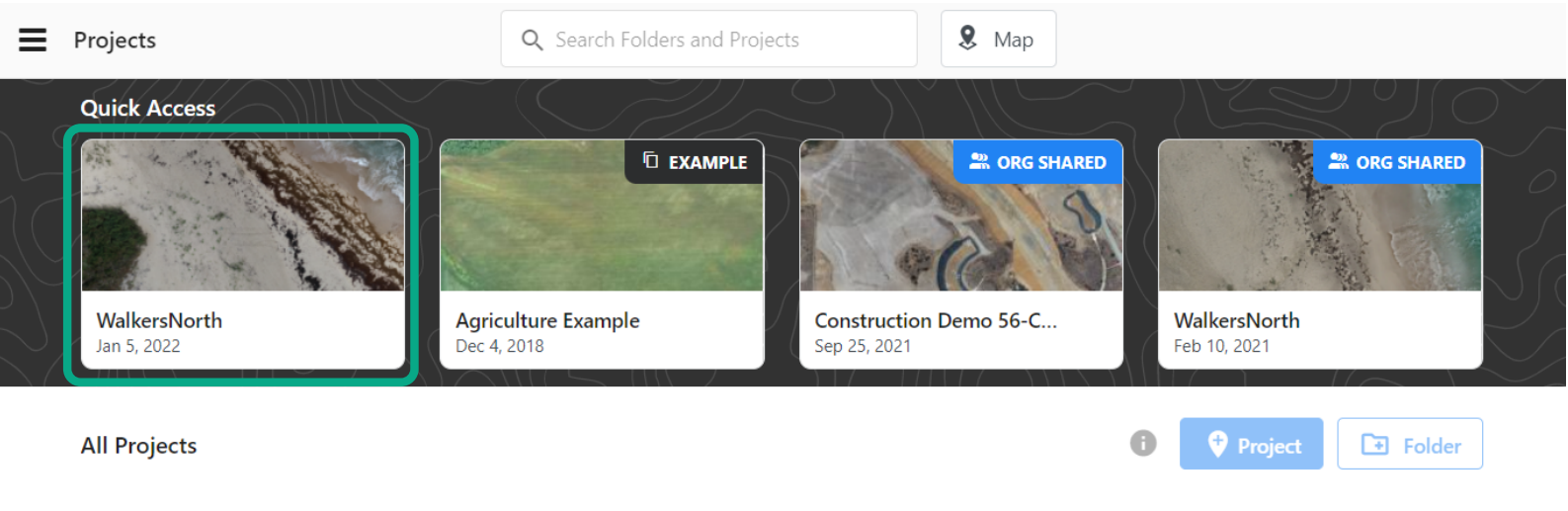
Standarized Naming Convention

SurveyName Month.Day.Year XX ← Drone model

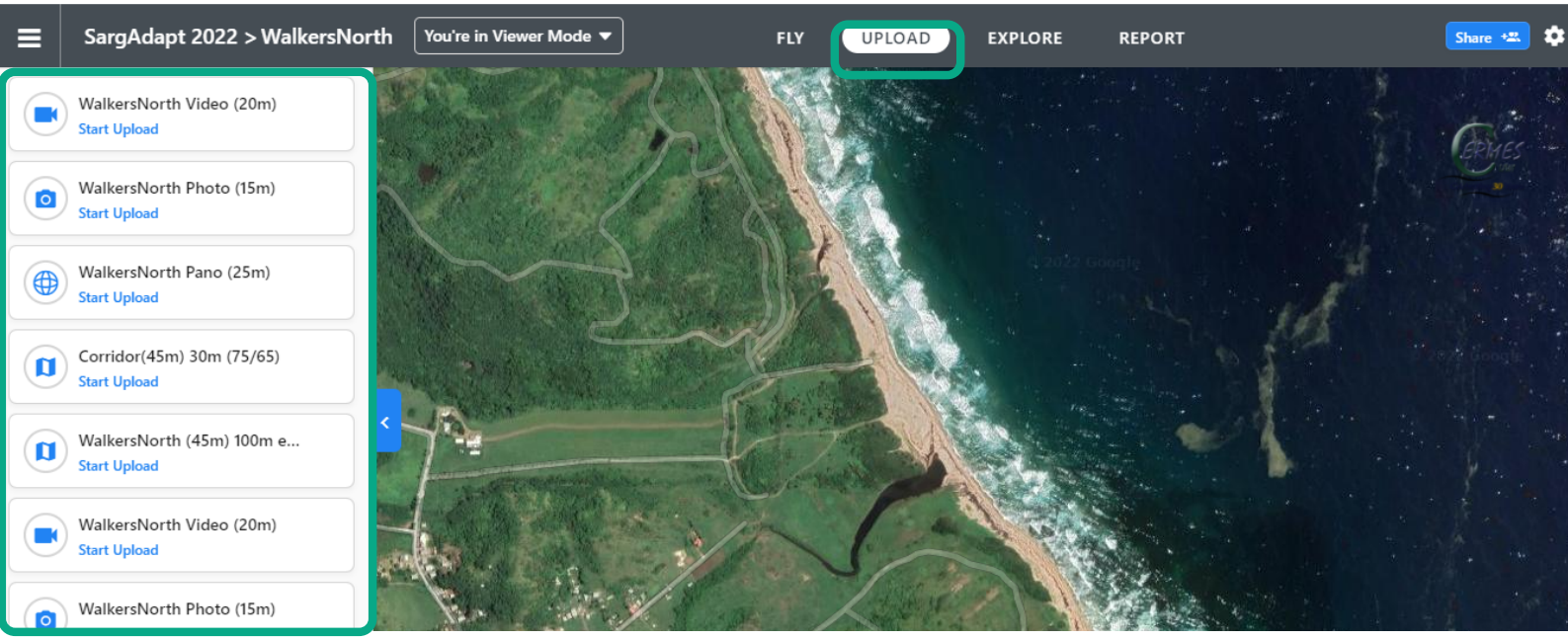
e.g. WalkersNorth 3.21.2021 P4P ← *Abbreviation for Phantom 4 Pro*

Use a desktop or laptop computer with internet access to upload data from each of the four flight surveys into DroneDeploy for cloud-based post-processing.

STEP #2
Upload Drone Data for Processing



1. Navigate to the monitoring site's Project folder



2. Use the UPLOAD tab to show the four flights and click on each to commence upload

Although DroneDeploy provides cloud-based storage for drone survey results, it is strongly recommended that all results exported and stored for safe keeping as well as for use with other software analysis platforms and sharing externally.

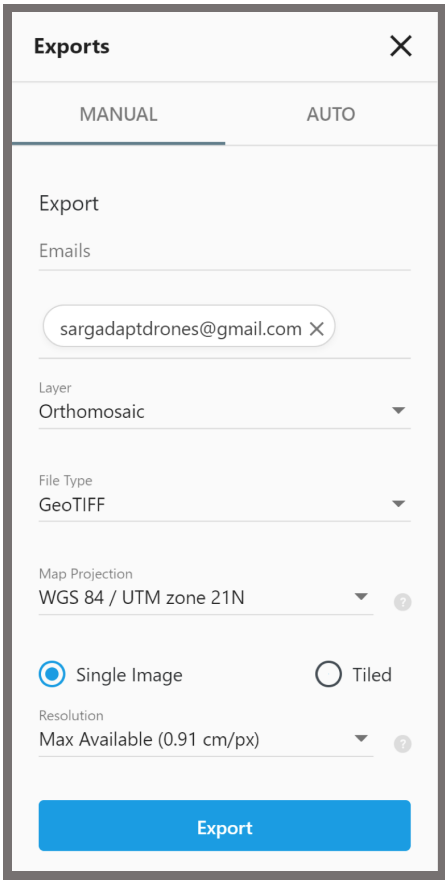
Once processing is complete, you receive an email that your map is ready to view. *Click the icon to see the example of Silver Sands Hotel.*

First, mapping results should be carefully checked...

Mapping results should always be exported & saved to corresponding results folder!

Several drone mapping products are produced from DroneDeploy, it is recommended at minimum, that the following are downloaded:

- *Orthomosaic image (as a GeoTIFF, JPEG or KML file)*
- *Elevation surface (as a GeoTIFF, JPEG or KML file)*
- *Elevation point cloud (as an LAS file)*
- *Flight survey and processing accuracy report (as a PDF file)*



It is important that the following are correctly selected/entered when exporting survey data:

- **the date & flight survey type**
- **your preferred file type (JPG, GeoTIFF) and output resolution***
- **the map projection (WGS84 / UTM coordinate system)**

File type and resolution will depend on your intended application and/or the end-users hardware resources

Remember to apply the naming conventions to all corresponding subfolders, data and supporting documents.

STEP #3
Assessing Drone Flight Results

Mapping Accuracy Report

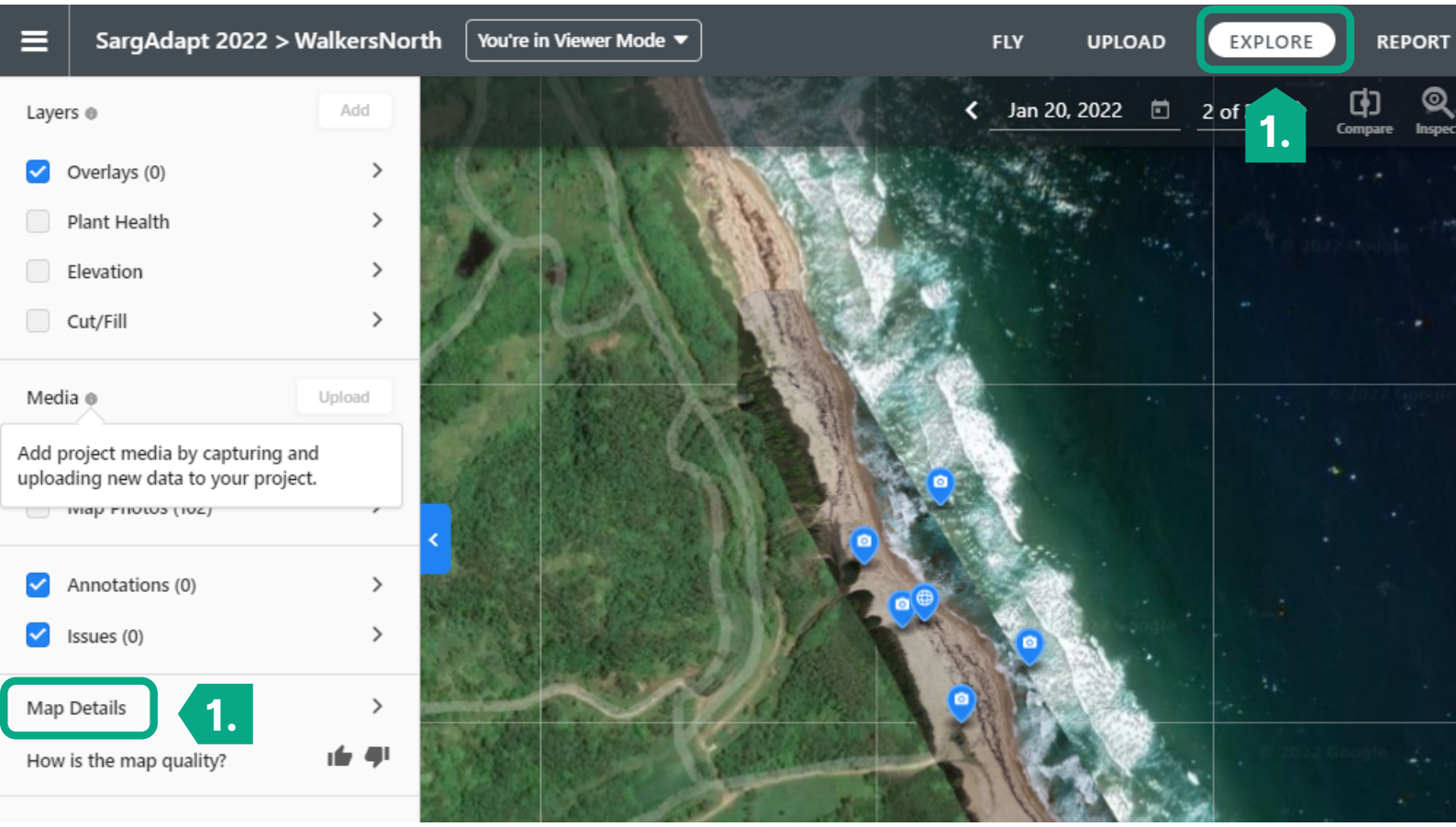
Your results can be viewed and assessed in DroneDeploy under 'Map Details'. A detailed 'Map Processing Report' is automatically generated for each mapping survey and can be downloaded as a shareable PDF document.

Online Resources

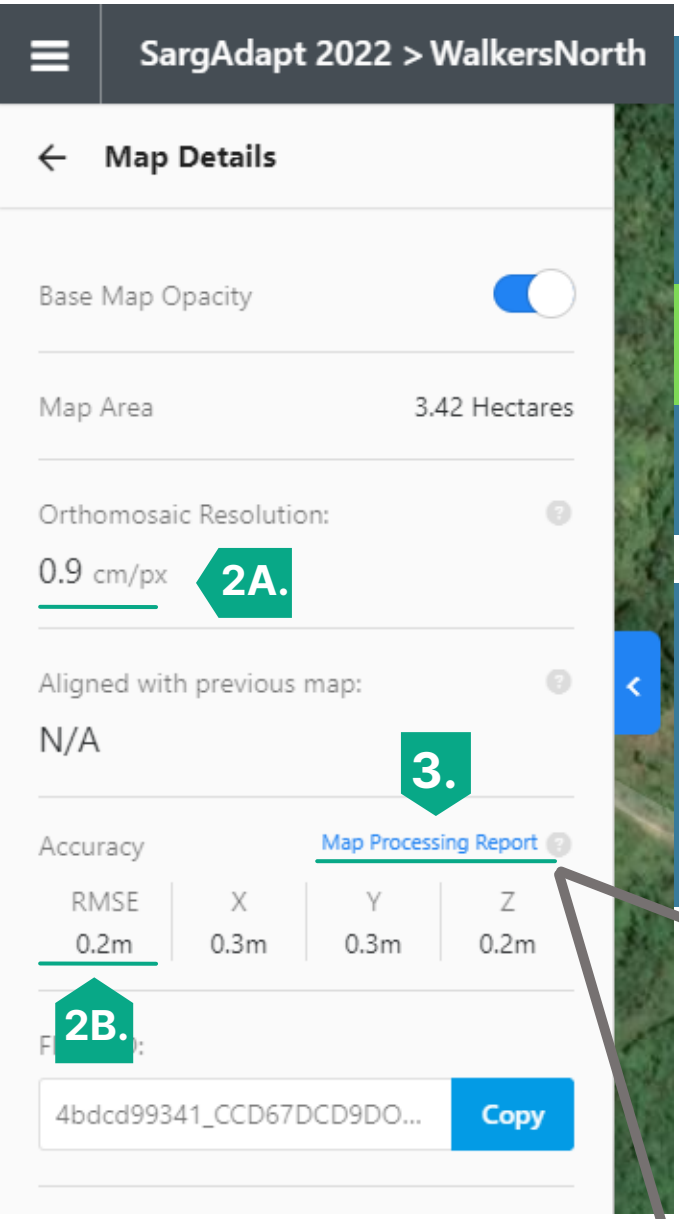
DroneDeploy

Learn more about...

How Accurate is My Map?



1. Select the EXPLORE tab, and select Map Details in the left-hand panel



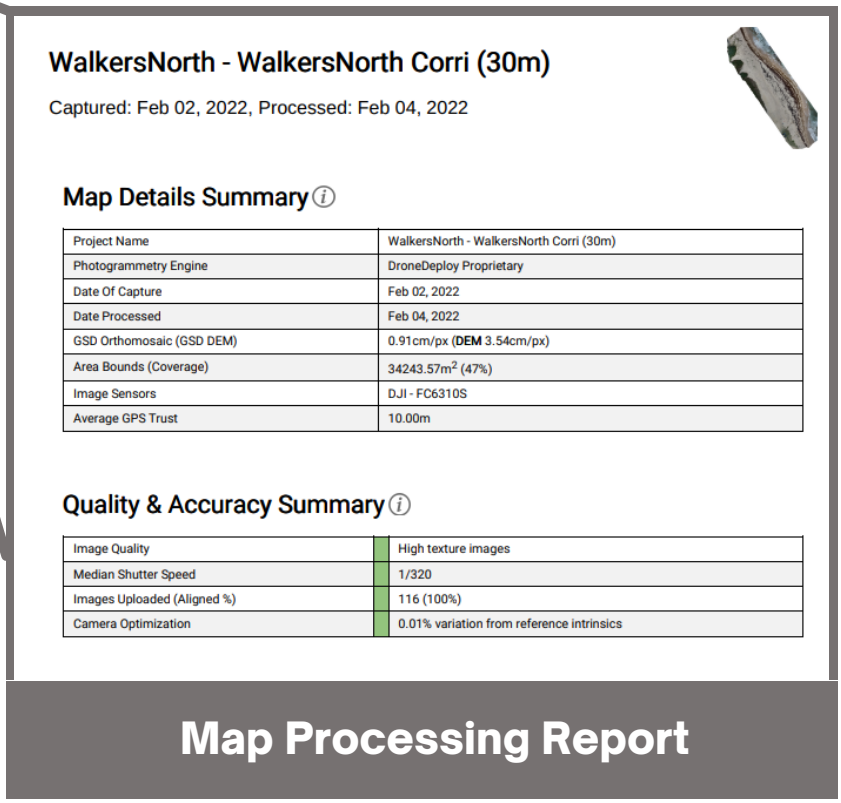
2. In the Map Details section, take note of:

A. the Orthomosaic Resolution
B. the RMSE value

Acceptable Values — **Orthomosaic Resolution <= 5 cm**; **RMSE value <= 5 m**

If values are within the acceptable range, proceed to step 3.

3. Select the Map Processing Report link to download the full PDF report, detailed examination of the flight survey parameters and accuracy of results



WalkersNorth - WalkersNorth Corri (30m)

Captured: Feb 02, 2022, Processed: Feb 04, 2022

Map Details Summary

Project Name	WalkersNorth - WalkersNorth Corri (30m)
Photogrammetry Engine	DroneDeploy Proprietary
Date Of Capture	Feb 02, 2022
Date Processed	Feb 04, 2022
GSD Orthomosaic (GSD DEM)	0.91cm/px (**DEM** 3.54cm/px)
Area Bounds (Coverage)	34243.57m^2 (47%)
Image Sensors	DJI - FC6310S
Average GPS Trust	10.00m

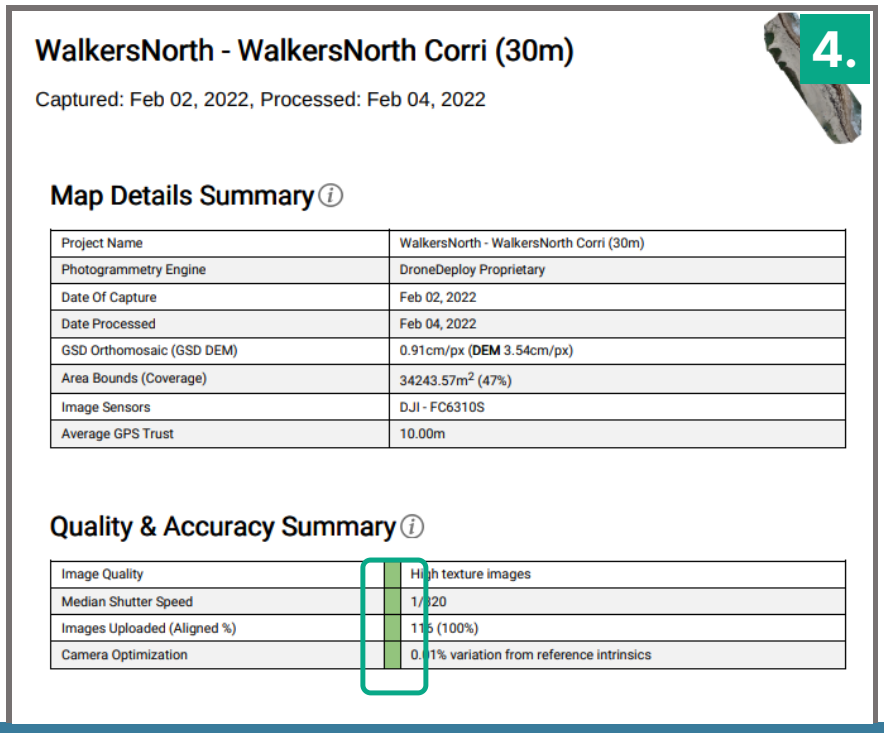
Quality & Accuracy Summary

Image Quality	High texture images
Median Shutter Speed	1/320
Images Uploaded (Aligned %)	116 (100%)
Camera Optimization	0.01% variation from reference intrinsics

Map Processing Report

Remember to apply naming conventions to all downloaded reports.

Map Processing Report



WalkersNorth - WalkersNorth Corri (30m)

Captured: Feb 02, 2022, Processed: Feb 04, 2022

4.

Map Details Summary

Project Name	WalkersNorth - WalkersNorth Corri (30m)
Photogrammetry Engine	DroneDeploy Proprietary
Date Of Capture	Feb 02, 2022
Date Processed	Feb 04, 2022
GSD Orthomosaic (GSD DEM)	0.91cm/px (**DEM** 3.54cm/px)
Area Bounds (Coverage)	34243.57m^2 (47%)
Image Sensors	DJI - FC6310S
Average GPS Trust	10.00m

Quality & Accuracy Summary

Image Quality	High texture images
Median Shutter Speed	1/320
Images Uploaded (Aligned %)	115 (100%)
Camera Optimization	0.01% variation from reference intrinsics

Orthomosaic Mapping Result

5.

4. **Ensure that all indicator boxes for each component of the Quality and Accuracy Summary are green.**

Any red or orange boxes indicate that there was a problem during processing!

If red or orange boxes are present in the output, the mapping results and accuracy report needs to be more closely examined for usability, and the survey may need to be reflown.

5. **Finally, zoom in and carefully inspect the Orthomosaic Mapping Result in the DroneDeploy Dashboard to ensure that the image is clear and that all key site features are included in your map before exporting!**

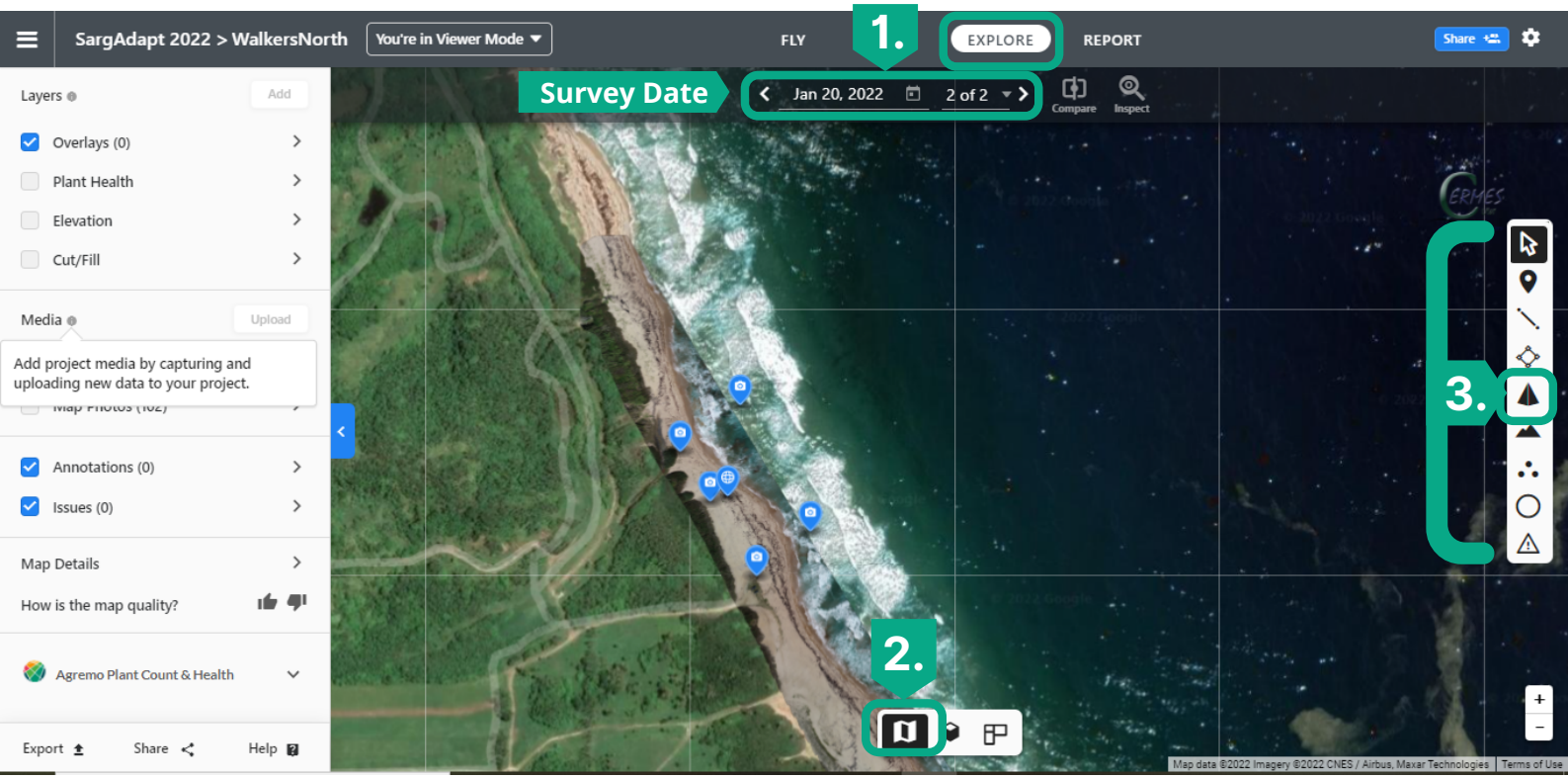
STEP #4
Entering Ground Measurement Data

Manually enter ground measurement data directly from the field slate into MS Excel spreadsheet using the same column headings.

Date	Location	Class	Transect #	Depth (cm)

Data Analysis

Analysis of drone data using the DroneDeploy Dashboard



1. **Within your Project - Under the EXPLORE Tab, navigate to the orthomosaic map by selecting the date & name of the survey.**

2. **Select the Map View icon and zoom in to your survey extent**
(easily identified by the 'site marks' or cleared sargassum on the beach)

3. **Using the Annotation Tools - select the Volume Icon**

4. **Carefully trace around the 'Fresh Gold' beached sargassum to create a polygon around this class (as shown in screenshot below)**

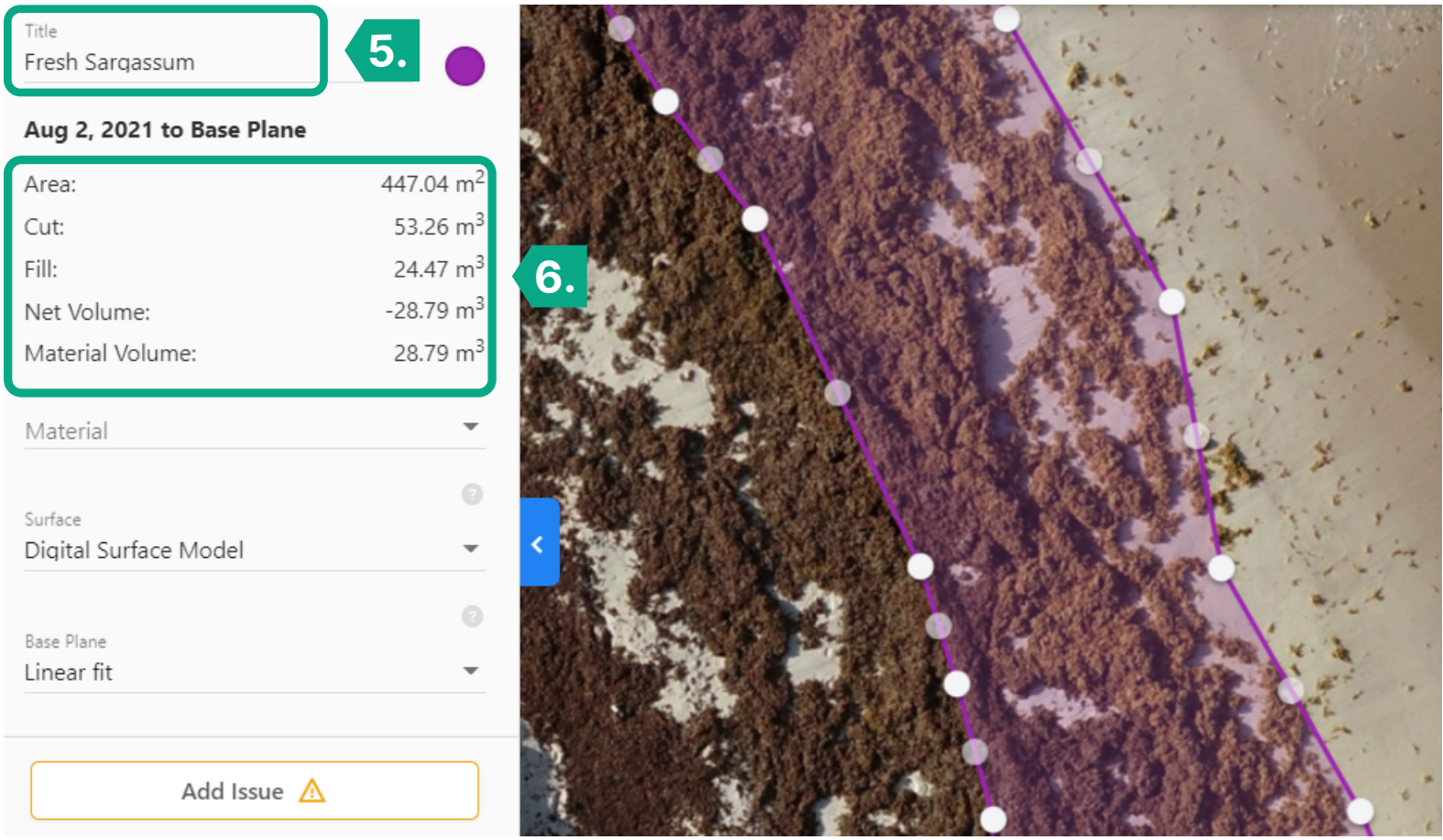
- Use the field marks (discs and/or flags placed on the beach prior to flying) as a visual guide and the water as the seaward edge.
- Be sure to zoom in on the image to ensure that the polygon follows the sargassum as precisely as possible.
- Repeat for other sargassum classes (if desired).

Online Resources

DroneDeploy

Learn more about...

Volume Measurements with Drones



5. **With each completed feature class, be sure to change the 'Title' to name the type of sargassum class *(e.g. Fresh Gold, Old Gold, Crispy)*.**

6. **The surface area of the polygon, and an estimate of the volume of the sargassum within, will be calculated automatically & displayed in the left-hand panel.**

For the best volume estimate, be sure to select 'Digital Surface Model' as the Surface and apply 'Linear Fit' as the Base Plane.

Note that volume measurements produced by DroneDeploy of beached sargassum and are NOT always accurate!

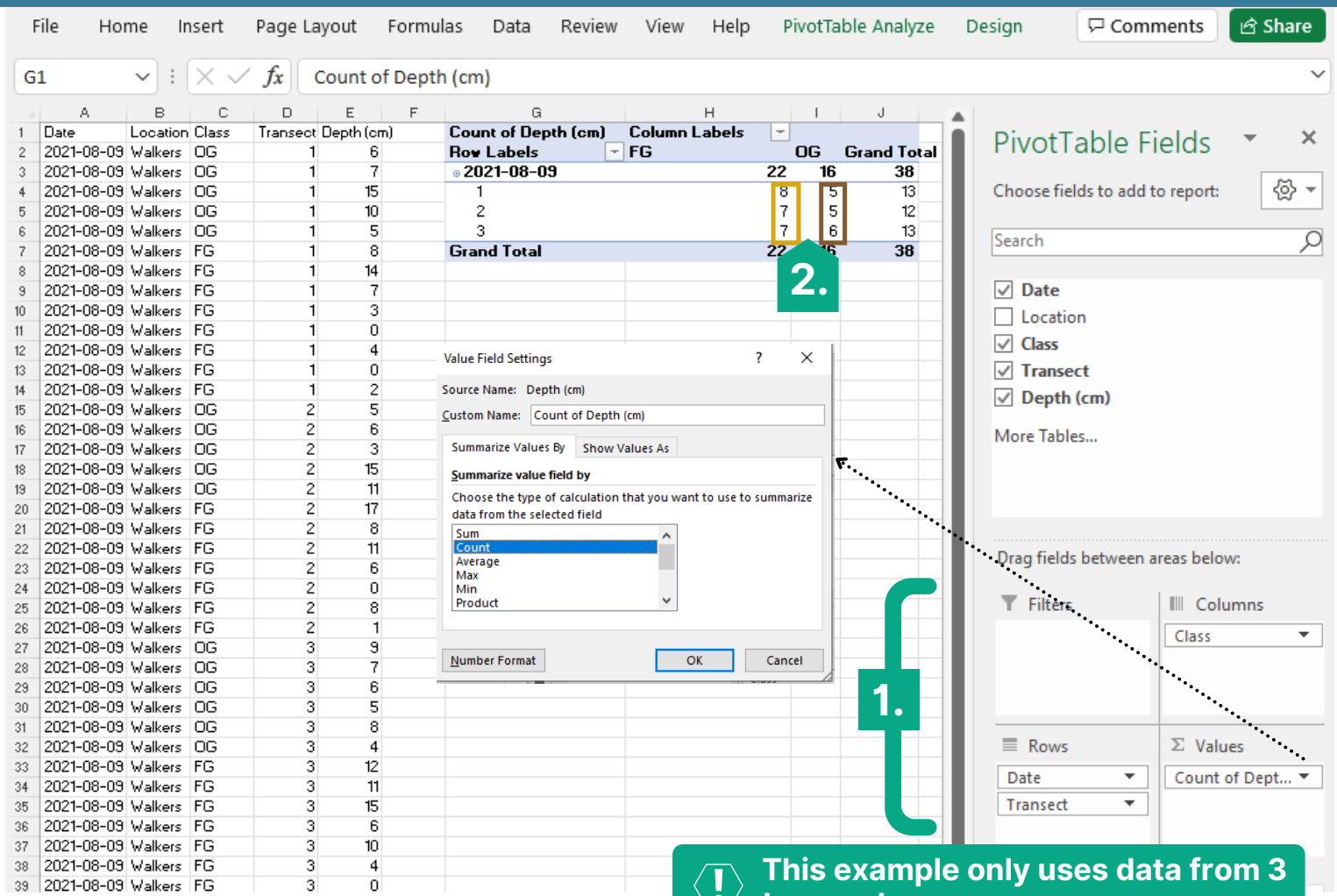
Data Analysis

Analysis of ground measurements using MS Excel

Your field data can provide estimates of sargassum abundance as surface area of the beach covered and as volume of beached sargassum.

A. Surface Area

A good estimate of surface area covered by Fresh Gold and/or Old Gold sargassum can be easily obtained from the mean length of the transects running across the sargassum.



Date	Location	Class	Transect	Depth (cm)
2021-08-09	Walkers	OG	1	6
2021-08-09	Walkers	OG	1	7
2021-08-09	Walkers	OG	1	15
2021-08-09	Walkers	OG	1	10
2021-08-09	Walkers	OG	1	5
2021-08-09	Walkers	FG	1	8
2021-08-09	Walkers	FG	1	14
2021-08-09	Walkers	FG	1	7
2021-08-09	Walkers	FG	1	3
2021-08-09	Walkers	FG	1	0
2021-08-09	Walkers	FG	1	4
2021-08-09	Walkers	FG	1	0
2021-08-09	Walkers	FG	1	2
2021-08-09	Walkers	OG	2	5
2021-08-09	Walkers	OG	2	6
2021-08-09	Walkers	OG	2	3
2021-08-09	Walkers	OG	2	15
2021-08-09	Walkers	OG	2	11
2021-08-09	Walkers	FG	2	17
2021-08-09	Walkers	FG	2	8
2021-08-09	Walkers	FG	2	11
2021-08-09	Walkers	FG	2	6
2021-08-09	Walkers	FG	2	0
2021-08-09	Walkers	FG	2	8
2021-08-09	Walkers	FG	2	1
2021-08-09	Walkers	OG	3	9
2021-08-09	Walkers	OG	3	7
2021-08-09	Walkers	OG	3	6
2021-08-09	Walkers	OG	3	5
2021-08-09	Walkers	OG	3	8
2021-08-09	Walkers	OG	3	4
2021-08-09	Walkers	FG	3	12
2021-08-09	Walkers	FG	3	11
2021-08-09	Walkers	FG	3	15
2021-08-09	Walkers	FG	3	6
2021-08-09	Walkers	FG	3	10
2021-08-09	Walkers	FG	3	4
2021-08-09	Walkers	FG	3	0

This example only uses data from 3 transects.

1.

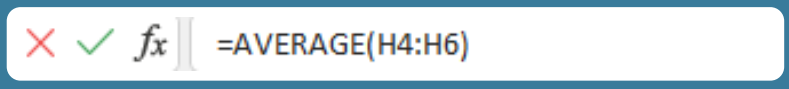
Using the MS Excel PivotTable tool:

- Drag sargassum 'Class' to Columns
- Drag 'Date' and 'Transect' to Rows
- Drag 'Depth' to Values and choose 'Count of...' function

This will give you a table showing the number of depth measurements per transect shown separately for each sargassum class.

2.

Use this table to calculate the average number of depth measurements per transect using the simple '=AVERAGE(number 1, number 2, ...)' function in MS Excel (values to be averaged highlighted in example screen shot).



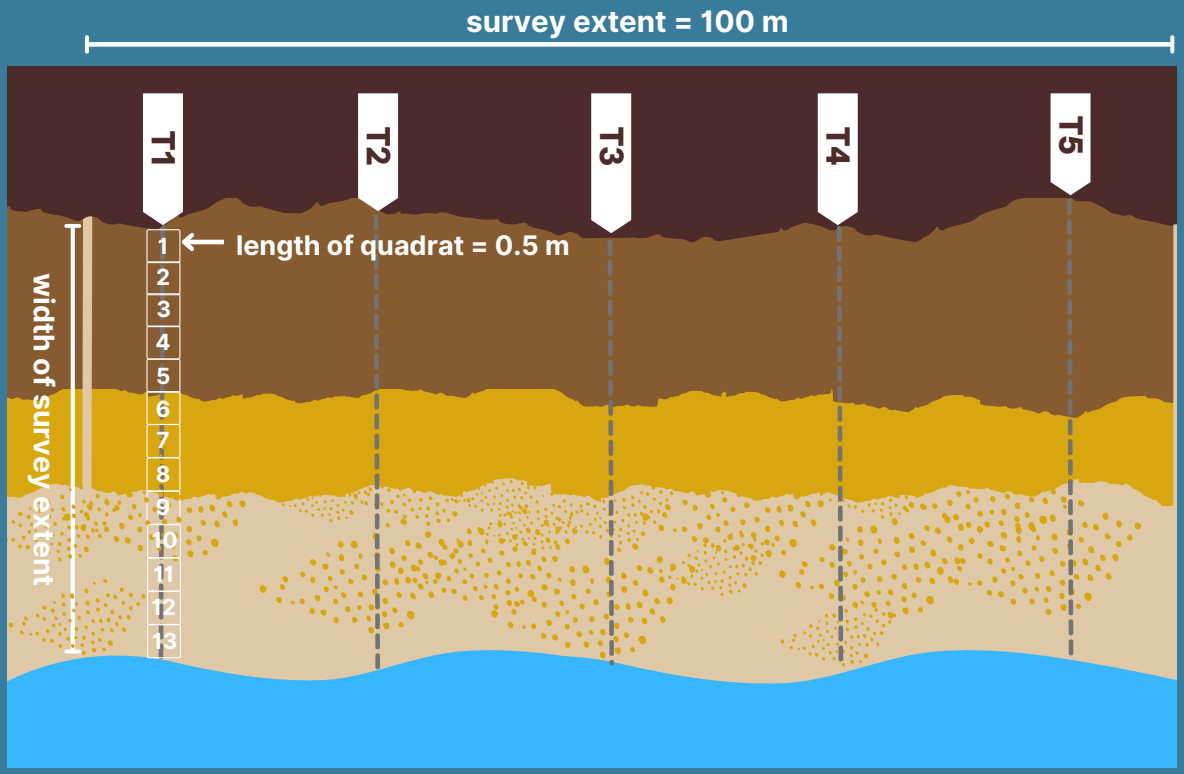
In given example: OG = 5.33 depth measurements per transect; FG = 7.33 depth measurements per transect.

Since you measured the sargassum depth every 0.5 m along the transect, you can multiply the average number of depth measurements by their distance apart (0.5 m) to obtain an average width of the sargassum band on the beach in metres.

In given example: OG = 2.67 m wide; FG = 3.67 m wide

Average width

	Average number of depth measurements	x	Distance apart (m)	=	Average length of transects (width of sargassum band)
OG	5.33	x	0.5	=	2.67 m
FG	7.33	x	0.5	=	3.67 m



Graphic showing fixed grid pattern used during ground measurements methodology

The surface area of each sargassum class can then be obtained in square metres (m^2) by multiplying the average width (m) of the beached sargassum band by the length (m) of the surveyed beach extent (e.g. 100 m).

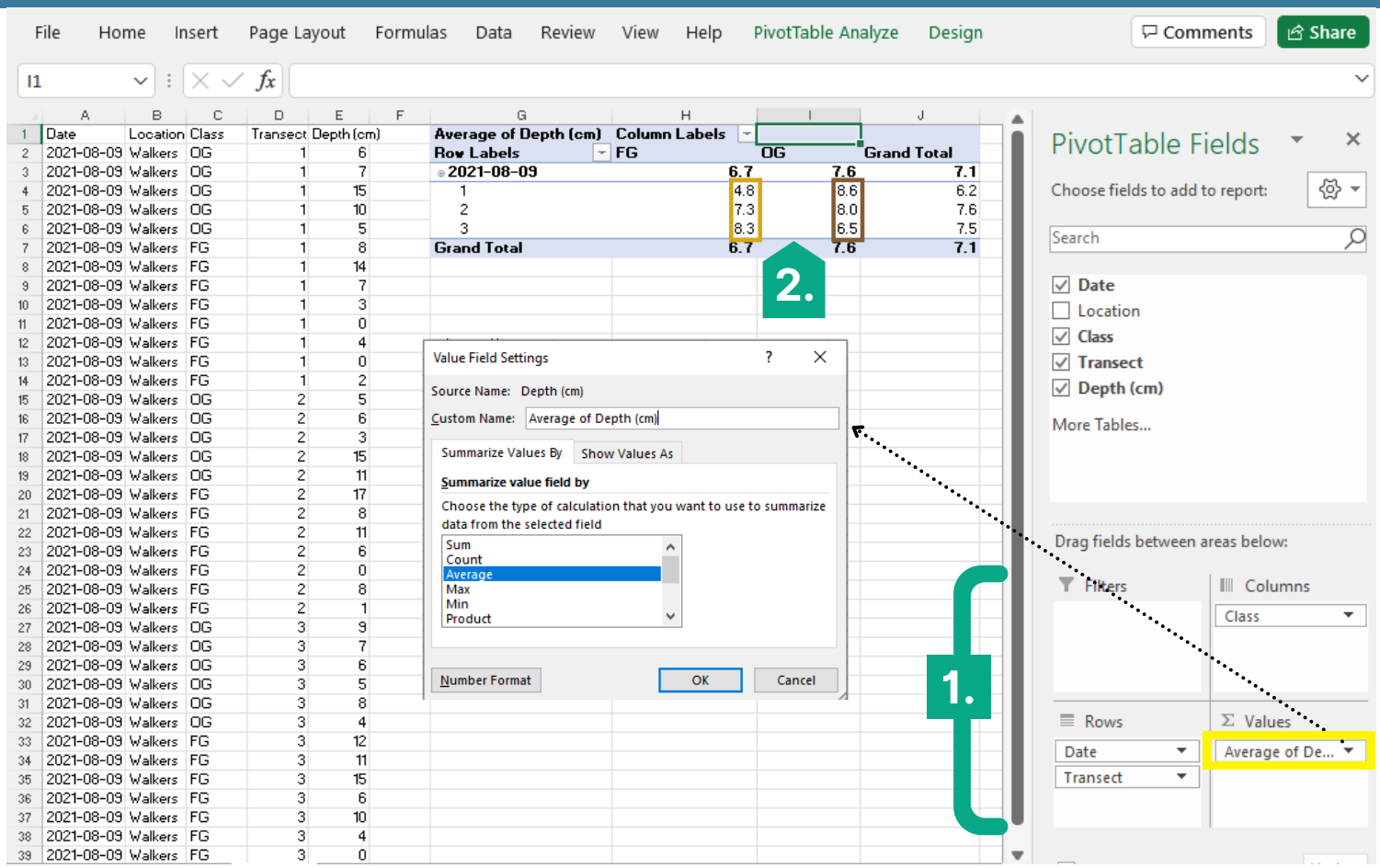
Surface area

	Average width	x	Beach extent	=	Surface area
OG	2.67 m	x	100 m	=	**267 m^2**
FG	3.67 m	x	100 m	=	**367 m^2**

Note that this estimate of area can be checked against the surface area obtained in DroneDeploy (which is precise).

B. Volume

An estimate of the sargassum volume (for each class) can also be obtained using the same MS Excel data sheet and the same PivotTable selections, **with one minor change**, as follows:



1.

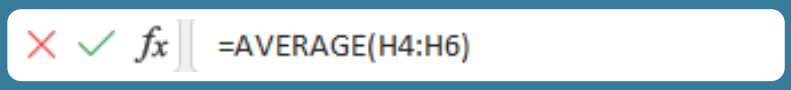
Using the MS Excel PivotTable tool:

- Drag sargassum 'Class' to Columns
- Drag 'Date' and 'Transect' to Rows
- Drag 'Depth' to Values and choose 'Average of...' function

This will give you a table showing the mean depth of sargassum per transect shown separately for each sargassum class.

2.

As before, use this to calculate the overall average depth of each sargassum class across all transects (using the simple '=AVERAGE(number 1, number 2, ...)' function in MS Excel (values to be averaged are highlighted in screen shot example.



In given example: mean depth of OG = 7.7 cm ; of FG = 6.8 cm.

This can be extrapolated up to the survey area (e.g. 100 m beach extent) by:

- **Dividing your average depth (in cm) by 100 to convert to metres**

Average depth of sargassum across survey extent

OG	7.7 cm / 100 = **0.077 m**
FG	6.8 cm / 100 = **0.068 m**

- **Multiplying this average by your calculated surface area (m^2) for each sargassum class to give you the volume of sargassum in cubic metres (m^3)**

Volume

	Average depth	x	Surface area (previous calculation)	=	Volume
OG	0.077 m	x	267 m^2	=	**20.6 m^3**
FG	0.068 m	x	367 m^2	=	**23.0 m^3**

Note that this estimate of volume can be compared with the volume estimate obtained using DroneDeploy (to check that they are in the same 'ballpark').

Based on previous research, the DroneDeploy result is highly variable and not always accurate, so your ground measurement estimates should be used.

C. Volume to Weight Conversion

The average weight of freshly beached (wet) sargassum can be easily measured in the field. This only needs to be done once to give you a good conversion between volume and weight. Note, however, that it should be done separately for each sargassum class.

1. Fill a bucket of known volume with handfuls of sargassum straight off the beach – exactly as you find it (do not compress in the bucket).

2. Take the weight. Repeat this at least 10 times to get a good average.

Volume of bucket used during protocol development

=

22.35 L

(0.02235 m³)

Average weight (minus the bucket's weight)

2.87 kg

So, 1 m³ of FG is

$$\frac{2.87\ \text{kg}}{0.02235} = 128.41\ \text{kg}$$

Average weight (minus the bucket's weight)

3.33 kg

So, 1 m³ of OG is

$$\frac{3.33\ \text{kg}}{0.02235} = 148.99\ \text{kg}$$

Sharing Information

We suggest three different summary products for sharing monitoring survey data.

A. **Progress Report**

B. **SMP Monitoring Report**

C. **Shared Database**

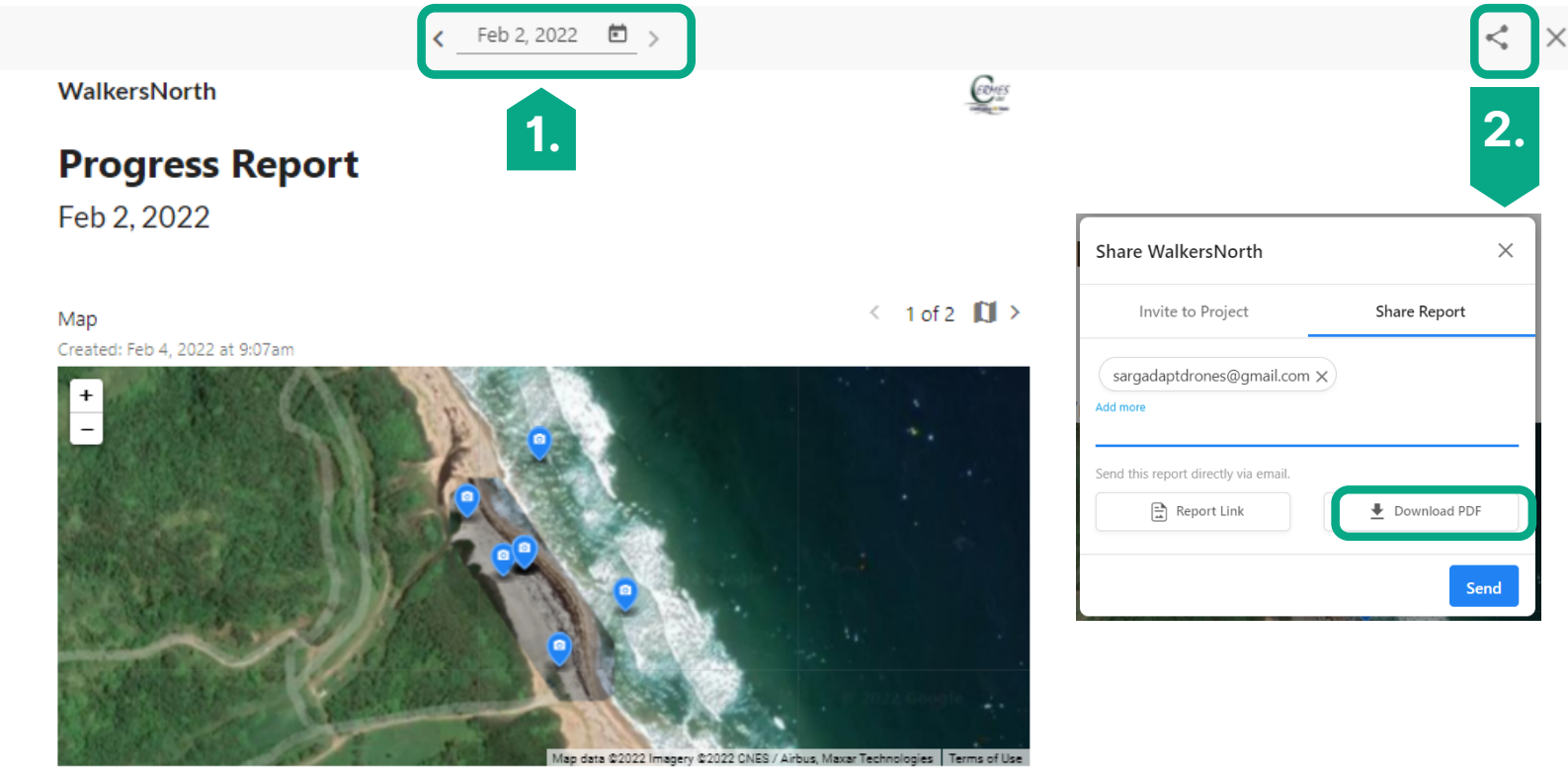
A. Progress Report

This provides a visual summary that contains all of the media for a project's specific flight date.

This Progress Report is automatically generated to give a site summary of all of the flight plans (maps, photos, 360° panorama and video) to share with stakeholders.

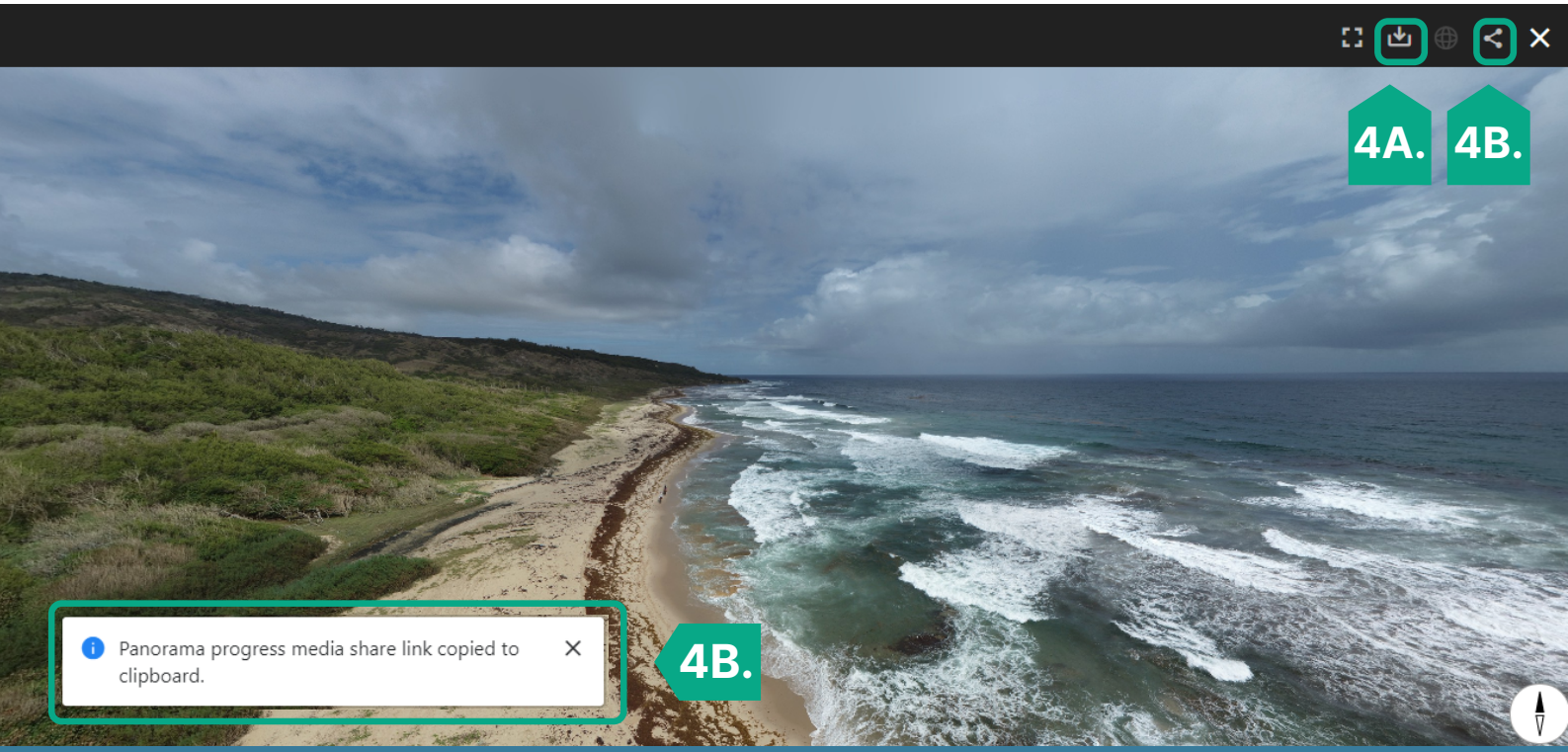
1. Select the Survey Date

Note: When more than one flight survey has been conducted at the site, you are able to view them in chronological order - starting from the most recent date.



2. You can download and save or print out or share an electronic copy of the report with others via email, or download the PDF on your device and share it via other means (WhatsApp, etc.).

3. If you left-click any of the representative images in the Report, you can open and interact with them, as shown in the image below.



4. This view appears on-screen after the Panorama image is selected; it allows for an interactive 360 panoramic view of the survey site!

You can also: A. download the panoramic image, or
B. copy and share the link to the 'super cool' interactive view.

B. SMP Site Monitoring Report

The 'Photo Report' in DroneDeploy can be customised and is used in this SMP-Drones to produce a 'SMP Site Monitoring Report' as explained below:

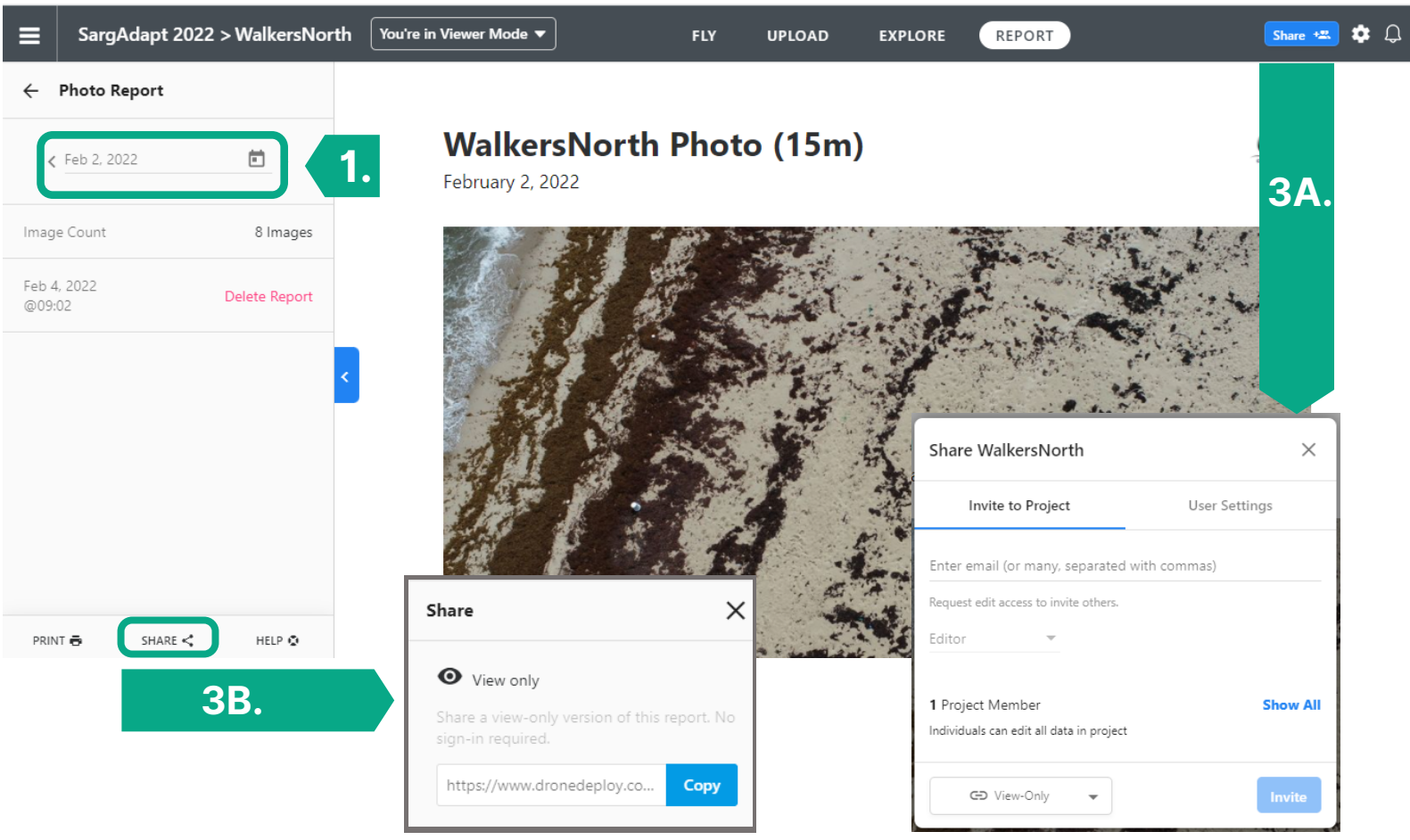
Online Resources

DroneDeploy

Learn more about...

Photo Reports

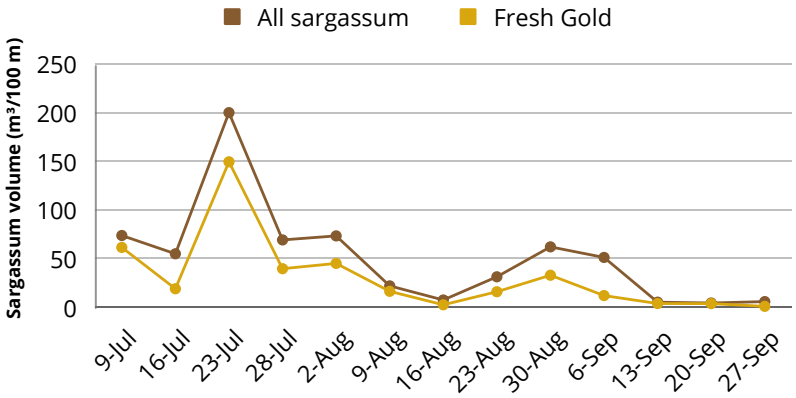
1. Like the Progress Report, when more than one flight survey has been conducted at the site, you can view them in chronological order - starting from the most recent date.



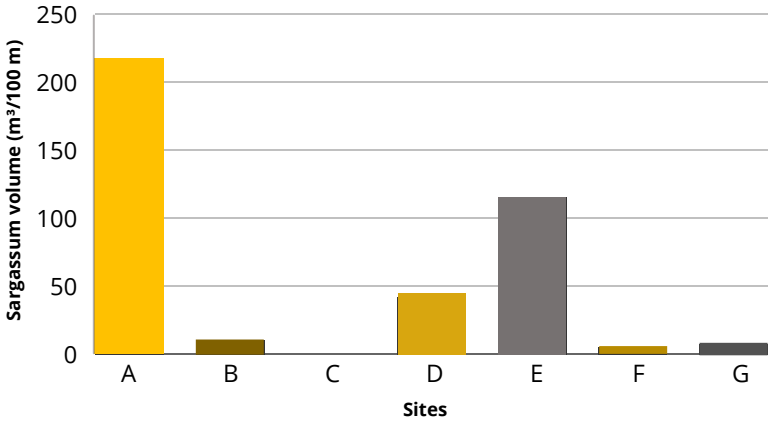
2. Ground measurement data, showing sargassum volumes and/or weights in a variety of formats can be added to customize your SMP Site Monitoring Report.

For example, Excel tables and graphics can be converted to JPEGs, and added. Other elements (maps, cell phone images etc.) can also be added along with text captions.

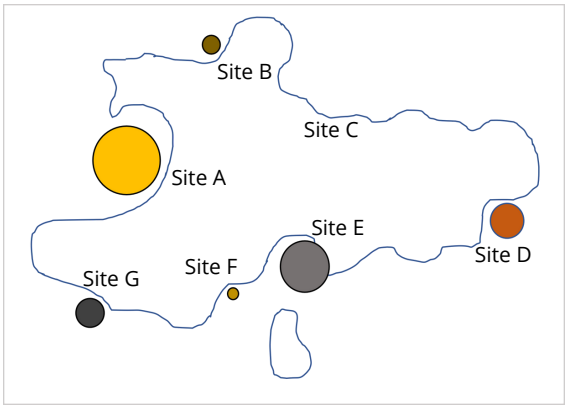
Data can be summarised and visualised from your Excel database to suit local applications, and added to your SMP Site Monitoring Report, as shown in these examples:



This line graph displays time series data collected at one site to show seasonal variation in sargassum beaching volume



This bar chart displays data collected at several sites at the same time and shows spatial variation in sargassum beaching volume



This map shows the same spatial variation in sargassum beaching volume among sites, but also indicates site location

3. To share this SMP Site Monitoring Report, you can:

A. invite others via email

B. copy and send a view-only link, to view survey photos from a specific date

C. Shared Database

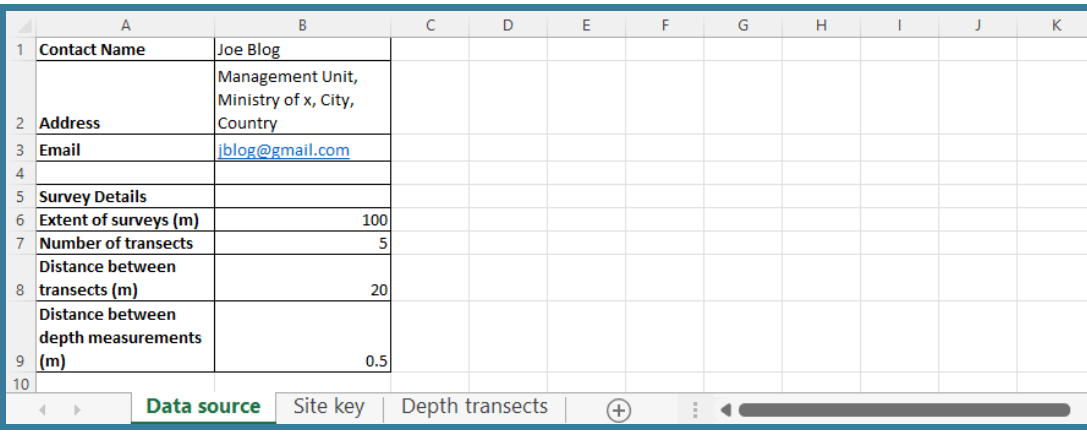
The simple standard-template MS Excel database created for downloading the ground measurement data in this SMP-Drones is appropriate for sharing across sites to create a regional dataset.

The standard database should have 3 data sheets:

Data source | Site key | Depth transcects

1. Data Source

to show who provided the data and how it was collected

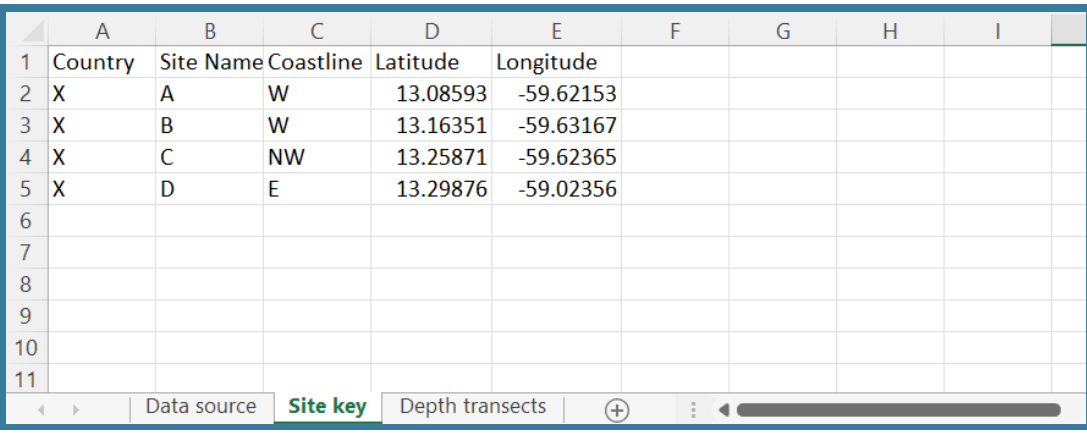


	A	B
1	**Contact Name**	Joe Blog
2	**Address**	Management Unit, Ministry of x, City, Country
3	**Email**	jblog@gmail.com
4		
5	**Survey Details**	
6	**Extent of surveys (m)**	100
7	**Number of transects**	5
8	**Distance between transects (m)**	20
9	**Distance between depth measurements (m)**	0.5
10		

Data source | Site key | Depth transects

2. Site Key

to give details on where sites are located

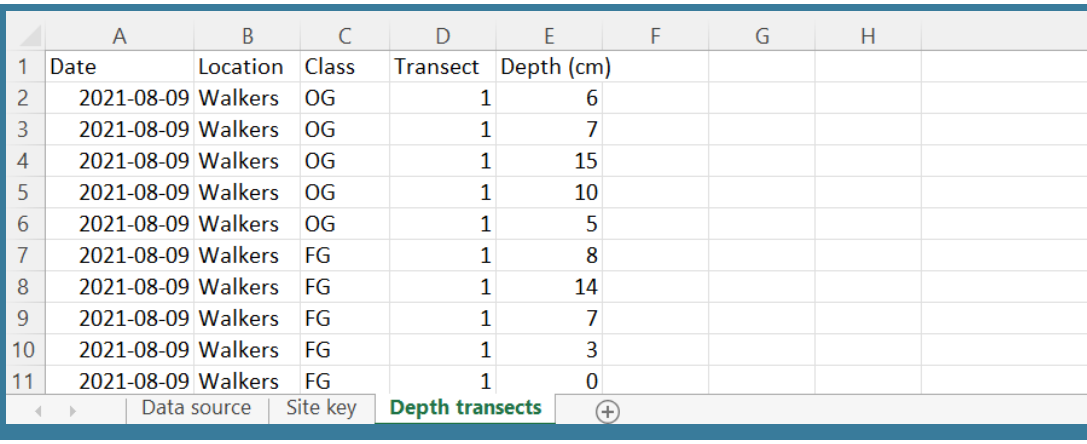


	A	B	C	D	E
1	Country	Site Name	Coastline	Latitude	Longitude
2	X	A	W	13.08593	-59.62153
3	X	B	W	13.16351	-59.63167
4	X	C	NW	13.25871	-59.62365
5	X	D	E	13.29876	-59.02356
6					
7					
8					
9					
10					
11					

Data source | Site key | Depth transects

3. Depth Transects

sargassum depth measurements for every transect



	A	B	C	D	E
1	Date	Location	Class	Transect	Depth (cm)
2	2021-08-09	Walkers	OG	1	6
3	2021-08-09	Walkers	OG	1	7
4	2021-08-09	Walkers	OG	1	15
5	2021-08-09	Walkers	OG	1	10
6	2021-08-09	Walkers	OG	1	5
7	2021-08-09	Walkers	FG	1	8
8	2021-08-09	Walkers	FG	1	14
9	2021-08-09	Walkers	FG	1	7
10	2021-08-09	Walkers	FG	1	3
11	2021-08-09	Walkers	FG	1	0

Data source | Site key | Depth transects

Standardized Naming Convention

SMPdata CountryName Years

e.g., SMPdata Barbados 2021-2022

Appendix

Drone Equipment Shopping List

Item	Description	Quantity
Quadcopter Drone	Equipped with standard (RGB) camera payload (1-inch 20-megapixel sensor with 4K/60fps video) ***e.g.* DJI© Phantom4 Pro, Mavic2 Pro, Mavic Pro, Air, Air2**	**1**
Drone Batteries	Intelligent Flight Battery (LiPo 15.2V)	**3**
Propellers	Low-noise quick-release (2-pack)	**2**
Memory Card	MicroSD (32 GB) high-speed (Class U3)	**2**
Carrying Case / Backpack	For transportation of the drone and accessories	**1**
iOS Mobile Device / Tablet	iPad 2019+ (25 cm) 64 GB (either Wi-Fi enabled or cellular)	**1**
Landing Pad	Lightweight portable drone landing pad	**1**
Polarizer Lens	Circular Polarizer / Linear (CPL) filter to reduce glare from beach and off of the sea	**1**
Clipboard and Datasheets	Recording of flight parameters and field notes	**1**
Desktop or Laptop Computer	Windows (64 bit) with minimum of 8 GB RAM	**1**
External Drive	Portable hard drive (minimum of 2 TB)	**1**

Acknowledgments

This document is an output of the Caribbean Biodiversity Fund (CBF) project 'Adapting to a new reality: managing responses to influxes of sargassum seaweed in the Eastern Caribbean' (SargAdapt), co-financed by the International Climate Initiative (IKI) of the German Federal Ministry for Environment, Nature Conservation, and Nuclear Safety through KfW.

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KFW

based on a decision of the German Bundestag

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DroneDeploy

MARINE SPATIAL INFORMATION SOLUTIONS

WIRRED
Walkers Institute for Regenerative Research, Education and Design

For more information

Check out the links below:

- Field Measurements Instructional Video
- Sargassum Drone Survey at Consett, Barbados
- DroneDeploy Ultimate How-To Guide
- CERMES Sargassum webpage
- CERMES StoryMap: "Surveying the Gold"

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