



DPLUS065 Coastal Habitat Mapping project

8th – 10th July 2019

Stanley, Falkland Islands

From Satellites to Drones: Earth Observation and Habitat Mapping Training Workshop



Version Control Table

Version	Date	Author	Comments
0.1	11/10/19	NG	Circulated to workshop participants
1.0	20/12/19	NG	Final version

Recommended citation: *Golding, N., Jones, G. & Black, B. 2019. From Satellites to Drones: Earth Observation and Habitat Mapping Training Workshop Report. DPLUS065 Coastal Habitat Mapping project 8th – 10th July 2019. 16pp.*

Cover image: *Satellite imagery courtesy of Digital Globe Foundation. Panchromatic image of Grytviken, South Georgia.*

1. Table of Contents

2.	Background	5
3.	Workshop aims	6
4.	Opening of the workshop	6
5.	Introduction to Earth Observation (EO).....	6
	Scenario 1:.....	7
	Scenario 2:.....	8
6.	Practical sessions to enhance understanding of Earth Observation data.	9
6.1.	Using Unmanned Aerial Vehicles (UAVs/drones) for coastal habitat mapping: regulations and flight demonstration	9
6.2.	Practical session: Introduction to spatial resolution.....	10
6.3.	Practical session: Introduction to spectral resolution	12
7.	Understanding the Coastal Habitat Mapping project modelling/mapping workflow	14
8.	Practical exercise collecting ground-truthing data in the field.....	16
8.1.	Pixel size or patch size:.....	16
8.2.	Mosaic habitats:.....	16
8.3.	Other thoughts during ground truthing:.....	16
9.	Project legacy discussion session.....	17
9.1.	Question 1: This training workshop is part of the legacy development for the project. Looking ahead, where do you feel the future long-term monitoring role could sit for both Falklands and South Georgia – to help identify where responsibilities lie?	18
9.2.	Given the intended legacy of the project, with maps that will be updated in the future, how can opportunistic data collection feed into the process? For example, data collection from ‘citizen scientists’ (e.g. tourists or cruise ship staff), asking other science projects to collect data whilst working at rarely visited sites etc.....	18
9.3.	Over and above what has been discussed to date, what other ideas/real world applications do you have for use of the project outputs (broad-scale and fine-scale habitat maps)? E.g. ideas for scientific applications etc.	19
9.4.	What would help make our approach/model usable for you for future work and/or on a more regular basis?.....	19
9.5.	For environmental monitoring purposes, how frequently would you choose to use high-resolution satellite imagery if it were available (e.g. WorldView)?.....	20
10.	Quiz to test Earth Observation (EO) knowledge	21
11.	Workshop feedback questionnaire.....	22
12.	Annex I:	24

Day 1 – Monday 8 th July 2019	24
Day 2 – Tuesday 9 th July 2019	25
Day 3 – Wednesday 10 th July 2019	26
13. Annex 2:	27
14. Annex 3:	28
15. Annex 4: Workshop feedback questionnaire.....	29

2. Background

The coastal and inshore marine ecosystems (and their constituent habitats within) and resources of the Falklands and South Georgia are an important ecological, social and economic component of these islands natural capital. The coastal ecosystems around South Georgia for example, provide an essential habitat for globally important populations of birds and marine mammals. Knowledge of these coastal environments is essential for their management, yet comprehensive island-wide broad-scale and fine-scale coastal habitat maps are lacking. Comprehensive habitat identification could fill a critical evidence gap and provide an important baseline from which to measure future change, habitat restoration success or human impact.

Habitat models and their visualization as maps are a fundamental element for understanding the distribution and extent of features across the landscape, and can facilitate better management practices, natural capital accounting, ecosystem service mapping, interpreting and targeting biodiversity monitoring and delivering policies. Both the Falkland Island Government (FIG) and the Government of South Georgia & the South Sandwich Islands (GSGSSI) have environmental policies and strategies where a baseline knowledge and understanding of the coastal margin assists related policy decisions.

The Darwin (DPLUS065) Coastal Habitat Mapping project, grant aided by the Darwin Initiative through UK Government funding, created the first broad-scale satellite-derived coastal habitat maps for both these UK Overseas Territories, using medium resolution satellite imagery alongside other spatial data and local expert knowledge. This three-year project brought together experts from [SAERI, Oregon State University, Shallow Marine Surveys Group](#), the UK [Joint Nature Conservation Committee, Falkland Islands Government](#) and the [Government of South Georgia & the South Sandwich Islands](#). Where there was significant uncertainty in these broad-scale maps, or in response to specific priorities from stakeholders, fine scale habitat maps utilising very high-resolution satellite imagery (via the Digital Globe Foundation grant) or bespoke imagery captured using aerial drones were developed. Together, these broad and fine-scale habitat maps have created a baseline for the Falkland Islands and South Georgia, providing a sound basis for use in future planning, decision-making and monitoring.

3. Workshop aims

Over the last two years, the [DPLUS065 Coastal Habitat Mapping project](#) developed a range of tools and methods to model, map and monitor the coastal margins of both the Falkland Islands and South Georgia. An important component of the Coastal Habitat Mapping projects legacy was the transfer of this knowledge to relevant individuals in both Territories, and a dedicated workshop was run in order to facilitate this transfer. Over three days, experts in Earth Observation (EO) and habitat modelling from the UK and the USA led the training alongside SAERI's Coastal Habitat Mapping project manager. The training was provided through a combination of classroom theory, indoor and outdoor practical sessions. To further the legacy of this training event, and the wider project, a series of videos was created as part of the workshop, as future training aid, and these are available on the [SAERI YouTube channel](#).

The workshop agenda can be found in Annex 1.

4. Opening of the workshop

Following round table introductions, and a discussion around participant's aspirations for the three days, Neil Golding, project manager of the DPLUS065 Coastal Habitat Mapping project, introduced the project ([presentation available here](#)). This was followed by two presentations by the Government representatives of the two UK Overseas Territories where the project was based. As project partners, they provided a summary of why the Coastal Habitat Mapping project was so important for them. Ross James, Visitor Management & Biosecurity Officer for the Government of South Georgia & the South Sandwich Islands presented a South Georgia perspective ([available here](#)) while Denise Blake, Environmental Officer and Policy Advisor for Falkland Islands Government presented a Falkland Islands perspective ([available here](#)).

5. Introduction to Earth Observation (EO)

All managers and decision makers were encouraged to attend this session, with the main aim looking to provide individuals with the tools to decide when EO is appropriate to use, and which types of EO would be the most suitable for a range of requirements and applications. Gwawr Jones went over the basics of EO, mostly focusing on optical and passive remote sensing ([presentation available here](#)). Then the group were given a tour of the technology with a focus on how satellite, aerial and drone data have been used in applications around the world ([presentation available here](#)).

There were some questions from the floor on how to activate the disaster charter, and what you can activate it for (based on the monitoring of wild fires example given by Gwawr). There was particular interest in being able to sign up to the disaster charter for use in oil spill events and small-scale fires in camp in the Falklands; this was an interesting and unexpected positive outcome from the workshop.

After the break, Gwawr went over the advantages and limitations of EO data ([presentation available here](#)). Part of the session focused on the need to pre-process satellite data into a useful form before any analysis could be undertaken, specifically carrying out atmospheric correction to optical data to

get consistent, surface reflectance imagery. The concept of producing Analysis Ready Data (ARD) was introduced (Figure 1) as a potential way of eliminating the barrier of needing earth observation expertise to carry out the pre-processing. Another limitation that was discussed was the vast volume of data being collected from space and how unpractical it is to download terabytes of data to local servers for analysis, especially in the Falkland Islands and South Georgia. The concept of cloud storage and computing was introduced as a potential way of reducing the limitation of data volumes and lack of bandwidth for downloading large images.



Figure 1: Gwawr Jones introducing the concept of Analysis Ready Data (ARD).

After this session, an exercise was given to the group where they were given two scenarios (listed below) had to decide what kind of EO data would be most appropriate to use to gather information or evidence based on the requirement of the scenario. The delegates were split into 5 groups of 4 people; each group was asked to discuss the scenarios and come up with an answer to the different resolutions required, and feedback in plenary.

Scenario 1:

Requirement = baseline map of broad habitats of all the Falklands and South Georgia, with potential to update and repeat the process in the future to record any changes in a cost-effective way.

- Most groups identified that a multispectral sensor at medium to high spatial resolution would be most appropriate as the data is being continuously collected and openly available therefore, cost effective easy of accessing data for future information.
- There was a discussion over whether seasonal or monthly data was needed to input into the classification process. During the discussion it was agreed that seasonal data would suffice, with particular caution to avoid the winter season in South Georgia due to snow and ice coverage limiting the ability of satellite data to visualise the habitats.

- No group identified the potential of active sensors such as Synthetic Aperture Radar (SAR) to monitor change over time and add another dimension to habitat identification and separability from surface roughness (backscatter products). The group was introduced to the concept of using other data sources, such as elevation, slope, aspect etc. into the classification process to maximise separability of habitats based on contextual knowledge.

Scenario 2:

Requirement = monitoring grazing pressures in the Falklands and monitor recovery of habitats after the removal of reindeer in South Georgia.

- Most groups identified multispectral sensors and an active sensor such as Sentinel-1 to monitor grasslands over time, with the active sensor being used to monitor growth stages and recovery after grazing pressure is removed.
- There was a range of answers in relation to the spatial resolution with some of the groups stating a requirement for very high-resolution data (Falklands specific) to pick out small changes, such as plant stress due to grazing. The other groups identified that medium to high spatial resolution would be sufficient as the requirement is looking to measure a change in signal over time potentially over large areas (as opposed to per field or other small unit of measurement).
- One group identified the link to the policy requirement and how often you would actually need to monitor based on the decisions you would make while the habitats are recovering i.e. once a season just to monitor recovery, as opposed to continuous monitoring on areas that are being grazed today like the Falklands.
- Most groups picked up on the need to use local knowledge, and farmers' information/data on grazing pressure, or location of known reindeer populations in South Georgia before eradication programme.

This session was well received, and initial comments were positive. Many of the groups were able to make appropriate decisions in the 'What EO?' exercise, picking up on the information that was presented to them during the sessions and combining the information with their own policy needs and requirements. Participants commented that they felt more confident in making decisions when needing to select EO data for project work and applications at many different levels, including participants from the local high school that volunteered to participate on the course and delivered their groups' answers during the exercise.

6. Practical sessions to enhance understanding of Earth Observation data.

6.1. Using Unmanned Aerial Vehicles (UAVs/drones) for coastal habitat mapping: regulations and flight demonstration

Neil Golding introduced the regulatory and legal framework governing UAV/drone use in the Falklands and South Georgia. A practical drone mapping demonstration was then undertaken at Hookers Point (Figure 2). The results from this mapping demonstration can be seen in Figure 3.



Figure 2: Providing a practical drone mapping demonstration at Hookers Point, outside Stanley.

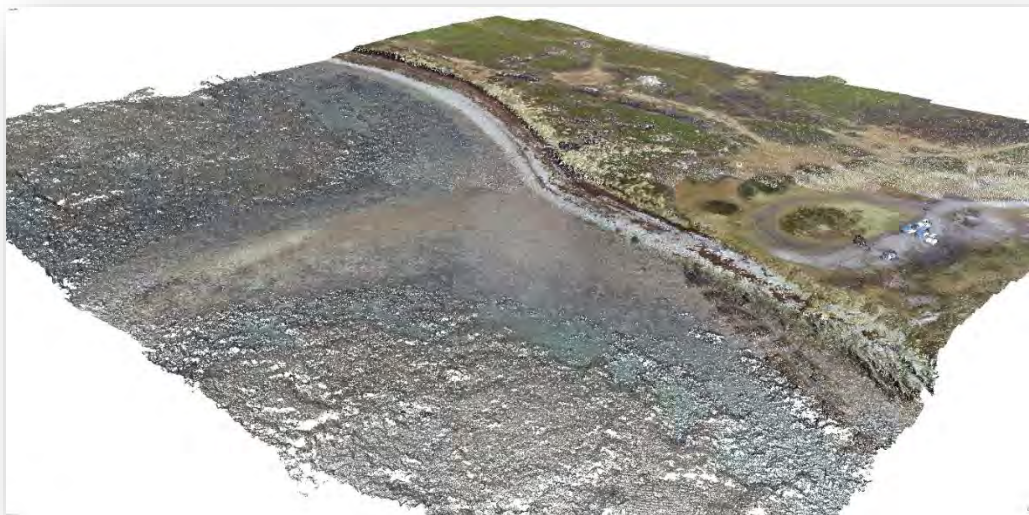


Figure 3: Dense point cloud generated from drone aerial imagery collected during the drone mapping demonstration.

6.2. Practical session: Introduction to spatial resolution

This practical session was carried out in the field, where participants were asked to 'create' pixels at different spatial resolutions to visualise what spatial resolution means on the ground. To 'create' pixels, individuals were asked to create a box with each person standing 30 m apart to simulate what a Landsat pixel would look like on the ground (Figure 4). The group then discussed what different habitats and land covers were visible within that one pixel. To simulate a Sentinel-2 pixel a smaller box was created where participants were stood 10 m apart, and a similar discussion on visible habitats/land cover followed.



Figure 4: Measuring out satellite imagery pixel size in the field.

Once the 'creating' pixels exercise was complete, the group was asked to look at figures of Landsat-8, Sentinel-2, Worldview-2 and drone imagery of the area we visited in the field (Figure 5 & 6). The purpose of this exercise was to emphasise that pixels do not conform to any particular features on the ground and that one mean value per spectral band is returned within the image. As pixels are arbitrary objects that can be affected by its neighbouring pixel values (adjacency affect), the participants were made aware of the impact of this and that features on the ground need to be of a selected scale to be separable in the different spatial resolutions present. This also works the other way around i.e. if you were interested in broad scale changes such as a vegetated area that is no longer vegetated, then Landsat-8 or Sentinel-2 would be appropriate scale imagery, and there is no need to purchase commercial imagery or collect drone data for monitoring.

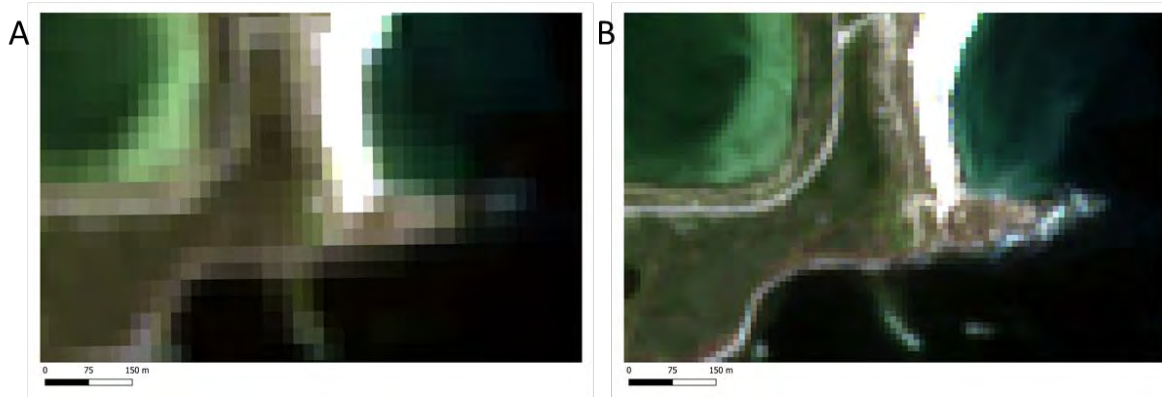


Figure 5: A) Landsat-8 image (4th February 2019) in true colour; B) Sentinel-2 image (9th February 2018) in true colour, of Hooker's point in the Falkland Islands. Contains modified Copernicus data [2018] processed by JNCC. Landsat imagery courtesy of NASA Goddard Space Flight Center and U.S. Geological Survey.

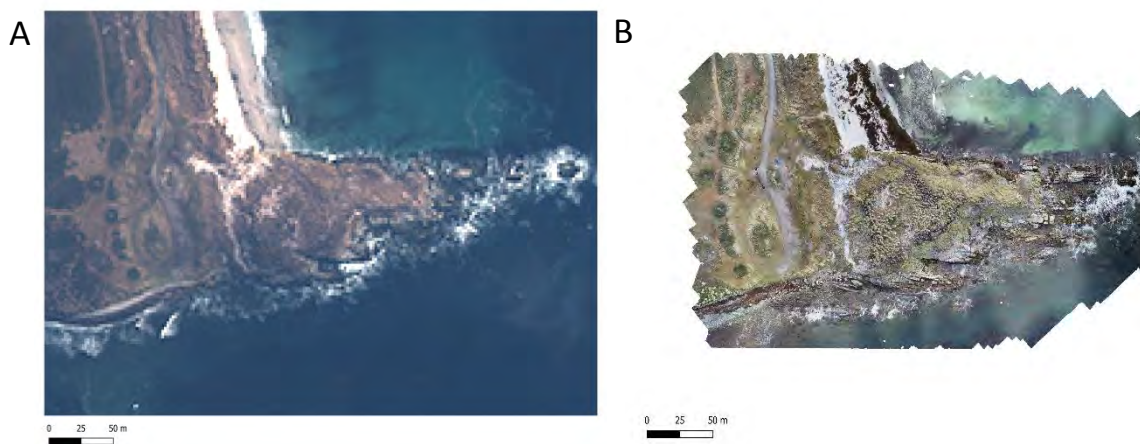


Figure 6: A) Worldview-2 image (21st October 2015) in true colour; B) Drone image (12th July 2018) in true colour, of Hooker's point in the Falkland Islands. Satellite image courtesy of the DigitalGlobe Foundation. Drone image © SAERI, 2018.

Many people commented that this was a useful task to relate pixels from imagery to actual size on the ground, especially when discussing the adjacency affect and how neighbouring pixels affect the mean value provided by a pixel in an image. The outcome of this exercise was that the participants learnt more about the spatial resolution trade-off between temporal frequency and cost, enhancing their understanding of what type of EO is suitable for which applications.

6.3. Practical session: Introduction to spectral resolution

This practical session was carried out on the participant's laptops where most people were using QGIS. The exercises were as follows:

- Open a Sentinel-2 image of choice (one of the Falklands and one of South Georgia) and discovered how to visualise imagery in true colour, while getting to grips with all the bands.
- Visualise the imagery in false colour and explore why vegetation appeared red when applying this band combination.
- While displaying each individual band in grayscale, participants discovered that there are some features present beneath the water surface in the blue band, but that no reflectance measurement was present in the NIR band (Figure 7 & 8).

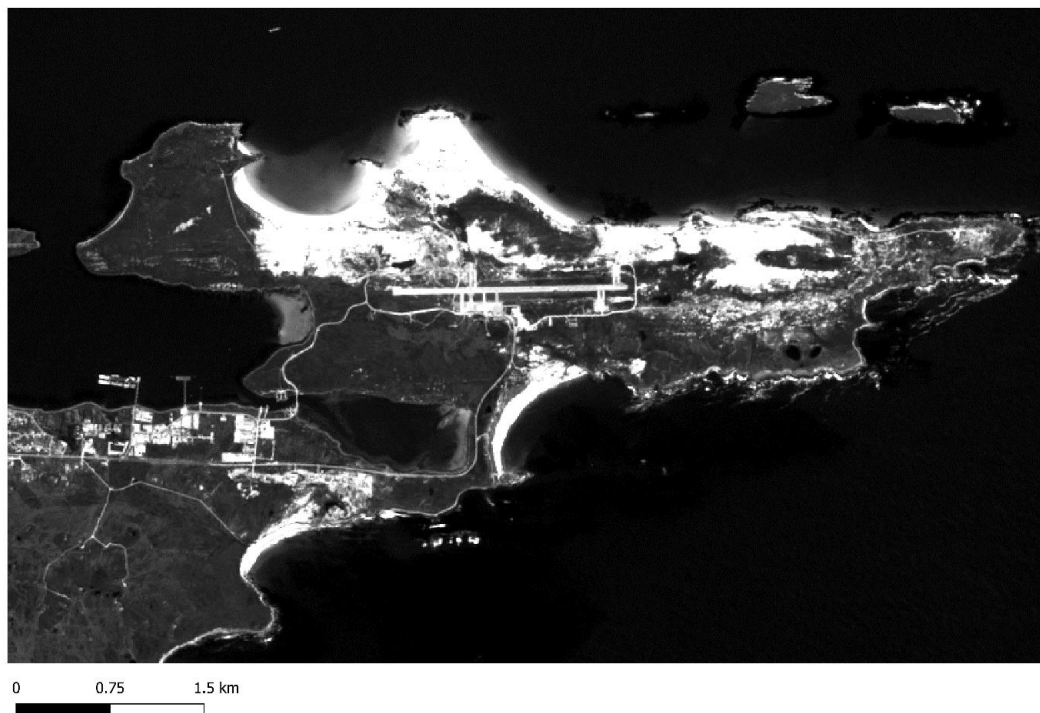


Figure7: Sentinel-2 image of the Falklands from 9th February 2018 with the blue band visualised in greyscale. Contains modified Copernicus data [2018] processed by JNCC.

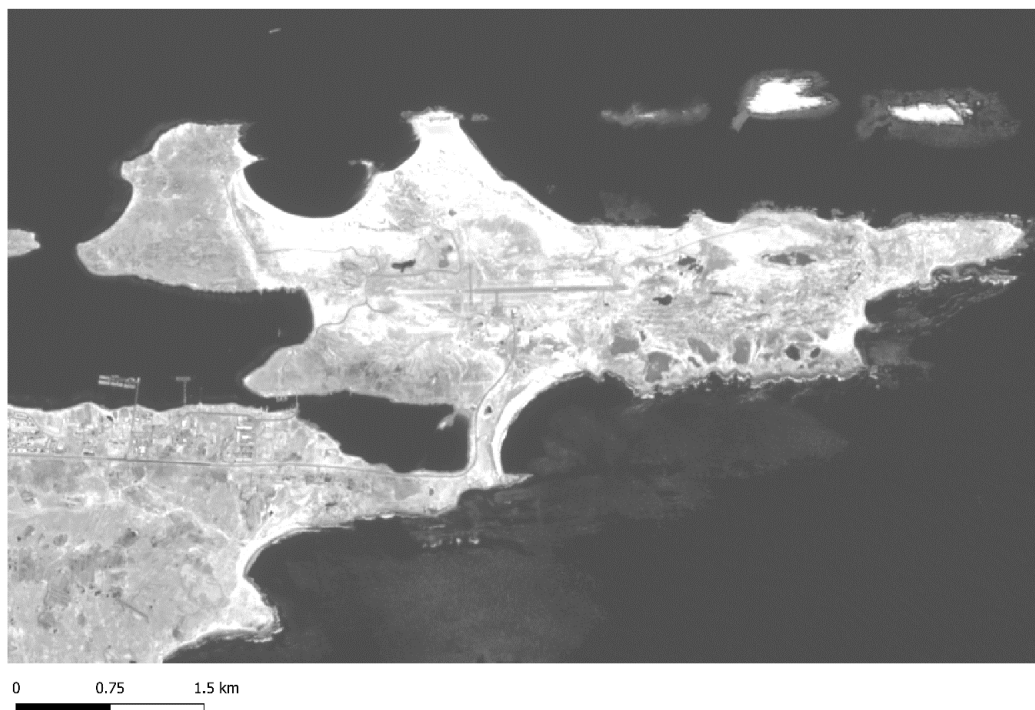


Figure 8: Sentinel-2 image of the Falklands from 9th February 2018 with the near infra-red band visualised in greyscale. Contains modified Copernicus data [2018] processed by JNCC.

- The last exercise of the day explained vegetation indices and asked the participants to calculate Normalised Difference Vegetation Index using raster calculator. They learned that this was a measure of productivity or greenness, as opposed to just looking at bands, and that the values related to a fraction (0-1).

This session was the most complex of the day and it involved participants exploring the images themselves using QGIS, which was the first time some of the participants had used this type of software. The concept of seeing ‘beyond the visible’ was explained with participants gaining an understanding of what parts of the spectrum are sensitive to which features on the ground. Some of the participants commented on the usefulness of the brief introduction to QGIS, and that they felt confident enough to continue exploring the imagery and other similar datasets on their own.

7. Understanding the Coastal Habitat Mapping project modelling/mapping workflow

Bran Black opened the morning session of Day 2, with an overview of the fine and broad-scale habitat modelling/mapping workflow ([presentation here](#)) utilised by the project, followed by a more detailed discussion of both modelling approaches ([presentation here](#)). The pixel-based, random-forest classification executed through the Google Earth Engine platform for the broad-scale map series was outlined. Following this, an overview of the object-based image analysis (OBIA) classification used for the fine-scale map series was provided, using open-source software options QGIS 3.4 (Madeira) and SAGA 7.2.0. Special attention was paid to a description of the segmentation process through which objects used to create object-based map products were produced.

There was a dedicated session on how the project tackled the collection of ground-truthing data, presented by Neil Golding ([presentation here](#)). P.B. Batista-Echevarría discussed how the IMS-GIS Data Centre had developed a smartphone application for the collection of ground validation data by the project, in Open Data Kit (ODK). Finally, Bran Black discussed how groundtruthing had been used within the habitat modelling process ([presentation here](#)).

After the mid-morning break, the process of compiling drone, commercial, and free medium resolution imagery was introduced, leading into an overview of principally supervised classifiers (with passing mention of unsupervised classifiers) and a description of how a supervised classification fitted into the overall project workflow. Random forest classifiers were then detailed with further attention, due to their predominate use in both the broad and fine-scale mapping projects ([presentation here](#)).

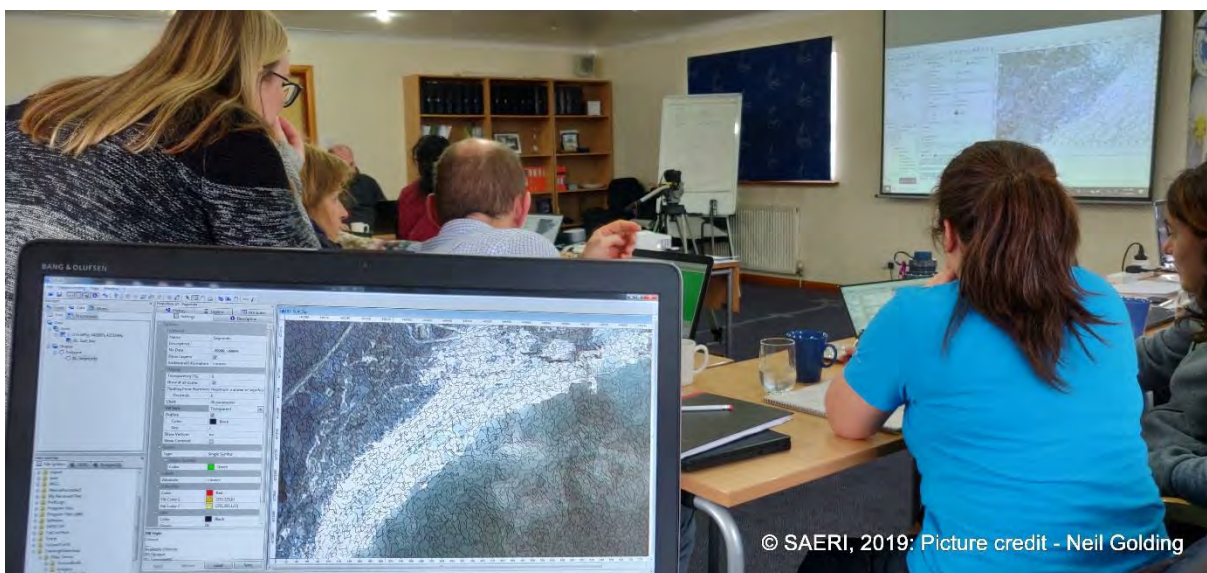
The creation and interpretation of confusion matrices, as a tool to test the success of a classifier used for landcover mapping, on a class-by-class basis, was then covered. Common causes of map inaccuracies were then discussed. The entire morning's proceedings were capped-off with a short open question/answer session where workshop attendees were presented with an opportunity to ask questions concerning the day's materials.

In the first half of the third day's presentations the discussion of the practical workings of this project's mapping process were broken into two segments; broad-scale and fine-scale mapping/modelling methods. The broad-scale mapping discussion covered the key components that would need to be created or addressed during the modelling process in chronological order, starting with the creation and importation of groundtruthing into the Google Earth Engine platform and the setup of the project map area. A well-annotated pseudocode [was presented](#) to workshop attendees, where the principle steps covered in the Earth Engine project code were "translated" into plain English for greater ease of audience interpretation. The pseudocode covered the following:

- the importing of project imagery and groundtruth data
- online project map display settings
- the application of a topographic correction to minimize the impact of shadow and excessive brightness in input imagery
- importing non-imagery data sources (digital elevation model (DEM) products, Geary's C analysis, NDVI, EVI, NDWI, etc.)

- the extraction of all input imagery to a final dataset to be used as input for the random forest classifier
- Splitting the training and validation datasets from the parent groundtruthing dataset
- Setting up and running the classifier
- Creation and exporting of confusion matrices
- Creation and exporting of final map geotiffs.

After the pseudocode was presented for the broadscale maps, a live demonstration where workshop attendees followed along throughout the process on their own laptops, was given. This presentation was an altered version of the project's object-based fine-scale modeling process modified to be easier for those workshop attendees who were relatively unfamiliar with the map creation process. The practical example map area was selected to coincide with a Surf Bay, a local beach familiar to many who attended the workshop and was located very near the site visited on the previous day's field demonstrations (Figure 9). Imagery was loaded and segmented in SAGA 7.2.0, followed by a round of groundtruthing for basic landcover classes visible in the provided imagery, followed by an object-based classification. The resultant classified polygon shapefile was then imported into QGIS for viewing and discussion.



© SAERI, 2019: Picture credit - Neil Golding

Figure 9: Running through a live demonstration of the fine-scale modelling workflow, using Surf Bay as an example.

8. Practical exercise collecting ground-truthing data in the field

After a briefing by Neil Golding, the workshop participants visited Hookers Point, and gained first-hand experience of using either the Coastal Habitat Mapping ground validation smartphone app (see Annex 3) and filling out field recording forms, to record ground-truthing data. This provided a useful insight into some of the challenges around ground-truthing data collection such as estimating patch size, percentage cover of different vegetation cover types and how to deal with mosaics.

8.1. Pixel size or patch size:

It was noted that the aspect at which you looked at your patch size influenced the percentage covers that were estimated. For example, two participants were looking at the same patch from different corners, and came up with estimates of 65% and 25% cover respectively.

When looking at patch size, you look at most dominant habitat/habitats to the top 3 to 4 habitats, and you generally ignore any small patches of different habitats as they won't significantly impact the signal from the pixel. [Sentinel-2].

If you look at the detail, then you have to consider GPS accuracy (generally around 3 to 4 m), and record features that may be outside your patch area on the notes. This can also serve as a way of validating the area of your GPS point (as unique features such as a memorial or track that are visible in the Worldview data can stand out in the imagery).

If unsure of patch size then scale up and note the most dominant habitat types in the area (large patch size). If area is homogenous then it is easier to record a ground truth point for both scales [Sentinel-2 and Worldview].

8.2. Mosaic habitats:

There are no straight lines in nature, so it is sensible to treat class boundaries with caution.

How to decide when to use a mosaic habitat class depends on spatial resolution of imagery, and all users need to be aware of class definition e.g. neutral grassland and dwarf shrub heath is a common mosaic in the Falklands.

8.3. Other thoughts during ground truthing:

When ground truthing at the WorldView (2m resolution) scale it is likely that an object-based image analysis is used during the classification process, therefore objects can be considered as opposed to pixels. An example of a linear feature was tested in the field, and a form filled in to reflect decision made is objects were being validated as opposed to pixels (Figure 10).



Figure 10: Getting some experience using the Coastal Habitat Mapping smartphone app as well as the paper recording forms to record ground validation information for the habitat modelling process.

Users can also validate object boundaries in the field if a project decides to take objects on form (or upload objects onto a base map on a tablet for example).

9. Project legacy discussion session

During this workshop session, participants were split into three sub-groups and tackled five questions, before coming back into plenary to discuss. The five questions were:

- This training workshop is part of the legacy development for the project. Looking ahead, where do you feel the future long-term monitoring role could sit for both Falklands and South Georgia – to help identify where responsibilities lie?
- Given the intended legacy of the project, with maps that will be updated in the future, how can opportunistic data collection feed into the process? For example, data collection from ‘citizen scientists’ (e.g. tourists or cruise ship staff), asking other science projects to collect data whilst working at rarely visited sites etc.
- Over and above what has been discussed to date, what other ideas/real world applications do you have for use of the project outputs (broad-scale and fine-scale habitat maps)? E.g. ideas for scientific applications etc.
- What would help make our approach/model usable for you for future work and/or on a more regular basis?
- For environmental monitoring purposes, how frequently would you choose to use high-resolution satellite imagery if it were available (e.g. WorldView)?

The compiled results for each of five questions from the sub-groups is shown below in Section 9.1 to 9.6 respectively. The key points raised in plenary for each question are also highlighted in blue boxes under each section.

9.1. Question 1: This training workshop is part of the legacy development for the project. Looking ahead, where do you feel the future long-term monitoring role could sit for both Falklands and South Georgia – to help identify where responsibilities lie?

- Government should lead and coordinate, while actual long-term monitoring could be undertaken by other bodies/organisations.
- Who would undertake the actual monitoring is dependent on application, e.g. agriculture/inshore fisheries/conservation remit with Falklands Conservation.
- From a Falklands perspective, data should be fed into IMS-GIS data centre. BAS may be the appropriate data lead from an South Georgia perspective.
- Could be collaboration with military/FIGAS/using vessels of opportunity.
- Regardless, a strategic approach is needed to data collection.

Coordination (and ownership) needs to be undertaken by the Governments of the Falkland Islands and South Georgia. However, the work itself can be completed by others.

A long-term, strategic approach needs to be adopted.

Existing data management frameworks (IMS-GIS data centre and BAS) should be utilised.

9.2. Given the intended legacy of the project, with maps that will be updated in the future, how can opportunistic data collection feed into the process? For example, data collection from ‘citizen scientists’ (e.g. tourists or cruise ship staff), asking other science projects to collect data whilst working at rarely visited sites etc.

- Need to empower people to contribute
- Tour guides could potentially collect more consistent data to monitor change
- Schools/Watch Group in Falklands – repeat class each year to build consistent record
- Harness the power of photography – to look at landscape change.
- Raise awareness through campaigns/advertise
- Important to set standards for citizen science – consistency and data management

Important to raise awareness of citizen science through social media campaigns

Use school groups and Watch Group to repeat exercises each year

Harness the power of photography – for example coastal change/glaciers – establishing photo points

9.3. Over and above what has been discussed to date, what other ideas/real world applications do you have for use of the project outputs (broad-scale and fine-scale habitat maps)? E.g. ideas for scientific applications etc.

- Project outputs used by farmers & land managers – to reduce cost/increase revenues
- Use by Government for habitat recovery & ice extent (in South Georgia).
- Conservation & farming purposes, such as erosion risk, Impact Assessments & resilience/recovery.
- Feed into existing projects, such as SOILS project
- Fire risk mapping
- Large-scale changes between 1956 (B&W aerial imagery) and now
- Spread of invasives
- Path/track formation – visitor management
- Post demining restoration/monitoring

Fire risk mapping

Invasive species monitoring

Conservation & farming purposes, such as erosion risk, Impact Assessments & resilience/recovery

Improving profitability of farms – reduce cost/increase revenues

9.4. What would help make our approach/model usable for you for future work and/or on a more regular basis?

- Regular training held (to account for staff turnover)
- Ongoing support
- Step by step guidance which is fully tested

- The answer to Q1 is critical, as this needs Government support/coordination to realise
- User group of likeminded people

Regular training – such as this workshop – perhaps held annually

Ongoing support through a central provider

Q1 answer is critical – this initiative will need Government support & coordination to succeed!

9.5. For environmental monitoring purposes, how frequently would you choose to use high-resolution satellite imagery if it were available (e.g. WorldView)?

- Depends on question being posed, resource available & processing power available
- Once per year for census/twice for growth/change

Really depends on the question being posed & available resource

10. Quiz to test Earth Observation (EO) knowledge

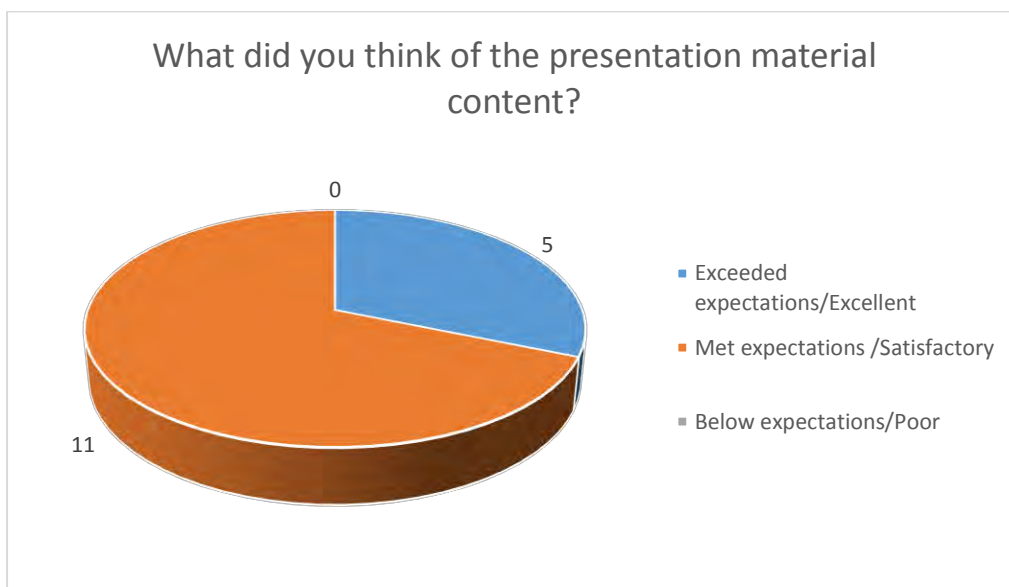
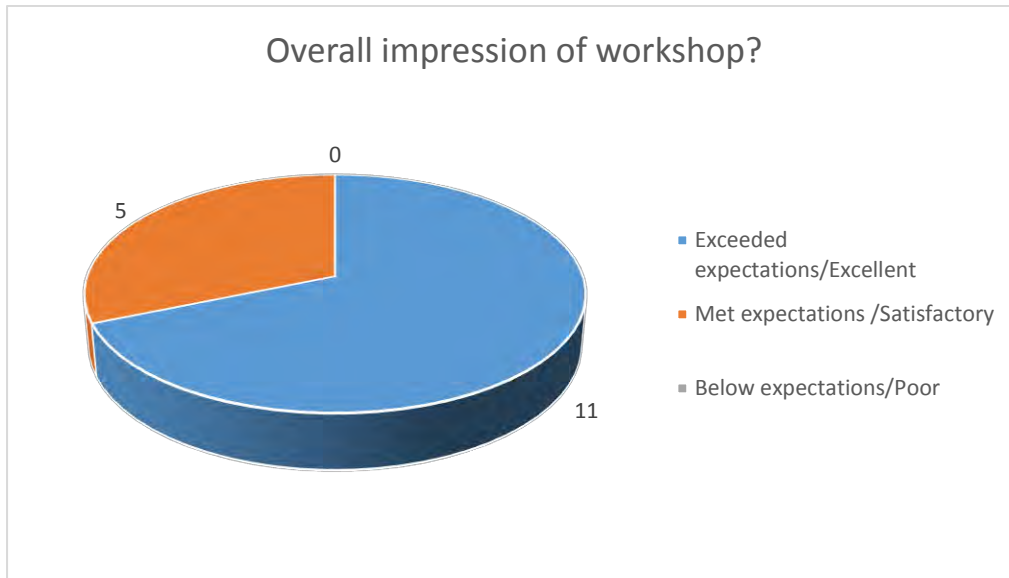
A fun quiz was run to test the participants understanding of what they had learnt over the three days of the workshop. This well received; as well as reinforcing knowledge, it also allowed the participants to ask questions about particular aspects of EO that maybe hadn't grasped as well as others (Figure 11).



Figure 11: Workshop participants completing an end of workshop quiz.

11. Workshop feedback questionnaire

Workshop participants were requested to complete a short feedback questionnaire, in order to allow the workshop content to be refined if it was to be repeated, as had been suggested by many workshop participants during the final project legacy discussion ([Section 9](#)). The feedback received was excellent, and is presented in Figure 12 below. No responses were below expectations or poor.



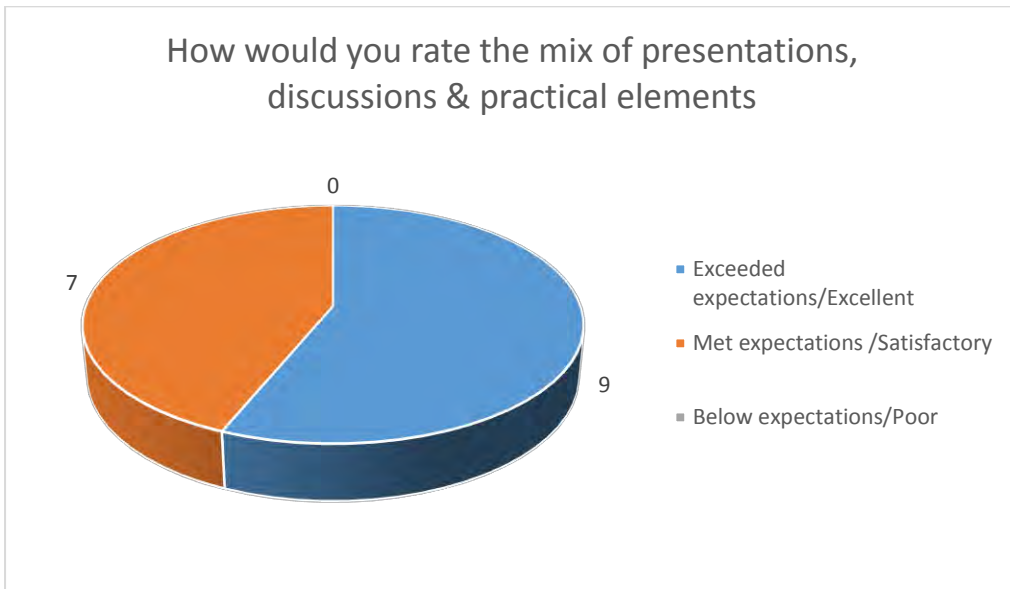
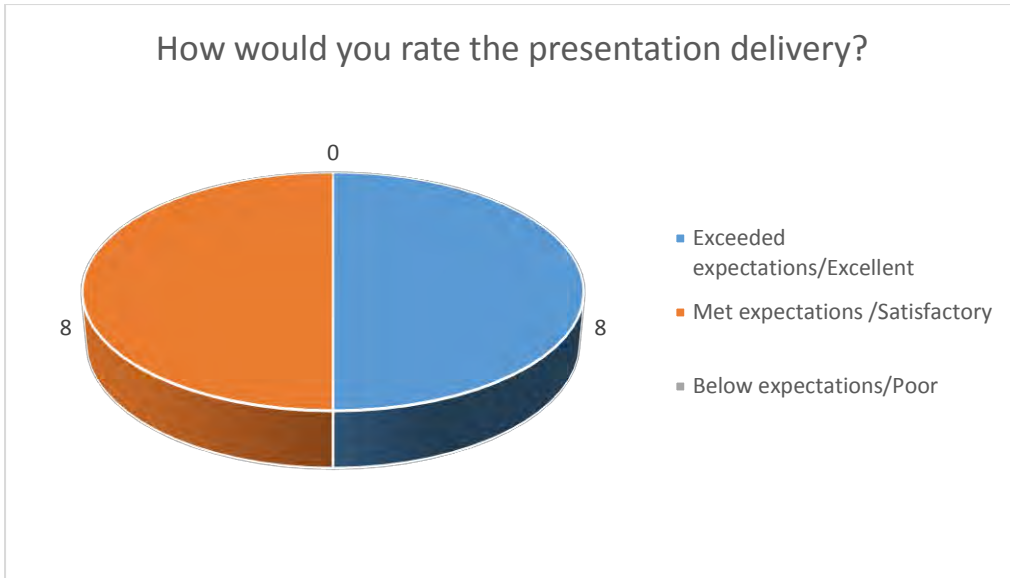


Figure 12: Results of the workshop feedback questionnaire completed by participants.

12. Annex I:

Day 1 – Monday 8th July 2019

Time	Details	Training lead
08:00	<i>Time allocated to install software on participant laptops (Please arrive promptly at 8am if you require assistance with installation)</i>	
08:30	<i>Training workshop registration and coffee</i>	
08:55	<i>Housekeeping</i>	NG
09:00	<i>Welcome & introductions</i> <i>Introduction to the Coastal Habitat Mapping project</i>	ALL NG
09:10	<i>“Why is coastal habitat mapping so important for us”? A Falklands and South Georgia perspective</i>	Denise Blake (FIG) & Ross James (GSGSSI)
09:30	<i>Introduction to Earth Observation (EO)</i> <i>1. What is EO</i> <i>2. Tour of the technology – satellite to drone (focus on optical but mention radar/LIDAR etc)</i>	GJ
11:00	Smoko	
11:15	<i>Introduction to Earth Observation (EO) – contd.</i> <i>3. What it can and cannot do</i>	GJ
12:00	Lunch	
13:00	<i>Drone mapping demonstration – Eliza Cove/Gypsy Cove (weather dependent)</i>	NG
14:00	<i>Practical session: Introduction to spatial resolution</i> <i>1. Drawing pixels (Outside – weather dependent)</i>	GJ
15:00	Smoko	
	<i>Practical session: Introduction to spectral resolution – contd.</i> <i>2. Visualising different bands in greyscale and analysing what is visible in the bands</i> <i>3. Calculating an index and interpretation</i>	GJ
16:30	<i>Close</i>	GJ/NG

Day 2 – Tuesday 9th July 2019

Time	Details	Training lead
08:30	<i>Coffee</i>	
08:45	<i>Recap Day 1 & Introduction to Day 2</i>	GJ/NG
09:00	<p><i>Coastal Habitat Mapping – Project Workflow</i></p> <ol style="list-style-type: none"> 1. <i>Defining map purpose, design</i> <ol style="list-style-type: none"> a. <i>Form dictated by function</i> b. <i>Spatial scale and resolution</i> c. <i>Deciding which landcover classes can, and cannot, be feasibly mapped</i> 2. <i>The story of groundtruthing</i> <ol style="list-style-type: none"> a. <i>Why is it important and how has the project tackled this</i> b. <i>Introduction to Open Data Kit (ODK) – how we created a smartphone App to aid in the project</i> c. <i>How do we use groundtruthing to make habitat models/maps (in the workflow)</i> 	<p>BB</p> <p>NG</p> <p>PB</p> <p>BB</p>
11:00	<i>Smoko</i>	
	<ol style="list-style-type: none"> 1. <i>Compiling imagery</i> <ol style="list-style-type: none"> a. <i>Deciding which data sources to use</i> 2. <i>Training, running, and testing the success of a classifier</i> <ol style="list-style-type: none"> a. <i>What is a classifier?</i> b. <i>How do supervised classifiers work? (compared to unsupervised)</i> c. <i>Confusion matrix creation and interpretation</i> d. <i>Assessing map uncertainty</i> 	BB
12:00	<i>Lunch</i>	
13:00	<p><i>Introduction to this afternoon’s practical session: Falklands and South Georgia habitats: a rapid overview</i></p> <p><i>Practical session – Ground validation (outside if conditions permit) – groups of four completing field recording forms and using smartphone app.</i></p>	<p>NG</p> <p>BB/GJ/NG</p>
16:30	<i>Close</i>	BB/GJ/NG

Day 3 – Wednesday 10th July 2019

Time	Details	Training lead
08:30	<i>Coffee</i>	
08:45	<i>Recap on Day 2 and Introduction to Day 3</i>	BB/NG
09:00	<p><i>Map creation: live demonstration model runs</i></p> <ol style="list-style-type: none"> 1. <i>Broad-scale maps</i> <ol style="list-style-type: none"> a. <i>Google Earth Engine map creation</i> b. <i>Major data sources: medium resolution, publicly available imagery.</i> 2. <i>Fine-scale maps</i> <ol style="list-style-type: none"> a. <i>Python-based map creation</i> b. <i>Major data sources: drone and commercial (Worldview 2 and 3) imagery</i> 	BB
11:00	Smoko	
11:15	<i>Map creation: Contd.</i>	BB
11:45	<i>Complete training workshop questionnaire</i>	ALL
12:00	Lunch	
13:00	<p><i>Discussion session with breakout groups: The breakout groups will be posed a number of questions to consider and discuss, in areas such as:</i></p> <ul style="list-style-type: none"> • <i>Making best use of the project outputs</i> • <i>Synergies & future work</i> <p>Rapporteurs:</p> <p><i>Ross James (GSGSSI)</i></p> <p><i>Gwawr Jones (JNCC)</i></p> <p><i>Denise Blake (FIG)</i></p> <p>Floater: <i>NG & BB</i></p>	Rapporteurs feedback to group in plenary
15:00	Smoko	
15:15	<i>Quiz: Test your newfound EO knowledge!</i>	GJ
16:30	<i>Closing remarks</i>	NG & ALL

13. Annex 2:

Attendee	Affiliation
Alexander Arkhipkin	Falkland Islands Government (FIG)
Bran Black	Oregon State University (OSU)
Denise Blake	Falkland Islands Government (FIG)
Paul Brewin	Shallow Marine Surveys Group (SMSG)
Steve Brown	Government of South Georgia & the South Sandwich Islands (GSGSSI)
Stefanie Carter	SAERI
Jack Cartwright	-
Debs Davidson	Falkland Islands Government (FIG)
Mike Davis	Falkland Islands Government (FIG)
Ander De Leca	SAERI
Neil Golding	SAERI
Ross James	Government of South Georgia & the South Sandwich Islands (GSGSSI)
Pamela Q. Jelbes	Falklands Conservation
Mike Jervois	Falkland Islands Government
Gwawr Jones	JNCC
Blessing Kachidza	SafeLane Global
Chris Locke	Falkland Islands Government
Hamish McKee	-
Alejandra Moro Soto	University of Oxford
Sally Poncet	Island Landcare
Jonathan Poynter	Falkland Islands Government
Frin Ross	Falklands Conservation
Lauren Shea	SAERI
Megan Tierney	JNCC
Peter Wessels	Falklands Conservation

14. Annex 3: Instructions for installing the Android smartphone DPLUS065 Coastal Habitat Mapping project field recording application¹

1. On your Android smartphone, go to the Google Play store, and download the *ODK Collect* application
2. Open the newly installed ODK Collect app
3. Got to the top right of the screen (three dots), Select *General Settings*
4. Select *Server*
5. Ensure *Type* is ODK Aggregate
6. Change *URL* to <http://ims.saeri.org:8080/ODKAggregate/>
7. Change *Username* to odk_demo
8. Change *Password* to workshop_072019
9. Then exit back out to main app screen
10. Click on the *Get Blank Form*, and select fi_hab_survey_mod3 & gs_hab_survey
11. Then click *Get Selected*
12. You're ready to go!

¹ developed using Open Data Kit (ODK)

15. Annex 4: Workshop feedback questionnaire.

Feedback Form

Please rate the following and tick the relevant box:	Exceeded expectations /Excellent	Met expectations / Satisfactory	Below expectations / Poor
What was your overall impression of the workshop?			
What did you think of the content of the presentation material?			
How would you rate the delivery of the presentations?			
How would you rate the mix of presentations, discussions and practical elements?			

What did you hope to achieve by attending the workshop and were those expectations met?

.....

Which areas did you feel were the most useful?

.....

Did we get audience right, or were we missing any key stakeholders?

.....

Do you have suggestions for areas where the Coastal Habitat Mapping project can provide further assistance following the workshop?

.....

If we can contact you to discuss your feedback and comments, please provide your name, department you work for, and email address.

.....

Any other comments

.....

Thank you for providing this feedback