



DPLUS065 Coastal Habitat Mapping

ENDURANCE

DUMBARTON CASTLE

CLYDE

Report of the Workshop on Fine-scale Mapping Stakeholder Prioritisation for the Falkland Islands



Version Control Table

Version	Date	Author	Comments
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0.2	07/12/18	NG	Second draft incorporating comments from rapporteurs
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Cover image: *Satellite imagery courtesy of Digital Globe Foundation. Pan-Sharpended image of the Camber, Stanley Harbour, East Falkland by Brandi Black.*

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1. Background

Historically, and to this day, the coastal and inshore marine ecosystems and resources have played an important role in the Falkland Islands, both from a social and economic perspective. Knowledge of these coastal environments is essential for their management, yet comprehensive island-wide broad-scale and fine-scale coastal habitat maps are lacking. Such maps would form an important baseline from which to measure future change.

The DPLUS065 Coastal Habitat Mapping project aims to fill this critical gap in coastal knowledge. This three-year project, grant aided by the [Darwin Initiative](#) through UK Government funding, brings together experts from [SAERI](#), [Oregon State University](#), the UK [Joint Nature Conservation Committee](#), [Shallow Marine Surveys Group](#), [Falkland Islands Government](#) and [Government of South Georgia & the South Sandwich Islands](#), representing the leading edge in remote sensing, ecological knowledge and field expertise. The project is due to conclude in March 2020.

The project utilises medium resolution satellite imagery, other geospatial data and local expert knowledge to develop broad-scale coastal margin (terrestrial, intertidal and subtidal) habitat maps for the Falkland Islands. Where there is significant uncertainty in these broad-scale maps, or in response to specific priorities from stakeholders, higher resolution habitat maps utilising very high-resolution satellite imagery or bespoke imagery captured using aerial drones will also be developed. These habitat maps create an essential baseline, providing a basis for use in future planning, decision-making and monitoring.

2. Workshop aims

The project had a mandate to illicit the views of stakeholders as to their priorities for the fine-scale mapping phase of the project. The stakeholder prioritisation workshop posed two key questions to stakeholders:

1. What aspects of the coastal environment are important to you/your business, and that you'd like incorporated into the fine-scale mapping outputs?
2. In light of those aspects highlighted in Question 1, where do you feel that fine-scale mapping should be prioritised (specifically, what locations)?

3. Opening of the workshop

The workshop¹, held at the Lighthouse Seafarers Mission, was opened on 8th August 2018 by Neil Golding, the Coastal Habitat Mapping project manager. Following a brief welcome, and approval of the agenda, Neil Golding presented an update on the Coastal Habitat Mapping project. A link to the presentation can be found in Annex II of this report. The presentation included an overview of the work underway to geo-reference historic 1956 aerial imagery and presented the latest iteration of the Falklands broad-scale habitat maps (circulated to workshop participants on 28th July) that have been developed using Sentinel-1 and Sentinel-2 satellite data (at 10 metre resolution) and other relevant spatial layers. The presentation also stressed that in the fine-scale mapping phase, there were no pre-conceptions as to what may be mapped where, but that the project intended to produce coastal habitat maps that would deliver stakeholders needs. Following this update on project progress, Bran Black (*Figure 1*) introduced the different imagery datasets in use within the project, and reviewed the different features (ponds, roads, areas of different vegetation) that can be resolved using the different imagery datasets.



Figure 1: Bran Black introducing the different imagery types being used by the DPLUS065 Coastal Mapping project.

¹ The workshop agenda and list of participants are provided in Annex I

Following the presentation, there was a short question/answer and discussion session. A number of specific questions were posed, summarised in Table 1.

Table 1: Summary of question/answer session, grouped by theme

Question/comment		Response from project team
Would the final broad-scale coastal habitat maps for the Falklands be made available on the IMS-GIS/FIG shared geodatabase?	Accessibility & Training	It was confirmed that the project was working closely with the IMS-GIS Data Centre and this was being considered as part of the project output dissemination process.
Would training be provided to relevant staff/interested individuals on the habitat modelling process and how to run the models?		It was confirmed that a training workshop was being scheduled next year (2019 – between July * September). Please do get in touch with the project manager if this is something which would interest you.
How far back in time is Sentinel satellite imagery available from?		Sentinel-2A was launched on 23 rd June 2015 & Sentinel-2b was launched on 7 th March 2017; data acquisition commenced a few days after launch. Data has been acquired every 5 days over Europe since 2017; 10 day frequency for rest of world. 5 day acquisition frequency was rolled out to the rest of the world in February 2018.
There was a question about the accessibility of Digital Globe data for other work (including commercial) in the Falklands.		<p>It was clarified that the Digital Globe Foundation (WorldView) imagery cannot be used for commercial purposes, although for small areas, the cost (approx. \$19 per km²) could be more cost effective than undertaking labour intensive drone surveys if this level of resolution was not required.</p> <p>It is important to stress that if centimetre-level resolution is not required (for example, if the features/habitat classes you are mapping can be discerned from metre-level resolution), then drones are not necessarily the most cost-effective solution. Undertaking drone surveys can be time consuming. For example, setting up an aerial drone survey to map an area of approx. 4 hectares (over 12 acres) such as Hookers Point, Surf Bay, can take 1 hour 20 minutes to fly the mission and then four hours to process the imagery into an ortho-mosaic, equating to over half a day in total. Especially when compared to using existing imagery such as WorldView, which is supplied analysis ready.</p>

Question/comment		Response from project team
<p>The implications of seasonality were raised. The drought in West Falkland in 2016-2017 had a significant impact on vegetation cover; the question was posed as to when the satellite imagery for the initial broad-scale map (the baseline) was sourced?</p>	Resolution, extent & utility	<p>Sentinel-2 imagery for the draft maps circulated at the workshop was acquired by the sensor in February 2018. It is important that imagery data (whether Sentinel-2 satellite imagery or drones) is classified with ground validation information collected at the same time of year (ideally in the same year). However, it is worth noting that climatic events (such as drought etc.) could have a dramatic effect on the land cover maps produced over two consecutive summers.</p>
<p>A question was posed about how the 1956 imagery would be used to compare with more recent years data?</p>		<p>The Coastal Mapping project manager clarified that the key output from the project in relation to the 1956 imagery is a new spatially geo-referenced product (currently the original 1956 imagery has no geo-referencing). Once this geo-referenced product is delivered, there will potentially be many uses for it in the future, such as land use change, but these are considered outside the scope of the current project.</p>
<p>There were questions about the mapped habitat classes, and whether these habitat classes will be quantified, with respect to extent (area)? For example, is it possible for end users to quantify the amount of intertidal sediment from the habitat maps?</p>		<p>Yes, it will be possible to generate extent values for each habitat class. This can be easily generated from the mapping data. A summary of values (area/extent) can be provided for across the Falklands from the broad-scale maps. However, areas of habitat from the fine-scale maps can easily be generated by the user from the raster datasets which will be provided as outputs from the project.</p>
<p>Various questions were raised about the Digital elevation models (DEMs) used within the habitat models.</p>		<p>The Falklands broad-scale habitat model uses the Shuttle Radar Topography Mission (SRTM) dataset (30m resolution) as one of the model inputs. It is also possible to generate much finer resolution DEMs from the drone imagery (cm resolution), which can be used to calculate volumes of material. A use for this high resolution DEM was identified through the Falklands Demining Programme. Using this process, volumes of sediment requiring screening can be better estimated, allowing for more accurate projections of task duration.</p>

Question/comment		Response from project team
<p>Questions around the development of a satellite-derived bathymetry dataset. Such as: whether rough/white water around the coastline during stormy days would impact the ability for the satellite imagery to penetrate the sea surface?</p>		<p>Yes, this is the case; where we are looking at the using the satellite imagery to classify/map subtidal features, including modelling satellite-derived bathymetry, it is important that imagery with calm, flat seas are used.</p>
<p>How does the habitat modelling deal with topography, and aspects such as shadow caused by topography?</p>		<p>A key step in the model is to apply a topographic correction, which uses a DEM to “correct” for topography.</p>
<p>Clarification was requested on the landward and seaward extents being mapped by the coastal habitat mapping project.</p>	<p>Resolution, extent & utility</p>	<p>Seaward mapping extent is largely determined by the penetration of satellite imagery data through the water column, so the maximum depth of twenty metres has been selected. Landward extent is anticipated to be determined by coastal/oceanographic influences, and may vary around the islands. It is anticipated that in places, the inland extent may stretch from between 5 to 10 kilometres. However, other areas may be considered as well if a priority (for example invasive species), and if sufficient resource is available after coastal margin areas have been completed. As Sentinel satellite imagery extends across the entire Falklands, the entire landmass will be mapped during the broad-scale mapping stage (10 metre resolution).</p>
<p>A question was asked around what type of information can be provided by the drone?</p>		<p>The standard optical sensor will provide visible (red/green/blue) bands. The multispectral camera (a different camera which can be installed on the drone) also collects red-edge and near infra-red bands, which is better for mapping vegetation (noting that different plants have different spectral signatures). There are potential applications of looking at plant health at different types of year (such as drought) using this near infra-red band (from WorldView/drone imagery). It is also worth noting that a detailed digital elevation model can be derived from drone imagery.</p>



Figure 2: Workshop participants discussing priorities for fine-scale habitat mapping.

4. Workshop Exercise One: What aspects of the coastal environment are important to you/your business, and that you'd like incorporated into the fine-scale mapping outputs?

The first group exercise identified which particular aspects of the coastal environment were important to stakeholders, and which they valued. The participants split into three sub-groups (see Annex A). Rapporteurs were assigned to guide the sub-groups through the exercise as well as feedback in plenary afterwards. Participants were each asked to “brainstorm” and jot down their ideas on Post-It notes (Figure 3), to then bring back to the group in plenary; the results can be seen in Table 2 and Figure 4.



Figure 3: Workshop group work – participants considering and discussion which aspects of the coastal environment they most value.

Table 2: Group exercise – why is the coastal (marine, intertidal and terrestrial) environment important to you?

Theme	Examples given
Habitat extent/area	Subtidal habitats (including Berkeley Sound)
	Estuarine & intertidal habitats (e.g. mudflats in Berkeley Sound)
	Kelp beds
	Measuring resources
Agriculture	Grass resources for grazing
	Health of grazing vegetation (including type and area of vegetation)
	Quantifying Diddle Dee
Development & changes to land use	Pre-European evidence
	Cultural / historical features
Habitat restoration	Habitat “quality”
	Monitoring in response to land management
	Identify areas where restoration is needed
	Restoring minefields
Aquaculture	Aquaculture sites
	Kelp
	<i>Loligo</i>
Shipping	MV Concordia Bay landing sites
Erosion	Nutrient run-off areas
	Change in extent to erosion areas

Theme	Examples given
Subtidal bathymetry	Satellite-derived bathymetry
Waste discharge	River & coastal discharge
Seabirds & pinnipeds	Rafting areas for seabirds
	Seal/seabird colony locations (size & change over time)
	Importance of wildlife (e.g. penguins/seals etc) to tourism
Invasive species	Invasive species around ports and harbours (large and small)
	Calafate areas around coastal Port Sussex
Monitoring	Monitoring protected areas

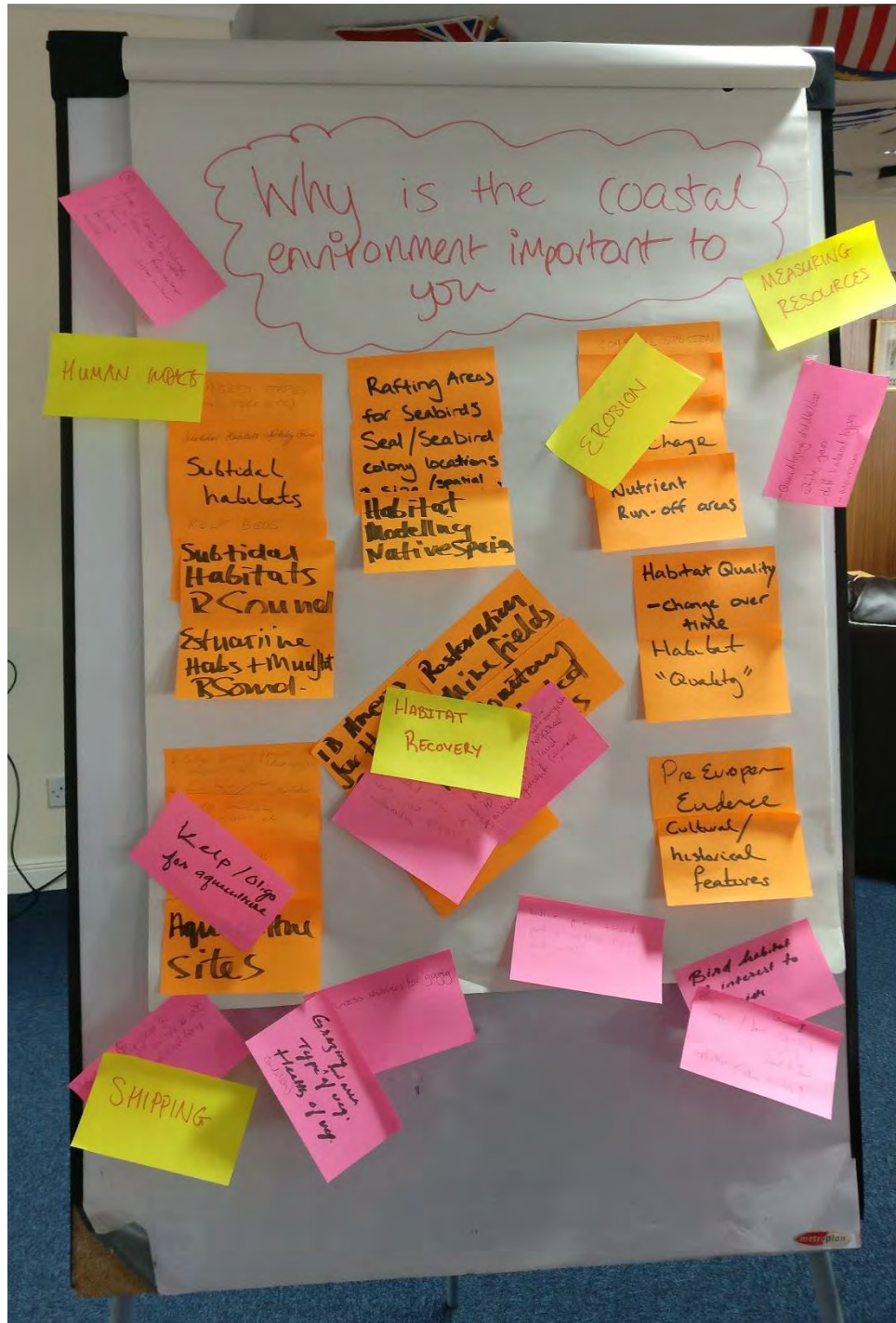


Figure 4: Flipchart showing a summary of the sub-groups feedback in plenary.

Following this “brainstorming” process, groups prioritised these aspects/values to create a consolidated list to take forward to the next phase. In plenary, chaired by Neil Golding, workshop participants prioritised which aspects of the coastal environment should be considered further. Priorities for consideration by the Coastal Habitat Mapping project were categorised into three areas: terrestrial, intertidal and marine. These are summarised in Table 3, and shown in Figure 5.

Table 3: Which aspects of the coastal environment should be considered by the Coastal Mapping Project – a summary of priorities agreed by the group (in no particular order).

Terrestrial	Intertidal	Marine
Habitat restoration	Extent (area) of habitat	Shallow coastal bathymetry
Agriculture (including aspects of erosion/non-native invasive & habitat restoration related to agricultural activities)	Seabird/pinniped colonies	Subtidal habitat mapping
Development & changes to land use	MV Concordia Bay landing sites	Aquaculture
Waste discharge		Kelp habitat
Invasive & native species		Waste discharge

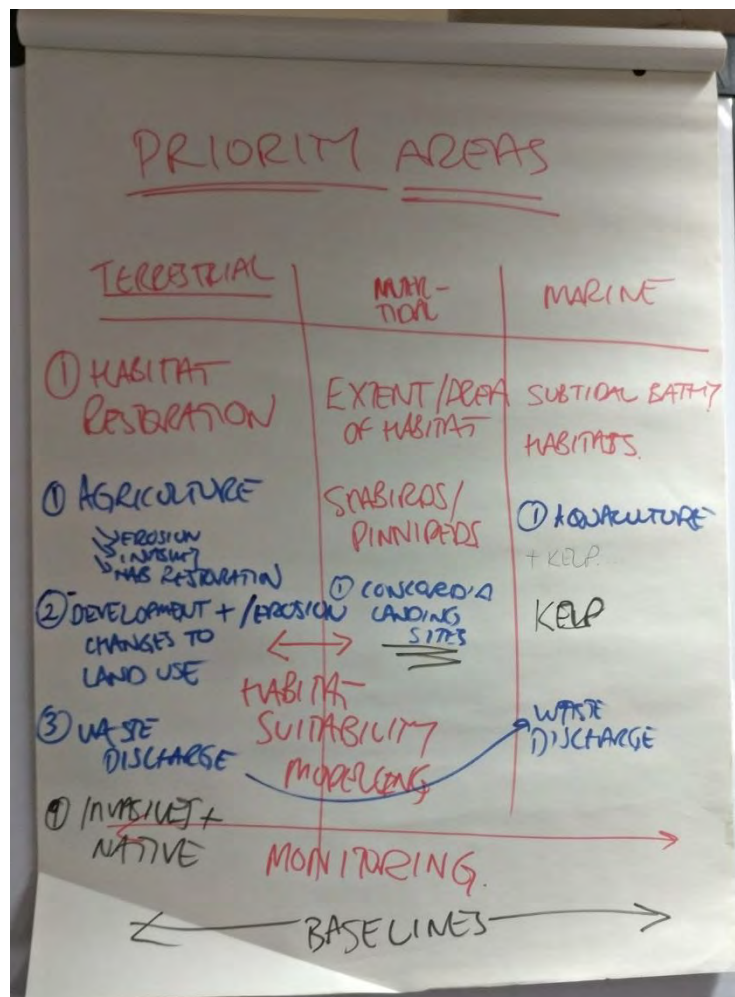


Figure 5: Flipchart showing a consolidation of priority areas for fine-scale mapping undertaken in plenary during the workshop.

There were some aspects/values which spanned all three categories. These included:

- Habitat suitability modelling
- Monitoring (to detect future change)
- Establishing baselines

This initial exercise resulted in a clear list of priorities for consideration in the next phase; a consideration of locations where fine-scale habitat mapping may take place. The chair highlighted that as there was only a finite resource available to undertake the fine-scale mapping, it would not be possible to focus on all aspects prioritised in Table 3. However, the creation of fine-scale mapping products in strategically selected areas should be able to deliver against multiple priority aspects listed in Table 3.

5. Workshop Exercise Two: In light of the aspects/values considered in Exercise One, where do you feel that fine-scale mapping should be prioritised?

The second group exercise was aimed at identifying where (spatial locations) fine-scale mapping should be prioritised across the Falkland Islands, noting that this second exercise was focussed on those aspects/values determined as being important from the first exercise. Once again, the participants went back into their three sub-groups (see Annex A). Using the coated maps of the Falklands and whiteboard markers, the sub-groups discussed and highlighted locations where fine-scale mapping could be undertaken in order to map relevant features from either WorldView and/or drone imagery. Annotated maps produced by each sub-group are shown in Figure 6, 7 & 8.

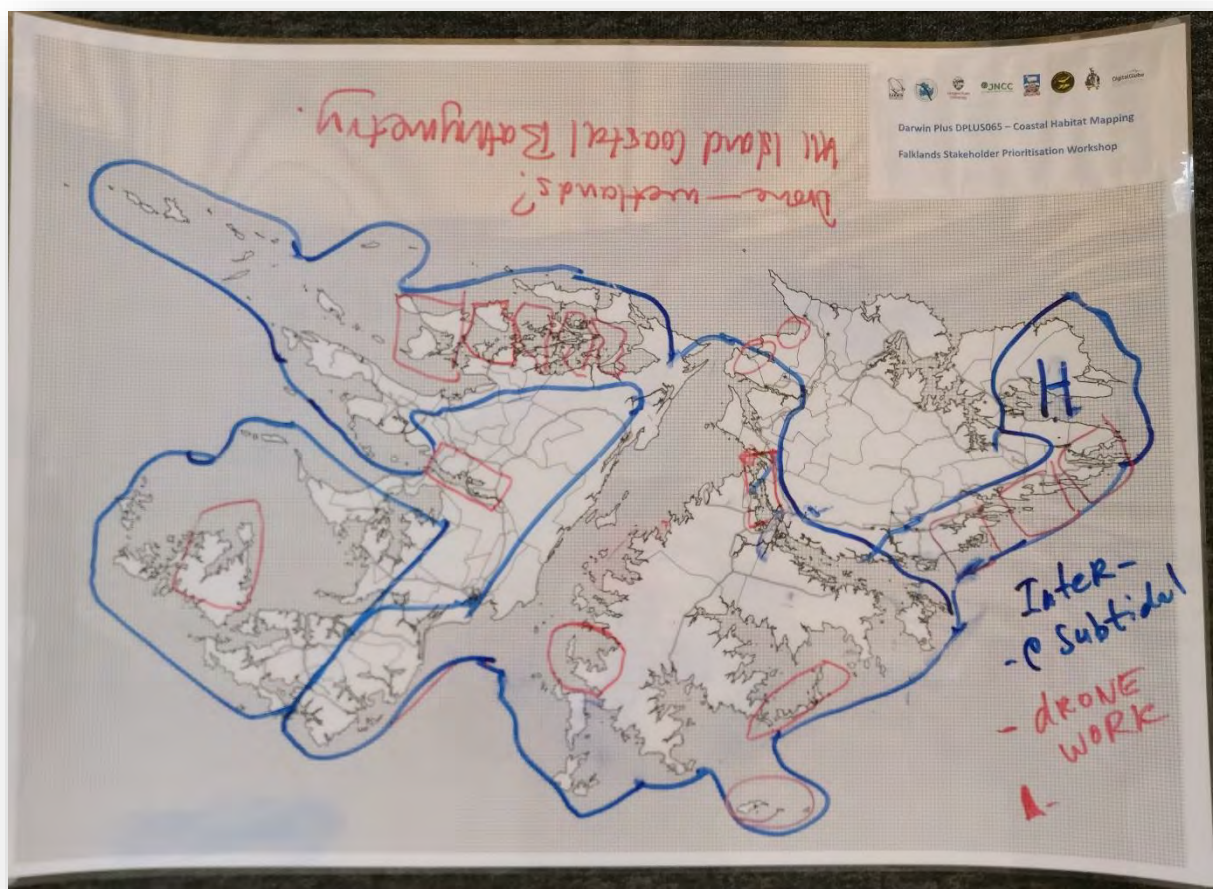


Figure 6: Priority areas for fine-scale habitat mapping proposed by sub-group A

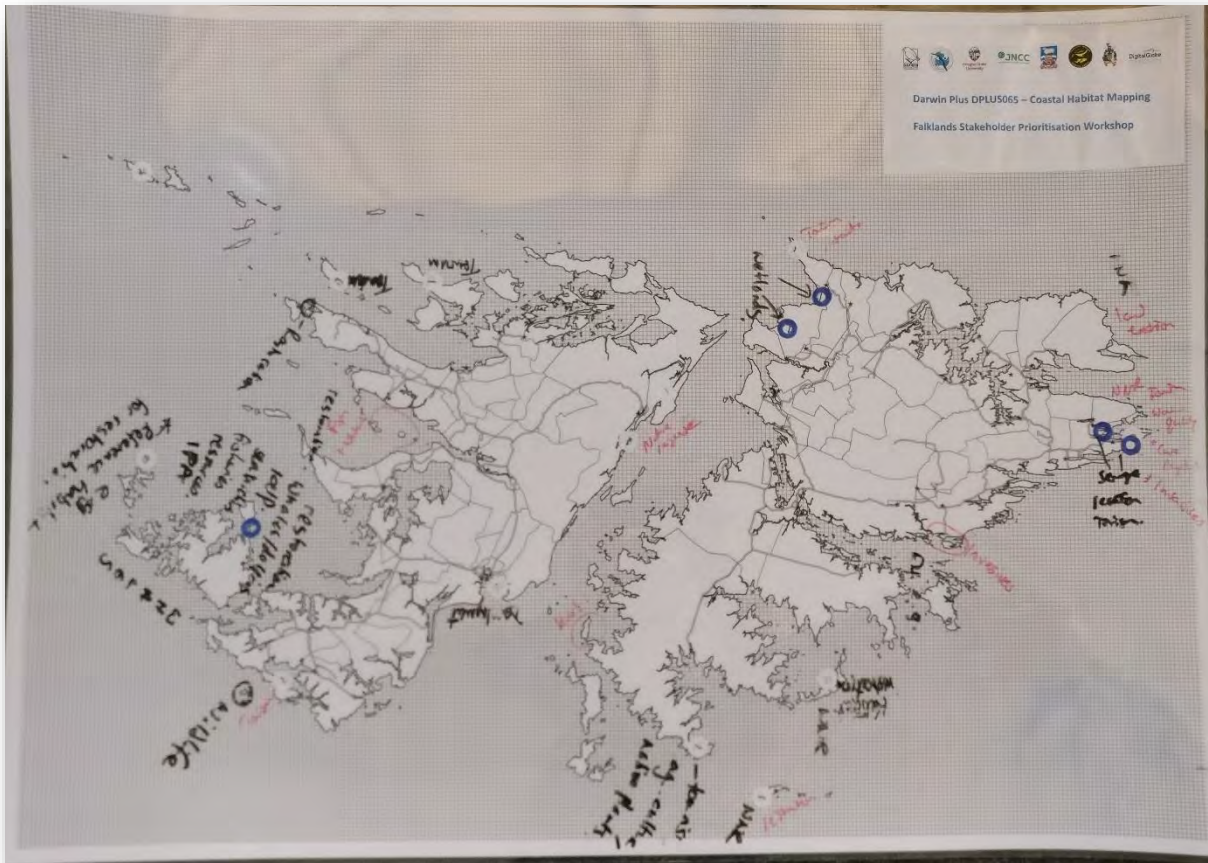


Figure 7: Priority areas for fine-scale habitat mapping proposed by sub-group B

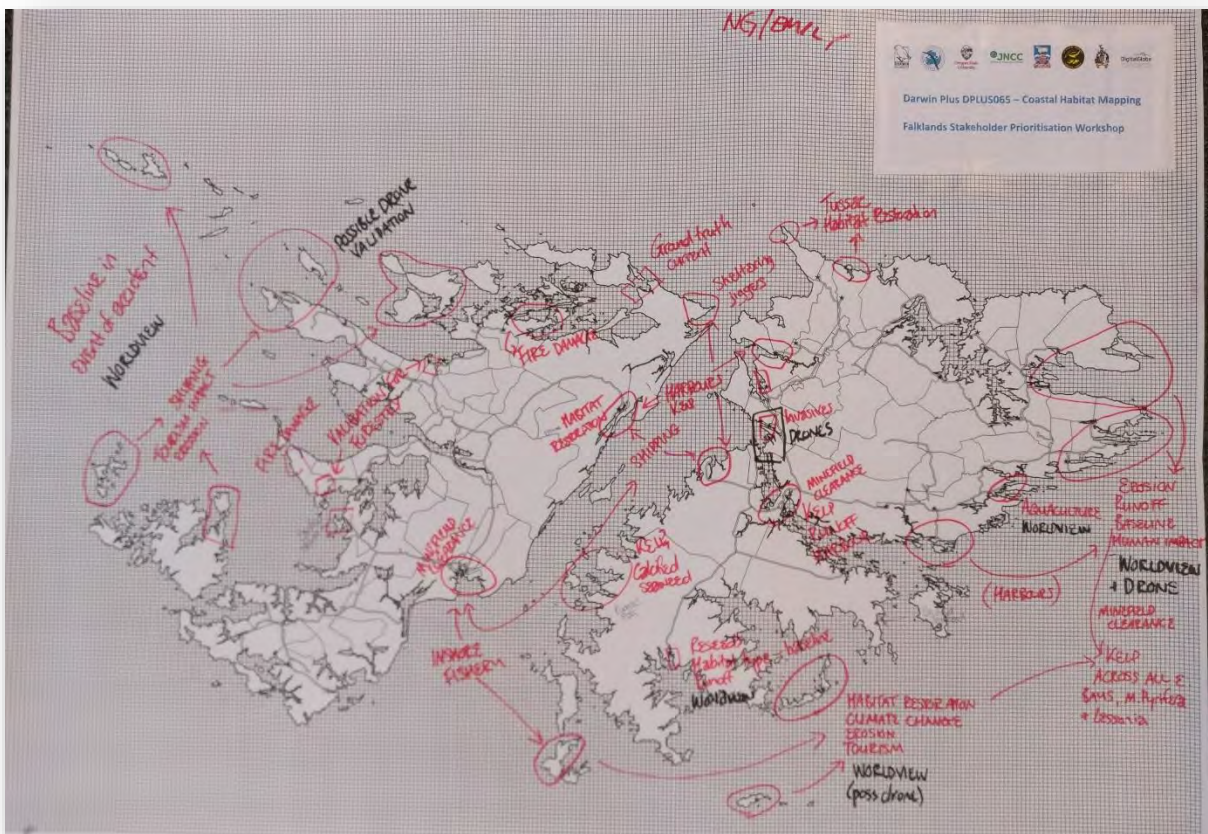


Figure 8: Priority areas for fine-scale habitat mapping proposed by sub-group C

Following this session, the sub-groups came back into plenary. Each sub-group rapporteur presented their annotated Falklands maps, highlighting suggestions for priority locations where fine-scale mapping could be undertaken (Figure 9). Through this exercise, a list of locations appropriate for fine-scale mapping using WorldView (2m resolution) and drone (2cm resolution) imagery was developed. This initial list of proposed locations can be seen in Table 4.



Figure 9: One of the sub-groups feeding back their suggestions on priority locations for fine-scale mapping in plenary.

Table 4: Initial list of proposed locations for fine-scale habitat mapping (clockwise from Stanley), as identified by workshop participants, based on either WorldView or drone imagery.

WorldView (2m resolution imagery)	Drone (2cm resolution imagery)
Stanley Common & Cape Pembroke area	Stanley Common/Cape Pembroke
Mare Harbour	Kidney Island/Tussac Islands
Lafonia	Bleaker Island (habitat restoration)
North Arm	Sealion Island
Sealion Island	Ruggles Bay
Bull Point	Weddell Island
Ruggles Bay	Dunbar/Shallow Harbour
Fox Bay	Saunders Island / Kepple Island (non-native invasives – thistles)
Port Stephens area	Port Howard (habitat restoration)
Bird Island	Port Sussex (non-native invasives – Calafate)
New Island	Cape Dolphin/Elephant Beach Farm (habitat restoration)
King George Bay/Hummock Islands	
Jason Islands	
Carcass Island	
Saunders Island (the Neck)	
Tamar Pass (to understand how strong currents may affect imagery from a subtidal perspective)	
Port Howard	
Foul Bay / Polomo Beach (to collect better ground validation for “wetlands” class)	
Johnsons Farm – examples of erosion/tracks	
Berkeley Sound	

N.B. Note the overarching principle of establishing a set of pristine control sites (for example utilising the existing National Nature Reserve network) which could be used as reference sites for future monitoring; these could be considered a priority for the development of fine-scale habitat maps.

Workshop participants were then asked to undertake a prioritisation from this initial list. Each workshop participant was supplied with five black/white shaded dots, and asked to stick them to the flipchart sheet against their priority locations. It was then down to each participant to decide how they distributed their dots; either all against one location or divided across several. The resultant list provided a clear mandate to the Coastal Mapping project as to where fine-scale mapping activity should be focussed (Table 5/Figure 10).

Table 5: Summarising the result of voting by workshop participants on priority locations for fine-scale mapping to be taken forward in the next phase of the Coastal Mapping project

WorldView (2m resolution imagery)		Drone (2cm resolution imagery)	
Stanley Common & Cape Pembroke area	7	Stanley Common/Cape Pembroke	10
Berkeley Sound	6	Kidney Island/Tussac Islands	7
Mare Harbour	6	Port Sussex (non-native invasives – Calafate)	6
Jason Islands	3	Bleaker Island (habitat restoration)	5
Johnsons Farm – Erosion/tracks	2	Ruggles Bay	5
Ruggles Bay	2	Saunders Island / Kepple Island (non-native invasives – thistles)	5
New Island	2	Dunbar/Shallow Harbour	3
Foul Bay / Polomo Beach (to collect better ground validation for “wetlands” class)	2	Cape Dolphin/Elephant Beach Farm (habitat restoration)	3
North Arm	1	Port Howard (habitat restoration)	3
Saunders Island (the Neck)	1	Weddell Island	2
Bull Point	1	Sealion Island	
Bird Island	1		
Port Stephens area			
Tamar Pass (to understand how strong currents may affect imagery from a subtidal perspective)			
King George Bay/Hummock Islands			
Sealion Island			
Lafonia			
Port Howard			
Carcass Island			
Fox Bay			

N.B. Establishment of control sites – 7 votes

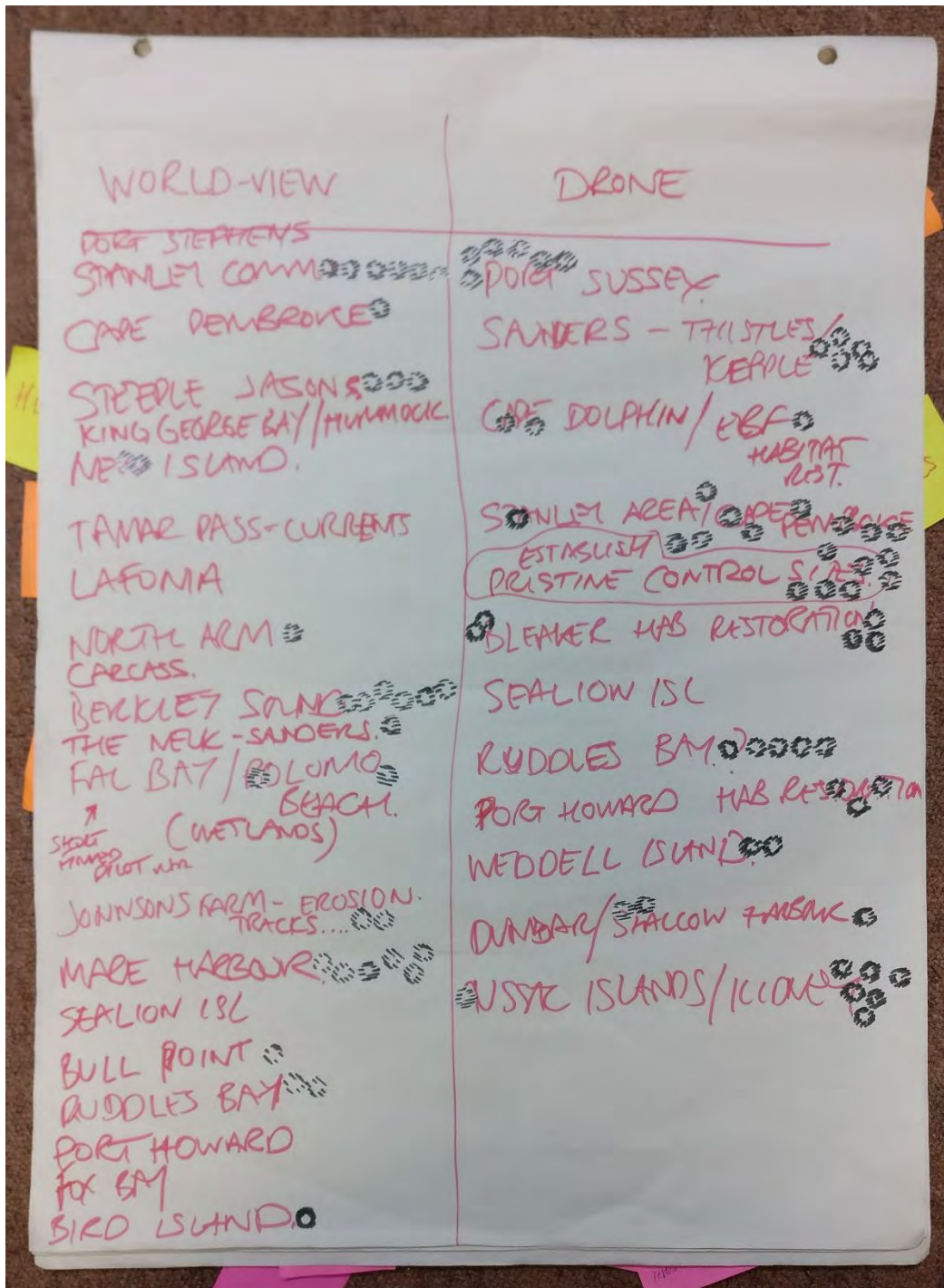


Figure 10: The result of a vote cast by workshop participants highlighting areas of priority for fine-scale mapping in plenary.

6. Workshop summary & prioritisation for fine-scale mapping

Through the stakeholder workshop, participants provided a clear mandate for the Coastal Mapping project to progress fine-scale coastal habitat mapping around the Falklands.

Two elements were considered. The first element were the aspects/values of the coastal environment considered a priority by stakeholders

Across the three themes of terrestrial, intertidal and marine, the following aspects were drawn out and considered a priority for the Coastal Mapping project to focus on during the fine scale mapping phase:

- *Agriculture*
- *Erosion*
- *Habitat restoration*
- *Non-native invasive & native species/habitats*
- *Habitat mapping (subtidal, intertidal & terrestrial) to quantify areal extent*
- *Shallow coastal bathymetry*

The second element considered which locations around the Falklands coastal margin should be prioritised for fine-scale habitat mapping, considering both WorldView (2m) and Drone (2cm) imagery.

It was noted that both Berkeley Sound and Mare Harbour were joint second priority from a WorldView imagery perspective. A significant amount of fine-scale mapping effort has already been undertaken in Berkeley Sound, as a consequence of a developing hydrocarbon industry. In light of this, it is recommended that locations next on the list of priorities, but less studied, should be considered as an alternative. In addition, Mare Harbour is a military installation where access for the collection of ground validation information could be restricted and problematic. Therefore, further consideration should be given as to whether this would negatively impact the acquisition of data; this point will be referred to the Project Management Group for consideration.

Priority locations for fine-scale coastal habitat mapping, based on WorldView (2m resolution) imagery:

1. *Stanley Common & Cape Pembroke*
2. *Mare Harbour (pending confirmation by Project Management Group)*
3. *Jason Islands*
4. *Ruggles Bay & Johnsons Farm (joint fourth)*

Priority locations for fine-scale coastal habitat mapping, based on Drone (2cm resolution) imagery:

- 1. Stanley Common & Cape Pembroke*
- 2. Kidney Island/Tussac Islands*
- 3. Port Sussex (Calafate - invasive species)*

Of note was the strong support for the creation of fine-scale habitat maps from control sites in pristine locations. Following the establishment of this baseline, future of monitoring could act as a sentinel for change. The workshop participants suggested that the network of existing National Nature Reserves should be considered here initially.

7. Next steps

The outputs from this workshop will allow a realistic work plan to be developed for the second phase of the project, delivering a series of stakeholder prioritised fine-scale habitat models/maps for the Falkland Islands.

Delivery of the fine-scale habitat models are scheduled for the end of June 2019, after which a training workshop, hosted by SAERI, will facilitate the transfer of knowledge gained through the project, both from a broad-scale and fine scale modelling perspective.

8. Acknowledgements

The Coastal Mapping project would like to thank all the workshop participants for their valuable input during the stakeholder prioritisation workshop, and the Lighthouse Seafarers Mission for an excellent venue.

Annex I: Workshop participants

Apologies: Nick Pitluga (Gibraltar Station / Salvador) - cormocountry@horizon.co.fk

Sub-Group A - Rapporteurs: Paul Brickle/Megan Tierney

Name	Affiliation	Contact email
Alexander Arkhipkin	Department of Natural Resources - Fisheries	AArkhipkin@fisheries.gov.fk
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Sub-Group B - Rapporteurs: Paul Brewin/Frin Ross

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Sub-Group C - Rapporteurs: Neil Golding/Emily Hancox

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Carli Sudder	Falkland Islands Tourism Association	info@fita.co.fk

Annex II: Workshop agenda

Darwin Plus DPLUS065 – Coastal Habitat Mapping

Stakeholder Prioritisation Workshop: Agenda

Wed 8th August 2018, 09:00 - 12:00hrs: Lighthouse Seafarers Mission

09:00 – Welcome and introductions

09:15 – Coastal Habitat Mapping in the Falklands – an update on the project, and what it can do for you.

09:30 - From broad to fine-scale – the issue of scale & resolution – what it means for you

09:45 - Group Exercise 1 followed by feedback in plenary

10:30 – Smoko

11:00 - Group Exercise 2 followed by feedback in plenary

11:45 – Next steps

12:00 – Workshop close and lunch

Annex III: “Setting the scene” introductory presentation

The introductory presentation given by Neil Golding and Bran Black at the Stakeholder Workshop can be downloaded from the Coastal Habitat Mapping project webpage here:

https://www.south-atlantic-research.org/wp-content/uploads/2019/01/2018_08_08_Falklands_StakeholderPrioritisationWorkshop_Presentation.pdf