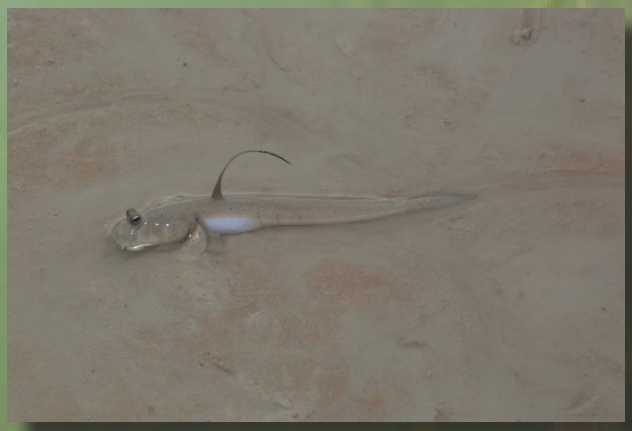
KALUTA UAV MAPPING SERVICES

KALUTA.COM.AU
PH: 0409008661
E: INFO@KALUTA.COM.AU
ABN: 23062600988
REMOTE PILOT LICENCE: 1061579

DRONES FOR CONSERVATION - SEAGRASS AND COASTAL COMMUNITIES

BY NATHAN LITJENS V: 2.0 (20/11/2019)



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INTRODUCTION TO KALUTA'S MAPPING SERVICES

Kaluta is passionate about making a difference in the ecological and conservation fields. One of the many ways the business is working towards that goal is with the use of **Drones**, also known as Remotely Piloted Aerial Systems (**RPAS**) or Unmanned Aerial Vehicles (**UAVs**). We aim to save work hours and track progress by first forming a baseline for ecological data and allowing tracking of changes over time.

INSPIRE 1 RAW

The ease at which data can be gathered and assessed makes this technology extremely valuable in current and future projects.

USE OF DRONE TECHNOLGY IN MONITORING CHANGES IN COASTAL HABITATS - THE ADVANTAGES

In this case study we will be looking at how Kaluta will handle monitoring of fragile coastal habitats by the use of drones, how this translates to efficiency both financially and over time and how this in turn protects the fragile habitats being observed.

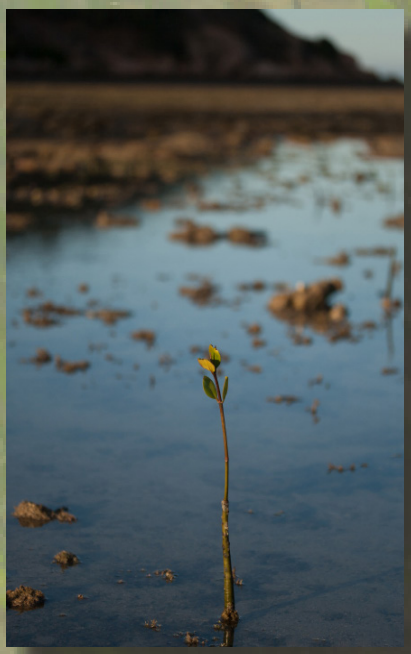
The main advantage is the cost. Compared to the cost of mobilising ecologists into the field and obtaining measurements from the shore or a boat, this technology is already able to do the work of ground based contractors in a fraction of the time. With the cost of ecological contractors going beyond $100 per hour and able to do less in that time; even if the hourly rate of the drone is higher, the overall cost will be lower, especially when the value of the data is considered.

The next advantage of course safety. With the drone taking off and landing in secure, safe areas and not flying over or too close to any persons, the safety factor is very high. Personnel are not exposed to the risks involved in working on the

mudflats such as stonefish, stingrays, sharp shells and other marine hazards. The operator will be safely on shore and can operate in shade, so long as the drone is visible at all times.

Damage to the habitat is limited, if any damage is sustained at all. Since humans will not be walking on the seagrass at the time, there are no footprints or other damaging traces of human interaction from the survey itself. This in turn protects the integrity of the data gathered as the act of gathering it does not cause harm.

Also, the chance of spotting and recording incidental species using the habitat is very high - a great deal higher than what is possible from the ground or even a spotter plane operating at a greater altitude. Dugongs, rays, sharks, turtles and more are easily visible in the resulting imagery and their presence alone can be a key indicator in the health of the ecosystem being monitored.



RIGHT: At a resolution of 1.2px/cm, mangrove seedlings such as this Rhizophora are easily seen and counted

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WHAT CAN BE DETECTED AND MONITORED IN COASTAL ENVIRONMENTS?

Coastal environments are without doubt the best environments to monitor with drones over time. As they are generally easily observed from the air, more so than most other environments, are accessible and will show effects of change very easily, they lend themselves to this method very well. Changes that can be quantified over time include:

- Seagrass bed growth and retraction
- Movement of sandbars
- Loss/regrowth of coastal vegetation
- Sand dune movement
- Growth of alluvial deposits from stormwater outflows
- Mangrove recruitment, spread and retreat
- Mangrove health (dead patches)
- Water levels in wallum swamps and other coastal lakes
- Tidal inundation at different stages of the tidal cycle
- Pioneer plant colonisation

More immediate observations of the habitat may also include:

- Monitoring of floodwater plumes
- Checking on damage by professional fishers
- Planning salvage of boats and other items from sensitive areas

THINK OF IT AS A PERSONAL GIS SATELLITE - WHEN YOU NEED IT

GIS imagery available through government and non government portals may not have a high enough resolution to make more precise measurements - and the maps are not formed **when** you need them. Kaluta will come out, weather permitting and build these maps for you **when you want them**. Typically we will aim for as much consistency as possible by aiming for the same weather and the same time of day each time so maps can be assessed accurately when they are re-flown in the future.

HOW DOES IT WORK?

First, the area to be mapped is selected and a desired resolution set, from about **0.8px/cm** at the lowest to a maximum of about **2.5px/cm**. Reasons for selecting a higher resolution would be to look for fine details, however the battery usage becomes extremely high over larger areas as a lower height is required and the area must be mapped more thoroughly. Conversely a greater height allows a greater area to be mapped in a shorter time but will not show the same level of detail. We set the desired height and resolution. Typically we will find a number of **key study areas of up to 4Ha** to map in detail rather than map the entire area.

Then, we go through checks with CASA to determine if airspace is restricted and fees will be needed to allow access. Normally we would suggest a different area in this case. If the area is clear for flight, we then move on to safety checks, which include a JSA and a risk assessment matrix.

Once at the site, we ensure that the public will not be in any danger by creating an exclusion zone and deploy the aircraft on its autonomous mission to take images along the pre determined path - the pilot being able to take control at any time if required. On the following pages the first few steps are illustrated.

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Table 1 - Mapping a small area of **1Ha**. Height, resolution and battery use*.

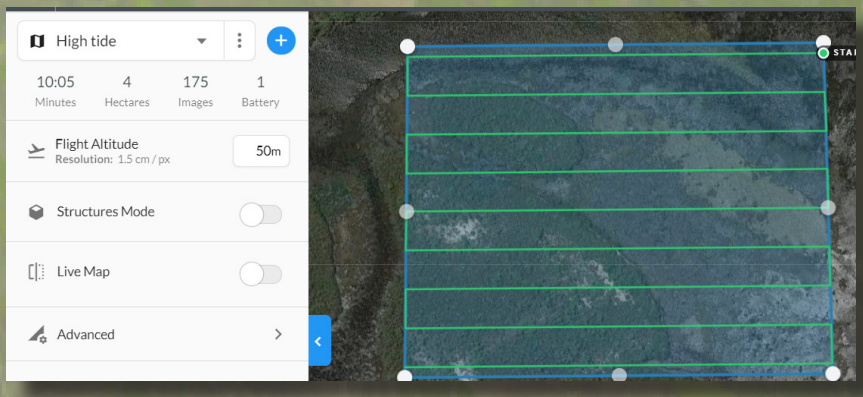
HEIGHT ABOVE TAKEOFF LOCATION	RESOLUTION OF FINAL PRODUCT	FLIGHT TIME	BATTERY USE (ESTIMATED)	NUMBER OF IMAGES
35M	1.0 CM/PX	9:50	1	190
50M	1.5 CM/PX	6:27	>1	112
70M	2.1 CM/PX	4:34	>1	65
85M	2.5 CM/PX	4:16	>1	54

*One battery gives an estimated flight time of 15 minutes total. This includes the flight to and from the mapping area. Changeover time for a battery includes shutdown, installation and restart. This takes approximately 3 minutes of ground time.

Table 2 - mapping a **square kilometre**, estimated

HEIGHT ABOVE TAKEOFF LOCATION	RESOLUTION OF FINAL PRODUCT	FLIGHT TIME	BATTERY USE (ESTIMATED MINIMUM)	NUMBER OF IMAGES
35M	1.0 CM/PX	308:00	20	7034
50M	1.5 CM/PX	155:12	10	3462
70M	2.1 CM/PX	82:00	6	1767
85M	2.5 CM/PX	57:33	4	1204

Obviously, these are considered the extremes of what this technology will be used for in most cases for ecological work, normally an optimal resolution will be decided upon in the planning process, bearing in mind that more linear or irregular flight paths may result in more or less flight time. Wind and other factors will also affect the battery use and speed of the drone in the air.



ABOVE: Flight planning. The green line is the proposed path for the drone to follow

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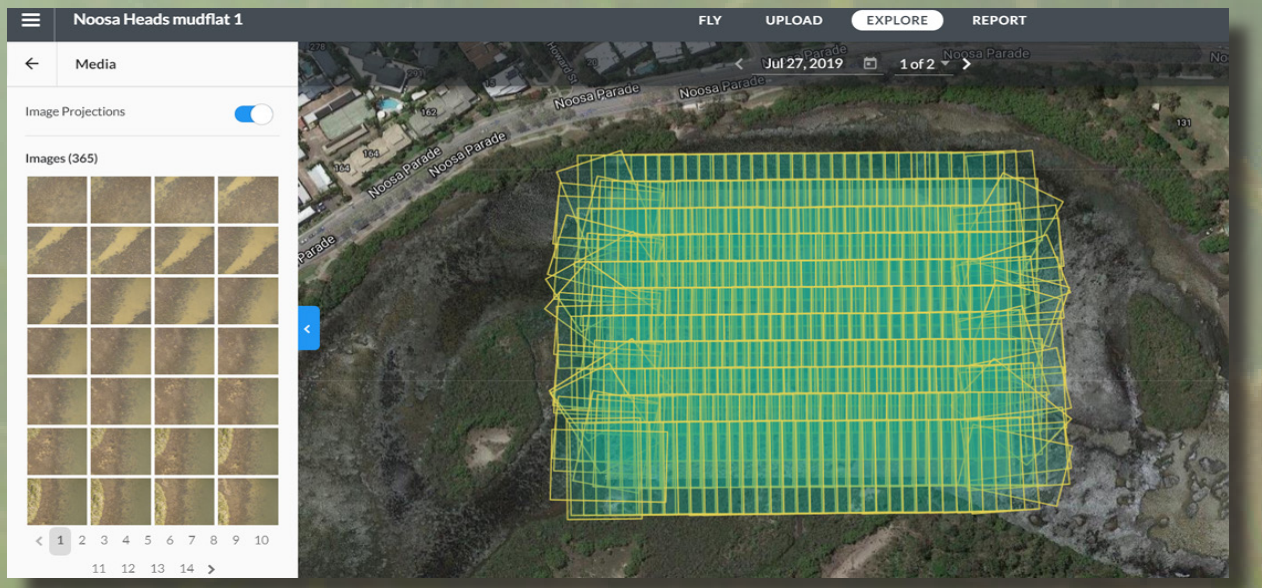
PROCESSING THE IMAGERY

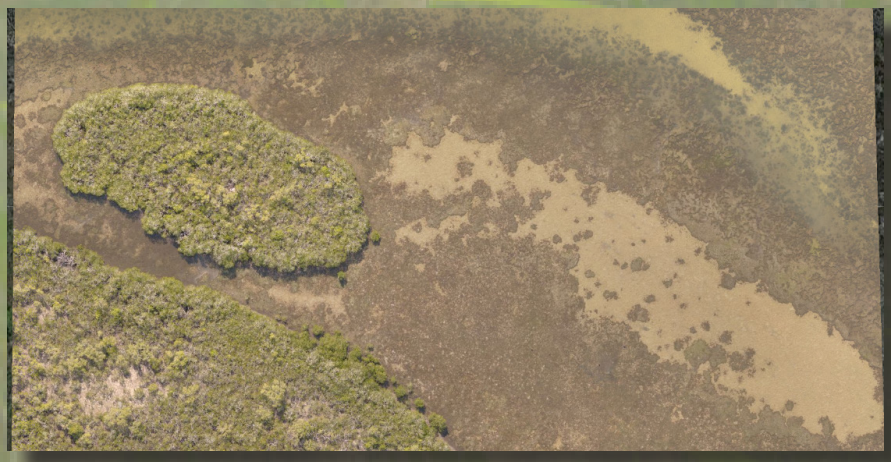
Once the imagery has been obtained, it is uploaded to a server and processed, during which time it will take into account the ground control points (GCPs), visible features and GPS coordinates to align and stitch the photographs together into an Orthomosaic.

After processing is complete, the imagery is ready to be viewed. The time required is subject to upload time and remote server load.

The results are presented on the server's console to be further assessed and downloaded.



ABOVE: Projections for each individual image collected on the flight.
BELOW: The completed Orthomosaic after stitching on the server is complete



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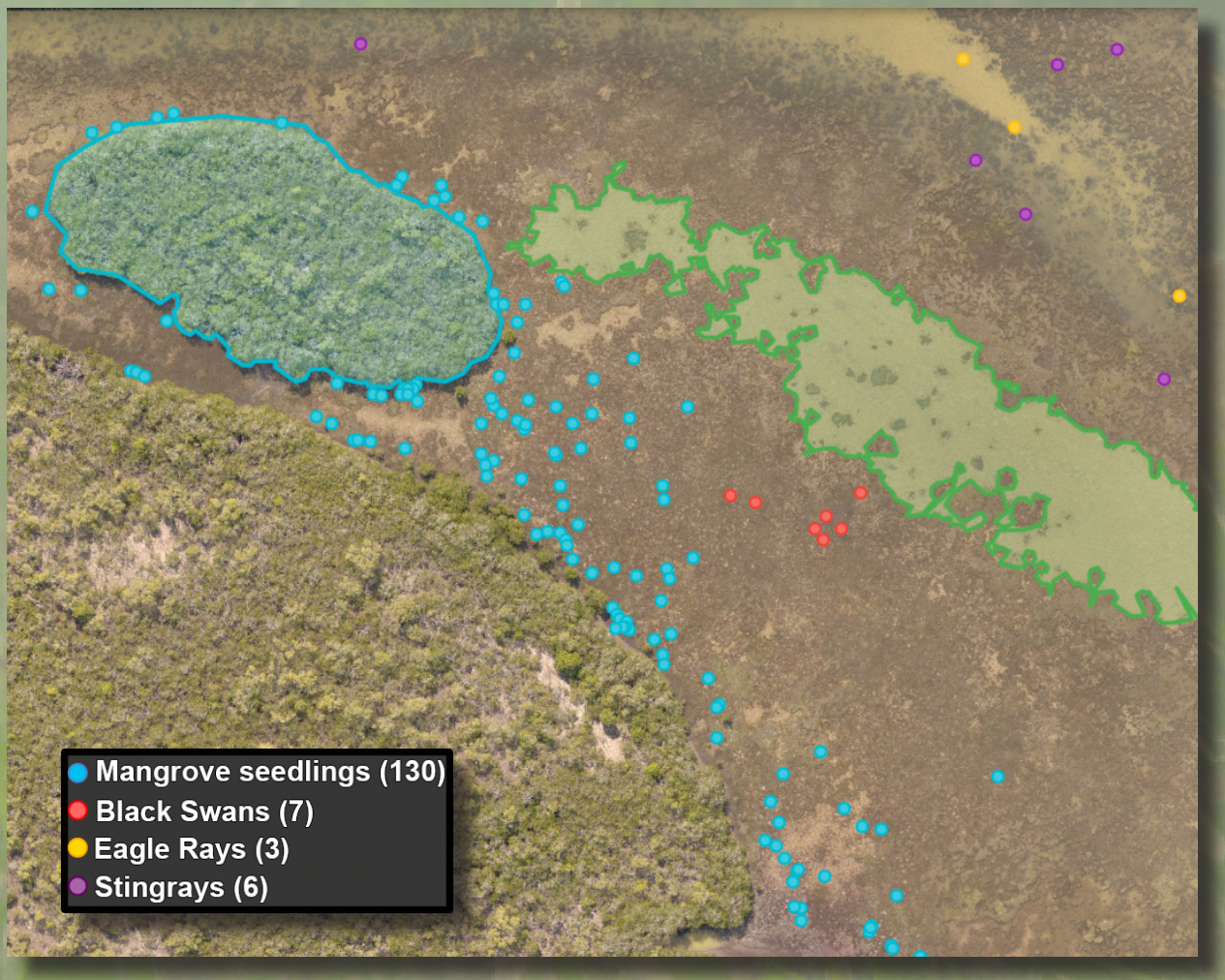
Once the stitching is complete, there is an option for making measurements and collecting data on the cloud based platform.

However, if you wish to download the file and import it into **ArcGIS** or another program for analysis, this also may be done.

BELOW: Analysis of the study area on the cloud based console. Results have been superimposed in the inset. Data points and shape files can be downloaded in useable formats.



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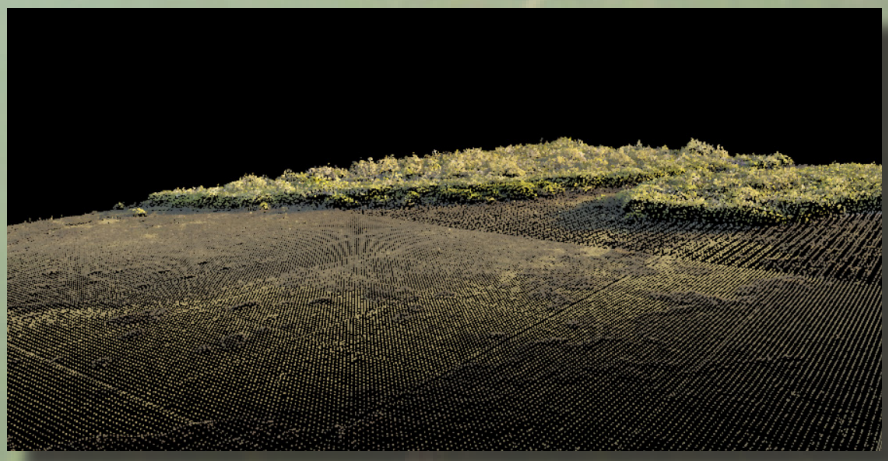
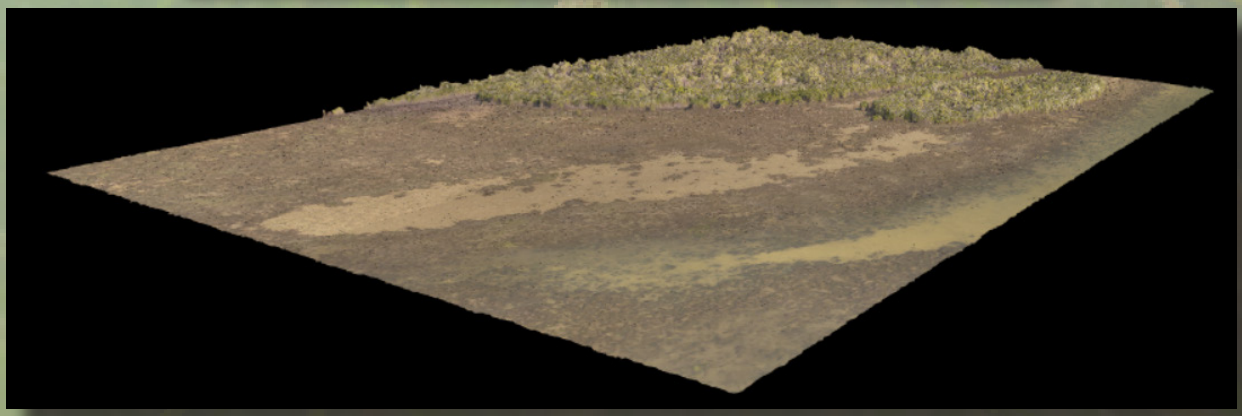
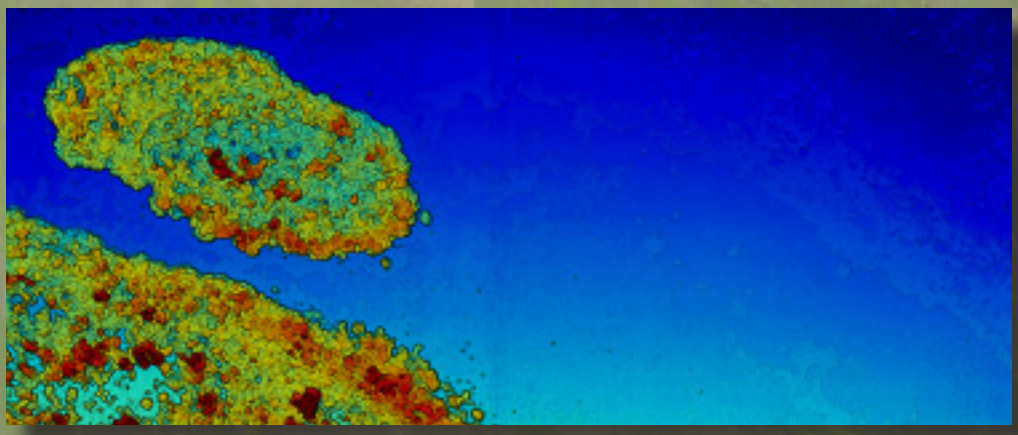
BELOW: 3D point cloud generated by analysing differences in the images





Above: 3D map generated from the imagery. This map was **not** flown with 3D imagery in mind and it can be improved on dramatically with additional images taken for that purpose.
Below: Elevation map generated from the imagery. Note the mangrove seedlings in this case are very obvious.



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ACCURACY

The accuracy of the imagery is subject to a number of variables such as satellite fix and error margin for the onboard GPS unit of the drone itself. The three tiers of accuracy are as follows:

1. **Onboard GPS only.** This is the basic level, subject to only the data taken from the drone itself. The accuracy may vary by as much as approximately 1m horizontally and 3m vertically. For the majority of ecological work, this level is adequate.

2. **Onboard GPS + GCP**. A number of Ground Control Points (GCPs) are strategically placed within the map and the location of each is recorded with a survey-grade GPS unit. Before processing, the details of the real location of each are added to the file bundle and verified manually. This aligns the map with a far greater accuracy and the results can be used for more exact planning, however accurate it may be it will not be legally considered survey grade without the use of a licenced surveyor.

3. **Onboard GPS + GCP + Survey approval.** This is the same as above, however a surveyor will be required to confirm the accuracy of the resultant map and data.

Upon processing, the software will report on the accuracy of the data and present that accuracy report to the end user. Kaluta has no control over the stitching of the map within the software as it is all done on a remote Drone Deploy server. Kaluta will use the accuracy report provided by Drone Deploy.

Drone Deploy reports very high levels of accuracy are possible when Ground Control Points are used properly. A Ground Control Point is a highly visible target with a easily discernable center that can be viewed on the map itself after the flight. The exact center of each GCP is measured using the GPS unit for the greatest accuracy.

IMPROVING THE IMAGERY

The imagery captured directly from above may be used for most ecological work such as counting seedlings, tracking progress and many other uses. However it can be significantly improved. The software allows the addition of more images from other angles to capture data from areas not fully visible from above. This greatly improves the quality of the map, especially the 3D model if it is required. This process does require many more images to be taken and a longer processing time, however this is worthwhile wherever any structures or large trees are involved. The additional images are generally taken manually and will require more time than the initial, automated orthomosaic images.

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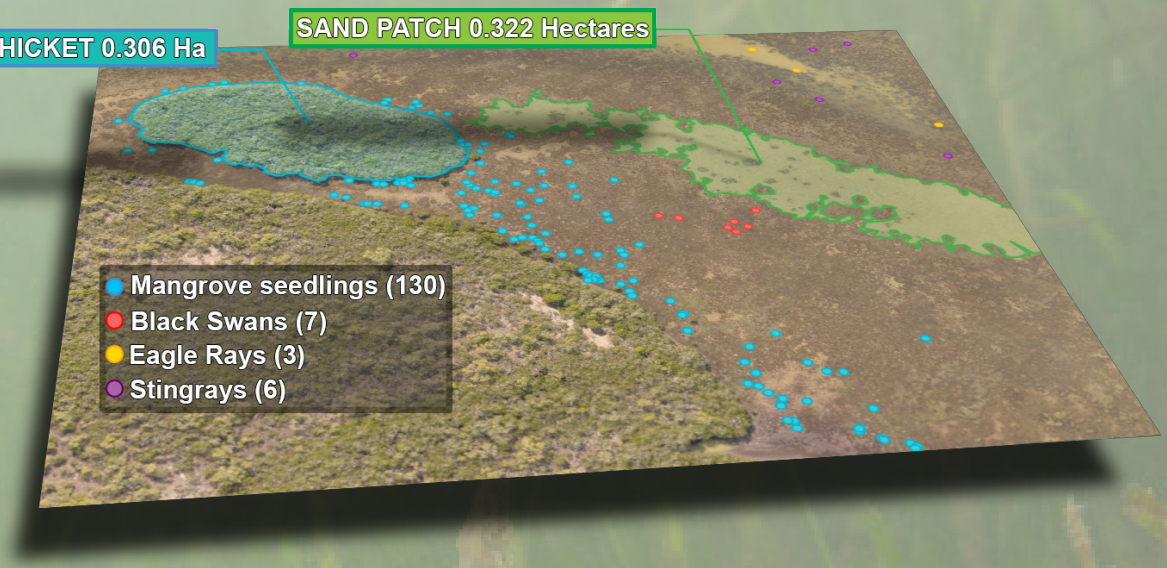

Above: The orthomosaic complete with annotations made into a 3D-like image quickly and easily on Photoshop that would be suitable for the cover of a report or website

FILE EXPORTS/DELIVERABLES

The **orthomosaic** may be exported in a number of projections such as WGS84 and used in popular GIS software such as **ArcGIS**:

- **GeoTIFF** file and downloded from Drone Deploy to be opened and used in popular GIS software such as **ArcGIS** and many others. Also available is **JPG** in single or tiled format, and **PDF**.

Shape files are available for download in:
- ***.SHP**
- Google Earth ***.KML**

Elevation maps and **Digital Terrain Models** may also be downloaded as:
- **GeoTIFF**
- **PDF**
- **JPG**
- Raw Elevation Values ***.DEM**
- Countour ***.DXF** (AutoCAD)
- Countour ***.SHP** (ShapeFile)

3D models are available to download as ***.OBJ** packages

A Point Cloud download is also available in:
- LiDAR Data Exchange (***.las**)
- ACSII xyzrgb (***.xyz**)
- Autodesk (***.rcp**)

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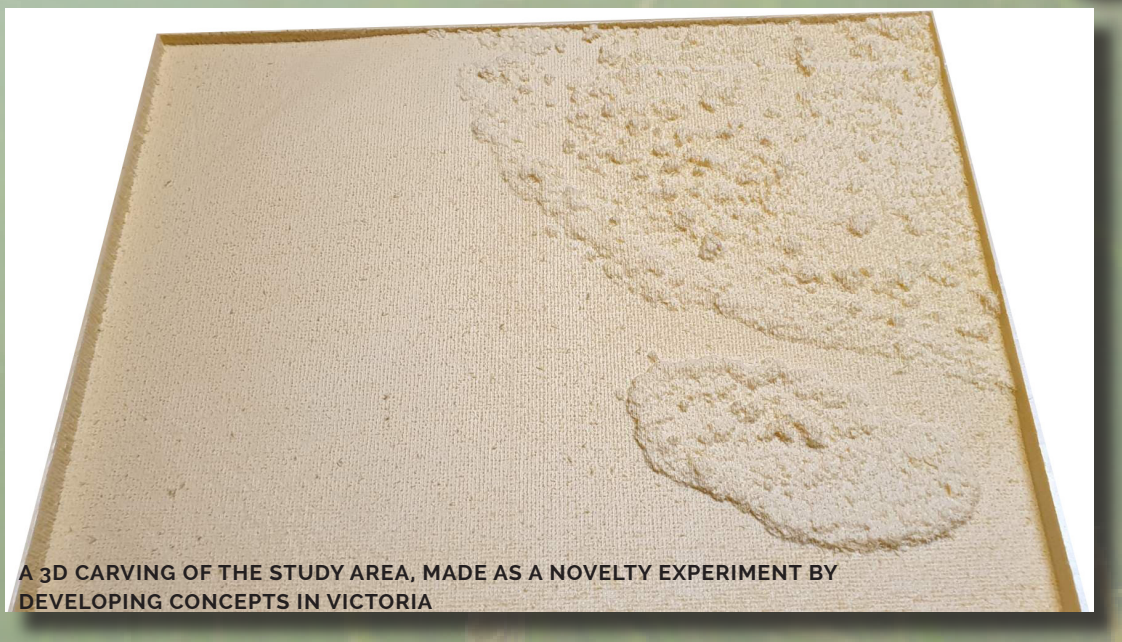

A 3D CARVING OF THE STUDY AREA, MADE AS A NOVELTY EXPERIMENT BY DEVELOPING CONCEPTS IN VICTORIA

EFFICIENCY AND SAVINGS

There is no denying that this system is vastly more efficient, much safer and much less damaging to rehabilitation areas, study sites and ecosystems in general. Usage of the drone/RPAS/UAV maximises efficiency and safety in the following key areas:

- Vast reduction in data gathering time
- Formation of baseline data that can be repeated and assessed over time
- Less personnel hours
- Greatly reduced requirement to walk through rehabilitation areas and study sites, therefore reducing or even negating disturbance
- Less safety issues from personnel walking through areas that carry higher risk
- Collaboration with colleagues over the internet with gathered data for quality assurance and additional opinions

The **4Ha** example used in this paper was set up and executed as follows:
Setup time (JSA, safety checks, documentation): 30 minutes
Flight time: >15 minutes
Data analysis: 25 minutes
Compared to walking through the habitat, altering it and making measurements that would take easily 8 personnel hours or more, the drone option is clearly the most effective and efficient.

ADDITIONAL DELIVERABLES

In addition to 2D and 3D mapping, Drone Deploy also allows for **excavation and stockpile analysis**. This may prove extremely useful for monitoring the spread of alluvial deposits following rain, as well as measuring the erosion of gullies, not to mention the volume of newly constructed dams and turkey nests prior to filling. Access to this software will come at a small additional cost if required as it is part of a different software package.

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SAME DAY MAPS

Getting the results imported and integrated onto your phone or other smart device gives the client a huge advantage.

To be able to get a map collected in the morning and uploaded for use on mobile mapping software on the very same day allows any users with the software and an internet connection to have the most up-to-date view of the site possible!

This is great news for:

- Farmers
- Land managers
- Fire crews
- Disaster response teams
- Ecologists
- Councils
- Any sort of property owner
- Civil engineering firms

So how will you use Kaluta's mapping resources to benefit your own business, project or study?

Call us today and we'll be happy to chat and see how we can help.

Alternatively, head to kaluta.com.au to find out more.

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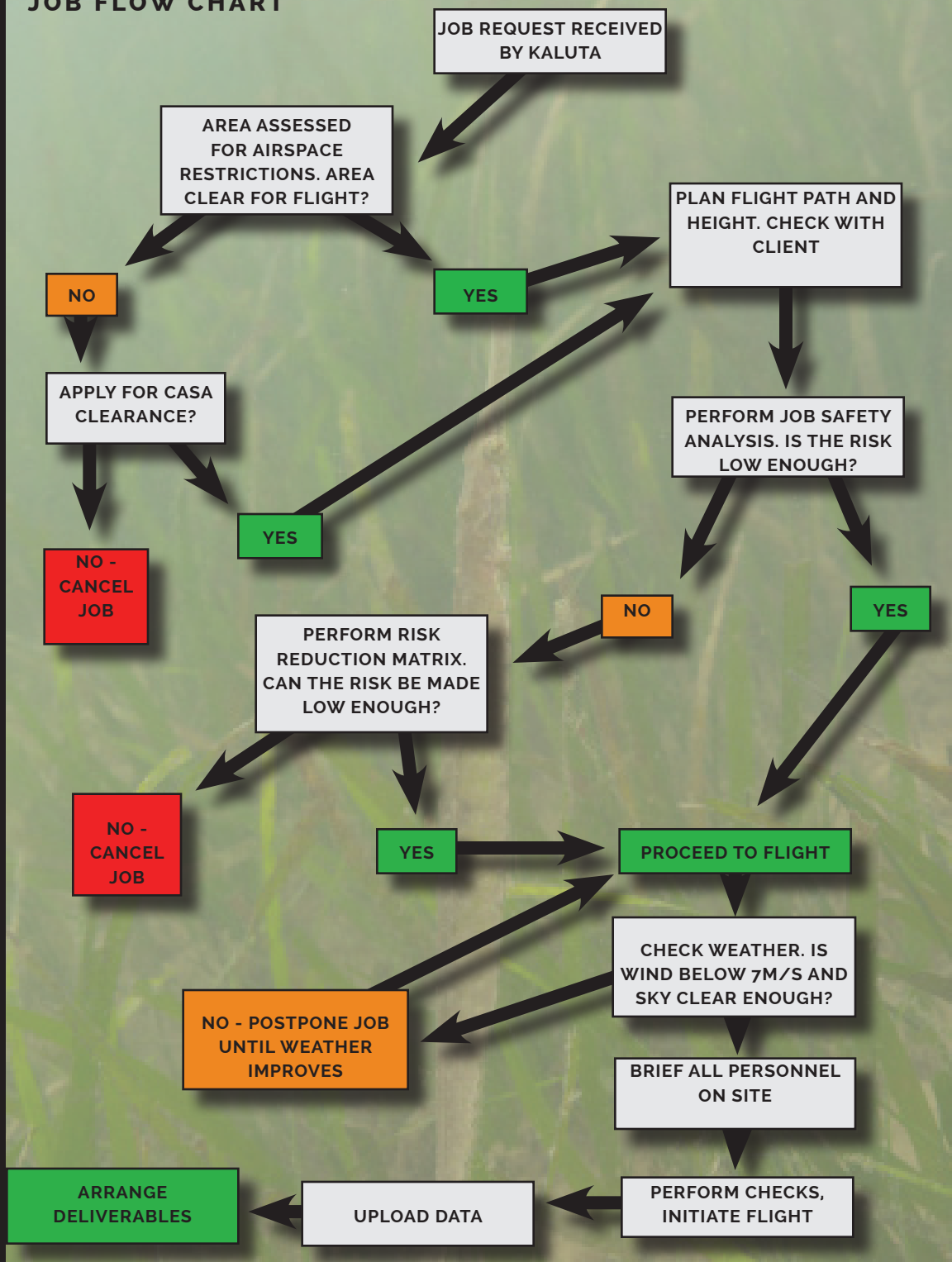
JOB FLOW CHART