weedREMEED

USER PROTOCOL

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These guidelines are intended to support users to achieve the best possible outcomes when using the WeedRemeed software for drone-based species (native plant or weed) detection and mapping. WeedRemeed uses still RGB drone imagery to detect and geolocate target plant species, and its performance is strongly influenced by survey design, data quality, and species characteristics.

The guidance below focuses on three critical stages of the WeedRemeed workflow: survey planning, undertaking the drone survey, and processing imagery within the platform. While the software provides powerful analytical tools, it does not remove the need for informed decision-making. Survey timing, plant phenology, vegetation context, and method selection all play a decisive role in whether detection is successful.

It is important to understand that WeedRemeed does not deliver uniform results across all species or environments. Some species are best detected through colour-based analysis during specific phenological windows, while others are more suitable for machine-learning approaches that rely on plant form and structure. Understanding these trade-offs before collecting data will significantly improve outcomes and reduce rework.

Survey Planning

- Identify target species
- Survey location and timing
- Identify drone limitations to gather quality data

Drone Survey

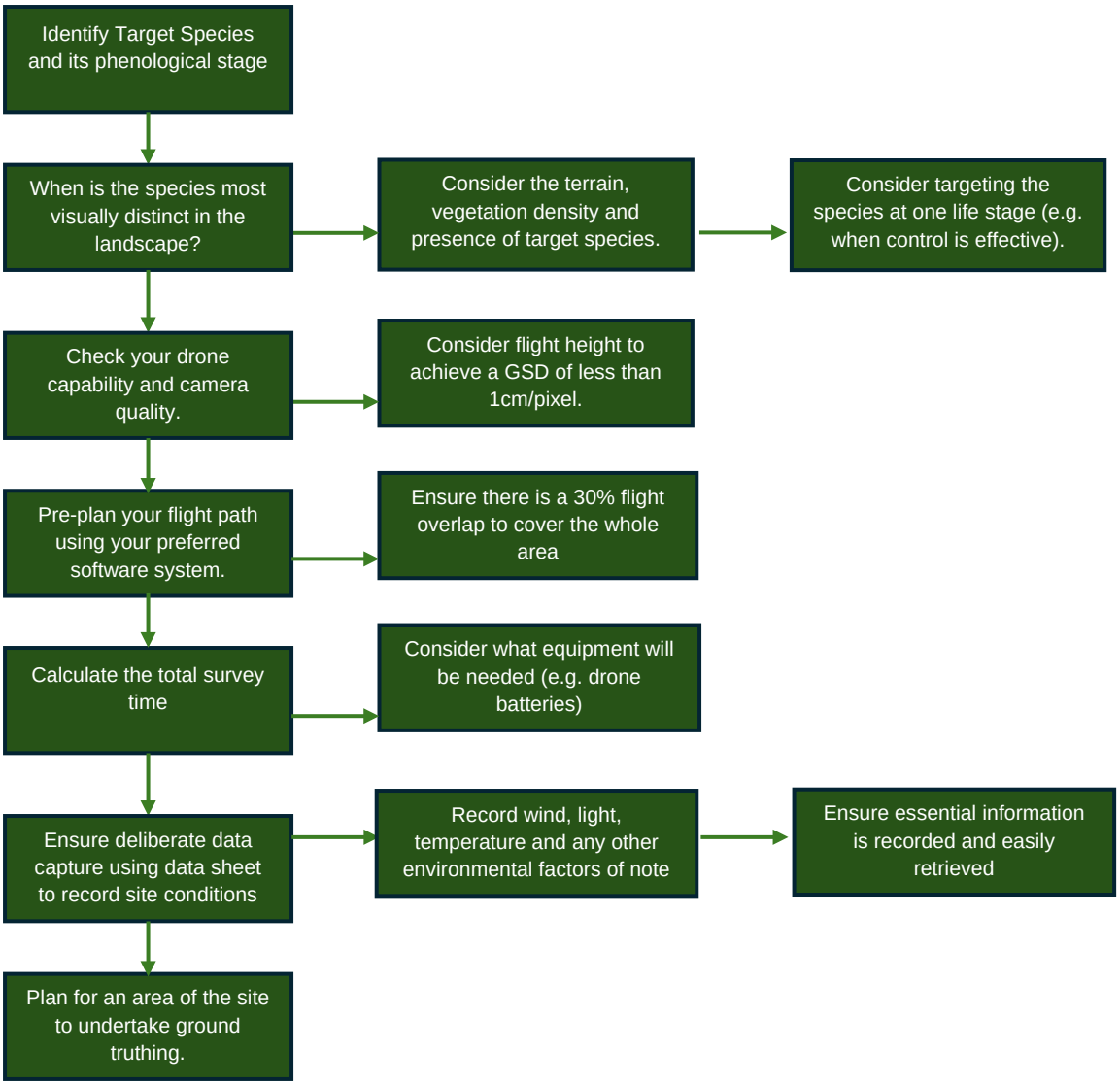
- Consistency during flights
- Record all data and anything of note
- Consider undertaking some ground truthing

Data Processing

- Select the detection method best suited to the target species
- Annotate images to provide a good training data set
- Invest time in training the model to get the best results

SURVEY PLANNING

Proper planning before undertaking drone surveys is essential to achieving reliable results. Survey timing is one of the most important considerations and should be aligned with the period when the target species is most detectable in the landscape[1]. This may mean that survey timing is optimal for one species but not for others present on the site. Similar species with comparable colour or structure can also reduce detection precision, particularly for colour-based analysis. When planning a survey, users should consider:



[1] "Most distinct in the landscape" can vary depending on the analysis method you are using (Colour Picker or Machine Learning). Using the Colour-based detection (Colour Picker) analysis, you would be targeting a survey time when there is a distinct colour signature (e.g. flowering). To achieve the best results with Machine Learning analysis, the survey time should be taken at when the target species is most similar to the trained model.

DRONE SURVEY

Collecting quality data is essential to developing a successful model to detect and geolocate your target species. Your drone's capability will be a guiding factor for how you undertake your survey. Trade offs can be made to improve drone efficiency, but this may result in a poor dataset and an unsuccessful model. All drone surveys for the WeedRemeed software need to be conducted in a grid style with still images taken from a top-down angle. Table 1 provides a guide to setting your drone parameters.

Table 1: Details the recommendations for drone flight specifications.

Drone Parameter	Recommendations	Example drone: Mavic 3
Ground Sample Distance (GSD)	<1cm/Pixel	0.8cm/pixel
Altitude above ground level (AGL)	Varies depending on the quality of the drone camera	30m
Flight Speed	<3m/s	3m/s
Overlap	30%	30%
RTK	Yes	Yes

Note: Images collected will not be stitched together for the WeedRemeed software.

Essential information to record:

- Pixel size (cm)
- Flight Height (m)
- Flight bearing
- Base station handset height
- Site elevation
- Wind speed and temperature
- Flight details
- Date and flight time
- Flight issues
- Variations in flight take off altitude

Undertaking drone surveys for species detection models can be complex and pilots need to have confidence in their capacity to understand the drone software they are using to correctly input parameters to ensure data quality. It is important to remember that there can be significant variation between cameras, and this will affect data collection. Other factors that can influence the creation of detection models are the time of day (i.e. shadows) and drone speed (i.e. image blur).

Ground truthing may be necessary to ensure your model is accurately detecting your target species. For ground truthing, select a defined area that can be surveyed. Walk the area and take GPS points at each sighting of the target species. This can be used to verify the detection results of your model and the accuracy of the geolocation. Alternatively, model detection results can be verified by randomly sampling your annotated data set into a training, validation and testing grouping. For further information on drone survey planning and ground truthing visit the Charles Sturt University Website: UAV mission planning - The Weed Manager's Guide To Remote Detection.

DATA PROCESSING

The WeedRemeed software uses two techniques to detect weeds from drone imagery:

- The first method utilises colour-based detection, where the colour picker applies a user-defined colour swatch to the imagery set.
- The second method utilises an object detection neural network fine-tuned for a given species.

If this does not already exist for your target species within your target terrain a new model will need to be produced and integrated into the platform. This will involve annotating the target species within a subset of your total survey.

Colour-based detection performs best where a species exhibits a strong and distinctive colour signal relative to its background, often during flowering or senescence.

Machine-learning detection performs best where plant form and structure are visually distinct and consistent with the trained model. These approaches are complementary but not interchangeable, and users should select the method best suited to the target species and survey conditions.

COLOUR-BASED DETECTION (COLOUR PICKER)

One of the techniques for identifying artifacts within imagery that is utilised by WeedRemeed is Colour Picking. The Colour Picking tool is configurable within the data processing Workflows. Every time this tool is run, the user must configure it with a colour swatch.

The colour picker samples the colour values defined in the swatch and generates a 3-dimensional colour range. The image is then scanned for pixels that fall within this range, which are marked as detections.

Creating a colour swatch involves sampling distinct colour signatures from your imagery that can be used to identify your target artifact, most commonly the weed or

native plant you are searching for. This is done with third party tools such as MS Paint, GIMP, or Photoshop. Good colour swatches are generally created by following an iterative test and develop approach. A sample colour swatch creation workflow can be found in appendix 2.

ML TRAINING

If the included detection technologies are not fit for your workflow a new Object Detection model can be produced for your use case. There are additional data requirements if intending to produce a new ML model.

Producing a model for detection of a target species will require 2,000-3,000+ annotated instances of the target plant. Subject to:

- the desired accuracy[2]
- desired imaging distance
- visual 'distinctness' of the plant
- presence of look-a-like plants
- variations in the landscape where the plant is to be detected
- variability in plant life stages (consider only labelling the plant life stage control will occur)

See the Image Labelling Requirements document for a guide on labelling images (Appendix 3).

Image labelling and model training are offered as paid services by CISS in partnership with 2Pi Software. Users of WeedRemeed are welcome to bring along their own labelled data and/or train their own models. Integration of these models into the WeedRemeed platform will require communication with the WeedRemeed team.

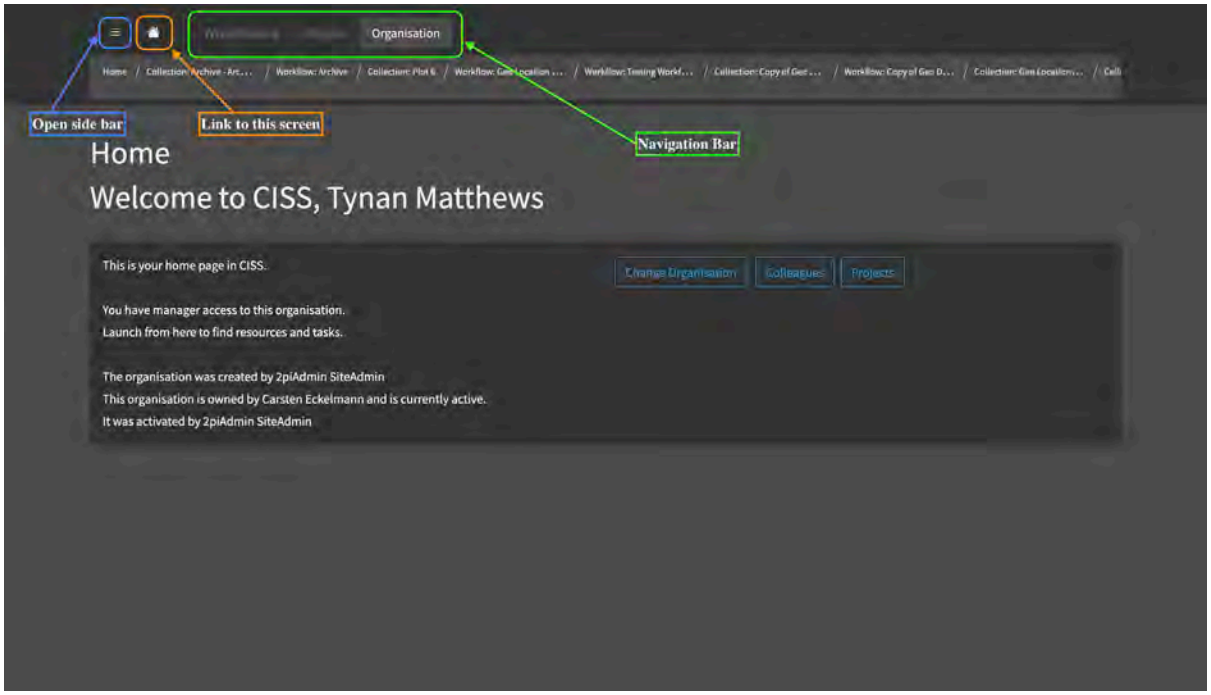
CONSULTANCY SERVICE

CISS in partnership with 2Pi Software can undertake all aspects of colour swatch creation, image annotation and detection model training. To discuss this service further please contact: *landsmart@invasives.com.au*.

[2] Model accuracy is context-dependent and varies with species characteristics, survey timing, image quality, and environmental conditions

WEEDREMEED PROCESSING

This section provides a detailed user interface walkthrough. When you first sign into WeedRemeed you will be greeted with the home screen.

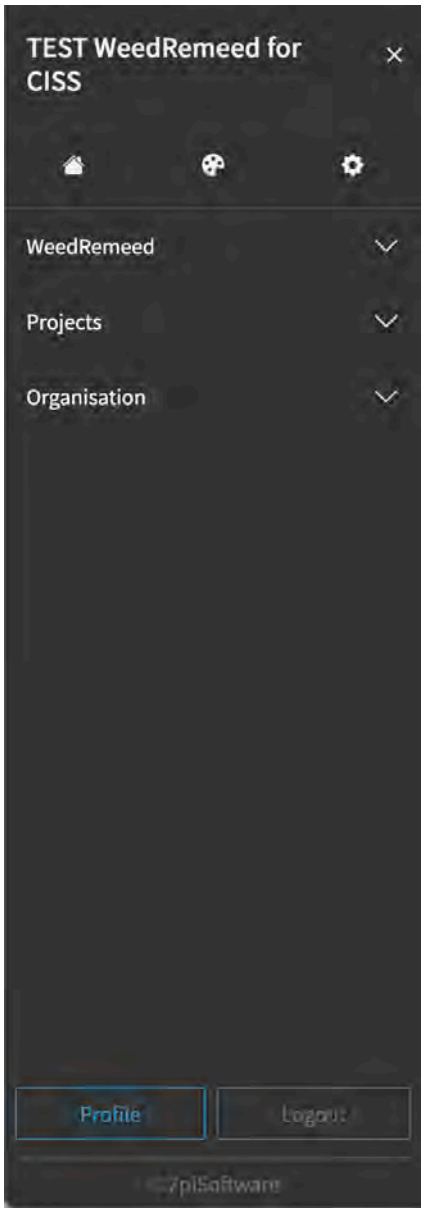


This screen displays your name and currently active organisation.

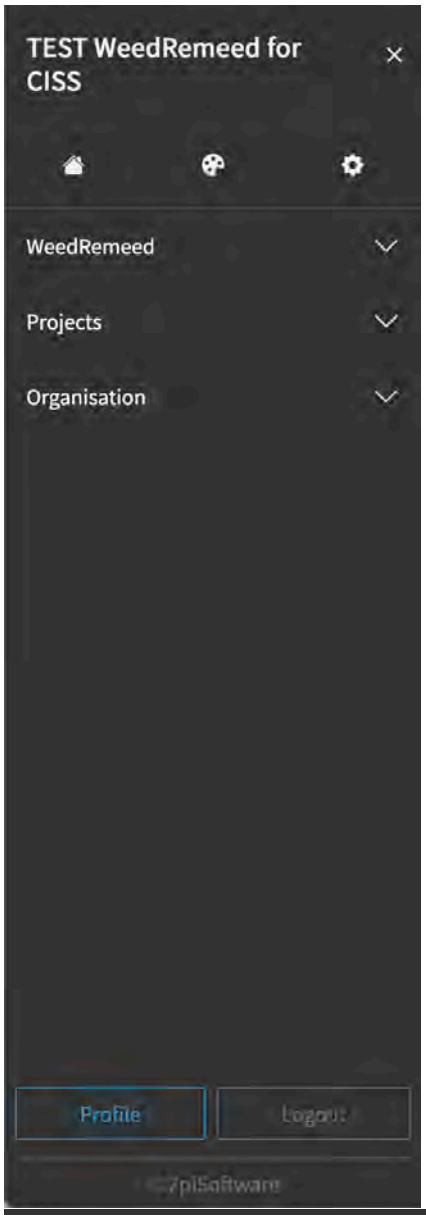
At the top of the screen are buttons for navigating to various parts of the WeedRemeed software.

The button with the house icon takes you to this screen.

The three lines opens the side menu, from there you can see the top nav bar in a new style.



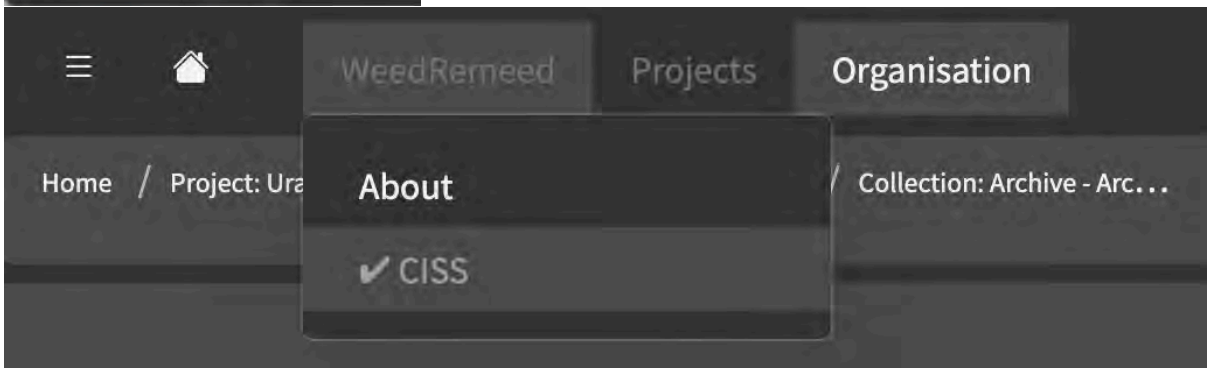
The colour palette button switches your theme between dark and light.



The Profile button takes you to a page that allows you to edit your name, email address, change your organisation.

To log out of your account, press the Logout button.

If you wish to change your organisation, click the WeedRemeed header and select your current organisation.



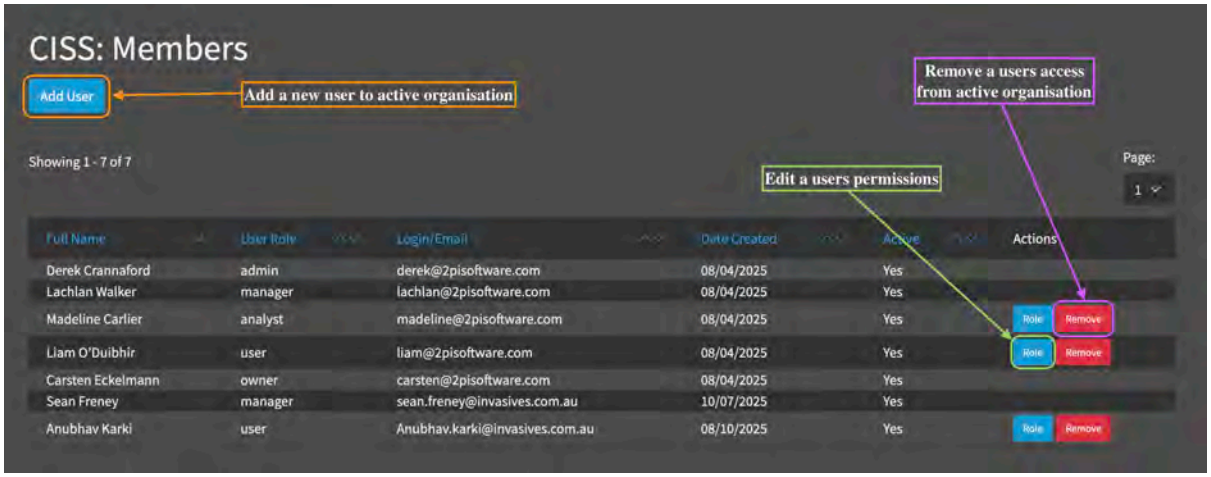
This will open a modal window where you can select any other organisations you may own or be a user in?

The “about” page in this menu holds some information about WeedRemeed.

“Organisation” allows you to manage the people who make up your WeedRemeed organisation.

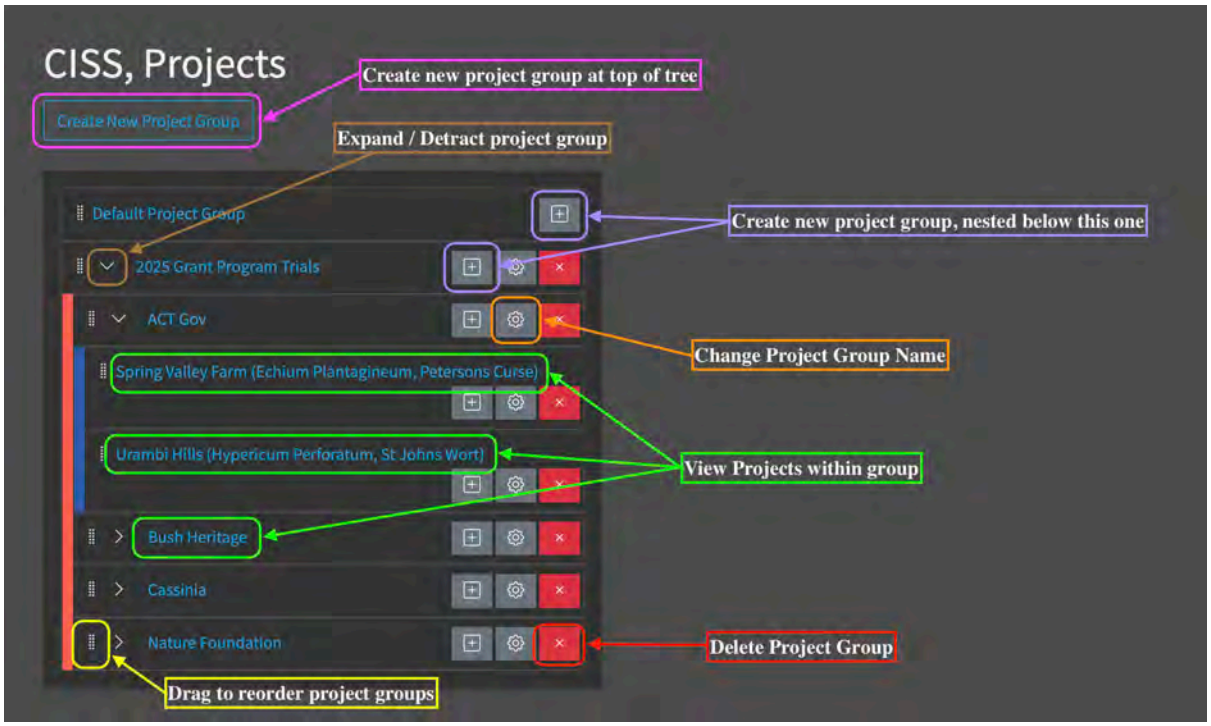


“My Colleagues” provides a quick access view available to all role levels that summarises the names, roles and email addresses of each person within your active organisation.



The “members” page allows some actions to be taken by users with the correct permissions. Here you can add a new user, change a user's role or remove a user from the organisation.

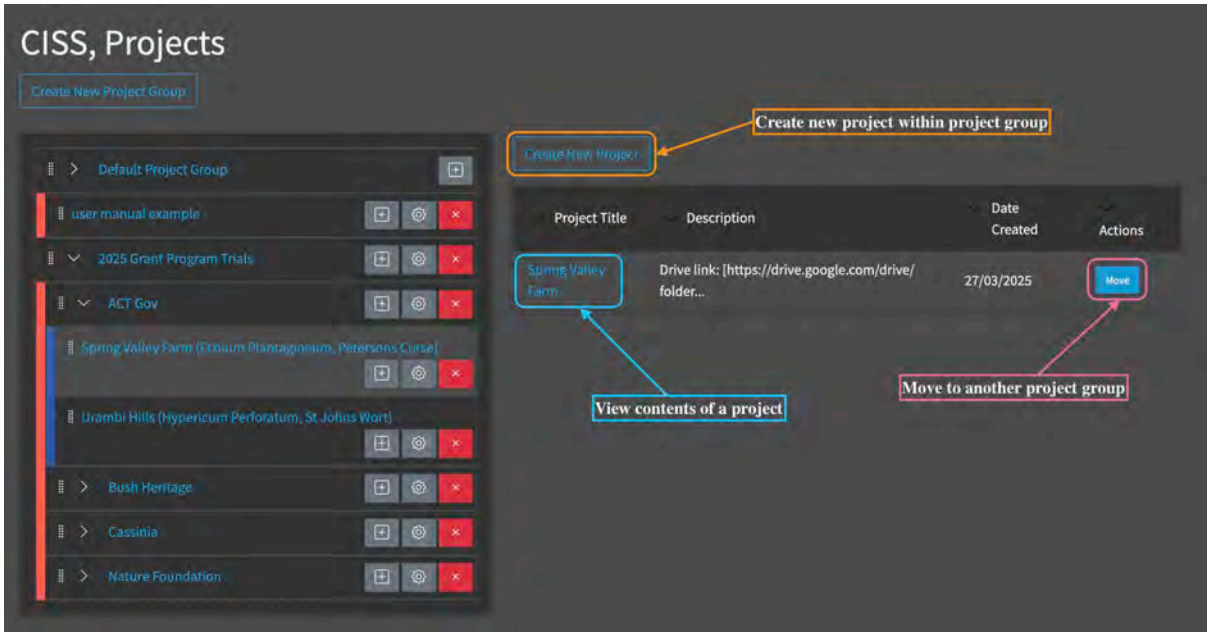
The “Projects” tab allows you to navigate to project groups,



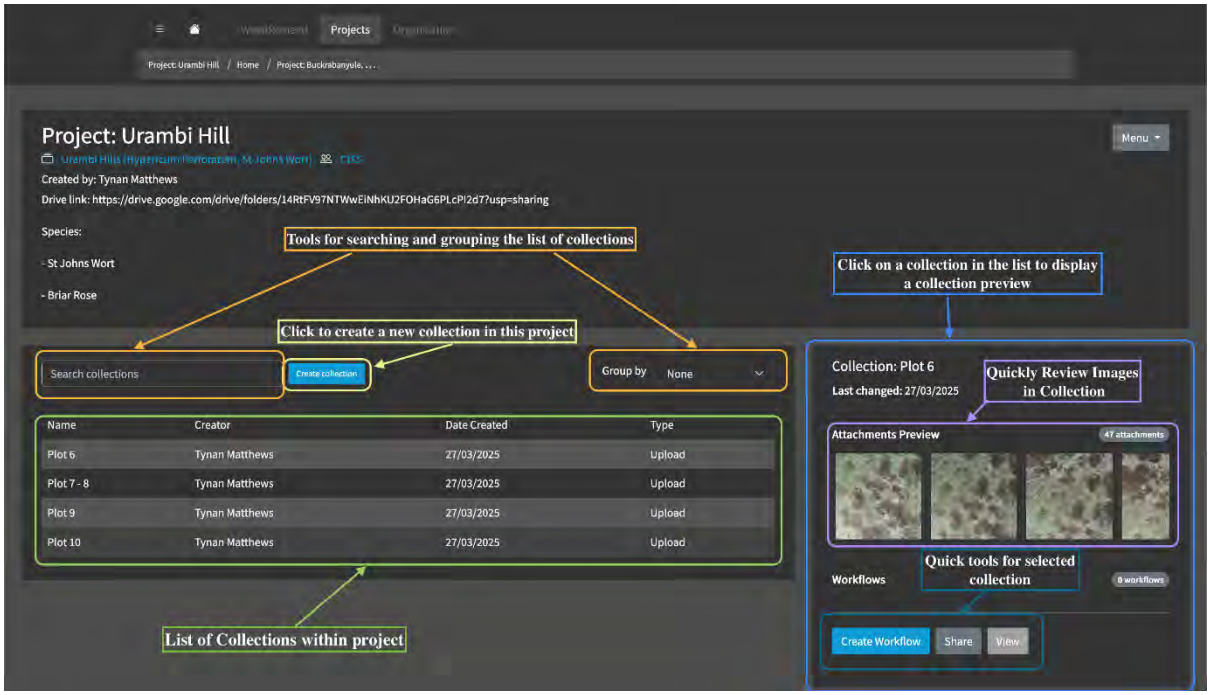
“Project groups” are a nestable structure for organising projects within an organisation.

They can be collapsed and expanded by interacting with the chevrons on the screen.

Once a project group has been selected, click on it with your mouse to see what projects it contains.

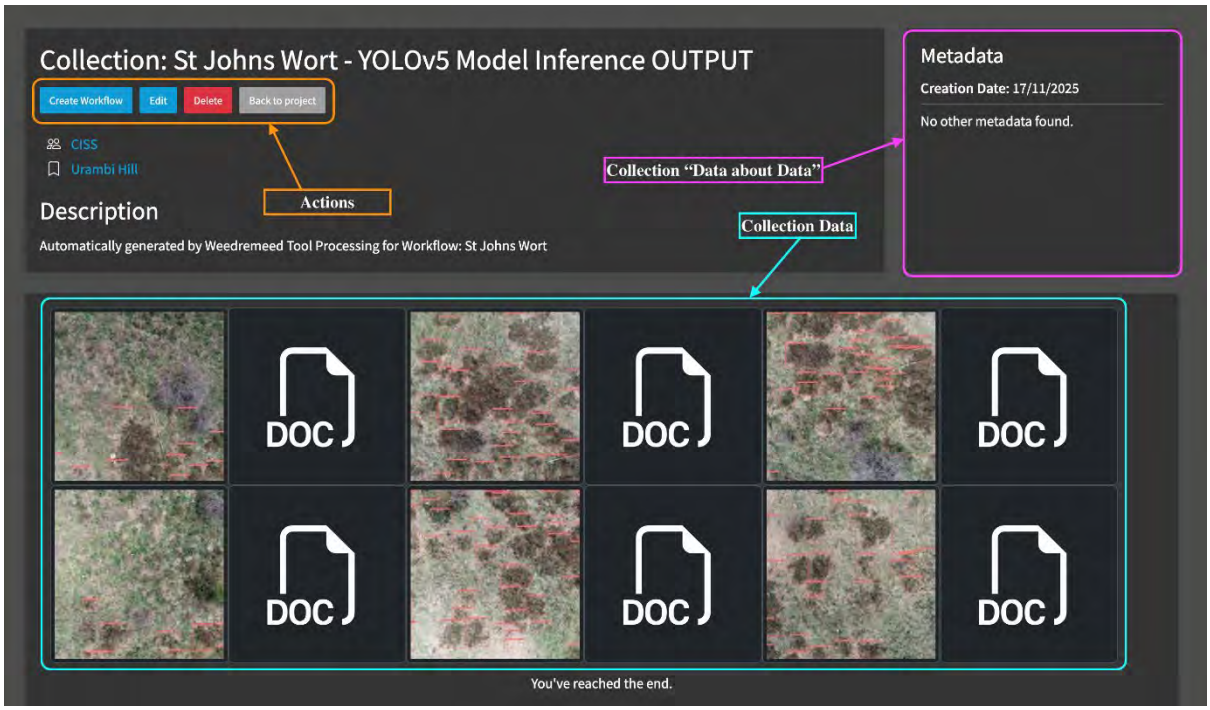


From here you can create a new project within the selected project group, move the projects within this group to another group, or navigate to the projects within the group.



The project screen consists of a description of the project, a list of the collections within the project (green) with an option to create a new collection (yellow), and a preview window of the selected collection (blue).

From the preview window, you can share the collection with another user from outside your organisation, view the contents of the collection or create a workflow.



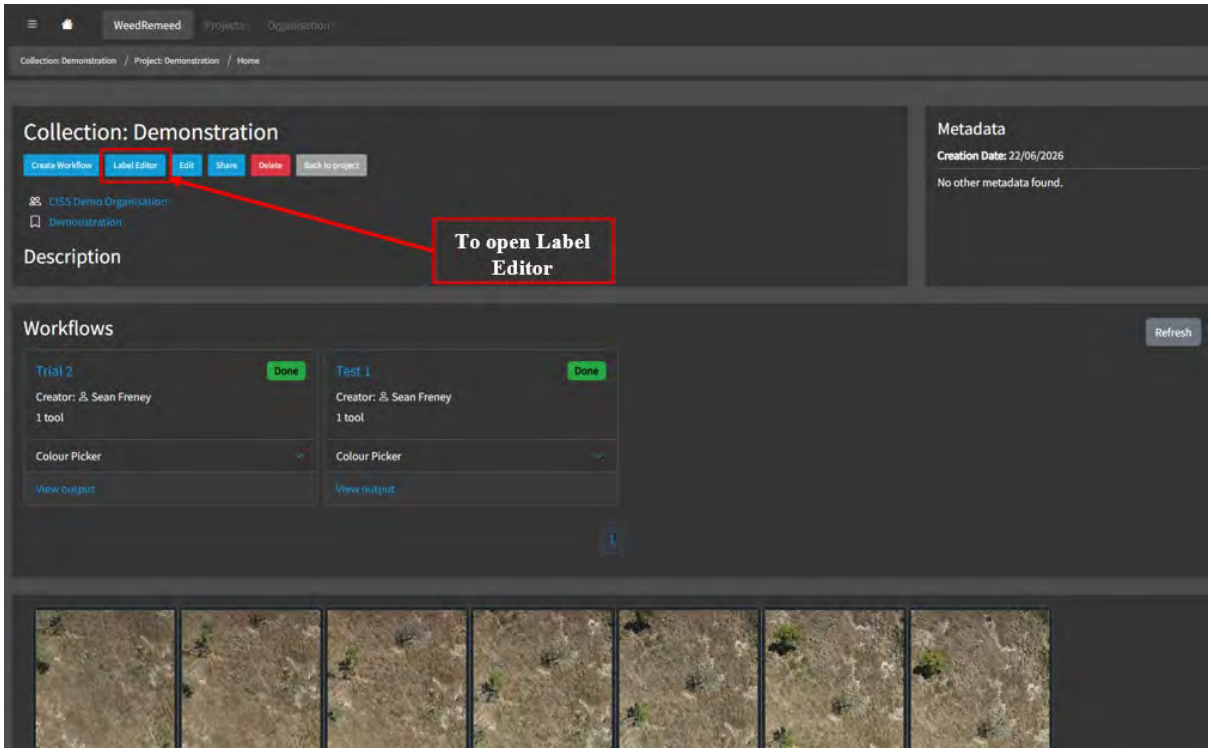
You can also access the label editor or create a workflow from within the collection view screen.

In this screen you can see a preview of all the content present within a collection, from the meta data (data about the data) to the binary files contained within. Binary files are represented via an icon or image preview, whichever is appropriate.

From this screen the user can:

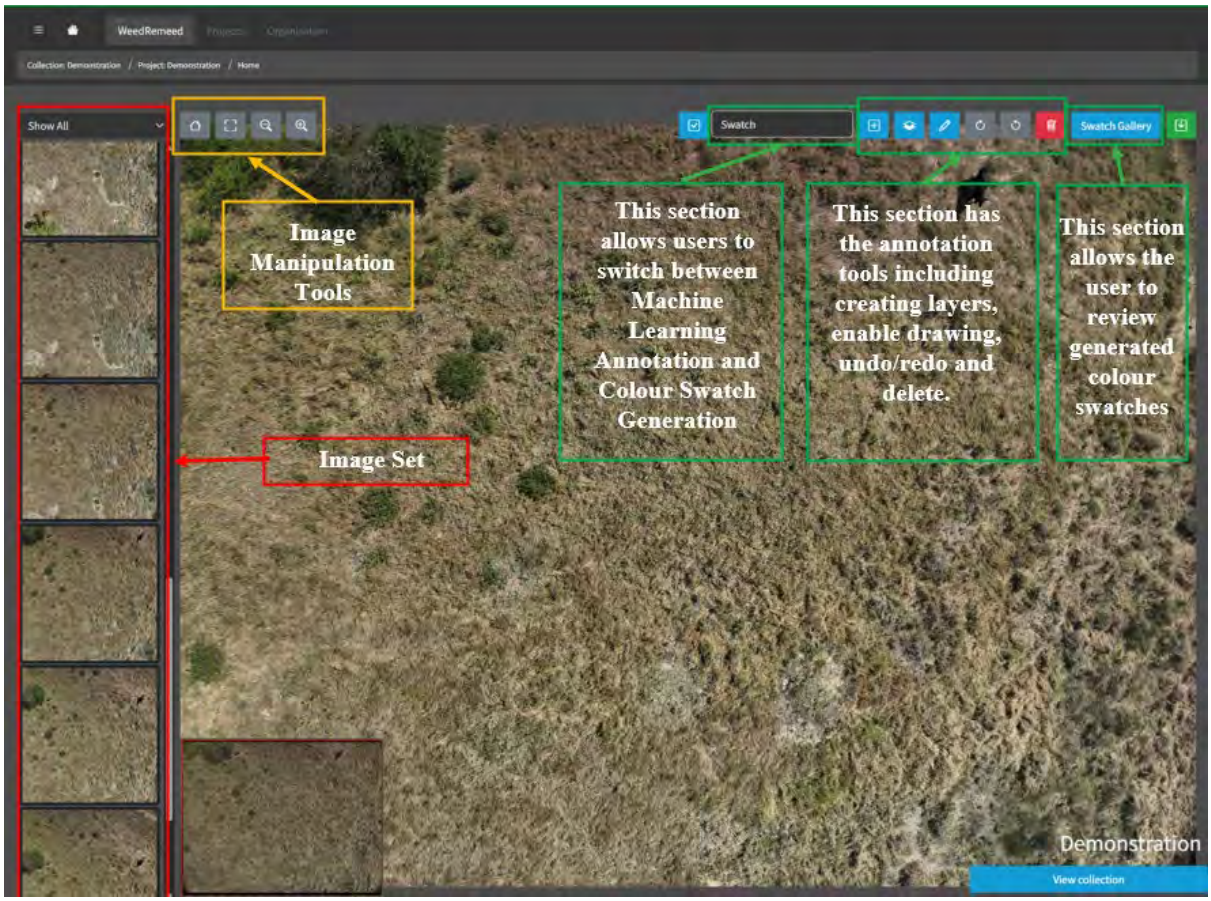
- Open the label editor to create a colour swatch.
- Execute a workflow with this collection as the input collection.
- Edit the details of the collection such as its title or description.
- Delete the collection if they have the sufficient permissions.
- Upload data to the collection if it has not yet been used for processing or is empty.
- Expand one of the images or files by clicking on them, with an option to download the binary file.
- Navigate to the project or organisation the Collection exists within.

Labelling Editor

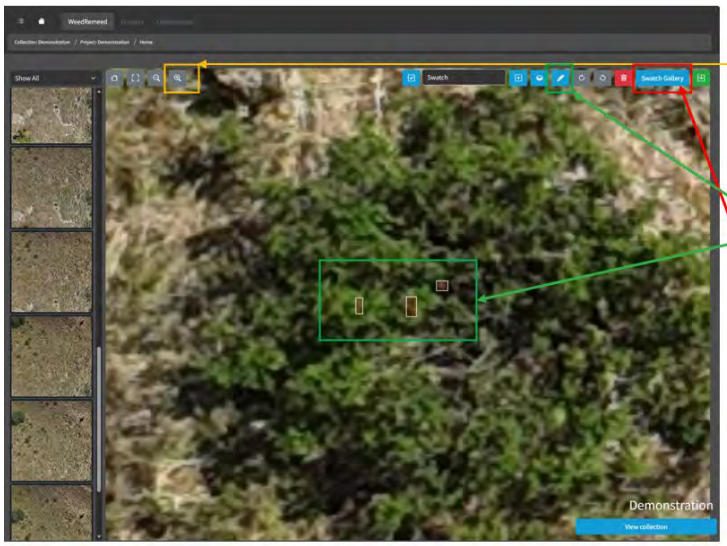


This screenshot is the collection view page as detailed above on page 13. WeedRemeed now has a label editor in house which can be accessed through the collection view page. This feature enables users to annotate image sets by drawing bounding boxes on images.

The below screenshot showcases the label editor and its features. The label editor will allow users to annotate their image set to train a Machine Learning model or create a colour swatch by taking small samples from the image. Users can hover over each tool to understand what each tool does. The green button shown allows users to save their progress, a warning will pop up if users try to change images without saving.



The below screenshot details how to generate a colour swatch for use in a detection workflow.

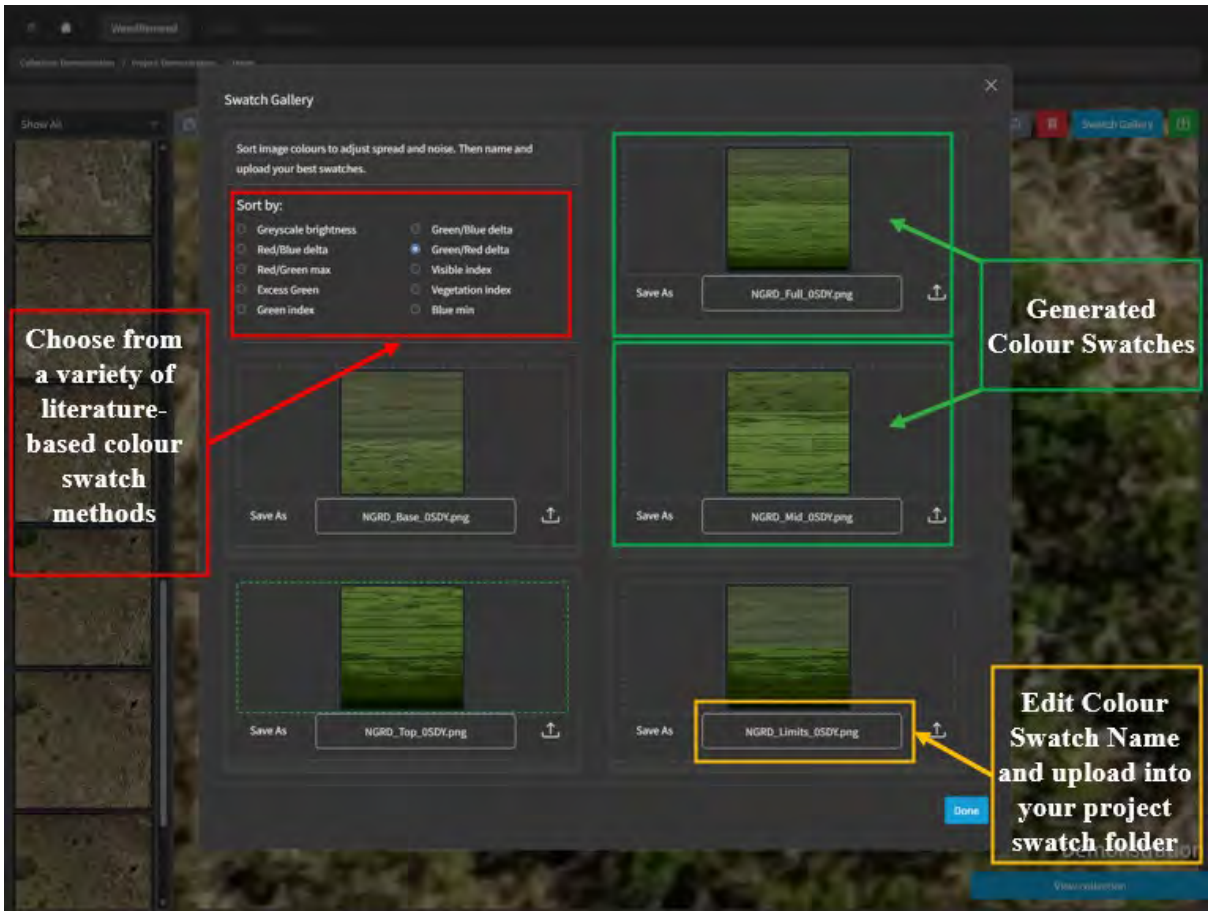


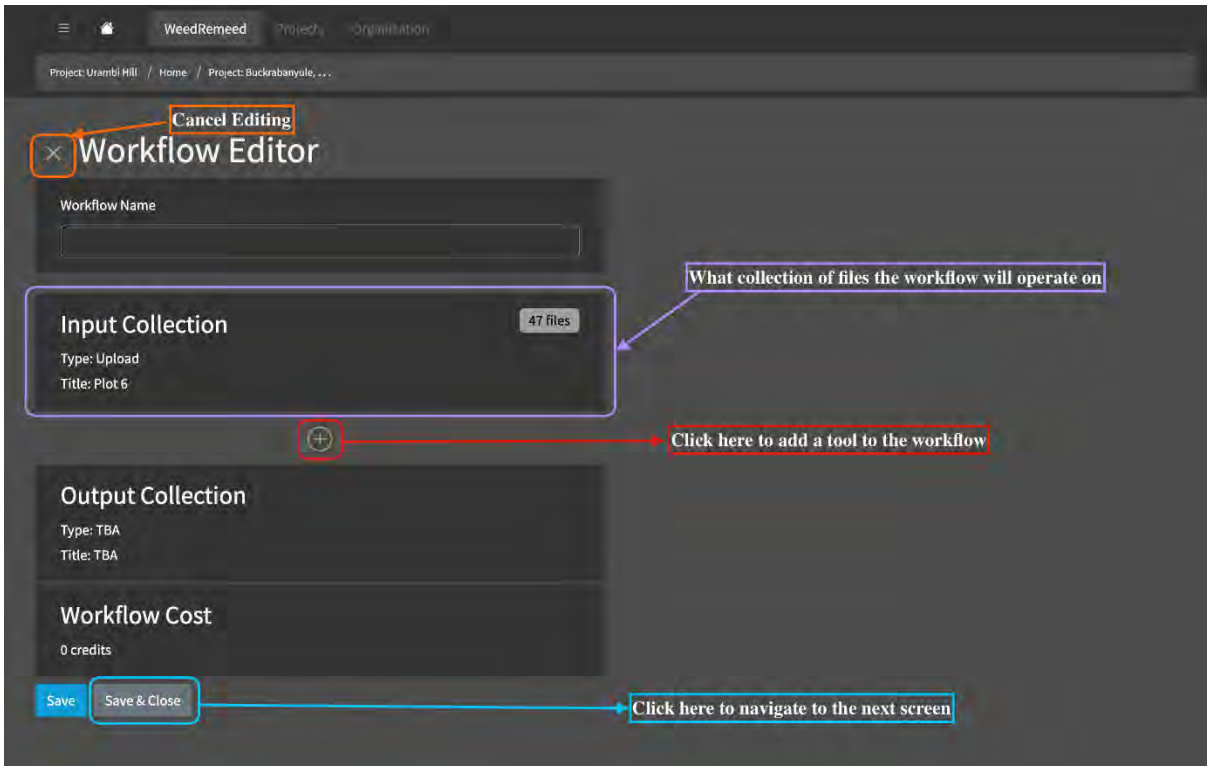
Next, we zoom into the target species to take a sample of the unique colour we are wanting for detection.

To take this sample we click here and simply click and drag on the image.

To view the auto-generated swatches we click the swatch gallery.

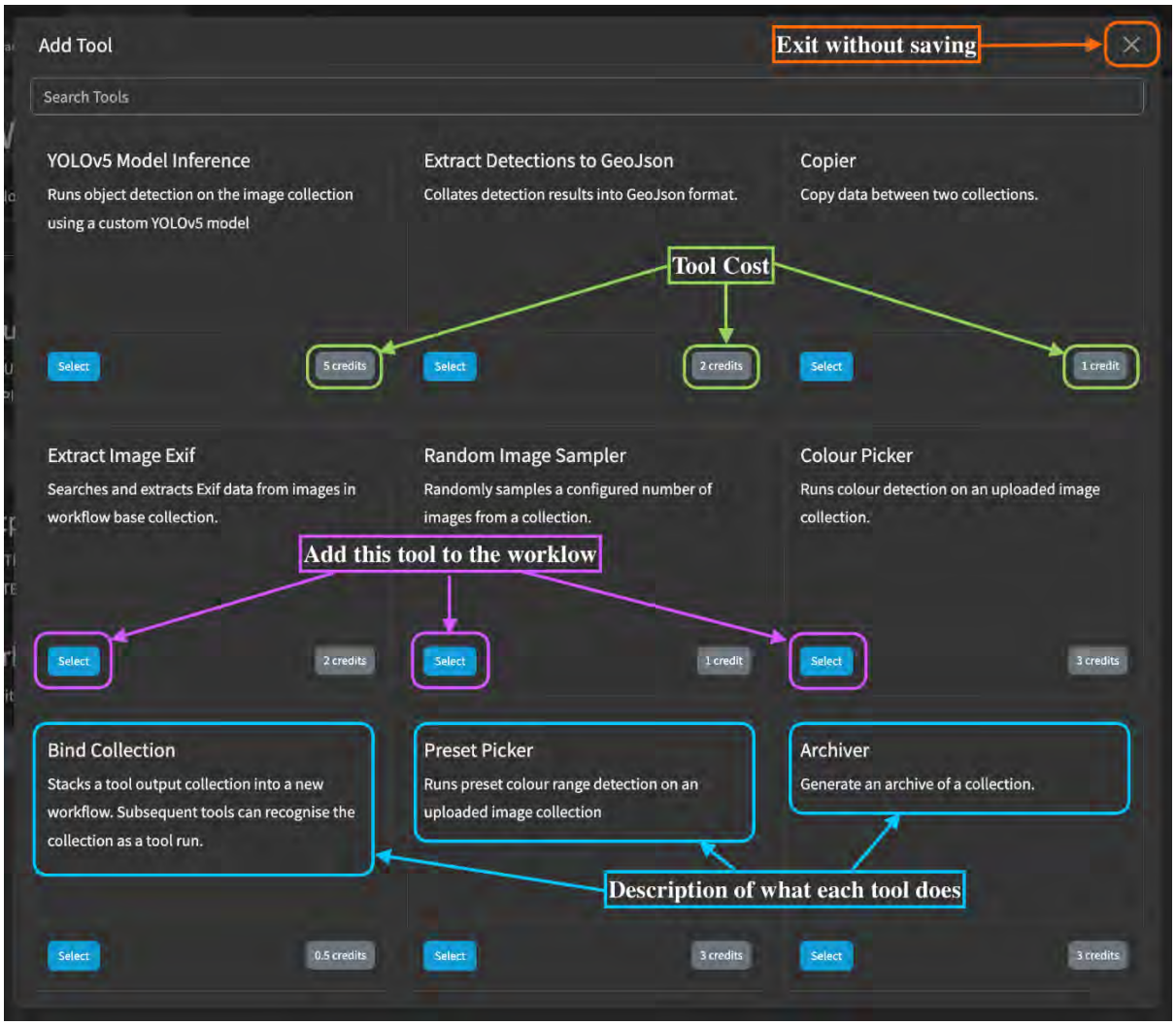
The swatch gallery screen displays the generated colour swatches from the sampled image. The generated colour swatches can be relabelled and saved to be used in workflows. It is good to trial a couple of colour swatches that show the colour of your target species best. It is also recommended to test colour swatches on smaller image sets (<50).





“Workflows” are the tools within WeedRemeed that are used to configure and execute data processing pipelines on your data. At launch the primary use case for data processing is detecting artifacts within imagery.

Configuring a workflow consists of chaining together the desired tools to achieve a processing goal.



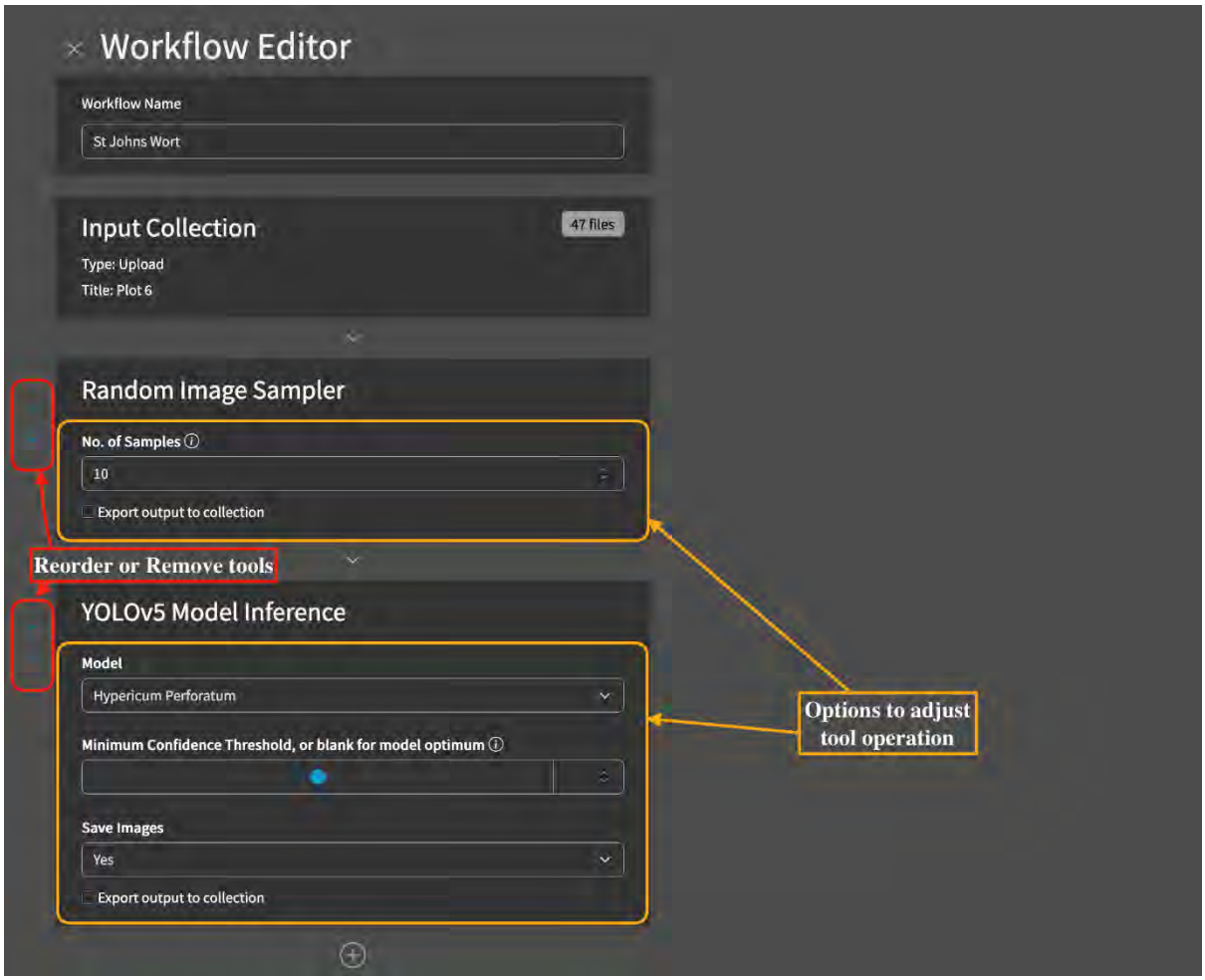
The above image shows all of the available tools in the current Alpha version of WeedRemeed. When selecting the add tool button on the workflow configuration interface the user will see this list of tools displayed.

Each tool has a title, description, cost indicator and “Select” button in blue. When this select button is clicked the tool will be added as the next tool in the workflow.

The costs displayed in this screenshot are not necessarily aligned with the costs on the current live version of WeedRemeed and are subject to change.

Below is a table describing which collections each tool operates on and some common use cases for each.

Tool Name	What collections it works on	Why would I use it
YOLOv5 Model Inference	Collections of Images	Utilise an already existing object detection neural network to detect instances of a given plant within imagery.
Extract Detections to GeoJson	Collections with detection JSON files	Convert a tools detection format into GeoJSON form for export. Generally useful for importing into mapping software.
Extract Image Exif	Collections of images	Collects important meta data about imagery that is lost when using YOLOv5 or colour picking detection
Random Image Sampler	Any collection	To extract a random subset of files from a collection. Typical use cases are for testing effectiveness of tools quickly and cheaply on a sample of the complete data set.
Colour Picker	Collections of Images	Utilise a colour swatch to detect objects within imagery based on a colour signature
Bind Collection	Any Collection	Bring in important data for future processing that might have been lost. Commonly used to bring in EXIF data in detection workflows
Preset Picker	Collections of Images	Utilise an established colour range to detect objects based on colour signature. Utilising a colour swatch in a colour picker generates these ranges each time the process runs. This allows power users to have more control over the colour processing.
Archiver	Any Collection	Useful for downloading the contents of a collection to your local machine.



Tools can be reordered within the workflow configuration UI. When reordering tools, it's essential to consider if the tools are compatible within that order. Some tools, such as the Random Image Sampler, will work on any input collection and can be preceded by any other tool. Other tools, such as the YOLOv5 Model Inference Tool, require the input collection to contain images and will fail if not configured correctly.

Taking the time to consider what each tool does and whether they are ordered appropriately is necessary when constructing data processing workflows in WeedRemeed.

TOOL CONFIGURATION

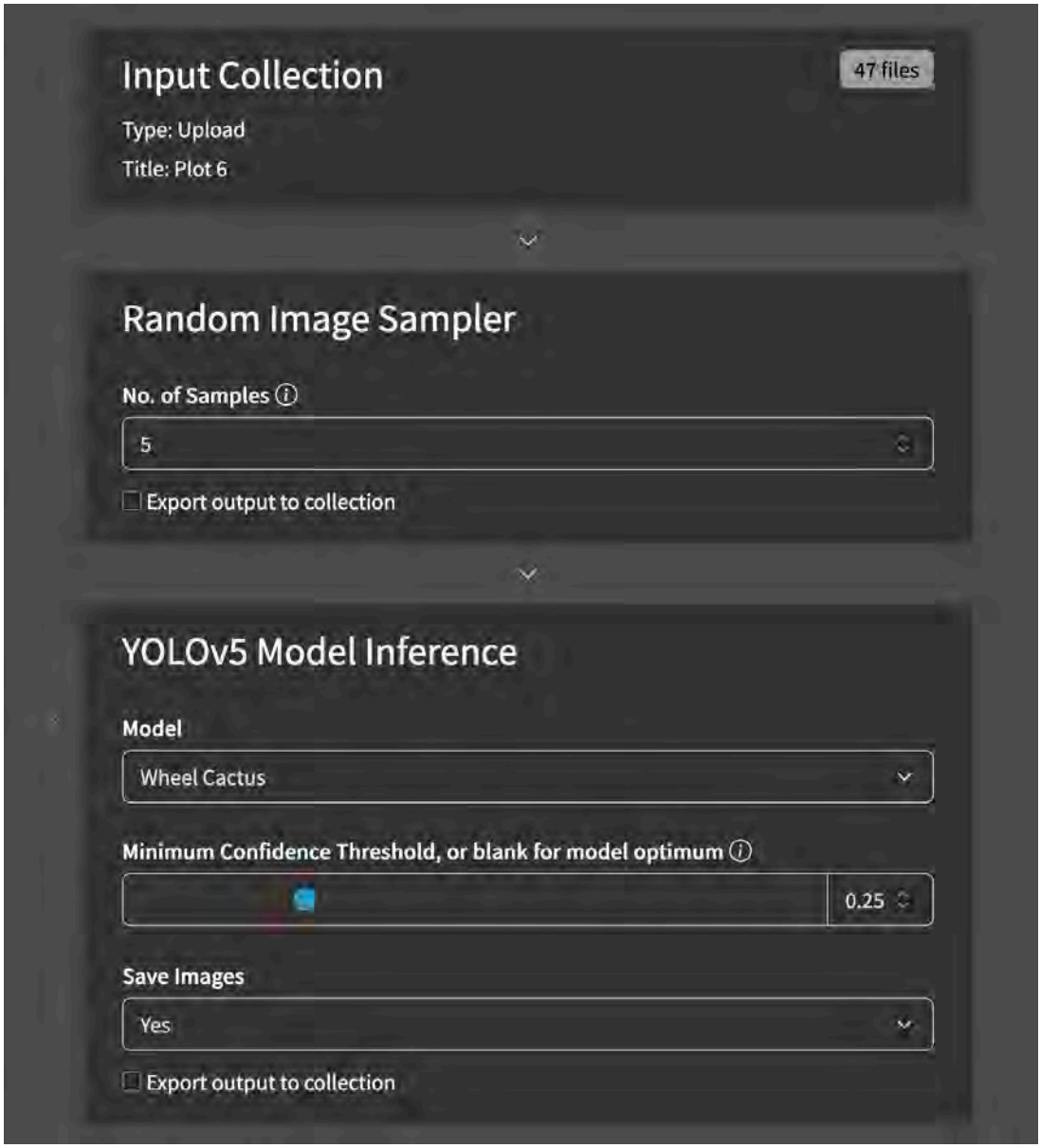
WeedRemeed tools come preconfigured with sensible defaults where applicable. However, in many use cases an end user may wish to tweak the configuration of tools to maximise the effectiveness of detection pipelines.

Below are some tools and their configuration options.

UTILITY TOOLS

Random Image Sampler

The random image sampler is highly useful for testing the configuration of detection tools.



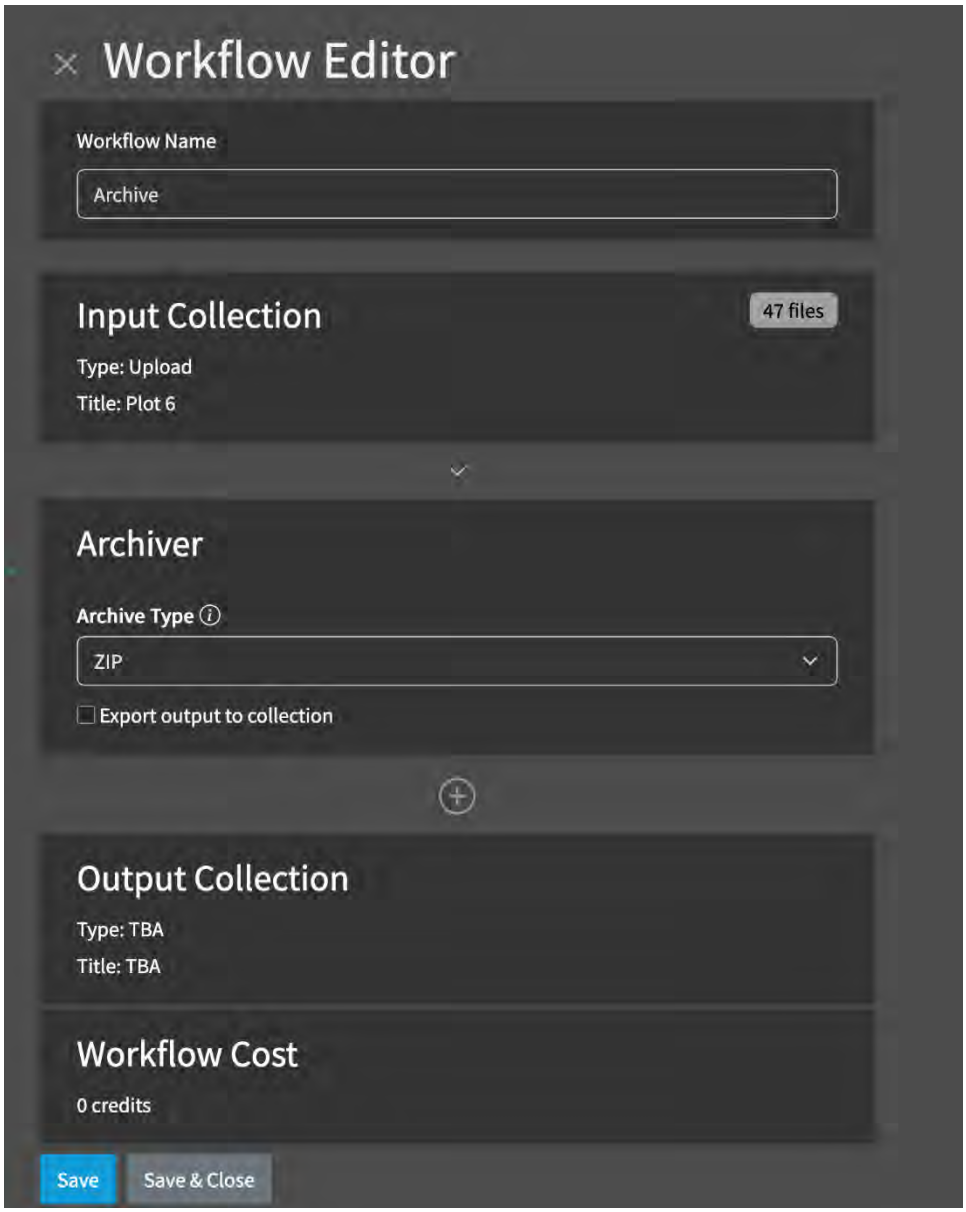
Here it is being used to test the Minimum Confidence threshold setting of 0.25. Be sure to set “Save Images” to “yes” so you can visually review the results.

If you wish to use the same sample multiple times you can tick the box marked “Export output to collection”. This will create a new collection with the Sampled images that you can run future testing workflows on.

You can control the number of images in the sample by adjusting the configuration of the Random Image Sampler tool.

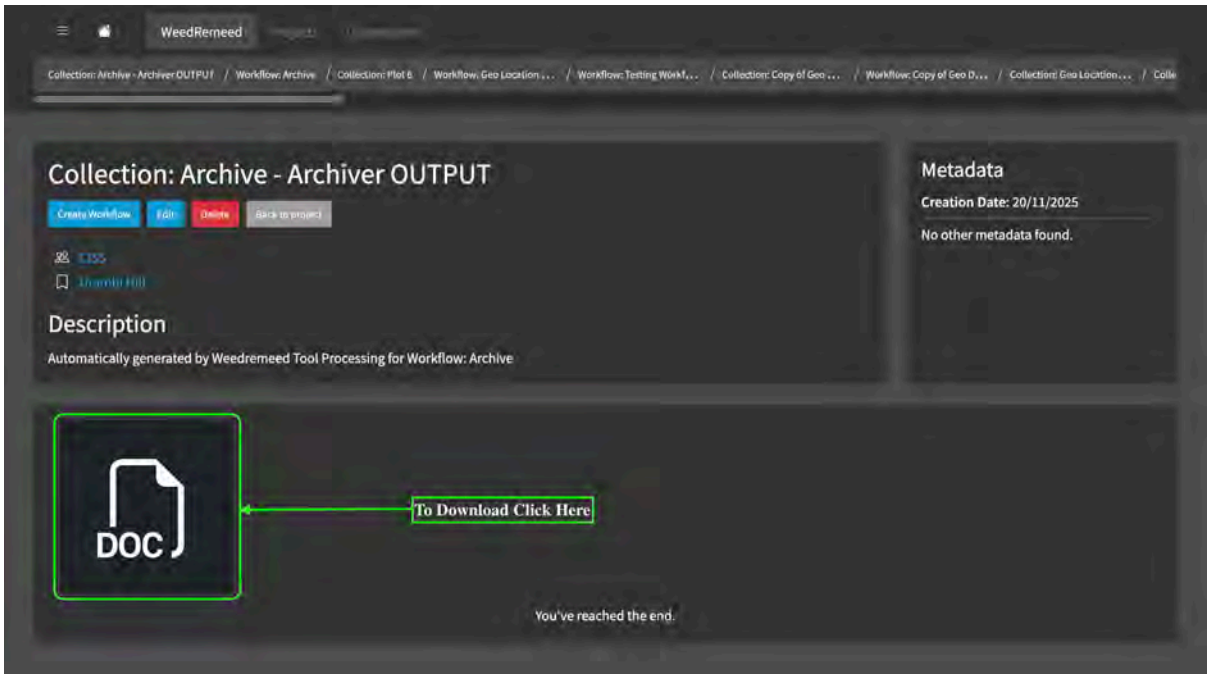
Archiver

The Archiver tool is used for moving files off WeedRemeed onto a local device. It compresses the contents of an entire collection into a single .zip file. This file can then be downloaded to the user's local machine and unzipped.



It is configured simply, as above.

To download, navigate to the output collection generated by this workflow.

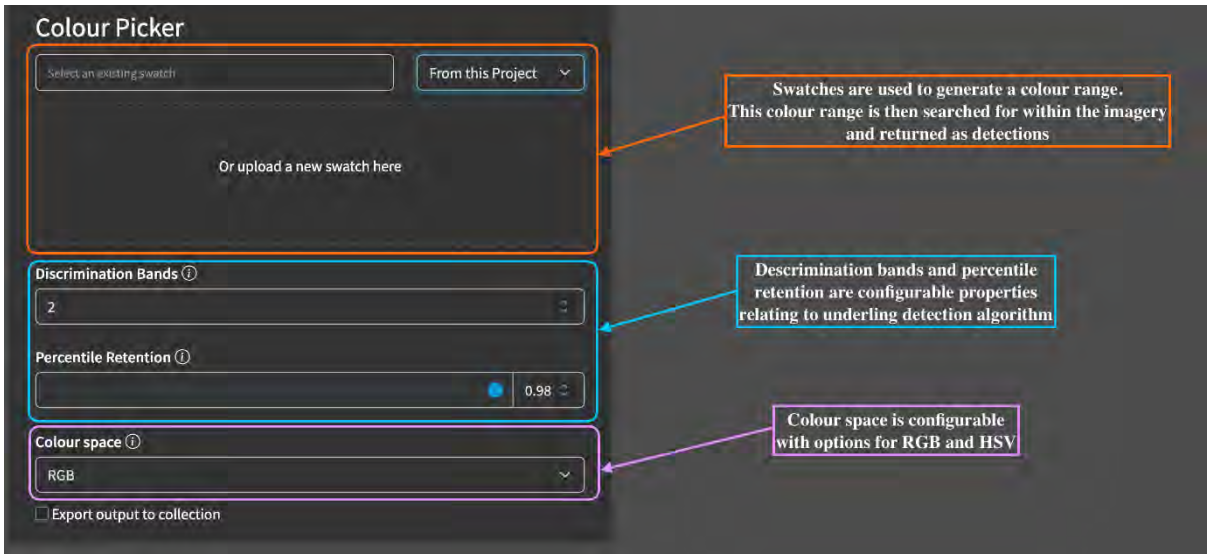


Click on the “DOC” icon.

Then click the blue Download button that appears within the modal window.

DETECTION TOOLS

Colour Picker

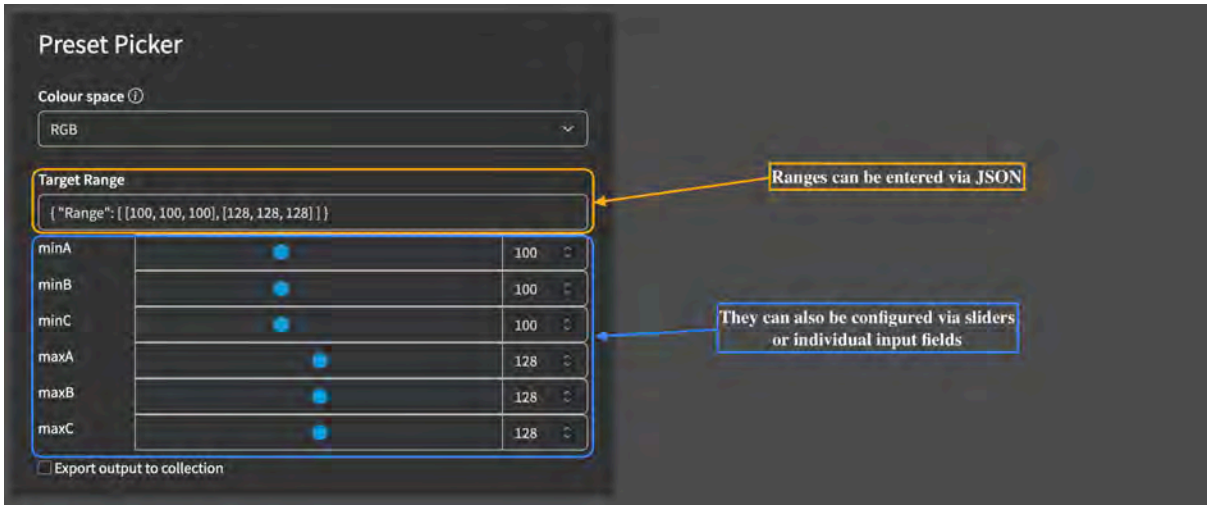


Swatches can be selected from the swatch library by clicking inside the box labelled “select an existing swatch”. Swatches generated in the image labeller function of WeedRemeed will be saved here. New swatches can be uploaded by dragging them into the “Upload a new swatch here” box.

Discrimination bands represent the number of colour clusters formed from the swatch uploaded. This is generally adjusted alongside a colour swatch for best results.

The Colour Picker tool samples the colour values of the input swatch and represents them as three dimensional vectors in a colour space (Either RGB or HSV, configurable within the workflow editor screen). Vectors / Colours that are geometrically close to one another are clustered together. The number of clusters is determined by the discrimination bands. In each iteration some percentage of the largest cluster is retained as the colour range, while the smaller clusters are discarded. The percentile retention describes how much of the majority cluster is retained. This is how a colour range is developed from a colour swatch.

If the colour range you wish to use is already known, you can instead use the Preset Picker tool.



Again, you can configure the colour space, but this time you can directly enter the colour range instead of deriving it from the swatch + discrimination bands + percentile retention.

YOLOv5 Model Inference

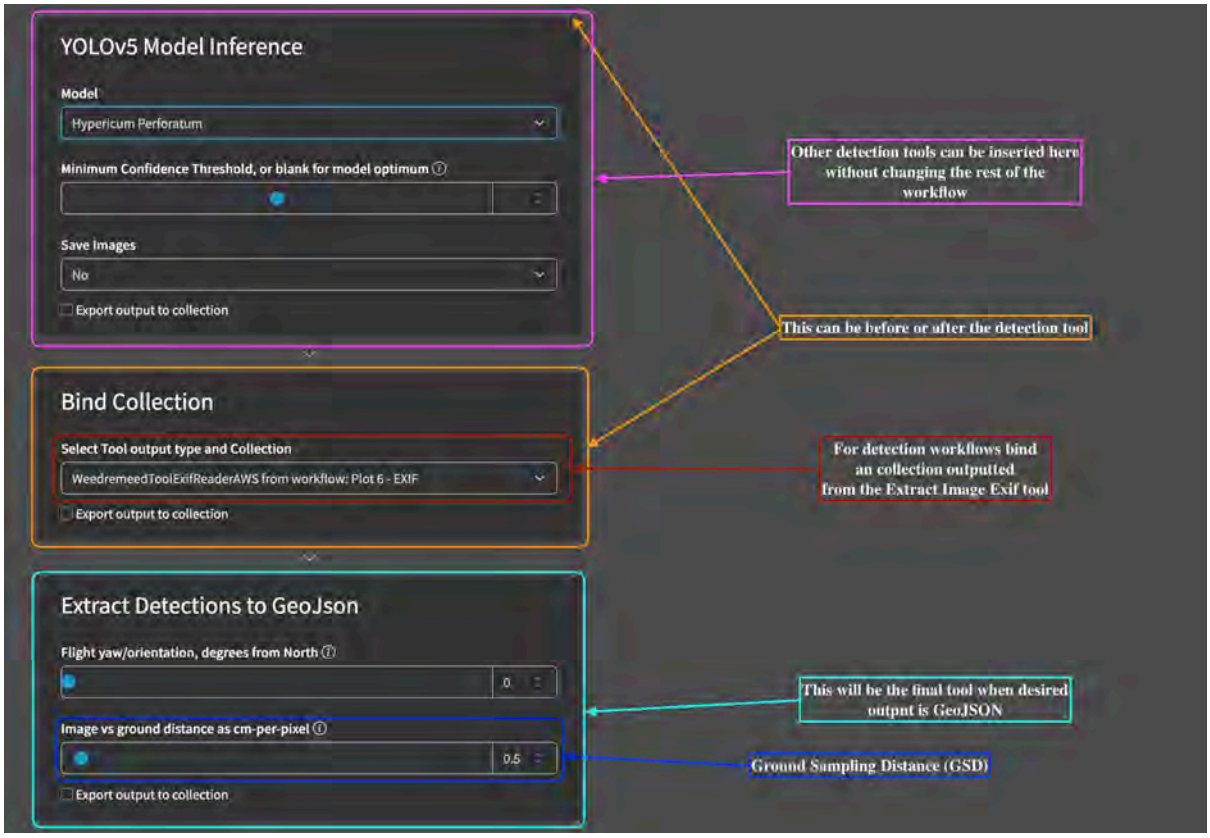


There are many models available for selection within this tool. It is essential that you select the species of plant that you are targeting. If your species does not exist and you want to use YOLOv5 Model Inference to detect plants on WeedRemeed, please refer to the above section on ML Training.

Computer vision models output detections with a score representing how confident they are about a given prediction. The minimum confidence threshold setting adjusts the lowest score acceptable as a detection. Turning this lower will increase false positives, turning it higher will increase false negatives.

The default output of the YOLOv5 Model Inference is a JSON document containing all of the detections. By choosing Save Images -> yes, the tool will also output the input images with all detections labelled with red boxes.

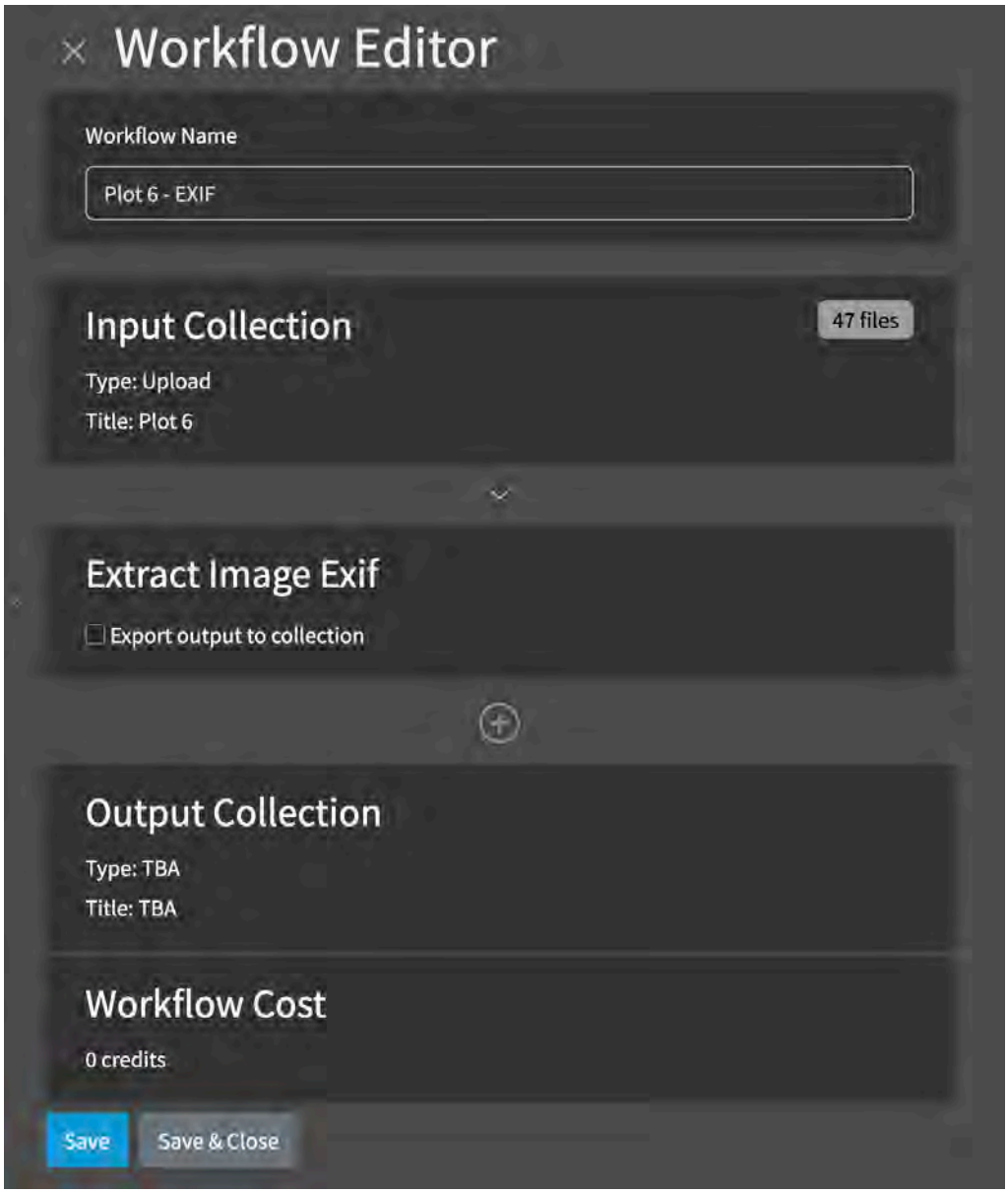
DETECTION WORKFLOW TEMPLATE



This screenshot shows a typical detection workflow within WeedRemeed. Marked in pink is our detection tool. In this example the YOLOv5 Model Inference tool is shown, if you are performing colour-based detection you would replace this tool with the Colour Picker or Preset Picker.

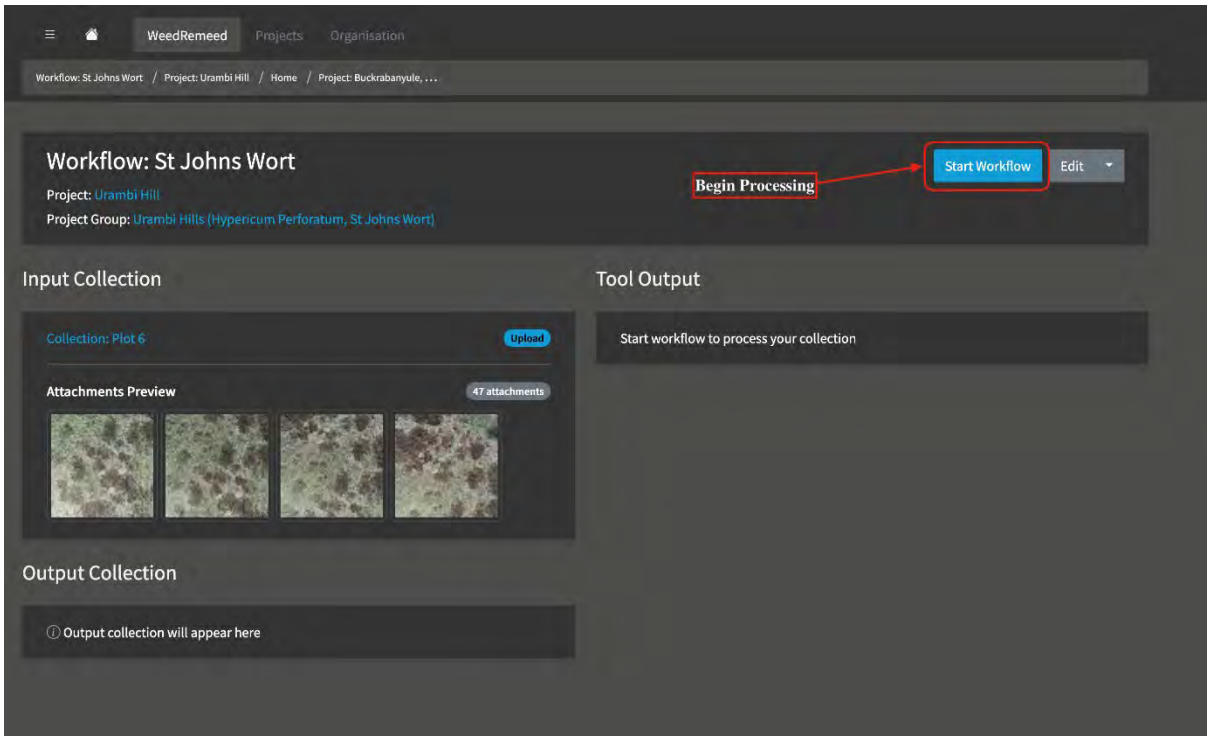
The workflow ends with the Extract Detections to GeoJson tool. This tool requires two inputs to be present within the workflow. The first of these is the location within each image of a detection. It gets this information from the detection tool. The second piece of information it requires is where each image is located in space. It can get this information from the EXIF data within each of the images. This is where the Bind Collection tool comes into play, marked in orange. The bind collection tool is used to pull in the output of an EXIF extraction workflow run on the base collection.

The following screenshot shows how to configure the Extract Image Exif tool. The output collection produced will become available as an option in the dropdown menu for the Bind Collection Tool (tick ‘export output to collection’) .



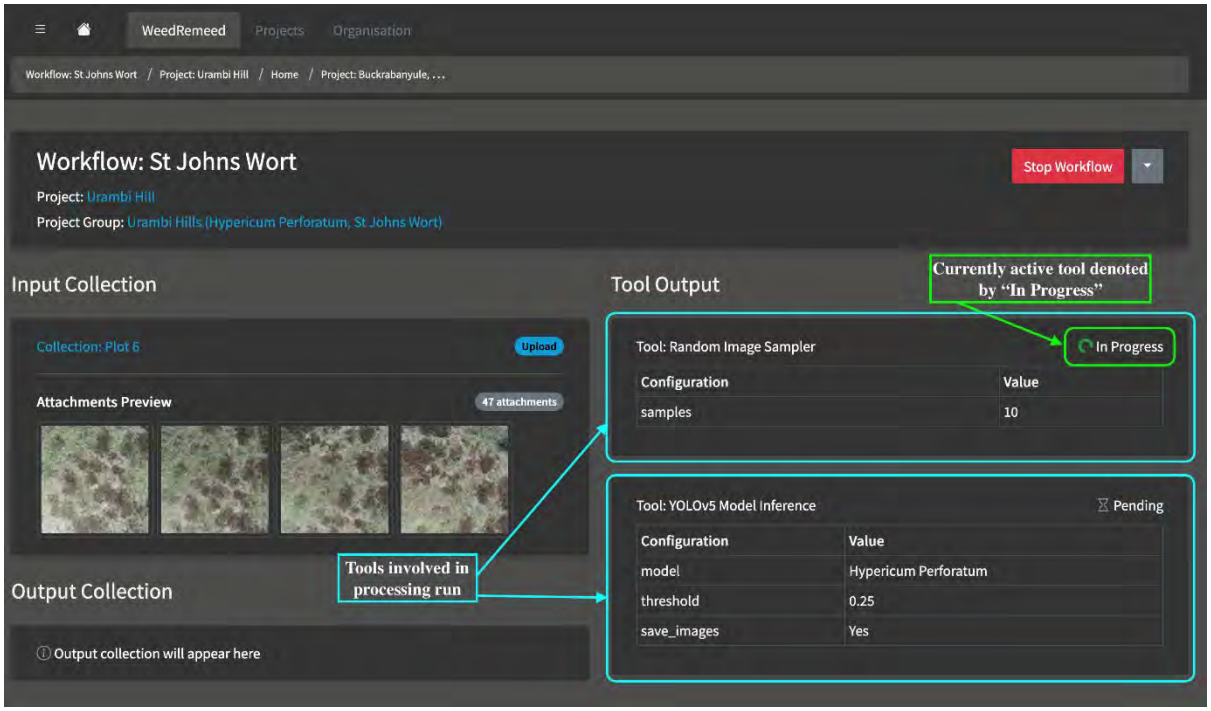
The Bind collection tool must be placed before the Extract Detections to GeoJson tool, but it can come before or after the detection tool in a detection workflow.

If you are wanting to run the Extract Detections to GeoJson tool on a detection workflow previously run, you will need to run a workflow with two bind collection tools. The first bind collection tool will grab the image Exif output and the second will use the detection model output before running the Extract Detections to GeoJson workflow.



After hitting “Save and Close” for a workflow you will be taken to this screen. Here you have the option to Start Workflow, initiating the data processing pipeline, or use the “Edit” button to resume configuring your workflow.

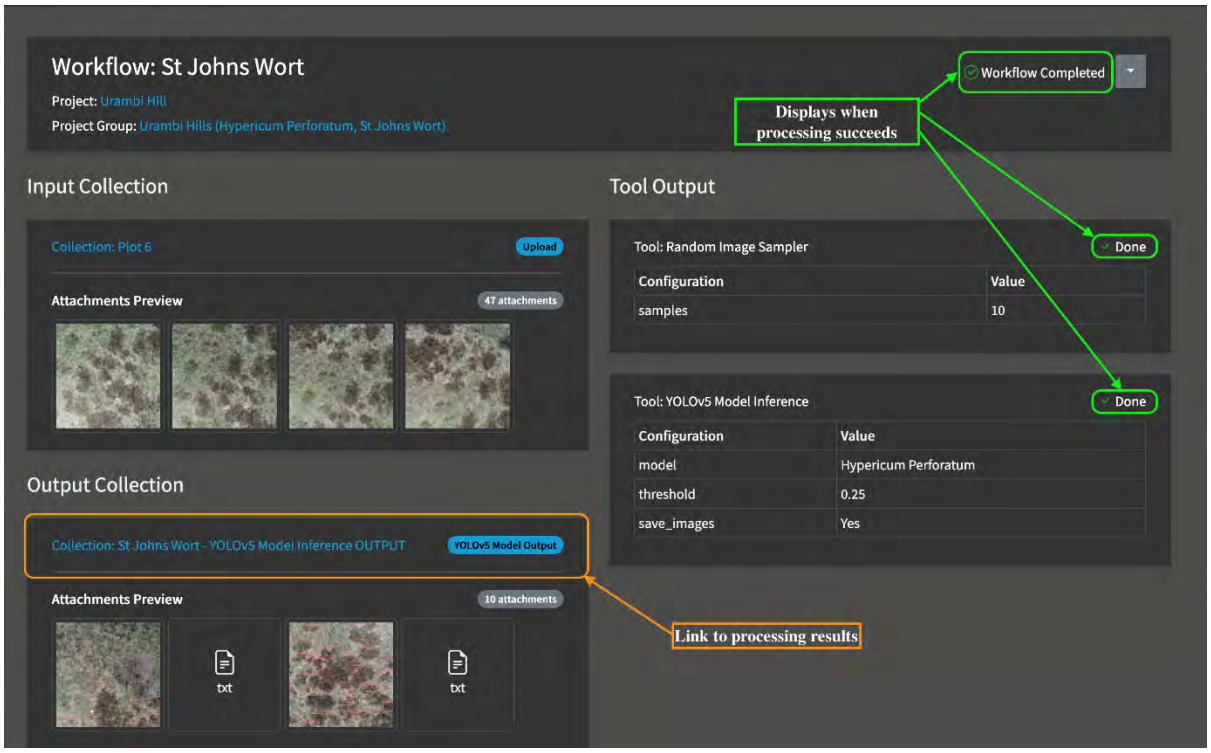
The downward facing triangle next to the edit button allows a user to duplicate or delete the workflow.



One you have clicked start workflow the screen will update and display the tools and

their configured values. Tools each have a status, marked in green, varying from In Progress, Pending, Done or Failed. The currently active tool is shown as “In Progress”.

If you notice that you have misconfigured a tool and wish to stop processing, you can use the Stop Workflow button to cancel processing before all tools are used.



Once all tools have completed, the workflow status will update to “Complete” and the screen will change again. The output collection title now serves as a link to the results of the processing. There are a few images shown as a preview as well.

The downward facing triangle opens an option to duplicate the workflow if you wish to quickly recreate the processing pipeline and tweak some of the tool configurations.

Once a workflow has run it cannot be edited or deleted, but it may be duplicated.

GLOSSARY

Colour Swatch
A defined set of colour values representing the visual signature of a target species under specific conditions. Colour swatches are created from representative imagery and are used as input to colour-based detection processes.

Colour Picker
A detection tool that applies one or more colour swatches to imagery to identify pixels or regions that match defined colour signatures. The colour picker performs the analysis; it does not learn or adapt.

Colour-Based Detection
A detection approach that identifies potential target species based on colour similarity between imagery and predefined colour swatches. Performance is strongly influenced by phenology, lighting, and background conditions.

Preset Picker
A colour picker configuration that uses pre-defined colour swatches and tolerance settings to standardise detection across surveys and users.

YOLOv5 Model (Object Detection Model)
A machine-learning model trained to detect target species based on visual form and structure rather than colour alone. YOLOv5 models require annotated training data and perform best where plant morphology is distinct.

Detection Method
The analytical approach used to identify a target species in imagery, such as colour-based detection or machine-learning object detection.

Target Species
The plant species being surveyed and analysed using WeedRemeed.

Phenology
The timing of biological events in a plant's life cycle (e.g. flowering, senescence) that influence its visual appearance and detectability.

Ground Sample Distance (GSD)
The real-world size represented by a single pixel in an image, typically expressed in centimetres per pixel. Smaller GSD values indicate higher image resolution.

Ground-Truthing
Field-based verification used to confirm the presence, absence, or characteristics of a target species at a survey site.

Workflow

A sequence of tools and processes applied within WeedRemeed to analyse imagery and generate detection outputs.