CENTRE FOR
INVASIVE SPECIES SOLUTIONS

Swatch Making Case Study

Colour Picker Methods

The Colour Picker scans raster imagery (drone/air photos) for the location of pixels having colour within a minimum, maximum vector range in a 3d colour space.
The “colour space” can be visualised like a rainbow stretched and packed to fit into a cube, with all possible colours evenly blending between opposite corners and edges. A “vector range” in the 3d colour space is like a smaller box somewhere inside the cube, and set of colours fitting within it.

To establish the vector range, the Colour Picker accepts a swatch of sample colours. Colours in the swatch are k-means clustered, with a percentile retained from the largest representative cluster. The obtained colour extremes provide the minimum and maximum values.

Thinking again of a rainbow in a box, the swatch is examined to find the largest set of colours which could fit most compactly into a “small box”. The Colour Picker then searches the air photos for pixel colours which also fit in that same “box”.

Swatches can be:

- made piecemeal directly from clipping out sample images when the target colours have clear distinction against backgrounds but are themselves diverse
- synthetically drawn as colour gradients from target pixel sampling if the target colours are highly saturated and invariant
- a small – almost monochromatic – pixel selection from a reference image, if the target colours are sufficiently limited

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This document follows the process of compositing a swatch from source image fragments, where the target contrast is good but the target colours are scattered over a complex range of hues.

Case study : Briar Rose

Step 1: What am I looking for?

Close ups | Can I find some species features typical for the target species?

A good sample image set is available for the site. The images are closer than flight elevation, and include reference markers highlighting species targets. Seasonal presentation of species features is clear and consistent.

Delineation | Vegetation vs flowers/seed heads etc?

Target species foliage is unclear, due to dormant/die-back growth pattern and interspersion with other species. Fruits give a clear colour signature. Noting: close detail of fruits pushes into saturated reds, less apparent at distance. Fruits often show a golden/yellow flare, which may incur on stray colour bands/highlights elsewhere. The red/orange aspect of the fruits should be preferred, avoiding saturated yellows seen in St John's Wort (*Hypericum*), for example.

Contrast | What is the immediate texture of background areas?

The background textures and colours are consistent, with few sudden transitions such as bare soils, rocky outcrops, flowering canopies etc. There is minimal overexposure/flaring on background texture highlights. The suggestive Briar Rose fruit colours are not represented at visible scale in the background tones. There are many instances of vivid yellows from *Hypericum*. Swatch inclusion of the yellow tints in Briar fruits should be avoided.

Step 2: Where am I looking?

Flight samples | Can I find some samples typical for season, lighting, tone?

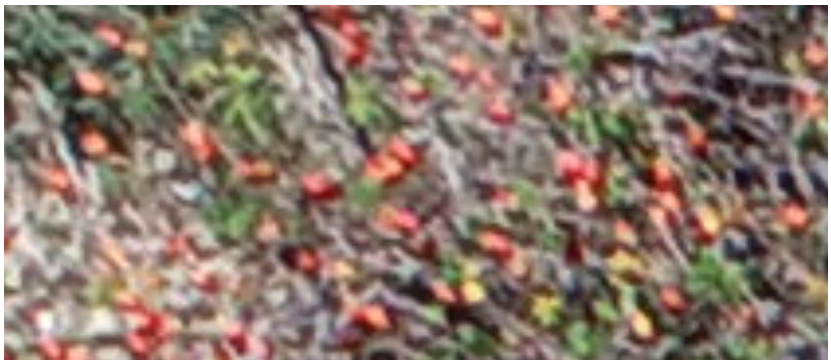
The site offers a good-sized sample set at typical flight height, with consistent colour tones.

Reference | Is the target species evident?

Without relying on ground marker points, the target species is evident in a random sub-selection from the flight images.

Delineation | Do field capture examples match close up characteristics?

From a zoomed fragment, the fruits are still distinct at a multi-pixel resolution. The strong red saturation is less apparent, and the flaring/highlighting is more distributed.



Contrast | Does landscape-scale match close-up scale?

The background textures match those present in the close-ups. Colour grade and lighting aspects are also similar. Abrupt changes to overall geography or vegetation structure are not apparent in a random sub-selection.

Features | Do landscape features impinge on detection choices?

As previously observed, a colour swatch inclusive of high brightness flared tones will increase risk of picking up exposure highlights of vegetation more generally. But the strong saturated reds seen in the close-up images are less represented in the field images. Swatch composition could sample from the field images mixed with some strong colours from the close-up images.

Step 3: Target colours.

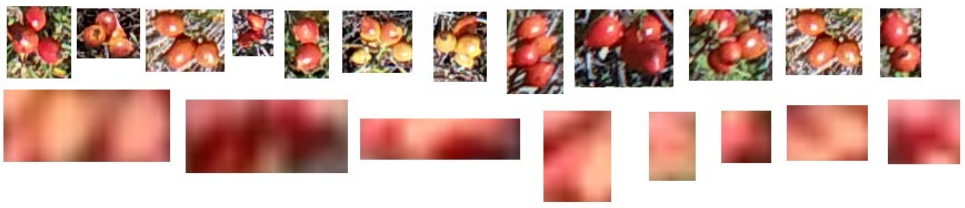
Rejection hinting | Can we 'trim out' extremes of the colour range?

Over-exposed and dark/shadow tones are difficult to infer as hue. The sample images give cause for concern that a 'silvery-white' flare on Briar fruits may be adjacent to neutral yet

bright reflections in the background. Colour picking range will be derived from the majority set of clustered swatch colours. So we can use a small ‘noise’ sample of a range we want to avoid. This can help Indistinct hues of our fruit targets to be clustered into the minority range instead of ‘stretching’ the majority range. Small sections are cropped here from the close up and flight set:

Emphasise common aspects | Close-up vs field samples?

Our close-ups give best pixel selection resolution, but may exaggerate the clarity of the distinguishing colours. Conversely, the flight images are blurred at a feature level, and image software may spread/approximate a palette when displaying. A good composite will draw strong colours from the close-ups, using the field images for the range of tints. We want to avoid inclusion of over-bright neutral tones and of high saturation strong yellow.



Compose

Fruit colours and gradients are distinctive, but are ambiguous through the gold and orange tints away from saturated red. A swatch composed of diverse samples will reduce mis-selection of colours by eye. Using the clips above, an initial swatch was formed with high resolution fruit samples, packed with colour spread from zoomed field images. The mixed alignment of partial duplication means we can later section out smaller candidate swatches from transition and boundary areas of this first attempt.

Step 4: Run Colour Picker.

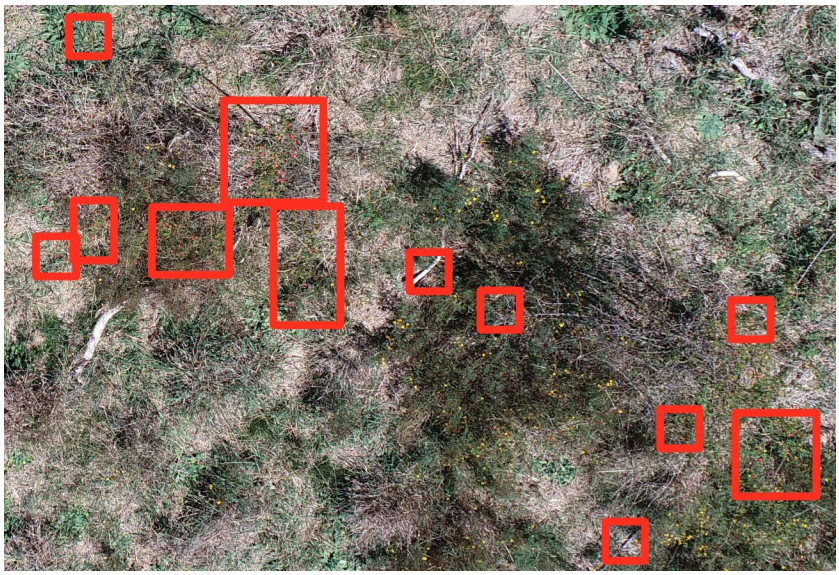
Assess

The initial swatch was run in both HSV and RGB colour space with Colour Picker settings:

discrim_bands	2
retention	0.82

Meaning: cluster to 2x only pixel groupings as minority vs majority then retain an 82% spread of colour from the majority group. HSV and RGB detections were similar at face value. Both had appreciable rejection of yellow from *Hypericum*, with RGB being slightly more ‘reactive’. Both runs tended to identify range extremes in field noise.

HSV reliable detection:

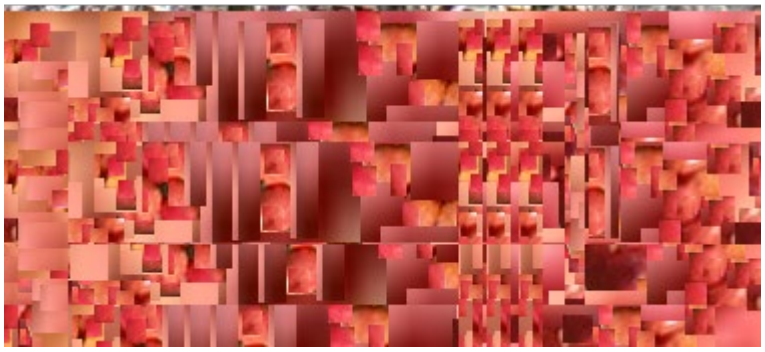


RGB reliable detection:

Field noise:

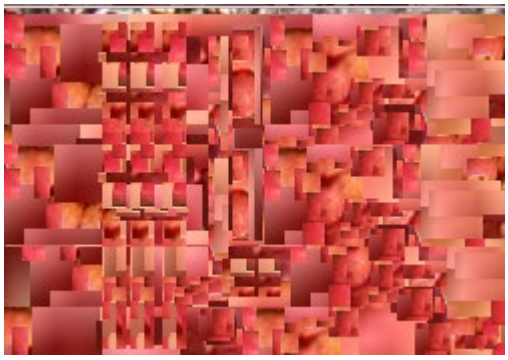
Adapt

In response, a second swatch was cropped out with dark features diminished. This was again run under HSV vs RGB and generated similar results in both cases.



The foremost observation was an increased tendency to pick up on the yellow of *Hypericum* flowers resulting in substantial over detection. Further experimentation, by applying 3x band discrimination, allowed small numbers of swatch pixels at both bright and dark extremes to cluster into minority groups. The overfit on yellow detection persisted, and the swatch was abandoned.

A final swatch was prepared, accenting mid/reds with dark and flared areas both reduced.



Good detection was obtained on this mid-heavy swatch, with settings:

discrim_bands	3
retention	0.96
colour_space	HSV

Mid-heavy, 3band HSV:

Original:

Overall detection is similarly sensitive. Aggregation of detection areas is diminished by the heavy mid-band. In exchange, ‘stray’ point detection is better targeted with less tendency to pick up field noise or *Hypericum*.

Step 5: Report.

Count

Broad Briar (initial) Swatch, 2x band, RGB, 82% retention:

- 5 images with no detection
- 44 images with positive detection
- Colour Range: [101.0, 114.0, 225.0] [137.0, 158.0, 251.0]

Broad Briar (initial) Swatch, 2x band, HSV, 82% retention:

- 9 images with no detection
- 40 images with positive detection
- Colour Range: [5.0, 115.0, 187.0] [7.0, 165.0, 255.0]
- Note: HSV here is 256 based, not 100 as sometimes used

MidHeavy Briar Swatch, 3x band, HSV, 96% retention:

- 10 images with no detection
- 39 images with positive detection
- Colour Range: [4.0, 93.0, 223.0] [6.0, 148.0, 235.0]
- Note: HSV here is 256 based, not 100 as sometimes used

Compare

Compare the Swatch results to determine whether the colour swatch modifications were beneficial for detection rate and reduced false positives. Look for evidence that runs with increased rejection are improving on poor edge case colour detections and are not abruptly dropping files already well classified by previous runs.

Check

Despite differences in specific detection range and rejections, the 3x selected runs have strong agreement as per images with no detection.

Examining the single file detected by HSV & RGB but rejected only by 3-band gives confidence that the “Heavy-Mids 3x Band” run decreased false positives both on bright yellow (lower left, *Hypericum*) and artefacts of over saturated red (here on marker tape, elsewhere in pixel noise of deep shadows):

Plot

After colour picking, the base images have their EXIF data extracted (for Lat/Lon centres) and the picker results are re-projected as approximate GPS coordinates. The marked detection image can be compared with mapped points using typical GIS software.

Detection image:

Points mapped over base layer at 1:375: