Multi-spectral imagery – a primer

The data files Mitch was able to obtain from the National Space Service are from a multispectral sensor that measures in six different bands (B1 – B6). It is important to keep in mind that the sensor is a sensitive scientific instrument and the resulting images are optimized for measurement and are not simply “pictures”.

Entries are shown for a set of five X, Y coordinates in the example dataset in Table 1.

Table 1: Example multi-spectral dataset

X	Y	B1	B2	B3	B4	B5	B6
10	0	174	167	171	158	194	185
11	0	157	152	159	148	194	169
12	0	112	103	109	105	116	106
13	0	59	63	58	68	38	51
14	0	63	62	57	70	38	67

The bands can be thought of as the integrated values associated with six different filters, each of which can be useful in assessing land cover. B1, B2 and B3 represent portions of the visible spectrum. B4, B5 and B6 represent longer wavelengths that are beyond human perception.

Table 2 shows the colors, wavelength regions and utility of the different bands.

Table 2: Multi-spectral bands and their utility

Band	Color	Wavelength (nm)	Useful for Mapping
B1	Blue	450-520	Penetrates water, shows thin clouds and general visible brightness
B2	Green	520-600	Shows different types of plants and general visible brightness
B3	Red	630-690	Vegetation color and certain mineral deposits.
B4	Near Infrared (NIR)	770-900	Partially absorbed by water, sensitive to vegetation structure and chlorophyll
B5	Short-wave Infrared (SWIR) 1	1550-1750	Completely absorbed by liquid water. Sensitive to moisture content of soil and vegetation; penetrates thin clouds
B6	Short-wave Infrared (SWIR) 2	2090-2350	Insensitive to vegetation color or vigor, shows differences in soil mineral content

When looking at multi-spectral images, sometimes it is useful to map the values of the different bands to RGB image channels. When B3, B2 and B1 are mapped to RGB this generates a “true-color” image.

Other band combinations can also be mapped to the RGB image channels to create what are known as "false color" images.

Frequently used false-color images:

- B4, B3, B2 → RGB: can be useful in seeing changes in plant health.
- B5, B4, B2 → RGB: can be used to show floods or newly burned land
- B1, B5, B6 → RGB: can differentiate between snow, ice and clouds

In other cases it may be helpful to use ratios of different bands to assess vegetation health or detect anomalous signals. A frequently-used ratio is the Normalized Difference Vegetation Index (NDVI) shown below,

$$NDVI = (B4 - B3) / (B4 + B3).$$

When this index is plotted across the image frame, it is easy to distinguish between healthy vegetation and bare ground cover.

Evaluating the data as various false-color or ratio images may allow you to identify interesting features within the images that change over time and could help Mitch understand any potential changes that could be happening in the nature preserve.

It is common to apply different contrast stretch techniques to highlight certain brightness values and minimize others. Also note that apparent differences in brightness can occur between dates due to changes in sun angle and atmospheric conditions. When comparing images from different days and seasons, it is important to keep in mind that the values of specific pixels can change due to a number of factors including

- Clouds
- Atmospheric conditions (e.g. increased dust or aerosols in the air)
- Ground cover changes (e.g. plant growth between spring and summer)
- Sensor artifacts (e.g. bad pixels due to sensor failure or electronic noise)
- Contrast Stretching (e.g. the values of the pixels may have been enhanced so that when they are mapped into images they "stretch" to the full range of values 0-255)