Listed below are five different scenarios, progressively ranked in terms of complexity, outlining a specific science question that can be answered with the use of field spectroscopy. For each of the scenarios, you will be asked a series of questions, which focus on which instrument, technique and methodology would be appropriate in answering the science objectives of the scenario. Refer to the NERC Field Spectroscopy Facility application form, attached, which outlines the instruments and type of measurements available, to help make a decision on which instrument is appropriate for the user's needs.

1 Creating a spectral library of tropical plants

Scenario A team at a botanic garden have a large collection of tropical plant samples, and wish to create a library of spectral reflectance values for each of them across the 350 - 2500 nm range.

- **Question 1** – Refer to the NERC Field Spectroscopy Facility application form, and select an appropriate instrument(s) and type of measurement to use in this scenario. Justify your selection.

- **Question 2** – For the instrument you have chosen, what foreoptic accessory would be appropriate to use in this scenario?

- **Question 3** – For the measurement type you have chosen, what additional accessories will you require for the measurements in this scenario?

- **Question 4** – After the measurements are completed, the team asks you to process the data and provide an output that would allow them to compare the vegetation health of the samples. What processing technique could be used to generate such a value? Can you provide an example of such a value?

2 Coral reef health

Scenario A research group wishes to determine how different marine environmental factors impact the health of coral reefs. One proxy to determine this is by measuring the reflectance spectra of the coral (which can be done by measuring downwelling irradiance and upwelling radiance), and analysing the reflectance spectra at the 425 - 450 nm and 600 - 700 nm wavelength ranges (the regions at which coral algae photosynthesize). In order to take measurements of living coral, they will need to work underwater. The team would like to have a data end product that would give an indication of the coral algae health.

- **Question 1** – Refer to the NERC Field Spectroscopy Facility application form, and select an appropriate instrument(s) and type of measurement to use in this scenario. Justify your selection.

- **Question 2** – What particular challenges – in terms of both theory and methodology – do you think are important to consider when conducting field spectroscopy underwater?

- **Question 3** – In this scenario, can you think of which environmental factors will have an impact on coral health? Are there any instruments that you could use to measure that, either listed in the application form or not?

- **Question 4** – What would be an appropriate data product for the team, if they wish to consider the health of the coral reef?

3 Measurements of invasive species along river banks

Scenario A research group are tasked with identifying from Sentinel-2 satellite imagery the presence of an invasive species that grows alongside river banks. To do so, they will need to a. to directly determine the reflectance spectra of the invasive species, and b. acquire imagery of large patches of the invasive species. They will need to process their field data (and Sentinel-2 acquired imagery) to enable comparison, and eventually, building a spectral library for satellite identification. As the vegetation grows along deep river banks, the team can not get direct access to the samples, but can get 5 m to the samples.

- **Question 1** – Consider the objectives outlined for direct sampling and acquiring imagery over large patches. Referring to the FSF application form, which instruments and type of measurement would be appropriate for direct sampling of the vegetation and for sampling the vegetation over large areas? Justify your choices.

- **Question 2** – What data processing technique can be used to convert hyperspectral data to the spectral response features of satellite sensors like Sentinel-2?

- **Question 3** – The methodology notes that the satellite acquired imagery will need to be corrected to enable comparison. Which two instruments listed in the FSF application form could help with this task? Which one would be more appropriate for a short term campaign where portability and infrastructure are a concern?

4 Measurements of sea ice radiant exitance

Scenario To improve estimates of radiative feedback in the Arctic, a research team wants to measure the radiant exitance of sea ice which is being ”grownïn an ice tank in their laboratory. They want to measure the radiant exitance across the 350 to 2500 nm hyperspectral range.

- **Question 1** – Refer to the NERC Field Spectroscopy Facility application form, and select an appropriate instrument(s) and type of measurement to use in this scenario. Justify your selection.

- **Question 2** – Refer again to the FSF application form. For radiant exitance, which type of measurement is required? What will the instrument chosen need to be calibrated for, and what units will it take measurements in?

- **Question 3** – The sea ice will be measured within a laboratory, with the ice held in an ice tank (which contains water). What are some of the problems with this setup for measurements, and how would you resolve them? What instrument attachments could be used to mitigate risk?

5 Determining the impact of ozone pollution on plant photosynthetic activity

Scenario A commercial agricultural company has tasked you with determining how tropospheric ozone (O_3) might impact the gross primary productivity (GPP) of their wheat yields. You have asked to a. monitor the O_3 concentration and photosynthetic activity at their farm over the growing season, and b. measure the photosynthetic activity of wheat plots contained with O_3 enrichment chambers set at different O_3 concentrations.

- **Question 1** – List all of the variables that you should measure at the O_3 enriched dome site, and determine which are independent and dependent.

- **Question 2** – What is a potential proxy for GPP, and photosynthetic activity, in general? Are there any instruments in the FSF application form that could be used to measure this?

- **Question 3** – How would you measure the concentrations of O_3 throughout the year at the main growing site, both for long term measurements and for short term visits?

- **Question 4** – Consider the instrument that you chose in question 2, and the output that it measures. Looking online, are there any satellite sensors currently in existence, or which are planned, that measure the same variable?

- **Question 5** – At the end of the growing season, you are tasked with taking hyperspectral imagery of the entire field at the growing site. What would be an appropriate instrument to use, and what would you need to do to plan for these measurements?