Lab 05

ENVX2001 Applied Statistical Methods

Contents

Welcome!

This week we will analyse two experiments using one-way ANOVA: a completely randomised design investigating dingo and fox activity from camera trap data, and a randomised complete block design examining fire severity effects on small mammal abundance.

You will come across **Exercises** in this lab. Solutions will be posted on Friday evening.

Learning outcomes

In this lab, we will learn how to:

1. Use R to analyse CRDs and RCBDs.
2. Assess the usefulness of blocking.

Specific goals

By the end of this lab, you should be able to:

- ☐ Fit and interpret a one-way ANOVA for a CRD
- ☐ Check ANOVA assumptions using diagnostic plots
- ☐ Perform post-hoc tests using `emmeans`
- ☐ Fit a one-way ANOVA with a blocking term for an RCBD
- ☐ Calculate the percentage of variation explained by blocking

Preparation

This lab uses `emmeans`. Install it if you are missing it by running the following **in the console**:

```
CODE
install.packages("emmeans")
```

Downloads

File	Used in	Download
`crd_dingo_fox_exclusion.csv`	Section 1	Download
`rcbd_mammals.csv`	Section 2	Download

Save the files into a folder called `data` inside your project folder.

1. Completely randomised design (~25 min)

You are tasked with analysing data from an experiment that investigated the effect of dingo activity on fox activity. You set out camera traps at 36 sites for 36 days at sites with high, medium and no dingoes (exclusion). You recorded the number of foxes that were captured on camera. Our measure of activity is the number of images per 100 trap nights. This was calculated by:

$$FoxRatePer100 = \frac{FoxDetections}{TrapNights} \times 100$$

Figure 1: Introduced red fox (*Vulpes vulpes*) caught on camera trap in the Greater Blue Mountains World Heritage Area. Image credit: Ecosystems Dynamics Lab, The University of Sydney.

We predict Higher fox activity ⟶ lower dingo activity based on mesopredator release hypothesis.

Data is in the **crd_dingo_fox_exclusion.csv** file.

- Experimental units: Sites (randomly assigned to treatments; no blocking)
- Factor: DingoActivity (3 levels: High, Medium, Exclusion)
- Response: FoxRatePer100 (images per 100 trap-nights)
- Replicates: n = 12 sites per treatment (36 total)

Other variables:

- SiteID: unique identifier for each site
- TrapNights: number of nights the camera trap was active at each site (max of 36, but some cameras surveyed for less)

- FoxDetections: number of images of foxes captured by the camera trap at each site

Statistical model for CRD:

$$Y_{ij} = \mu + \alpha_i + \epsilon_{ij}$$

Where:

- Y_{ij} is the observed fox activity (FoxRatePer100) at the j-th site in the i-th dingo activity level.
- μ is the overall mean fox activity across all dingo activity levels.

OR:

$$fox\ activity = overall\ mean + dingo\ activity + random\ error.$$

Analysis

Exercise 1

(i) Test the assumptions of the ANOVA and transform the data (if needed). Hint first run the model using the `aov()` function and then use the `plot()` function to check the assumptions.

```
CODE
#
```

(ii) Use an ANOVA to analyse the CRD and report on the results.

```
CODE
#
```

(iii) Explore any significant results using post-hoc tests from `emmeans` package and its `emmeans()` function. Include any plots that you think are useful to visualise the results.

```
CODE
#
```

Before we move on, now is a good time to take a 5-minute break.

2. Randomised complete block design (~25 min)

A researcher designs a study to investigate the effect of fire treatment (unburnt, low severity and high severity) on small mammal abundance. They set up four blocks (Block_1, Block_2, etc) and select sites that were unburnt, low severity and high severity fire within each block. At each site to survey small mammal abundance. The data is in the **rcbd_mammals.csv** file.

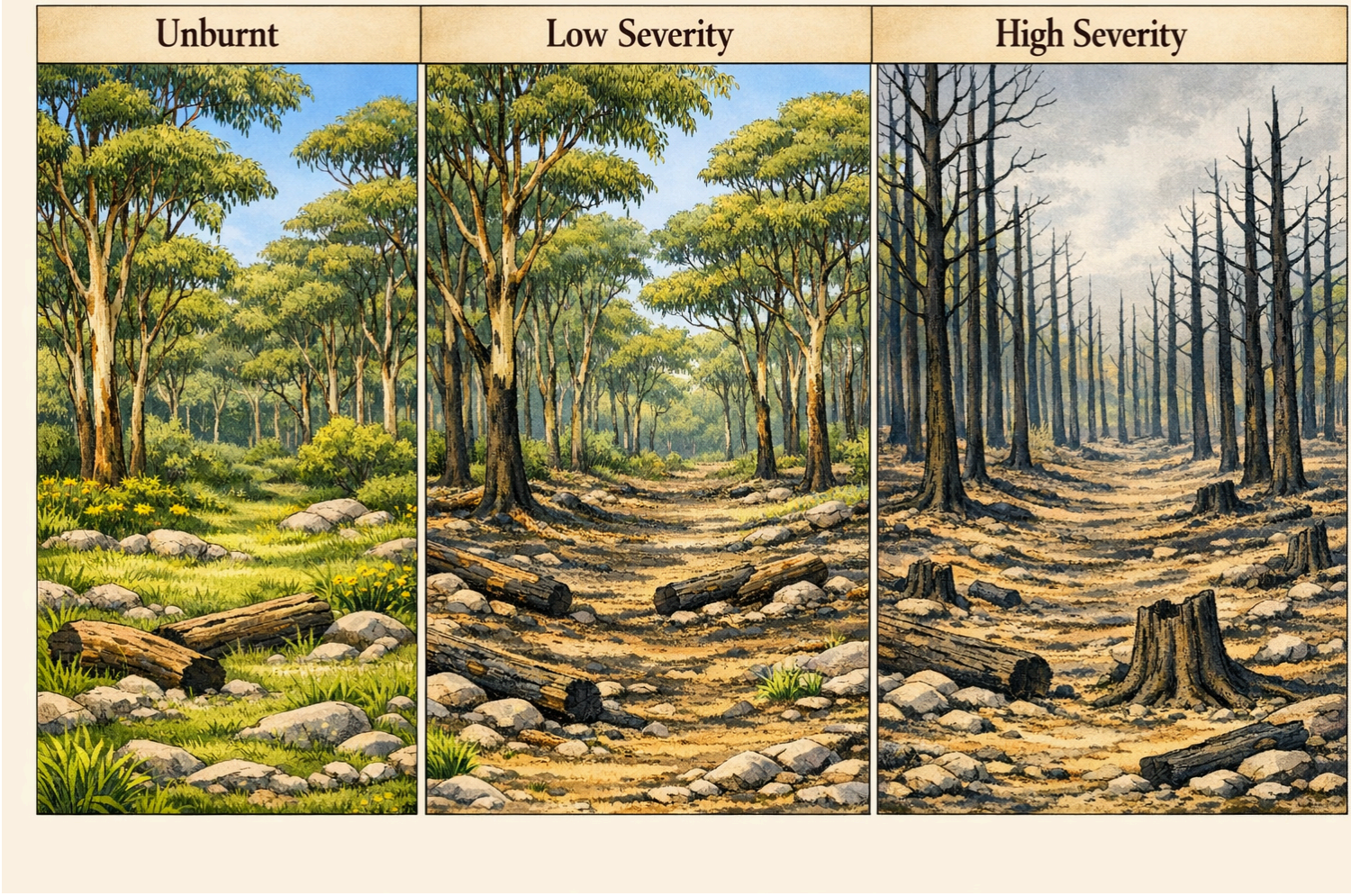

Figure 2: Fire severity classes. Image credit: CoPilot.

Analysis

Exercise 2

(i) Write out the statistical model for the ANOVA model for this experiment. Define all the terms in the model. You can write out in words or in mathematical notation.

```
CODE
# Answer here
```

(ii) Test the assumptions of the ANOVA and transform the data (if needed). Hint first run the model using the `aov()` function and then use the `plot()` function to check the assumptions.

```
CODE
#
```

(iii) Use an ANOVA to analyse the RCBD and report on the results.

```
CODE
#
```

(iv) Explore any significant results using post-hoc tests from `emmeans` package and its `emmeans()` function. Include any plots that you think are useful to visualise the results.

```
CODE
#
```

(v) Calculate the variation explained by the blocking term.

```
CODE
#
```

Conclusion

Closing thoughts

We analysed two experimental designs this week: a CRD using camera trap data to test the mesopredator release hypothesis, and an RCBD examining fire severity effects on small mammal abundance. These designs and analysis techniques will continue to be used as we work with more complex models throughout the course.

Attribution