Lab Tutorial: Conservation Planning in Antarctica

Wen Wen, Mike Bode, Kerrie Wilson

2023 SAEF Annual Conference: Conservation Planning in Antarctica

SAEF Securing Antarctica's Environmental Future

Australian Research Council Special Research Initiative

Outline

Introduction – 5 minutes

Data – 15 minutes

Gap Analysis – 15 minutes

Prioritizations – 20 minutes

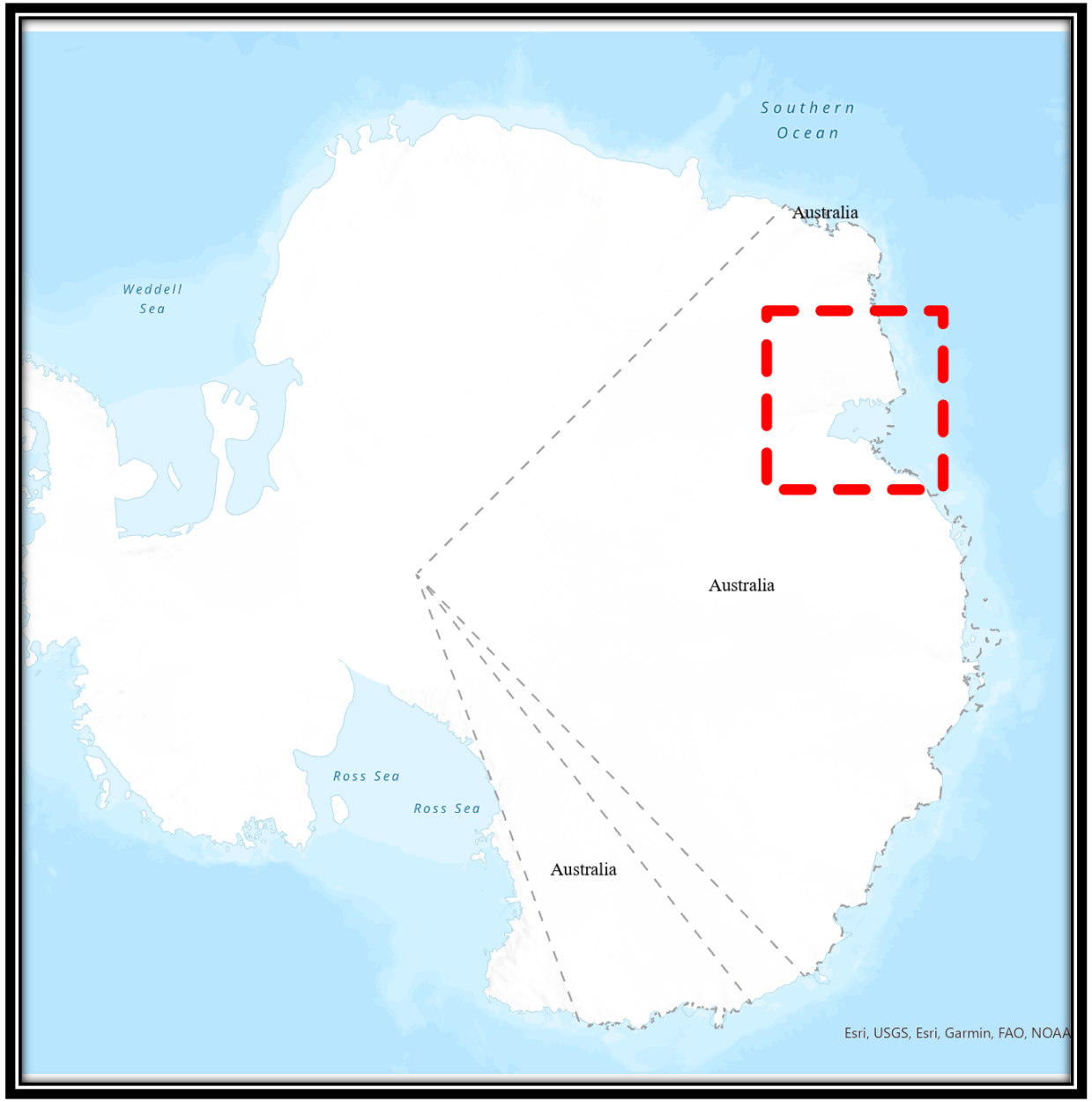
Conclusion – 5 minutes

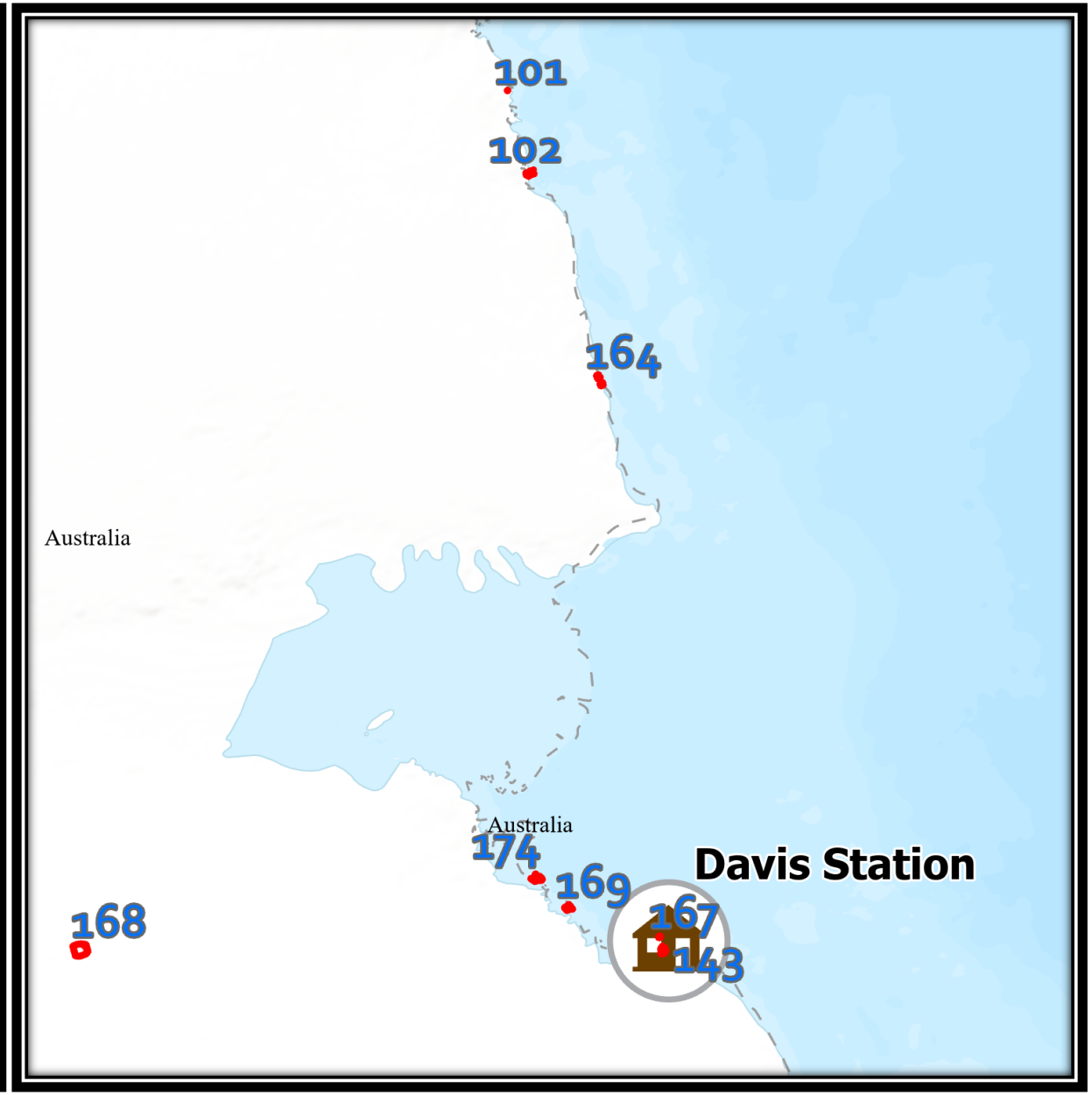
Learning Objectives

- To understand the core principles of conservation planning.
- To provide the knowledge base to conduct conservation planning analyses.

1. Introduction

- You are playing the role of a conservation planner, for which you have been tasked by the Antarctic Scientific Committee to evaluate the existing system of protected areas in the Australian Antarctic Territory (AAT), which are in Antarctic Conservation Biogeographic Regions (ACBR's) 7 and 16.
- You will be using the prioritizr R package as a decision support tool for spatial conservation prioritization.
- Your task is to find new conservation areas that will protect the species of interest, while minimizing the overall cost.


Southern Ocean
Australia
Weddell Sea
Australia
Ross Sea
Ross Sea
Australia
Esri, USGS, Esri, Garmin, FAO, NOAA


101
102
164
Australia
Australia
174
169
168
167
143
Davis Station

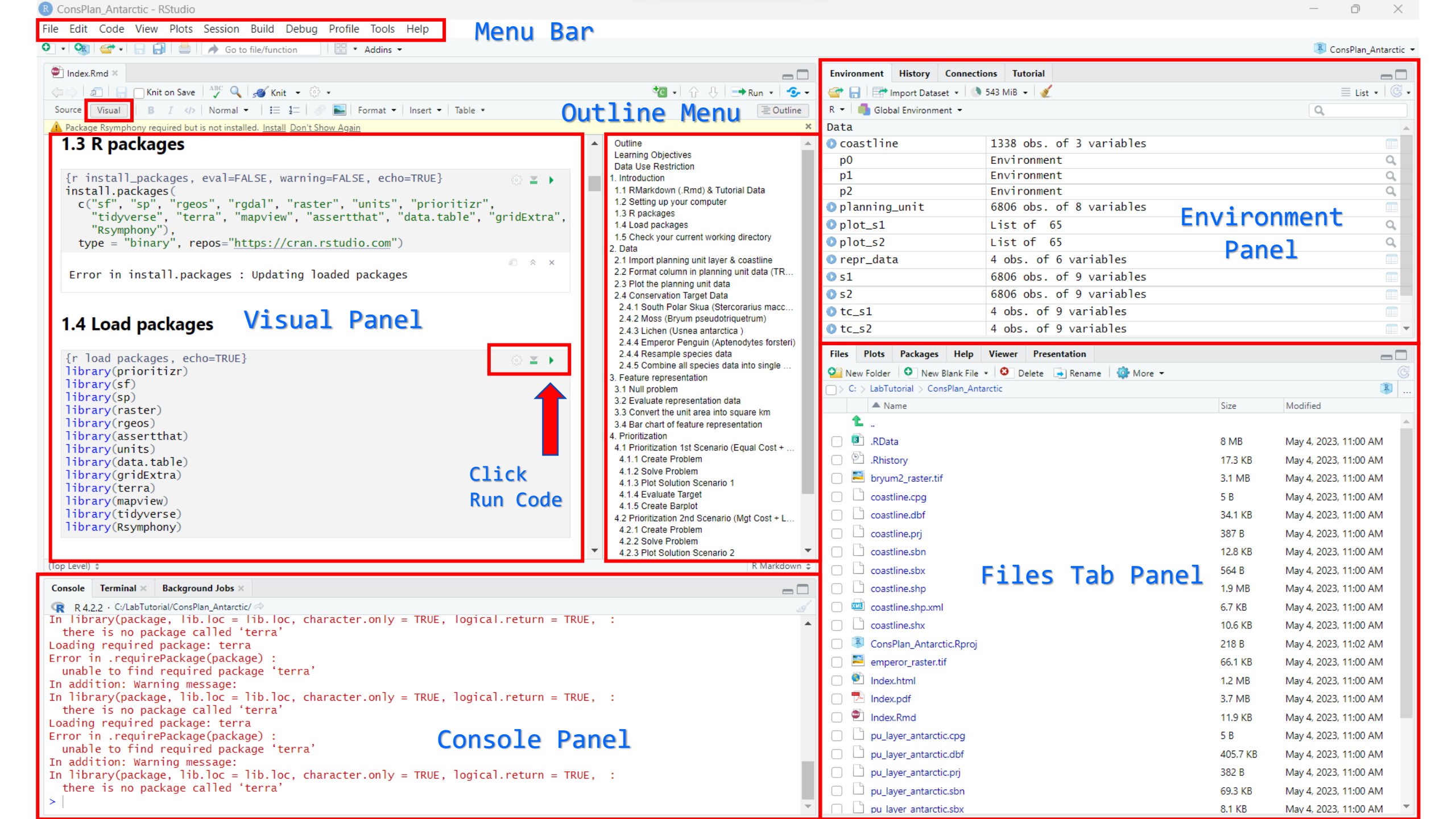
Rmarkdown (.rmd) + Tutorial Data

The data for this tutorial has been provided in this google drive link. After downloading the LabTutorial.zip, extract the files into a folder and titled "LabTutorial" folder.

DATA USE RESTRICTION AND DISCLAIMER

THIS LAB TUTORIAL DATA IS INTENDED ONLY FOR TRAINING PURPOSES AND NOT FOR FURTHER SCIENTIFIC PUBLICATION OR ANY LEGAL CLAIMS. THE DATA HEREIN HAS BEEN OBTAINED FROM SOURCES BELIEVED TO BE RELIABLE, BUT ITS ACCURACY AND COMPLETENESS, AND THE OPINIONS BASED THEREON, ARE NOT GUARANTEED.

- ✓ Open the **RStudio** application
- ✓ Click Menu '**File**' and **Open Project**... **\LabTutorial\ConsPlan_Antarctic.Rproj**
- ✓ Navigate to the **Files tab** to open the **Index.Rmd** file and switch from the **source panel** to the **Visual panel** on the markdown.
- ✓ If you haven't installed any library packages yet, don't worry about the error warning on the console. Simply click on the "**R packages**" option in **section 1.3** or follow the warning message if some packages are required. If you've already installed the packages, feel free to skip ahead to **section 1.4** to load them.


ConsPlan_Antarctic - RStudio
File Edit Code View Plots Session Build Debug Profile Tools Help
Menu Bar
Go to file/function
Addins
ConsPlan_Antarctic
Index.Rmd
Knit on Save
Knit
Run
Source
Visual
Normal
Format
Insert
Table
Outline
Outline Menu
Package Rsymphony required but is not installed. Install Don't Show Again
1.3 R packages
{r install_packages, eval=FALSE, warning=FALSE, echo=TRUE}
install.packages(
c("sf", "sp", "rgeos", "rgdal", "raster", "units", "prioritizr",
"tidyverse", "terra", "mapview", "assertthat", "data.table", "gridExtra",
"Rsymphony"),
type = "binary", repos="https://cran.rstudio.com")
Error in install.packages : Updating loaded packages
1.4 Load packages
Visual Panel
{r load packages, echo=TRUE}
library(prioritizr)
library(sf)
library(sp)
library(raster)
library(rgeos)
library(assertthat)
library(units)
library(data.table)
library(gridExtra)
library(terra)
library(mapview)
library(tidyverse)
library(Rsymphony)
Click
Run Code
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(Top Level)
R Markdown
Environment History Connections Tutorial
Import Dataset
543 MiB
List
R
Global Environment
Data
coastline 1338 obs. of 3 variables
p0 Environment
p1 Environment
p2 Environment
planning_unit 6806 obs. of 8 variables
plot_s1 List of 65
plot_s2 List of 65
repr_data 4 obs. of 6 variables
s1 6806 obs. of 9 variables
s2 6806 obs. of 9 variables
tc_s1 4 obs. of 9 variables
tc_s2 4 obs. of 9 variables
Environment
Panel
Files Plots Packages Help Viewer Presentation
New Folder
New Blank File
Delete
Rename
More
C: LabTutorial ConsPlan_Antarctic
Name Size Modified
.RData 8 MB May 4, 2023, 11:00 AM
.Rhistory 17.3 KB May 4, 2023, 11:00 AM
bryum2_raster.tif 3.1 MB May 4, 2023, 11:00 AM
coastline.cpg 5 B May 4, 2023, 11:00 AM
coastline.dbf 34.1 KB May 4, 2023, 11:00 AM
coastline.prj 387 B May 4, 2023, 11:00 AM
coastline.sbn 12.8 KB May 4, 2023, 11:00 AM
coastline.sbx 564 B May 4, 2023, 11:00 AM
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ConsPlan_Antarctic.Rproj 218 B May 4, 2023, 11:02 AM
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Index.pdf 3.7 MB May 4, 2023, 11:00 AM
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pu_layer_antarctic.sbx 8.1 KB May 4, 2023, 11:00 AM
Files Tab Panel
Console Terminal Background Jobs
R 4.2.2 · C:/LabTutorial/ConsPlan_Antarctic/
In library(package, lib.loc = lib.loc, character.only = TRUE, logical.return = TRUE, :
there is no package called 'terra'
Loading required package: terra
Error in .requirePackage(package) :
unable to find required package 'terra'
In addition: Warning message:
In library(package, lib.loc = lib.loc, character.only = TRUE, logical.return = TRUE, :
there is no package called 'terra'
Loading required package: terra
Error in .requirePackage(package) :
unable to find required package 'terra'
In addition: Warning message:
In library(package, lib.loc = lib.loc, character.only = TRUE, logical.return = TRUE, :
there is no package called 'terra'
>
Console Panel

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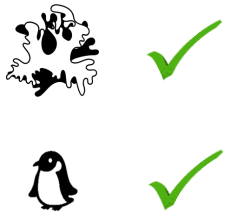
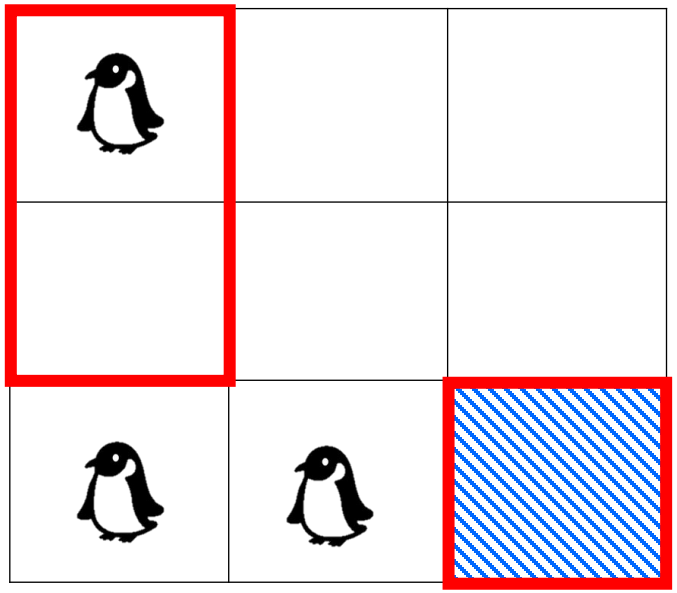
Species X

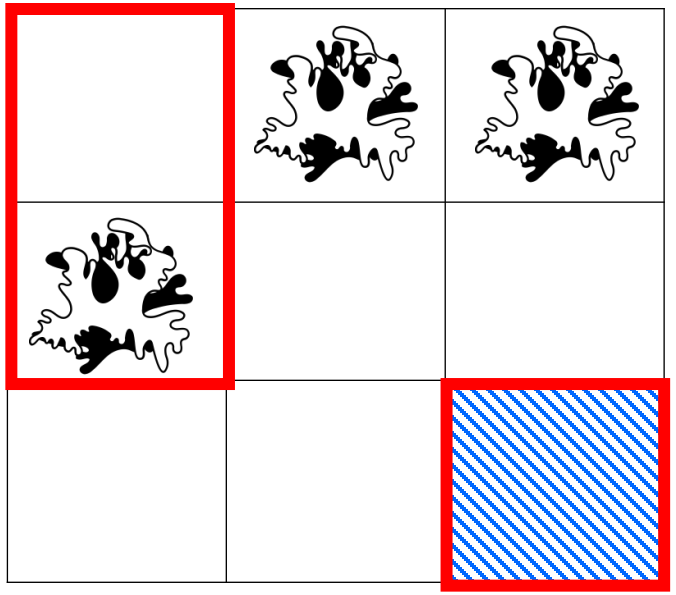
Target = 25%



Minimum Cost = 20$

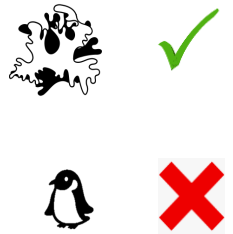


ASPA



Species Y

Target = 25%

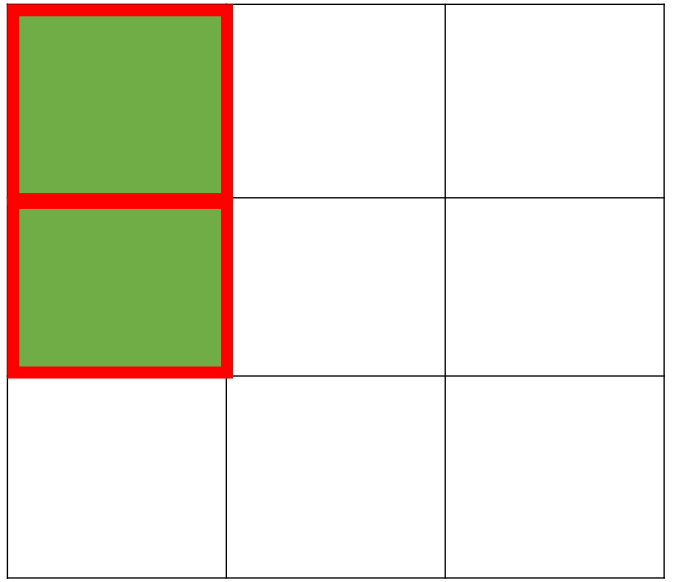


Cost

10 $	10 $	10 $
10 $	10 $	10 $
10 $	10 $	10 $

Planning Unit size = 100 km x 100 km

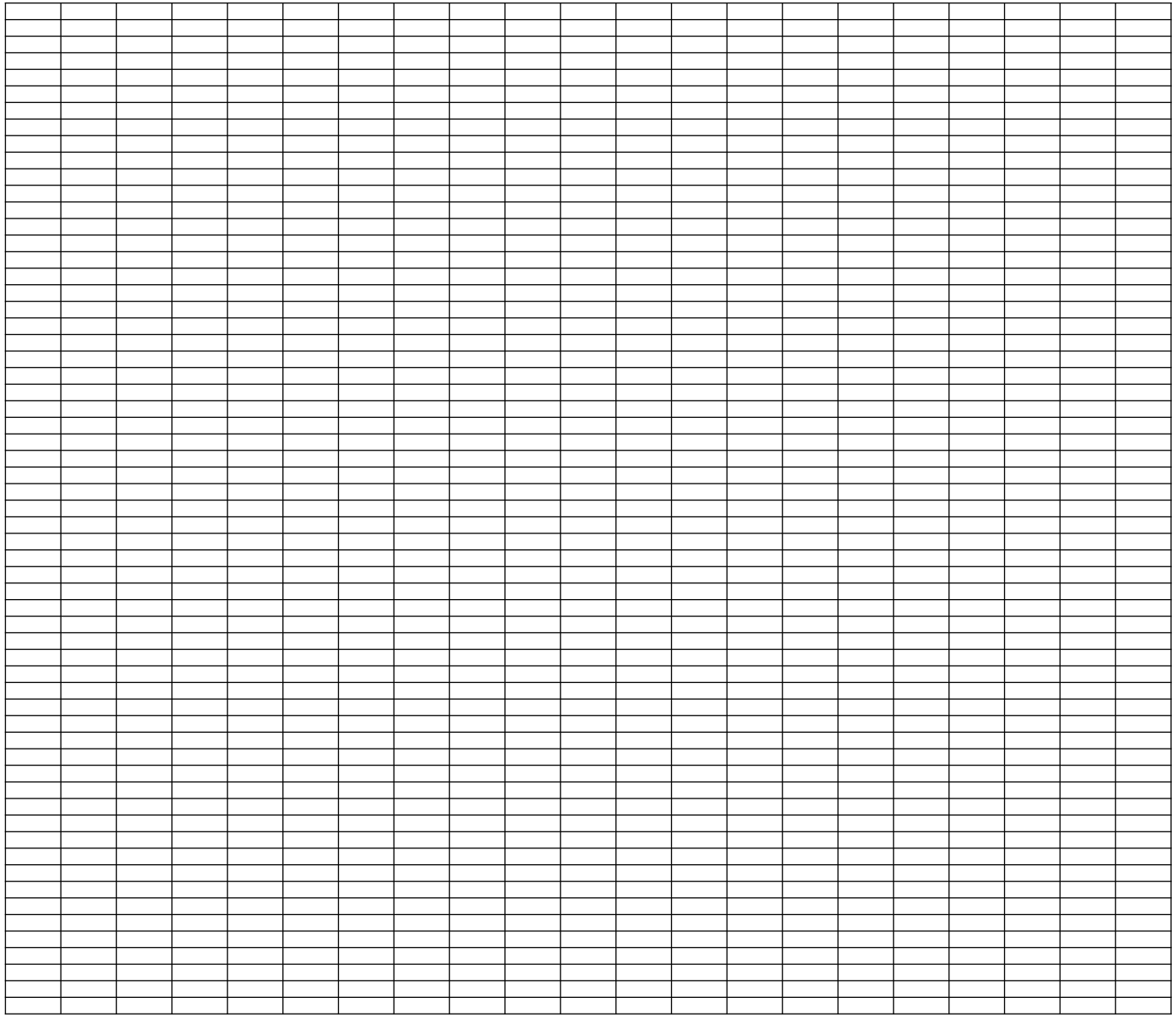
Decision



Selected (1)

Not Selected (0)

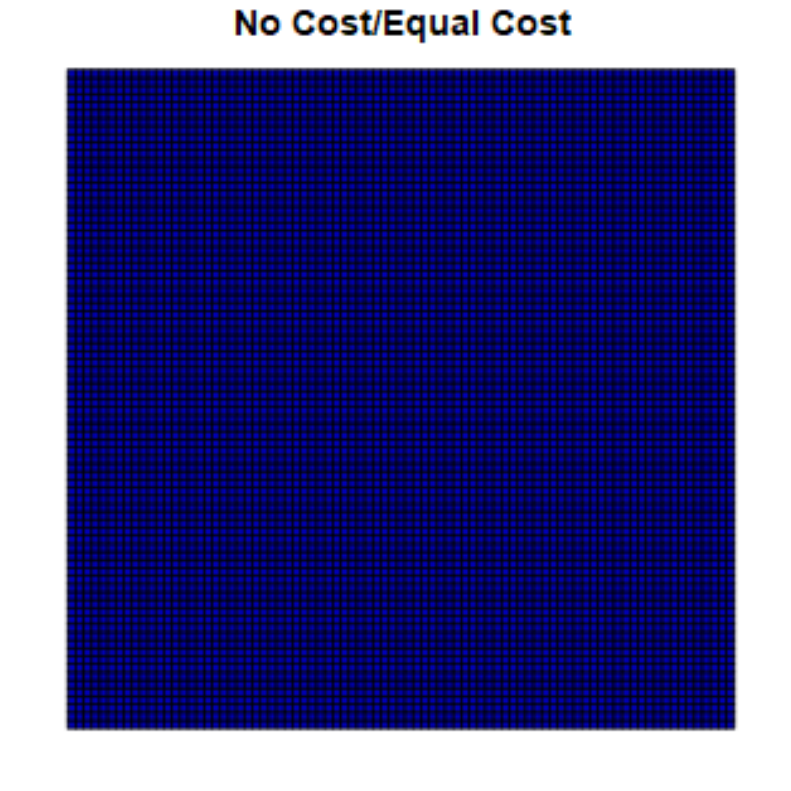
Now consider.....

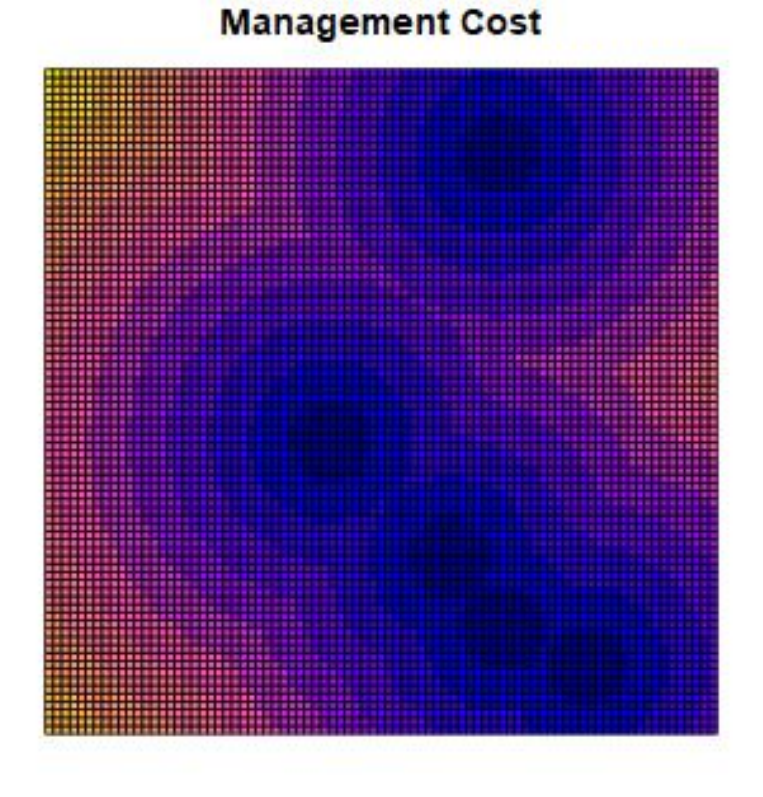


Two types of cost scenarios

No Cost or equal cost – Assuming that land in Antarctica does not need to be purchased.

Management costs – The distance of new PAs from the nearest station, reflecting monitoring costs or administration costs.



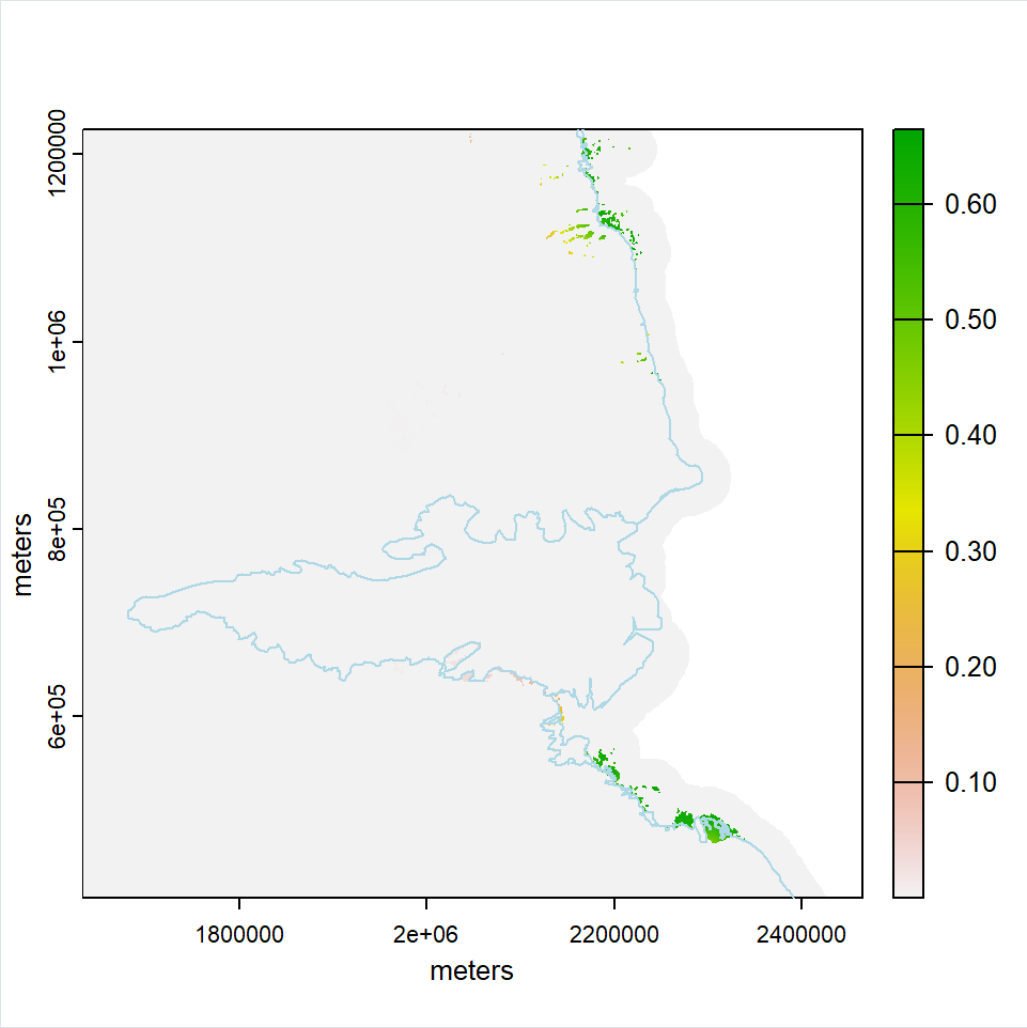


2. Data

- ✓ Please click on “Run Current Chunk” **section 2.1** to import the planning unit layer.
- ✓ Next, click on **section 2.2** to format column in planning unit data.
- ✓ Then, plot the planning unit layer on **section 2.3** and you will see **PU ID**, **Cost Layers**, **Status**, **Locked In**, and **Locked Out**.

Species Data

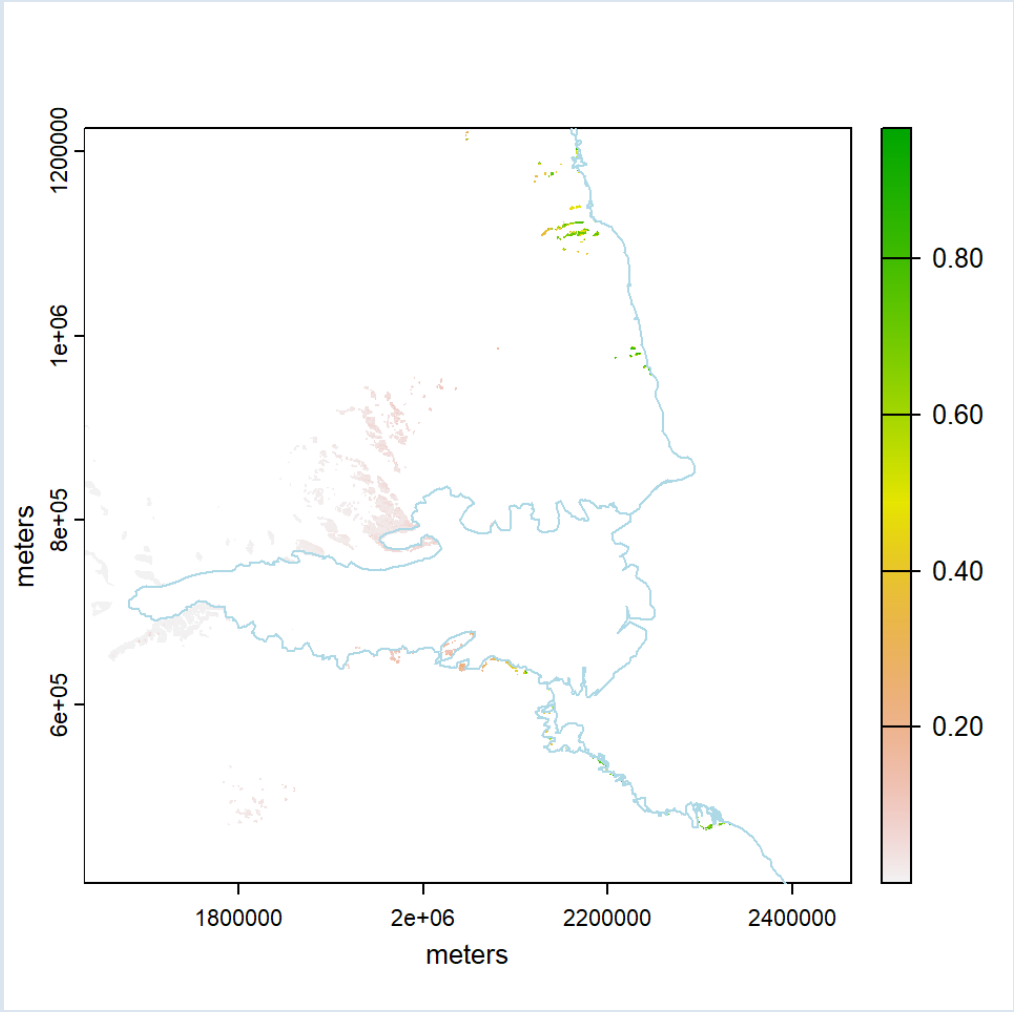
- ✓ Please click on **section 2.4.1** to import the Skua raster.



Todd, I. 2021

Species Data

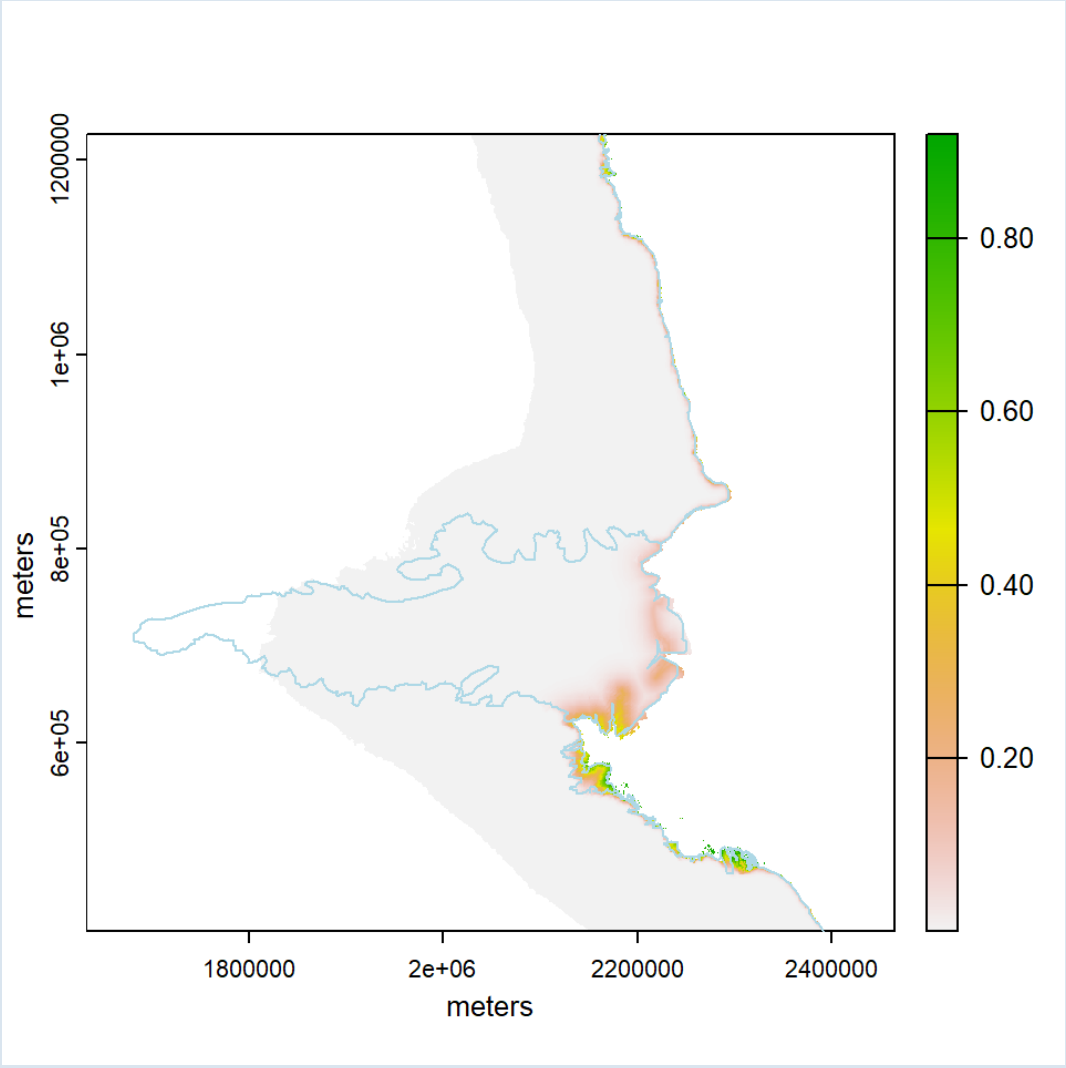
- ✓ Please click on **section 2.4.2** to import the Moss raster.



Todd, I. 2021

Species Data

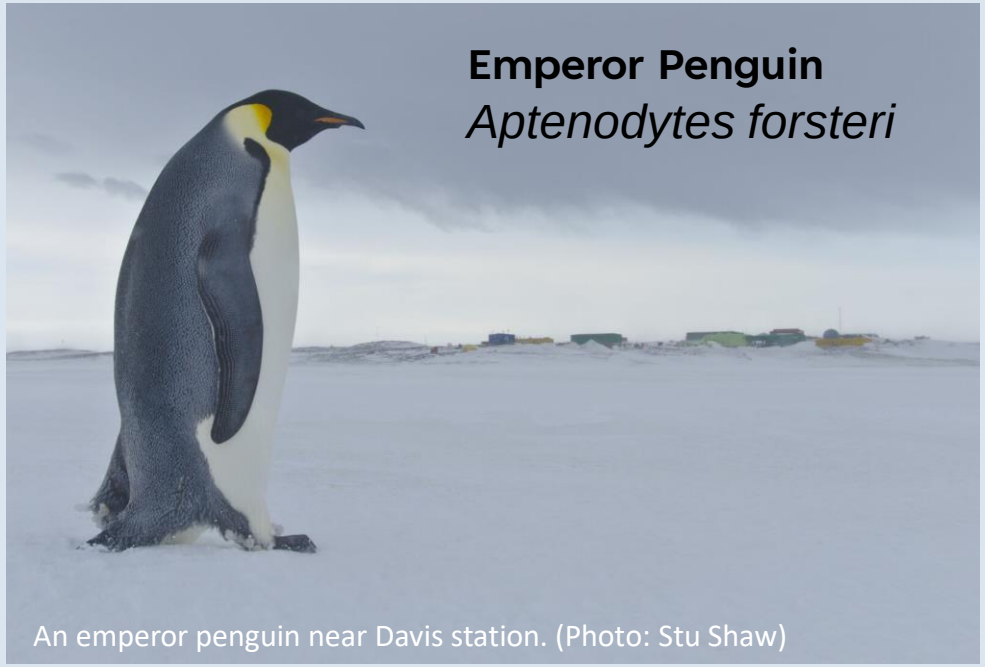
- ✓ Please click on **section 2.4.3** to import the Usnea raster.



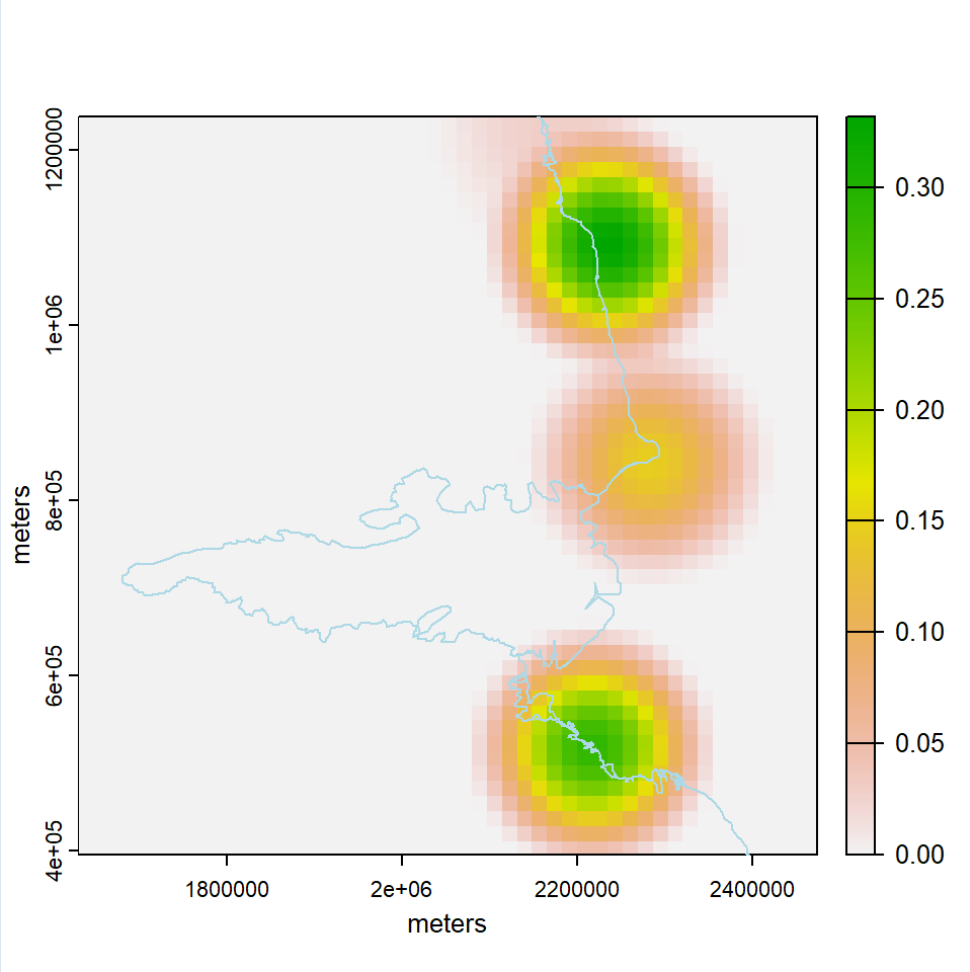
Todd, I. 2021

Species Data

- ✓ Please click on **section 2.4.4** to import the Emperor raster.



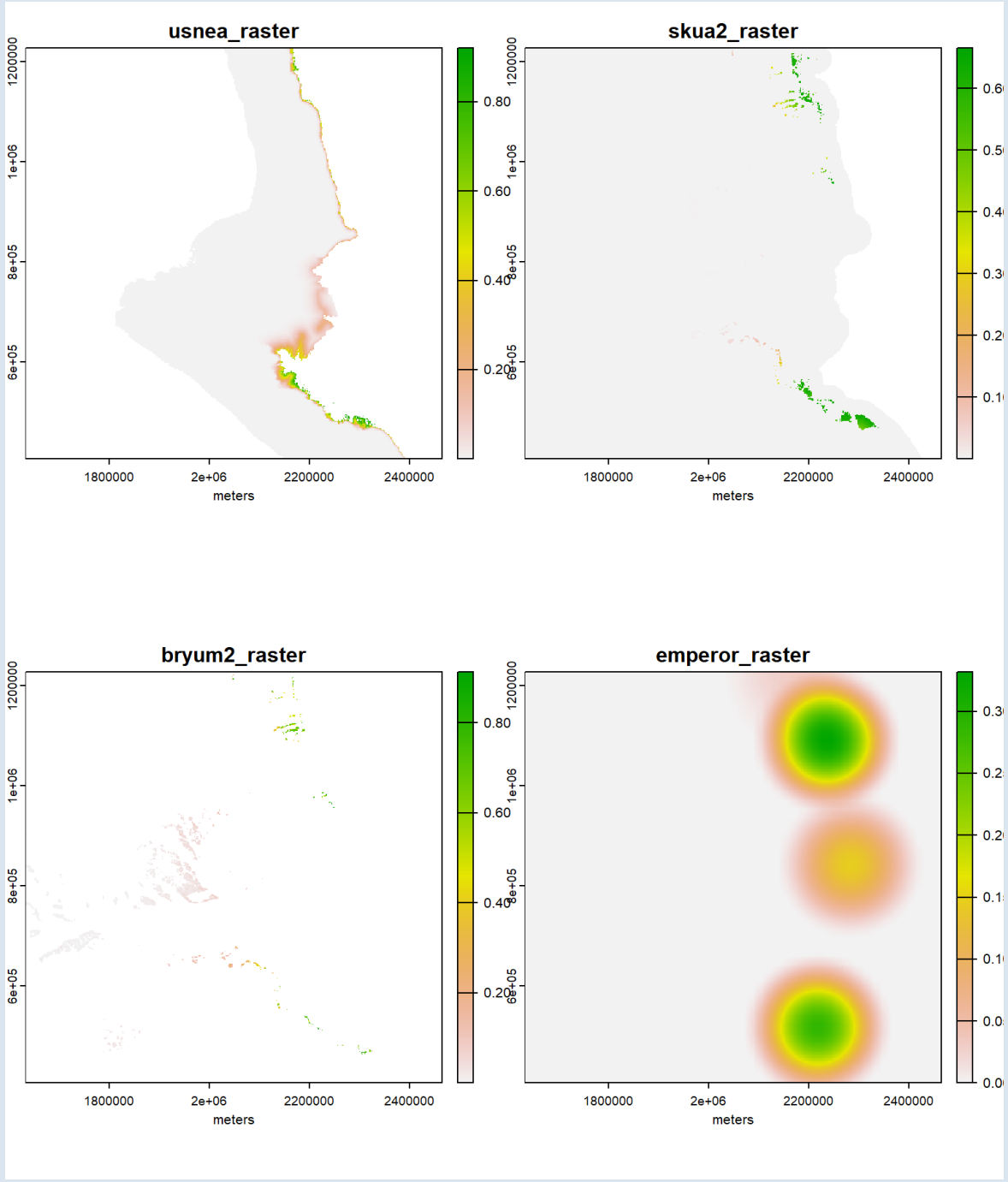
An emperor penguin near Davis station. (Photo: Stu Shaw)



Fretwell et al. 2021

Resampling & Standardize Raster Data

- ✓ We need to ensure that all rasters have the same **dimensions**, **resolution**, **extent**, and **projection**.
- ✓ Click on **section 2.4.4** to resample the emperor penguin and Bryum data to standardize the format.
- ✓ Then, click on **section 2.4.5** to combine all species data into a single layer. You will now see maps of four species.

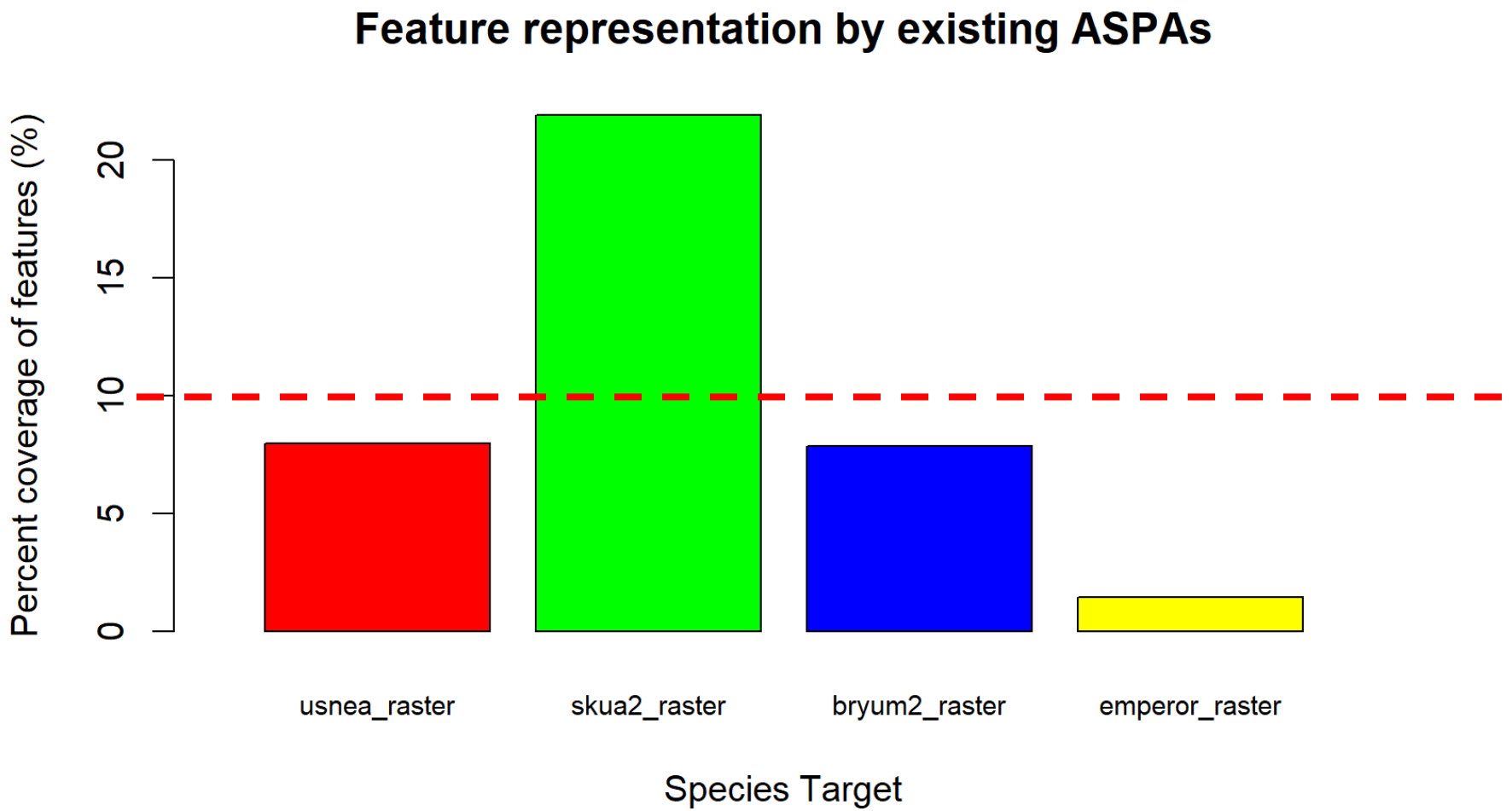


Species Data

3. Feature representation

- ✓ Click on **section 3.1** to create a null problem
- ✓ Then, click on **section 3.2** to evaluate the extent of the species.
- ✓ **Section 3.3** will convert the planning units into square km to describe the total extent of the species in the planning unit layer.
- ✓ Click on **section 3.4** to plot a histogram of the representation of the species in existing protected areas (i.e., ASPAs).

Feature representation



Scenarios for prioritization analyses

	Relative Target	Lock in existing ASPAs	Cost
Scenario I	10%	No	No Cost/Equal
Scenario II	30%	Yes	Management Cost

Human-readable code

Mental model

```
problem <-
  data +
  objective +
  constraints +
  decision type +
  solver


solution <- solve(problem)
```

Code

```
p <-
  problem(areas, feats) %>%
  add_min_set_objective() %>%
  add_relative_targets(0.1) %>%
  add_binary_decisions() %>%
  add_rsymphony_solver()


solution <- solve(p)
```

4. Prioritization 1st Scenario (Equal/No Cost)

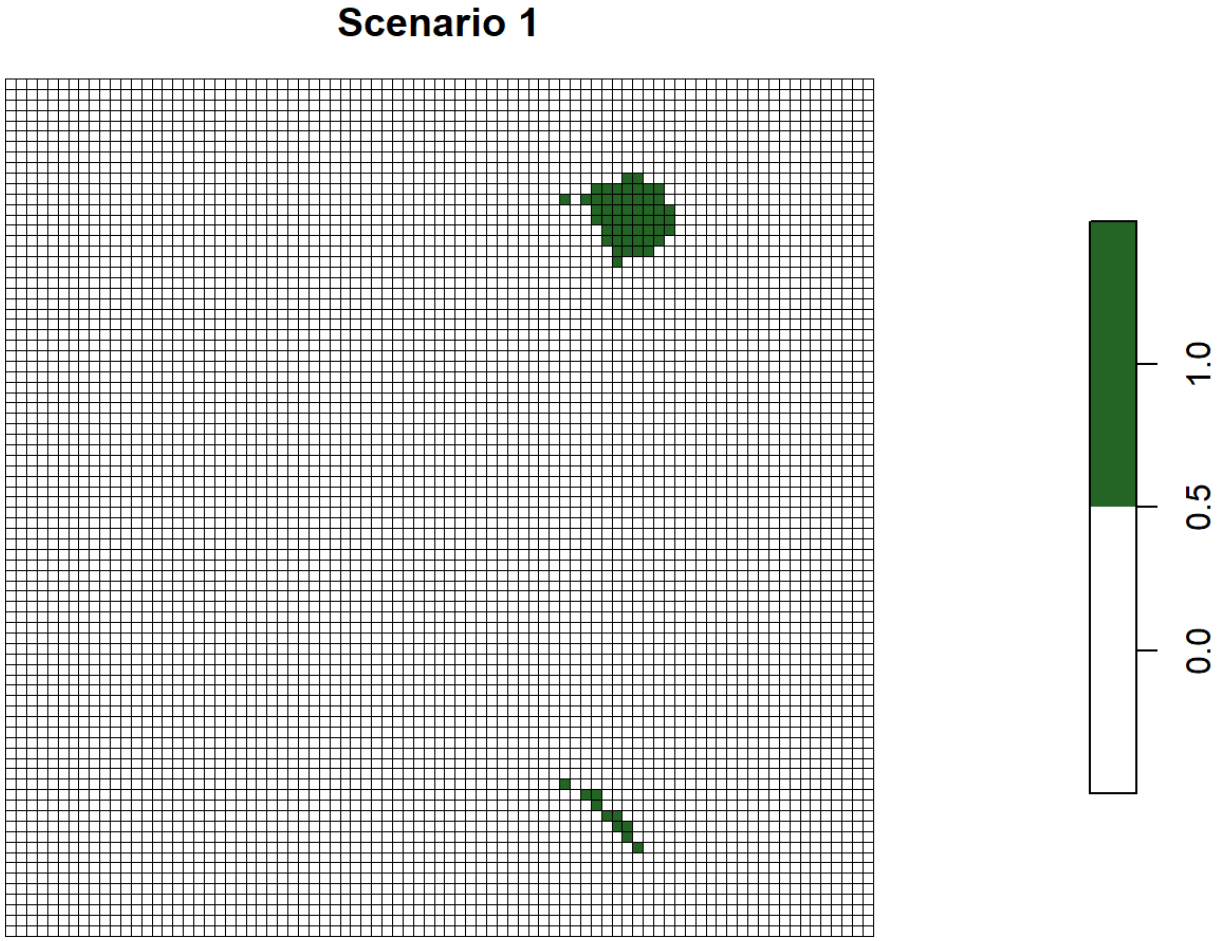
- ✓ Click on **section 4.1.1** to create the 1st prioritization problem
- ✓ Then run **section 4.1.2** to solve problem

```
# here we will state the prioritization problem
p1 <- problem(planning_unit, species, cost_column = "nocost") %>%
      add_min_set_objective() %>%
      add_relative_targets(0.1) %>%
      add_binary_decisions() %>%
      add_rsymphony_solver()

 # solve problem
s1 <- solve(p1)
```

4. Prioritization 1st Scenario

✓ Click on **section 4.1.3** to plot the solution map



4. Prioritization 1st Scenario

✓ Click on **section 4.1.4** to evaluate target

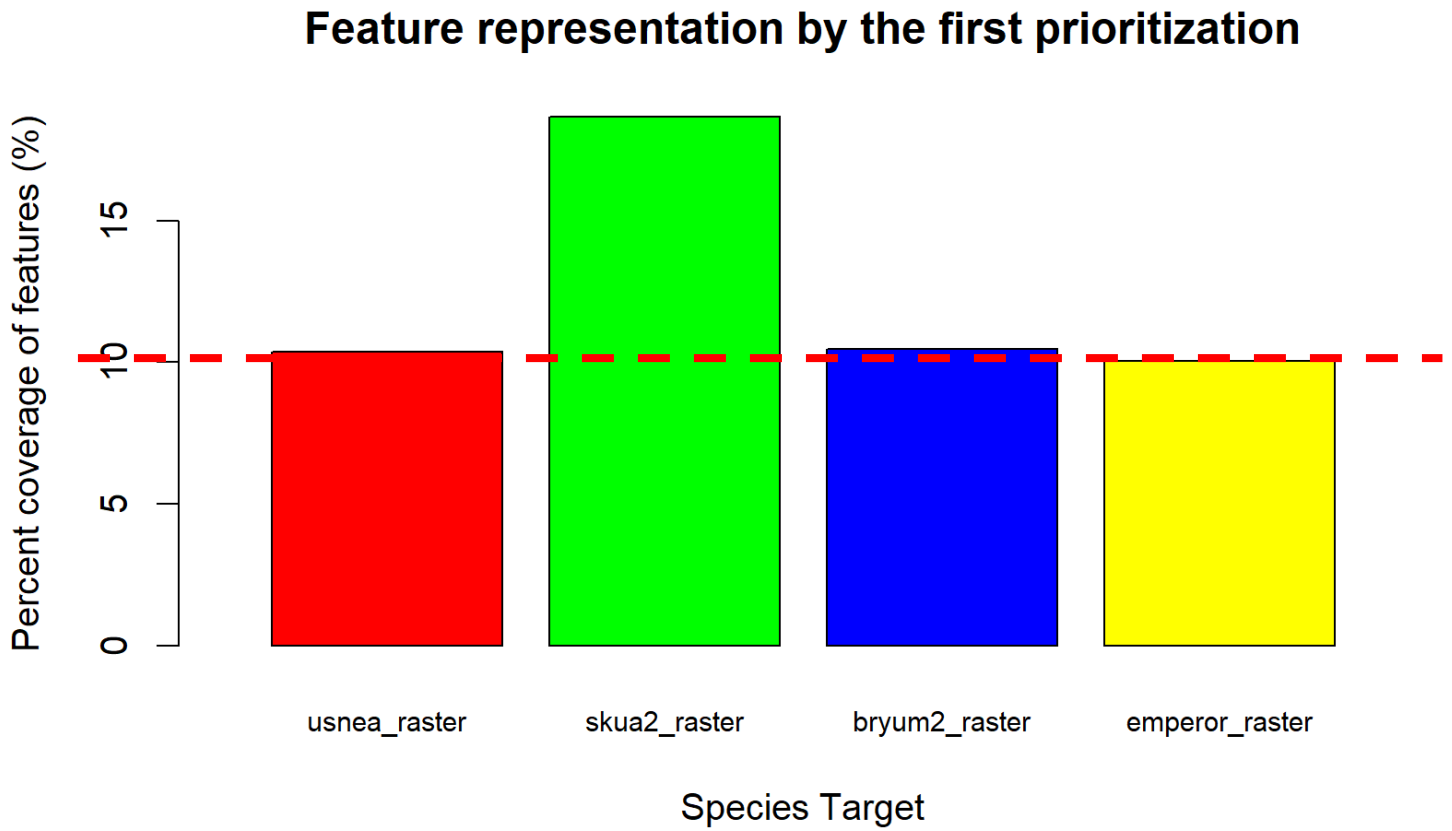
A tibble: 4 × 9

feature <chr>	met <lgl>	total_amount <dbl>	absolute_target <dbl>	absolute_held <dbl>
usnea_raster	TRUE	3069.9549	306.99549	318.32969
skua2_raster	TRUE	1664.9076	166.49076	310.60229
bryum2_raster	TRUE	656.2078	65.62078	68.65025
emperor_raster	TRUE	18434.4948	1843.44948	1851.98718

4 rows | 1-5 of 9 columns

4. Prioritization 1st Scenario

✓ Click on **section 4.1.5** to create a histogram



5. Prioritization 2nd Scenario (Management Cost + “Locked in” + 30% target)

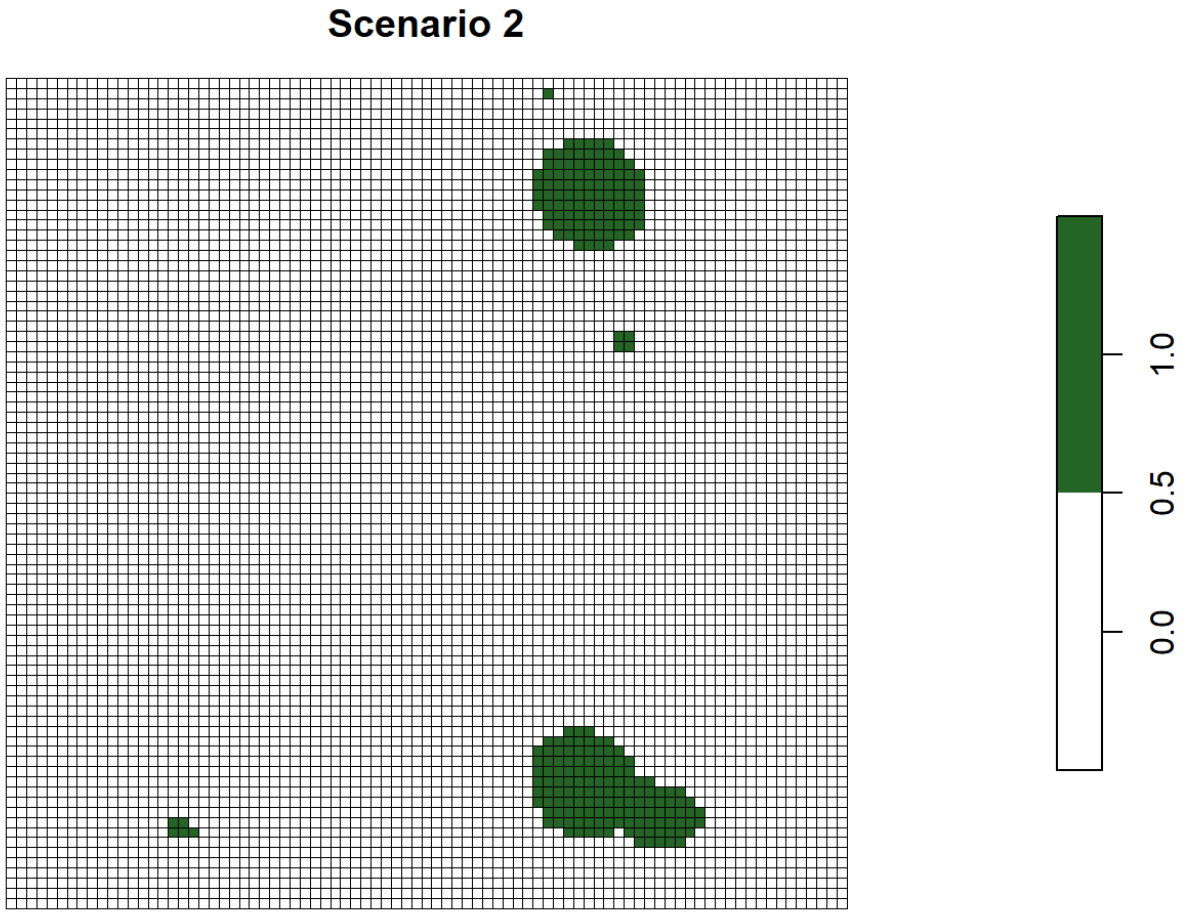
- ✓ Click on **section 4.2.1** to create the 2nd prioritization problem
- ✓ Then run **section 4.2.2** to solve problem

```
# we will add a management cost + lock in existing ASPAs + seek a 30% representation target
p2 <- problem(planning_unit, species, cost_column = "mgtcost") %>%
      add_min_set_objective() %>%
      add_relative_targets(0.30) %>%
      add_locked_in_constraints("locked_in") %>%
      add_binary_decisions() %>%
      add_default_solver()

# print the problem
S1 <- solve(p2)
```

5. Prioritization 2nd Scenario

✓ Click on **section 4.2.3** to plot the solution map



5. Prioritization 2nd Scenario

✓ Click on **section 4.2.4** to evaluate target

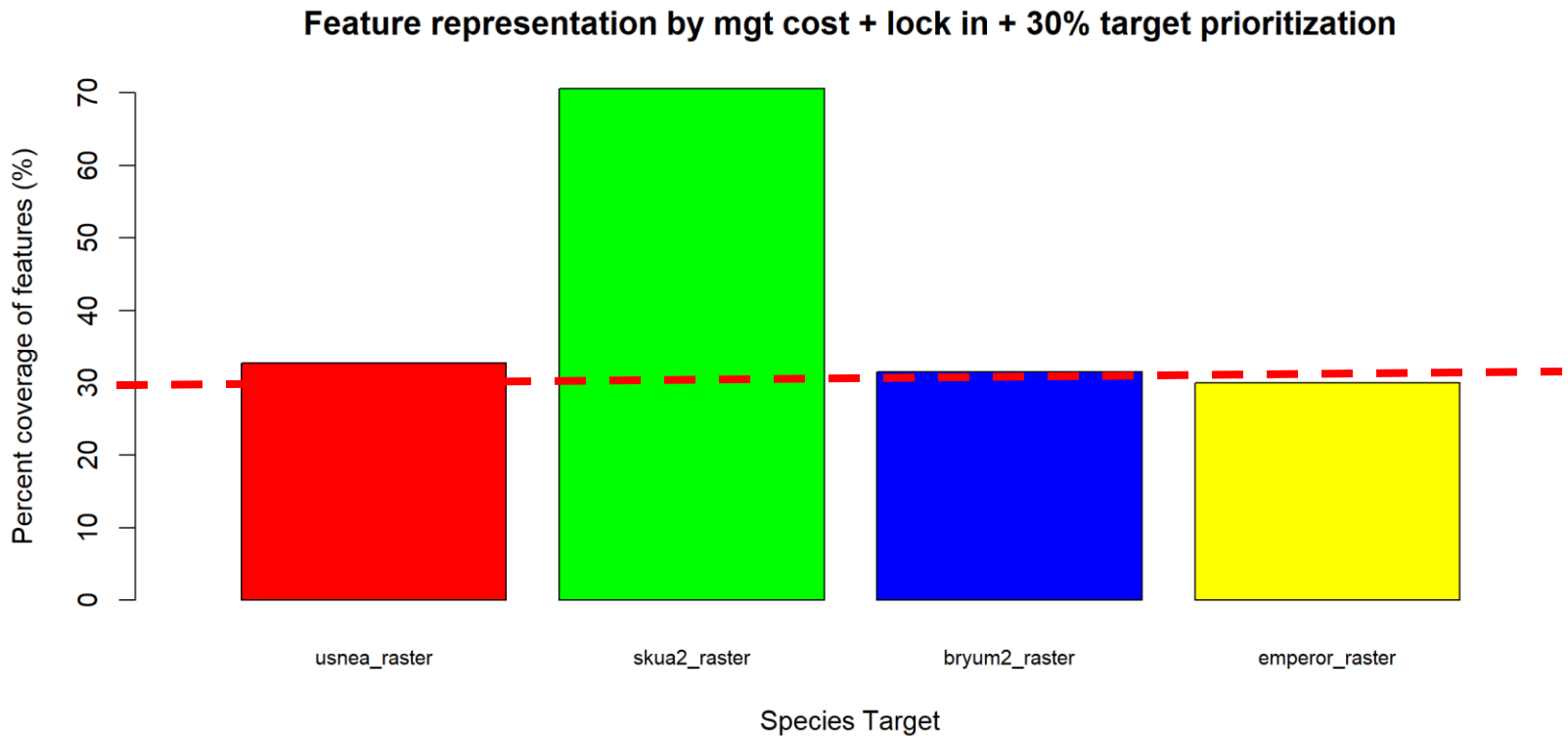
A tibble: 4 × 9

feature <chr>	met <lgl>	total_amount <dbl>	absolute_target <dbl>	absolute_held <dbl>
usnea_raster	TRUE	3069.9549	920.9865	963.6687
skua2_raster	TRUE	1664.9076	499.4723	1174.7166
bryum2_raster	TRUE	656.2078	196.8623	206.8852
emperor_raster	TRUE	18434.4948	5530.3484	5530.3641

4 rows | 1-5 of 9 columns

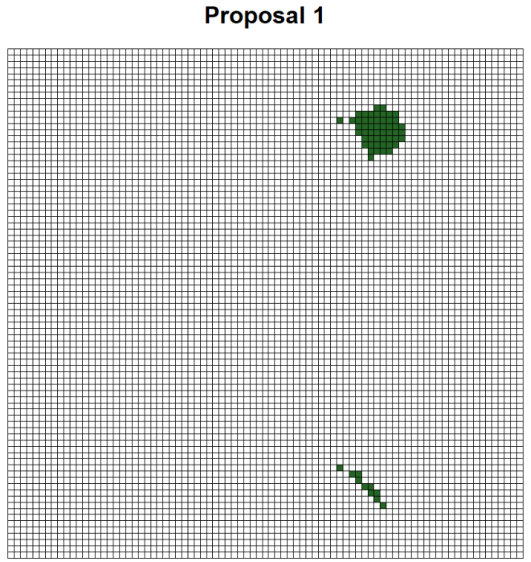
5. Prioritization 2nd Scenario

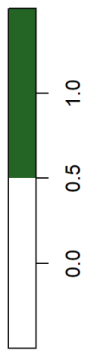
✓ Click on **section 4.2.5** to create a histogram

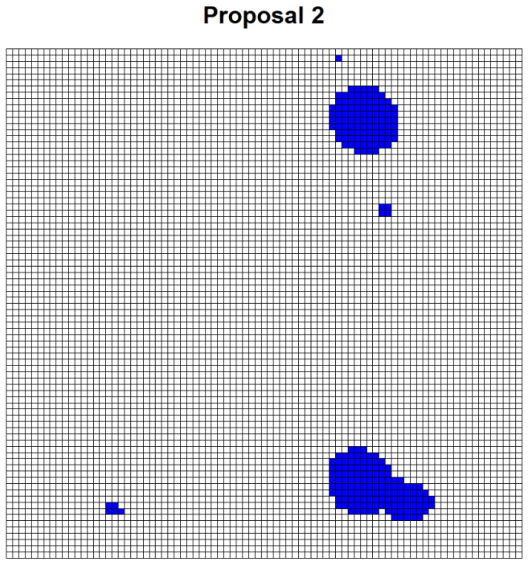


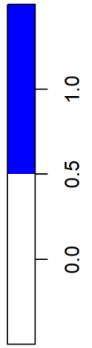
Prioritization Multi Scenarios

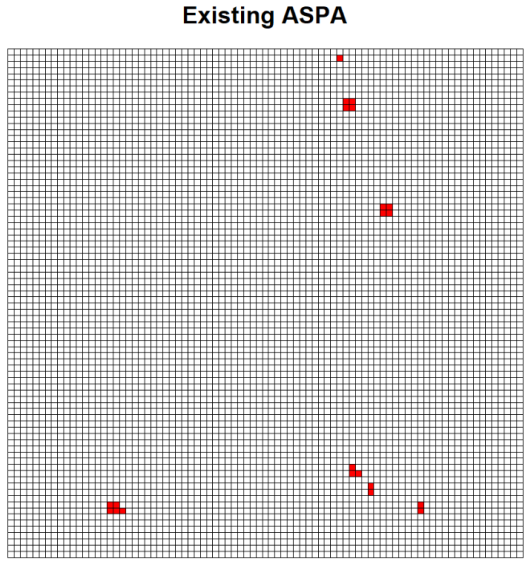
✓ Click on **section 4.3** to combine two prioritization results

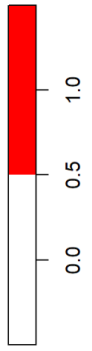


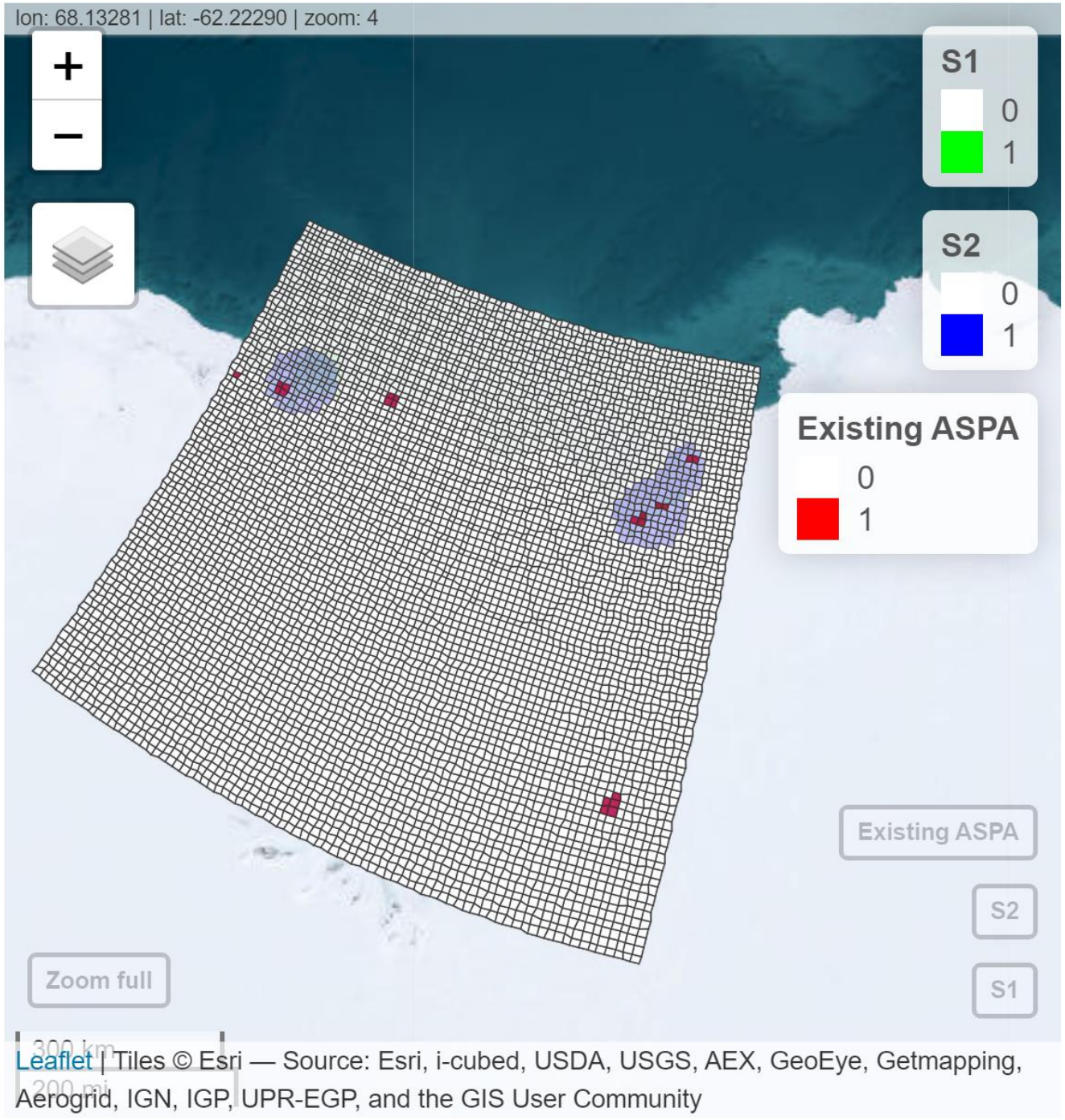








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+
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S1
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300 km
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Leaflet | Tiles © Esri — Source: Esri, i-cubed, USDA, USGS, AEX, GeoEye, Getmapping, Aerogrid, IGN, IGP, UPR-EGP, and the GIS User Community

Any questions?

Congratulations! You have completed the tutorial.

And we welcome any feedback

Wen Wen - ww.wen@hdr.qut.edu.au
Michael Bode - michael.bode@qut.edu.au
Kerrie Wilson - kerrie.wilson@qut.edu.au

Thank you

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