Conservation planning

Brooke Williams, Caitie Kuemple

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In this session we are using the prioritizr package to create a set of conservation scenarios for protecting the future distribution of koalas in the SEQ region.

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Optimiser installation

The prioritizr package requires that you download and install an optimiser - a commonly used one is Gurobi. You can obtain a free academic license for Gurobi here: https://www.gurobi.com/features/academic-named-user-license/.

Here is a guide to install Gurobi for R: https://docs.gurobi.com/projects/optimizer/en/current/reference/r/setup.html.

Alternatively, if you cannot obtain an academic licence there are other solvers available https://prioritizr.net/reference/solvers.html. We recommend installing the CBC solver: https://github.com/dirkschumacher/rcbc.

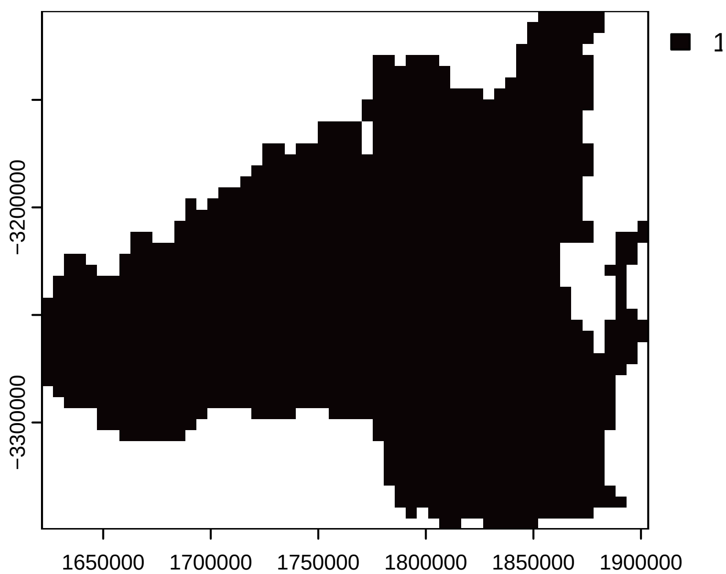
If you have issues with installing a solver, please let us know.

Install packages

```
# Load required packages
library(terra)
library(viridisLite)
library(prioritizr)
library(raster)
```

Load Spatial Data

```
# Load the Planning unit
PU <- terra::rast("data/otherdata/PlanningUnits.tif")
plot(PU, col = viridisLite::mako(n = 1))
```

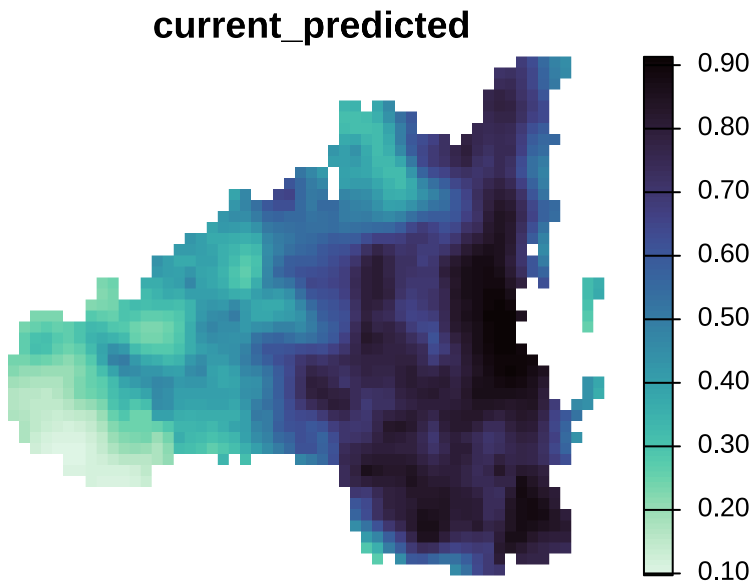



```
# Get the file names of the testing data
spp.list <- list.files(path = "data/SpeciesDistributions/", full.names = TRUE, recursive = T
```

Load current species distribution

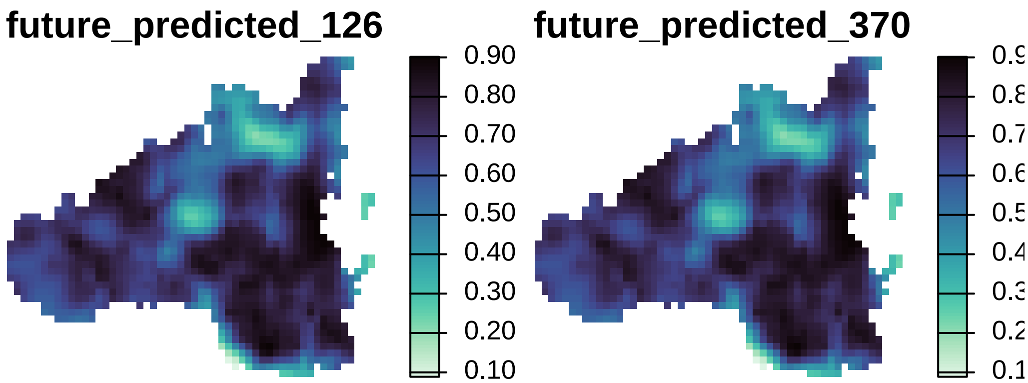
```
# Load all files and rename them
spp <- rast(spp.list[grep("current", spp.list)])
# Get just the filenames (without full paths and extensions)
new_names <- tools::file_path_sans_ext(basename(spp.list[grep("current", spp.list)]))
```

```
# Load and assign names
spp <- rast(spp.list[grep("current", spp.list)])
names(spp) <- new_names
# Plot species distributions
plot(spp, axes = F,col = viridisLite::mako(n = 100, direction = -1), main = c(names(spp)))
```



Load future species distribution

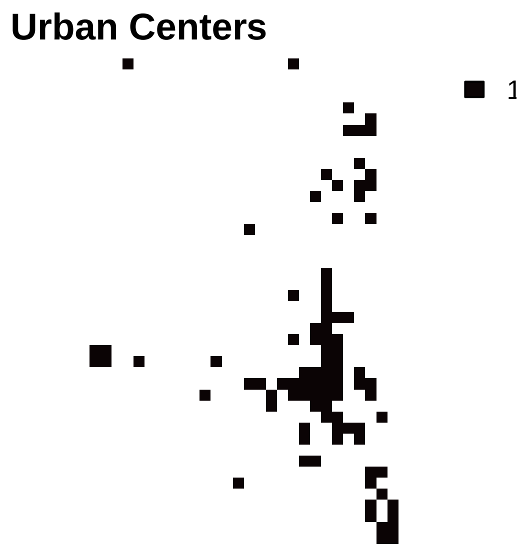
```
# Do the same for "future" rasters
spp <- rast(spp.list[grep("future", spp.list)])
# Get just the filenames (without full paths and extensions)
new_names <- tools::file_path_sans_ext(basename(spp.list[grep("future", spp.list)]))
# Load and assign names
spp <- rast(spp.list[grep("future", spp.list)])
names(spp) <- new_names
# Plot first four species distributions
plot(spp, axes = F,col = viridisLite::mako(n = 100, direction = -1), main = c(names(spp)))
```



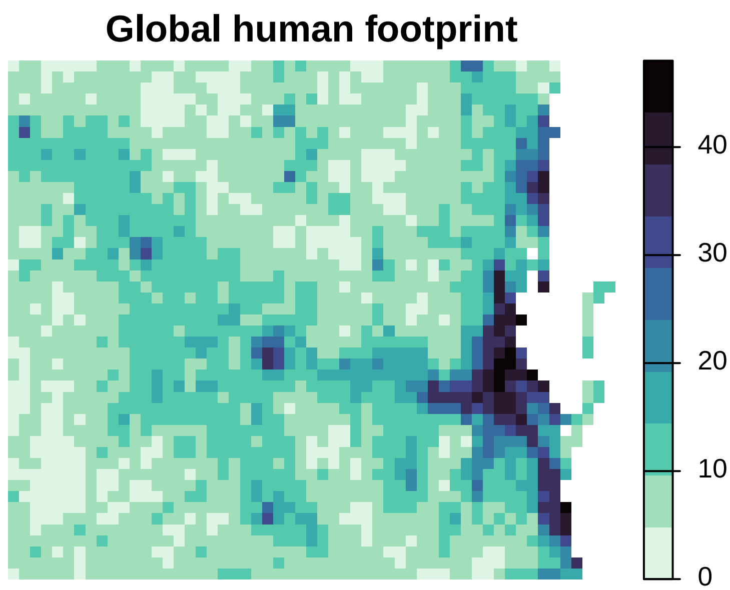
Load protected areas, urban centers, and cost layer

```
PA <- rast("data/otherdata/protected_areas.tif")
plot(PA, axes = FALSE, col = viridisLite::mako(n = 100, direction = -1), main = "Protected A
```


```
urban <- rast("data/otherdata/urban_centers.tif")
plot(urban, axes = FALSE, col = viridisLite::mako(n = 100, direction = -1), main = "Urban Ce
```




```
hfp <- rast("data/otherdata/cost_hfp2013.tif")
plot(hfp, axes = FALSE, col = viridisLite::mako(n = 10, direction = -1), main = "Global huma
```

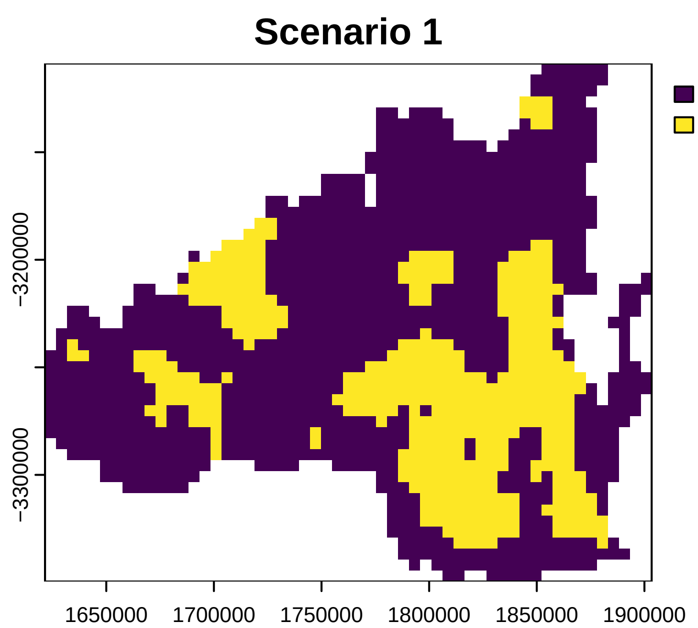


Define Budget

```
budget.area <- round(0.3 * length(cells(PU)))
```

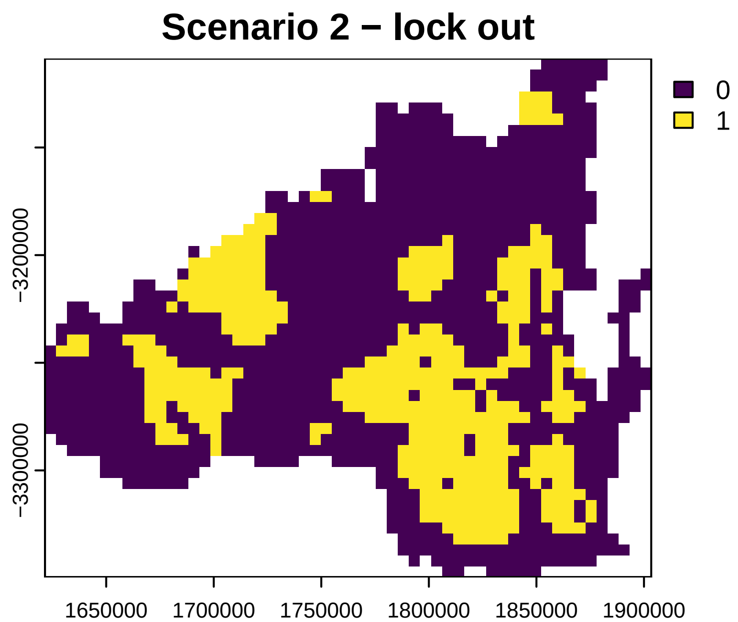
Scenario 1: Basic Shortfall Objective

```
p <- problem(PU, spp) %>%
  add_min_shortfall_objective(budget = budget.area) %>%
  add_relative_targets(targets = 1) %>%
  add_default_solver() %>%
  add_proportion_decisions()

s1 <- solve(p)
plot(s1, main = "Scenario 1")
```



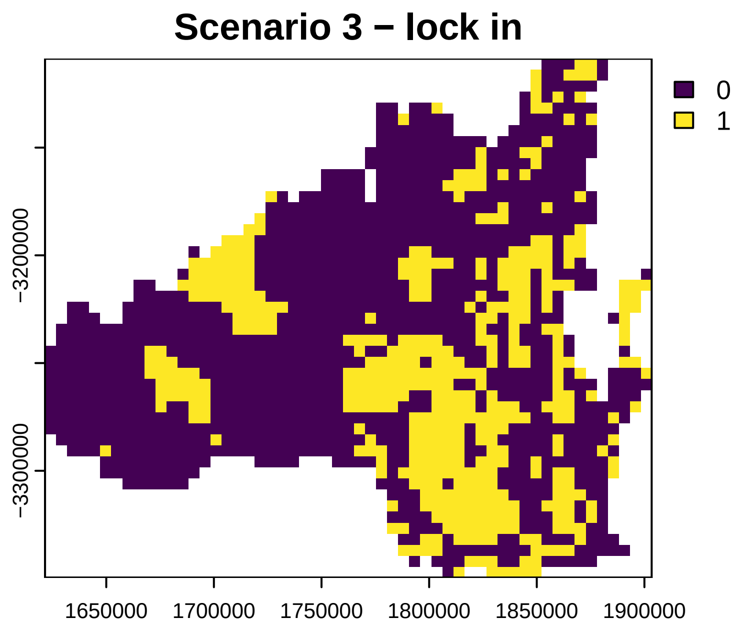
Scenario 2: Lock Out Urban Areas

```
p <- problem(PU, spp) %>%
  add_min_shortfall_objective(budget = budget.area) %>%
  add_relative_targets(targets = 1) %>%
  add_proportion_decisions() %>%
  add_locked_out_constraints(urban) %>%
  add_default_solver()

s2 <- solve(p)
plot(s2, main = "Scenario 2 - lock out")
```



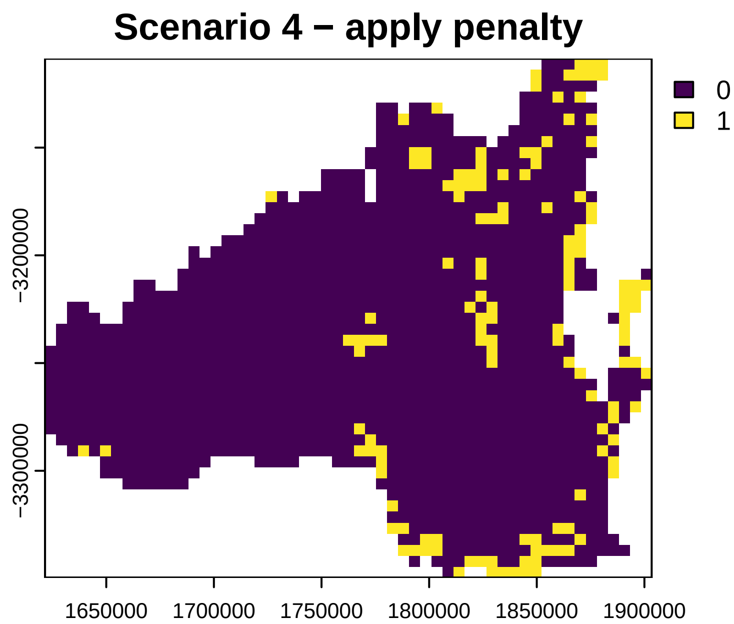
Scenario 3: Lock In Protected Areas

```
p <- problem(PU, spp) %>%
  add_min_shortfall_objective(budget = budget.area) %>%
  add_relative_targets(targets = 1) %>%
  add_proportion_decisions() %>%
  add_locked_in_constraints(PA) %>%
  add_locked_out_constraints(urban) %>%
  add_default_solver()

s3 <- solve(p)
plot(s3, main = "Scenario 3 - lock in")
```



Scenario 4: Penalize Human Footprint

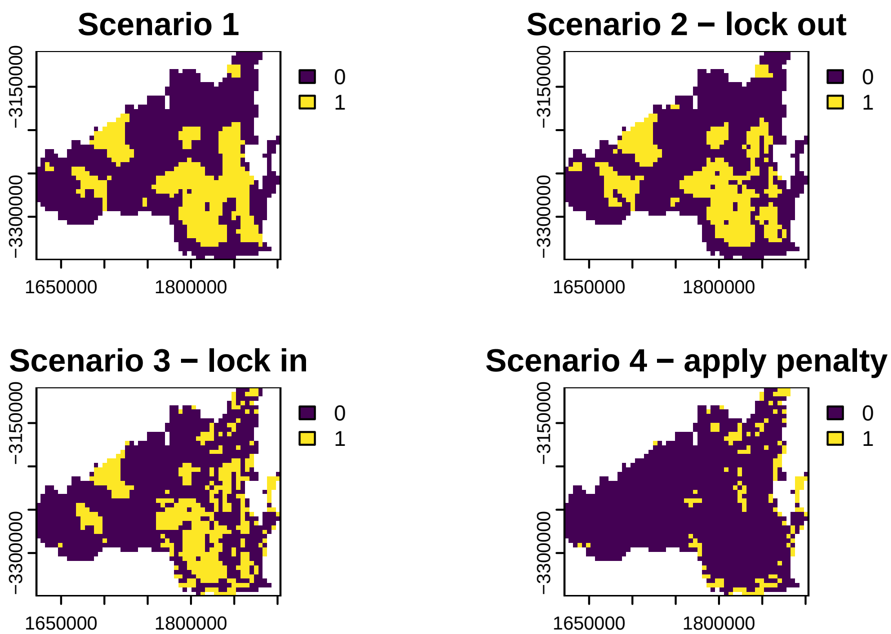
```
p <- problem(PU, spp) %>%
  add_min_shortfall_objective(budget = budget.area) %>%
  add_relative_targets(targets = 1) %>%
  add_linear_penalties(penalty = 1, data = hfp) %>%
  add_proportion_decisions() %>%
  add_locked_in_constraints(PA) %>%
  add_locked_out_constraints(urban) %>%
  add_default_solver()

s4 <- solve(p)
plot(s4, main = "Scenario 4 - apply penalty")
```




```
# Export to GeoTIFF
writeRaster(s4, "scenario_4.tif", overwrite = TRUE)
```

Plot All Scenarios Side by Side

```
# Set plotting area to 1 row, 4 columns
par(mfrow = c(2, 2), mar = c(3, 3, 3, 1))

plot(s1, main = "Scenario 1")
plot(s2, main = "Scenario 2 - lock out")
plot(s3, main = "Scenario 3 - lock in")
plot(s4, main = "Scenario 4 - apply penalty")
```




```r
# Reset plotting layout to default (optional)
par(mfrow = c(1, 1))
```

Calculate metrics

```r
#Scenario 1
rpz_target_spp_s1 <- eval_target_coverage_summary(p, s1)
mean(rpz_target_spp_s1$relative_held)
```

```
[1] 0.3863076
```

```r
mean(rpz_target_spp_s1$relative_shortfall)
```

```
[1] 0.6136924
```

```r
#Scenario 2
rpz_target_spp_s2 <- eval_target_coverage_summary(p, s2)
mean(rpz_target_spp_s2$relative_held)
```

```
[1] 0.3801815
```

```r
mean(rpz_target_spp_s2$relative_shortfall)
```

```
[1] 0.6198185
```

```r
#Scenario 3
rpz_target_spp_s3 <- eval_target_coverage_summary(p, s3)
mean(rpz_target_spp_s3$relative_held)
```

```
[1] 0.3350504
```

```r
mean(rpz_target_spp_s3$relative_shortfall)
```

```
[1] 0.6649496
```

```r
#Scenario 4
rpz_target_spp_s4 <- eval_target_coverage_summary(p, s4)
mean(rpz_target_spp_s4$relative_held)
```

```
[1] 0.06277898
```

```r
mean(rpz_target_spp_s4$relative_shortfall)
```

```
[1] 0.937221
```