Marine Spatial Planning: Marxan MaPP: Spatial planning for Micronesian coral reefs

Dr Maria Beger m.beger@leeds.ac.uk

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Welcome! You are about to embark on an exciting journey; by the end of this tutorial you will be able to run your own Marxan analyses, an important step towards protecting the planet more efficiently and cost-effectively.

You take on the **role of a spatial planning and conservation officer** conducting an analysis for the Micronesia Challenge. The Micronesia challenge was issued initially by Palau, and agreed upon by the other Micronesian governments. They pledge to protect 30% of their nearshore marine environment, and 20% of their terrestrial habitats.

You have been tasked with designing a marine protected area network across the three nations of Palau, the Federated States of Micronesia (FSM), and the Republic of the Marshall Islands (RMI) that includes at least 30% of each feature (in our case species or ecosystem), for the least amount of cost, and **assess the conservation benefit as the potential improvement of fish biomass**.

There are different data sets available to represent coral reef biodiversity, and you are also tasked with assessing whether they are both suitable.

Cost represents the current fishing pressure. In other words, the cost represents the value of the local fisheries that will be displaced if we protect an area from fishing.

Some fisheries stakeholders have picked out two fish species and mangroves, features that they believe will be sufficient as surrogates to represent all of reef biodiversity. Whether these surrogate species will create a similar conservation benefit will need testing.

Targets for features

In systematic conservation planning, the number of species contained in any protected area network alone should not determine its effectiveness. More important is how any one area complements the existing protected area network, for example how "representative" the protected area network is of all species. Marxan can be used to capture a **target** amount of each biodiversity feature to ensure representativeness.

To convince the stakeholders and governments of the three nations, you are required to present different solutions that are good solutions for different possible scenarios.
Let's work out the approach and do it!

Beach overlooking the Pacific Ocean, Rongelap Atoll, Republic of the Marshall Islands

WHERE IS MICRONESIA

Not everyone knows where Micronesia is, so if that's you, check out Google Maps so that you can follow the geographical parts of the instructions below. Here is a map, just in case.

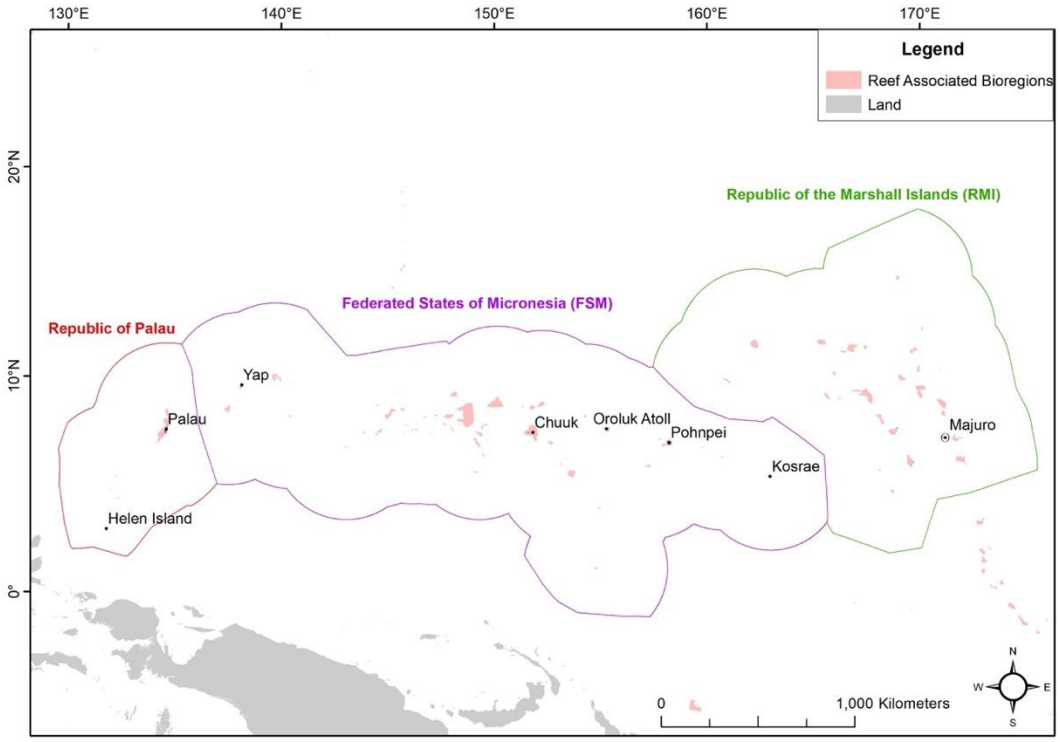


Figure. Map of Micronesia, showing key geographic locations.

ADDITIONAL RESOURCES FOR CONSERVATION PLANNING

To find out more about Marxan visit: https://marxansolutions.org/

What is Marxan? https://marxansolutions.org/what-is-marxan/

What is Conservation Planning? https://marxansolutions.org/whatisconservationplanning/

Resources on systematic conservation planning:
https://marxansolutions.org/learn/
https://onlinelibrary.wiley.com/doi/10.1111/brv.12008

A. GETTING STARTED

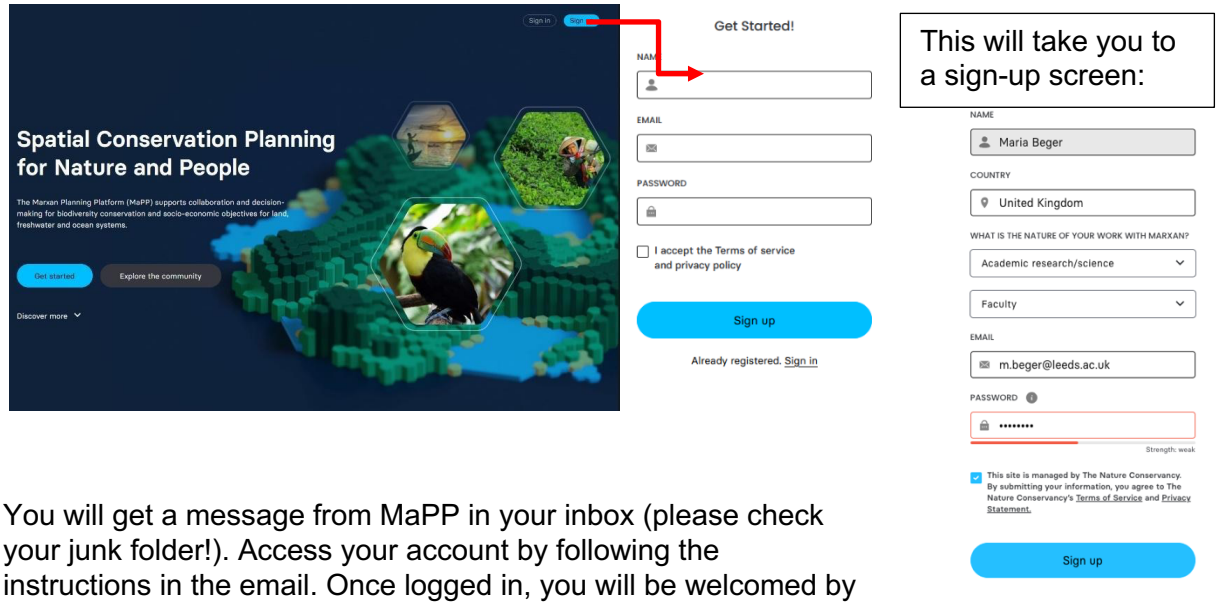
1 Make sure that you have the files you need:

- This guide
- Word template with questions to guide you through the prac

2 Marxan Planning Platform MaPP – getting in

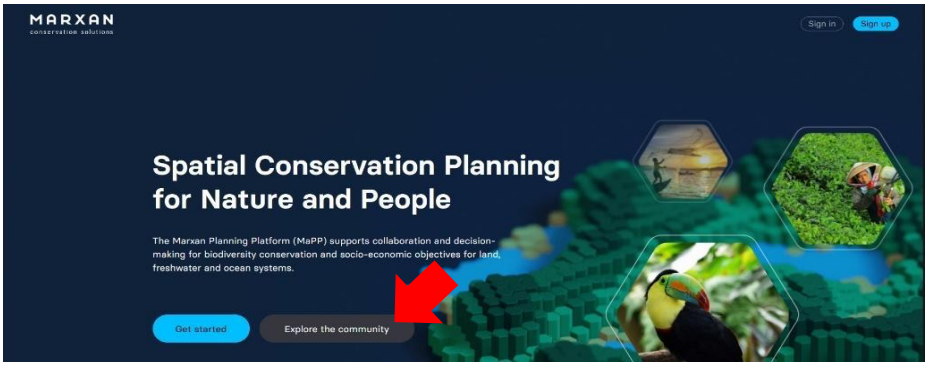
Go to marxanplanning.org

Register to use the Marxan Planning Platform (MaPP), and create an account.



You will get a message from MaPP in your inbox (please check your junk folder!). Access your account by following the instructions in the email. Once logged in, you will be welcomed by your username in your personal dashboard.

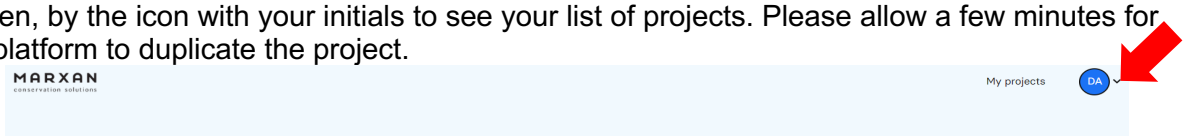
3 Select the project for this practical



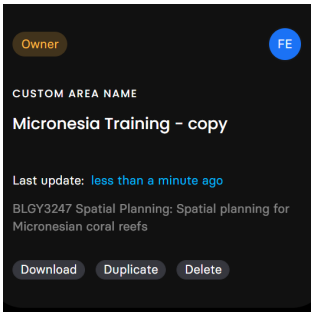
In Marxan MaPP you may upload your own data securely to create your planning projects and develop scenarios. Here, we are going to use an existing project that has been publicly shared in the community page of MaPP. This project already has preloaded planning units, conservation features, and parameters defined. Click on the *Explore the community* in the landing page of MaPP. In the Community page you will be able to see all MaPP projects that have been published as "Public".

Find the project called *"Micronesia Training"* and click on *Duplicate*.

The project will be copied into your dashboard. Click on *My Projects* on the top right side of the screen, by the icon with your initials to see your list of projects. Please allow a few minutes for the platform to duplicate the project.



You will see the newly duplicated project “Micronesia Training - copy” in your workspace, name it “*Micronesia Training – YOUR NAME*”.



This is the file you will be working with for this practical.

B. EXPLORE YOUR SPATIAL PLANNING PROBLEM, and DATA IN MICRONESIA

Begin with familiarising yourself with the spatial planning "problem", *i.e.*, how your objective function will be defined with features and their targets, the costs, and the benefits. You will need to consider conservation targets too – how much of each feature do you want to protect?

Here are **maps** depicting the main inputs into this Marxan MaPP analysis, including **features, costs, and benefits**. The data are sourced from:

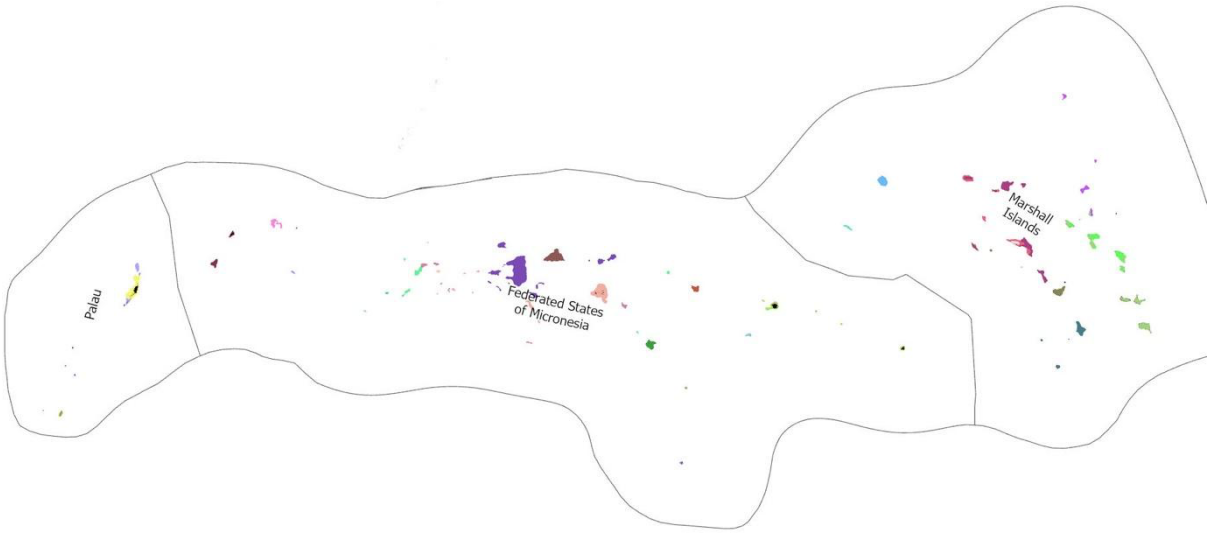
Harborne, A.R., Green, A.L., Peterson, N.A., Beger, M., Golbuu, Y., Houk, P., Spalding, M.D., Taylor, B.M., Terk, E., Treml, E.A., Victor, S., Vigliola, L., Williams, I.D., Wolff, N.H., zu Ermgassen, P., Mumby, P.J., 2018. Modelling and mapping regional-scale patterns of fishing impact and fish stocks to support coral-reef management in Micronesia. *Diversity and Distributions* 24, 1729–1743.

Mapping ocean wealth, The Nature Conservancy: https://oceanwealth.org/project-areas/micronesia/

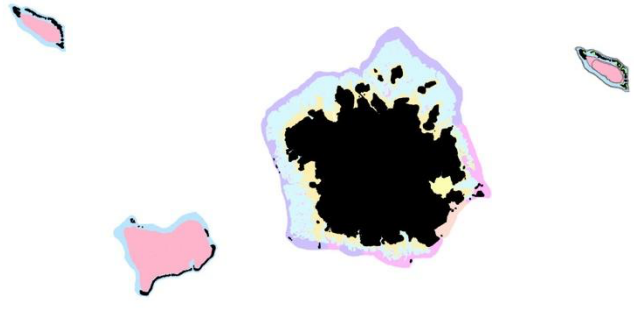
Beger, M., et al. 2020. National-scale marine bioregions for the Southwest Pacific. *Marine Pollution Bulletin* 150.

FEATURES:

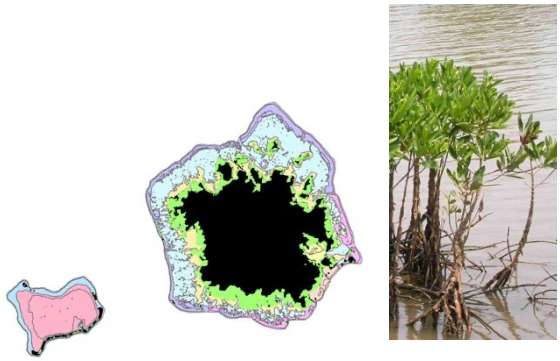
Bioregions (Beger et al 2020).



Reef morphological classes (habitat)
(shown for Pohnepei, a state in FSM)

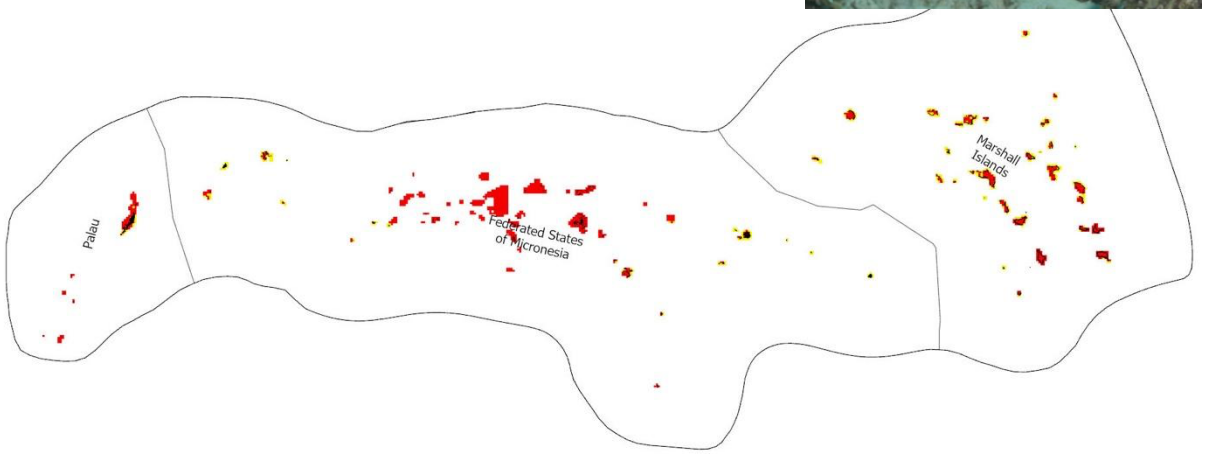


Mangroves (green, on land)

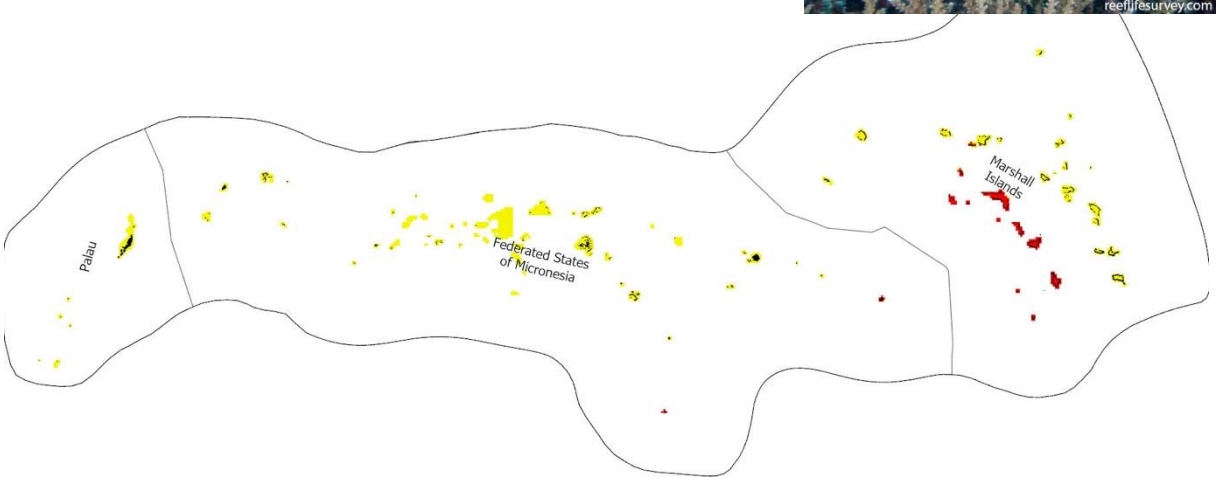


SPECIES FEATURES:

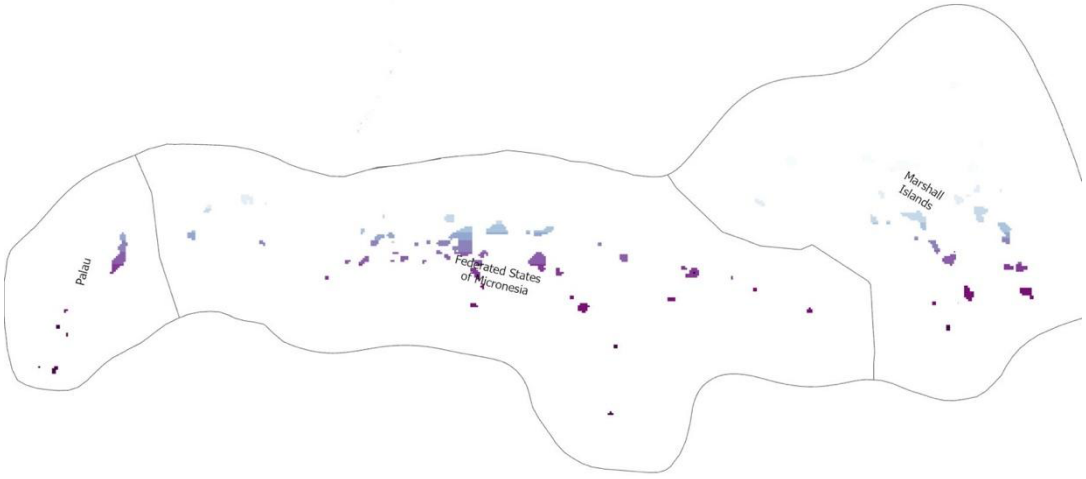
***Plectropomus laevis* (a fish)**
Occurrence map (yellow: not present, red: present)



***Epinephelus ongus* (a fish)**
Occurrence map (yellow: not present, red: present)



COST
Current fishing pressure (*i.e.*, opportunity cost)
Light blue: low fishing pressure, dark purple: high fishing pressure, with everything in between.



C. MICRONESIA CASE STUDY DATA AND PROBLEM FORMULATION

Now that we know the data, let's think about the steps and scenarios we need to run to meet the outputs requested by the boss at the Micronesia Challenge (details described above).

First, we will need to assess whether there are any current protected areas that already contribute towards the final marine protected area system to see if we actually need to protect additional areas (*i.e.*, how far away from meeting our 30% targets for all features), and if our targets are not being met, we will identify new areas to protect in Micronesia to meet our conservation objective.

Second, we will check which data set is a potentially a better representation of reef biodiversity across Micronesia. While it is important to focus on the data here, let's consider which processes and aspects of the reef community they represent. This will enable us to work out how the data can best be used to include biodiversity-relevant processes into our conservation objectives.

- The bioregions dataset was produced from the species distributions of over a thousand coral reef species: fishes, corals, and other macroinvertebrates. They are quite specific to each part of the region, as they are delineated according to biogeographical species turnover within the communities.
- The habitat dataset contains morphological habitat classes that were derived from satellite imagery that can classify different structures on the reef. Species associate with these structures, the same as species would associate on land with rocky outcrops, meadows, and valleys (for example). Similar morphologies exist on reefs across the world, though there are some broadscale variations.

Third, we will assess the suitability of six species/ habitat types to be used as surrogates (*e.g.*, Olds *et al.* 2014 for conceptual background). Here, we mean species for which we have good data (*e.g.*, because they are easier to fund monitoring programmes for) whose distributional patterns mirror those of many other species, rendering them useful surrogates for all species.

Olds, A.D., *et al.* 2014. Incorporating surrogate species and seascape connectivity to improve marine conservation outcomes. *Conservation Biology* 28, 982-991.

Hint! If you cannot answer a question about Micronesia, you can look in the papers. But why not GOOGLE it?

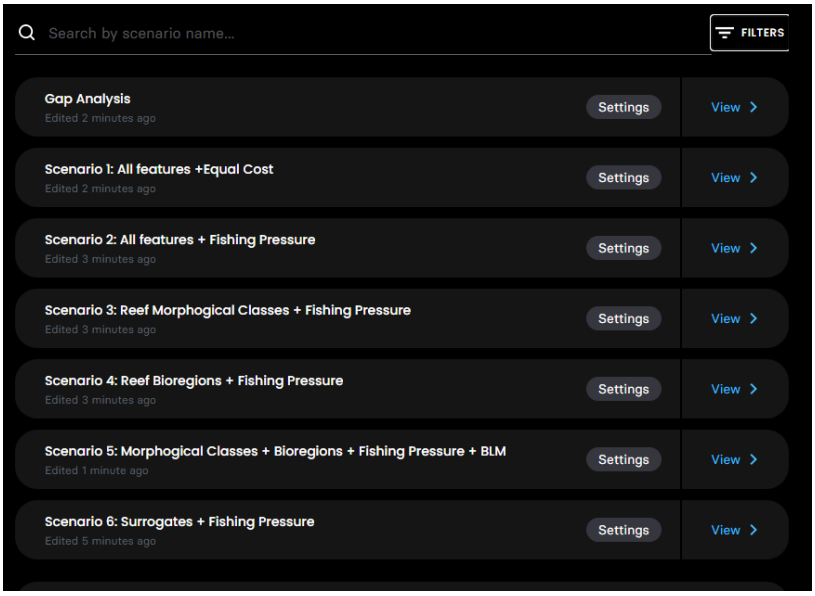
GUIDANCE QUESTIONS!

MARXAN conservation solutions

D. STRUCTURE OF THE PROJECT: TASKS AND SCENARIOS

The project contains one gap analysis (work out how much of your objective is already met for each feature) and six scenarios. If scenarios are in a weird order, click on *filters* and order them by name. These scenarios have been preloaded so that you can work more easily, but you could also build your own scenarios.

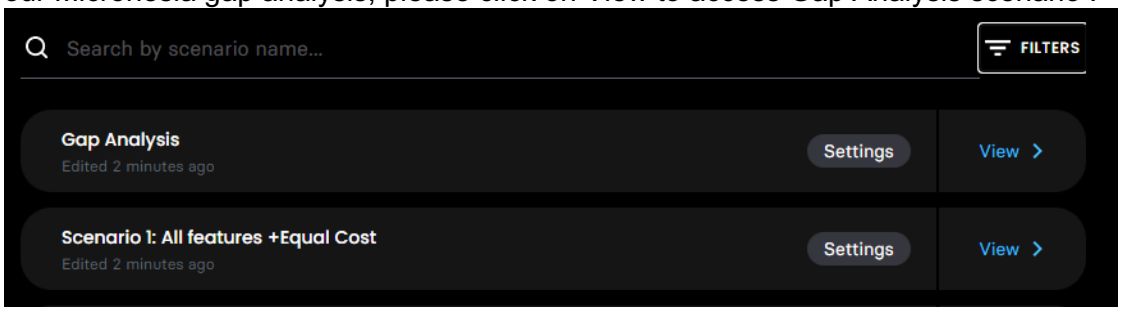
We will work through these scenarios step by step later on.



E. GAP ANALYSIS FOR MICRONESIA: EXISTING MPAS

First, we want to consider any protected areas that are already protected as contributing to meeting our targets. There are different categories of protection (which represents what uses are allowed to occur in them https://www.iucn.org/theme/protected-areas/about/protected-area-categories).

For your Micronesia gap analysis, please click on View to access Gap Analysis scenario .



When you access a scenario you will find a screen with a map on the right and a panel with 4 tabs on the left: (1) Planning Unit, (2) Features, (3) Parameters, and (4) Solutions. These are the 4 main steps in the MaPP workflow, and you will follow them every time you create or work with a scenario.

Let's "lock in" the planning units that fall within protected areas. In the *Planning Units* tab, check the status of the planning units – status can be locked in (planning units are always part of a conservation solution, *i.e.*, they are existing MPAs), locked out (planning units will never be part

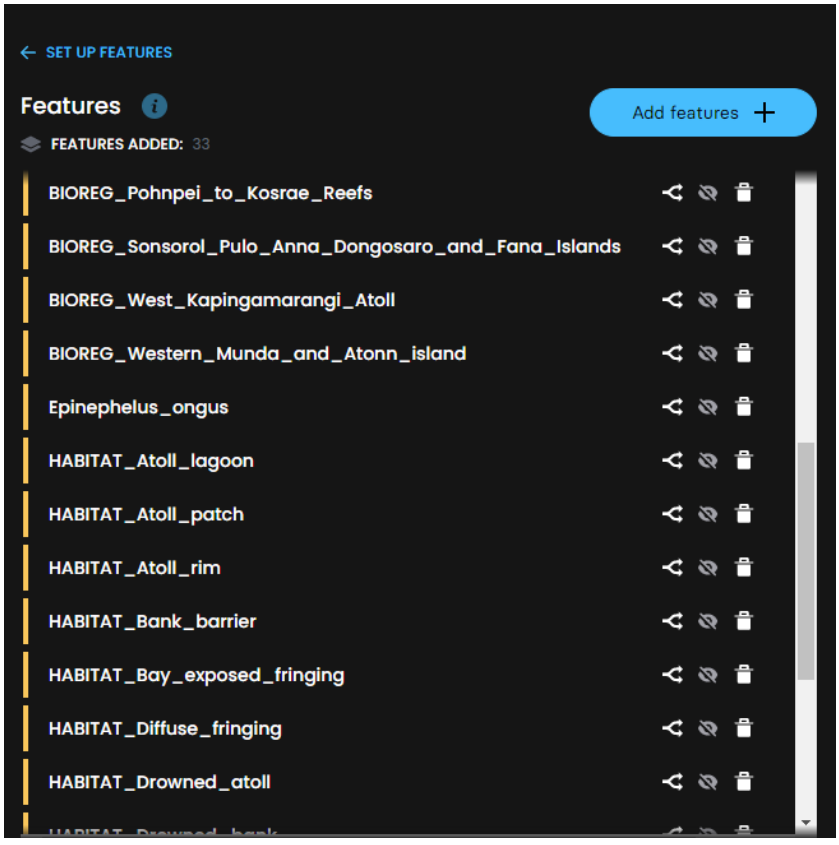
of a solution, *e.g.*, a port or stationary fishing device that cannot be protected), or available (planning units can be picked or not for a conservation solution.

Click on *Protected Areas* and select *IUCN Ia*, *IUCN Ib* and *IUCN II* (the various IUCN protection levels are listed here, see link above for their definitions). Have a look where the current MPAs are by zooming in and moving around, or reducing the opacity/ visibility of the planning unit grid.

To work out how much of our features are already protected, go to the *Features* tab. We will first click on "*Set up features*". Here you will be able to add, visualise, and explore your conservation features. In this case, we have already preloaded the features for you. You will be able to see the feature distribution selecting the "show on map" icon. The distribution will be highlighted in the map of the right panel of your screen. You may also use the map to zoom in and zoom out. You can remove or add features to the scenario but in this case, we will leave it as it is.

Gap Analysis

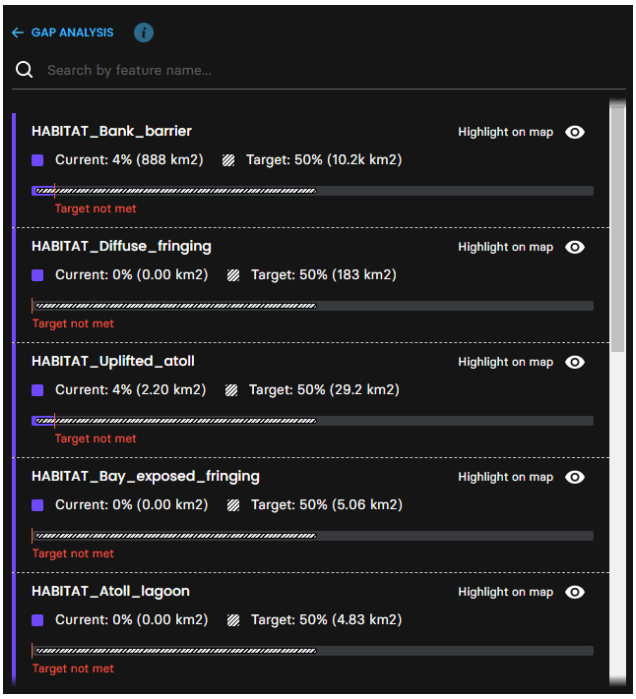
A gap analysis calculates how much of each feature is protected within the existing protected area network and then summarises the representation as a score. To find out more about the Gap Analysis, see Rodrigues et al. 2004. https://doi.org/10.1641/0006-3568(2004)054[1092:GGAPRF]2.0.CO;2



Click on ***Continue*** to set the representation targets.

You may change all the feature targets at once by using the top bar or modify targets individually. You may do this by clicking on the % number and typing the desired target or by moving the slider bar. We know that we want to protect 30% under the Micronesia Challenge, so let's set the Feature Targets to 30%. The Species Penalty Factor (SPF) is a parameter that indicates the importance of a species, we leave this as the default of 1. Then, click *Save*. The platform automatically processes these features and conducts a gap analysis considering the existing protected areas (*i.e.*, what you just locked in). This might take a few minutes.

Next, click on the "*Gap Analysis*". Under each feature, you can now see a bar, it is coloured in (purple) to show the percentage of the conservation feature already under protection. You can find the proportion (and area in km^2) of each feature distribution that is already under protection flagged as "*Current*" (the purple bar). The striped bar indicates the target area for each feature, and here you can evaluate how far away from the chosen target the protection provided by IUCN I+II protected areas are.



Now, if you want to assess the targets already met for MPAs with other IUCN status (*i.e.*, less stringently protected areas), you could go back to setting the existing MPA status and go through the process again. You will see that there is shark conservation area covering the whole of Palau (it is not IUCNI+II as it does not protect other species, it is a country-wide shark fishing ban), and others in the RMI (World Heritage area northern atolls of Bikini and Ailinginae).

GUIDANCE QUESTIONS!

KEEP/ GO BACK TO THE SETTING for IUCN I+II areas for the rest of this practical.

National Gap Analysis

To find out more about Gap Analyses, see Jantke et al. 2019.
https://doi.org/10.1111/ddi.12853

F. WORKING WITH MARXAN MAPP: MAIN OUTPUTS

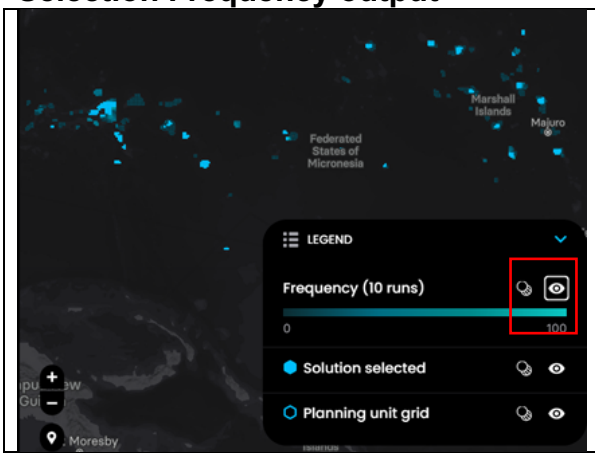
MaPP determines good solutions based on minimising the objective function score with an algorithm called simulated annealing. If we run Marxan multiple times, we will get multiple, slightly different, solutions. MaPP for you is **preset to 10 repeat runs**, so you can pick the best of ten solutions by looking at the score. Normally, we would run Marxan with 100 runs, but **please do not change this setting** so that the server can cope with all of us.

Marxan produces two kinds of map outputs:

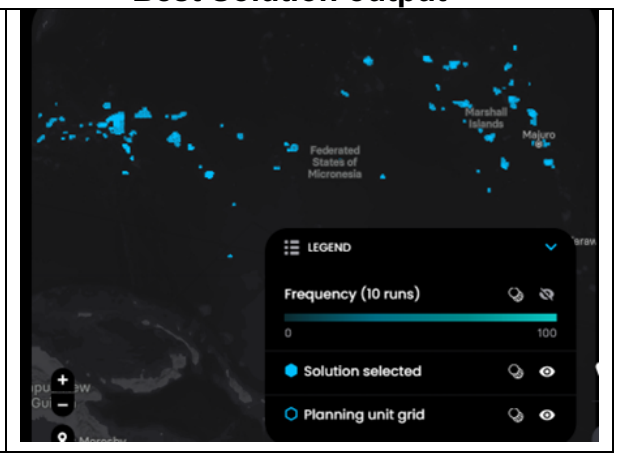
1. **Selection Frequency Map** - This map shows the number of times a planning unit was selected to be in the final solution, across all runs—this is the default output when you run MaPP, shown on MapView. This output shows you the relative value of the planning units needed to meet the objectives. For example, if you set the number of runs to 10, the maximum value in the selection frequency will be 10. If, after running Marxan, a planning unit has been selected in 8 solutions, its selection frequency will be 8. The default for this example should have a max SF = 10, as we ran Marxan 10 times by default. This map shows you the relative value of the planning units needed to meet the objectives–if a planning unit is selected in almost every run, it is important.

2. The **"Best Solution"** is the lowest scoring run and is often the preferred or baseline output of any single solution. The platform shows the best solution by default in the map but you can toggle all solutions from the dropdown menu. By default, at the end of a MaPP analysis, the summary of solutions is shown in the map and the Best Solution row is selected in the table. The table also shows each one of the individual solutions with information on the overall score, cost, number of planning units and the number, if any, of targets that have been missed for each run. To show an individual solution on the map, click on the relevant solution in the table, and click on the eye next to Frequency (10 runs) to switch off the SF map. The table data can be sorted (like all tables in MaPP) by clicking on the column header to sort in ascending or descending order. This allows you to rank the solutions in order of score.

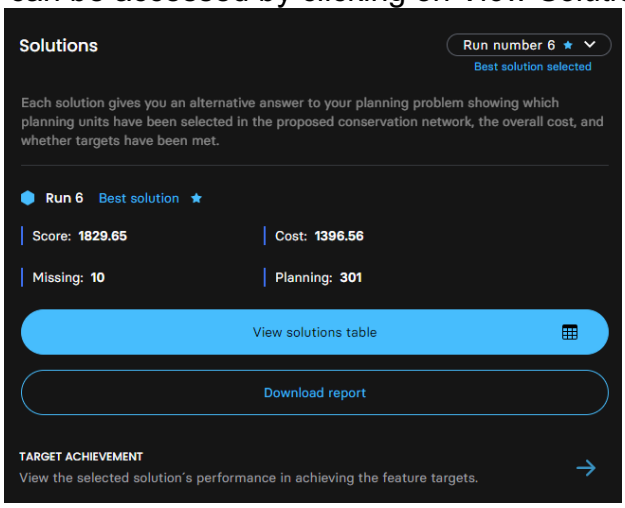
Selection Frequency output



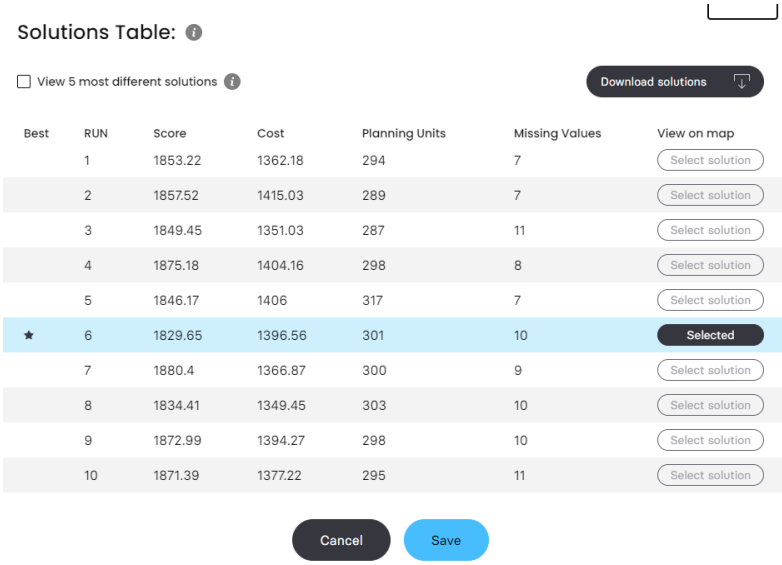
Best Solution output



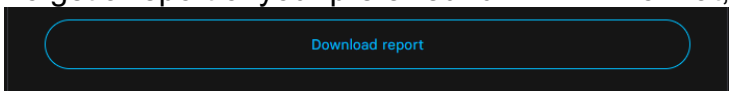
In the left panel you can see some of the key values after running the analysis such as the overall score (the mathematical answer to Marxan's objective function), cost (the summed cost of all selected planning units), number of planning units and the number, if any, of targets that have been missed for each run. The summary of solutions as well as all Marxan output files can be accessed by clicking on *View Solutions Table.*



If you would like to download all Marxan output files, click on *Download solutions.*



To get a report of your preferred run in PDF format, *Click on Download report.*



You can check to see if any of the targets have not been met by simply looking at the *Missing value* in the SOLUTIONS tab. Go back to the ***Solutions Table*** and select a Run number that has not met more than one target. To know which features have not met the target go back to the Solutions tab and click on *Target Achievement***.**

You will see the list of features on the left panel and the map on the right. On the left panel each species has a *Current* (the amount captured in this solution) and *Target* (the

target amount for that feature). If *Current* is lower than the *Target*, then the target has not been met. Click on *Highlight on map* to visualise the features.

CONSERVATION BENEFIT

How good a solution is can be assessed in various ways. Classic ways to assess and compare solutions are: . eyeballing them
. comparing the number of planning units in each solution
. comparing the cost of each solution

Here, we use the potentially achievable increase of fish biomass when protected as the conservation benefit. This means some areas will rarely be providing much of an increase in fish biomass, because they are perhaps already largely unfished (with near pristine biomass) or the environmental conditions do not support as high a biomass than other places.

As this is a new way of assessing conservation benefit, I have introduced a workaround on the Marxan platform, by having an excel sheet with the benefit value per planning unit. After each run, you can export the results on **Solutions → View Solutions table → Download solutions**. It´ll generate a zip file, and you should look for the file named "`output_best.csv`".

This csv file contains the planning unit identification number (puid) and if the planning unit was included into the best solution (1) or not (0). Open the file in Excel, split the text into two columns  , select both columns and perform an ascending sort  .

	A	B
1	PUID,SOLUTION	
2	26,0	
3	912,0	
4	1183,0	
5	236,0	

	A	B
1	PUID	SOLUTION
2	1	0
3	2	0
4	3	0
5	4	0
6	5	0
7	6	1
8	7	0

Copy the SOLUTION column and paste in the corresponding scenario column in the `Benefits.xlsx` file. **Watch out for the order of the planning units ID**! The benefit for the scenario will be calculated in the column M.

	A	B	C	D
1	puid	Benefit	Scenario 1	Scenario 2
2	1	60.62697622	0	
3	2	14.02472859	0	
4	3	2	0	
5	4	57.69585787	0	
6	5	36.39007091	0	
7	6	37.2521715	1	

	L	M
1	Scenario	Benefit
2	Scenario 1	33510.74133
3	Scenario 2	0
4	Scenario 3	0
5	Scenario 4	0
6	Scenario 5	0
7	Scenario 6	0

F. SCENARIOS TO ASSESS CONSERVATION PRIORITIES FOR TWO DIFFERENT BIODIVERSITY SURROGATES (REEF MORPHOLOGICAL CLASSES and BIOREGIONS)

Now we are ready to run Marxan scenarios that help us work out where conservation priority sites are that allow us to meet our representation targets.

BEFORE you start: Check out the Discussion and Implications section of your guidance questions, note which information is needed later on to compare scenarios.

SCENARIO 1: Best option planning: Use all available information

Go to *Scenario 1: All Features + Equal* cost in the main project and click on *View.*

We can assume that we have all the information available for spatial planning. So let's set targets for all conservation features to investigate where conservation priority sites are located. Let's begin with 5% and go up to the 30% targeted by the Micronesia Challenge. For this scenario, we will use the default planning unit area as our cost surface under the assumption that the less area we need to acquire or manage to meet our targets, the more cost-efficient the plan will be. The MaPP platform uses "equal area" as a default cost, but you can define costs from this panel and we will look at how cost influences the outcomes in the next scenario.

Under FEATURES, set new targets for all features. Click on *Set up features* → *Continue* → *Target and SPF* and enter the new targets. Click *Continue* to go to *Parameters*. For now, we are not going to change any default settings. Hit *Run Scenario*!

Look at targets of 5%, 15%, and 30% and run Marxan. Ideally, we would want to run more percentages, but in the interest of not overloading the server we will keep it to three. Report how the changing targets affect the following with Excel plots:

- Conservation Benefit
- Cost
- Number of planning units selected.

The Conservation Benefit can be computed by merging the best solution to the `MaPP_Benefits_Micronesia_Imperial_Jan2024` file, as explained in the CONSERVATION BENEFIT box above.

To get map plots, check the Appendix at the end of this document for tips on saving maps!!

GUIDANCE QUESTIONS!

SCENARIO 2: Cost

Go to *Scenario 2: All Features + Fishing Pressure* in the main project and click on *View.*

So far you have been using "*equal area*" as a default cost, but now we want to look at the implications of using different "*costs*". Use the 30% target for all conservation features from the previous analysis. We need to now work out how to best represent the cost. On one hand, it would be good to know how solutions pan out when only biological criteria are used to inform the conservation priorities (Scenario 1). On the other, displaced fishing pressure presents an actual cost to fisheries and governance. To evaluate whether/ how conservation priorities and the conservation benefit achieved differ between these two cases, run these scenarios:

- Equal area as cost (each planning unit has a cost of 1, Scenario 1)
- Fishing pressure as cost (each planning unit has a cost that reflects fishing pressure, some lower, some higher than 1)

You will find that the all Marxan solutions have a high number of conservation features that miss their target. This means that the fishing pressure cost overrules the importance of species, so we need to increase the importance of species. Go back to the *Conservation Feature* tab, and set the SPF (Species Penalty Factor, the importance/ weight of species in the objective function) to 10. Then rerun Marxan, and check whether now all conservation features meet their target. Check that all targets are met for all scenarios!

To view the cost surface, you can go to the *Planning Unit panel* → *Cost surface*. The cost surface is already preloaded.

Run the scenario, export the results, follow the procedure described on the CONSERVATION BENEFITS box above, and take a note of the Conservation Benefit achieved by this Scenario!

GUIDANCE QUESTIONS!

SCENARIO 3: Reef morphological classes

Go to *Scenario 3: Reef Morphological Classes + Fishing Pressure* in the main project and click on *View.*

Now, we want to explore the effect of using different higher level ecological categories (community type representations) as surrogates for reef biodiversity.

Here, we will run a scenario only for the habitats, *i.e.*, the reef morphological classes. Under FEATURES, go to *Set up features* → *Continue* → *Target and SPF* to set new targets for all features starting with Habitat_. You may do this by clicking on the % number and typing the desired target or by moving the slider bar. Set/ leave the targets for Habitat_ classes at 30% and use fishing pressure as cost. Check that all targets are met for all scenarios!

Make sure you take a snapshot of the maps for Selection Frequency and the Best Solution. To get these maps, in the SOLUTIONS tab, the Selection Frequency map will be displayed on the MapView. Change the visibility using the button to switch to the solution selected.

Export the results, follow the procedure described on the CONSERVATION BENEFITS box above, and take a note of the Conservation Benefit achieved by this Scenario!

GUIDANCE QUESTIONS!

SCENARIO 4: Reef bioregions

Go to *Scenario 4: Reef Bioregions + Fishing Pressure* in the main project and click on *View.*

Now, we will run a scenario only for the bioregions. Under FEATURES, set new targets for all features starting with BIOREG_ to 30%and use fishing pressure as cost.

Export the results, follow the procedure described on the CONSERVATION BENEFITS box above, and take a note of the Conservation Benefit achieved by this Scenario!

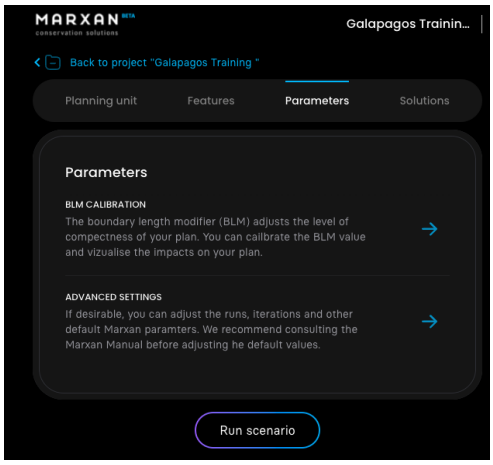
GUIDANCE QUESTIONS!

SCENARIO 5: Adjacency of protected areas

Go to *Scenario 5: Morphological Classes + Bioregions + Fishing Pressure + BLM* in the main project and click on *View.*

In spatial planning, we sometimes want to ensure that protected areas are not scattered across a land/ seascape, as there are benefits to large protected areas. In Marxan we use the Boundary Length Modifier (BLM) to increase the adjacency or spatial connectedness of a protected area system. The BLM helps the user decide how "clumped" the network should be.

Here, you will work with Bioregions and Morphological Classes, but no species and mangroves. Click on *BLM calibration*.

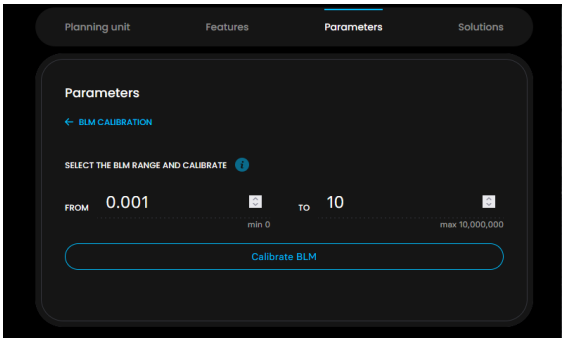


You will see that by default the BLM values 0.001 to 10 are selected. Please leave as it is and click on "*Calibrate BLM*" to run the calibration.

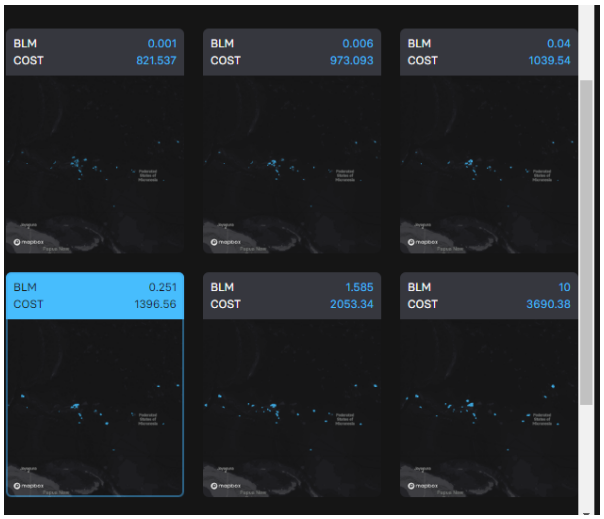
CLUMPING, CONNECTIVITY, & ADJACENCY OF PA's

The classical view in spatial planning is that we want to minimise fragmentation of protected areas and aggregate solutions into patches via "clumping". Such a view is particularly relevant in terrestrial ecosystems where habitat fragmentation can be a threat to biodiversity (see Fahrig *et al*. 2003). Also, it is not feasible to enforce a network of fragmented protected areas (as often are selected when we run Marxan without spatial adjacency constraints). More recently, attention has been given to situations where large clumped protected areas are socially inequitable or ineffective because their burden on local communities leads to non-compliance. Equitability in conservation is very important (spread both benefits and burdens to many communities and stakeholders). In coral reef environments, it can be particularly important to not clump Marxan solutions. Spreading out smaller protected areas means that each community can still sustainably fish locally and also have a protected area. Read Jumin *et al*. 2017 to see the example of Tun Mustafa Marine Park, where spatial planners were taught to clump solutions, but these were then completely rejected in the community consultation phase. The result is a park that misses many targets. Remember that everything you learn needs to be questioned for the local context, to ensure spatial conservation is implemented well.

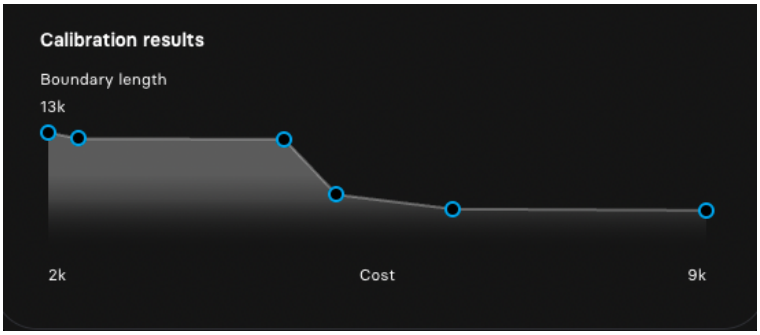
Fahrig, L. 2003. Effects of habitat fragmentation on biodiversity. Annual Review of Ecology, Evolution, and Systematics **34**:487-515.
Jumin, R., A. Binson, J. A. McGowan, S. Magupin, M. Beger, C. J. Brown, H. P. Possingham, and C. J. Klein. 2017. From Marxan to Management: Ocean Zoning with stakeholders for Tun Mustapha Park in Sabah, Malaysia. Oryx **52**:1-12.



This analysis might take several minutes. The platform is calculating all of the pairwise boundaries shared between planning units. Once complete, you will see a panel with the visual result of the clumping. It might take some time to load the following images.

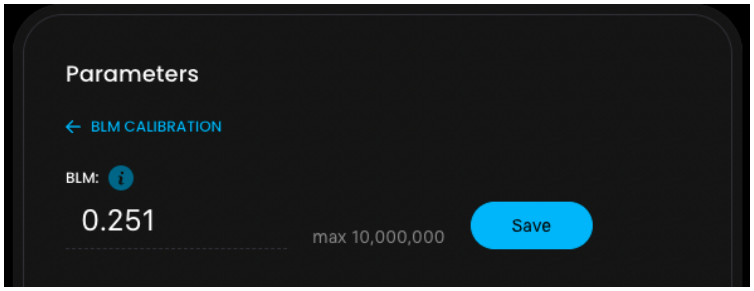


At the bottom of the page, you will also see the relationship between the BLM value and the cost. This helps you understand the BLM value that will give you impact without just adding more cost to the solutions. We typically use the “elbow” of the curve to help us identify a good BLM. You can always reset the values of this calibration to a wider or smaller range for iterative calibration.



Note: Your calibration results may look different than this curve

Which BLM value do you think we should use? It is subjective and depends on the decision maker, choose a value that looks appropriate and click save. Try to go for a value where cost is relatively low but boundary length is just getting down (in the “knee”).



Hit RUN SCENARIO!

Export the results, follow the procedure described on the CONSERVATION BENEFITS red box above, and take a note of the Conservation Benefit achieved by this Scenario!

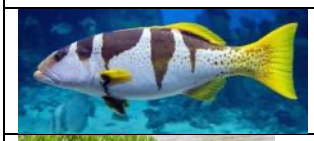
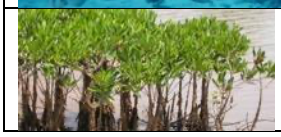
GUIDANCE QUESTIONS!

G. SCENARIO TO EVALUATE THE USE OF SURROGATE TAXA OR SPECIES

SCENARIO 6: Important fish species and mangroves: surrogate features

Go to *Scenario 6: Surrogates + Fishing Pressure* in the main project and click on *View.*

Fisheries stakeholders have picked out two (2) fish species that they believe will be sufficient as surrogates to represent all of reef biodiversity. In addition, mangroves are important ecosystems that may be good surrogates for biodiversity, they say. Here, we will test whether these surrogate features will create a similar conservation benefit compared to using habitats plus bioregions. The three species are these:

	*Epinephelus ongus*, a highly prized market fish.
	*Plectropomus laevis*, a recreational and competitive fisheries species, also prized as a market fish.
	*Mangroves,* important as nursery areas and habitat for mangrove dwellers.

Run four scenarios, one for each species, one for mangroves, and one for all of the three features together, with each feature set to a 30% target. Continue to use fishing pressure as the cost data set. Assess to what degree these fish species can serve as surrogate species for overall biodiversity, assumed to be represented when planning with both bioregions and habitat features.

Export the results, follow the procedure described on the CONSERVATION BENEFITS box above, and take a note of the Conservation Benefit achieved by this Scenario!

GUIDANCE QUESTIONS!

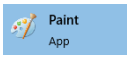
CONGRATULATIONS!!! You have now completed your first Marxan Planning Platform practical!

I. APPENDIX HOW TO EXPORT MAPS FROM MaPP

MaPP does not yet have an inbuilt functionality to export map outputs (*e.g.*, as .jpeg, .png, .pdf), with visualisation being done in real-time through the internet browser.

However, we can easily take screenshots of the browser and save these. This makes visual comparison between different scenarios easier as we don't have to re-run scenarios.

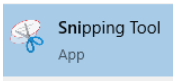
<u>Method 1. Take a screenshot of your entire screen and crop to the desired area</u>

1. Hit the 'PrtScr' button on your keyboard, it might be a combination of 'Windows Key' + 'PrtScr' or 'Fn' + 'PrtScr' or something similar depending on your device ('Shift' + 'Command' + '3' on a Mac)
2. Open MS Paint 

or a similar graphics editor.
3. Paste with 'Ctrl + v' ('Command' + 'v')
4. Choose desired area with the 

tool and paste into your working document.

<u>Method 2. Use a tool like Snipping Tool to capture only the desired area</u>

1. Open the Start Menu and type in 'Snipping Tool' to access 

('Shift' + 'Command' + '5' on a Mac)
2. Hit 

and select the area you want to export.
3. File -> Save as to save the image, or paste into Paint or Word directly.

<u>Method 3. Use a tool like Grab on a Mac</u>

1. In Applications, find the Grab tool in Utilities. Under Capture, chose <Selection> and drag across the bit of the screen you want to capture 
2. Command+C to copy the resulting bitmap, and paste it where you want it.

<u>Example map</u>:
In this example the legend is visible on the right, the Features panel is hidden for easier viewing of the map, the scale is included in the bottom right.

The map extent will vary, depending on which part of Micronesia you want to depict.