

ETC5512: Wild Caught Data

Week 5

Let's look at the Great Barrier Reef

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The magnificent Great Barrier Reef

📊 The Australian Great Barrier Reef is one the world natural wonders and contributes \$6.4 billion to Australia's national economy as well as some 64,000 jobs.



Photo source



Photo source

Facts about the GBR

The Great Barrier Reef makes up about 10 per cent of the world's coral reef ecosystems:

- it covers 344,400 km² in area and it is the world's largest coral reef ecosystem
- it includes some 3000 coral reefs, 600 continental islands, 300 coral cays and about 150 inshore mangrove islands
- it extends south from the northern tip of Queensland in north-eastern Australia to just north of Bundaberg
- it is between 60 and 250 kilometres in width and it has an average depth of 35 metres in its inshore waters, while on outer reefs, continental slopes extend down to depths of more than 2000 metres

Source

The magnificent Great Barrier Reef

Visit the Great Barrier Reef



Great Barrier Reef Marine Park Authority

- The authority has been managing the GBR since 1975
- It is in charge of the Marine Park policy and decision making
- Also about the planning and regulation that protects key values and enable ecologically sustainable use for a changing Reef.

Threats

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- The greatest threat to the Reef is climate change.
 - The other main threats are associated with coastal development, land-based run-off, and threats from direct human use of the Reef (such as illegal fishing).

Reef management: Marine Monitoring

- 📊 Coral cover trends over time
- 📊 Coral diseases
- 📊 Condition and trends of the water quality
- 📊 Health and resilience of seas grasses
- 📊 Fish abundance
- 📊 Reef condition
- 📊 Crown of Thorn Star fish
- 📊 Land-based run off
- 📊 ...



GBRMPA collaborates with industry, private companies and other government organizations. In particular, the monitoring program is being coordinated by the Great Barrier Reef Marine Park Authority and involves a range of partner organisations:

-  Australian Institute of Marine Science (AIMS)
-  Australian Government Department of Defence
-  Australian Government Department of the Environment and Energy
-  Association of Marine Park Tourism Operators
-  Many others

*Great Barrier Reef
Marine Park Authority*

For full list of partner organization please see [here](#)

Great Barrier Reef Monitoring

The Marine Monitoring Program (MMP) was established in 2005 to monitor the inshore health of the Great Barrier Reef. Part of the program is carried out the Australian Institute of Marine Science (AIMS).

The program will inform the development of the Reef 2050 Integrated Monitoring and Reporting Program.

Monitors

 Water (AIMS)

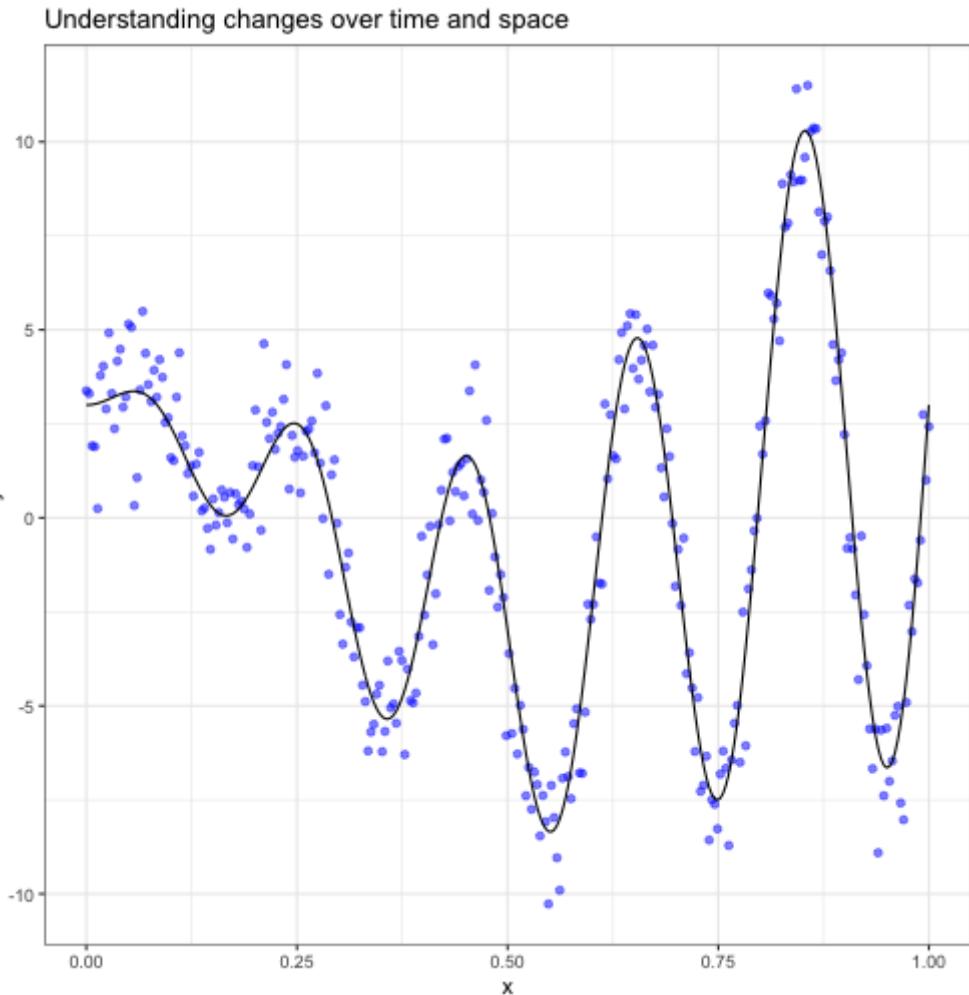
 Seagrasses

 Coral (AIMS)

GBRMPA uses the information for tactical, operational and strategic planning, as well as for, quantifying management effectiveness and reporting.

Great Barrier Reef Monitoring: MMP

The Marine Monitoring Program is a collaborative partnership. Monitoring is conducted by the Australian Institute of Marine Science, James Cook University, Howley Environmental Consulting, the University of Queensland, Queensland Parks and Wildlife Service, Reef Catchments, and community volunteers.



The Australian Institute of Marine Science

The Australian Institute of Marine Science (AIMS) is Australia's tropical marine research agency.



Provides large-scale, long-term and world-class research that helps governments, industry and the wider community to make informed decisions about the management of Australia's marine estate.

AIMS is a Commonwealth statutory authority established by the Australian Institute of Marine Science Act 1972.

AIMS

Headquaters Cape Ferguson (National Park) 50km from Townsville



Virtual tour to the Marine Sea Simulator where controlled experiments are run

Why monitoring the GBR?

Understanding how the resilience of the Reef is affected by pressures is vital for management. Monitoring the inshore health of the Reef has been routinely carried out since 2005 under this program. Annual monitoring enables us to analyse:



- Trends in water quality parameters (turbidity/water clarity, nutrients) relative to the Water Quality Guidelines for the Great Barrier Reef Marine Park
- The ecological risk of mixtures of pesticides to Reef ecosystems
- Wet-season river-derived pollutant exposure
- Coral cover, seagrass abundance and ecosystem health

The GBR Shelf positions

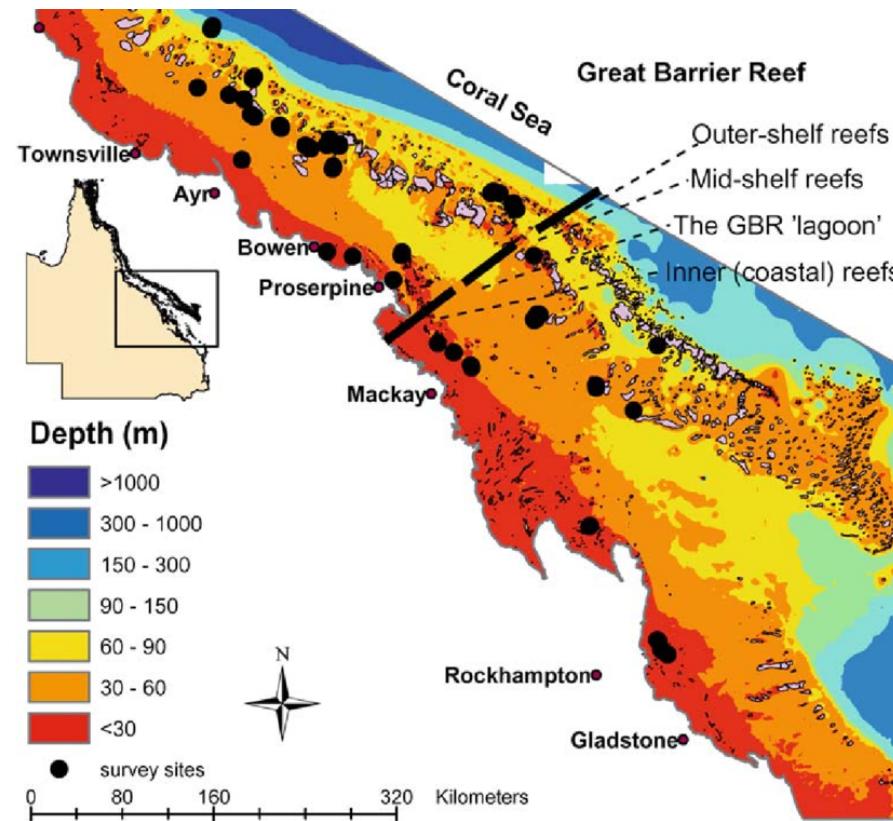


Photo Reference here

The GBR sector positions

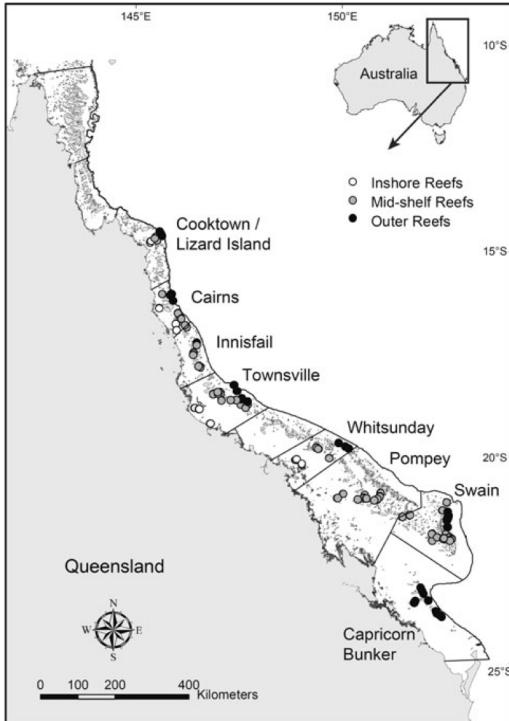


Fig. 1 Map of the Great Barrier Reef showing survey reefs (*circles*) coded by shelf position (*unfilled symbols* inshore, *shaded mid-shelf*, *filled outer*). Sectors are demarcated by *solid lines*

Photo Reference here

Focus: Monitoring programs run by AIMS

MMP (Inshore reefs)



MMP : Inshore reefs (those that can be reached from shore by a small boat) are vulnerable to more threats than those further from shore. 32 inshore reefs are monitored under the Great Barrier Reef Marine Park Authority's Marine Monitoring Program.



The Inshore Marine Monitoring Program (MMP) is designed to detect changes in reef communities adjacent to the Wet Tropics, Burdekin, Mackay, Whitsunday and Fitzroy Natural Resource Management Regions.

Focus: Monitoring programs run by AIMS

LTMP (Mid and outer shelf)

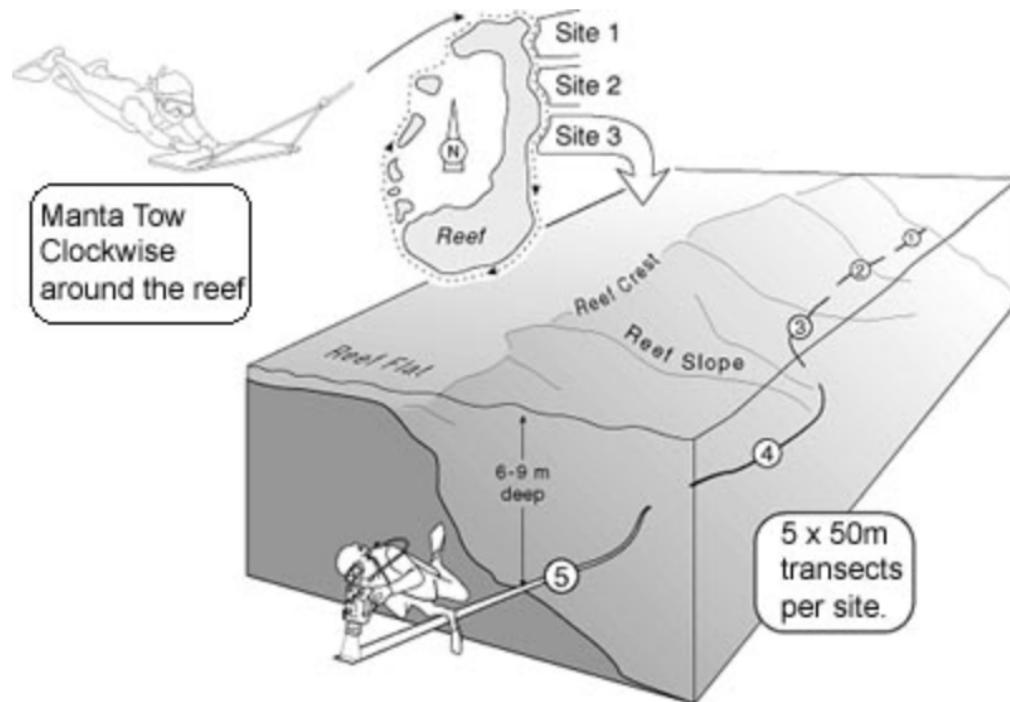


LTMP: For over 30 years, AIMS has been surveying the health of 47 midshore and offshore reefs across the Great Barrier Reef region. The Long-term Monitoring Program represents the longest continuous record of change in reef communities.



Data captures natural variability of coral and fish populations, and documents effects of disturbances such as crown-of-thorns starfish outbreaks, cyclones and bleaching events. Also it provides awareness of other threats to the Reef (such as outbreaks of coral disease) and other issues of concern to reef managers.

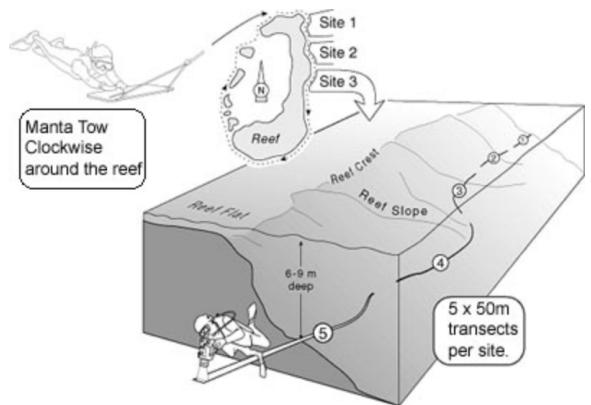
AIMS: Sampling methods on the GBR



A schematic diagram of the sampling design on a single reef.

More info on AIMS sampling techniques

Manta tows: Sampling methods on the GBR

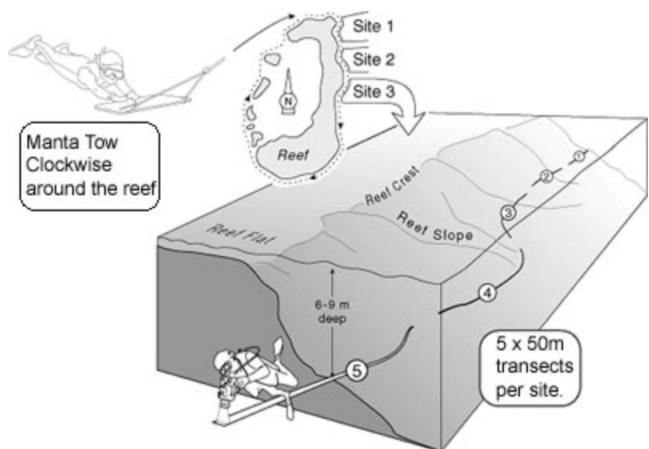


A schematic diagram of the sampling design on a single reef.



📊 The primary objective of the broadscale surveys is to detect and monitor populations of crown-of-thorns starfish. Manta tow surveys also provide estimates of percentage cover of living hard corals, living soft coral and recently dead hard coral, allowing assessment of the impact of starfish outbreaks and other large-scale disturbances.

Sites: Sampling methods on the GBR



A schematic diagram of the sampling design on a single reef.



■ Sites are at least 250 m apart where possible. Within each site, five 50 m transects are laid along the reef slope parallel to the reef crest at about 6-9 m depth.

■ Transects are marked with a star picket at each end and with lengths of reinforcing rod at 10 m intervals.

Monitoring



The AIMS Long-term Monitoring Program ([LTMP](#)) is designed to detect changes in reef communities at a subregional scale. In this context, a subregion encompasses inshore, mid-shelf and outer shelf reefs across the continental shelf within one band of latitude (a sector).



The Inshore Marine Monitoring Program ([MMP](#)) is designed to detect changes in reef communities adjacent to the Wet Tropics, Burdekin, Mackay, Whitsunday and Fitzroy Natural Resource Management Regions.

AIMS: Data eAtlas of Australia

Discover, learn, investigate and download environmental research and reference data for the Great Barrier Reef, its catchments, the Wet Tropics and the Torres Strait regions. The eAtlas is a website and mapping system for presenting environmental research data in an accessible form that promotes greater use of this information.



<https://eatlas.org.au>

Obtaining data I

📊 eatlas: LTMP and MMP data

📊 Metadata : Contains descriptions of data which allows users, including researchers, to identify potential data of use to them. Data can then be downloaded (if available) or requested. Access to some data will be via legal data agreement.

The screenshot shows a web page from the Australian Institute of Marine Science (AIMS) eatlas system. At the top, there are logos for the Australian Government and the Australian Institute of Marine Science, followed by a search bar. The main title is "Manta tow data summarised by reef". Below the title, a message says "Thank you for your interest in this data file. For more detailed data please contact adc@aims.gov.au". There are four input fields for user information: "Name:", "Email Address:", "Purpose for the data:", and "Details:". At the bottom left is a blue "Download" button, and at the bottom center are links to "Back to metadata", "Attributing AIMS", "Copyright Notice", "Disclaimer", and "Privacy Policy".

Obtaining data II

Crown-Of-Thorns Starfish And Benthos Manta Tow Data (Great Barrier Reef)

[Info](#)

Let's start working with the data!

GBR data

eatlabs.org.au/gbr/ltmp-data

Saved Tabs ■ Deep learning ▾ mlss.tuebing...20/dates.html Largest GBR c...TMP | eAtlas

R Leaflet for R - Colors

Largest GBR coral reef survey data repository now online - AIM

Long-Term Monitoring Program

The Long-Term Monitoring Program (LTMP) is designed to detect changes in reef communities at a local scale. At the moment, a submarine transects measure, reef-wide and outer shelf reefs across several shelf widths, one third of available (3 sectors).

There are three approaches:

- Coral manta tow surveys of crown-of-thorn starfish populations and reef-wide coral cover.
- Photographic surveys of stationary benthic (benthic) organisms on fixed transects.
- Visual counts of reef fish, juvenile corals, crown-of-thorn starfish, coral-eating snails and coral bleaching.

For an overview of the AIMS Long Term Monitoring Program view this record.

AIMS Long-Term Monitoring Program: Crown-Of-Thorns Starfish (Acanthaster Planci) And Benthos Manta Tow Data At Great Barrier Reef

This record is for 11 sections of the Great Barrier Reef (Great Barrier Reef, Whitsundays, Charlotte Bay, Townsville, Cape York, Far North, Townsville, Cape York, Whitsundays, Northern, Central, and Capricorn Banks) are annually surveyed for crown-of-thorn starfish using the manta tow technique. An additional 117 reefs from the sections (excluding the Whitsundays, Severe and Capricorn sections) are scheduled for survey every third year ('cycle' reefs). The cycle means two reefs per section if surveys are unable to be completed because of bad weather and limited ship availability.

View the LTMP Manta Tow metadata to access data download.

AIMS Long-Term Monitoring Program: Video And Photo Insects (Great Barrier Reef)

Insects were surveyed annually on fixed sites in one habitat on each of 47 selected sites from 1993 to 2005 in 6 regions throughout the Great Barrier Reef (GBR). Surveys were situated at 3 sites per reef, with both transects surveyed per site.

A new survey plan was implemented in the Great Barrier Reef Marine Park and in 2008 the survey strategy was changed. The original set of reefs (47) are surveyed in odd years (e.g. 2007), a different set (34 reefs) are surveyed in even years. The new set consists of paired reefs (reef no. and one open) which are surveyed to assess effects of bleaching. The paired reefs are near and immediately Townsville, Mackay, the Bowen Fracture and the Capricorn Bunker group.

View the LTMP Photo Transects metadata to access the data download.

Plan Monitoring Of Inshore Coral Reef Communities, At Barrier Reef (RRMMP)

After 2008, reefs were surveyed in alternate years, alternating with a different set of reefs (not with same reefs) in consecutive years. The purpose is to monitor the effect of bleaching on inshore reef communities.

Surveys have been carried out on inshore reefs since 2003.

No community monitoring program validated.

Long percent cover of benthic organisms normally by genus level resolution (hard corals, soft corals and macroalgae), numbers of juvenile corals, prevalence of coral diseases.

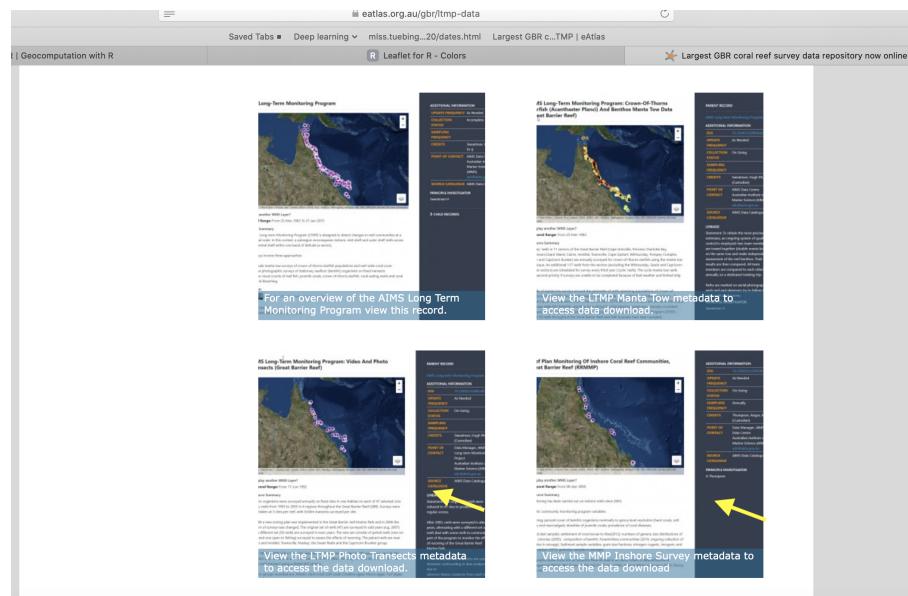
Other samples: number of coral larvae to 600 (L2); numbers of generic size distributions of corals (2005); composition of benthic invertebrates communities (2014); ongoing collection of fish surveys; Sediment sample variables: grain size fractions, nitrogen, organic, biological and chemical.

View the MMP Inshore Survey metadata to access the data download.

Visualizing monitoring locations



Leaflet is one of the most popular open-source JavaScript libraries for interactive maps. It's used by websites ranging from The New York Times and The Washington Post to GitHub and Flickr, as well as GIS specialists like OpenStreetMap, Mapbox, and CartoDB.



Installing leaflet in R

```
install.packages("leaflet")
# to install the development version from Github,
# devtools::install_github("rstudio/leaflet")

library(leaflet)
library(ggmap)
```

Read LTMP data

```
ltmp <- read_csv(file = "Data/ltmp_hc_sc_a_by_sit
```

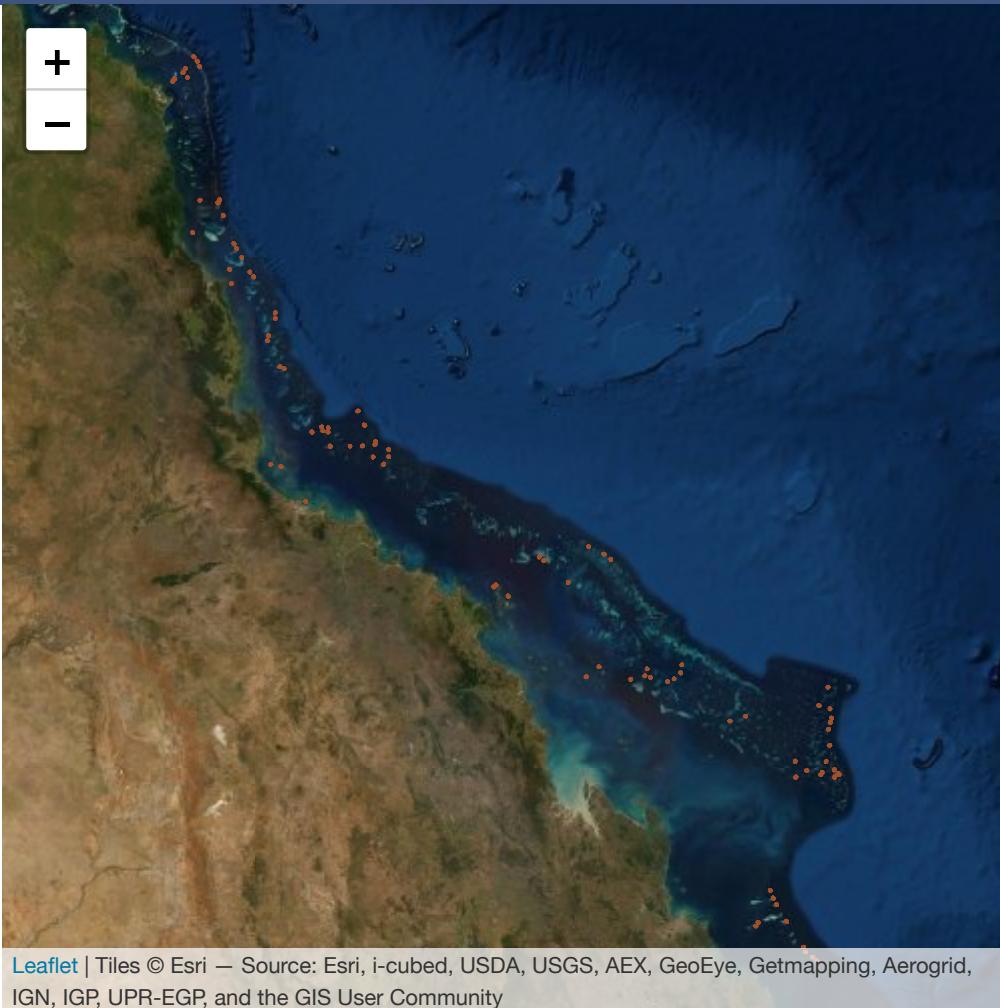
Visualizing monitoring locations using map widget

Steps

- Using the function `make_bbox()` from the `ggmap` package, we are going to create a bounding box for the longitude and latitude collection in our data set.
- Then using the `leaflet()` function, we will start creating the layers of our map. We will add a tile layer from a known map provider such as `googlemaps` for example.
- After that we will decide on the symbols that we want to use in our map to mark our sampling locations

Then our leaflet map will be ready! Demo

Visualizing LTMP monitoring locations using map widget



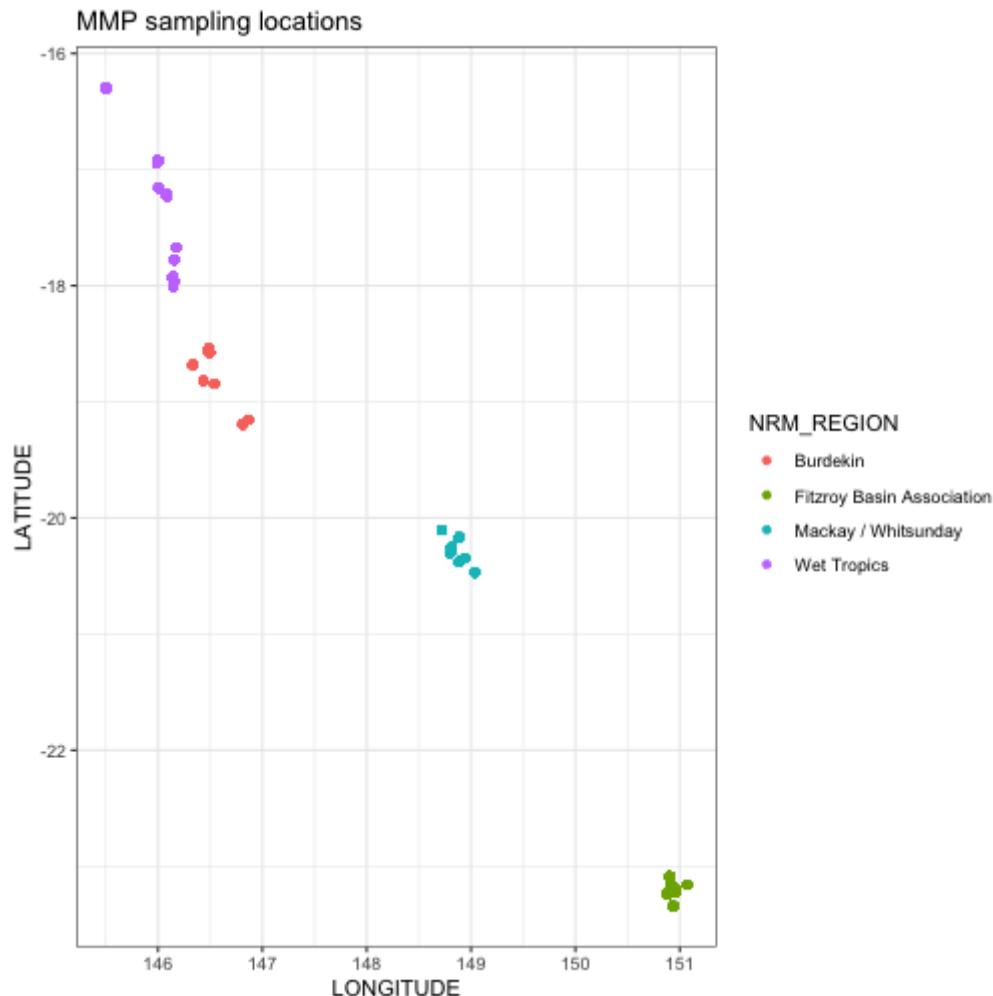
Monitoring MMP locations on the GBR

R demo

Great Barrier Reef
Marine Park Authority

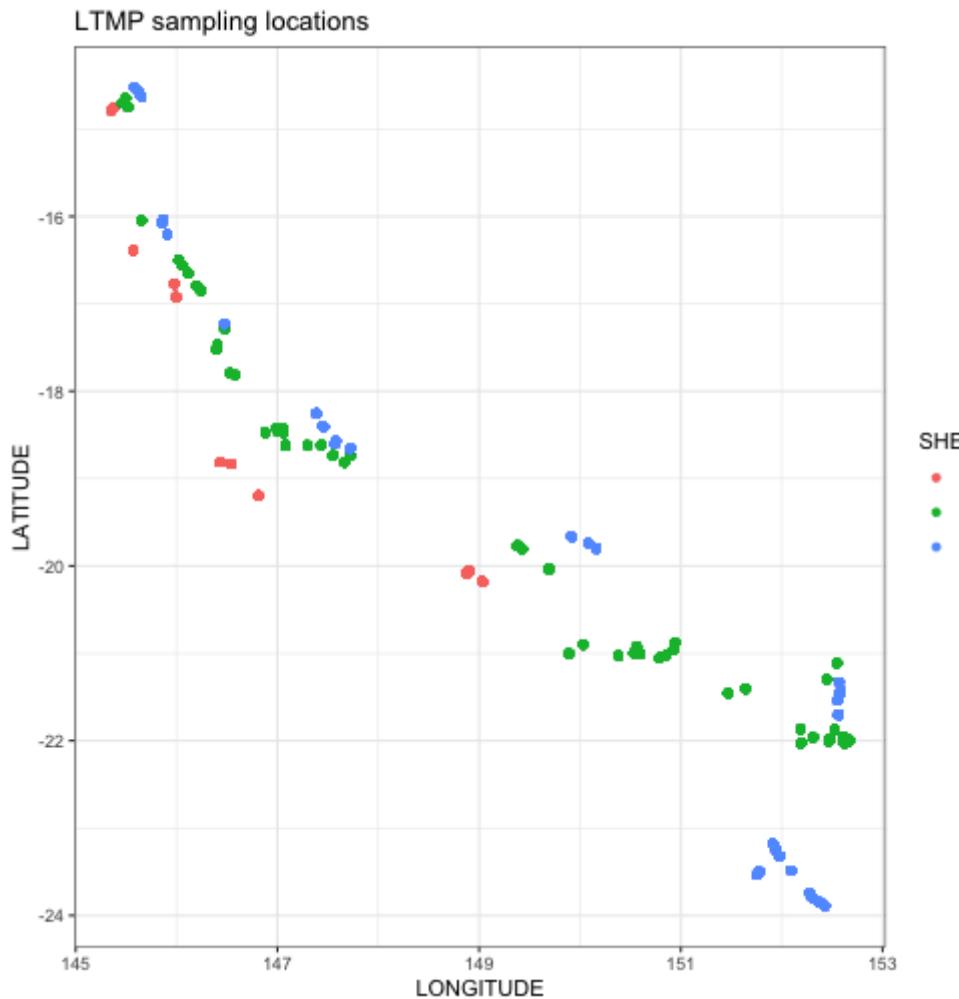
Data --> Long term marine monitoring program (LTMP)

Regions



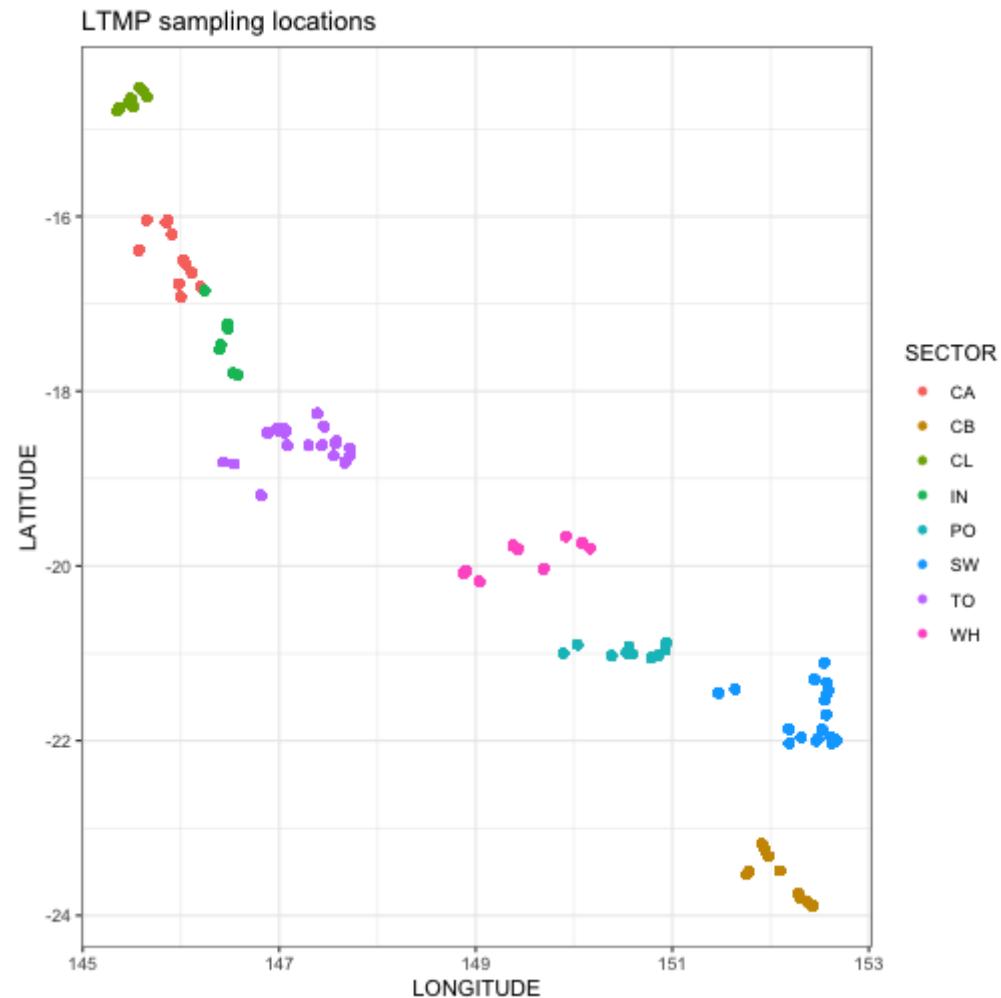
Data --> Long term marine monitoring program (LTMP)

Shelf



Data --> Long term marine monitoring program (LTMP)

Sector



Data --> Long term marine monitoring program (LTMP)

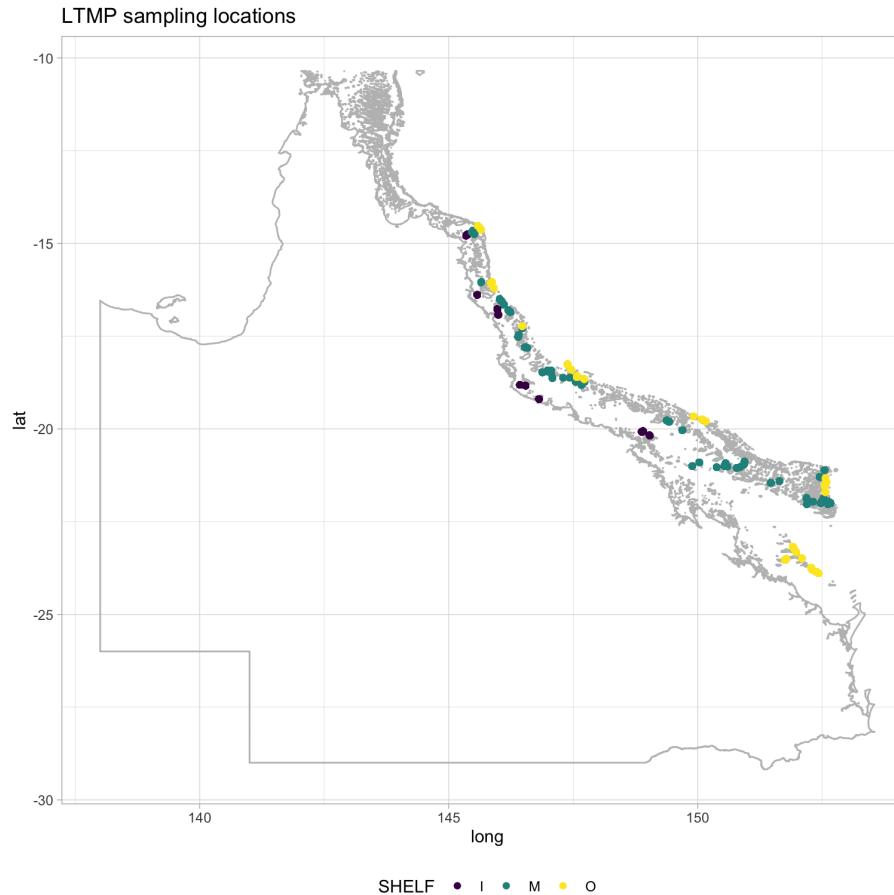
Shelf

```
ggplot(data = ltmp,  
       aes(  
             x = LONGITUDE,  
             y = LATITUDE,  
             color = SHELF)  
       ) +  
   geom_point() +  
   theme_bw() +  
   ggtitle("LTMP sampling locations")
```

Can we make nicer figures/visualization????

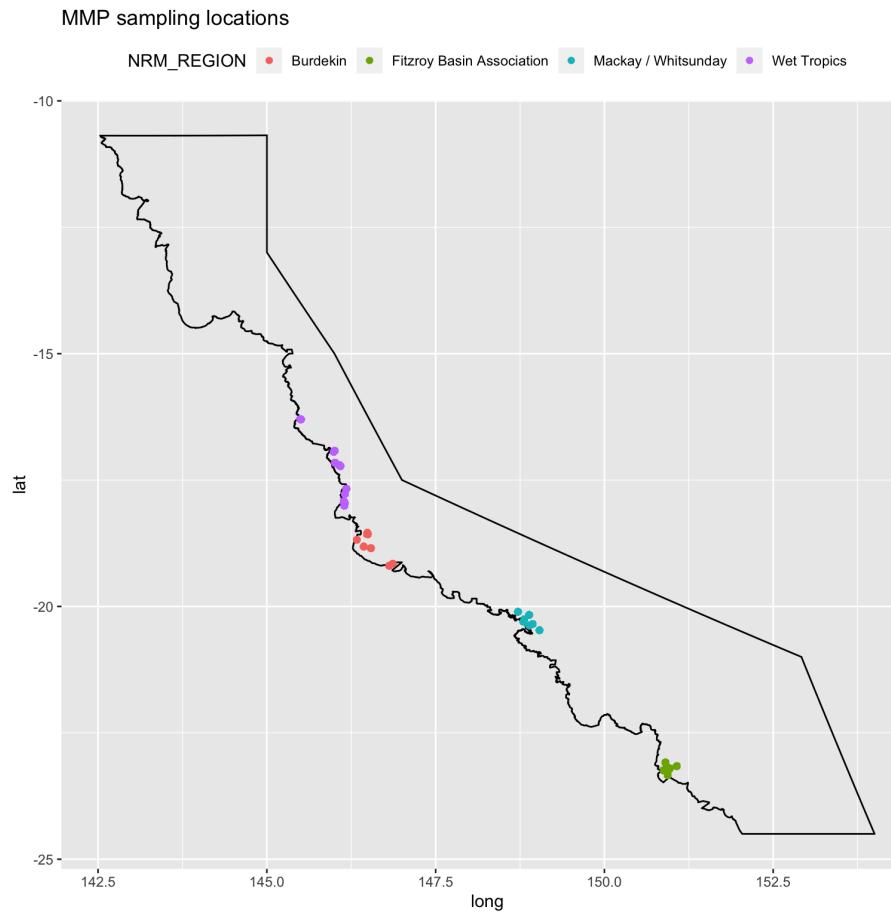
Of course!!!

We can do that by incorporating a shape file in our figures!



Another example

Using a shape file in our figures to plot geographical areas.



Maps using shape files

Shape files

Shapefiles are a common way to store geospatial data.



A shapefile is a simple, nontopological format for storing the geometric location and attribute information of geographic features. Geographic features in a shapefile can be represented by points, lines, or polygons (areas). The workspace containing shapefiles may also contain dBASE tables, which can store additional attributes that can be joined to a shapefile's features.

[More info](#)

More on shape files

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The term "shapefile" is quite common, but the format consists of a collection of files with a common filename prefix, stored in the same directory. The three mandatory files have filename extensions .shp, .shx, and .dbf. The actual shapefile relates specifically to the .shp file, but alone is incomplete for distribution as the other supporting files are required. Legacy GIS software may expect that the filename prefix be limited to eight characters to conform to the DOS 8.3 filename convention, though modern software applications accept files with longer name

Source

Nicer maps

R demo

Great Barrier Reef
Marine Park Authority

Understanding the GBR structure

LTMP sampling design

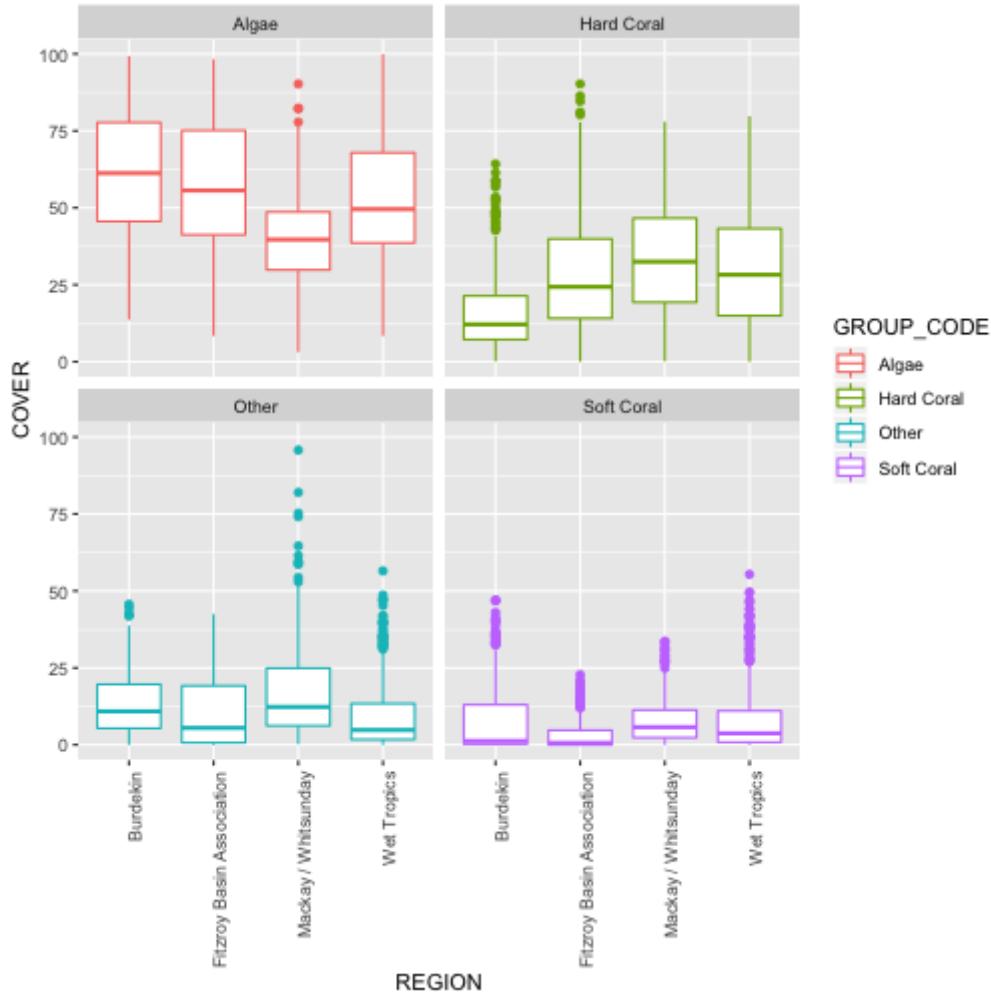
SECTOR	SHELF	REEF_NAME
CA	I	LOW ISLANDS REEF
CA	I	GREEN ISLAND REEF
CA	I	FITZROY ISLAND REEF
CA	M	MACKAY REEF
CA	M	HASTINGS REEF
CA	M	MICHAELMAS REEF

Data --> Reefs and location in the shelf

MMP sampling design

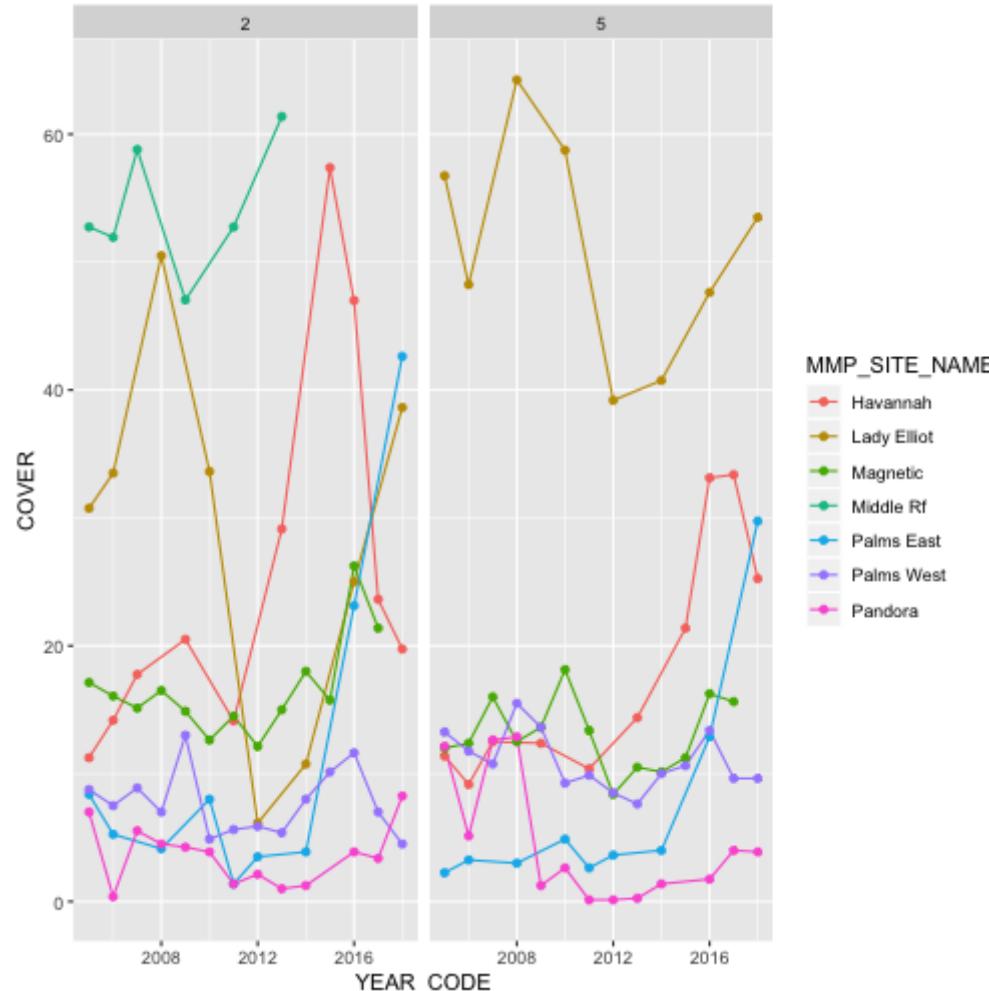
MMP_SITE_NAME	NRM_REGION
Havannah	Burdekin
Lady Elliot	Burdekin
Magnetic	Burdekin
Middle Rf	Burdekin
Palms East	Burdekin
Palms West	Burdekin

Marine Monitoring program



MMMP hard coral cover trends

For the Burdekin region and site 1 by depth



Optional: Not needed for the tutorial!

Optional

Great Barrier Reef
Marine Park Authority

Registering for Google maps API

In order to be able to use all the capabilities from the *ggmaps* R package you would need to create a Google maps API.

- 📶 For that you can use your monash email account (you will not have to pay)

Get API

-  Visit the Google Cloud Platform Console.
-  Click the project drop-down and select or create the project for which you want to add an API key.
-  Click the menu button and select APIs & Services > Credentials.
-  On the Credentials page, click Create credentials > API key.
-  The API key created dialog displays your newly created API key.
-  Click Close.
-  The new API key is listed on the Credentials page under API keys.

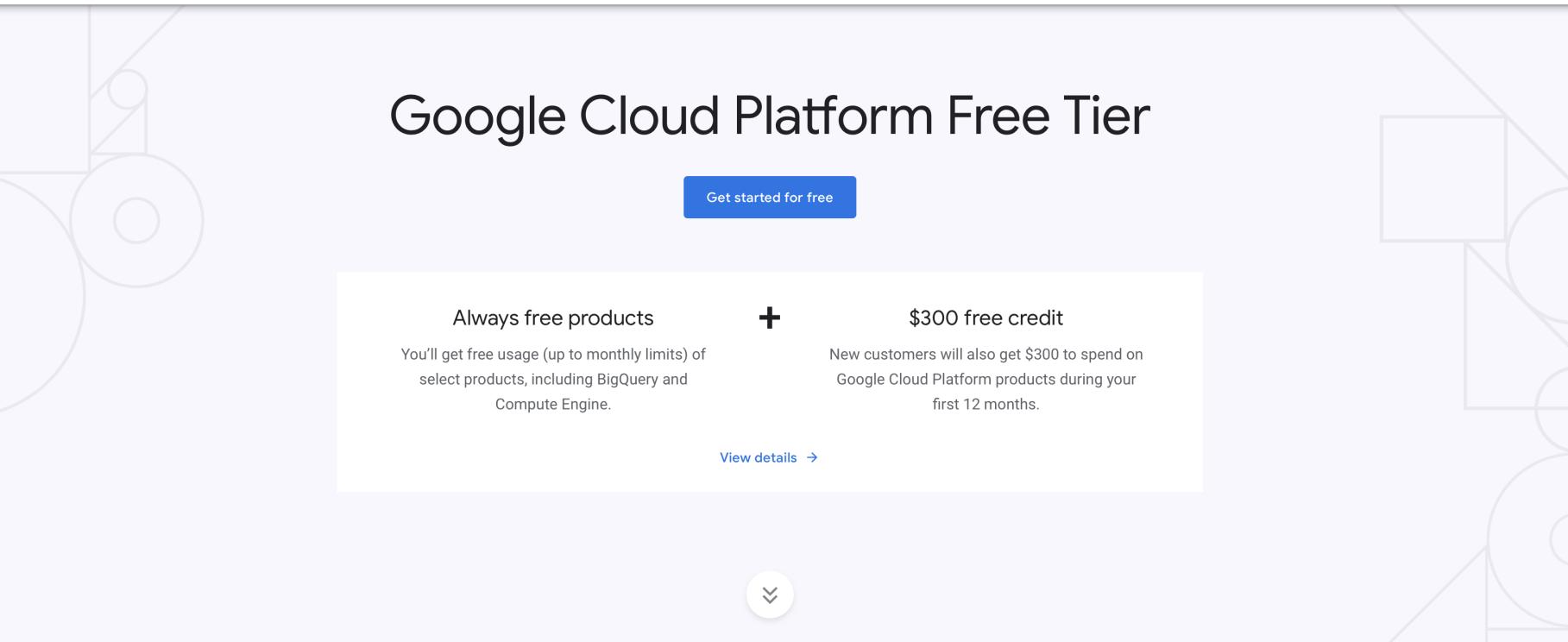
[Google Cloud Platform console](#)

Get API for free using a free trial

Your API key is private and unique to you, so be careful not to share it online, for example in a GitHub issue or saving it in a shared R script file.

- To create a free API you can go to <https://cloud.google.com/free> and use your Monash log in details
- Follow the instructions
- Then create a new projet
- More instructions here [Instructions page here](#)

Step 1



The image shows the Google Cloud Platform Free Tier landing page. At the top, there is a navigation bar with the Google Cloud logo, a search icon, "English" dropdown, "Console" link, and a profile icon with a 'P'. The main title "Google Cloud Platform Free Tier" is centered above a blue "Get started for free" button. Below the button, the page is divided into two sections: "Always free products" and "\$300 free credit". A plus sign (+) connects the two sections. Under "Always free products", it says: "You'll get free usage (up to monthly limits) of select products, including BigQuery and Compute Engine." There is a "View details →" link. Under "\$300 free credit", it says: "New customers will also get \$300 to spend on Google Cloud Platform products during your first 12 months." A small circular arrow icon is located at the bottom center of the page.

Always free products + \$300 free credit

You'll get free usage (up to monthly limits) of select products, including BigQuery and Compute Engine.

[View details →](#)

Step 2

Try Google Cloud Platform for free

Step 1 of 2



Patricia Menéndez

SWITCH ACCOUNT

Country

Australia

Terms of Service

I have read and agree to the [Google Cloud Platform Free Trial Terms of Service](#).

Required to continue

CONTINUE

Access to all Cloud Platform products

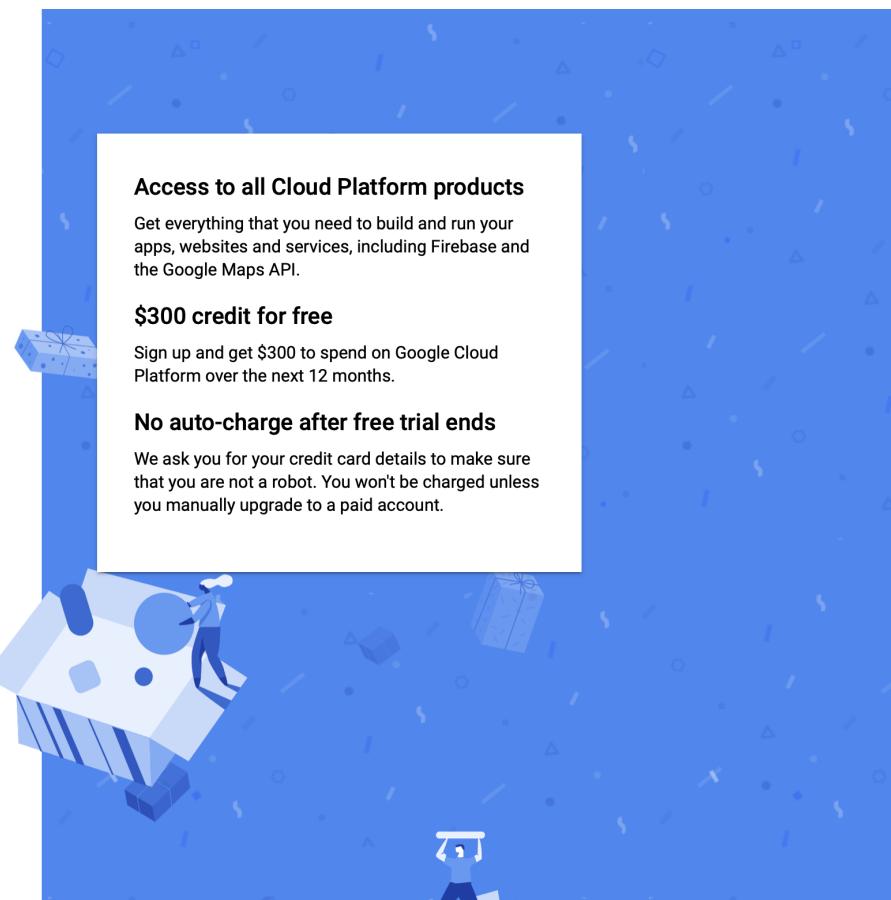
Get everything that you need to build and run your apps, websites and services, including Firebase and the Google Maps API.

\$300 credit for free

Sign up and get \$300 to spend on Google Cloud Platform over the next 12 months.

No auto-charge after free trial ends

We ask you for your credit card details to make sure that you are not a robot. You won't be charged unless you manually upgrade to a paid account.



Step 3

Try Google Cloud Platform for free

Step 2 of 2

Customer info

 Account type  

Business

 Name and address 

Business name

Name
Patricia Menéndez

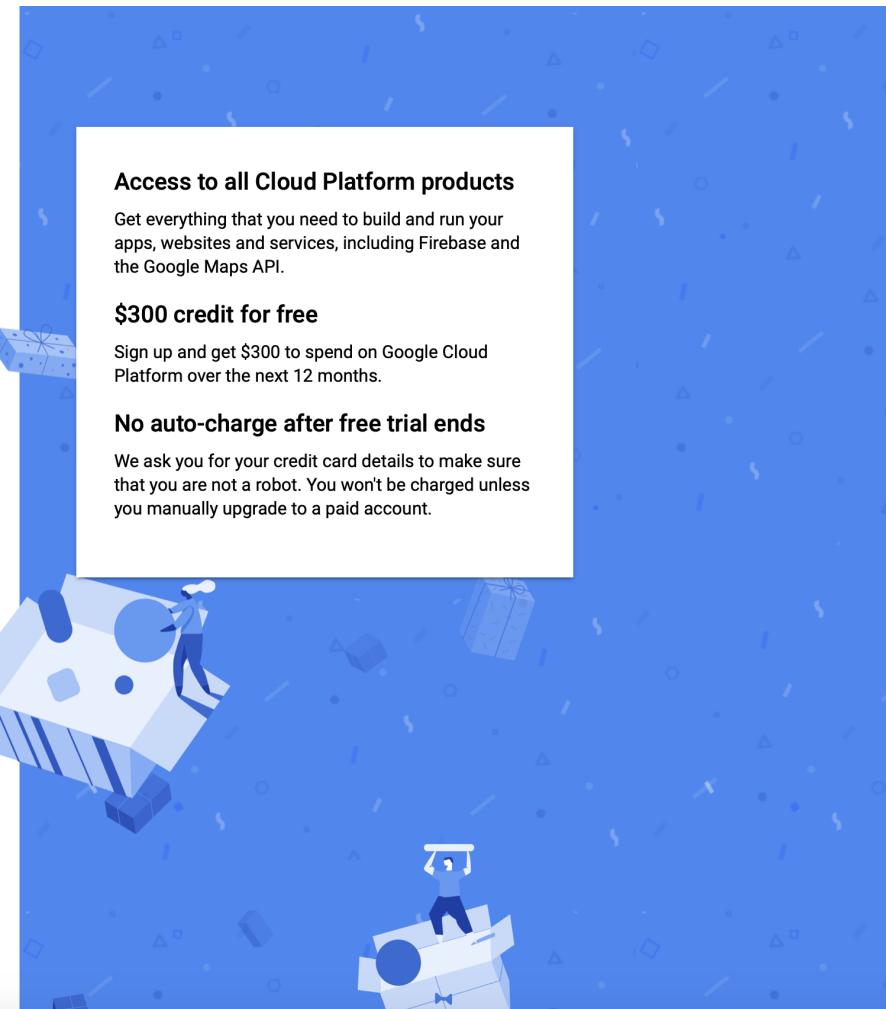
Address line 1

Address line 2

Suburb

State  Postcode 

 Primary contact  



Step 4

Create a new project and then

State Postcode ⓘ

Primary contact

Patricia Menéndez
[REDACTED]
[REDACTED]

How you pay

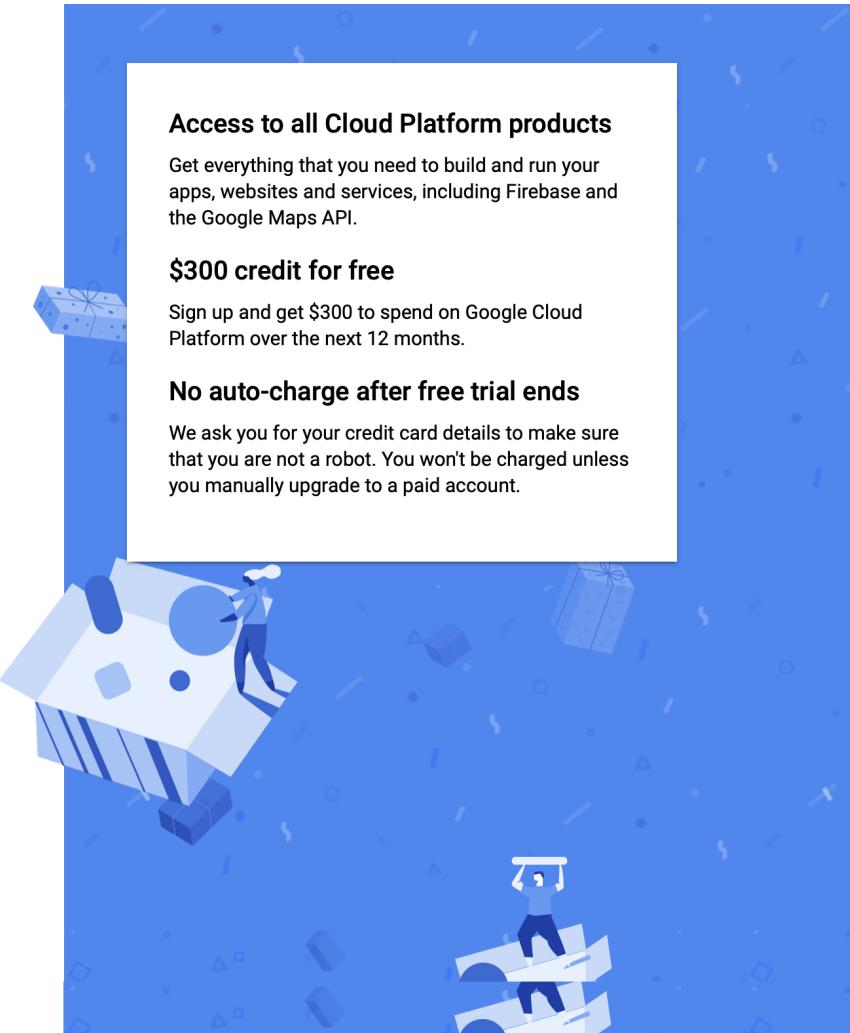
Automatic payments

You pay for this service only after you accrue costs, via an automatic charge when you reach your billing threshold or 30 days after your last automatic payment, whichever comes first.

Payment method

Card details

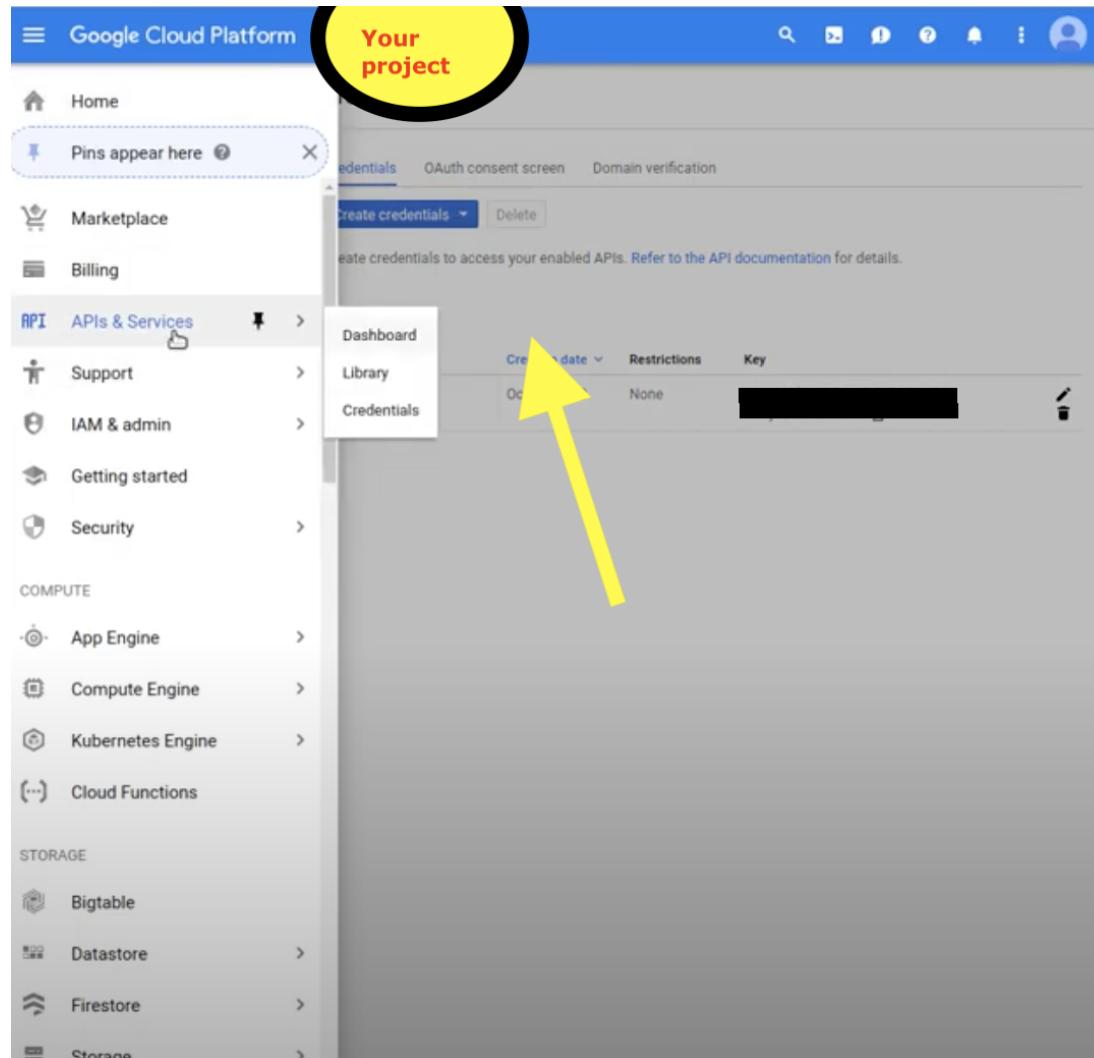
Credit or debit card address is same as above



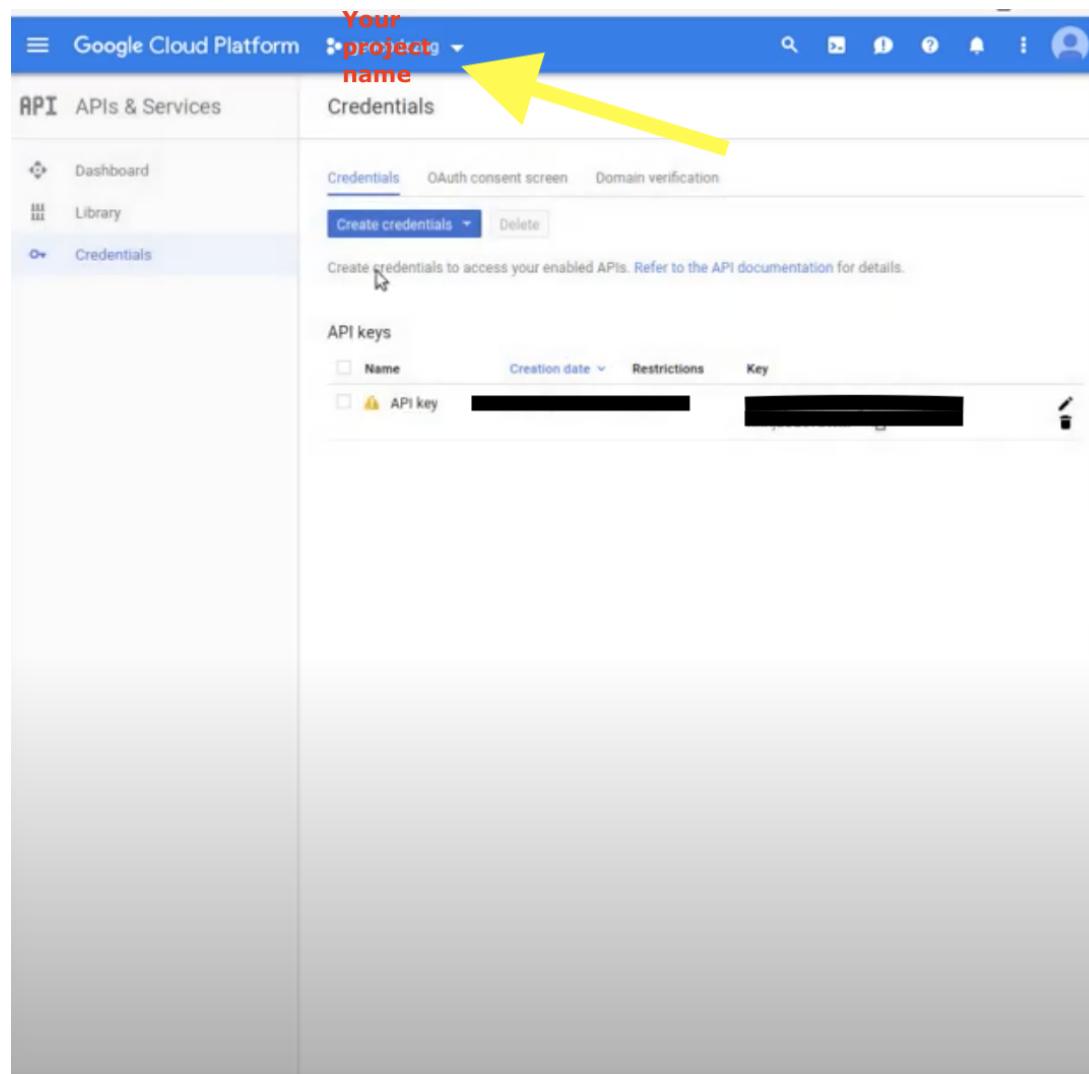
[Privacy policy | FAQ](#)

[Privacy policy | FAQ](#)

Step 5



Step 6



That's it!



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