Weekly summary of Tropic101x
as posted by student Lucia_Agudelo

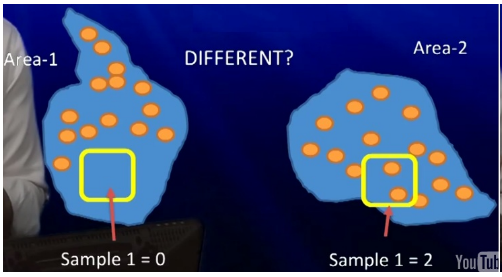
With minor grammatical and content edits by Tropic101x team

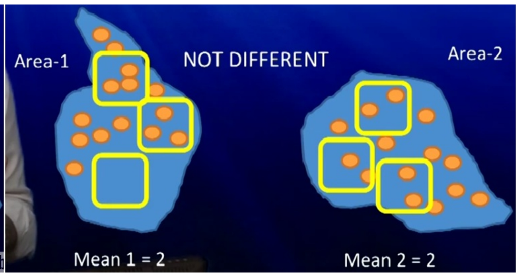
Summary of Week 6

FIELD METHODS LECTURE 6.1.1

Being able to measure the distribution, abundance and condition of tropical coastal ecosystems is crucial for their management and conservation. Without this information, natural resource managers can not make the best descisions about how to use their limited resources.

Replication of measurements is extremely important. For example, if one had an experimental design which had a single measurement in each of two areas, one might come to the conclusion that there was a difference when there actually wasn't. In fact, repeating the experiment with your two measurements could easily end up with a totally different result. The problem is that you have not included the variability between studies that is often independent of whether or not there is a difference between two areas. The solution to this is to include replication of your measurements within each area.

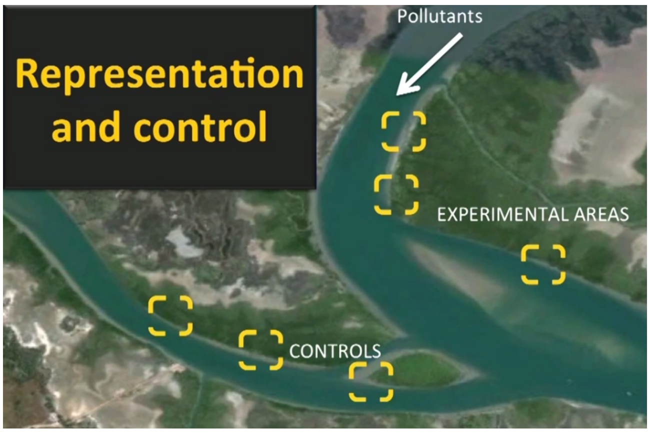




How much replication?

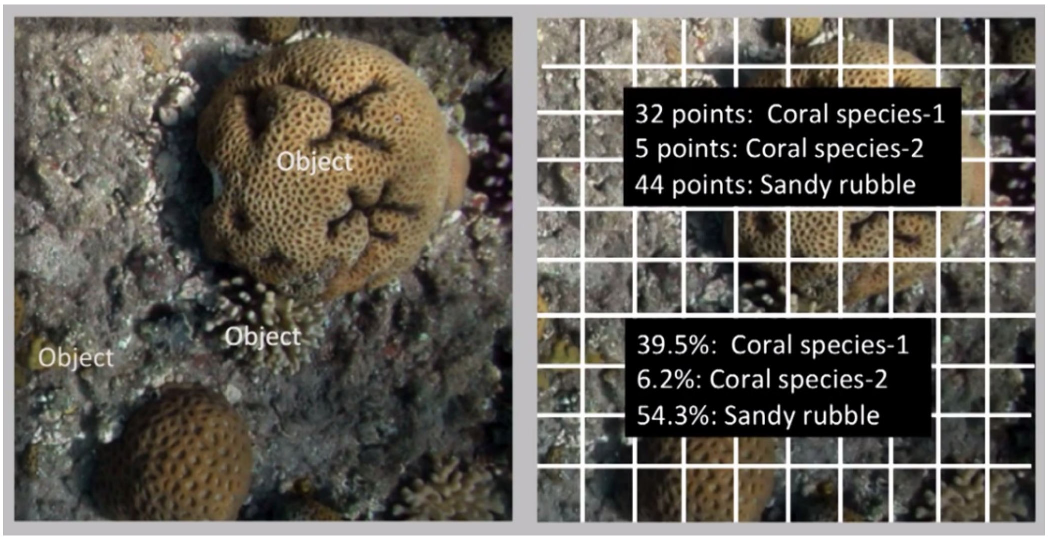
- The more you sample, the better the estimate of the “true” mean associated with your sampling area.
- But, increasing the number of your replicates means more time and energy.
- **Trade-off: precision versus effort**
- Statistical power analysis

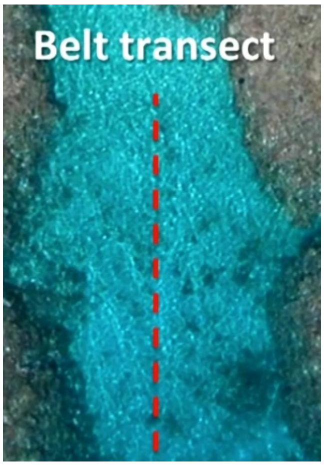
We need to replicate our sites within each location, because there may be variability between different sites within a location and there is a risk that you won’t pick a representative site within each of those locations. You need to think about representative sites, and ensuring there is replication of measurements, but also replication of sites within each location.



Sampling methods

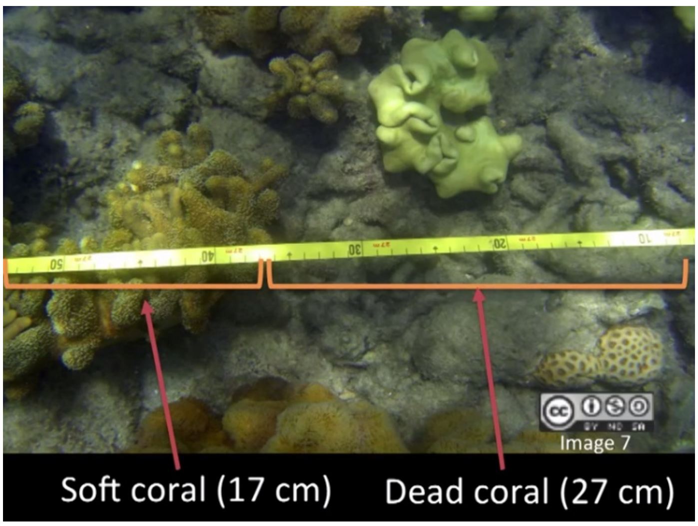
• *Quadrats*: A frame of a defined size made out of plastic pipe. They often have strings attached to them which cross over. Quadrats can be laid down on the substrate, enabling an ecologist to estimate the number of objects within a certain area. A diver or field technician may count the number of objects of interest within the defined area of the quadrat. Another way quadrats can be used is to record which type of organism or substrate category appears under each of the intersecting strings.





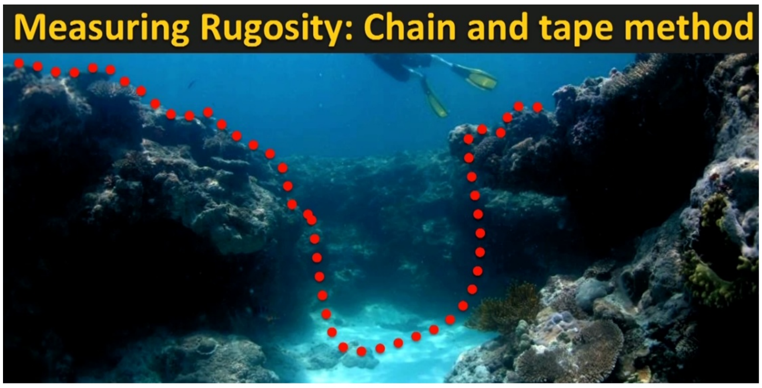
• *Belt transects:*

Belt transects tend to use transect tapes, but involve divers swimming a certain distance and counting organisms within. They are also useful for estimating the abundance and diversity of mobile organisms such as fish to be measured.



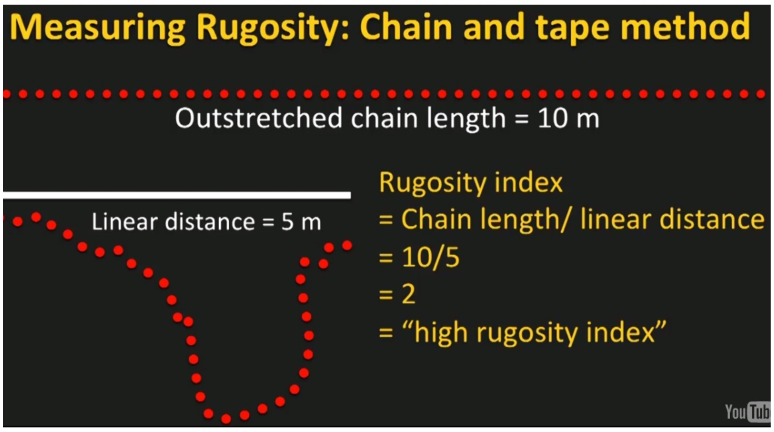
• *Line Intercept Method:*

Involves laying down a transect tape across an area of interest and then recording the length of tape associated with each different category of organism or substrate type.



- *Measuring Rugosity:*

The more structurally complex a reef, the more “rugose” it is considered. On the other hand, a reef which has low rugosity has less structural complexity. This affects the types of organisms that are able to live in those habitats.



The 'chain-and-tape method' involves laying a chain across the substrate (red dotted line) and also measuring the linear distance covered (white line). The total length of the chain divided by the linear distance covered gives us the “**rugosity index**” of the benthos.

LECTURE 6.1.2

Fish and other mobile organisms can be measured using belt transects, but the presence of divers swimming along a reef crest can cause fish to hide from the transect leading to much lower estimates of fish abundance and diversity then there actually might be. Mobile organisms like fish may also behave differently at different times of the day. One way around this problem is to deploy unobtrusive video cameras. You can count fish; you can estimate the size and abundance of those fish, as well as the frequency of important behaviors such as feeding and grazing.

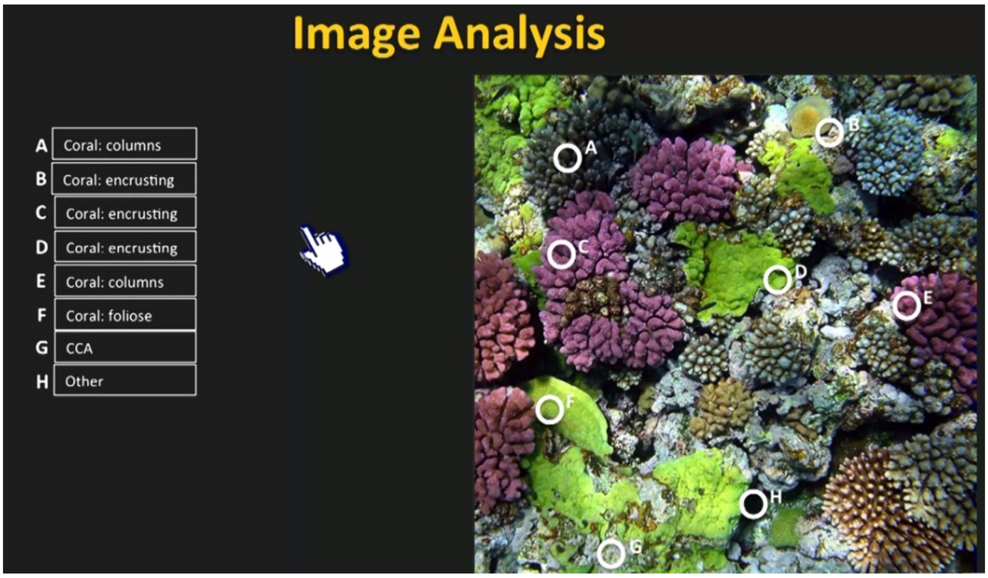
A pulsed amplitude modulated fluorometer is used to investigate the health of photo-systems within the symbionts of corals. Researchers may also take measurements of key chemical and physical variables such as temperature, chlorophyll, the amount of sediment in the water column, isotopic content, water clarity, toxins and many other variables in order to understand how an ecosystem works and whether or not it's under stress.

Satellite and other large-scale measurements are enabling modern science to understand tropical coastal ecosystems at truly global scales. In an age of unprecedented anthropogenic-driven climate change, the importance of these measurements cannot be overstated.

LECTURE 6.1.3

The Catlin Seaview Survey is an innovative project is focused on coral reefs. This project is using cameras mounted on underwater vehicles to steadily move over reefs. As the camera system moves across the reef it takes simultaneous images using three cameras every couple of seconds. These high-definition pictures are used to create 360° degree panoramic images.

This is the largest survey of coral reefs in history and coral reef specialists are now training computers to recognise different benthic categories using image recognition and machine learning.



Summary:

• Field methods are designed to explore the distribution, abundance and condition of tropical coastal ecosystems

• Any methodology used must have: adequate replication, representative sampling and representative control sites

• Field data + physiological measurements → holistic understanding of ecosystems

• Modern technology is advancing our ability to study and comprehend our global environment

EXPERIMENTAL DESIGN

LECTURE 6.2.1

• Field observations: Distribution and abundance of organisms • Identification of the influence of an external factor

• Manipulative experiments:

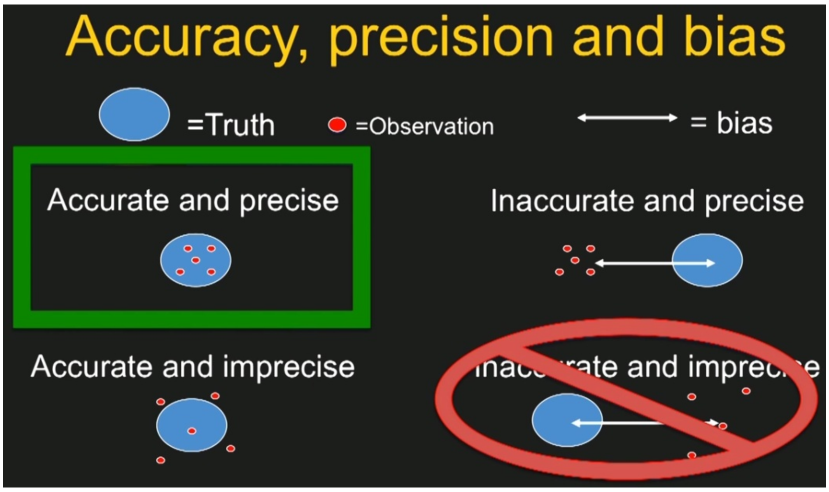
In the field (FOCE or ENCORE experiments) • In aquaria •

Experiments:

• To precisely answer specific questions

• To observe the impact of treatment(s) on a group

• To identify known or expected sources of variability



Observations are precise and accurate if they are closely clustered and overlap the truth. Observations are inaccurate but precise if they are closely clustered but don't approximate the truth. They can be accurate and imprecise when they overlap the truth but are not closely clustered and they can be both inaccurate and imprecise.

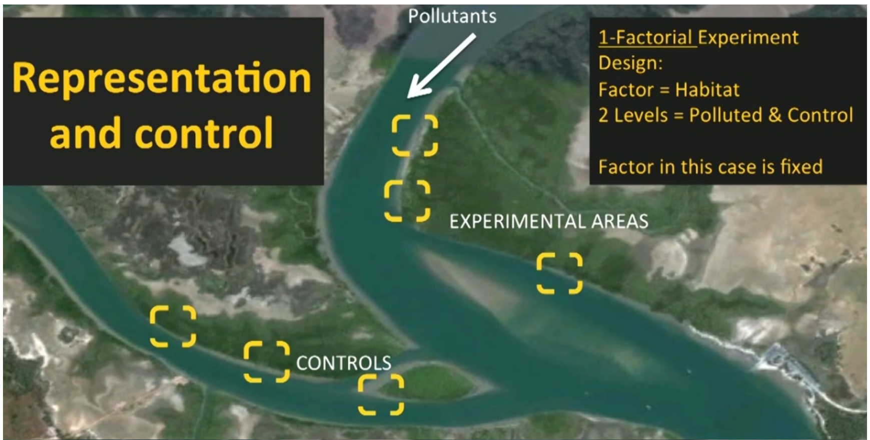
Factor and levels:

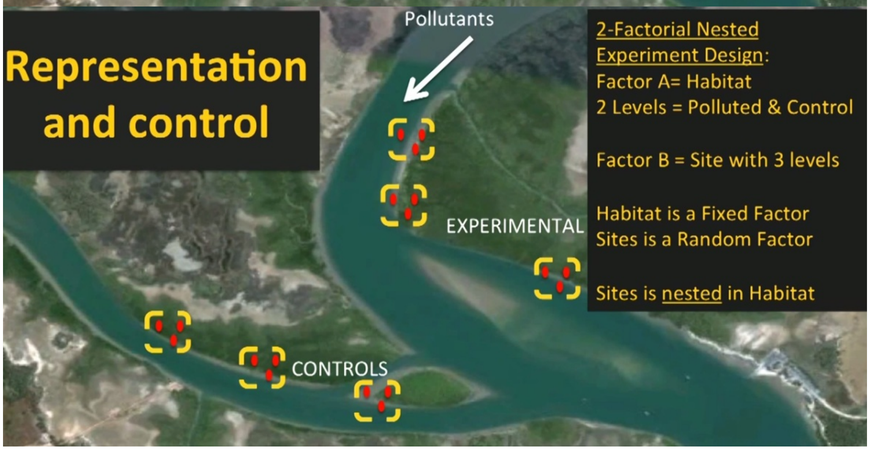
- Factor: controlled independent variable
- Level: different amounts of the factor
- Experimental design can include more than one factor

Fixed vs. Random Factors:

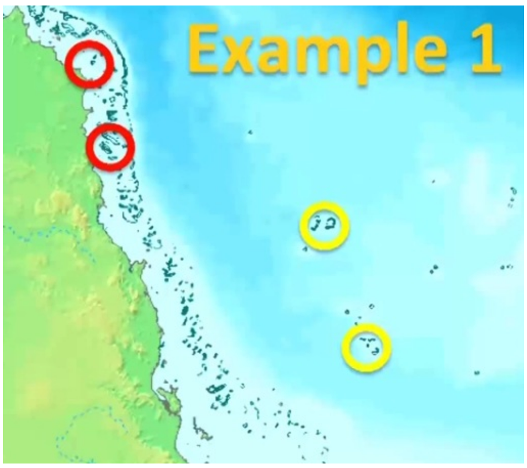
- N: levels of interest for a Factor
- n: levels studied
- n/N=1 then the factor is FIXED
- n/N<1 then the factor is RANDOM

Experimental design:



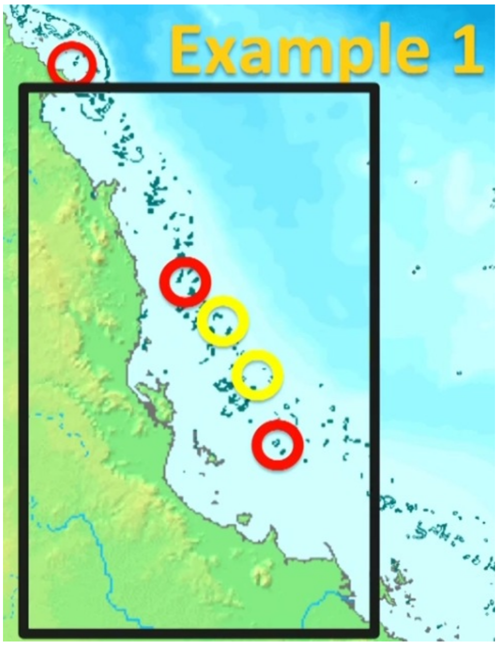


When we select sites amongst possible options it is important that we check that any differences obtained isolate our specific question from other background conditions (confounding factors).



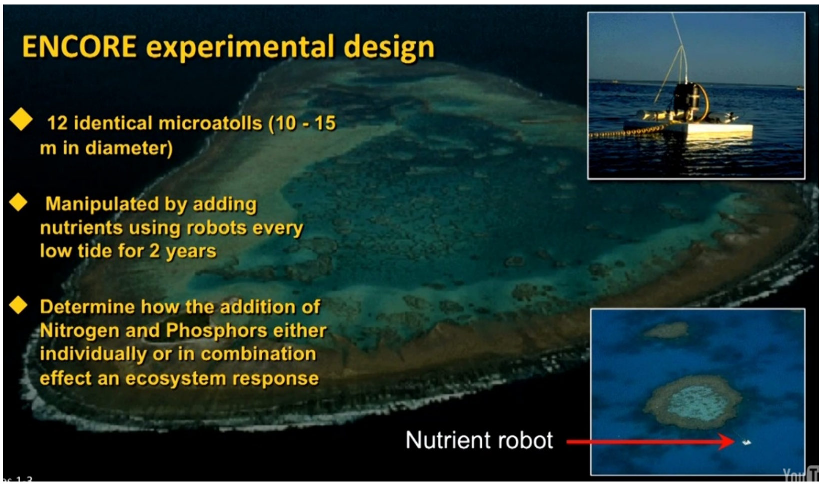
- Example 1:

If you select inshore reefs as "plume affected" and offshore reefs as "not affected" it is possible that non-plume effects drive any outcomes observed. For example, upwelling and cooler water may affect the offshore as opposed to the inshore reefs. Likewise if you select your plume-affected sites from just the northern regions and your plume-unaffected sites from just the southern regions, again these distinct latitudinal regions come with long-term differences in temperature profiles.

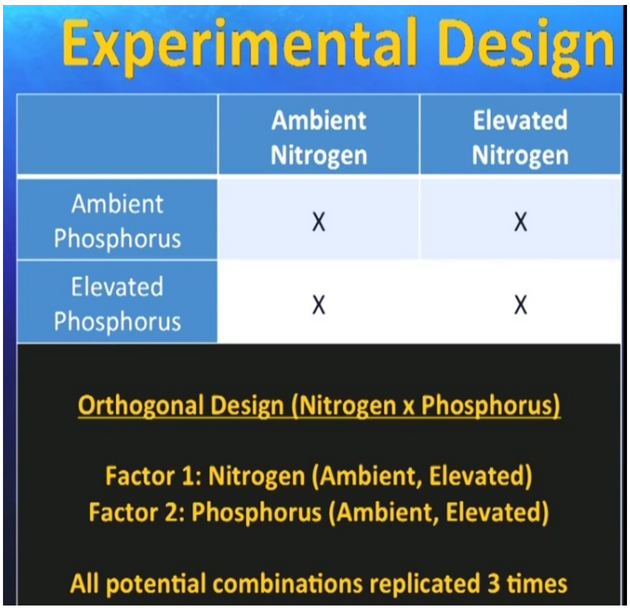


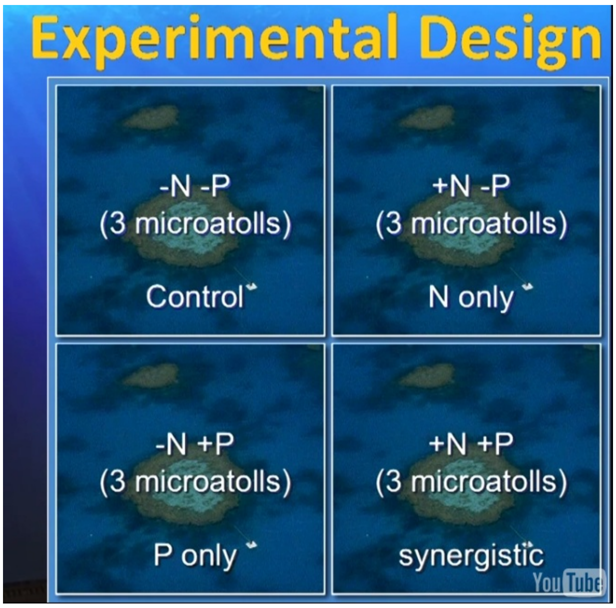
As much as possible you need to select sites that eliminate these confounding background features. Here I hope to find satellite images that would show the plume extending to the red sites but not to the yellow sites, however this may not always be possible. Furthermore your interesting river plumes may be tied to the effects of either the nutrients or salinity or sediment or pesticide concentrations on the subject. Thus, it may not be possible to find sites in the field that isolate these different drivers but otherwise have similar background features. You might need to conduct your experiment in a lab to manipulate these conditions.

LECTURE 6.2.2



One Tree Island reef is a ponding reef meaning the water within the reef is isolated from the surrounding ocean at every low tide. The question was: how do inorganic nitrogen, (ammonia) and/or phosphorus affect the coral reef communities and processes?



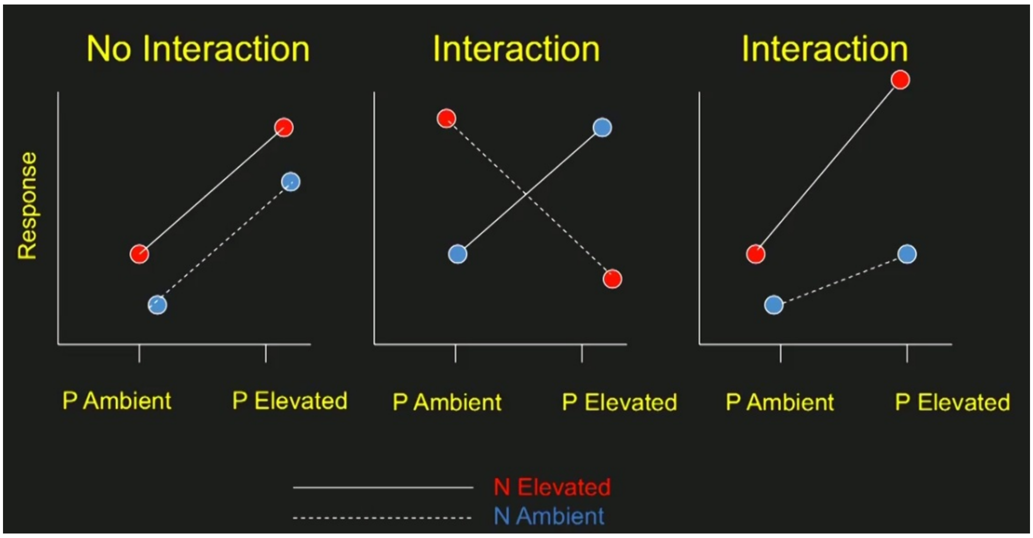


Results:

• Figure 1 (left): The effects of the factor nitrogen and the factor phosphorus are additive and there is no interaction amongst the factors. Lines are parallel

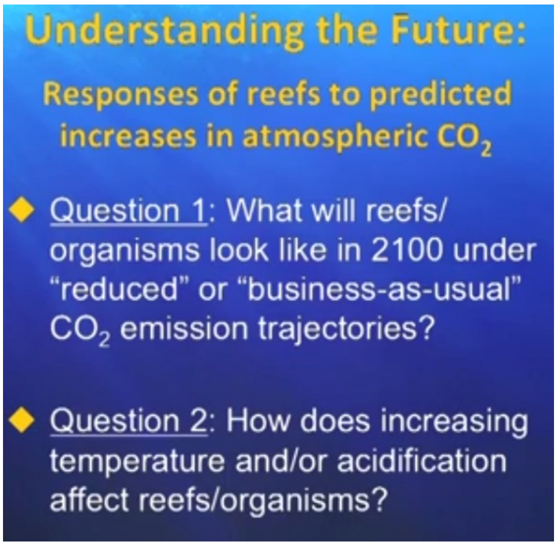
• Figure 2 (middle): Enriching phosphorus at the same time as enriching nitrogen gets same response as no enrichment of either. The addition of either, *but not both*, nutrients has a positive effect. The factors are interactive (negative interaction).

• Figure 3 (right): Elevating nitrogen in the presence of elevated phosphorus approximately doubles the effect on the response assassinated with elevating nitrogen on its own. The factors are once again interactive (positive interaction).

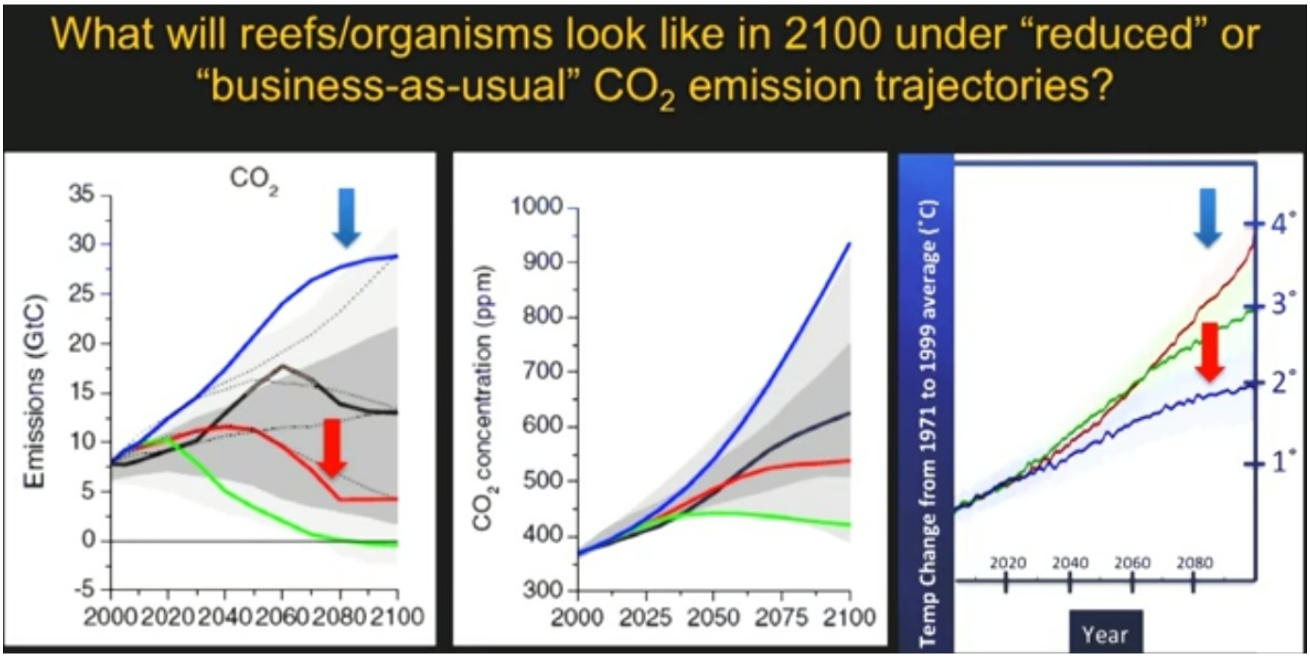


LECTURE 6.2.3

All experiments are performed under financial, spatial, and time constraints. Because of the observed increases in atmospheric carbon dioxide and predictions regarding future increases, there is a great interest in understanding what this will mean for organisms and communities in the future.



The first question is associated with a risk assessment. In the figure, RCP 8.5 pathway is illustrated in blue where CO2 emissions continue to increase through 2050. A reduced CO2 emission pathway or RCP 4.5 is in red.



Carbon dioxide in the atmosphere will equilibrate with the water column leading to ocean acidification. This can be examined in a one-factorial experimental design where the factor is pathway explored at three levels: Present-day, RCP 4.5 and RCP 8.5, where each incorporates the appropriate amount of acidification and warming given as offsets from present day levels.

Pathway	Name	+ ppm CO_2	+ °C Temp
"Business-as-usual"	RCP8.5	+570	+4
"Reduced"	RCP4.5	+180	+2
"Present Day"	PD	+0	+0

The second question is directed towards more mechanistic understanding of how two factors influence outcomes separately or in combination. There are two factors: temperature and pCO2 (also referred to as acidification). Such experiments are typically performed for short periods of time without including seasonal fluctuations.

	+0 °C	+2°C	+4°C
+ 0 ppm CO_2	X	X	X
+ 180 ppm CO_2	X	X	X
+ 570 ppm CO_2	X	X	X

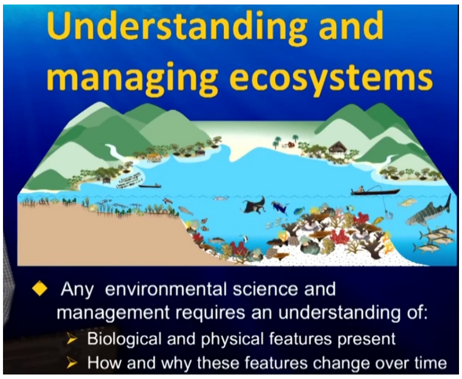
<u>Orthogonal Design (Temperature x pCO_2)</u>

Factor 1: Temperature (3 levels)
Factor 2: pCO_2 (3 levels)

All potential combinations replicated 4 times
9 x 4 = 36 mesocosm required!!

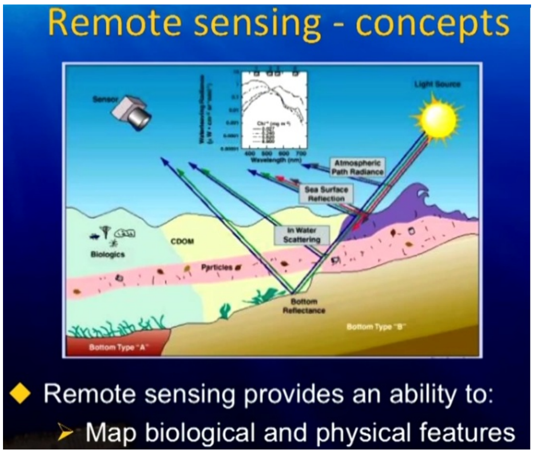
REMOTE SENSING

LECTURE 6.3.1

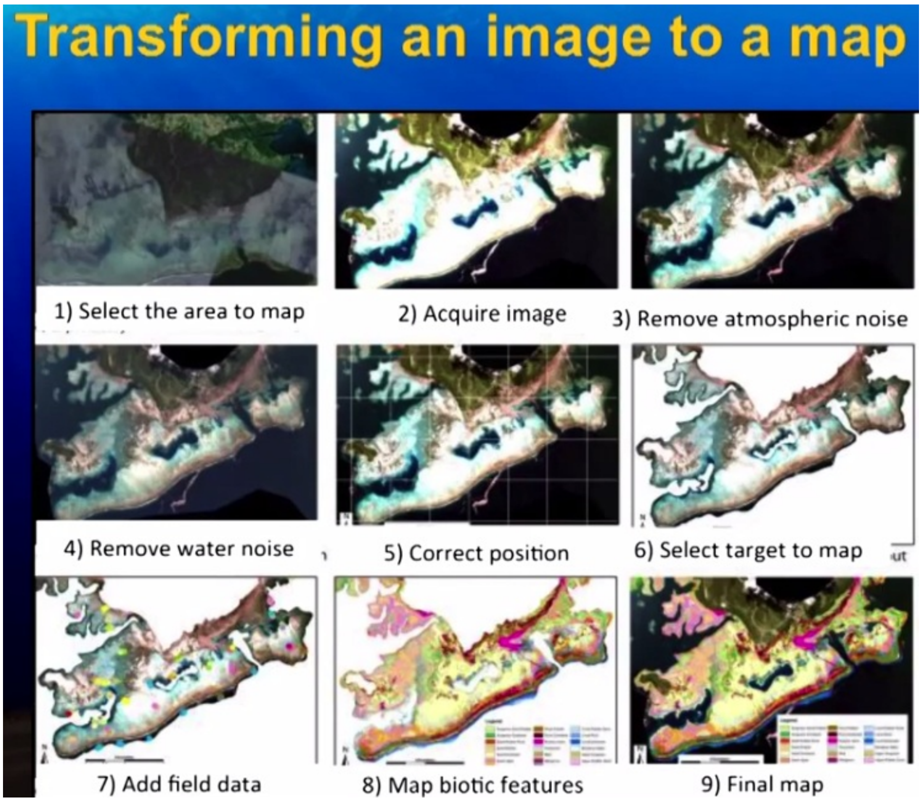


Remote sensing provides a way of understanding what exists in terms of the biological and physical features of an ecosystem. It lets us collect that information over time and see how the environment is changing, whether that's due to natural disturbances or due to human activities in the environment.

The way that we're able to take images from satellites and transform them into large-scale maps is by looking at the amount of light which is absorbed and reflected.



When you're taking a picture either from an aircraft or a satellite it shows you the amount of sunlight which is being reflected, absorbed or scattered by the water surface. You can sometimes use this to find out what's in the water column, like the amount of organic matter or suspended sediment, and what's on the sea floor there, so whether it's coral, macro-algae or seagrass.



Once you take an image you need to transform it into a map which is useful for scientific or management applications. When the maps are done, we can compare them to field survey information to check how accurate that map is, and so people can make decisions on whether to use that as part of scientific or management information.

Information types for monitoring and management:

• **Composition**: what's actually on the surface the water or what's on the benthos?

• **Biophysical properties**: In the case of seagrass this could be the amount of cover in an area, it could be its biomass, it could be the amount of photosynthesis

• Changes in (1) and (2) over time

Information on composition:

• What is on the water surface?

• What is in the water column?

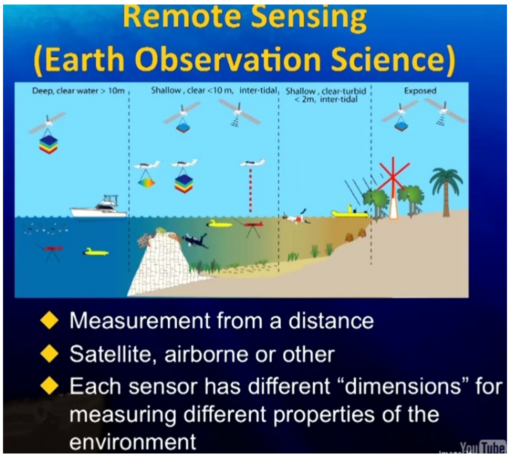
• What is on submerged surfaces?

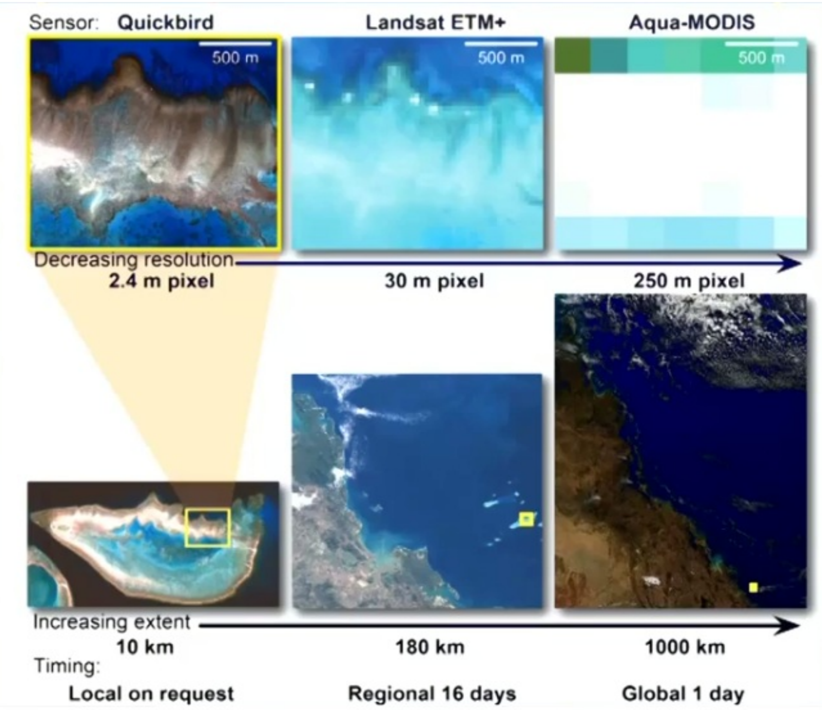
• What is on the land?

Biological, physical and chemical attributes:

Vegetation: biomass, chemistry Water bodies: depth, temperature, etc.

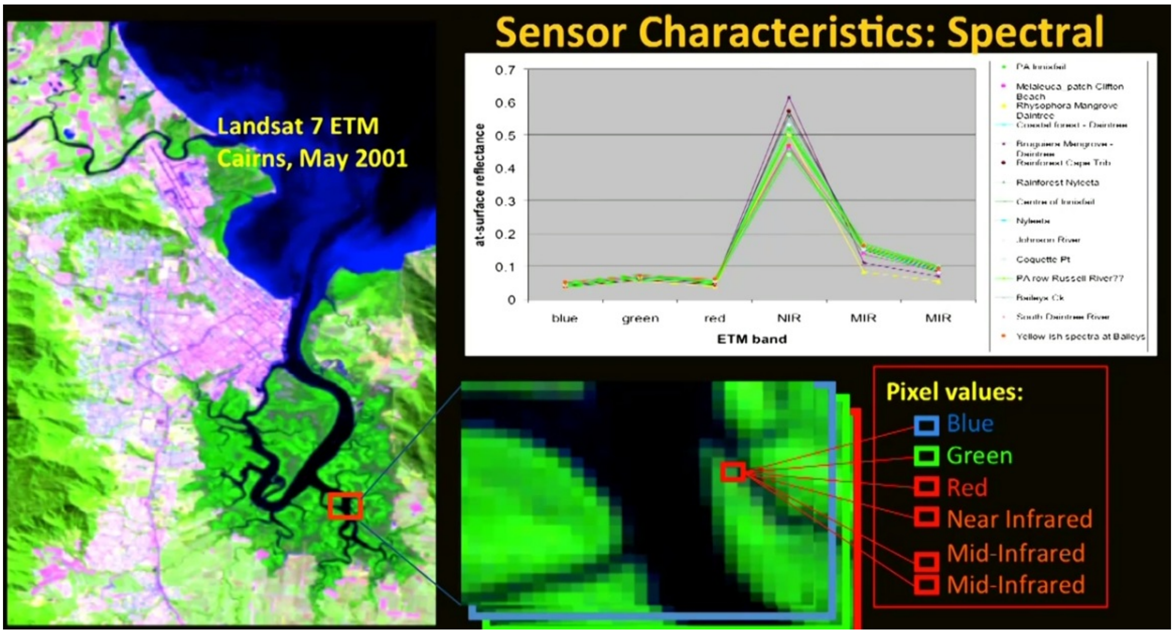
LECTURE 6.3.2



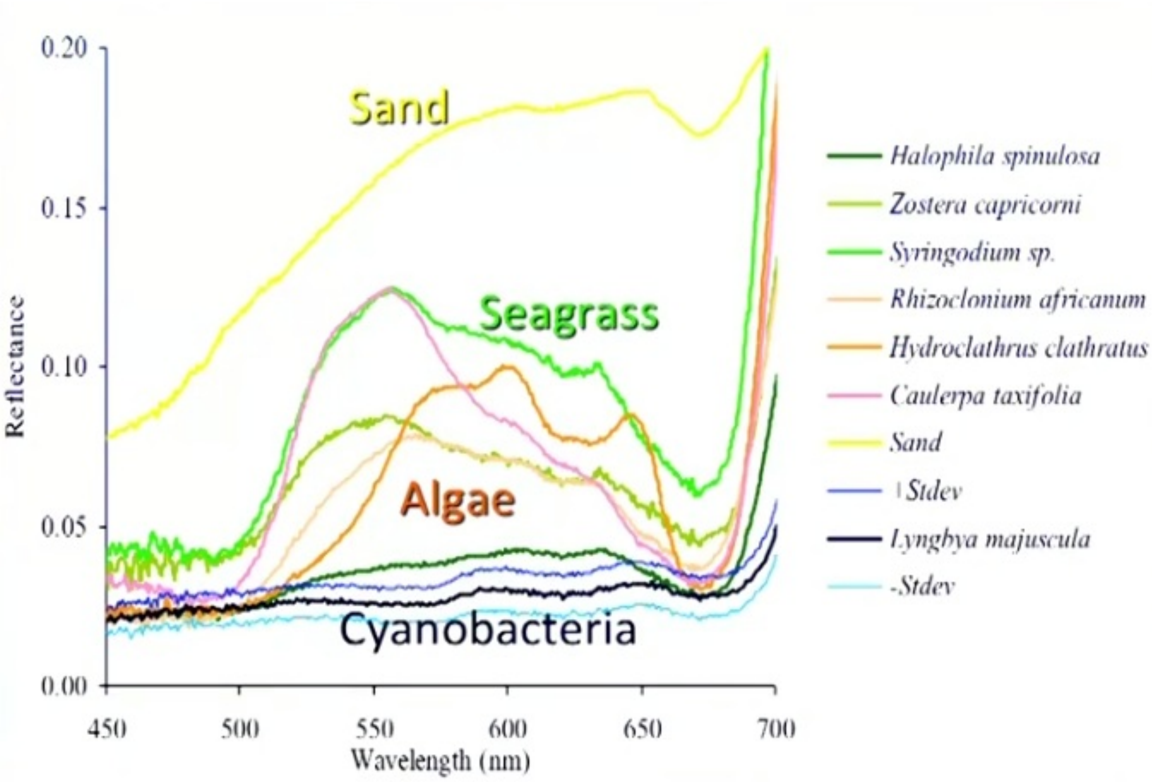


These are a series of images collected over Heron reef it's surroundings on the Great Barrier Reef, Australia.

If we zoom in on that area in the red box and we look at that image, what we'll see is each pixel in the image is actually made up six different reflectance values and those reflectance values are from different spectral bands, or different types of light, and we can take each pixel value and plot it on a graph, to produce a spectral signature.



Materials with photosynthetic abilities, like seagrass and algae, absorb blue and red light and reflect some green light there as well.

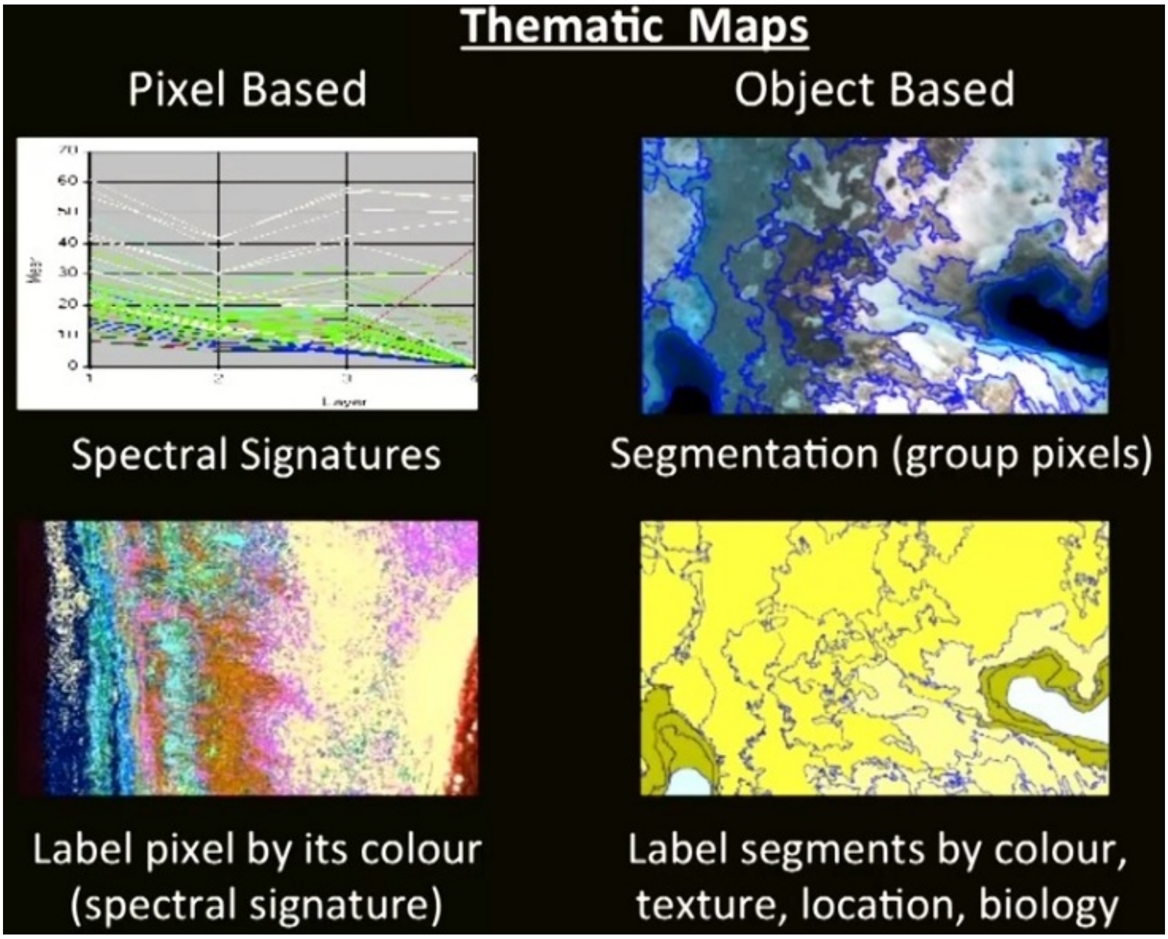


Temporal dimension refers to how frequently an imaging sensor can be used to obtain an image for a target area.

• Thematic maps

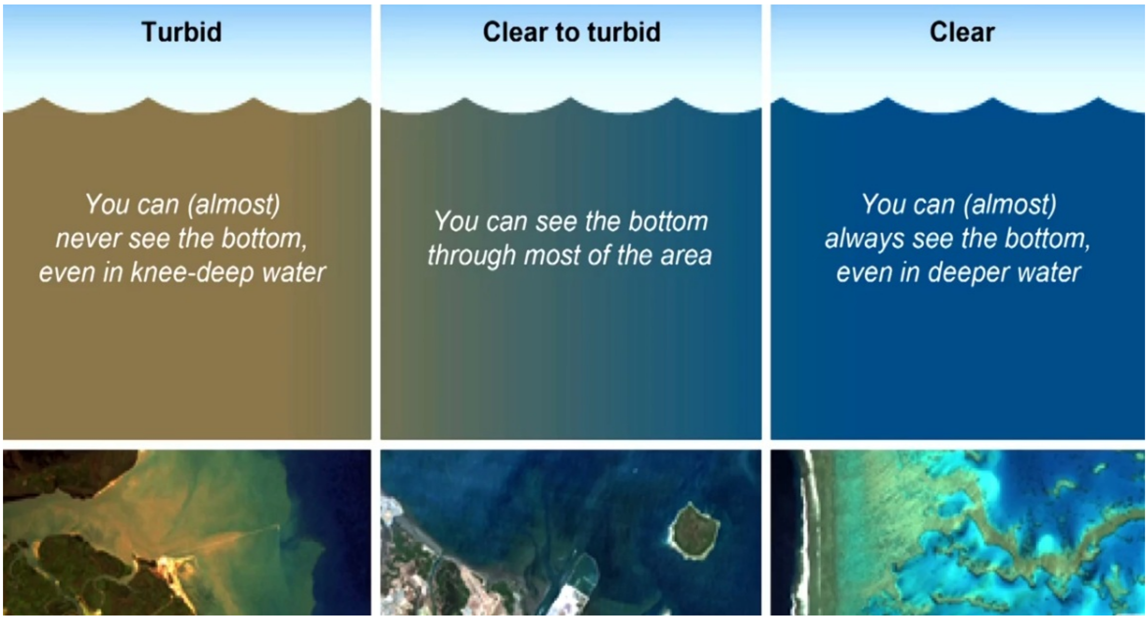
There are different approaches. The first one is a **pixel-based approach**; basically every pixel is characterized by specific spectral signatures. If we know some of the spectral signatures, then we know what it is, then we can look and compare other pixels to see if they have the same spectral signatures. If we find two or more pixels that have the same kind of characteristic then we're able to label them with the same category or color.

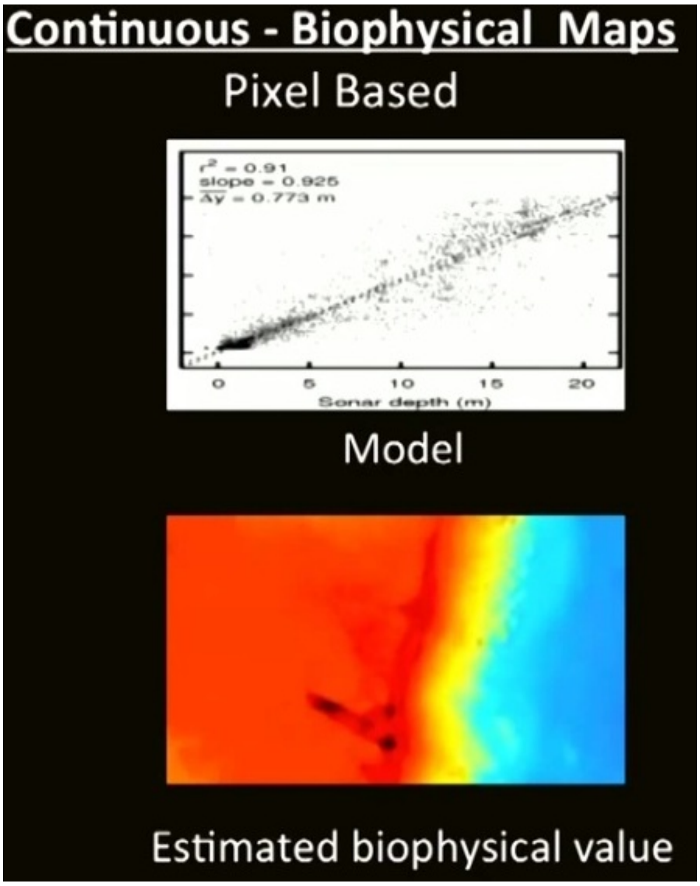
Object based approach: segments (pixel groups) are characterized by their texture and their color and their size. After this segmentation, we decide how to label these different characteristics, using their texture and color.



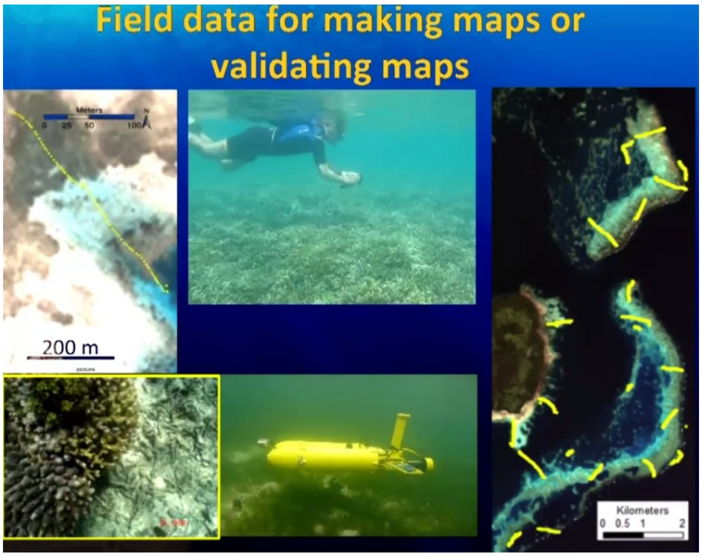
• Continuous maps:

Continuous maps are a result of comparing field data with pixel values of an image to create a model. This model is then applied to the whole image, resulting in an image of estimated bio-physical values.

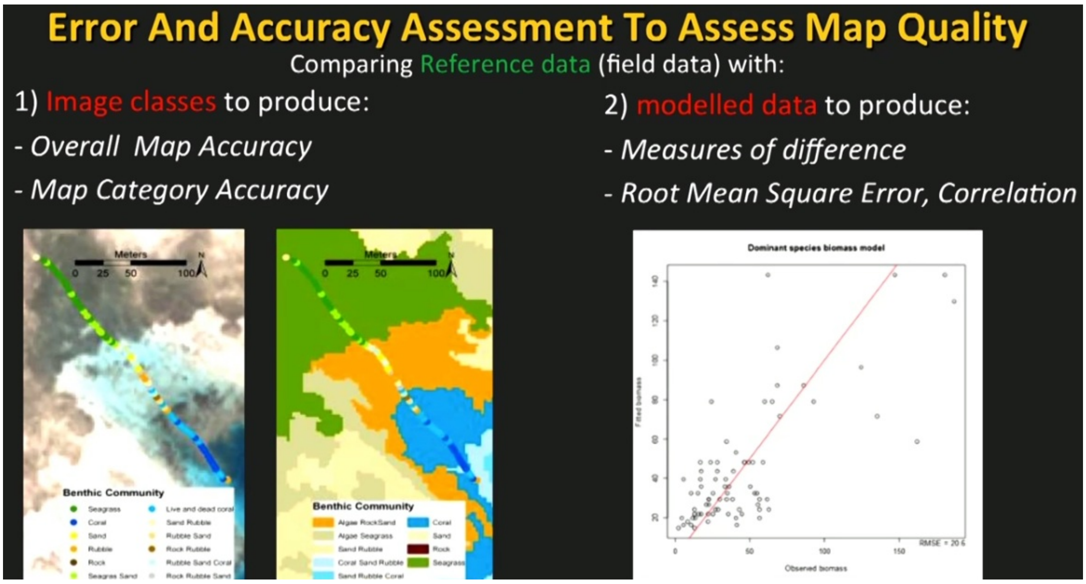




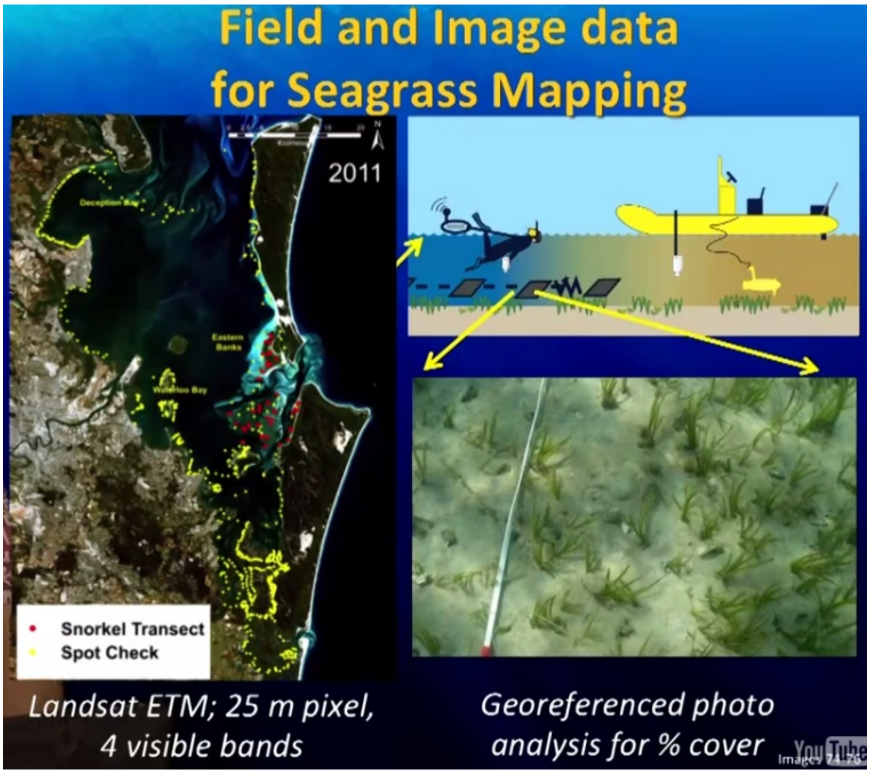
We go into the field ourselves, using a GPS to track our location and then snorkelling or diving. We do a basic survey, writing down what we see in that environment. We can also do detailed survey where we conduct photo transects. These photos are then geo-referenced to the satellite image based of the synchronization of the camera and a GPS that floats at the surface. The field data is then used for calibration and/or validation of satellite data.



To validate our model data, we compare the observed field data with the model data.



LECTURE 6.3.3



Monitoring and management of coastal ecosystems is important and requires information about these systems. We gain this information using a combination of field measurements and satellite data.

Coral reef systems can look different at different spatial scales. Each level contains a different feature size and scale:

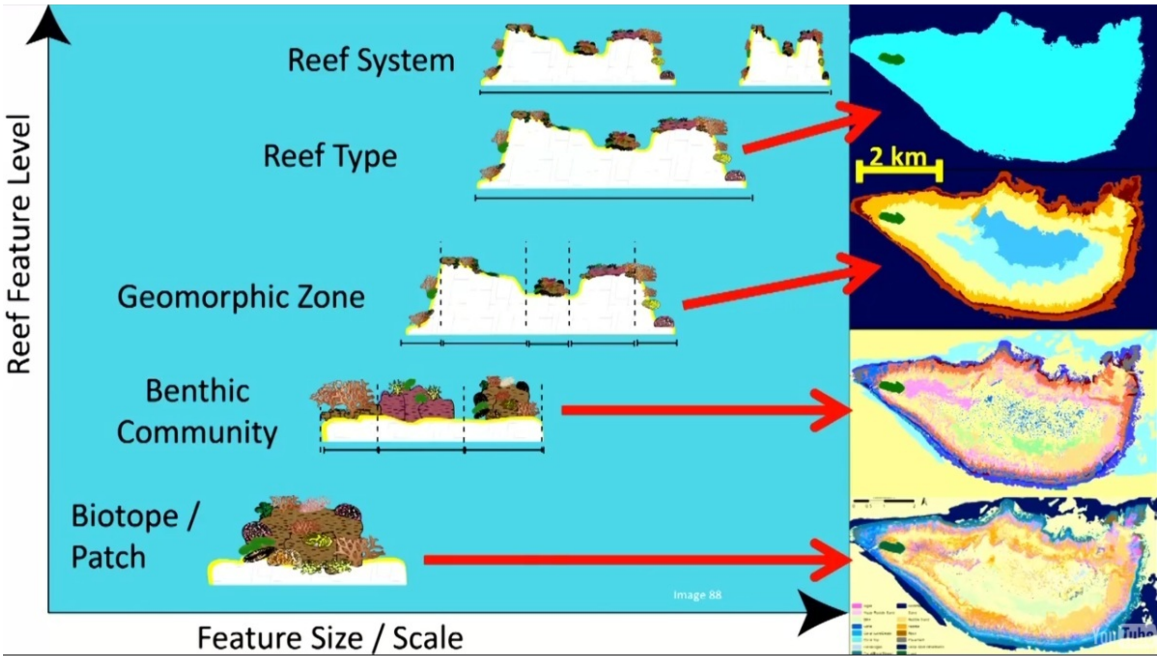
• Reef system

• Reef type: fringing reef, or lagoon reef, or a barrier reef.

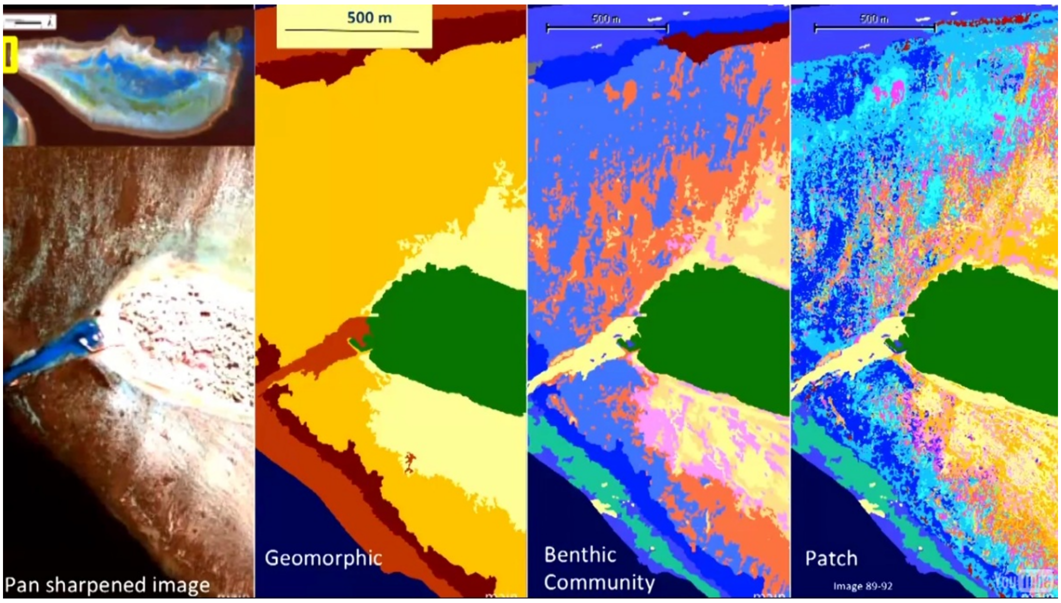
• Geomorphic zone: different zonation: reef slope, reef crest, reef flat and the lagoon

• Benthic community: sand rubble algae, algae coral sand and coral rock

• Biotope/Patch: coral, algae, benthic micro algae, sand, rubble, and rock



Each of these maps provide valuable information but at different spatial scales and detail. This kind of information can be used to help management and research.



Summary:

• Understanding and managing any ecosystem requires information about its composition, biophysical properties, and how they are changing over time

• Remote sensing enables essential ecosystem information to be measured, mapped and monitored