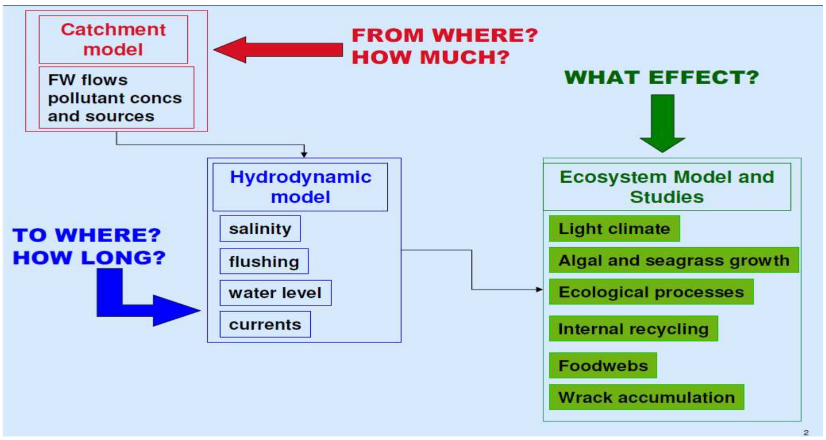
The Office of the Environment and Heritage's Kirsty Brennan's and Dr Peter Scanes' presentation[1], 21 June, 2011 at 7:00pm on "Tuggerah Lakes Ecological Response Modelling"

The Chairperson of TEPCP, Vivienne Scott gave Kirsty Brennan and Dr Peter Scanes a warm welcome reminding those in attendance that tonight's presentation was about the condition of the lake and what causes it and not about solutions such as providing a permanent opening at The Entrance,

Peter began by saying that his job was providing scientific advice to parties on estuary and coastal waters in NSW. He is providing Wyong Shire Council with the tools necessary to understand the causes of the condition of the lake to enable Council to manage them. The presentation was the result of eighteen months work with Wyong Shire Council. He explained that they use mathematical equations to model ecological changes and thus to understand how the ecology of the lake operates. This allow us to compare Tuggerah lakes with other lakes.

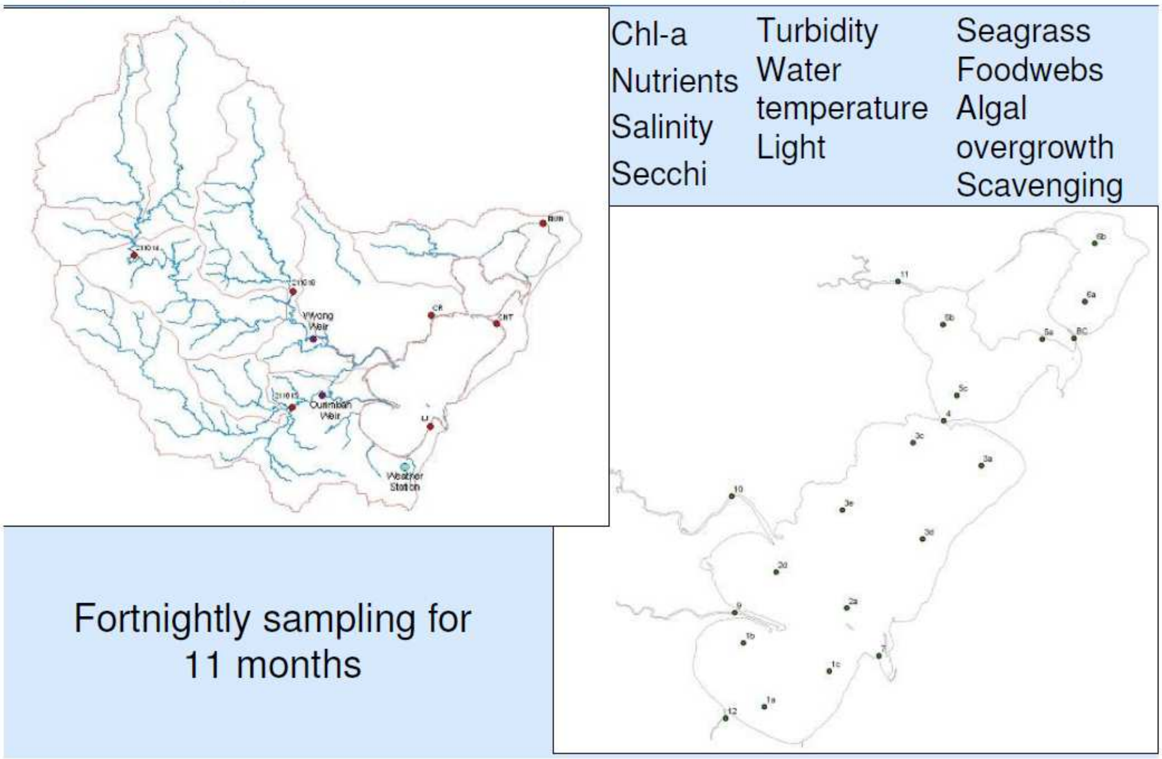
The presentation was divided into two parts with Kirsty Brennan taking the first and advised that they were contracted by Wyong Shire to model the ecology of the lake. Kristy said modelling consists of boxes; information goes in and information comes out. What material goes into the lake and where it goes to. She presented the following slide to illustrate this process.



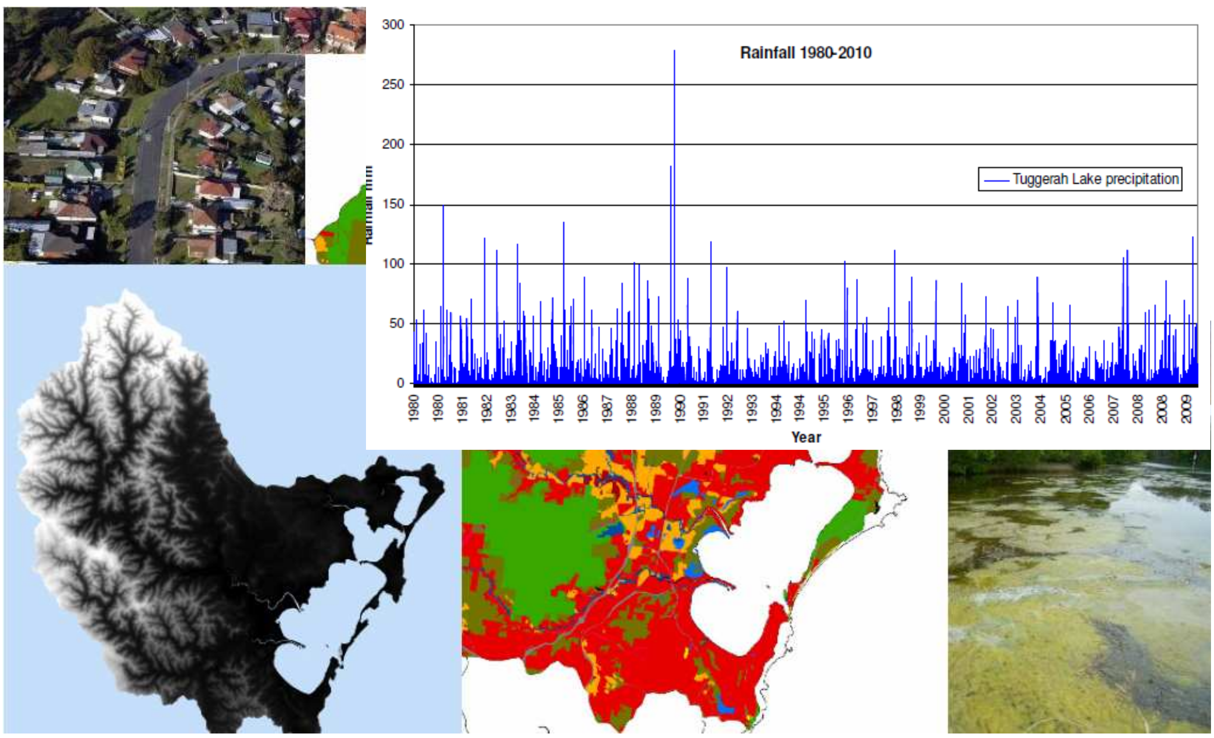
[1] Scientific Contributors: Dr Angus Ferguson, Dr Sonia Claus, Tony Weber, Brian Sanderson, Joe Neilson, Renee Gruber, Jaimie Potts, Aaron Wright, Dr Rod Connelly Technical: Cheyne Ramsay, Gus Porter, Michael Orr, Chris Richard

The outputs get put into the second box, the hydrodynamic model, salinity, flushing water level and currents. These effects, things like wind, go into the third box. Models are only as good as the information put into them.

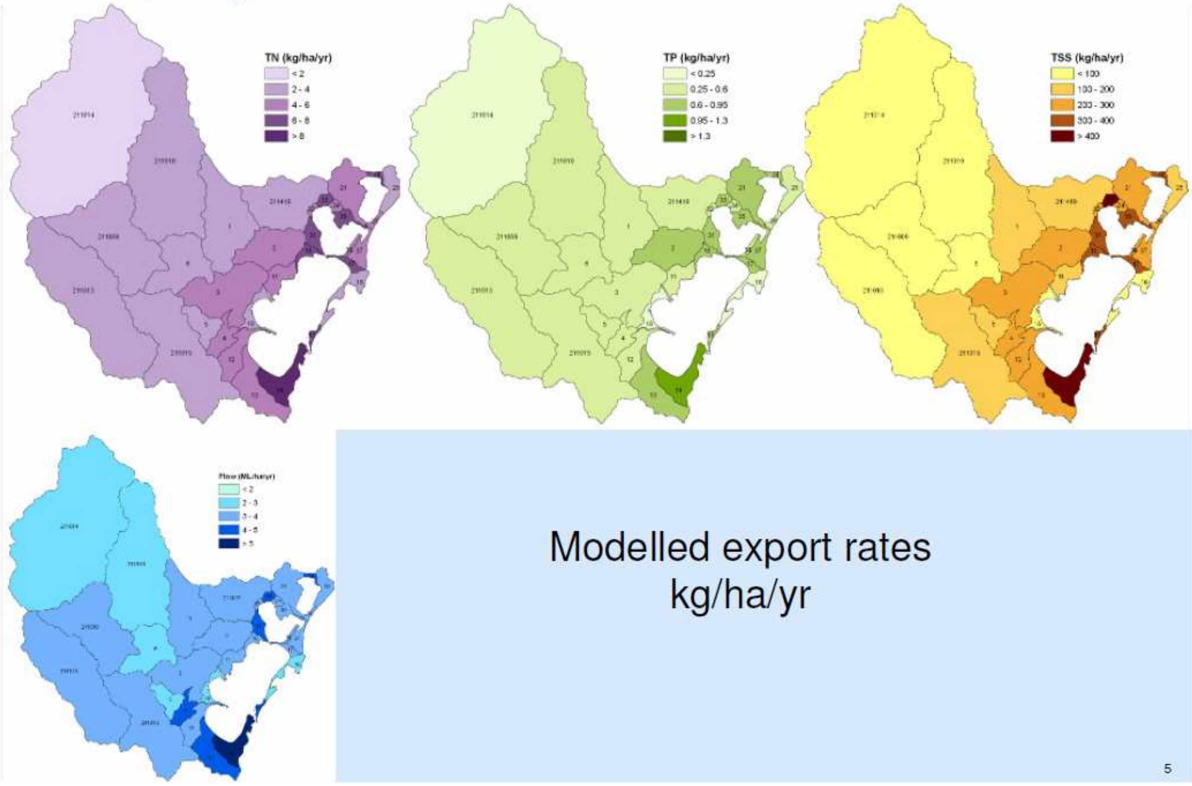
Field samples were taken for eleven months looking for the key indicators. Experiment were on what drives the sea grass were carried out. The samples were taken from three gauging stations, two weirs, four drains and nineteen lake sites.



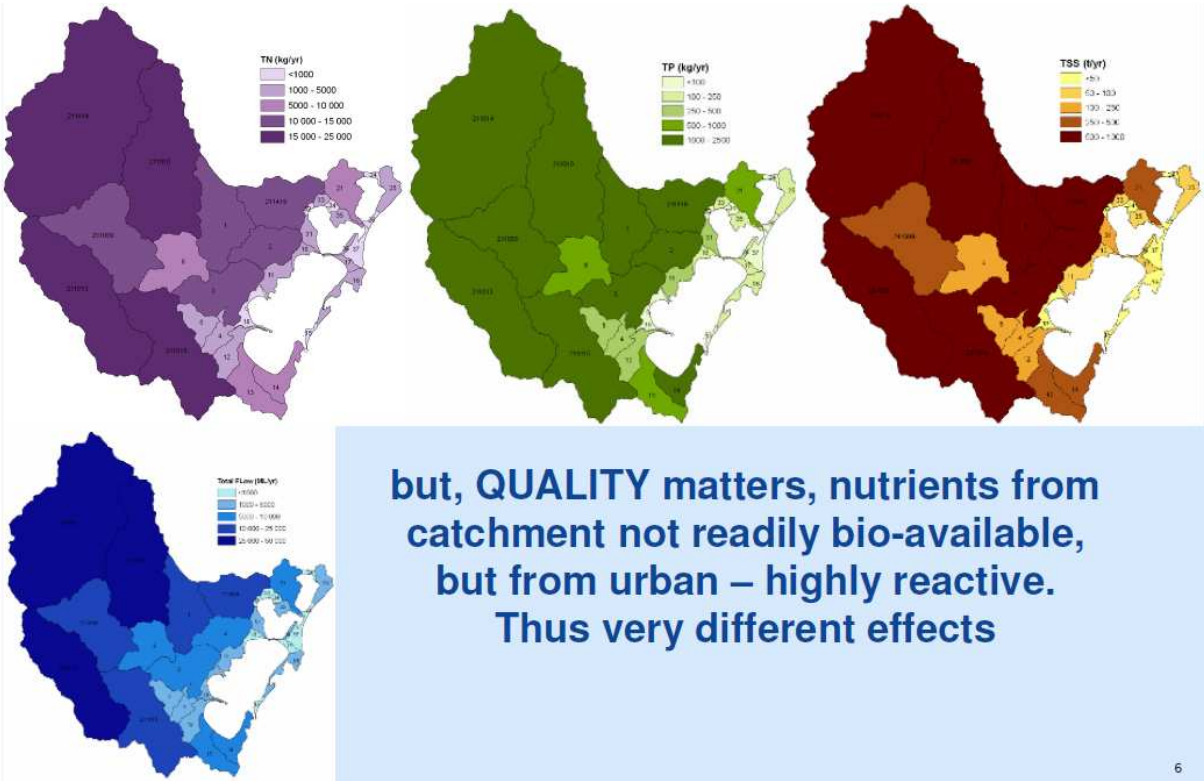
In order to develop a model we need to look at Landuse, Elevation and rainfall:



Outputs show; Total Nitrogen (TN), Total Phosphorates (TP) and Total Suspended Solids (TSS)

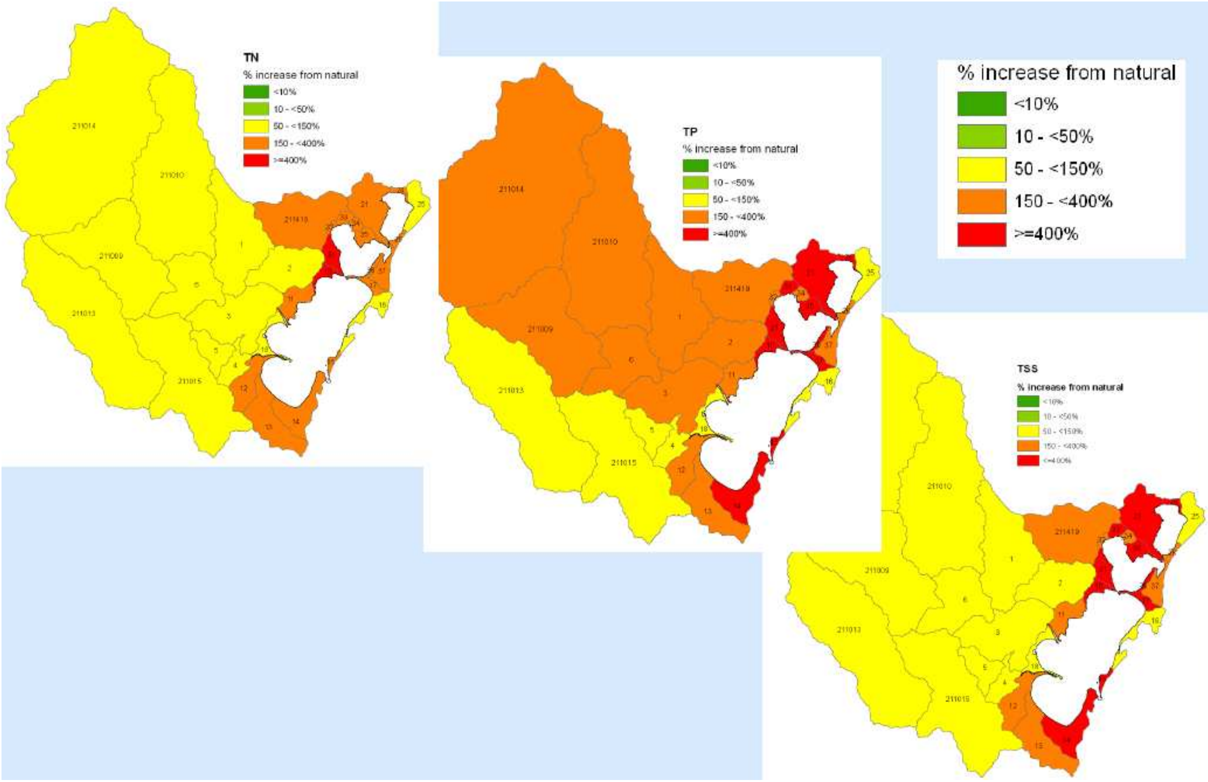


The model shows the fringe areas around the lake produce the most per hectare per year.



Considering the Total Catchment Model, the larger catchments produce the most "stuff". The "stuff" from the upper catchment is different from the "stuff" from the lower catchment. They come down into the lake by rivers and creeks. In the urban catchments the runoff from the roads. The nutrients are attached to the sediments. The total nitrogen from the road is quiet different from those from the upper catchment.

The next slide showed the Pre-settlement scenario:

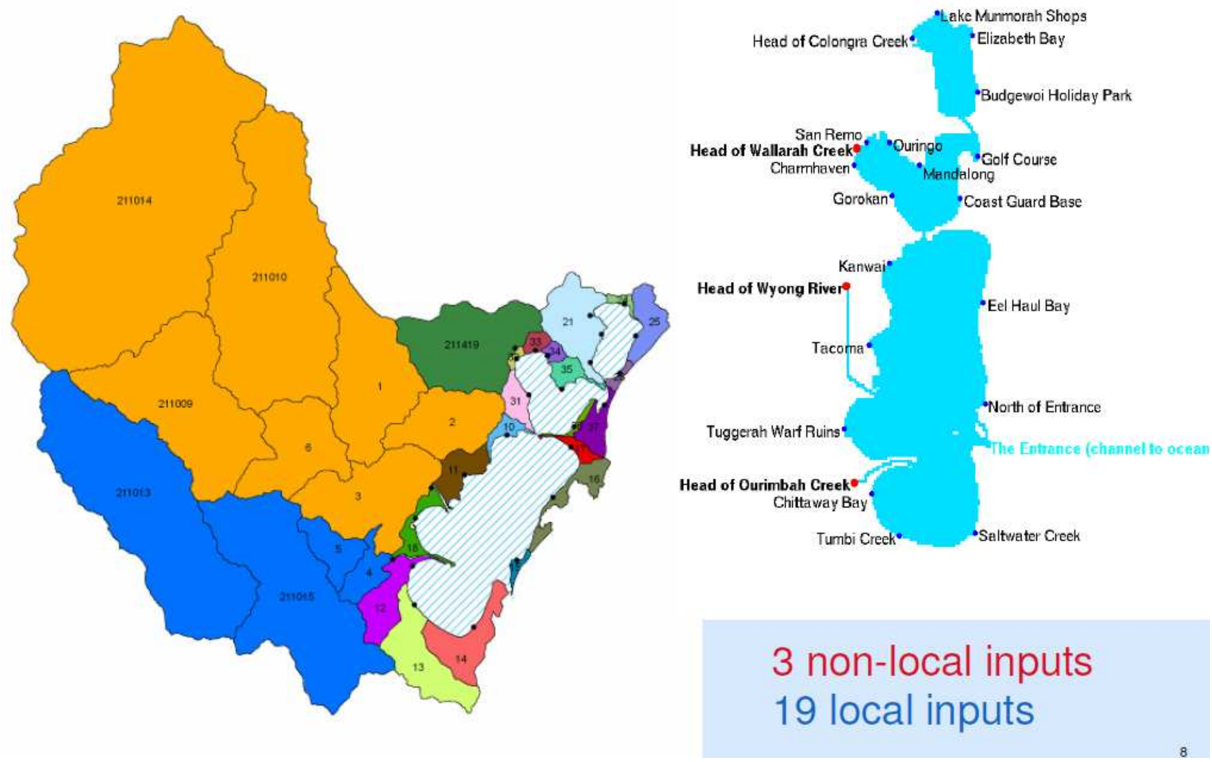


Once the baseline model was running, we tested scenarios to see the difference in nutrients and sediments that occurred before development. A number of scenarios were tested. The scenarios are to see what effects land use changes have on the nutrients and sediments entering the system. The catchment model was set up using land use which is 100% forested to test the likely loads for each subcatchment under natural-like conditions. We then compared the current modelled loads to see how far the system has deviated from a natural state.

To compare the percentage increase in load to the lakes from each fringing catchment as a result of urbanisation, we use land use that is 100% forested. The trends are similar for TN, TP and TSS

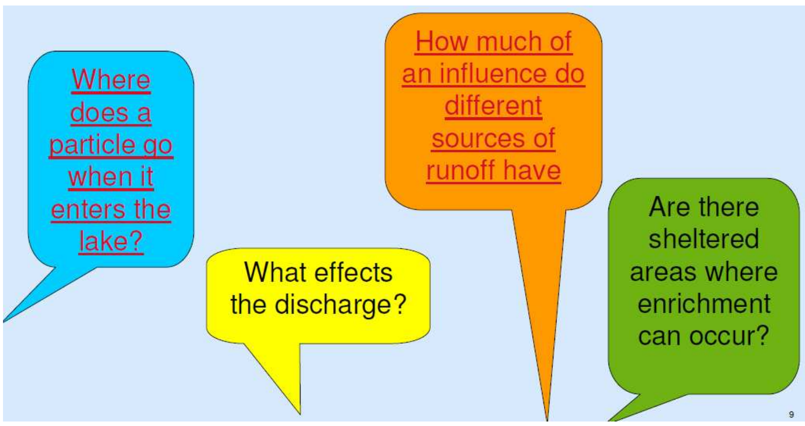
While the larger catchments deliver the largest loads, this is just due to their size. The subcatchments with the biggest change from natural are the urban catchments fringing the lake, with up to over 400% increase pre-settlement.

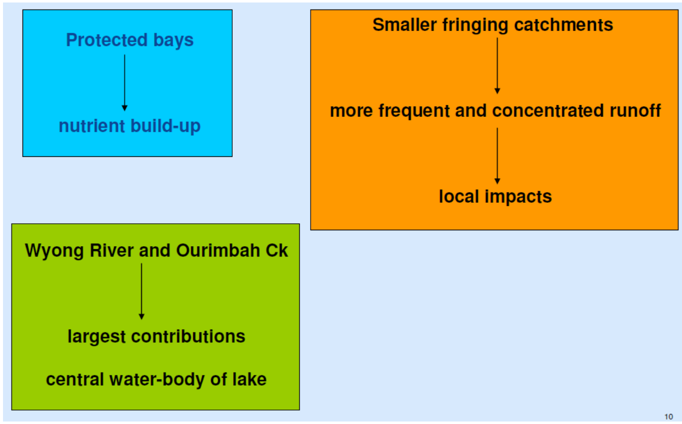
The next slide showed the Hydrodynamic model setup:



There are three non-local inputs, Wyong River, Ourimbah Creek and Wallarah Creek and nineteen fringe catchments via drains.

The hydrodynamic model results shows:





Kristy then showed an animation of the sediment movement.

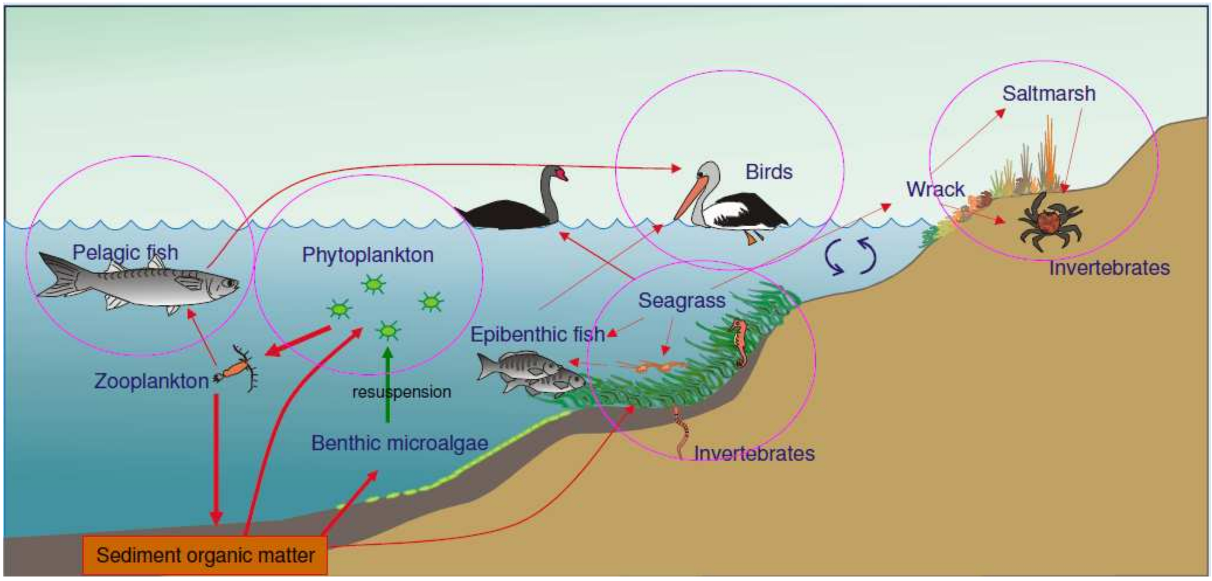
It showed the movement of water throughout the system and highlights the areas of most and least activity. It showed that Chittaway Bay is relatively sheltered and water may stay in this bay for some time. Tuggerah Bay by comparison is well flushed according to this model. The discharge from Wyong River showed the movement from the Wyong River as it moves around the system. It also showed the distribution of runoff from the subcatchments draining into Wyong River and the relative impacts on other areas of the lakes over time.

Runoff into Tuggerah Lake has an impact on Budgewoi and Mumorah lakes. Seawater through the entrance allows some exchange.

David Ryan[2] then commented that the animation shows that sediment is being moved around as the water is being moved around. The image showed that the water coursing from the fringe drains is mostly being trapped in the edge of the lake

Kristy then handed the presentation over to Dr Peter Scanes saying that after we have an idea about where it comes from and where it goes, we need to know what effect it has on the lakes.

Peter's part of the presentation was on Estuary Ecology.



Peter began by telling us that "Ecology" is how everything intertwines and relates to each other. What we have been trying to do is disentangle and describe the elements. That is we have been looking at the food webs around the lake. Peter described the food chain in its simplest forms giving the example of how cows eat grass, and in turn humans eat cows, showing that grass impacts on humans. The grass cows eat depends on sunlight. Chlorophyll is vital for photosynthesis, which allows plants to obtain energy from sunlight. The food chain starts with plants. Their characteristics get carried through the food chain. We set out to find what the higher end animals rely on in Tuggerah lakes. Scavenging is a measure of how active fish are in the system. Sea grass[3] is a very important.

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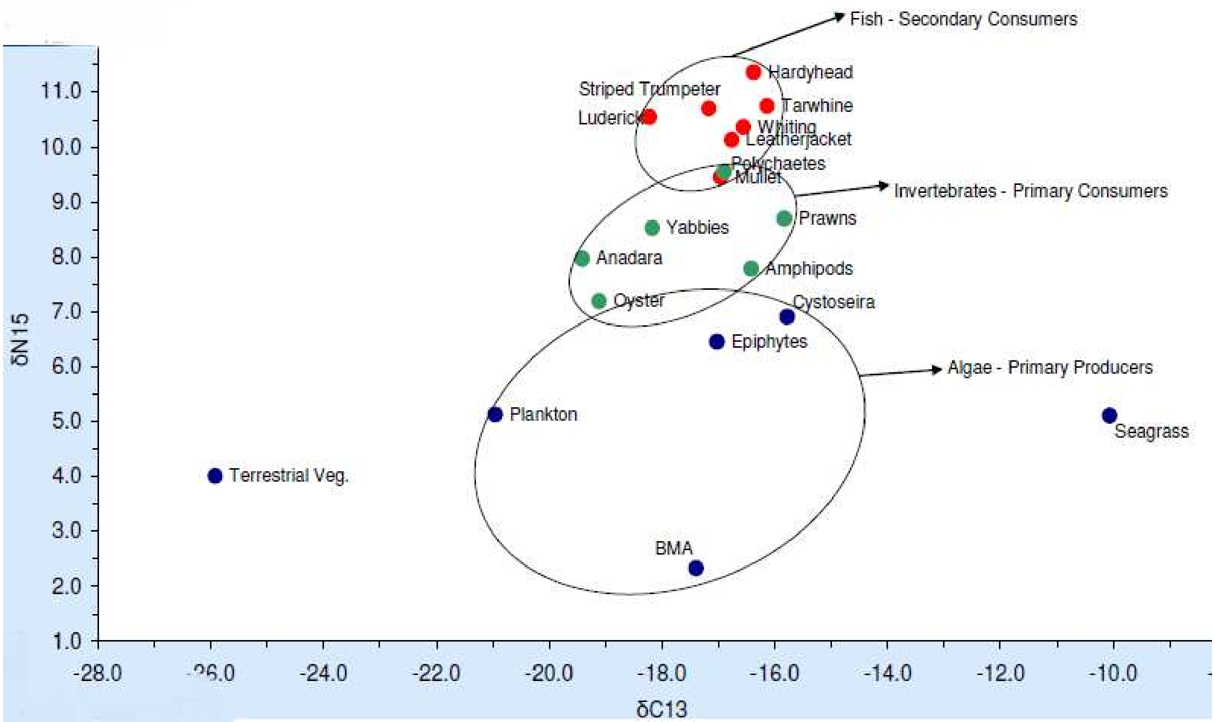
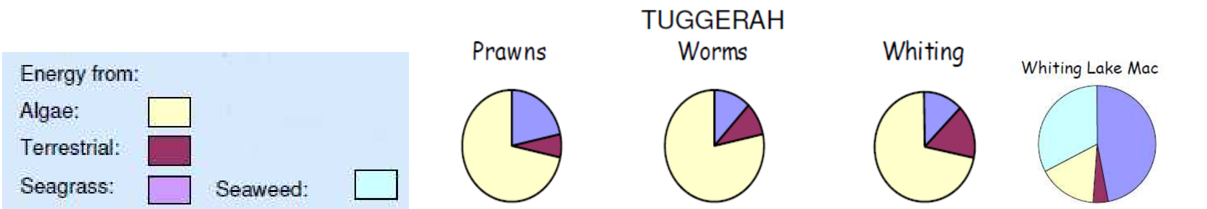
[2] Dave Ryan, Acting Manager Estuary Management, Wyong Shire Council.

[3] Section 7–2 of the WATERWATCH ESTUARY FIELD MANUAL is on identifying sea grass and can be accessed on our web site: http://www.theentranceprecinct.org/WATERWATCH/Estuary/Estuary%20Field%20Manual.pdf

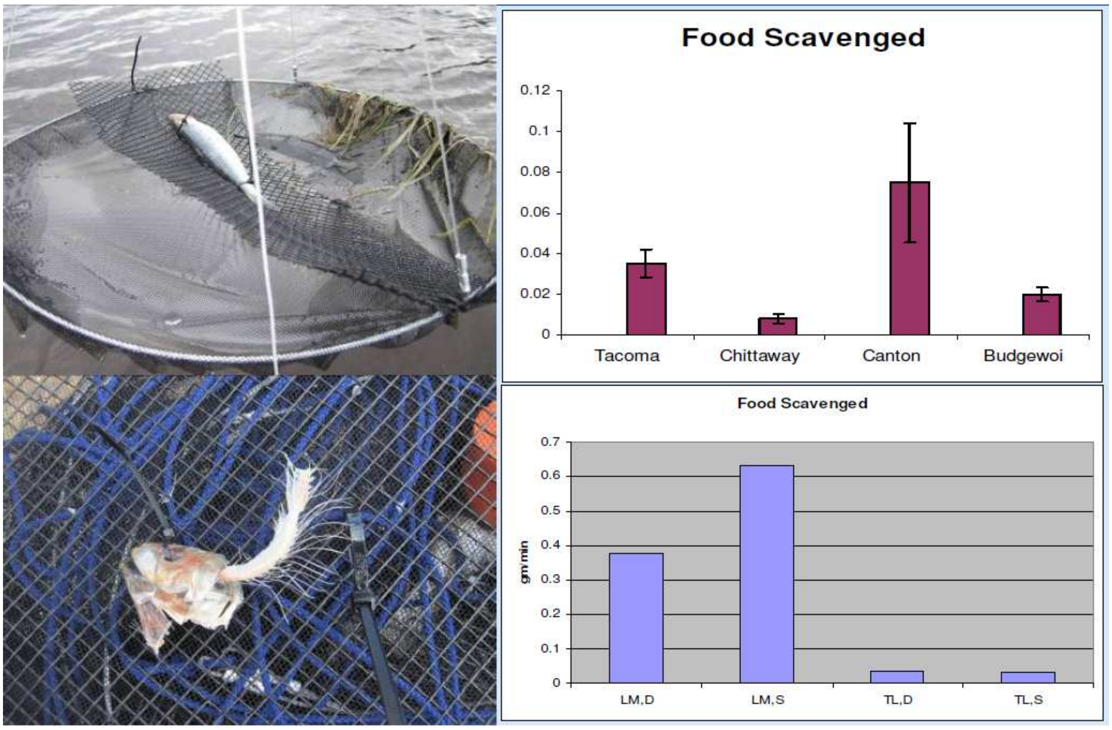
The next slide Peter showed gave examples of the species collected that form the food web: sea grass; algae; middle plants; antipodes; yabbies; prawns; grass fish; mullet and other things. This allowed them to build up the lakes food chain. Peter then showed the **Tuggerah Foodweb - Biplot** seen below.



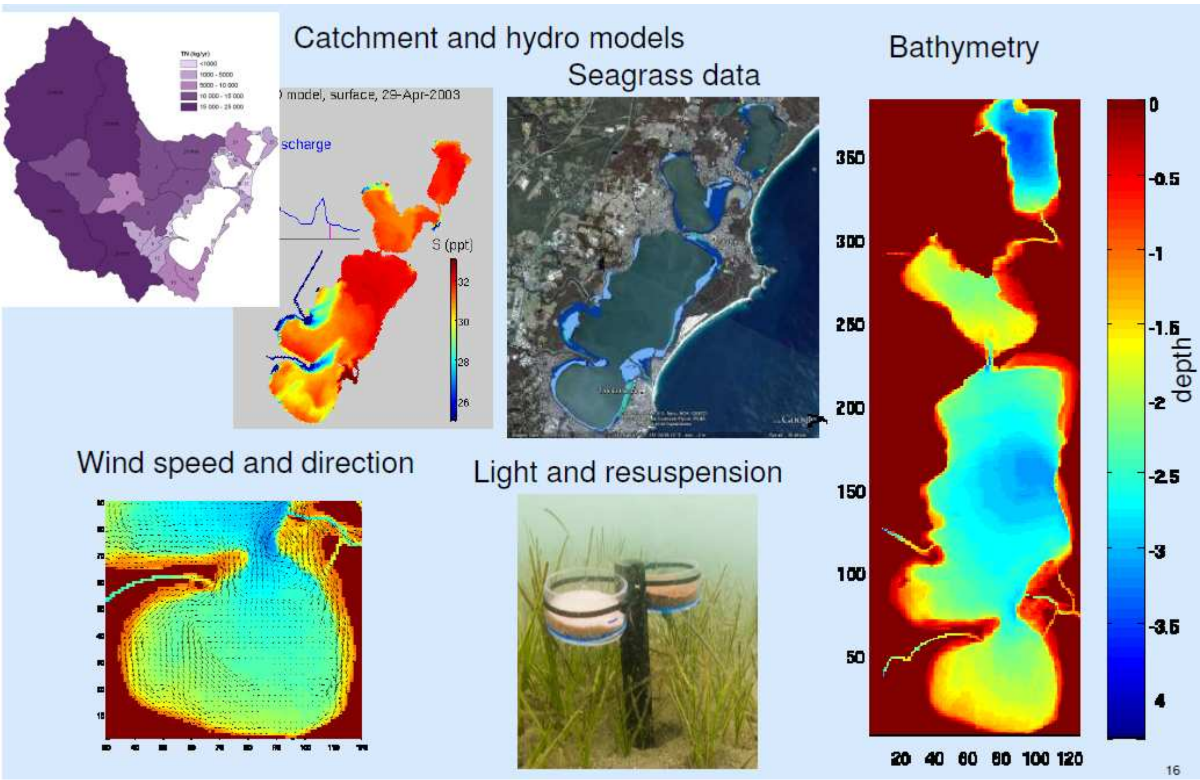
It consists on Terrestrial Vegetation on the one side and sea grass on the other. For Tuggerah Lakes most of the food chain is based on algae. Animals in the middle groups feed on algae. Most lakes are based on seagrass. This system has lost most of its seagrass. This is not a good thing - it is not a bad thing.



The next thing we looked at was the scavenging. We put a pilcher out and looked at how soon it was eaten. If you compare it to Lake Macquarie this activity is very small and indicates a system under pressure.

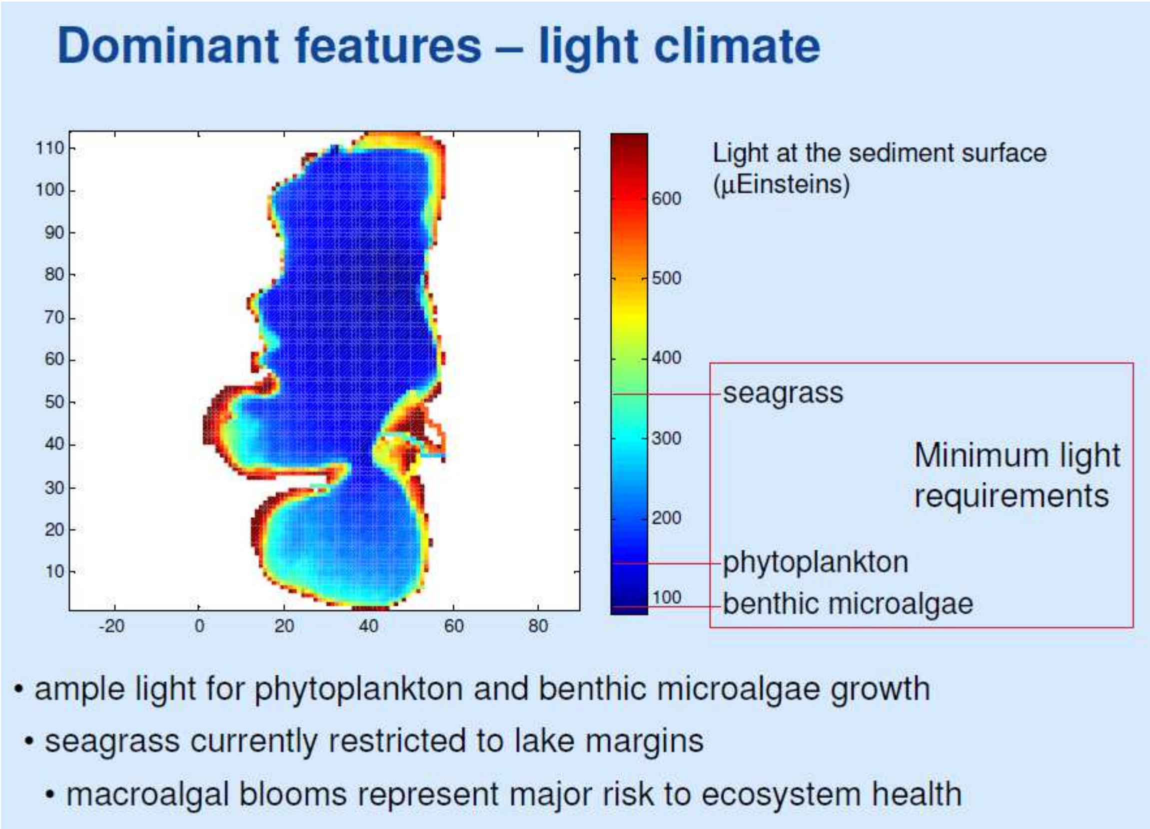


Peter then explained how they use the model to look at the growth of seagrass and algae. They needed to know the depths of the lake, most of which is less than 2.5m deep[4]. Life depends on light through the water. Seagrass tends to survive when it gets enough sunlight.

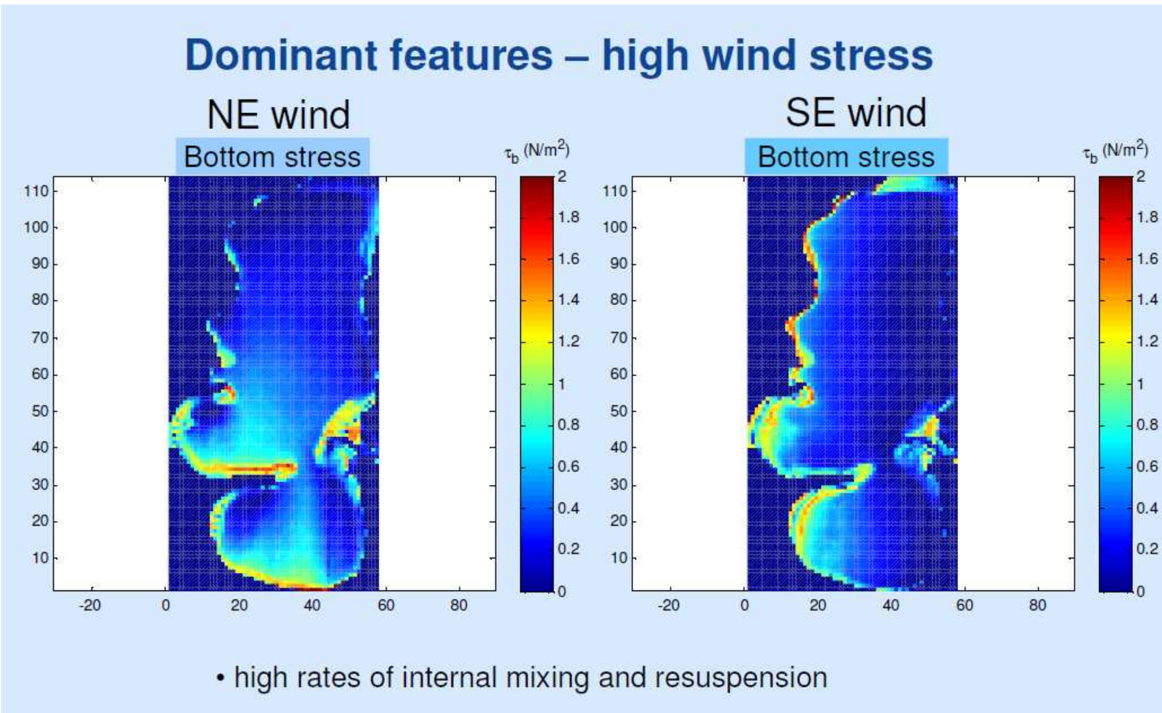


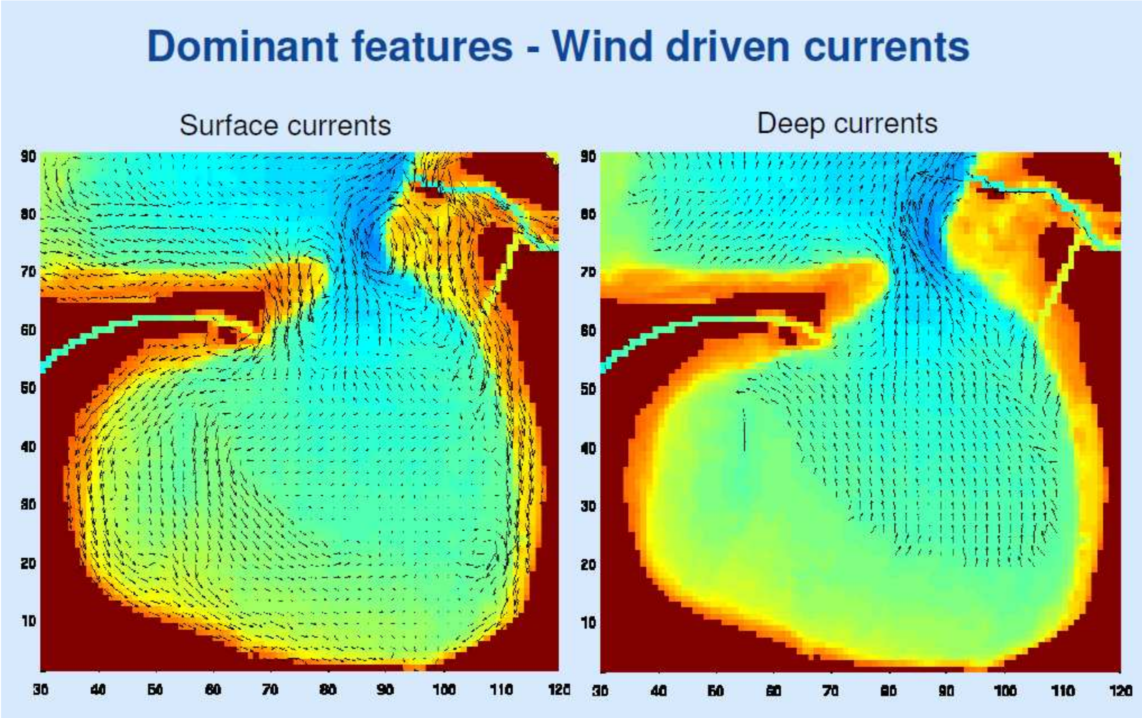
[4] **Bathymetry** is the study and mapping of seafloor topography. It involves obtaining measurements of the depth

The Hydrodynamic Model shows how the currents moves material around and how wind causes the re-suspension of solids. The model simulates conditions for one year. It shows that material moves around all the time. It shows what happens to the light and what happens to the algae growth.

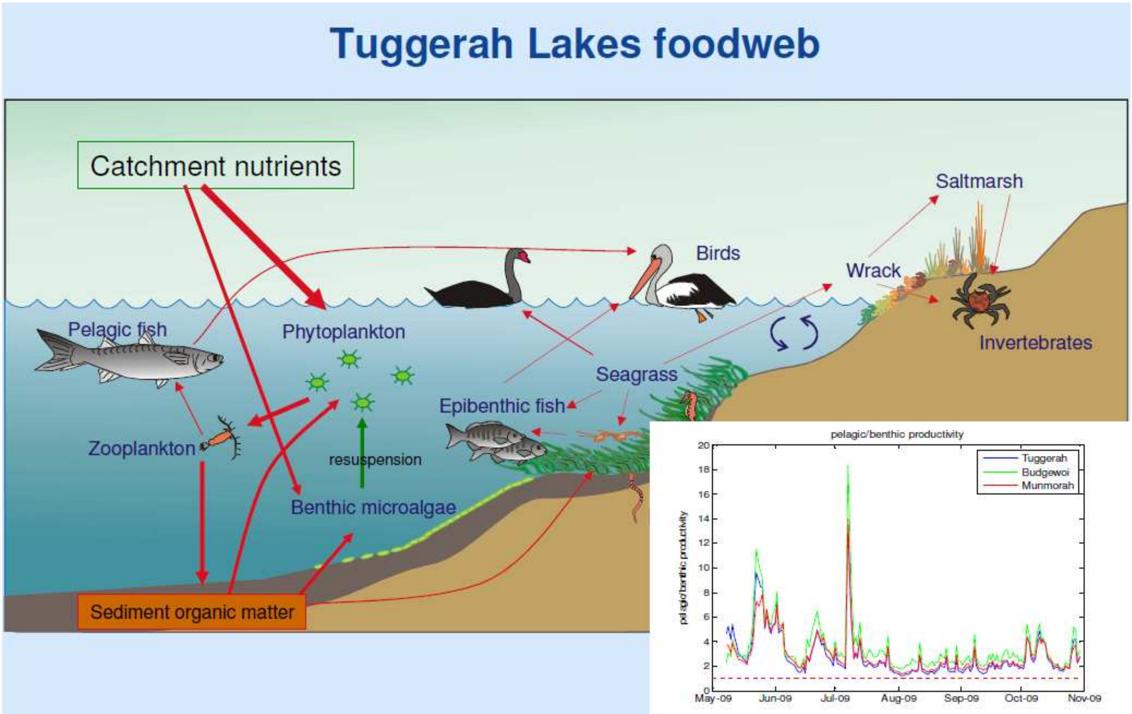


Seagrass grows between the yellow and the light blue. Using this as a model of ecological response, we look at the ability of seagrass to survive and algae to grow. The chlorophyll level is higher than we would expect. There are muds instead of white sand and the water is murkier than it was. The greatest threat to the lake system is the sediments coming in because they are making the water murkier. It is three times murkier than it used to be.





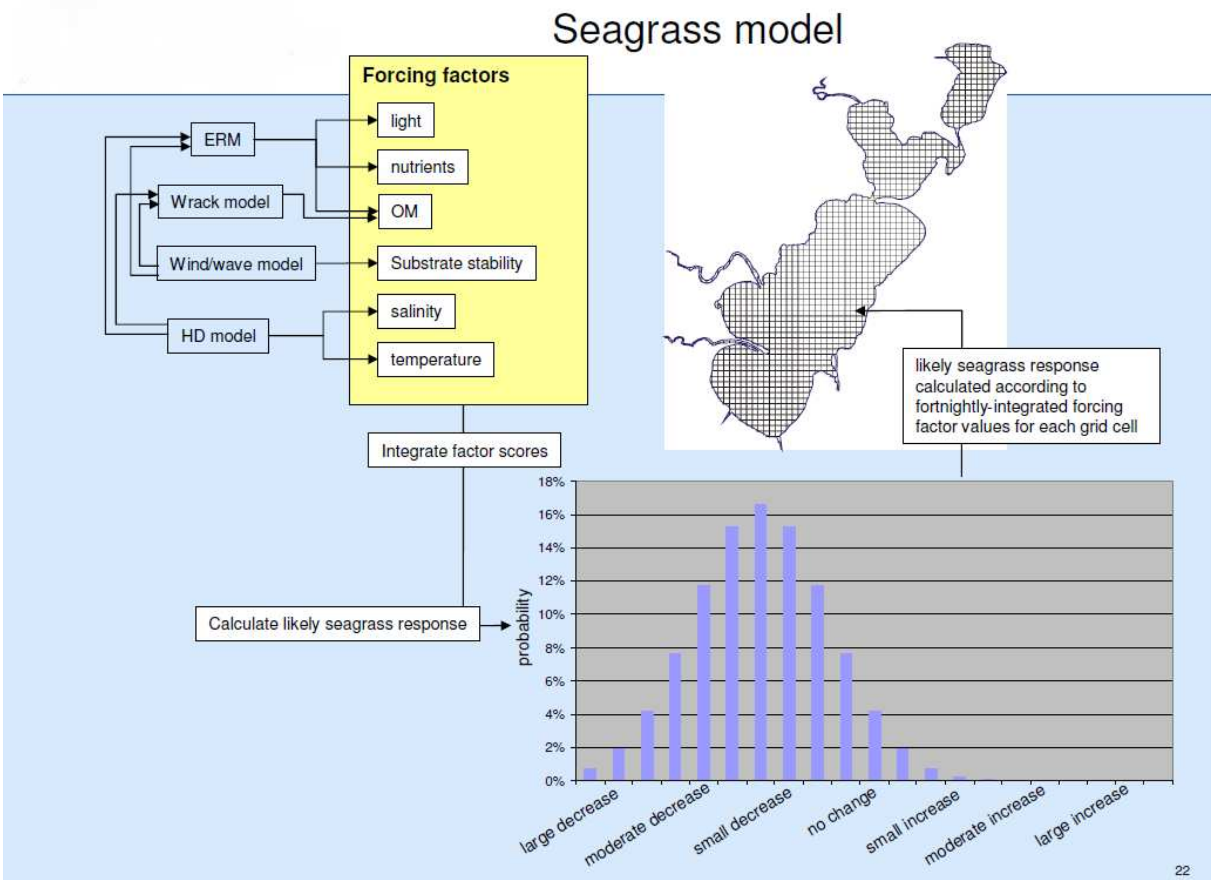
We have the concerns in the fringe catchments. Here all the nutrients, like grass clippings etc. flow into the lake and ate trapped near the shore.



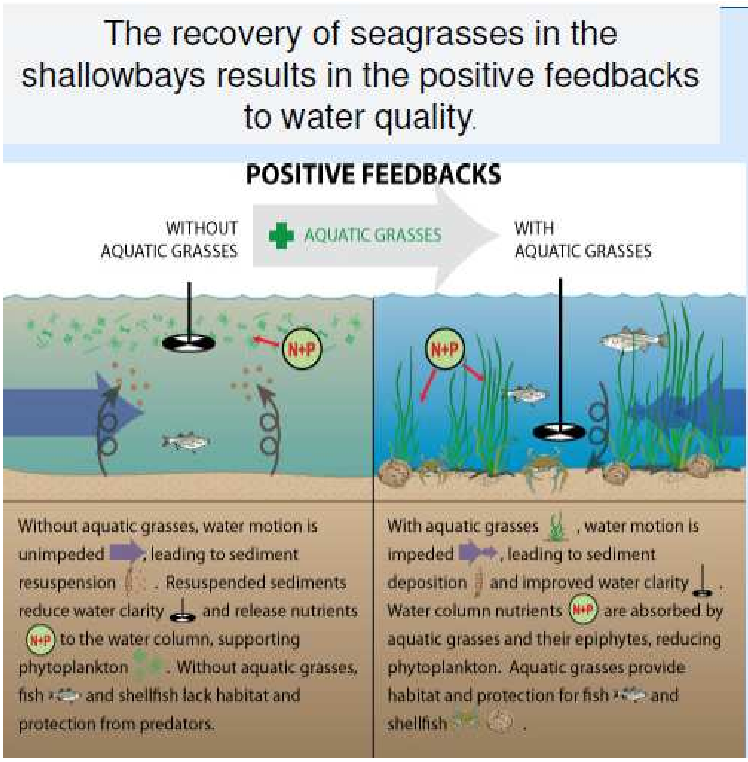
Main Findings

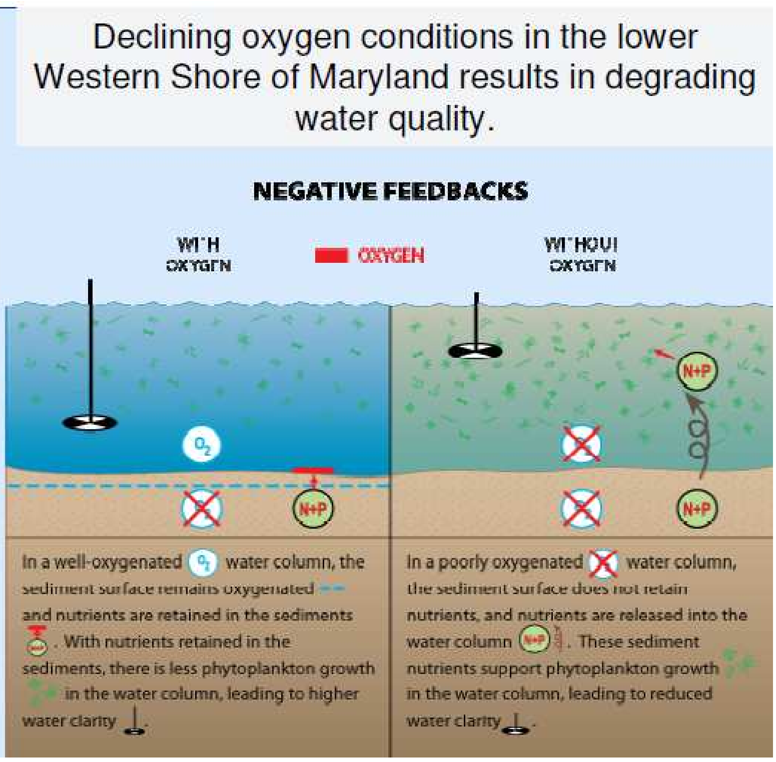
- Chlorophyll, organic sediments have increased; water clarity has become poorer; seagrass cover has declined.
- Wider Catchment - sediment is a greater threat than further small increases in nutrients, but nutrients should continue to be controlled.
- Fringing Catchment - nutrients, sediments and organic are a large threat due to retention in fringing zones (ooze formation, algae).

Peter then explained the Seagrass model.

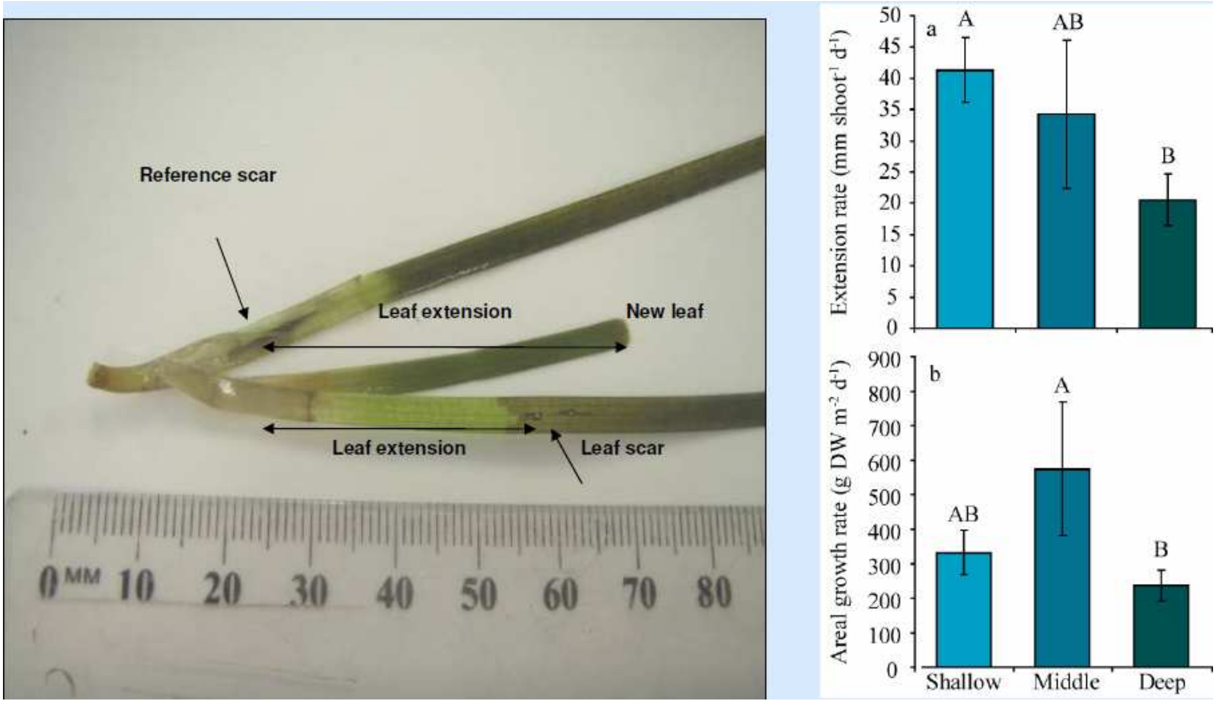


It shows the things that effect seagrass. These are labelled as forcing factors, things like light, nutrients, etc. Seagrass is a habitat and a food and has a positive effect on water quality. Waves stir up sediment resulting in more algae growth and sediment re suspension. You can't get the seagrass back until you improve water clarity. The following slide shows feedbacks – Chesapeake Bay, USA

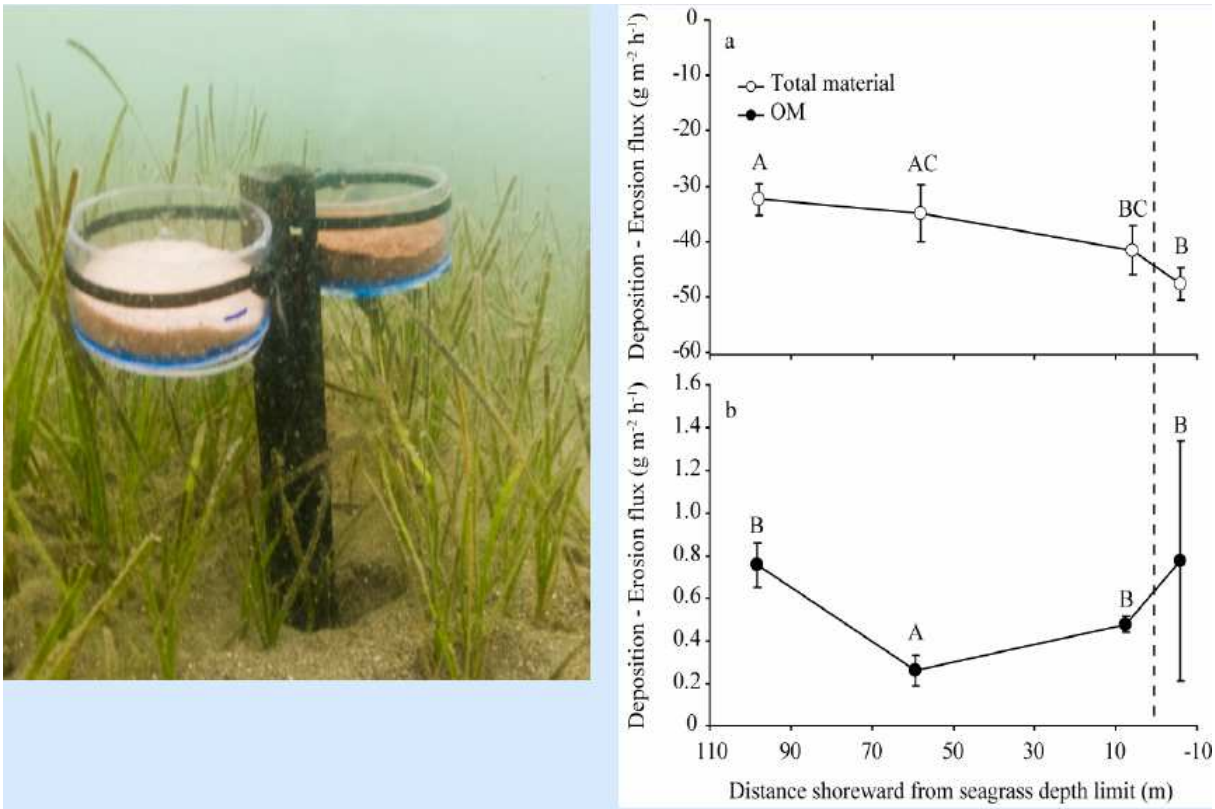




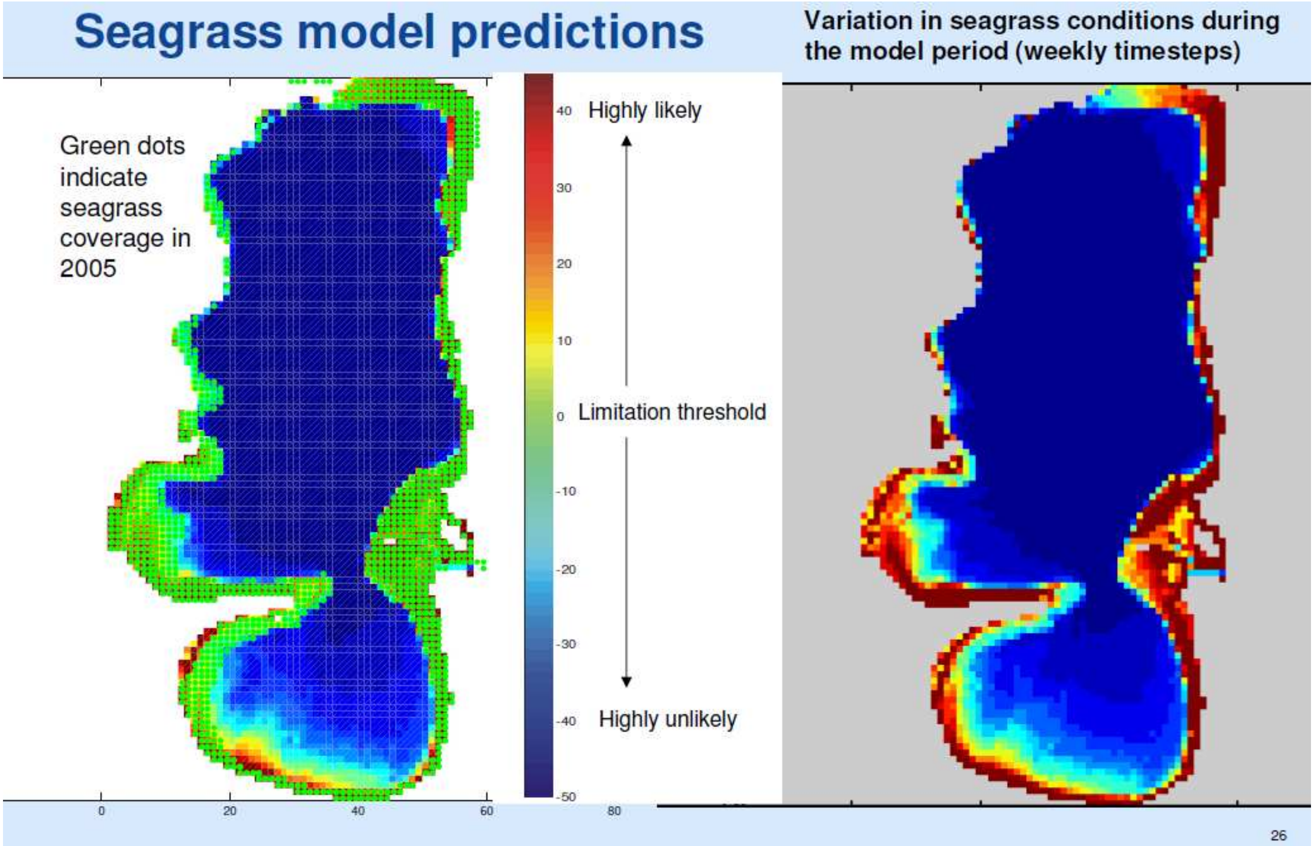
There was little information on how fast seagrass grows. We put a nick in the seagrass with a pin hole at the bottom end. The scar moved with the growth enabling us to measure the growth rate, which is 40mm per day as shown on the graph on the left of the slide. Imagine the mowing if your lawn grew at an inch and a half a day!



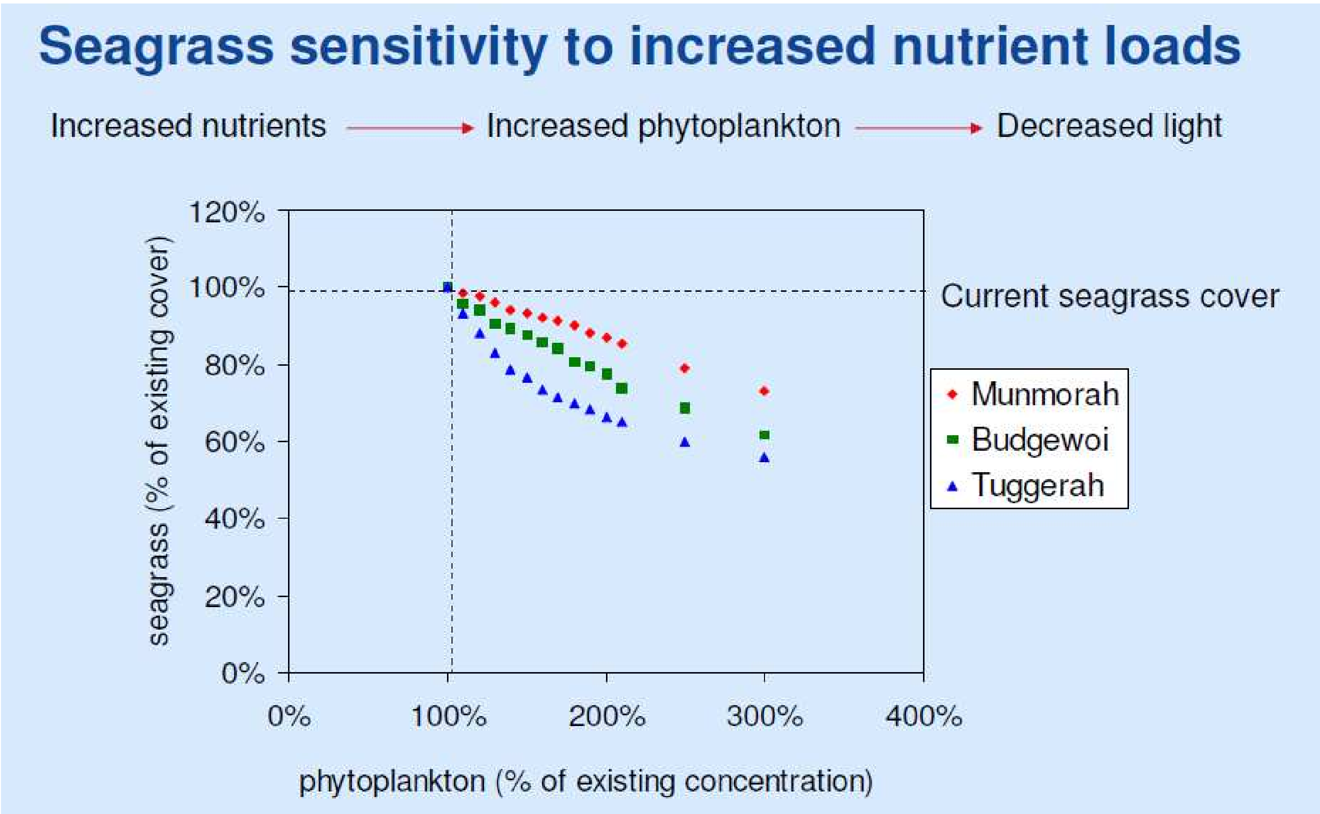
The other thing we investigated was how much does seagrass stop storms from resuspending sediments.



The model was run all the so it would show where the seagrass is able to survive. It averaged out the weather conditions needed to survive and showed the long term average.



The model is used to test different scenarios over the period.



In 1941 there was a wide area of sand along the Long Jetty shore and the sea grass was in deeper water. The near shore zone changes with development. The lake level is stable because the entrance is open.

Historical changes to the nearshore zone

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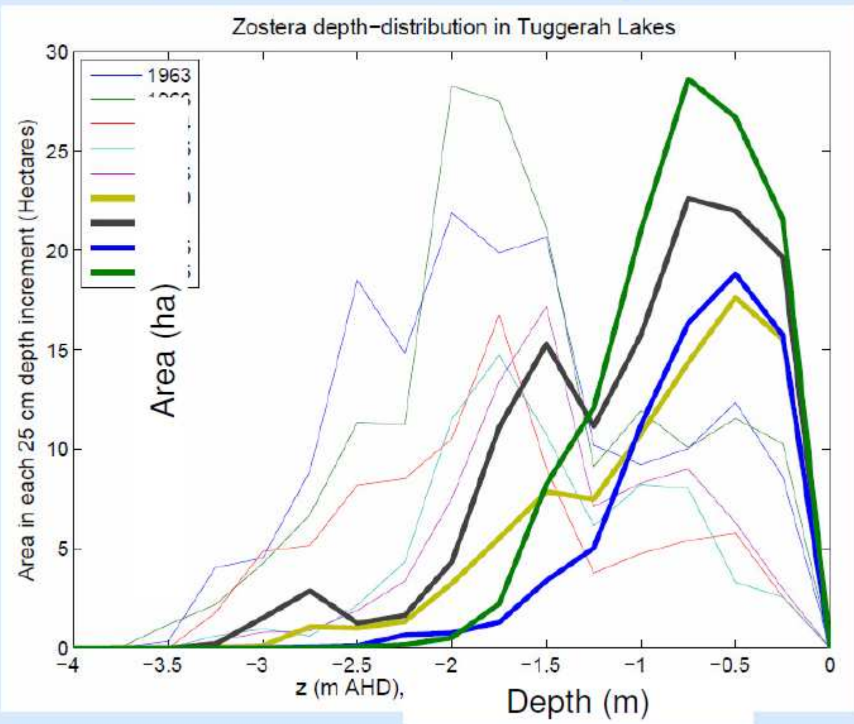
The graph below shows the steady march of the seagrass closer to the shore because the increase in sediment makes the water murkier and growth is not possible in the deeper water.

Historical shoreward migration of seagrass



- **Reduced light prevents growth in deeper water**
- **Altered shoreline and constant depths allow growth in shallows**

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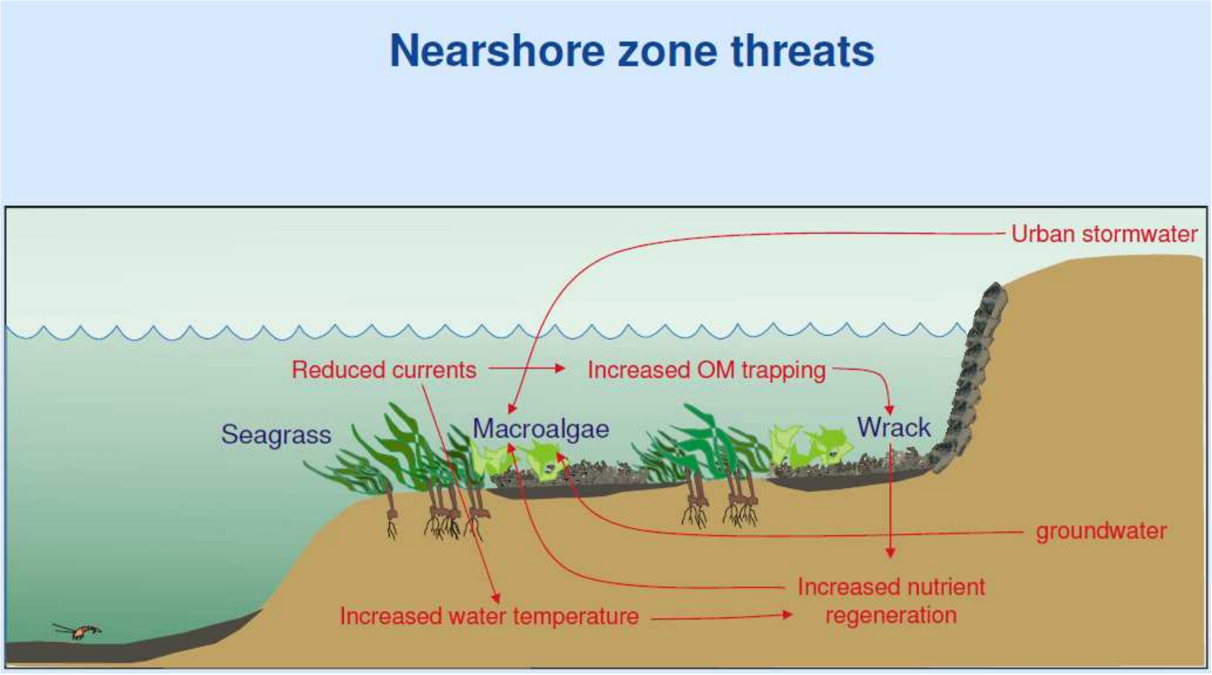
Development changed the shore line, making it more vertical and the seagrass is squeezed into a zone closed to the shore. That is the reason why the seagrass becomes rank. It causes the black ooze to build up.



Peter made the following conclusions from the results of their modelling.

- The shallow nature of Tuggerah Lakes leads to high phytoplankton and benthic microlalgal production
- The near shore zone has been significantly altered and is primed for further degradation if urban inputs increase
- Wrack degradation is fastest during the first 2 weeks, then is significantly slowed. Rate is then highest among seagrass beds
- Seagrass has migrated shoreward over the last 50 years and will experience significant decline if water quality and macroalgae blooms worsen
- Fine suspended sediment and organic matter are the biggest concerns (reduced light) – impact on seagrass and contributes to ooze
- Much of the resuspended material is comprised of algal concentrations which contains both phytoplankton and benthic microalgae (BMA)
- Resuspension can increase algae present in the water column up to 200%
- Seagrass beds reduce the amount of resuspension

Peter advised that he usually finished with a slide that quoted Professor Graham Harris who said: *"If you are looking at the lake and wondering how to manage it, then you have your back to the real problem."* You don't manage lakes, you manage their catchments.

Vivienne Scott thanked Kirsty Brennan and Dr Peter Scanes for their detailed and informative presentation on the ecology of the lake.

Note taker: Doug Darlington