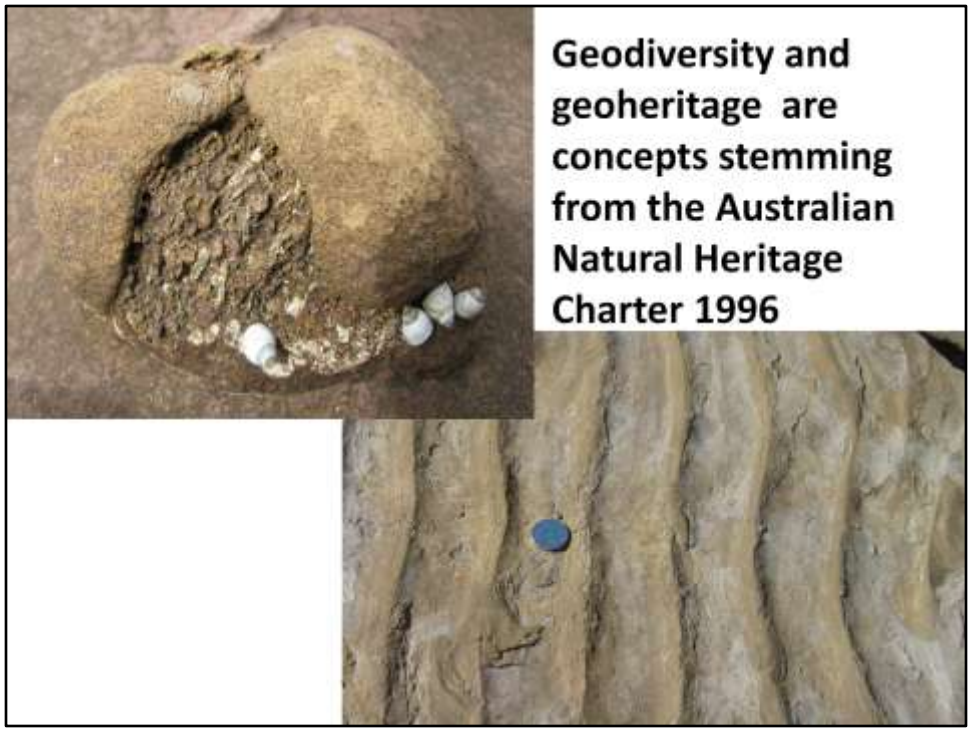
SYDNEY COASTAL COUNCILS GROUP

Coastal geodiversity under threat.

Dr Peter Mitchell



Two words that you may not be familiar with but if you know what biodiversity, is then apply the same idea to all earth features and processes.

Geoheritage is the interesting things, fossils, sedimentary structures, landforms and so on. In this talk I am not concerned with them but with the variety of geologic and geomorphic conditions that provide the substrate for inter-tidal and shallow marine biodiversity.

Shore platforms are great places for kids and families. Their biodiversity attracts people but what attracts the organisms?

It has a lot to do with the substrate. Different rocks have different surfaces, different physical form, and different weathering characteristics. Some rocks are pretty simple and don't provide a variety of habitat opportunity, others provide a wealth of variation and biodiversity shoots up to take advantage of it.

Hard rocks like granite make good solid cliffs and tor fields, but poor shore platforms. They are difficult to break down, produce hard slick surfaces which are tough to hang onto, and they have relatively few crack and crevices because their joints are wide spaced defining big blocks that are usually very tight.

The total surface area available for colonization is limited to vertical faces and biodiversity is low.

Granites weather and produce a lot of quartz sand so beaches in this system are either coarse quartz sand or boulder fields.

Abandoned granite boulder beach.

But every time I make a generalization an exception will pop up. This granitic rock has very close jointing making lots of spaces for living and allowing it to break down quickly to the low tide level of saturation creating wet flats amongst the outcrop, and sandy beaches nearby.

Basalt, another hard rock that commonly has columnar joints that are a function of cooling. Surfaces tend to be vertical, the joints are tight, and the rock weathers fairly slowly so living spaces are limited and biodiversity is low to moderate.

But basalts are often layered in sub-horizontal flows separated from one another by less coherent volcanic ash beds. The softer sediments erode easily and basalts can make quite large inter-tidal platforms often with deep pools on the surface of the next lower flow.

The margins of such pools may be protected by bio-constructed rims of coralline algae and the base of the pool in this case has a collection of large boulders that were partly responsible for eroding the pool.

Boulder beaches are common in a basalt environment, creating a paradise for crabs, but sand beaches are rare as the weathering of basalt produces very little sand size material as all the minerals in the rock are converted to clay.

Again I have an exception. This is a basaltic dyke that has intruded shale and is exposed on the Long Reef shore platform. Water layer weathering, slaking and abrasion by gravel has planed off the platform surface to an almost uniform depth and there is no obvious difference in the distribution of organisms on the basalt compared with the shale.

Move to the sedimentary rocks such as Sydney's quartz sandstones and structure, particularly joints and bedding planes, is again seen to be an important control of cliff and platform topography.

Joints in granite and basalt are stress relief fractures caused by shrinkage as the rock cools. Joints in other rocks are fractures made as a result of tectonic forces. Jointing always has a pattern and joints occur across a huge scale range.

This sandstone at Norah Head (a person is arrowed) has great vertical zonation of organisms in each embayment but low total surface area and it's a bit like granite – it doesn't have the biodiversity you might have expected.

Smaller open joints in sandstone at Long Reef. These blocks are about 2m across but the joints are persistent and allow water to flush along the crevice with almost every wave. Biodiversity is high and the crevices support organisms that are normally found below low tide.

Another sandstone and the joint spacing is between 20 and 100mm. These joints are sealed by iron oxides and it isn't the joint that weathers out but the intervening rock and that can make mini-pools. High on the rock platform these pools will dry out, further down they might get extra salty and hot but they will support organisms.

Put vertical joints and sub-horizontal bedding together and you develop ridge and gutter topography like this which will have isolated pools that become hyper-saline in the sun alongside well flushed pools. There are also shady places and exposed surfaces, boulders and other sediment in the gutters and the biodiversity becomes seriously high.

The message: **structural complexity on the shore platform creates varied living spaces and promotes biodiversity.**

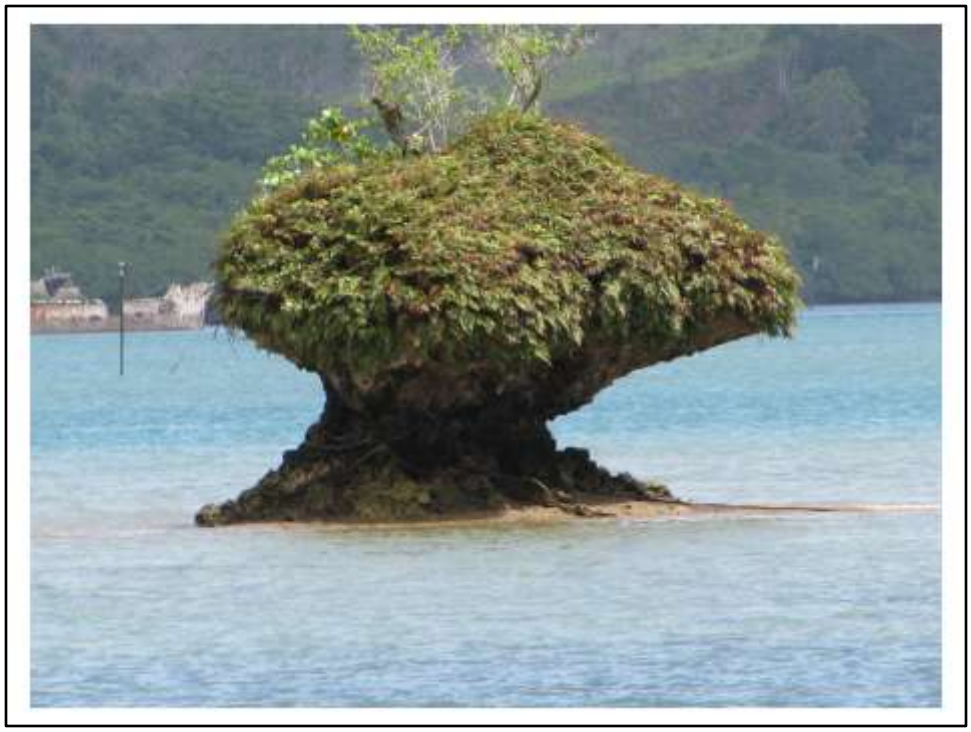
Still in sandstone, but more subtle. No joints to speak of and a sandstone that weathers rapidly to mud not sand and in the process forms a series of concentric spheres or onion rings around a less weathered and slightly higher core. The distribution of oysters and Neptunes necklace reflect these differences.

Moving to soft rock we find other patterns. On shale that frets and slakes with wetting and drying joints still form shallow pools but nothing much can live there as the surface fails so frequently. On a daily basis you won't notice it but the erosion rate over a year or so is easily measurable.

Even softer, barely consolidated rocks such as at Aldinga create a lot of soft sediment and we have a shore platform that is drowned in mud and shell sand. This condition favours burrowers but not much else.

A most extreme example from Auckland where there are beds of weak sandstones and soft mudstones. Oysters settle on the sandstones and the mud between is full of burrowing bivalves, worms and echinoids. Is it a shore platform or a muddy beach? Well it still has geological integrity and I reckon it's a shore platform but not everyone would recognize it, and unfortunately it's not an easy one to visit.

SA well known Victorian coast with soft sedimentary rocks; limestones, calcareous sandstones and marl, well bedded but with no jointing to speak off in a high energy environment where the cliffs and stacks are rapidly eroded. They do make narrow shore platforms but those beneath the cliffs are buried in mobile sediment. Inter-tidal biodiversity is quite low.



Some rocks are chemically special, for example limestones are generally almost in chemical equilibrium with sea water but not with fresh water. In this reef limestone wetting and drying combined with the effects of boring algae create classic visor structures on the cliffs and rock stacks.

This is a carbonate cemented dune sandstone – aeolianite, note the complex bedding.

In the spray zone the periwinkles cluster in holes dissolved by rainwater.

But the shore platform is planed off almost level close to low tide where the rock is saturated and stable. Pools are formed where there are variations in the bedding planes that we saw in the cliff.

Finally in the metamorphic rocks such as slates and quartzites which have been tossed and turned, and baked and fractured so that they have some very complex structure. Apply our rule of structural complexity leading to high biodiversity and that's exactly what you find. Look at all the living spaces visible here!

And just to remind you that not everything can be explained geologically here is another nice example of bio-construction, mussels and coral worms, it hardly matters what the substrate is, it's not even visible.

So it seems that geodiversity is an important factor in providing living space for intertidal biodiversity but the original question was, is it threatened?

Rising sea level?

- The low tide end of our shore platforms will become marine.
- The high tide end will be compacted against the cliffs and we will get more cliff failures.
- As beaches wash away a few new shore platforms will appear but the overall message is that we are looking at loss.

We have changed the shore platforms in lots of small ways but in comparison to the next few decades to a century of projected sea level rise these are not important.

Is there anything we can do about it and how can we use the lessons from geodiversity?

These days, especially in the city we have lots of engineered inter-tidal surfaces. To some extent they can be used to offset some of the natural losses if we engage the right design rules,

Remember structural complexity leads to biodiversity.

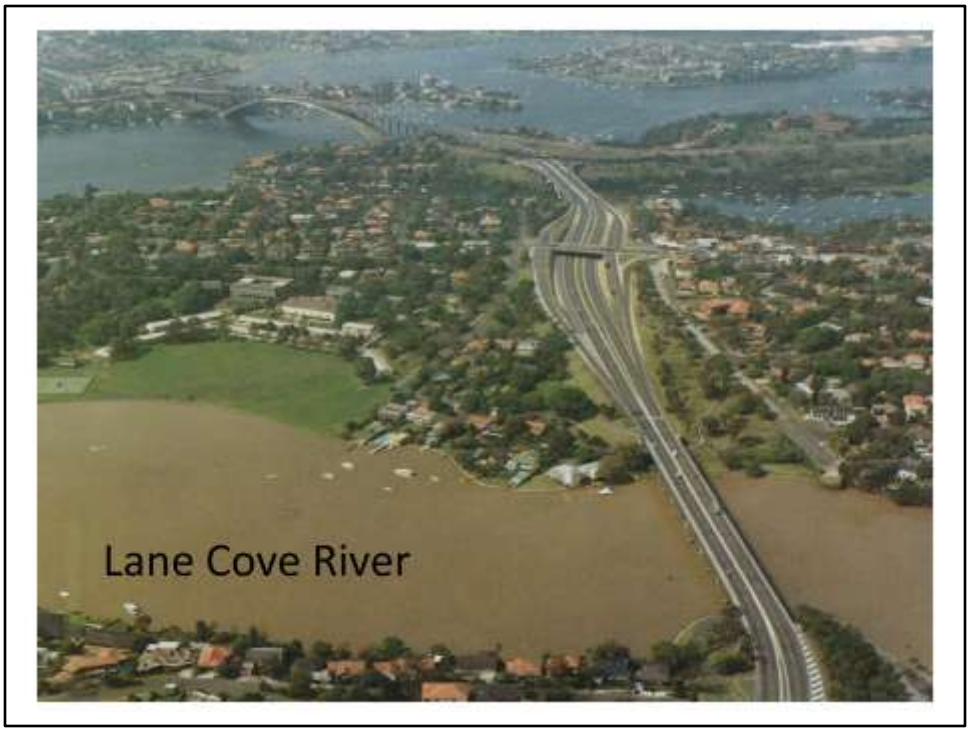
But we do not have that complexity in our engineered surfaces.

This is a bit of old concrete swimming pool wall. It started life smooth and is now developing some surface roughness but concrete does not colonize as well as natural rock at any time - possibly because it has very different surface pH.

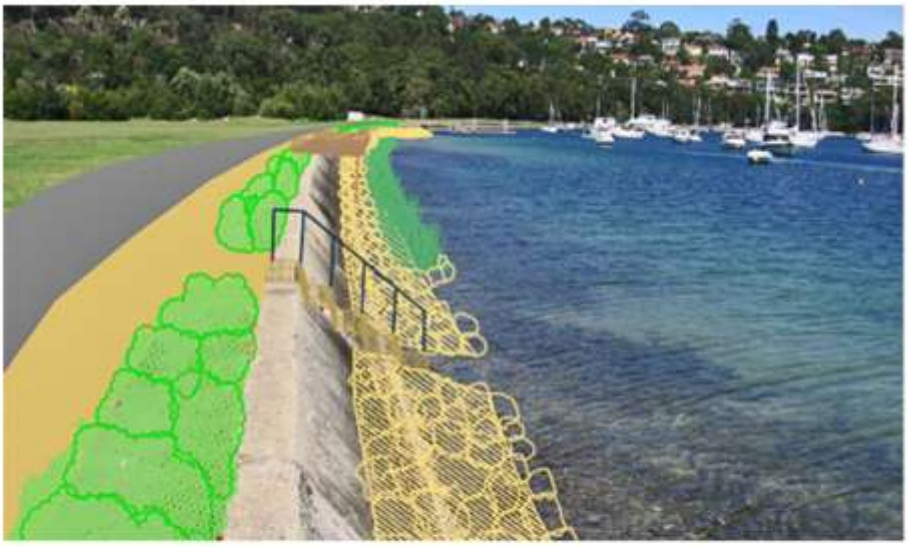
Inner harbour sea walls

We have many km of sea walls especially in the harbour. Not much chance of high biodiversity on these is there? And note that the one on the right is regularly overtopped by King tides, I'm sure that wasn't part of the planning brief - it's sending a message to that Council.

A lot of the upper harbour walls are like this. They often retain areas of landfill where saltmarsh and mangrove have been converted to soccer fields. There used to be quite a lot of shore platform in the harbour too but upstream of the coat hanger these surface are being smothered by suspended mud and on those near stormwater drains the organisms have to deal with high pollutant loads especially zinc.



Does the photo need explanation? The lower Lane Cove River after a fire. Sediment loads always increases in urban areas and that seriously compromises biodiversity, on the bottom, on the banks and in the water.



Mosman Council concept drawing for seawall reconstruction at The Spit. 2009

Sea walls are everywhere. They are almost all poorly constructed. They don't meet today's protection requirements and are mostly in poor condition.

But Mosman Council have begun to think differently about seawall reconstruction by including shoreline habitat in the design. By reinforcing the old sea wall with constructed boulder fields and making places for salt marsh to establish they have created habitat, done a bit to offset losses and Council staff say it was actually cheaper.

I'd like local government to think hard about our impending loss of coastal geodiversity and start to dream up some new approaches to engineered hard surfaces in the inter-tidal zone.

If we can just maintain the future options for nature then maybe this won't be the only way your descendents get to play with crabs.