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Tipping Points in Coastal Ecosystems

Change can happen fast in our coastal ecosystems and we often do not know what has been lost until it's too late. Once ecological 'tipping points' are passed, it is difficult to reverse the state of the ecosystem.[1] Often these changes creep up on us because they are caused by the cumulative impact of multiple stressors. These changes in ecosystems mean we can lose important ecosystem functions that underpin many of the things we value about out coastal ecosystems. One of the key challenges of ecosystem-based management (EBM) is therefore to identify what combination of stressors are likely to cause threshold changes and what parts of the ecosystem are most likely to be affected. A multi-institutional team of scientists from across New Zealand is conducting the science to assess the risk of passing these 'tipping points' in estuaries before they happen.

The Tipping Points project is an essential part of the Sustainable Seas National Science Challenge, and explores how estuaries respond to sediment and nutrient loading, two of the most important land-based stressors affecting the coast. Sediment inputs can smother shellfish beds and reduce water clarity,[2] while nutrient loading can promote blooms of nuisance macroalgae[3] and alter sediment conditions. When acting in concert, these subtle but cumulative impacts can profoundly change the way estuaries function and diminish the goods and services we enjoy from these ecosystems.

An integral component of the Tipping Points project is field experiments conducted from Northland to Southland to examine the impacts of nutrient and sediment runoff into estuaries and harbours. These experiments focus on sandflats as these areas are an important source of kaimoana, provide nursery habitats for juvenile fish and are critical habitats for natural processes that reduce excess nutrient loads. At each study site, we measured these processes – ecosystem functions – to assess how the estuaries are responding to the impact of nutrient enrichment against a background of reduced water clarity, which indicates sediment inputs.

The artists working with us were interested in these measures of ecosystem functioning and the scientific method used to measure them. Using mixed media, the art installations explored how we measured ecosystem responses such as organic matter decay. Artist Becky Cameron was inspired by the Rapid Organic Matter Assay (ROMA) we used to measure degradation rates at different depths in the sediment. ROMAs are perspex plates with a series of replicated wells of a known volume that

are filled with a carbon-rich substrate.[4] Researchers can measure the degradation of this substrate and relate that to how organic material is broken down, recycled or how carbon is sequestered deep in the sediments. Using the shape of these plates as inspiration for her art, Becky created round tiles using clay and sediment from one of our field sites, Blueskin Bay. The individual tiles had imprints from various components of the estuarine food web in Waitati. Her work explored the current and past environmental condition of the estuary to portray how humans have changed this ecosystem over time. Becky used the template to show how marine science uses multiple lines of evidence to gain a better understanding of the health of the ecosystem.

In another art installation relating to the Tipping Points project, artist Jessica Ritchie explored how the release of nutrients from the sediments influences processes in the overlying water column. This movement of nutrients out of the sediments is in part a product of the breakdown of organic matter as assessed by the ROMA plates. Jessica adapted the custom-made incubation chambers we use in the field to measure these sediment-water column fluxes in nutrients and produced her own chamber which enclosed a painted world. Her installation combined the field and laboratory components of our research as she mixed the field-based chamber measures with a technique we use in the laboratory to assess microbial decomposition rates. Jessica was inspired by the spectrophotometer we use in the laboratory to measure enzyme activity by bacteria.[5] The intensity of fluorescent light represents the bacterial activity, which provides data on the nutrient conditions and rates of microbial processing in the estuary. Jessica's vibrant fluorescent colours in her painted work captured the interconnectedness between processes.

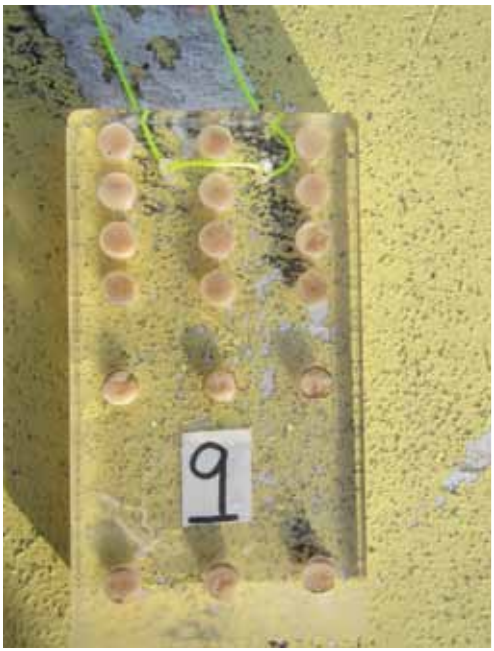

Figure 1. A Rapid Organic Matter Assay (ROMA) plate showing the wells filled with substrate that are used to measure organic matter breakdown. Photograph: Jenny Hillman.

Figure 2. The paired light and dark chambers used to measure ecosystem functions like nutrient and oxygen flux in the field, in this case Blueskin Bay, Otago. Photograph: Candida Savage.

The Art + Oceans Project has provided an opportunity to connect the collaborative process around multidisciplinary science, such as the Tipping Points project, with the creative process that artists use when interpreting science. The resulting artworks captured the complexity of unseen interactions that happen in estuarine ecosystems and, importantly, engage people in looking for connections between how we use these systems and the threats they face. Ultimately, the Tipping Points project aims to provide a better understanding of these connections so that we can define new ways to manage coastal ecosystems.

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BECKY CAMERON

How can we model the effects of changes in the environment?

The Blueskin Bay / Waiputai estuary is a constantly changing place, affected on a daily basis by tides and weather, and by longer-term shifts in climate and land use. As part of the national Tipping Points project, Candida Savage and her team are collecting and analysing samples to study how the estuary responds to the stressors of excess nutrients and sediment. I wanted my response to their work to be a way for me to understand and reflect on the changing nature of the estuary, its biological, geological and social elements. I also wanted to experiment further with using found materials for art making.

In researching the area, I found out that its recent history was one of greater change than I'd realised. There had been Maori settlements at what is now called Warrington, and by the Waitati River, and at the time of the first European arrivals the area of the estuary had been a flax swamp. After the flax was cleared for rope-making, a channel was dug connecting the swamp to the river, resulting in the swamp flooding, becoming what is now the estuary. The estuary is perhaps now gradually silting up; the island was not there till the 1930s, and perhaps formed due to sand from the dredging of the Otago Harbour that is carried up the coast by currents. This sand is also building up the spit on the seaward side, which is being eroded on the estuary side. A recent increase in lifestyle properties being developed on its southern flanks has resulted in increased sediment in the Waitati River being noticed by local residents, who also reported that oyster beds had vanished before later reappearing at a different location.

As I walked round the estuary at low tide, I looked to see what birds and animals were present and made drawings of the area. I collected samples of materials from around the estuary: sand, ochre, shells and organic matter. I gathered clay from two different areas adjacent to the north of the estuary, and carried out trial firings with them at a range of temperatures. One sample was high in bentonite, causing it to be very plastic but have a lower firing range than the other, less gritty, but also less plastic sample. As Candida and her team were studying the effects of sediment loading, I carried out trials, adding in increasing proportions of sand from the estuary to the clays until, with the addition of 70 percent sand, they no longer held together.

Figure 1. Overall installation view.

Figure 2. Detail(s) of tiles and background.

The finished work for the Art + Oceans exhibition incorporates a map of the Blueskin Bay / Waiputai area, with a loose grid of round clay tiles pinned to it. Flax flower heads hang from the bottom edge. The map has an under-drawing of coloured pencil and was then painted using clay and powdered pigment, applied very wet and allowed to run and pool, reflecting the interplay and lack of fixed boundaries between land and water.

The layout of the tiles echoes that of the sampling holes on the ROMA (Rapid Organic Matter Assay) plates used by Candida's team as a method of assessing biological activity at different levels in the mudflat. There are gaps in the grid of tiles, indicating that the information is far from complete. The

Figure 3. Detail(s) of tiles and background.

individual tiles have imprints from shells, plants and feathers; patterns of sand ripples; fragments of maps and of found items from human habitation. They are treated in a variety of ways, with different firing temperatures and the addition of oxides, stains or glazes, resulting in a range of tones and colours. They form a record of the different techniques of making and surface decoration trialled by me, as well as a sampling of elements that make up the estuary today. The white flax flowers that hang beneath form 'ghosts' of the flax swamp that the estuary once was. I wanted my work to provide multiple small glimpses of the area that would add up to a view of the whole, reflecting the scientists' gathering and analysis of numerous small samples to build up a picture of the overall health of the ecosystem.

Becky Cameron is an artist who explores ideas of landscape, memory and belonging. She is an MFA student at the Dunedin School of Art, Otago Polytechnic. (See www.beckycameronart.co.nz.)