Te Hunga Takutai o Aotearoa
NEW ZEALAND COASTAL SOCIETY

Coastal News

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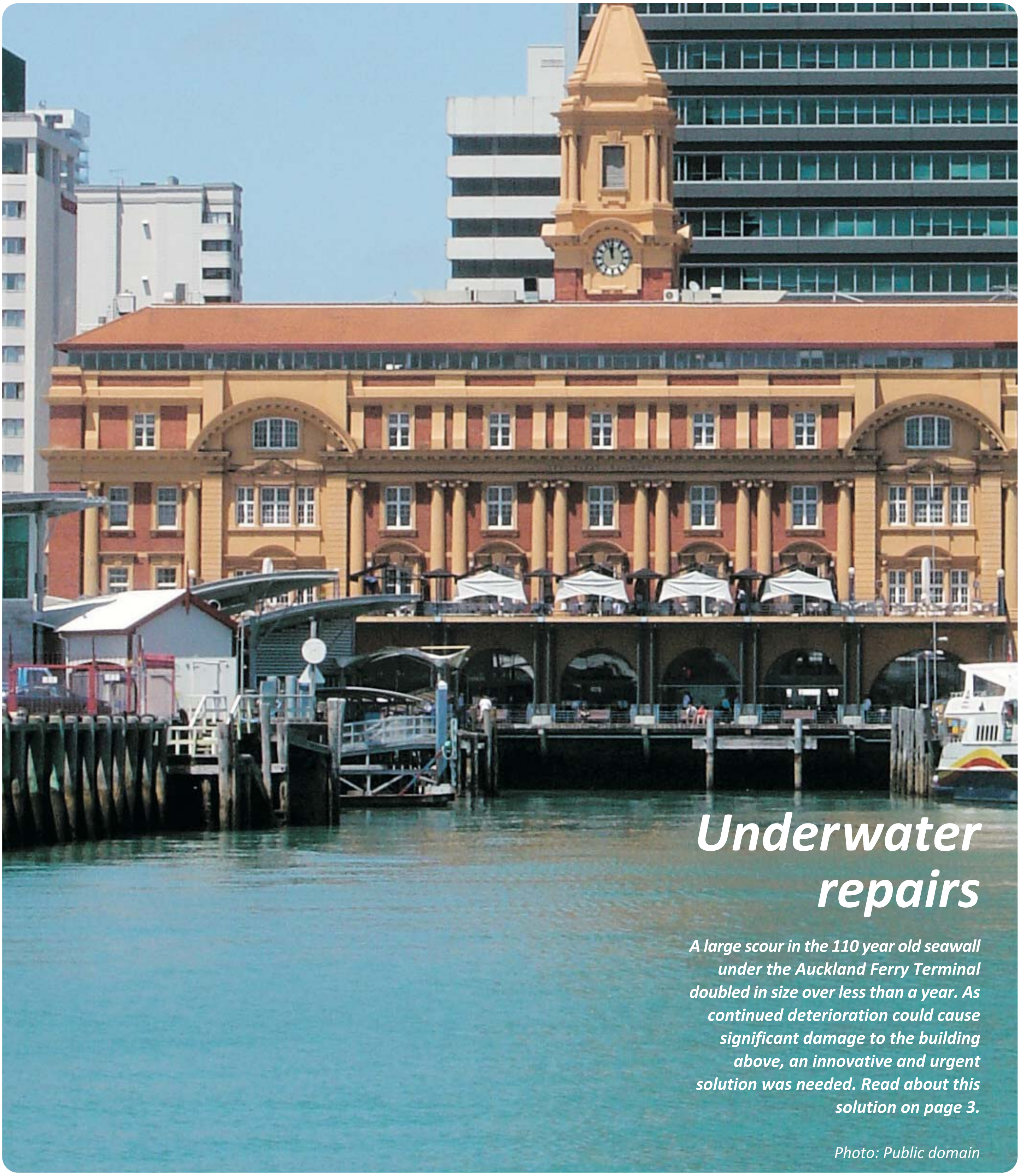

Underwater repairs

A large scour in the 110 year old seawall under the Auckland Ferry Terminal doubled in size over less than a year. As continued deterioration could cause significant damage to the building above, an innovative and urgent solution was needed. Read about this solution on page 3.

Photo: Public domain

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Word from the Chair

Tom Shand

Tēnā koutou

As 2018 draws to a close we can reflect on the year that has been for the New Zealand Coastal Society. Our committee and regional coordinators have been hard at work organising a record number of regional events, which have been extremely well attended by members and non-members. We've had three issues of *Coastal News* and a special issue on the Kaikōura Earthquake published, and all awards and scholarships allocated. Furthermore, we have had a chance to contribute as a society to thought-pieces such as *Engineering a Better New Zealand*, a report aimed at sparking political and national conversations on a more resilient future. The society is well positioned both membership-wise and financially to continue working towards our goals of improving the understanding and management of our coastal and marine environment. I'd like to thank our committee and regional coordinators and, most importantly, our members for their continued and ongoing support towards this.

This issue of *Coastal News* includes discussion on innovative repair methods for an historic seawall, research into the sustainable management of New Zealand's surfing breaks, submarine geophysical surveys, and the effects of ocean acidification on ecosystem processes. These are all worthy issues for investigation with some useful and interesting findings. Our professional development award and academic scholarship winners are announced and I offer my congratulations and wish them all the best for their projects and research. Finally, the news from the regions, government and universities continues to provide useful insight into activities and happenings.

Our final event of the year will be the NZCS annual conference starting November 20th in Gisborne. This will be a chance to catch up with colleagues and friends, make new connections, see some sights and find out about some local history, and to be inspired and educated by a full programme of presentations. Looking forward to seeing you there. Mā te wā.

I'm continually amazed by the variety and dramatic beauty of the New Zealand coastline – views out the window during just one short flight.

Innovative, underwater repair of the Auckland Ferry Terminal seawall

Aaron Holland, LDE Ltd

Background to the problem

The Auckland Ferry Terminal was completed in 1912. The Edwardian baroque building at the north end of Queen Street stands on reclaimed land of sandstone and brick with a base of Coromandel granite. A reinforced concrete seawall under the building descends 8 m deep and protects the building's stability against the significant propeller backwash from the daily ferry services that operate out of the terminal.

The heritage building underwent significant renovation in the 1980s and seismic strengthening in the late 1990s. Remedial work was carried out on the wharf structures in 2009, but the seawall itself has remained untouched since it was constructed 110 years ago, apart from post-tension anchors installed to improve its stability.

A large scour in the seawall at the base of the building near Pier 1A was detected in October 2016, and by August 2017 a routine dive inspection revealed the hole had doubled in size to 16 m in length, 3 m high and with depths of up to 1.2 m. This discovery raised alarm since a 1.3 m depth is the tipping point where significant damage could start to occur in the form of building cracks. If the seawall continued to deteriorate it could cause rotation of the building causing significant damage and eventual collapse.

The problem was acute and the risks were high, calling for an innovative and urgent solution that would least affect the public, businesses in the ferry building, and Fuller ferry operations.

Design solution

The first phase of the project was to establish a project team to design, test and implement the solution. Recognising that the project required a diverse set of specialised skills not held by any individual or company, it was drawn from a variety of engineering, design and construction partners.

The second phase was to develop a solution; the original drawings of the wall showed that it was a simple concrete mass structure, built in situ with a shear key founded on the seabed at a depth of 4 m below chart datum. The scour hole had eroded well below the shear key in some locations into the underlying seabed layers, which were assumed to be sandstone and mudstone based on the extensive cone penetration and borehole testing undertaken along Quay Street.

After considering three options, it was decided to plate the wall with sheets of stainless steel to be used as shuttering for grouting the voids. The voids would then be pumped full of grout and, to avoid future undermining, the seabed in front of this area would be protected by an ElcoROCK sand bag.

The third stage was to design the solution, keeping in mind that the design methodology needed to achieve both the design requirements and have a minimal impact on the surrounding businesses and public ferry services, including:

- No heavy machinery could be located any closer than the side of Quay Street, and even using this as a staging area would have caused significant disruptions to the public.
- The work area was underneath the middle of the suspended harbourside pedestrian walkway, which had to remain open to the public for the duration of the works.
- The ferry terminal had to remain fully operational throughout its busiest period of the year.
- Pumping concrete into the voids was out of the question as this could result in a significant concrete plume cloud, which has environmental impacts and is not considered good practice.

Because of these constraints the team decided that all work should be done underwater by locating two barges permanently on Pier 1A, which enabled Fullers to continue its full range of public services with only the loss of one berth.

Stage four involved testing and implementing the solution identified in phase three. In weeks 1-3 the site was secured, and extensive preparation work undertaken while equipment was installed. Due to the location, all construction equipment and materials had to be manhandled into place using divers, floats, and small 500 kg lifting gantries that were set up on the wall face.

In weeks 4-9 the seawall voids were mapped and cleaned. The rough, non-uniform concrete wall face was subsequently trimmed to true to obtain a flat surface for the steel plates. All materials and design methodology were simultaneously tested to optimise their performance.

Mapping and cleaning the scours

The next challenge was to accurately map the wall scouring to enable the grout ports to be correctly located in the plating. This step was critical for both filling and venting the erosion holes. During this process we discovered that significant debris needed to be removed and quite extensive cleaning was required to prepare the wall for grouting. This was all undertaken in limited visibility where the divers mainly worked by touch and involved weeks of preparation.

The initial design was being constantly modified to suit the new information the divers gathered as the cleaning highlighted a large number of other scour holes not

Figure 1: Aerial view of the Auckland Ferry Terminal showing locations of scour areas.

previously accounted for because of the poor visibility.

Once the cleaning had been finished, the wall was accurately measured using the top row of plates as a datum and taking measurements at 200 mm intervals. This confirmed the depths of the scouring and enabled the lower rows of plates to be modified and ordered ensuring each component was accurately fabricated with sufficient grouting ports to allow the multiple grout pours to occur.

During weeks 10-26 the voids were plated and bolted in place. Grout was then pumped into the voids via ports in the plates, QA checks were completed, and the port valves were then closed. A 15 m ElcoROCK sandbag was installed at the base of the seawall, filled with 80 m^3 (110 tonnes) of sand.

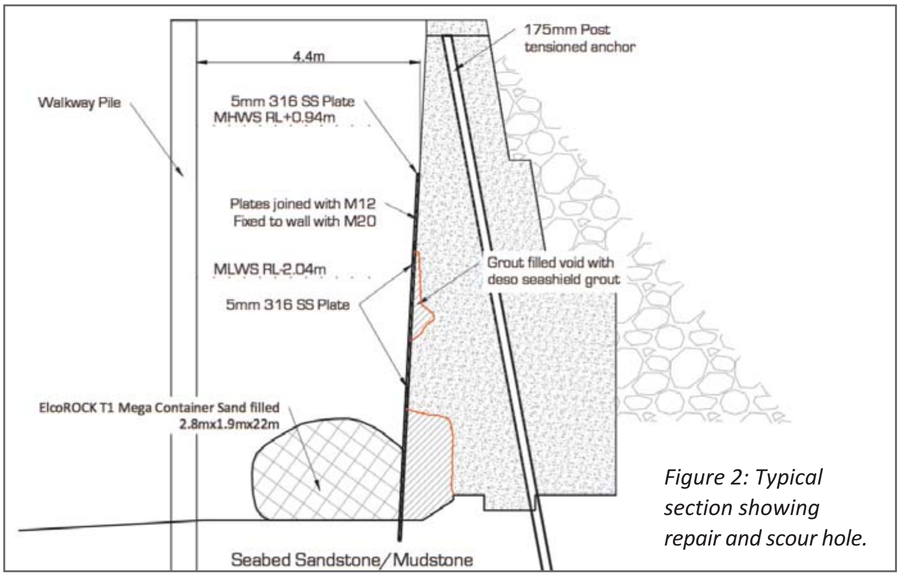

Figure 2: Typical section showing repair and scour hole.

Fitting the anchoring plates

The wall contained large, soft dacite boulders, which were not suitable for bonding the anchors into the concrete, so the plates had twice as many anchoring points built in and these were sealed with covers where not used. Problems encountered with the anchoring were due to the wall being over 100 years old and therefore, through time, becoming full of small voids and weak areas beneath the surface. The divers trialled binding the anchor bolts until an optimum mix was determined.

Further problems emerged when grouting the wall, as sludge formed during the first few batches being pumped into the void. This was a serious problem because it required cleaning between every pour. We managed to reduce the amount of sludge that formed in the first place by: implementing careful pumping procedures by the dive team; ensuring the design of the grout mix had as little water in it as possible while remaining fluid; and strictly adhering to the chosen mix ratios.

Corrosion issues

While we didn't initially expect corrosion to be a significant problem, after about two months we observed rusting of some of the fixings. The wall had a cathodic protection system installed to protect the steel in the upper slab and corbels, which were supporting the building, and initially we thought that this may be influencing the corrosion rates. Our investigation found that the cathodic protection system was not directly affecting the stainless steel, but that stray currents were causing the stainless steel to corrode and causing crevice corrosion in the smaller bolts. The problem was also causing significant corrosion to the underwater equipment and the plates needed protection to ensure maximum life. The corrosion report recommended putting passive anodes on the stainless steel plates to deal with the problem. This required installing 14 x 90 kg anodes, which should last 20 years based on the currents they measured.

Quality assurance

Quality assurance (QA) was both important and difficult to achieve, given that the geotechnical and structural assumptions could not be physically viewed by the designers and were only marginally visible to the divers. The QA work involved:

- the underwater testing of areas of the concrete and the seabed
- visual inspections of the areas prior to plate placement and grouting
- checks of the plate attachments, the sandbag placement, and the completed works.

Constant monitoring was needed to ensure any changes to the wall's stability were instantly recognised. This was achieved by regular accurate surveying and installing a series of new earthquake sensors that Auckland University were working on to provide real-time monitoring of any movements within the wall and ferry building.

Conclusion

The remedial repairs cost $3.5 million. This sum was significant but, relative to the financial risks of doing nothing, which could have resulted in structural damage to the heritage building, it was considered a small price to pay for swift and effective action.

The repair timeframe was seven months from October 2017 to April 2018; the design life was originally five years as an emergency repair, but the final construction is expected to last 20 years or more until a final replacement seawall is delivered.

This kind of in situ underwater repair to a seawall was unique in the New Zealand context. It required a careful but flexible approach and a customised design. Every aspect of the design and method had to be adaptable to last-minute changes. Good planning and QA management meant no changes were required to design components after the steel plates were fitted.

For more information on this project, or to obtain a detailed report, contact: Aaron Holland at a.holland@lde.co.nz

Figure 3: Row one plates.

Managing our surf break resources

Terry Hume[1], Ed Atkin[2], Karin Bryan[3], Shaw Mead[2], Jordan Waiti[4]

Introduction

Surfing has been part of New Zealand culture from the time Māori surfed waves on boards (*kopapa*) and bags of kelp (*poha*) (Beattie, 1919; Best 1924) and the Hawai'ian surfer Duke Kahanamoku demonstrated surfing to Wellington locals in 1915. Today it is estimated that approximately 7% (310,000) of New Zealanders surf on a regular basis. Unfortunately, the growing popularity of surfing has led to overcrowding and conflicts between users at prime locations. There are also increasing threats to surf breaks from development activities in the coastal space.

The demand for space and resourcing around surf breaks and the recognition of threats to their amenity value has resulted in surf breaks becoming increasingly acknowledged in New Zealand coastal resource management. Policy 16 of the New Zealand Coastal Policy Statement 2010 (NZCPS) provides a legislative framework that identifies and calls for the protection of surf breaks by 'ensuring that activities in the coastal environment do not adversely affect the surf breaks' and by 'avoiding adverse effects of other activities on access to, and use and enjoyment of the surf breaks'. While this policy was a world first in that it specifically identified surf breaks as protected spaces, it does not provide guidance for management authorities and resource users on how to identify, study, monitor and manage the surfing resource.

This article describes a Ministry of Business, Innovation and Employment funded project* that has compiled a knowledge base and developed management guidelines for New Zealand's surf breaks. These resources will underpin and enable informed decision making by council staff, resource users/applicants and stakeholders about activities in coastal areas that may affect the functionality and amenity value of surf breaks.

Site investigations and measuring surf break characteristics

Seven sites were selected for detailed studies to provide methodological guidance on site baseline characterisation and monitoring for different types of surf breaks. Selection was made from a list of the 17 Surf Breaks of National Significance and prominent Surf Breaks of Regional Significance using a decision-making matrix with scoring categories reflecting: access, infrastructure, environment sensitivity, threats, usage, dependent population, Surf Life Saving NZ presence, and effectiveness of remote monitoring methods. The chosen surf breaks were Piha South, Whangamata Bar, Manu Bay, Wainui Beach (Gisborne), Lyall Bay, Aramoana and Whareakeake. This selection also provided representation of the main types of surf breaks, which are: beach break, estuary entrance bar (or delta) break, reef break and headland (or point) break.

Data collection was undertaken for each site by collating existing information, using remote video imaging systems, undertaking hydrographic surveys, and GPS positioning of surfers. Existing information on the sites was collected through a process of literature reviews of scientific journal articles, community group websites, technical reports and other published material. Stakeholder meetings at each of the sites and online surveys encouraged participation from locals and non-locals, surfers and non-surfers and business owners. Separate hui were undertaken with tangata whenua in recognition of their role as kaitiaki (guardians) of each area. The site investigation information is summarised in baseline reports for each of the seven sites.

Video imaging systems were built for five of the sites (Aramoana and Whareakeake already have operational systems that were installed by the Port of Otago and NIWA). The new systems acquire 1,200 images once a second at the start of each hour during day light, every day, all year round. Following collection of the 1200 images, the stack, or 'image cube' is automatically processed to extract an average, standard deviation and variance image. These outputs, along with a sequence of 20 consecutive still images, are uploaded to a cloud-based server. Surveyed ground control points allow for geo-referencing of each pixel within an image and these georeferenced pixels are used to convert the image to a birds-eye (ortho-rectified) view. The processed data are used to assess seabed and breaking wave characteristics such as peel angle, and determine bank and rip channel characteristics. Bathymetry surveys were undertaken at each of the sites on several occasions to monitor the changes in seabed banks and rip channels to validate the video imaging. GPS positioning of surfers riding waves was obtained using Rip Curl SearchGPS watches. The data provided information on physical parameters such as surfer speed and ride length, and also geographic parameters such as the boundaries of surf break areas, take off zones and access routes.

Figure 1: Papatowai is recognised as a big wave surfing venue (Photo: M. Stevenson).

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(1) Hume Consulting Ltd; (2) eCoast Marine Consulting and Research; (3) University of Waikato; (4) (Ngāti Pikiao, Te Rārawa, Ngaati Maahanga), University of Waikato.

**Remote Sensing, Classification and Management Guidelines for Surf Breaks of National and Regional Significance*. The project ran for three years (October 2015 to September 2018).

Research findings

In the first year of the project, with the help of MSc student Jai Davis-Campbell, we advanced methodologies for extracting surfing and seabed morphology parameters from video imagery using the data sets from video monitoring cameras at the Aramoana and Whareakeake surf breaks. We went on to quantify the length and orientation of the sand bars at all our monitoring sites. Bar orientation and bar length are directly correlated with the length of surfing ride and the wave peel angle, two measures that quantify surfing wave quality. Our results show that there is a large amount of natural temporal and spatial variability of sand bars at beach breaks, and that detecting anthropogenic changes may only be possible when the changes are substantial (such as the impact of the Lyall Bay airport runway on surf condition toward that end of the beach). In the end, we were interested in whether the monitoring data sets from our 3-year study were too short to detect changes, and so undertook the same analysis on a 10-year-long record of video data from Tairua Beach (provided by NIWA and the Waikato Regional Council). The additional analysis revealed a strong interannual signal that was correlated to the Southern Oscillation Index.

During the above work we discovered that bar characteristics were not well correlated with surfing characteristics in the dataset examined from Aramoana. Following thorough analysis of the data provided by the Port of Otago, we concluded that the sampling regime of snap shot images every 5 minutes was not ideal for extracting surfing parameters. To improve on this our monitoring stations have been set up to provide 20 minutes of continuous video at 1Hz every hour every day. This sampling regime has allowed us to develop much improved techniques to extract surfing parameters, such as peel angle and length of ride, from video footage.

To place our studies of surf breaks into a wide context, we considered the use and values of the breaking wave environment in New Zealand and how surfing fits into that space. Collaborating with Nick Mulcahy, an aquatic risk assessment specialist and advisor to Surf Life Saving NZ, we determined that one of the main drivers of the growing numbers of people using the breaking wave water space for sport and recreation is advances in technology. Such advances are due to an increasingly diverse range and number of water craft available, ready access to met-ocean forecasting services via the web, mobile devices allowing users to target specific locations and sea states, and improved equipment such as wet suits that allow activities to continue throughout the winter. As a consequence, there has been overcrowding and conflicts between users at prime locations, particularly at times when wind and wave conditions are suited to the various activities. Using four case studies we examined the increasing challenges for management facing councils and water safety bodies and the roles of policy and the various stakeholder groups in this process. We also considered at the national level a risk management approach to water safety that is being applied to beaches throughout New Zealand and the role surfers play in water safety as 'informal responders' rescuing swimmers.

Figure 2: 'Undisclosed river mouth bar' (Photo: J Aubertin).

Website and data portal

The data collected in this research will be made publicly available through a website and online portal (www.surfbreakresearch.org). This will provide the opportunity for organisations such as universities and crown research institutes, district and regional councils, port and harbour authorities, iwi, marine resource prospectors and coastal developers to freely access the data for their own research, consent applications and/or planning purposes.

The website will provide background information on the research project, include all the technical reports, and present the findings of the project including the guidelines document. The portal is the repository for a large and increasing dataset and access point for data such as: all the images collected by the cameras, the ground control and raw data needed to rectify the images, data from several bathymetry surveys undertaken at each of the camera sites, and results from swell corridor modelling/mapping at each camera site.

Information on the website/portal will continue to be updated as information streams in from the video camera sites.

Guidelines

A major output of the study was the development of *Management guidelines for surfing resources*, which are available online*. The guidelines provide background information and specific methodologies to assist authorities charged with implementing policies and plans to protect surf breaks and will serve to inform future reviews and amendments to regional and local level policies and plans. They also aim to manage the expectations and responsibilities of resource users and applicants with respect to consent requirements where proposed activities are likely to affect access to, water quality and the amenity value of surf breaks. For stakeholders, the guidelines provide clarity on how developments might affect the amenity value of their surf breaks and the responsibilities of those proposing the developments.

Section 1 of the guidelines provides some key background information such as the legislative and social context of surf breaks. Sections 2 and 3 provide specific guidance for authorities and resource users/applicants, while recognising that authorities require a regional perspective and resource users/applicants require a site-specific focus. Key steps for authorities are described as:

1. Identifying and mapping surf breaks;
2. Mapping swell corridors;
3. Identifying threats and risk assessment and preparing a 'watch list' of potentially threatened surf breaks;

* www.surfbreakresearch.org

4. Incorporating surf break provisions into policy and plans;
5. Baseline studies; and
6. Baseline monitoring.

Key steps for resource users/applicants provide a more in-depth understanding of the mechanics of individual surf breaks and methods to avoid, remedy or mitigate any actual or potential impacts from a proposed activity/development. The steps are described as:

1. Identifying surf breaks, swell corridors and threat/risk assessment; and
2. Detailed site characterisation.

Section 4 of the guidelines provides additional information for users in support of Sections 2 and 3, on: stakeholder engagement, identification of surf breaks, construction of swell corridors, threats and risk assessment, surfing resources in policy and plans, baseline monitoring, considerations for consenting authorities, and detailed characterisation. Additional information is provided in the appendices along with six case studies highlighting the range of threats faced by New Zealand's surf breaks.

Going forward

Several initiatives are underway to maximise the project outcomes beyond the project end. We have been allocated a special issue in the *Journal of Coastal Research* dedicated to managing surf breaks in which a selection of papers will describe findings from the project along with those of some related studies.

We have secured continued support for the five video monitoring stations through eCoast and Vodafone that will continue to make the data publicly available via the open access data portal. Beyond this we are establishing a Technical Group on Surfing Resources to, amongst other things, undertake regular reviews of the guidelines, host and maintain the video monitoring stations and seek funding to add new ones, and provide expert knowledge on surfing resources, and bring together New Zealand's leading professionals in surfing resource management.

Reflections

There is more to making a good surf break that just the breaking wave characteristics. Orchard's (2017) review of literature of surf break management in New Zealand identified the importance of a surf break's rarity, uniqueness, naturalness (environmental setting) and wilderness values, amenity values, levels of use, economic value, and historical/cultural associations. Surfers don't just surf for 'the thrill of the ride'. It's also the sense of freedom of riding the wave, the connection with the elemental forces of the wave, the aesthetics of the surrounding landscape, the social interactions with mates, the history of their connection to the break, and the coastal environmental quality that contributes to the surfing experience.

Surf break management must therefore recognise the need to manage the resource holistically and not to treat aspects in isolation.

Looking ahead there will be more pressure on well-known surf breaks as the number of people using surf breaks continues to increase and the ever-growing diversity and availability of equipment for surfing provides more opportunity for users to exploit the waves. This will result in a change of use, whereby users frequent lesser known surf breaks to reduce user numbers.

Access to the lesser known and 'hard to get to' surf breaks might become more accessible via new roading or access by water craft. In some areas the reverse may happen and access to known surf spots will be restricted. The list of surf breaks, their value rankings and known threats should be re-evaluated by councils prior to each iteration of their Coastal Plan, or at a time frame that reflects population growth and demands on the surf break resource.

Surfers must be involved in the management process. They can be no longer be simply regarded as 'surf bums'. Surfers appreciate their surf breaks and environment and have a strong sense of ownership of surf breaks (Usher, 2017). They represent a wide variety of trade and professional groups and as frequent visitors to the coast have an inherent understanding of coastal processes. This sense of place and knowledge allows them to play a valuable role as coastal protection stakeholders (ASBPA, 2011).

Iwi must also be part of the management process. Any engagement process with stakeholders needs to acknowledge the relationship between the Crown and Māori, by taking account of the principles of the Treaty of Waitangi (Te Tiriti o Waitangi), and kaitiakitanga (guardianship) in relation to the coastal environment (Policy 2 of the NZCPS 2010). Indeed, local iwi can contribute to the protection of surf breaks as kaitiaki (guardians) of their rohe (region) and play a valuable role as traditional resource custodians.

As with any element of our natural environment, the best management solutions for surf breaks must take into account social and cultural elements, as well as managing the surf break 'ecosystem' as a whole, including the services and functions it provides.

Acknowledgements

The Principal Investigators for this project are the authors. Funding for the project was provided by MBIE (contract UOWX1502).

The project was supported by a steering committee representing Auckland Council, Department of Conservation, Landcare Research, Lincoln University, Waikato Regional Council, Surfbreak Protection Society, and Surf Life Saving New Zealand.

We thank the stakeholders and Iwi representatives who attended workshops held at each of the seven study sites, Rip Curl for providing 21 SearchGPS watches for use by surfers at the seven study sites, and the Port of Otago for releasing data from the Aramoana and Whareakeake video monitoring stations for use in our analysis. Video data from Tairua Beach was provided by NIWA and Waikato Regional Council.

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Sub-tidal marine-geophysical survey for pipeline corridors, Lyttelton Harbour

Alan Orpin[1], Geoffroy Lamarche[1,2], Susi Woelz[1], Steve Wilcox[1], Jim Bell[3], Rob Christie[1]

The Christchurch City Council's project to cease routine wastewater discharge into Lyttelton Harbour includes the installation of two submarine pressure pipelines between Naval Point (Lyttelton) to the western tidal shoals of Governors Bay; and, Naval Point to Pauaohinekotau Head at Diamond Harbour. The pipeline routes will be buried in shallow trenches (<2 m deep) along 200 m wide consented corridors. As such, sub-seafloor obstructions such as hard substrates and buried volcanic rock represent a significant logistical consideration for pipeline-route selection. Jacobs NZ Ltd was tasked with overseeing this project and, in 2017, NIWA was contracted to undertake its shallowest ever marine seismic survey and the first of its type for a civil works project in New Zealand. This would also be the first multibeam survey to be conducted in the western Lyttelton Harbour, and according to current maritime charts, these upper reaches were last hydrographically surveyed by the *HMNZS Lachlan* in 1951.

The geophysical survey used NIWA's 13.9 m long research catamaran, *RV Ikatere*, equipped with a Kongsberg PS120 sub-bottom profiler and a Kongsberg Geoswath Plus shallow-water multibeam system. The PS120 uses a parametric acoustic source from a 0.3 x 0.4 m transducer array to produce a narrow beam (+/- 3° wide) signal that is motion compensated (i.e., always points vertically, independent of ship motion). The parametric array utilises the effect of the non-linear propagation properties of water when a high intensity, acoustic waveform is transmitted. By transmitting two sinusoidal waveforms (in the range from 70–100 kHz) simultaneously, difference and sum frequencies are formed. The duty cycle and total transmitted energy limit the ping rate, so for short single pulses the maximum ping rate is typically 10 Hz. NIWA's 500 kHz Kongsberg Geoswath Plus Compact sonar was used to acquire co-registered, geo-referenced side-scan (backscatter) and MBES bathymetric data.

(1) NIWA, Wellington; (2) School of Environment, University of Auckland; (3) Jacobs NZ Ltd, Christchurch.

The Geoswath Plus system is an interferometric multibeam that provides data coverage of up to 12 times the water depth, and acquires simultaneous bathymetry and side-scan data using a frequency of 500 kHz. Both PS120 and Geoswath systems were operated synchronously with real-time navigation data provided via a Fugro Marinestar DGNSS, and motion corrected using an Applanix POSMV 320 V5 with L1/L2 Receivers (position & orientation system).

We surveyed two corridors along pre-defined parallel survey lines at 20 m spacing, retrieving a comprehensive geophysical dataset consisting of continuous bathymetry (water depth), backscatter (reflectivity) and very-high resolution seismic reflection data (Figure 1). Short orthogonal tie-lines were also recorded across the corridors to facilitate interpretation of the prominent seismic reflectors and provide a coherent sub-seafloor image. The survey extended as far west as operationally feasible onto the tidal flats of Governors Bay, to ~0.7 m of water below the transducer. A total of twenty-three seismic lines were acquired using the sub-bottom profiler, totalling 50-line km and over 242,000 seismic shot-points, with typical vertical resolution better than 5 cm.

Survey results

The seismic data suggested soft sediment with no hard bedrock along the corridors within 2 m below seabed. Five sub-bottom reflectors of sedimentary origin were identified from the seismic data, and one reflector corresponding to the top of the Kamautaurua reef (i.e. buried rock) that outcrops at the tidally emergent Kamautaurua Island. Prominent sub-bottom reflectors could be traced along most of the seismic profiles, which provide good indications of the geometrical relationships of the different horizons (Figure 2). A sixth pervasive pseudo-reflector is commonly recognised in shallow-water and has been attributed to energy absorption of the seismic energy by superficial, probably biogenic, gas and/or fluids. The masking of potential geologically meaningful reflectors below this pseudo-reflector is known as gas-masking or acoustic blanking.

The depths below seafloor to the top of the buried flanks of the Kamautaurua reef, and to the regionally extensive upper horizons, are shown in Figure 3. This figure displays the depth to a given horizon (here the reef) every 100 shots (15-20 m) and are colour coded by depth. Since the horizontal distance is very close to the distance between each

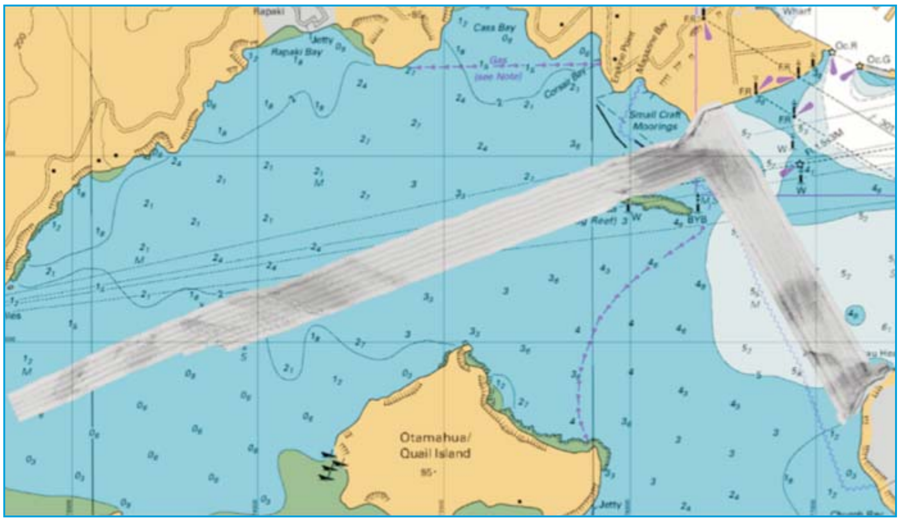
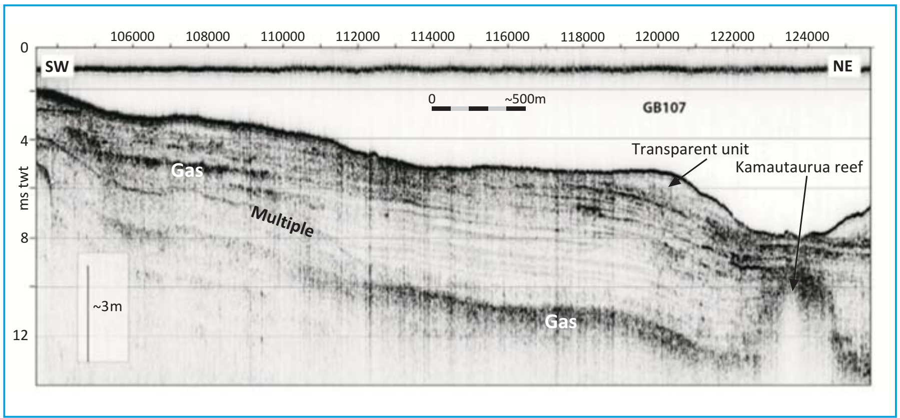


Figure 1: Seafloor reflectivity generated by the Geoswath Plus multibeam system. The mosaic uses a grid-cell size of 0.4 m. High reflectivity is indicated in dark grey, low reflectivity in light grey.



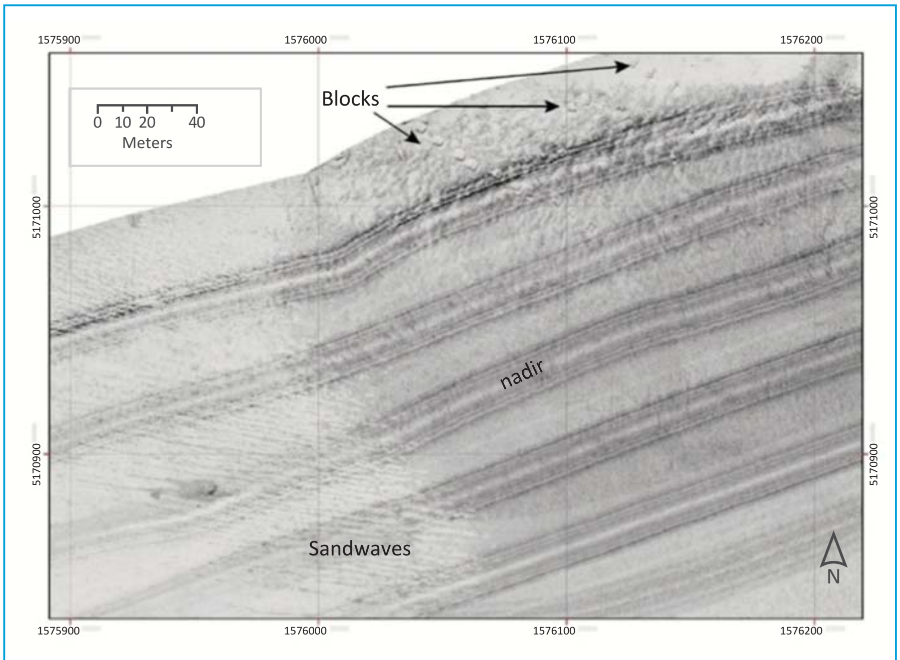


Figure 2 (top): Line GB107 – the seismic profile shows the uppermost transparent unit, the seafloor depression above the Kamautaurua reef, and gas masking, some of which is associated with the Kamautaurua reef. Note vertical scale is in milliseconds, two-way travel time (TWT).

Figure 3 (middle): Depth below seafloor for the top of the Kamautaurua reef. The top of the reef is interpreted from the localised strong gas masking that rises rapidly towards the seafloor. Points are approximately 15-20 m apart, and colour coded by depth (blue deepest to red shallowest below seafloor).

Figure 4 (bottom): Sandwaves and concrete blocks imaged with the Geoswath Plus reflectivity. High reflectivity is dark grey, weak reflectivity is light grey.

seismic profile, the result is somewhat similar to a coarse 20 m grid, but without gridding artefacts. That is, each colour point relates to a direct measurement of the depth to a horizon at that shot point. Similarly, the visual effect is not dissimilar to a colour-shaded contour map of the sub-bottom horizons. A total area of 1.4 km^2 was covered in c. 6 hrs using the Geoswath. From these data, a tidally and geodetically corrected digital-terrain model was generated for the seafloor along the corridors, from 10 m distance from the rock breakwater at the Lyttelton Marina to Pauaohinekotau Head and into about 2.5 m water depth in the shoals of Governors Bay.

The Geoswath mosaics are presented in levels of grey-scale and inferences on the type of substrate can be made. A characteristic of backscatter data is a nadir track-line in the centre of the acoustic swath (giving rise to the parallel banding), which can be minimised with careful processing but not eliminated. Dark greys correspond to highly reflective substrates, likely representing coarse sand, shell hash or bioturbated coarse layers. The darkest pattern potentially represents hard reflective rock, or gravelly beds. Microtopography, such as small sandwaves and ripples, often produce high reflectivity. Light grey patterns correspond to weakly reflective sediments such as mud or very fine sand.

Some striking examples of seafloor-target detection using the reflectivity data included locating several rectangular concrete blocks,

c. 4.3 m across, north of the Kamautaurua Island beacon (Figure 4). The selected design alignment of the pipeline ran through the concrete block area. The ability to accurately position the blocks reduced the time and effort to establish an obstacle free route for the installation of the pipeline through 2018 using the incremental bottom-pull technique.

Other excellent examples are seafloor imprints of current and abandoned potable water and telecommunications services between Lyttelton Marina and Pauaohinekotau Head (serving the Diamond Head catchment) (Figure 5). Deviations in the cable route are clearly evident, and continuous positioning afforded by the Geoswath system along the length of these services facilitated their temporary protection during the capital works programme through 2018. These are also valuable geospatial data to monitor future environmental change.

Figure 5: Geoswath backscatter mosaic showing partially-buried and outcropping cables on the seafloor adjacent to Pauaohinekotau Head.

NZCS Mission Statement

The New Zealand Coastal Society was inaugurated in 1992 ‘to promote and advance sustainable management of the coastal environment’. The society provides a forum for those with a genuine interest in the coastal zone to communicate amongst themselves and with the public.

The society currently has over 300 members, including representatives from a wide range of coastal science, engineering and planning disciplines, employed in the engineering industry; local, regional and central government; research centres; and universities.

Membership applications should be sent to NZCS Administrator Renée Coutts (nzcoastalsociety@gmail.com).

New Zealand's coastal ocean acidification: Effects on ecosystem processes and tipping points

Bonnie Laverock[1], Kay Vopel[1], Conrad Pilditch[2], Craig Cary[2]

Ocean acidification – the decrease in seawater pH due to increasing carbon dioxide (CO_2) concentrations – is 'the greatest human threat to New Zealand marine habitats' (MacDiarmid, 2012). New Zealand's coastal zones are critical habitats for shellfish aquaculture, fisheries, and recreation and leisure activities, but are particularly vulnerable to changing environmental conditions. In response to this problem, our team of researchers from the University of Waikato and Auckland University of Technology is running a series of experiments that will reveal how microbial processes, which support the base of coastal food webs and contribute to the resilience of coastal ecosystems, will respond to such changes in our future oceans.

Coastal marine environments are dynamic systems that are closely connected to the land and atmosphere. Surface seawater constantly exchanges gases and aerosol particles with the atmosphere above: a physical process linked with biological activity such as primary production, which consumes dissolved CO_2 and produces oxygen (O_2). In fact, the absorption of CO_2 by our oceans is one of the most important processes regulating our current climate, because a large proportion of this CO_2 is converted to marine biomass (algae, vegetation, coral, and microorganisms) and eventually 'locked away' in seafloor sediments, where it no longer contributes to atmospheric processes.

When CO_2 dissolves in seawater, it undergoes a number of predictable chemical reactions that together make up the marine carbonate system:

$$CO_2 + H_2O \leftrightarrow HCO_3^- + H^+ \leftrightarrow CO_3^{2-} + 2H^+$$

These reactions are spontaneous and reversible, forming a 'carbonate buffer' that helps to maintain a stable ocean pH (Figure 1). Under 'normal' conditions (~pH 8.1), the bicarbonate ion (HCO_3^-) makes up approximately 90% of the dissolved inorganic carbon (DIC) in seawater. When the concentration of CO_2 in seawater increases – due to increasing atmospheric CO_2 concentrations – the seawater carbonate system increases the concentration of bicarbonate ions (HCO_3^-), but decreases the concentration of carbonate ions (CO_3^{2-}) and the pH, putting stress on organisms including those that create carbonate shells. The absorption of atmospheric CO_2 has already led to a decrease in surface seawater pH of ~0.1 pH units since the beginning of the Industrial Revolution, and is expected to cause a further fall in pH of 0.3 units (to pH 7.8) by the end of this century. Unfortunately, the ocean's carbonate buffer cannot function quickly enough to combat the relatively rapid changes in atmospheric CO_2 that are still occurring, and the ability of the oceans to absorb atmospheric CO_2 is therefore also declining.

In addition to the changes to ocean chemistry, ocean acidification causes less predictable changes to the functioning of biological systems. For some organisms, an increase in seawater CO_2 concentration can be positive; for example, leading to enhanced growth and primary production in photosynthetic plants and microbes – these species are thought of as the 'winners' of ocean acidification. However, many organisms will be negatively affected by changes in pH and carbonate chemistry, especially those organisms that create calcium carbonate shells, because of the decrease in carbonate ion (CO_3^{2-}) concentration in more acidified oceans. These future 'losers' include economically and culturally important shellfish such as pāua and mussels, corals and crustaceans. All of these species live in New Zealand's coastal habitats; we know, however,

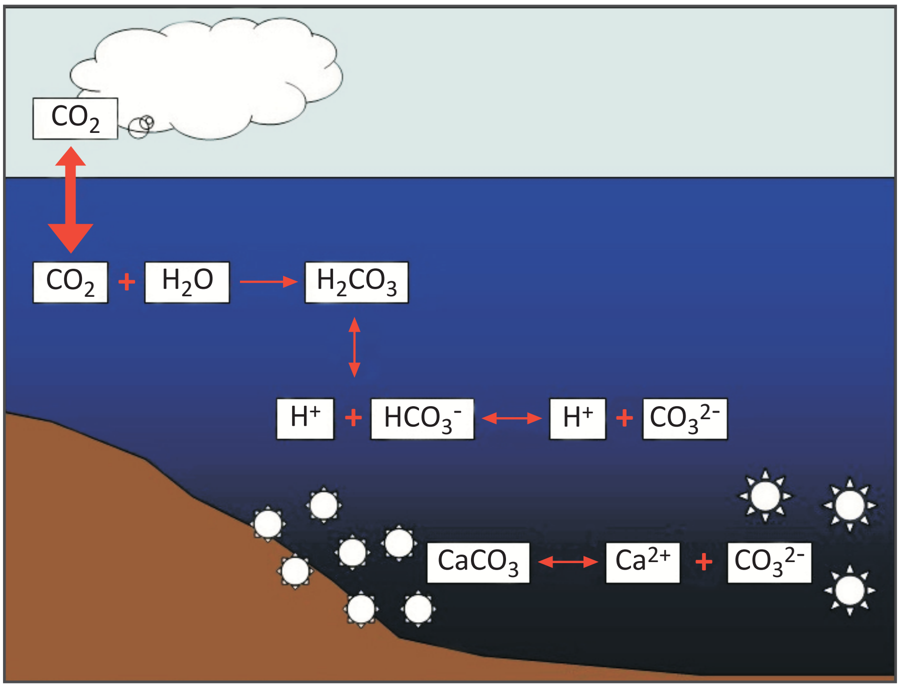


Figure 1: The marine carbonate buffer, showing the air-sea exchange of carbon dioxide (CO_2) gas, and the subsequent chemical reactions of the marine carbonate buffer. CO_2 reacts with water to form carbonic acid (H_2CO_3), which then further breaks down into the bicarbonate ion (HCO_3^-), and the carbonate ion (CO_3^-). Hydrogen ions (H^+) are a product of both of these reactions, and their formation contributes to decreasing seawater pH. Also shown is the dissolution of organisms that create their shells out of calcium carbonate ($CaCO_3$), under future ocean acidification scenarios.

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surprisingly little about the effects of ocean acidification on these habitats.

The key to predicting the response of marine coastal ecosystems to ocean acidification lies at the seafloor, specifically, inside coastal soft sediments. These sediments play an important role in maintaining the health of our valuable coastal zones. First, they act as a habitat and feeding ground for shellfish and many bottom-feeding fish species. Second, they support microbial communities that produce and recycle nutrients (such as nitrogen and phosphorous), which drive primary production at the seafloor and in the overlying seawater. For these reasons, our project tackles the questions: "how will New Zealand's coastal marine sediments respond to ocean acidification?", and "what are the 'tipping points' in seawater pH, after which ecosystem functions (such as nitrogen cycling) cannot recover?"

The key to predicting the response of marine coastal ecosystems to ocean acidification lies at the seafloor.

We study the sediment of Man O'War Bay (Waiheke Island), in the Hauraki Gulf, using laboratory and field experiments designed to test the resilience of the coastal seafloor ecosystem to declining seawater pH. We expose these soft, silty sediments to different pH levels – mimicking future ocean acidification scenarios – and then analyse how these levels affect the rates of different ecosystem functions (Figure 2). By measuring oxygen consumption rates, we can show how the sediment 'metabolism' changes. Sediment metabolism is a function of two factors: (i) photosynthesis, which consumes CO_2 and produces O_2, and (ii) respiration by both macrofauna and microorganisms living within the sediment, which consume O_2 and produce CO_2. The balance between these two processes could be disrupted by decreasing seawater pH.

For example, we have observed that diatoms – photosynthetic microalgae living on the sediment surface – are likely 'winners' of ocean acidification. However, their increased growth and activity under ocean acidification scenarios could have knock-on effects on microbial nitrogen cycling (Vopel et al., 2018). Briefly, if diatoms consume more nitrogen in the form of ammonia, NH_4^+, this likely inhibits other processes that rely on NH_4^+ uptake, such as nitrification. Nitrification is

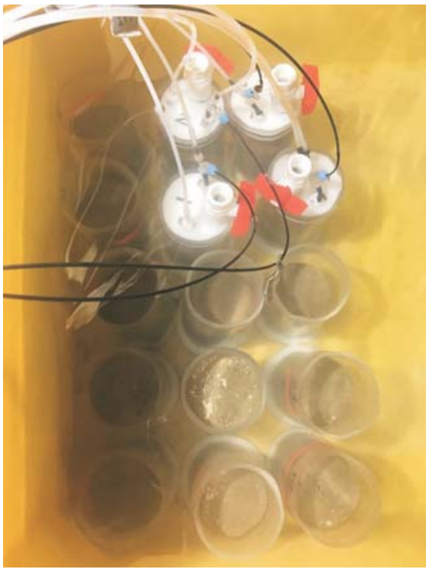

Figure 2: Aquaria within the Ocean Acidification Laboratory at Auckland University of Technology. Sediment cores are collected from Man O'War Bay in the Hauraki Gulf, and exposed to different pH levels in the laboratory, to mimic future ocean acidification scenarios. Shown in the top left cores: sediment oxygen and nutrient consumption rates are measured by carrying out incubations on sealed cores, fitted with oxygen sensors and peristaltic pumps to create water flow throughout the 4-hour incubation period.

an important step in the nitrogen cycle, linking organic matter breakdown with the removal of nitrogen from the system via denitrification, and contributes to ecosystem resilience to environmental change. Our results show that, in a high-CO_2 world, changes in coastal nitrogen cycling will probably occur, which could affect the nutrients available for higher life forms living in both the sediment and the overlying seawater.

We study nitrogen cycling directly by measuring the rates of production or consumption of the nutrients, ammonia (NH_4^+), nitrite (NO_2^-) and nitrate (NO_3^-). Because the concentrations of these nutrients are mostly a result of microbial reactions, our project also investigates the microbial communities living in the sediment. We are interested in whole-community shifts – that is, whether ocean acidification will cause changes to the composition of the microbial community – as well as whether decreased seawater pH causes changes in microbial function. To answer this last question, we target specific microbial genes, for example, the genes responsible for nitrification, to see if they are more or less abundant when we lower seawater pH.

Finally, by combining observations of oxygen and nutrient consumption in the sediment, we can develop insights into how the macrofauna that live in the sediment are responding to lower seawater pH. Macrofauna – including the commercial shellfish species cultivated in New Zealand – affect important sediment functions, either by physically moving the sediment to create burrows (e.g., shrimps, crabs), or because their feeding and burrow flushing activities aerate the sediment, and thus affect which microbial reactions can take place (e.g., worms, shellfish, crustaceans). We therefore expect the impacts of ocean acidification to be greater in areas populated by macrofauna that are negatively affected by lower seawater pH. For example, mud shrimp can significantly enhance sediment nutrient cycling (Figure 3), but at lower seawater pH

Figure 3: Sediment core collected from Man O'War Bay in the Hauraki Gulf, showing a shrimp burrow at the top of the core. Mud shrimp are highly active in the sediment, and continuously flush their burrows with fresh seawater. This has a large effect on nitrogen cycling processes because it provides oxygenated seawater to deep sediment layers, allowing microbial communities to use the oxygen in processes such as nitrification. If ocean acidification affects shrimp behaviour or survival, this could have negative, knock-on effects for the coastal nitrogen cycle.

they become less active or die, leading to decreased rates of microbial nitrogen cycling (Laverock et al., 2013). Since coastal sediments tend to host a large community of macrofaunal species, we expect these interactions to be particularly important in our coastal ecosystems.

Indeed, the interactions between different organisms – macrofauna, microalgae and bacteria – are what make coastal sediments such productive and complex environments, with the capacity to support a wide range of important species and ecosystem functions. Our research uses a series of different experiments to break apart this complexity and explore the response of New Zealand's coastal ecosystems to ocean acidification, by focusing first on single components, and then building these into an overall picture of coastal ecosystem change. In this way, we aim to pinpoint New Zealand's future coastal 'winners' and 'losers', and what effects these may have on our economy, culture and environment.

Our work is funded by MBIE Smart Ideas project UOWX1602: 'Tipping-point responses of coastal primary productivity to projected ocean acidification scenarios'.

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Figure 4: Evan Brown, a member of the AUT marine research group, deploys an automated sediment porewater analyser in Man O'War Bay, Waiheke Island, in about 10 m water depth. The robot uses four electrochemical microsensors to resolve microscale changes in pH and oxygen at the sediment–seawater boundary.

NZCS Regional Representatives

Every region has a NZCS Regional Representative who is available to help you with any queries about NZCS activities or coastal issues in your local area. If you are interested in becoming involved as a regional representative, please get in touch with Paul Klinac (paul.klinac@aucklandcouncil.govt.nz).

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Back issues

Back issues of *Coastal News* (from 1996 onwards) are available to download from the Society's website at www.coastalsociety.org.nz (under the 'Publications' tab). Also available for download are author and article indexes for issues 1 to 65 (these will be updated each year), a Contributor's Guide to writing articles for *Coastal News*, and copies of the three NZCS Special publications published in 2014, 2016 and 2018.

NZCS 2018 award winners

Each year, the NZCS presents awards to some of its members to recognise their efforts and to give financial support for their work. These are the recipients of the 2018 awards.

Kate Davies
NZCS Professional Development Award

Kate is a social scientist at the National Institute of Water and Atmospheric Research (NIWA) with eight years of experience working on collaborative and interdisciplinary research projects that inform coastal and marine governance and management at multiple scales. She is passionate about improving social and ecological outcomes, especially reducing vulnerabilities and risks for indigenous and local communities through the co-production of knowledge and practice. Much of Kate's current work focuses on participatory efforts to address cumulative effects (CE) and implement ecosystem-based management (EBM) in coastal and marine areas.

Coastal and marine management in Aotearoa New Zealand is covered by 25 statutes governing 14 agencies across seven spatial jurisdictions. This fragmented approach does not account for CE, broadly defined as the effects of stressors overlapping in space and/or time. Slippage in baselines resulting from the inadequate management of CE could lead to the degradation or loss of resources, and creates uncertainty for investors, making this issue a crucial one to address in the move towards the implementation of EBM. EBM emphasises the maintenance of ecosystems and human well-being over sectoral management.

In July 2018, Kate received a Professional Development Award from NZCS to establish connections between current Aotearoa New Zealand-based CE research (https://sustainableseaschallenge.co.nz/programmes/our-seas/navigating-implementation-impasse) and similar work being undertaken by interdisciplinary colleagues based in Hobart, Australia at CSIRO, the University of Tasmania, the Institute for Marine and Antarctic Studies, and the Centre for Marine Socioecology.

The resulting workshop, held in Hobart in September, was a cross-pollination of ideas that illuminated shared learnings, barriers, and pathways to address CE that extend across the Tasman Sea. In particular, the group discussed ways to support systems-based thinking and mobilisation that stretches across scales, as well as the crucial role of indigenous sovereignty, governance structures and co-management practices.

This work is needed because challenges associated with CE and EBM do not end at the 200 nautical mile mark; connecting research in Aotearoa New Zealand to efforts in Australia is an important step towards developing international approaches to CE management and could set a precedent for establishing similar partnerships around the world.

Hilke Giles
NZCS Professional Development Award

Hilke is a coastal and systems scientist with a diverse background derived from her PhD research and 12 years working at NIWA and the Waikato Regional Council. Motivated by the desire to contribute more proactively and independently to sustainable management of our coastal environment, Hilke started her own consultancy, Pisces Consulting, in March 2018.

Hilke's consultancy services span the interfaces between research and applied science, resource management, industry, policy, and community interests. Her expertise includes cumulative effects, land-sea interactions, marine biosecurity and especially environmental management of aquaculture, an area Hilke has worked in for 15 years. Focussing on informing resource management with robust and relevant science, Hilke's expertise can help research scientists increase the value of their work for resource management, support consent applicants in commissioning the right science for their development, assist planning consultants to manage science aspects, or regional councils to review AEEs and write effective consent conditions, monitoring programmes or policy.

Hilke received a Coastal Society Professional Development Award for her studies towards a Bachelor of Laws. Through her (part-time) studies, Hilke aims to raise the profile of the interface of science and law, where decision-making on coastal resource management increasingly sits. Most major consent decisions will be litigated and there is potential for science to be misunderstood and misused in the legal context. Furthermore, direction for science best practice provided in legal decisions is often not accessible to practitioners and therefore not implemented. For example, this applies to the use of predictive models as revealed in a project conducted by Hilke with colleagues at Waikato Regional Council and the University of Waikato.

A focus of Hilke's studies is the use of adaptive management to address the issue of limited scientific information. Adaptive management is frequently promoted to allow consent to be granted despite the risk of significant adverse effects. However, the theoretical basis of adaptive management is limited and there are few examples of its practical implementation. While case law has provided some guidance, and several major consents have been issued with adaptive management conditions, adaptive management in practice has largely remained untested, particularly regarding the adequacy of information gathering, triggers for management responses, enforcement of required actions, and consequences for non-compliance. Hilke is currently preparing the first stages of her research for publication.

Dana Clark
Student Research PhD Scholarship

Environmental metabarcoding as a novel tool for coastal management

Dana's project aims to investigate the feasibility of using molecular tools for coastal monitoring. Traditionally, coastal health is determined by identifying and counting the animals (e.g. shellfish, worms) living within the seafloor sediments. While this is a valuable indicator, the approach is time consuming, expensive and requires taxonomic expertise, which is in decline globally. This focus on the 'visible' portion of the community also neglects the contribution of the 'invisible', but critically important smaller organisms (e.g. bacteria), which are known to be sensitive indicators of environmental change.

Recent advances in molecular technologies allow species to be identified from genetic fragments contained in small amounts of sediments using a technique known as environmental DNA (eDNA) metabarcoding. This approach has the potential to become a cost-effective, reliable and rapid option for comprehensive environmental assessment, but further research and validation is required before these techniques can be applied for routine monitoring.

As part of the Tipping Points project, which is funded through the Sustainable Seas National Science Challenge, Dana was involved in setting up field experiments in 15 estuaries across New Zealand. These controlled experiments provide an excellent opportunity to test the applicability of eDNA metabarcoding techniques for detecting nutrient enrichment effects in coastal environments.

Results from this study will be the first step towards the development of molecular monitoring tools, which could provide more standardised approaches to coastal monitoring with faster turnaround times and lower costs.

Dana's supervisors are Professor Conrad Pilditch (University of Waikato), Dr Joanne Ellis (King Abdullah University of Science and Technology) and Dr Anastasija Zaiko (Cawthron Institute and University of Auckland).

Vanessa Taikato

Māori/Pacific Island Student Research PhD Scholarship

Ancient resource management and the translocation of toheroa

Māori have a well-documented history of translocating aquatic and terrestrial plants and animals both to and around Aotearoa/ New Zealand. Thanks to recent research we

Dana Clark

Vanessa Taikato

Prajakta Niphadkar

now know that translocation of shellfish was an important component of Māori marine resource management. Anecdotal evidence suggests that several shellfish species have been transported over distances ranging from tens to hundreds of kilometres, being successfully introduced to new areas. What we do not currently understand is the science behind this ahumoana tawhito (ancient aquaculture).

Vanessa is examining the evidence for, and logistics of, shellfish translocation and is focusing on the iconic toheroa (*Paphies ventricosa*) and its historical distribution. An ingenious tool that is suggested to have facilitated translocation is pōhā, an organic storage bag that has been utilised by Southern Māori for hundreds of years, made from *Durvillaea* bull kelp.

Combining Mātauranga Māori with methods from archaeology, ecology and natural products chemistry, Vanessa aims to gain an in-depth understanding of pre-historical and historical toheroa distribution and the biological and practical implications of translocation using pōhā.

Vanessa's research will be an important contribution to a growing body of knowledge around taonga bivalve species in New Zealand, with a strong focus on traditional conservation practices (mahinga kai) undertaken by tangata whenua in the past. This kaupapa will aim to determine how the Mātauranga of kaimoana translocation in New Zealand can inform contemporary restoration of depleted shellfish resources, engaging with iwi, wider communities and conservation scientists, alike, in alignment with an holistic approach to research and conservation management.

Vanessa's supervisors are Dr Phil Ross and Professor Chris Battershill (University of Waikato).

Prajakta Niphadkar

Student Research MSc Scholarship

Sea level variability around New Zealand: Observations, contributions and projections

Regional sea levels vary considerably more than the global mean, and this variability has been evident in sea level records from tide gauges around New Zealand.

Prajakta's research aims to investigate interannual (~1-9 year) and decadal (~10-20 year) fluctuations in New Zealand's tide gauge records. Ensemble Empirical Mode Decomposition, an adaptive time-frequency analysis technique, is applied to separate the variability and assess the relationship with climate oscillations in the South Pacific.

Then, a high-resolution global ocean model, the Ocean Forecasting Australia Model 3 (OFAM3), is used to simulate the last 40 years of sea level around New Zealand to investigate the ocean dynamics that have contributed to the changes in sea level. This will establish how well the model can provide high-resolution sea level projections around New Zealand over the next century.

Regional sea level changes affect a large proportion of New Zealanders and infrastructure in close proximity to the coast. This study will benefit coastal adaptation practices through a better understanding of low frequency sea level variations, which will provide a stronger predictive capability for storm surge and other extreme event planning. The application of the OFAM3 to New Zealand sea level will allow for more detailed sea level information at the coast that can be used by planners and local councils.

Prajakta's supervisor is Dr Melissa Bowen (University of Auckland, New Zealand). She has also received guidance from Dr Xuebin Zhang (CSIRO Oceans & Atmosphere, Australia).

News from the regions

Waikato

Christin Atchinson and Jacqui Bell, Regional Representatives

Fish farm tender awarded

The Waikato is on track to establish the North Island's first offshore finfish farm, which will be for a new commercial species – kingfish. Waikato Regional Council has granted Pare Hauraki Kaimoana authority to apply for resource consents to occupy 240 hectares of finfish farming space in the Firth of Thames following a tender process. The council called for tenders in 2017. The tender proposals were assessed against criteria such as proposed environmental management practices, economic and social benefits to the community, and monetary contribution to the council and central government to occupy and use the water space. Following the tender evaluation and negotiation process, authorisation has been granted to Pare Hauraki Kaimoana.

Pare Hauraki Kaimoana propose farming kingfish in the space and the authorisation means they now have two years to prepare and submit an application for the necessary resource consents. Any application for a resource consent to farm fish must consider a staged approach to development, accompanied by a site-specific assessment of potential environmental effects and a holistic environmental monitoring plan.

The space, known as the Coromandel Marine Farming Zone, is located about 10 kilometres offshore of Coromandel Town. The Coromandel Marine Farming Zone was established in 2011 by a central government amendment to the Waikato Regional Coastal Plan following strong interest in farming kingfish and hāpuku in the region.

Coromandel Marine Gateway

Pita Street Development is looking to establish a new $22 million marine facility near the centre of Coromandel Town that will provide the following:

- a ferry landing terminal right in Coromandel Town with direct service from Auckland City;
- a central facility for Fishing Charter operators based in Coromandel Town;
- hardstand storage for 35 boats up to 12 m in length with a Travel lift haul-out;
- boat-rack on land storage for 180 trailer boats;
- temporary short-stay wet marina berths within the marina basin;
- channel dredging to provide all-tide access to and from the harbour via Furey's Creek right into Coromandel Town;
- channel dredging to provide all-tide access to recreational boaties launching from the adjacent Patukirikiri Reserve;
- 10-12 marine side apartments; and
- car parking and toilets for facility users.

It is proposed that the existing Furey's Creek public waterway will be widened and deepened by dredging the creek and developing stop-banks, a marine basin, and marine facility for users. Soil sampling of the proposed dredging areas commenced in October 2018.

For further 3D visualisations as well as a location map please refer to the website: www.coromarinegateway.nz

Consultation is underway with key stakeholders including TCDC, Waikato Regional Council, Iwi, NZTA, Department of Conservation, Forest & Bird, adjacent landowners, and the wider public.

To register your interest or make a comment go to the www.coromarinegateway.nz at the 'Contact Us' page.

Bay of Plenty

Jonathan Clarke and Kieran Miller, Regional Representatives

Access to Water project receives Judges' Choice Award

Tauranga City Council's Access to Water project at Tauranga's waterfront received the Judges' Choice Award at the inaugural Bay of Plenty Property People Awards. The awards celebrate people in property, recognising excellence in leadership and innovation in the Bay of Plenty property industry whilst celebrating outstanding contributions to the industry and economy. The Access to Water project signalled council's first investment in amenity in the city centre and the city's waterfront for a number of years.

Following extensive community engagement, council set out to achieve the aspirations of the community and create a high-quality open space with access to our treasured harbour. The Access to Water project replaced a hard rock seawall, with curved concrete steps that fold down into Tauranga Harbour, reconnecting people with the waterfront and city centre. The $3.2 million project included tidal steps, a bombing platform, pier and pontoon.

Vessel Works – Tauranga's new marine servicing hub

Vessel Works is a new purpose-built marine servicing hub in the heart of Tauranga, catering for commercial and recreational vessels, large and small. Vessel Works has been in the making since 2014, when the council at the time recognised the need to replace key facilities that the local marine industry lost when the Tauranga Harbour Bridge was expanded. Construction proper started in October 2016, and stage 1 of the project is now close to completion. The site and the travel-lift were given a morning blessing by tangata whenua, with a karakia led by Ngai Tamarawaho kaumatua Tamati Tata, and stakeholders joined in for an evening celebration.

Through considered yet ambitious decision making and project management, the new hub at Sulphur Point has the potential to be a game changer for the local marine refit industry. At the centre of the hub now sits a 6300 m^2 post-tensioned hardstand, which took out the record for the largest outdoor concrete pour ever attempted in the Bay of Plenty. The pavement is engineered to support loads of 500 tonnes – just under the fully-laden weight of an Airbus A380. The star of the precinct is Hikinui ('big lift'), the largest capacity mobile vessel-hoist in the country that can lift vessels of up to 350 tonnes, and move them around the site and into marine businesses. The sheer capacity of the vessel-hoist will give the precinct the competitive edge when it comes to servicing large commercial and leisure boats. Vessel Works also boasts deep water berthage and a refit wharf suitable for large boats, a washwater processing and recycling system to protect the harbour, barge loading ramps, and facilities for unloading catch and loading ice that are well used by local fishing companies.

University of Waikato Marine Research & Education Facility

Tauranga City Council will assess the recreation reserve Marine Park at Sulphur Point to identify a potential site for the establishment of a purpose-built Marine Research and Educational Facility. TCC considered the consultation outcomes for the area of open space land at northern Sulphur Point in July 2018 and as a result the site has been removed from further consideration. The vision is to create an interdisciplinary research and teaching facility including specialist marine laboratories, engineering design workshops, and a large public engagement space to showcase the Bay of Plenty marine environment to the public.

The proposed research centre would be distinctive to New Zealand and create the capacity to attract and host national and international collaborations and research programmes. It would expand the capability to protect Tauranga's and New Zealand's marine environment by providing opportunities and solutions to key issues for the Bay of Plenty coastal and marine environments. By providing tertiary education opportunities and courses unique to New Zealand, the world-class centre would help to keep more young people in the area.

Whilst the facility would not be a commercial operation, significant direct economic benefits to the city are expected through growth in student, researcher and administrative staff numbers; new local and international research; development partnerships and conferences; and the development of marine products and technologies.

The facility would put Tauranga on the map as a home of world-class research specialising in marine research, biotech and engineering, and tertiary education.

Gisborne

Murry Cave, Regional Representative

Logs on the beach

Woody material, primarily comprising pine logs, is a perennial issue on Tolaga Bay beach, one of Gisborne/Tairawhiti's most popular tourist destinations. Significant influxes of woody debris from forest harvest areas have occurred in 2012, 2014, 2017 (ex-Cyclone Cook) and now in 2018 (Queens Birthday storm). The 2017 ex-Cyclone Cook event was reported in a previous *Coastal News* (Issue 64, November 2017).

For the Queens Birthday 2018 event, the analytical approach to the woody debris on the beach was different from that undertaken in 2017. This was because a forestry contractor started to push the logs into large piles soon after the storm. Thus it was not possible to do a statistically valid assessment of the types of material delivered to the beach by the storm. What was done was an estimate of the volumes of material present on the beach as a result of the storm.

This was easier said than done. Variables include the semi-random piles of logs of various diameters, orientation and length, the shape of the piles, the presence of voids, the incorporation of sand, and the specific gravity of the material.

Drone footage was used to determine the location and approximate dimensions of the log piles (Figure 1). Sentinel satellite imagery dated 22nd July and at a resolution of 10 m was used to supplement the drone data as were an initial series of photographs taken on the ground. Several piles were also measured on the ground to validate the analysis and the specific gravity of the material was taken as 0.59, which is the SG of the heaviest pine species. Pile heights as estimated on the ground varied from 1.5 to 2 m. Obviously the piles are not perfect rectangles but are more ellipsoid in character, but have been treated as rectangles to add a factor of safety.

Figure 1: Drone footage of logs on north Tolaga Beach.

All of this data was used to plot the areas onto a GIS and thus derive an area for each pile. The metadata was then exported to Excel and the total volumes and mass calculated.

Results

There are twenty-eight log piles on the beach. Logs located south of the Tolaga Bay wharf have not been put into a pile, but have been concentrated by wave action. This was one site where an assessment of the types of material could be undertaken.

The operation to construct the piles did not follow the same procedure in all cases. On north Tolaga Beach, there are sixteen discrete piles of variable shapes. Some have been piled into discrete ellipsoids, while others are far more extensive linear piles. On South Tolaga there are twelve piles. There is one large, shaped pile between the wharf and the fishing boat entry point, but north of there the logs have all been pushed up into a series of very long linear piles. The volume immediately at the river mouth was not put into piles to protect the population of NZ dotterel and leucistic oystercatchers in that area. Based on the multiple methods used to assess the volume of material, the calculated volume across all piles equates to around 47,909 m^3.

Composition of Tolaga Bay woody debris

Work undertaken by counting all woody material within three 10 m^2 plots after ex-Cyclone Cook (2017) demonstrated that the woody debris excluding dross (small disaggregated material) was dominated by pine (68%) with the remainder willow or poplar (32%). That work also showed that the pine material comprised cut pine (19%), fresh cut pine (2%), long resident processed logs (67%), and 'windthrow' (12%). It is noted that 'windthrow' is a misnomer as these logs can comprise windthrow, trees displaced by slips, and trees knocked over on flood plains by the large volumes of migrating woody debris during the event.

It was not possible to re-occupy the plots used in 2017 as material within these areas had been highly modified during the clean up that occurred immediately after the Queens Birthday storm. One 10 m^2 plot was counted in the area immediately south of

Tolaga Bay wharf. This showed that the Queens Birthday event was largely comparable to ex-Cyclone Cook with 13% cut pine, 54% long resident pine logs and 17% 'windthrow' pine, while willow and poplar comprised 11.5% and indigenous 4%.

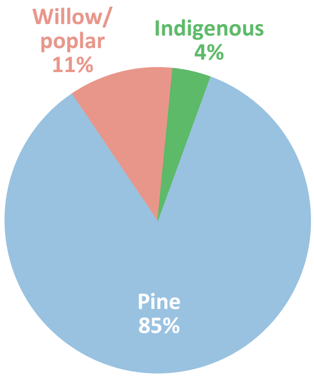

Figure 2: Percentage of pine, willow and poplar, and indigenous.

The aftermath

Gisborne District Council is working with the forestry companies to work out a way to remove the logs. The cost is very high. An initial experiment to burn the logs using forced air to elevate burn temperatures to eliminate the dioxins that form when logs have been in the sea was not very successful. Further work is being undertaken to work through removal issues. One issue, however, is the presence of around 250,000 m^3 of logs within the catchment that are vulnerable to relocation in a future flood event. Work is underway to assess the best means of removing this material.

Eastland Port citizen scientists: Staff take part in national litter data programme

Hayley Redpath, Eastland Port

Eastland Port staff are helping look after East Coast's Kaiti Beach through a nationwide beach litter data collection programme. Staff are working with charity organisation Sustainable Coastlines on its crowd-sourced scientist Litter Project.

"We're everyday Kiwis who love the beach and want to look after it so we're doing something to help" says Eastland Port's Martin Bayley, who along with fellow staff is a passionate advocate of the nationwide project. "Enabling others is crucial if we want to look after waterways and the oceans so we're encouraging others to take part during our beach clean-up days," adds Mr Bayley.

Kaiti Beach is one of over 100 beaches having its litter analysed in the three-year Sustainable Coastlines project. Litter from a 100 m stretch on each participating beach is collected, analysed and collated by locals so scientific data about New Zealand's contribution to the global problem of marine pollution can be better understood. Details on the litter quantity, weight and type are recorded and then fed into a national data base. The Litter Project will form the basis of scientific reports to be shared with leaders and politicians who can help exact change at a national and international level. Eastland Port staff received their Litter Project training in August. The 100 m stretch of Kaiti Beach being analysed runs from the end of Eastland Port towards the Gisborne Yacht Club.

The first analysis was done on Sunday 26 August in conjunction with a Plastic Bag-Free Tairawhiti beach clean-up and attracted 80 people.

Eastland Port's Martin Bayley and a clean-up volunteer working on Kaiti Beach. Photo: Canaan Akuhata-Brown.

Taranaki

Thomas McElroy, Regional Representative

Regional Coastal Plan

The Council is currently reviewing the Regional Coastal Plan for Taranaki. A Proposed Coastal Plan for Taranaki has been publicly notified and 61 initial and 24 further submissions were received. As part of the process, and prior to holding a formal hearing on the submissions, Council officers are meeting with interested submitters across October and November to discuss issues raised in their submission. In previous plan reviews, this pre-hearing consultation has proven to be a useful tool for clarifying respective viewpoints, discussing issues, and identifying potential solutions.

Coastal Hazards and Climate Change Guidance

The final public event for MfE's Coastal Hazards and Climate Change Guidance was held in New Plymouth at Puke Ariki earlier in the month. The presenters did an excellent job on the event, which was well received by the local audience.

West Coast

Don Neale , Regional Representative

The main coastal happenings on the West Coast are mostly related to responses to the 2018 summer storm events (see *Coastal News* #66). At the town of Hector, the West Coast Regional Council has applied for CSR funding on behalf of Buller District Council to help build a seawall to encapsulate the asbestos and other waste materials that are currently being exposed by ongoing erosion at the town's contaminated dump site. At Greymouth, a seawall to help protect the old Cobden rubbish dump from coastal erosion is largely completed, and NZTA's work is well underway at Punakaiki to reconstruct part of SH6 that was swept away.

Disclaimer

Contributing to *Coastal News*

We welcome contributions for forthcoming issues of *Coastal News*. Please contact the Editor, Charles Hendtlass, at cellwairmonk@gmail.com if you'd like to submit an article, contribute a news item, have content suggestions or a photo to share, or to give some feedback on the newsletter.

The submission deadline for the next issue is 31 January 2019.

A Contributor's Guide is available for download from the Society's website at www.coastalsociety.org.nz (under the 'Publications' tab). This provides information on the style and format requirements when writing for NZCS publications.

University & education news

University of Canterbury

Seb Pitman

Post-earthquake mixed sand and gravel beach response, Kaikoura, New Zealand

Kate MacDonald, a UC Masters student, is studying the geomorphic response on the mixed sand and gravel beaches in Kaikōura, following the major uplift event in late 2016. The research uses 18 years worth of beach profile survey data to determine how these beaches have fluctuated geomorphically in the past. By identifying past trends of the Kaikōura coastline, data from two post-earthquake surveys can be analysed to determine how uplift and change to the sediment budget has altered the shoreline, and how long these changes are sustained in the short-term geomorphic profile following the event.

The aim of this research is to help better inform resource management decisions along the coastline, by identifying key trends in beach change as it re-adjusts to a change in relative sea level. Results so far suggest that beaches undergo an instantaneous change in volume with uplift, and its ability to maintain the increase in volume is dependent on the sediment budget of the site. Two years on from the event, all sites have maintained some of the growth that resulted from the uplift, but sites with erosional trends pre-quake are retreating back to pre-quake shoreline extents and morphology quicker than those that had stable and accretionary trends prior to the earthquake. This research is being supervised by Deirdre Hart and Seb Pitman, and is funded by the Waterways Centre for Freshwater Management.

Dune erosion in Pegasus Bay

A group of final year undergraduate students have been conducting research on behalf of Tūhaitara Coastal Park, to try and understand differential dune stability along a stretch of coastline in Pegasus Bay. The park ranger, Greg Byrnes, asked the students to investigate why the dunes are seemingly healthy at one end of his 10 km park, but eroding rapidly at the other.

The students have been out conducting UAV 3D mapping, ground penetrating radar work and sediment sampling, along with historical beach profile analysis, in order to try to understand the changes in the park. The group reported back at a Community Partners conference in late October.

General News

Seb Pitman and Deirdre Hart have just finished a piece of research looking at the Holocene storm response of a mixed sand gravel beach in Pegasus Bay, funded by a Royal Society NZ Hutton Fund grant. The research utilised ground penetrating radar to image the subsurface, and results show the scarp and subsequent recovery of a high return period (c. 1 in 200 years) storm event on the beach. Future ambitions are to extend the scope of this pilot study and combine the results with numerical modelling to better understand the magnitude of the event and the process of post-storm recovery.

Seb is currently working with Surf Life Saving New Zealand on the SafeSwim project, which aims to build real time beach hazard prediction into the existing water quality app. This work has involved analysis of the lifeguard incident statistics with respect to hydrodynamic forcing in order to propose thresholds responsible for increased beach hazard. The next stage of this work includes GPS drifter deployments on east and west coast beaches during the early part of 2019. We also have a Summer Scholarship student starting with us in November, collaborating with Surf Life Saving NZ and Kevin Moran at the University of Auckland, to investigate public perceptions and understanding of rip current risk on New Zealand beaches.

Shoreshop: a shoreline modelling workshop

Giovanni Coco and Jennifer Montaño

A wide range of numerical models are implemented in the prediction of the shoreline evolution and few comparative studies exist to assess their relative strengths and weaknesses. We devised a non-competition (Shorecast) and subsequent workshop (Shoreshop 2018) to bridge this gap.

In February 2018 we invited world experts in numerical modelling of shoreline evolution to participate to a non-competitive competition: Shorecast.

The competition was centred on a question: Can you predict shoreline evolution at Tairua beach for the period 2014-2016?

We provided scientists with 14 years (1999-2013) of daily shoreline evolution from video images and wave/tide characteristics from numerical modelling of Tairua beach. We asked them to predict shoreline evolution for the period 2014-2016. For that period, we only provided the wave characteristics and actual shoreline evolution was not given. Subsequently, participants were not biased by knowing the actual answer and were, therefore, unable to tune/fit the model. We also asked scientists to predict the evolution of Tairua beach until 2100, but discussed these predictions in a purely qualitative way.

Contributors from 18 institutions convened on June 6-8 at the University of Auckland to present and discuss the 'blind' predictions for Tairua beach. Models were subjected to intense scrutiny and discussions ranged from the details of modelling techniques to the role of climate models in long-term shoreline prediction. Interestingly, almost all models displayed evident agreement with the observations, but they also indicated shortcomings that need to be addressed. These shortcomings become more evident when attempting to predict over a longer temporal horizon (2100).

The shoreshop initiative does not end with the workshop. The interest raised has gone well beyond the initial expectations and future shoreshops are planned. The workshop was sponsored by the Hazard Hub (University of Auckland) and has been organised within the framework of the GNS-Hazard Platform project: Climate change impacts on coastal hazards. The shorecast competition was made possible thanks to the support and data sharing from Waikato Regional Council, MetOcean, NIWA, and the University of Waikato.

NZCS Undergraduate awards

The NZCS provides an annual award to encourage students at undergraduate level studying within a New Zealand Tertiary Institution. This year's winners are:

University of Auckland

Zheng Chen (zche440@aucklanduni.ac.nz)

Course GEOG 351 – Coastal and Marine Studies – This course focuses on the development of coastal landforms across a range of temporal and spatial scales. It introduces natural processes such as waves, tides and circulation, as well as geological-scale coastal evolution driven by changes in sea level and sediment supply.

The course has an applied focus, with specific emphasis on coastal management problems that affect society.

University of Waikato

Elliott (Ellie) McCleery (elliemccleery@hotmail.co.nz)

Ellie is a conjoint BSc/LLB student specialising in Environmental Law with a focus on coastal issues.

University of Canterbury

Katie Thompson (kth60@uclive.ac.nz)

Course GEOG311 – Coastal Studies – This course covers coastal hydrodynamics, coastal geomorphology and environment diversity, and coastal management.

Central government news

Sarah McRae, Central Government Liaison

New Zealand Coastal Policy Statement guidance 'roll-out' from the Department of Conservation

Roll-out of guidance on the New Zealand Coastal Policy Statement 2010 (NZCPS 2010) is continuing. DOC has been working with the regional councils' Coastal Special Interest Group (CSIG), MfE, MPI and other agencies to produce guidance notes on the policies in the NZCPS 2010.

See: https://www.doc.govt.nz/about-us/sciencepublications/conservation-publications/marine-and-coastal/new-zealand-coastal-policy-statement/policy-statement-and-guidance to view the existing guidance.

New DOC guidance notes include:

- Hazards policy guidance was released on the DOC website in December 2017 and can be found at: https://www.doc.govt.nz/globalassets/documents/conservation/marine-and-coastal/coastal-management/guidance/policy-24-to-27.pdf. This complements the MfE guidance on hazards which was released at the same time.
- The Introductory Guidance note (https://www.doc.govt.nz/globalassets/documents/conservation/marine-and-coastal/coastal-management/guidance/introductory-note.pdf) has been updated with a summary of the Supreme Court decision, *Environmental Defence Society Inc v New Zealand King Salmon Company Limited* [2014] NZSC 38 (*King Salmon*) and the findings in relation to how the NZCPS is to be read.
- The Policy 17 Historic heritage identification and protection guidance was put on the DOC website in early October 2018 and can be found at: https://www.doc.govt.nz/globalassets/documents/conservation/marine-and-coastal/coastal-management/guidance/policy-17.pdf
- Guidance on Policy 20 Vehicle Access has just been released on the DOC website and can be found at: https://www.doc.govt.nz/globalassets/documents/conservation/marine-and-coastal/coastal-management/guidance/policy-20.pdf

The guidance is being refreshed for Policy 13 'Preservation of natural character' and Policy 15 'Natural features and natural landscapes' in light of the implementation experiences since *King Salmon*.

The Water Policies guidance will be on the DOC website by the end of the year.

Guidance is also being developed for:

- Policy 5, Land and waters managed or held under other Acts;
- Policy 11, Indigenous biological diversity (biodiversity); and
- Policy 12, Harmful aquatic organisms.

For further information, please contact Karen Bell, kbell@doc.govt.nz or 027 5570 579.

The New Zealand Coastal Society would like to acknowledge our corporate members for their support:

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