Te Hunga Takutai o Aotearoa
NEW ZEALAND COASTAL SOCIETY

# Coastal News

Newsletter of the New Zealand Coastal Society: a Technical Group of Engineering New Zealand

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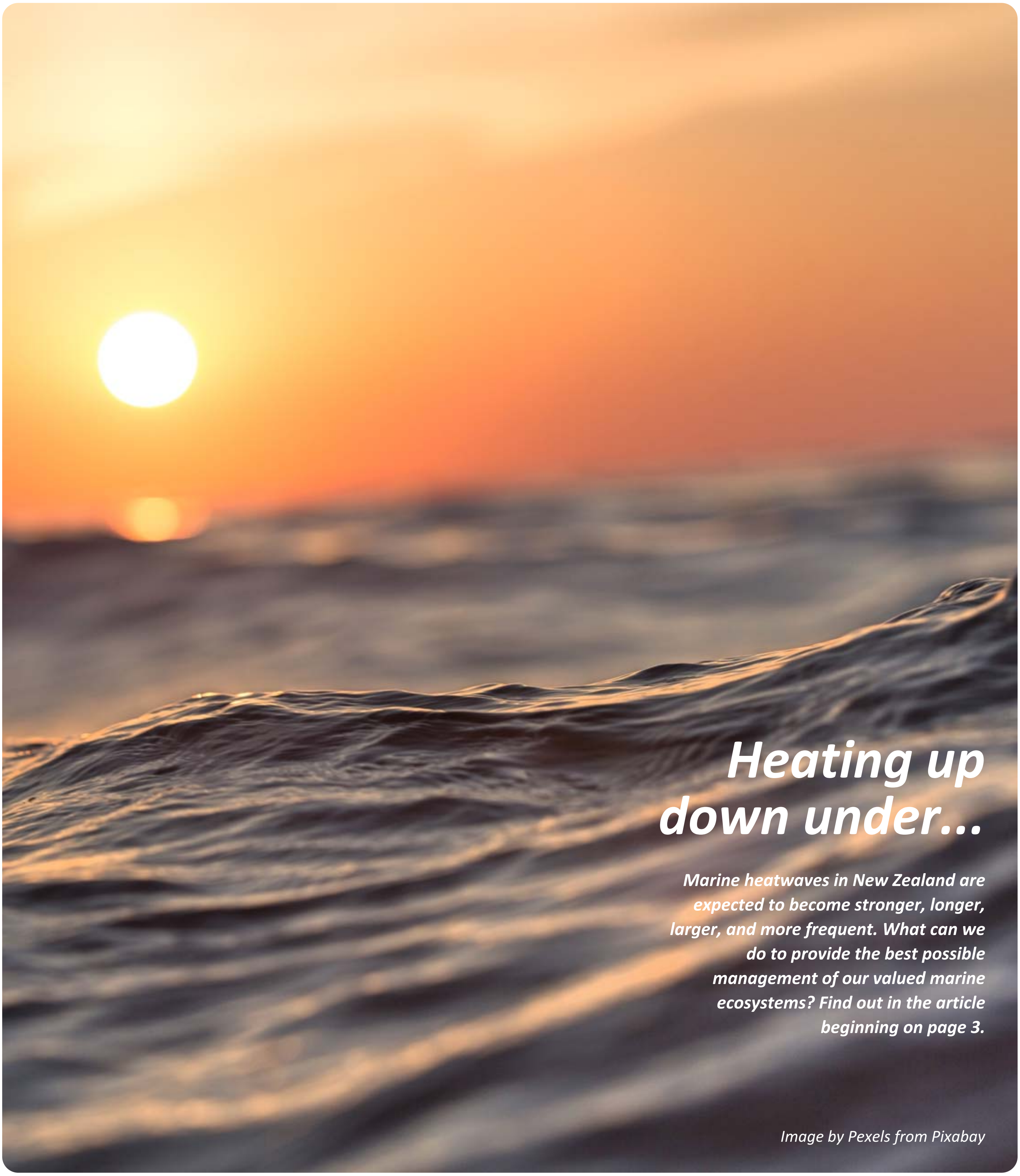

## Heating up down under...

***Marine heatwaves in New Zealand are expected to become stronger, longer, larger, and more frequent. What can we do to provide the best possible management of our valued marine ecosystems? Find out in the article beginning on page 3.***

*Image by Pexels from Pixabay*

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## CONTENTS



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# Word from the Chair

Welcome to the November 2021 issue of the *Coastal News*. This new issue brings you feature articles on the latest innovations in marine ecology, surf science and fluid mechanics. The collaboration among our members to share their work is fantastic and this often stretches across multiple disciplines. Also, catch up on what's happening along ngā takutai o Aotearoa in the News from the Regions section, plus we are proud to bring you an update on our two NZCS 2020 Scholarship award winners – Cassandra Newman (AUT) and Duc Nguyen (University of Otago).

You will all now know that we have postponed the 2021 Australian Coasts and Ports Conference for the final time to 10-13 April 2022. This decision will give you the best chance to attend in person and help deliver the successful conference that both you and Christchurch deserve. Special thanks to Deirdre Hart, Tom Shand and their local organising committee. This team has gone above and beyond in their volunteer role, on top of their business as usual mahi in these tough times. This included developing a *Dynamic Adaption Pathway Plan*, which sets out a decision framework that allowed us to change path when trigger points indicated trouble ahead. Please visit the conference website http://www.coastsandports2021.co.nz/ to register and for more information.

We are pleased to welcome two new members on to the NZCS Executive Management Committee. Ryan Abrey and Tom FitzGerald come on board to add value across the deputy treasurer, central government, and regional coordinator portfolios. Rebekah Haughey will be stepping down at the 2021 AGM after volunteering on the committee for over seven years. Thank you Rebekah for all your efforts to enhance the NZCS, starting off as a student representative and moving into administration and regional coordinator portfolios.

Lastly, you will find a Kupu Takutai printed resource in this issue that is full of coastal terms with te reo Māori translations. This initiative was developed by NZCS for Te Wiki o te Reo Māori 2021 and we hope you find this useful in your kōrero this summer.

Thank you for your ongoing support to the NZCS and we hope you all have a relaxing and safe break with whānau and friends.

*Amy Robinson and Mark Ivamy*
*NZ Coastal Society Co-Chairs*

## About the NZCS

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's mission is to take a leading role in facilitating robust discussion and nationally-coordinated interactions to better manage and learn about our coastal and marine environment. The society currently has over 300 members based in New Zealand and overseas, including representatives from a wide range of coastal science, engineering and planning disciplines, employed in the consulting industry; local, regional and central government; research centres; and universities.

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

# Impacts of marine heatwaves: What are they, what have they done and what can we expect in the future?

Mads Solgaard Thomsen[1], Shinae Montie[1], Derek Gerber[1], Francois Thoral[1], Paul South[3], Leigh Tait[4], Thomas Wernberg[2], Dan Smale[5], David Schiel[1]

## Marine heatwaves – a hot topic about unusually hot oceans

Temperature is the single most important environmental factor affecting the physiology, ecology, and biogeography of organisms living in our oceans. Scientists therefore study how unusually hot conditions affect marine species[1]. Research has consequently, over the last 75 years, investigated how Sea Surface Temperature Anomalies (SSTA), calculated by subtracting ambient temperatures from climatic mean temperature, are linked to weather and how SSTA affects marine populations, communities and ecosystems[2]. The amount of research on unusually hot oceanic conditions has increased considerably, however, for several reasons.

First, a 'marine heatwave' terminology was recently adapted from climatic research and introduced as an alternative to the lengthy and technical SSTA. A marine heatwave was defined as a period when seawater temperatures exceed a climatological defined threshold (usually the 90th percentile of a 30 year dataset) for at least 5 consecutive days[3]. Second, this definition with easy-to-interpret descriptive metrics, like duration, spatial extent, intensity, and frequency, make it straightforward to quantify when and where heatwaves have happened, compare them, and describe how long, large, strong, and common they are (see Figure 1). Third, freely available computer codes that are linked to global satellite-derived temperature data, and point-and-click webpages, have made it easier for scientists with different backgrounds and computational skills to explore these events (see www.marineheatwaves.org/tracker.html). Fourth, rising population sizes and economic development entails that more scientists today are doing more research and publish more papers, across fields and topics. Fifth, global warming and an increase in unusually hot conditions have made marine heatwaves more visible to scientists, conservationists, the public, and managers[4]. Indeed, just a few months ago, a billion marine animals were killed from a marine heatwave in the Northwest Pacific of the USA (see www.theguardian.com/environment/2021/jul/08/heat-dome-canada-pacific-northwest-animal-deaths). Finally, a high-profile case study that documented regional extinction of common kelp (*Ecklonia radiata*) and loss of their associated ecoservices, grabbed the attention of the global scientific community[5-7]. So, in less than a decade, hundreds of research papers have described marine heatwaves around the world and their impacts on a wide range of organisms from phytoplankton to kelp and fish to costly effects on ecosystem services, using before-after comparisons, laboratory experiments and modelling[2,8]. These new studies highlight that short-term extreme events may be ecologically more important than slow gradual average warming, which has typically been studied in climate change research[1].

## Marine heatwaves have happened in New Zealand and affected marine life

Until recently little was known about marine heatwaves in New Zealand, perhaps because marine temperate ecosystems traditionally have been considered robust to global warming compared to tropical and polar regions. This is primarily because temperate organisms experience a wide range of temperatures over a year, compared to those in tropical and polar ecosystems. However, marine heatwaves have always occurred because weather events with temperatures exceeding a 90% climatic average will occur simply due to chance. For example, more than 100 marine heatwaves have occurred offshore of Kaikōura since 1982[9]. Importantly, there is increasing evidence that

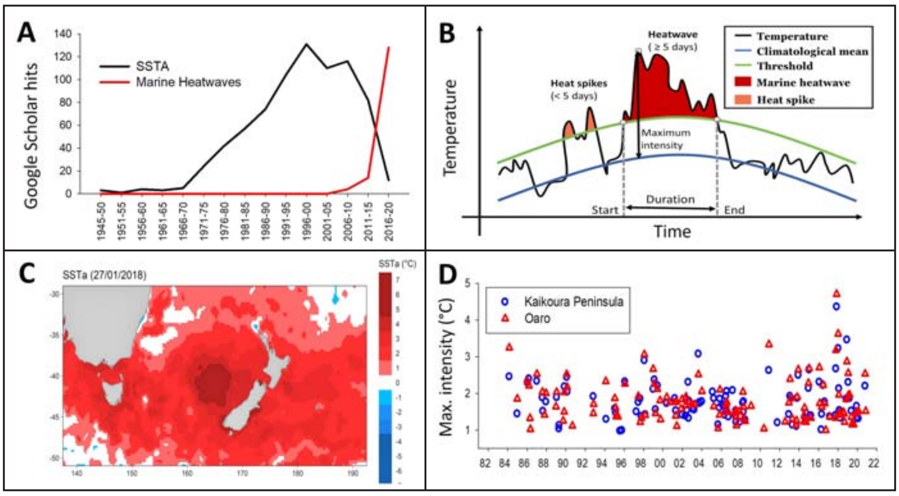



*Figure 1: Rise in marine heatwave studies, their graphical description, and the 2017/18 Tasman Sea marine heatwave. (A) Number of papers and reports with sea surface temperature anomalies (SSTA) or marine heatwaves (or heat waves) in their title per 5-year period. (B) Graphical depiction of a marine heatwave and main descriptors. The threshold is typically the 90th percentile of the climatological mean calculated from at least 30 years of data. (C) Maximal spatial extent of the Tasman Sea marine heatwave on January 27, 2018. (D) Maximum intensity of all marine heatwaves that have occurred around Kaikōura Peninsula (blue circles) and Oaro (red triangles) between 1982 and 2021. Note the large values around the summer of 2017/18.*

(1) University of Canterbury; (2) University of Western Australia; (3) Cawthron Research Institute; (4) NIWA; (5) Marine Biological Association of United Kingdom

because of emissions of greenhouse gases associated with human activities, marine heatwaves are becoming more common, longer, larger, and stronger[4]. Indeed, New Zealand experienced its hottest summer on record in 2017/18 – estimated to be the 5th most extreme marine heatwave worldwide[9]. This hot summer resulted in earlier harvests of summer fruit and melting of more than 20% of glacial ice volume[10]. In the marine environment, newspaper articles from New Zealand reported die-offs of surf clams (*Paphies australis*) in the wild, and green mussels (*Perna canaliculus*) and king salmon (*Oncorhynchus tshawytscha*) on marine farms. Furthermore, many warm-water swimming or drifting species, which can move quickly with changing sea temperatures, were observed at more southern latitudes than usual, including black trevally (*Caranx lugubris*) at the Kermadec Islands, snapper in Doubtful Sound, unusual catches of a mahi-mahi (*Coryphaena hippurus*) in Hawke's Bay, and Queensland groper (*Epinephelus lanceolatus*) in northern New Zealand 3000 km out of its normal range. Other examples included unusual observations of black hairy dogfish (*Antennarius striatus*), the Lord Howe Moray (*Gymnothorax annasona*), sergeant major damselfish (*Abudefduf saxatilis*), lion's mane jellyfish (*Cyanea rosea*), and early-season bluebottle jellyfish (*Physalia utriculus*) blooms[10].

In addition, we have documented impacts on long-lived and large habitat-forming seaweeds (see Figure 2). Habitat-forming seaweeds are particularly important because they are the 'foundation species' that provide essential marine functions like primary production, carbon uptake and storage, food and living space for fish and invertebrates, including economically and recreationally important taonga species, like pāua, butterfish and blue cod. Foundation species can also dampen waves, providing coastal protection, and take up nutrient runoff from the land. Our studies have shown that several important foundation seaweeds were affected by the 2017/18 marine heatwave, including giant kelp (*Macrocystis pyrifera*) and southern bull kelp (*Durvillaea* spp.). Giant kelp is the longest (up to 20 m in New Zealand and 50 m worldwide) and fastest growing seaweed that inhabits protected to moderately exposed rocky coastlines in the shallow subtidal zone down to around 20 m in southern New Zealand. Bull kelp can grow to 10 m and is among the heaviest seaweeds worldwide. Different bull kelp species inhabit different elevation levels from the low-tidal zone (*D. poha* and *D. antarctica*) and shallow subtidal zone to ca. 10 m (*D. willana*) – and all thrive on wave-exposed coastlines. Giant kelp and bull kelp have all the important traits of habitat-forming foundation species, including massive holdfasts that fix the seaweed to the rocks and that support a high biodiversity (see Figure 2).


*Figure 2: Photographs of habitat-forming seaweeds that have been impacted by marine heatwaves. (A) Thomsen doing biomechanical pull tests on common kelp in Western Australia before the 2010/11 marine heatwave killed common kelp along 100 km coastline. (B) Fur seal resting in a healthy bull kelp 'bed'. (C) Thomsen and Schiel collecting bull kelp from Lyttelton harbour for an ecology class before the 2017/18 marine heatwave killed all bull kelp in the harbour. (D, E) Holdfast of bull kelp (left) and giant kelp (right) that support high biodiversity. Photos: (A) T Wernberg; (B),(D),(E) M Thomsen; (C) S Gerrity.*

We have documented reduced canopy cover of giant kelp based on analysis of 60 months of satellite images across a latitudinal gradient southward from its northern distributional limit around Wellington[11] (see Figure 3). These reductions were strongest and lasted longest around Canterbury and Otago. We also found that temperature-induced loss was greater where water clarity was poor, and that giant kelp (with its high dispersal and vast reproductive potential) recovered relatively fast after the marine heatwave (see Figure 3). We have also studied impacts on bull kelp using drone images, photos, and quadrat data on different reefs from Kaikōura to Moeraki (see Figure 4). Bull kelp loss varied among species and latitudes, with regional extinction observed inside and around Lyttelton Harbour in Canterbury. Here, sea surface temperatures exceeded 23°C and air temperatures exceeded 30°C during a period of very low tides and calm sea conditions, so bull kelp was exposed for up to 3 h per day during low tide. Following this regional extinction, the invasive kelp *Undaria pinnatifida* invaded the same habitat[12]. A

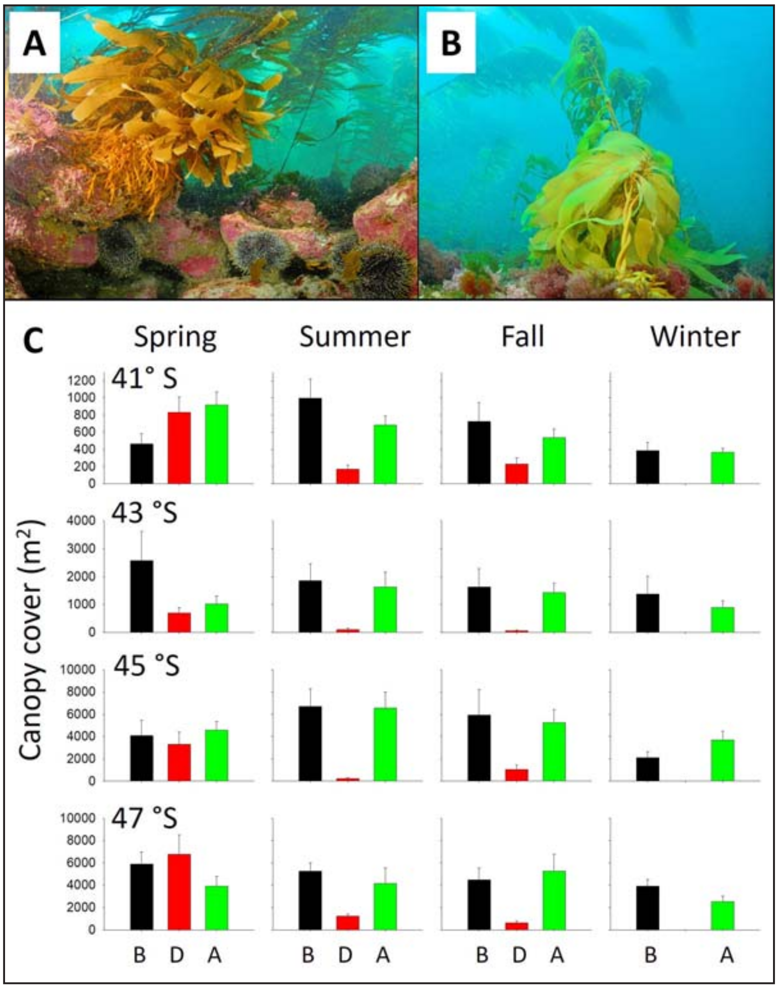



*Figure 3: Impact of the 2017/18 Tasman Sea marine heatwave on giant kelp. Mean areal cover (+ standard errors) in floating canopies of giant kelp (*Macrocystis pyrifera*, A,B) across latitudes and seasons (C) Before (B: Dec 2015 to Sep 2017), During (D: Oct 2017-Apr 2018) and After (A: May 2018-Dec 2020) the 2017/18 marine heatwave. Data were reanalysed from Figures 1 and 4 in Tait et al 2021; there are no winter 'During- marine heatwave' data. Photos: L Tait.*

follow-up study from Moeraki confirmed that even small plots that lost bull kelp after the heatwave also became occupied by *Undaria*. This study showed that entire plant and animal communities varied greatly between surviving bull kelp and plots where it had died back. Bull kelp facilitated calcareous encrusting algae, which in turn provided habitat for molluscs like limpets, chitons, and many larger gastropods including pāua, whereas plots without bull kelp had more *Undaria* and eventually became dominated by expanding turf-forming seaweeds that can inhibit the recruitment and recovery of bull kelp[13]. Finally, we found that marine heatwaves can compound the effects of other ecosystem stressors. For example, the 2017/2018 marine heatwave reduced bull kelp cover by an additional 35% compounding a >70 % losses of bull kelp that occurred due to the 2016 earthquake that devastated the Kaikōura coastline. Furthermore, recent surveys done in the same region four years after the earthquake and three years after the marine heatwave showed that bull kelp, in contrast to giant kelp, did not recover well and that the intertidal zone in some places now is dominated by much smaller turfing and foliose seaweeds[9].

Our results highlight two insights that sets them apart from most marine heatwave studies. First, most studies have shown that effects of marine heatwaves typically are most severe at a species' warm-water equatorial range where it lives near its upper thermal tolerance. However, in New Zealand, complicated currents, and perhaps different genetic capacity for temperature-tolerance between populations, resulted in strongest impacts away from the kelps' equatorial ranges. Second, and perhaps more importantly, our results highlight that water-associated temperature stress does not occur in an environmental vacuum. Instead, we found that impacts from marine heatwaves were more detrimental when light conditions were also low, and for intertidal species when high air temperatures coincided with low lunar tides and reduced wave-action. Finally, we found losses of bull kelp were smaller for populations that had survived seismic uplifts compared to near-by populations that did not experience the uplift, perhaps because surviving individuals may have been more robust to environmental stress[9].

## Marine heatwaves will become more common, longer, larger, and stronger, and should be incorporated into fisheries, management, and conservation plans

Climatic models predict that temperatures will increase for centuries due to greenhouse gas emissions, lag-effects, and environmental feedback mechanisms. New models now also predict that marine heatwaves will become stronger, more frequent, and longer over the next decades and centuries[14]. In the meantime, short-to-medium term forecasting is being developed that could be useful for short-term management purposes (e.g., for New Zealand see https://www.moanaproject.org and for Australia https://research.csiro.au/cor/home/climate-impacts-adaptation/marine-heatwaves/forecasting-marine-heatwaves).

Our research indicates that marine heatwaves can cause dramatic and near-instant changes to ecosystems. Species with wide temperature tolerances and high genetic plasticity may be able to withstand marine heatwaves for some time, but marine scientists generally expect poleward migrations to follow a species' climatic niche, and that migration will depend on regional oceanic currents that may inhibit or accelerate dispersal of some organisms. Furthermore, species that float, swim, have high reproductive outputs, and can colonise new habitats will likely be the first to follow new temperature conditions and move poleward. In addition, ecological changes arising from marine heatwaves may accelerate with arrival of invasive species, high nutrient and sediment runoff, altered grazing pressures such as expanding urchin populations, or reduced predation associated with fisheries. In concert, these stressors

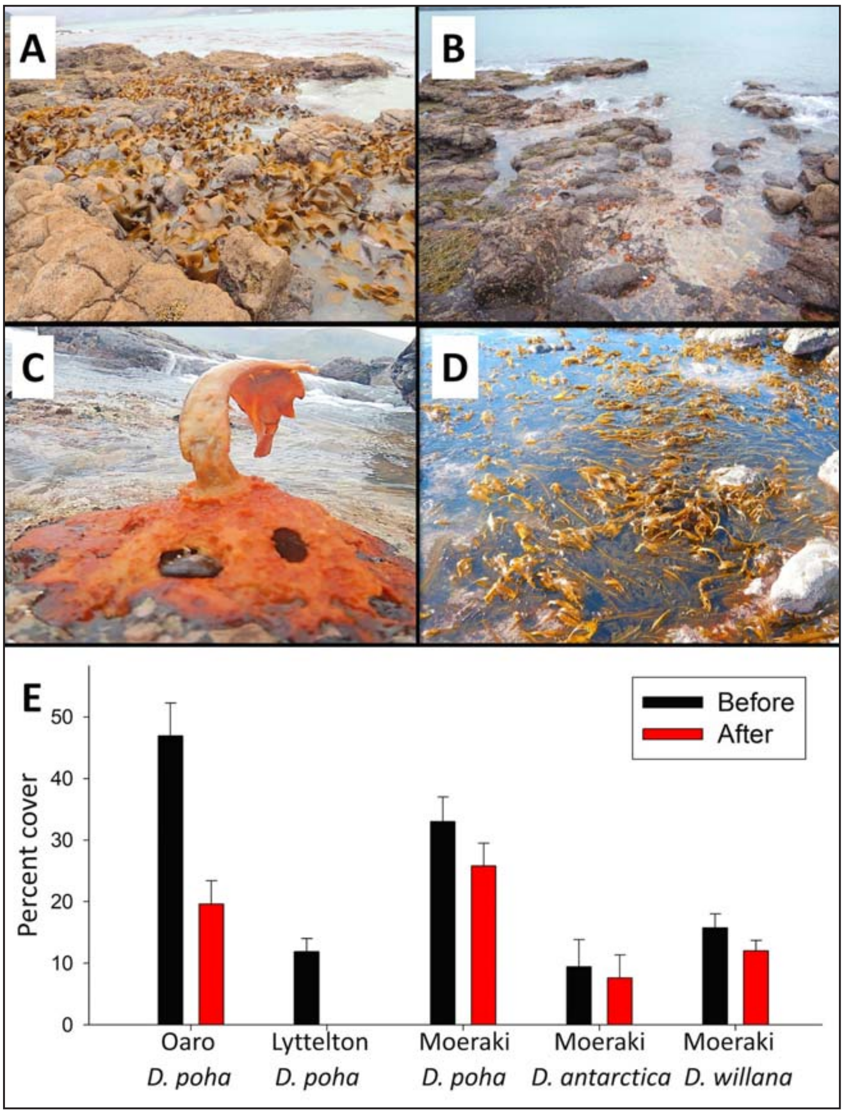



*Figure 4: Impact of the 2017/18 Tasman Sea marine heatwave on southern bull kelps. (A) Bull kelp (*Durvillaea poha*) in Lyttelton harbour, November 2017. (B) The same area in March 2018 where only remnants of holdfasts are visible. (C) Decaying holdfast in March 2018. (D) Invasive kelp* Undaria pinnatifida *invaded the same area in May 2018. (E) Percent cover (+ standard error) of* D. antarctica*,* D. willana*, and* D. poha *before and after the summer of 2017/18 on intertidal reefs at Oaro (42.5 °S), Lyttelton (43.6 °S) and Moeraki (45.4 °S). Photos: M Thomsen.*

imply that marine ecosystems in New Zealand are likely to change considerably over the next decades. Nutrient and sediment runoff, fisheries – and to a smaller extent arrival of invasive species – at least theoretically can be managed from local to national scales, but impacts from stronger, longer, larger, and more frequent marine heatwaves are more unavoidable (at least in short-to-medium time scales). In other words, management, like establishment of protected areas, fisheries, and aquaculture, should be flexible and adaptable to anticipate changes to marine heatwaves. For example, establishing new aquaculture facilities, protecting taonga species from overfishing, or restoring lost habitats should be done in a framework that incorporates expert knowledge of biological and ecological processes, and predictions of the impacts of marine heatwaves over the next decades and centuries.

New Zealand have been isolated for millions of years and has >15,000 km of coastline characterised by highly variable temperature regimes and many different marine habitats and environmental conditions. New Zealand therefore has a globally unique marine biodiversity with many species found nowhere else. These unique biogeographic regions will likely change considerably, in part because marine heatwaves will become stronger, longer, larger, and more frequent. We cannot avoid some of these changes, but research into documenting changes, resistance, and resilience, is a necessary first step in supporting the best possible management of these valued ecosystems and in preserving them in a best possible way for future generations to enjoy.

### *Marine heatwaves: Key scientific papers*

1 Bass, A, et al. (2021). Another decade of marine climate change experiments: trends, progress and knowledge gaps. *Frontiers in Marine Science: Global Change and the Future Ocean*.

2 Smale, DA, et al. (2019). Marine heatwaves threaten global biodiversity and the provision of ecosystem services. *Nature Climate Change* 9, 306-312.

3 Hobday, AJ, et al. (2018). Categorizing and naming marine heatwaves. *Oceanography* 31, 162-173.

4 Sen Gupta, A, et al. (2020). Drivers and impacts of the most extreme marine heatwaves events. *Scientific Reports* 10, 1-15.

5 Wernberg, T, et al. (2016). Climate-driven regime shift of a temperate marine ecosystem. *Science* 353, 169-172.

6 Wernberg, T, et al. (2013). An extreme climatic event alters marine ecosystem structure in a global biodiversity hotspot. *Nature Climate Change* 3, 78-82.

7 Wernberg, T, et al. (2018). Genetic diversity and kelp forest vulnerability to climatic stress. *Scientific Reports* 8, 1-8.

8 Smith, KE, et al. (2021). Socioeconomic impacts of marine heatwaves – global issues and opportunities. *Science*.

9 Thomsen, MS, et al. (2021). Cascading impacts of earthquakes and extreme heatwaves have destroyed populations of an iconic marine foundation species. *Diversity and Distributions*.

10 Salinger, MJ, et al. (2020). Unparalleled coupled ocean-atmosphere summer heatwaves in the New Zealand region: drivers, mechanisms and impacts. *Climatic Change*, 1-22.

11 Tait, L, et al. (2021). Loss of giant kelp, *Macrocystis pyrifera*, driven by marine heatwaves and exacerbated by poor water clarity in New Zealand. *Frontiers in Marine Science* doi: 10.3389/fmars.2021.721087.

12 Thomsen, MS, et al. (2019). Local extinction of bull kelp (*Durvillaea* spp.) due to a marine heatwave. *Frontiers in Marine Science* 6, 84.

13 Thomsen, MS, and South, PM. (2019). Communities and attachment networks associated with primary, secondary and alternative foundation species; A case study of stressed and disturbed stands of Southern Bull Kelp. *Diversity* 11, 56.

14 Oliver, EC, et al. (2019). Projected marine heatwaves in the 21st century and the potential for ecological impact. *Frontiers in Marine Science* 6, 734.

# Biodiversity offsetting and compensation in the marine environment

Tommaso Alestra[1] and Jacqui Bell[2]

With more than half of the world's population living in coastal areas and 80% of global trade carried by sea, marine ecosystems are under ever-increasing pressure from coastal development. Compounding this is the overexploitation of marine resources and the expansion of industries such as oil and gas, seabed mining, renewable energy, and aquaculture across the oceans, including remote offshore areas.

With marine habitat degradation and conversion to other uses often unavoidable, many countries have developed policies for marine biodiversity offsetting and compensation. Nonetheless, these practices are still emerging mechanisms for marine impact management, even where they are well developed for terrestrial environments. Here we look at why that is the case and explore the challenges and opportunities associated with marine offsetting and compensation.

Offsetting is used when actions to avoid, remedy, or mitigate impacts on biodiversity have been exhausted, with the aim to counter-balance residual adverse effects by enhancing biodiversity elsewhere. The goal of biodiversity offsetting is to achieve a measurable no-net-loss, and preferably a net-gain, of indigenous biodiversity in a like-for-like manner (that is, the same type of biodiversity is lost and replaced). Unlike offsetting, environmental compensation does not involve a like-for-like exchange of biodiversity and is not designed to demonstrate a no-net-loss outcome. Therefore, compensation is the last resort in the hierarchy of responses against adverse environmental effects.

Marine offsetting and compensation are challenging because it is hard to measure losses and gains of biodiversity in the marine environment. The marine environment is highly dynamic, and its diffuse nature makes it difficult to predict the spatial scale of adverse effects, which may well extend far beyond the project area. Near-shore coastal systems are also under the constant influence of land-generated perturbations, such as sediment and stormwater discharges. As a result, it can be difficult to distinguish project impacts from background noise and to assess the success of offset/compensation measures.

Our ability to accurately measure impacts on marine biodiversity and offset/compensation gains is often restricted even further by the scarcity of baseline information. Even for well-studied coastal and shallow systems, detailed mapping of the distribution of different ecological communities is often not available. Even less is known about the reliance of mobile species on different habitats, which can vary across their life cycles.

Finally, restoration-based offsetting/compensation is costly and often hindered by the lack of suitable habitats and eco-engineering techniques. As a result, active rehabilitation of marine habitats is still far from providing certainty about ecological gains.

Despite these challenges, we are beginning to see an increase in the application of marine offsetting and compensation in New Zealand. In addition to the application of practices common in terrestrial offsets, the uptake of new knowledge developed in other fields is providing more options for offsetting and compensation. For example, efforts to enhance biodiversity, combat sea level rise and coastal flooding, reduce carbon footprint, and improve water quality have led to a rapid development of a range of 'eco-engineering' products and 'building with nature' solutions that can be implemented to counterbalance biodiversity losses. Examples of these include living seawalls, artificial tidepools, mangrove planters, habitat enhanced concrete armour units, pile jackets and 3D printed subtidal reefs (see Table 1).

These engineering solutions are not the only options available. Restoration of mangrove, saltmarsh, seaweed and bivalve habitats are also increasingly implemented and detailed protocols have been developed (Table 1).

Knowledge gaps and practical challenges means that innovative offsetting approaches are required in the marine environment. For example, reclamation and permanent occupation of marine habitat by artificial structures such as wharfs, seawalls and rock revetments are difficult to offset with equivalence. An example of this was the loss of marine habitat associated with the construction of a shared pathway in Wellington Harbour. For this project, avoidance was not possible and offsetting in a like-for-like, no-net-loss capacity was also unachievable.

Therefore, we developed a compensation package which included a variety of habitat enhancement measures, such as the establishment of 6 ha of mussel habitat on the adjacent subtidal soft sediments, as well as the deployment of living seawalls elsewhere in the harbour. In addition, artificial tide pools and habitat enhanced concrete armour units will be incorporated within the revetment design. Biodiversity monitoring will be carried out and measures of success must be met, to avoid reverting to a contingency compensation measure of 11.5 ha of stormwater treatment for the adjacent state highway.

Our ability to reinstate important habitat-forming species is increasing thanks to research advancements in the field of habitat restoration. A new approach that we have recently investigated is the translocation of a seaweed population that would be affected by reclamation by seeding its spores onto newly-built structures and the habitat adjacent to the project area. This type of approach requires consideration of the time lag between biodiversity loss and gain and of the uncertainty about a no-net-loss outcome. Therefore, trials will be carried out before this method can be relied upon as a like-for-like offset.

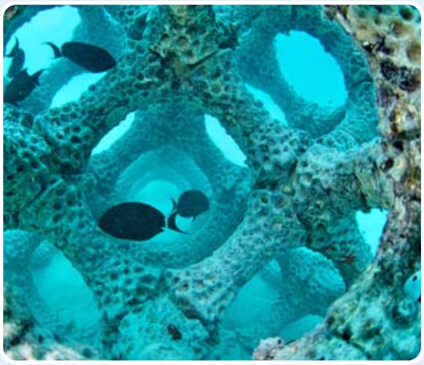
Habitat restoration can be much more straightforward when nature simply needs a helping hand. For example, we have

(1) Senior Marine Ecologist, Boffa Miskell Ltd;
(2) Senior Marine Ecologist, Associate Principal, Boffa Miskell Ltd

Living Seawalls ©Maria Vozzo, Sydney Institute of Marine Science.

Coastal lock units ©ECOncrete.

Mangrove planters ©Alex Goad, Reef Design Lab.



Artificial reef MARS system ©Alex Goad, Reef Design Lab.

Artificial tidepool ©ECOncrete.

Seaweed restoration in Sydney ©John Turnbull, Operation Crayweed

Pile jackets ©ECOncrete.

Mussel restoration in the Hauraki Gulf ©Shaun Lee, Revive Our Gulf.

*Table 1: Eco-engineering products and habitat restoration.*

recently recommended stock exclusion (through simple fencing) to enhance an area of naturally regenerating saltmarsh in compensation for the reclamation of estuarine soft sediments.

In addition to marine-based solutions, the high connectivity between land and coastal marine systems, often viewed as a challenge, can provide opportunities for offset/compensation interventions targeted at land-based effects. For example, when earthwork sediment discharges are unavoidable, riparian planting can be used to offset this effect once construction is completed. Catchment modelling has allowed us to calculate the amount of riparian planting required in the post-construction phase to capture the same amount of sediment likely to be discharged during construction. This approach also contributes to replacing terrestrial and freshwater habitat that may be lost elsewhere on a project. We have recommended and implemented this on a number of large roading projects.

In conclusion, offsetting and compensation in the marine environment are complex and carry risks and costs, so avoidance remains the most important step for the preservation of biodiversity. Nonetheless, the implementation of innovative approaches can help to overcome some of the current challenges and to secure better environmental outcomes.

# Advances in research and management of surfing resources

Ed Atkin, eCoast

Aotearoa New Zealand is a world leader in the management of surf breaks and has been at the forefront of surf science research since the mid-1990s. The nation's leadership in applied and effective surfing resource management is the envy of many surfing countries worldwide. It is the pairing of extensive research efforts, such as the University of Waikato/NIWA Artificial Reef Program (ARP, established in 1995) and the plethora of ensuing studies, with ground-breaking legislation in the Resource Management Act and New Zealand Coastal Policy Statement 2010 to recognise unique and finite coastal characteristics, that lead to this venerable position.

In late 2015, a research group lead by the University of Waikato received Ministry for Business, Innovation and Employment (MBIE) Targeted Research funding (see *Coastal News* Issue 67) to consider the nation's current position of applied and effective surfing resource management. A primary driver of the project was to address the lack of data and understanding of surf breaks needed to enable informed decision making by council staff, engineers, and consultants about activities in the coastal environment, with the aim of establishing clear, quantitative measures and guidelines describing the characteristics of surfing resources. The project undertook stakeholder engagement meetings, surveys, intensive fieldwork, and deployed monitoring systems. The research project culminated in the publication of scientific journal articles (Bryan and Atkin, 2019) and the *Management guidelines for surfing resources* (Atkin et al., 2019), which have since been endorsed by the Department of Conservation.

Beyond the ARP, subsequent MSc and PhD studies, and the MBIE project, since 2012 the regions of Northland, Auckland, Waikato, Taranaki, Greater Wellington and Southland have all identified Surf Breaks of Regional Significance (SBRS). Canterbury is currently in the process of public consultation. Moreover, Waikato, Greater Wellington and Southland have all delineated swell corridors for the identified SBRS. There have been detailed studies that consider complex characteristics of Surf Breaks of National and Regional Significance, and numerous consent hearings concerning the integrity of surf breaks (see Mead and Atkin, 2019; Weppe and Shand, 2019; and references therein). These significant efforts are a testament to the value Aotearoa New Zealand places on surfing resources.

However, with each potential threat to surf break integrity or episode of mismanagement, both at home and overseas, there are new learnings and surfing research is continually evolving. With a view to giving permanency to the efforts of the MBIE funded research project, a not-for-profit charitable trust was established, the Aotearoa New Zealand Association for Surfing Research (ANZASR). The ANZASR took responsibility for the camera systems, associated data base and *Management guidelines for surfing resources*. The overriding vision of the ANZASR is to help keep Aotearoa New Zealand at the forefront of surfing resource management. To this end, the ANZASR aims to:

- Educate the current and next generation on sustainable management, surfing resource management and surf science.
- Undertake reviews and updates of the *Management guidelines for surfing resources* to keep them relevant to the latest research.
- Establish surf break research goals that will benefit Aotearoa New Zealand, by:
  - providing a centralised, supportive body to aid in research funding applications;
  - funding and guiding student research projects.
- Promote the sharing of surf break research data and learnings to an international audience to aid global efforts to manage surfing resources.
- Engage with and educate local authorities about surfing resource management.
- Host, maintain and establish new surf break monitoring systems across Aotearoa New Zealand.

The use of cameras systems to monitor the coastal environment is well established both overseas and in New Zealand since 1997; they collect repeatable, high frequency data that is ideally suited to monitoring breaking waves. The georectification of oblique photogrammetry opens the capacity for spatial quantitative analysis. The camera systems set up as part of the MBIE project were done so to monitor South Piha (Auckland), Waikeri (Manu Bay; Raglan, Waikato), Whangamata (Coromandel Peninsula, Waikato; Figure 1), Wainui Beach (Gisborne) and Lyall Bay (Wellington), with camera data supplied from Aramoana and Whareakeake (Otago) by the Port of Otago.

While several efforts have focussed on monitoring surf breaks with camera systems, none have effectively recorded fundamental surfing wave quality characteristics in an automated and quantitative matter. Peel angle is the angle between the trail of broken white water and the crest of the unbroken part of the wave (Walker et al., 1972). Peel angle indicates the rate that the breaking part of the wave translates laterally. Early efforts to monitor a Multi-Purpose Reef in Boscombe, UK with oblique photogrammetry and derive peel angle from georectified imagery yielded meaningful results (Atkin, 2010). However, the overhead of field data collection and manual annotation of geo-rectified images make the approach unfeasible long-term. During the MBIE research project an automated system was developed to measure peel angles from geo-rectified images (McIntosh, et al., 2018). This system yielded comparable results to manual annotation and measurement approaches.

*Figure 1: Camera monitoring system at Whangamata, Waikato.*

However, the system was computationally intensive and relied on parameterising pixel intensity gradient thresholds – it still required manual input. More recent work has managed to track the breaking area of the wave (Thompson et al., 2021), but fails to capture both the fundamental components required for measuring peel angle – the unbroken wave crest and point of instantaneous breaking.

The first project under the ANZASR banner was to develop a methodology for efficiently documenting surfing wave quality characteristics. Given the core database of images, Machine Learning (ML) object detection was considered an applicable approach, and early investigations in the application of ML during the MBIE project yielded promising results.

Development of an effective methodology and application are now described in detailed research papers (Atkin, 2021; Atkin et al., 2021). In summary, a convolutional neural network object detection model (Jocher et al., 2020) was trained with a pool of 2000 randomly selected images from the remote monitoring system at Waikeri (Manu Bay, Raglan). Leveraging both oblique and orthorectified images, along with spatially restrictive annotation tools, all instances of surfable breaking waves in each image were annotated with breakpoint and crest locations. Training included more than 60 training runs that considered different combinations of annotations and model settings to maximize the accuracy for this application. By virtue of not being able to annotate surfable waves on some images during labelling, training of the model has effectively incorporated a surfability threshold Artificial Intelligence.

The trained model was used to analyse ~1 million images taken at midday between May 2017 and June 2020 from the Waikeri system. Object detection on a low-end graphics processing unit takes <20 ms/image. In this subset more than 750,000 objects were detected. A wave tracking algorithm was then used to isolate 117,540 individual peeling waves (consecutive break point clusters) comprising of 665,520 break points/crests and measured instantaneous peel angle (Figure 2; Figure 3; an example of multi-wave tracking is available at: https://www.ecoast.co.nz/surf-break-management-1).

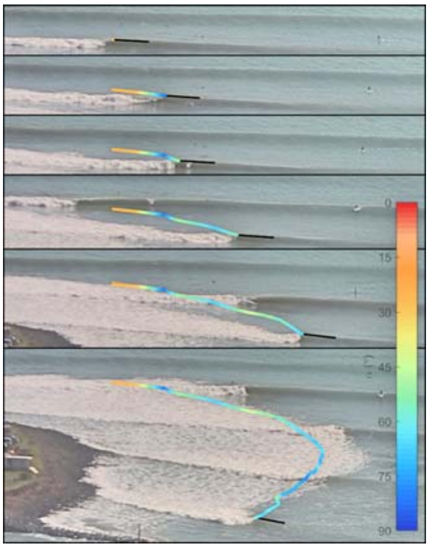



*Figure 2: An example breakpoint and crest tracking with instantaneous peel angle ($\alpha$). From Atkin (2021).*

A standout feature of the data set is a lack of breakpoints at the eastern end of the point; a hydrographic survey undertaken at the start of the data collection period indicates an elongated depression in this area that is likely to be a persistent seabed feature (Figure 3). Previous work studying Waikeri measured peel angles between 30-75° (Hutt et al., 2001; Scarfe 2008), with a mean value of 65°, which is comparable to the mean value of 60° in this dataset. The western end of the point break at Waikeri is known as 'The Ledge' and is associated with waves that break in a fast and hollow manner (Figure 4). This is consistent with this dataset where peel angles are lower in the vicinity of The Ledge where faster breaking occurs.

While the average rideable length of ~27 m is not consistent with the previously recorded 71.6 m based on surfer GPS location (Borrero et al., 2019), the camera system is collecting all surfable conditions and not just those favourable conditions that surfers tend to target. The maximum length of surfable wave recorded by the system is 275 m (Figure 2), ~125 m longer than that recorded by GPS. Neither approach provides information about wave shape, which is integral to how a wave is utilised by a participant. Further work has considered correlations between environmental variables (Atkin, 2021), although more detailed analysis will include qualities such as section length, wave breaking speed, and the implications for surfability.

This type of applied technology will likely play a big role in the establishment of natural baselines required for sustainable

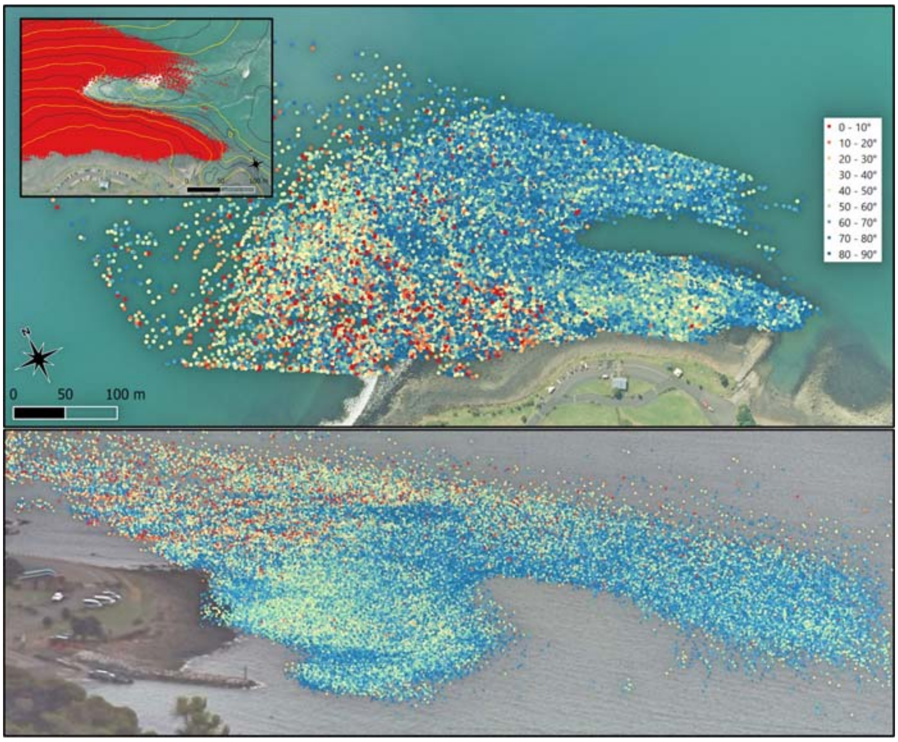



*Figure 3: Top (from Atkin, 2021): break points with peel angle value detected between May 2017 and June 2020. The insert shows the same breakpoint locations with a depth isobath overlay. The nearest contour to land is -0.5 m (MSL), contours are in 1 m increments. Bottom: break points coloured with peel angle value overlain on a cropped image from the camera system.*

*Figure 4: Waikeri resident expert Chris Malone riding in the vortex of the wave, or barrel, at The Ledge (Image courtesy of Cory Scott, nzsurfmag.co.nz).*

management. This approach can and will be readily replicated at other sites; but the application of machine learning for coastal monitoring of coastal hazards could very readily be incorporated into the same system, especially given the speed of detection, which lends itself to real-time monitoring. As for the ANZASR, the trust has sponsored the Surf Science, Engineering and Management special topic at the next Australasian Coast and Ports conference, with a plan to hold a hui regarding how our management strategies can be improved.

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## NZCS Management Committee

# Scour and countermeasures at offshore foundations

Yifan Yang[1] and Zihao Tang[2]

Recent research projects conducted in the Fluid Mechanics Laboratory at the University of Auckland revealed the complexity of current- and wave-induced sediment scour at offshore foundations and the significance of novel and targeted countermeasures.

Scour may significantly weaken the structural stability and bearing capacity of foundations. In our recent experimental studies, particular attention has been paid to complex structures, for example complex bridge pier and tripod wind turbines, for which the scouring processes have not been well understood. A project is currently being undertaken regarding scour counter-measures using a novel approach named microbial-induced calcite precipitation (MICP), which shows a bright prospect of wide application and cost-effective in-situ treatment.

## Mechanism

It is well known that quasi-steady current or long-period tidal currents in marine environments tend to produce a scouring process similar to that in fluvial environments. Under such circumstances, persistent and progressive sediment removal, scour hole development, and structure exposure are usually observed (Melville and Coleman, 2000). The existence of waves imposes an oscillating movement tendency of the water body, which, if predominant, weakens the persistence of scour-inducing flow features.

The superposition of waves and current in marine environments can also be further complicated by the directional alignment. The existing research tends to simplify the alignment into three ideal scenarios, that is co-directional, opposite and perpendicular, so that the key scour-inducing factors can be quantified more conveniently.

In general, the mechanism of marine scour is subjected to various factors that have not been well studied and understood. The current empirical design approaches in terms of scour depth/structural exposure tend to be reasonably conservative so that a specific level of safety redundancy is always maintained.

## Scour at complex structures

In the past twenty years, researchers in the area of marine scour have paid much attention to monopiles (see Figure 1a), which are the simplest foundation form suitable for shallow water conditions. Monopiles are insensitive to the variation of bed elevation or flow direction because of their uniform shape, and thus the scouring process is usually predictable.

It is widely accepted that, under the predominant influence of waves, the maximum scour depth is related to the ratio of the near-bottom orbital velocity to the pile diameter. Waves superimposed with uni- or bi-directional current may lead to a much larger scour depth than wave-only conditions; the scour depth is usually expressed as an augmentation of current-induced scour depth. Relevant research on monopile scour has been able to provide a fairly reliable prediction; more information can be found in Sumer and Fredsøe (2002).

Tripod foundations (see Figure 1b) are a more complicated foundation form that may better stabilise large structures in relatively deep water. Researchers at the University of Auckland have performed a systematic experimental study on current-induced scour at tripod foundations with various burial depth and alignment (Yuan et al., 2018). In contrast to monopiles, significant scour usually occurs at one of the three affiliated slim footings, whose alignment with the flow direction is essential to scour patterns. However, a knowledge gap still exists regarding wave-induced scour at monopiles.

The most intriguing scour phenomena are observed at complex bridge piers (see Figures 1c and 1d), which are usually constructed in tidal, estuary or coastal areas under the influence of combined currents and waves. The structural complexity of complex bridge piers makes them sensitive to the variation of burial depth and pier alignment with waves/current. The pile-cap behaves like a flow interceptor when it is located near the bed level or partially submerged, so that the scour-inducing turbulence structures cannot penetrate the top of the pile-cap. This protective effect is usually maximised for wave-only conditions (see Figure 1c) due to the oscillating nature of wave-flow and the absence of persistent streaming and excavation. However, once the pile-cap is undercut during scouring processes, the flow will be squeezed into the gap underneath and pressurised and accelerated. Such flow pressurisation will re-activate the scouring capacity and lead to a sudden increase of

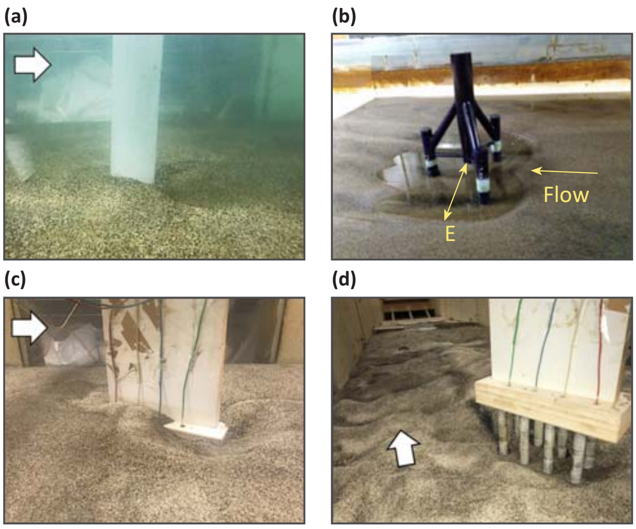


*Figure 1: Typical scour scenarios at offshore foundations: (a) monopile under regular waves; (b) tripod under steady current; (c) oblique complex bridge pier under regular waves; (d) oblique complex bridge pier under combined current and waves.*

(1) University of Waikato; (2) University of Auckland

scour rate (Figure 1d). This scour exacerbation is particularly apparent for current-dominated or combined wave-current conditions, as more persistent streaming is required to develop large-scale turbulence structures. The existing design approach for scour at complex piers in fluvial environments may not be suitable anymore. The first author of this article proposed an empirical design approach to address this issue (Yang et al., 2020). Still, new theoretical breakthroughs regarding fluid-structure interaction are required for long-term solutions.

## Novel countermeasures using bio-cementation

Scour countermeasures are critical to the stability of offshore foundations by reducing scour depth. Generally, traditional scour countermeasures can be categorised as armouring methods and flow-altering methods. Rock riprap is a typical armouring countermeasure for local scour mitigation. Other artificial units, including tetrapods, cable-tied blocks and gabions, are also widely applied (see Figure 2). However, marine scour needs an innovative solution for scour protection considering the complicated flow conditions in coastal and offshore environments.

Nowadays, microbially-induced calcite precipitation (MICP), a novel, environment-friendly and efficient bio-cementation method for soil reinforcement is emerging. This innovative technique has been tentatively applied to mitigate dam leakage/piping erosion, coastal erosion and soil liquefaction, which are caused by a similar sediment removal process as local scour. Researchers have envisaged a huge potential of MICP in various fields that need sediment reinforcement, including marine scour.

Microbially induced calcite precipitation (MICP) could be achieved either by bioaugmentation or biostimulation. The $CaCO_3$ precipitation induced by microorganisms could work as 'bridges' between separate sand particles, combining the loose sand as a firm one and, thus, enhancing the stress resistance of the soil. The biochemical mechanism of the MICP process can be grouped into urea hydrolysis, denitrification, sulphate reduction and iron reduction, of which urea hydrolysis is currently considered the most efficient method. Enzyme induced calcite precipitation (EICP) is an alternative calcite precipitation method where the production of carbonate ions is catalysed by enzymes directly instead of microorganisms. Figure 3 shows the mechanism of the MICP method schematically and a biostimulated sediment sample in the laboratory.

Compared with traditional armouring and flow-altering countermeasures, MICP is more stable and sustainable. However, the difficulties for engineering application in offshore conditions and the long-term impact on surrounding species remain challenges to be overcome. The second author of this article is currently exploring a novel method for reducing scour at offshore foundations using MICP and, in the meantime, an efficient way to treat sediment in-situ rather than injecting expensive microbe samples.

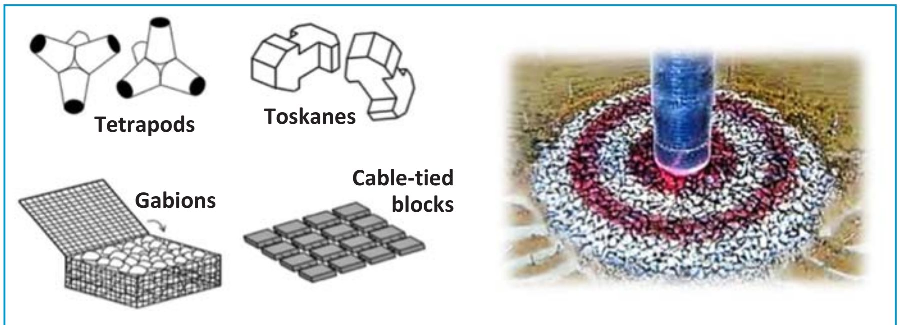


*Figure 2: Traditional artificial armouring units.*

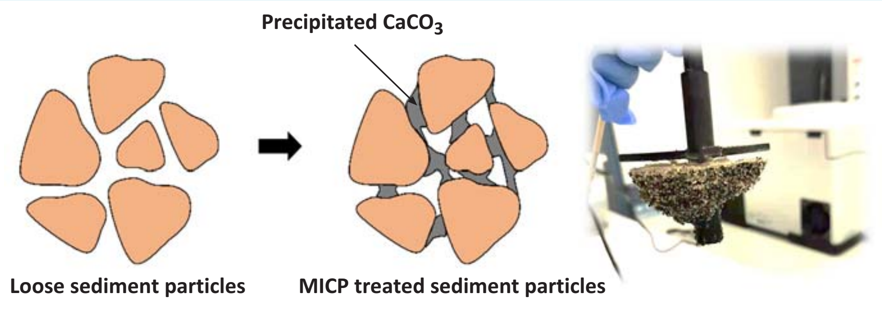


*Figure 3: Mechanism of soil reinforcement by MICP.*

## Future directions

We identified several research themes of significance for further exploration. Firstly, typical marine scour scenarios are sometimes associated with strong sediment transport and bedform migrations. The influence of migrating dunes/ripples on scour has not been well studied for waves and combined wave-current conditions. A few studies have been done for steady current-induced scour in fluvial environments, but the detailed mechanism is still quite different. Secondly, as the application of MICP technology in reducing scour is still expensive, a good balance/compromise is required regarding the treated area, the intensity of treatment, and the cost-effectiveness of treatment. Besides, it is valuable to investigate the feasibility of combining traditional countermeasures and MICP for better performance. Thirdly, the wide application of the MICP approach requires the advancement of in-situ treatment/biostimulation technology, especially for marine environments.

In the future, the topic of scour at offshore foundations will become more complicated than it has been in the past thirty years regarding structural complexity and how countermeasures are designed. In the meantime, relevant research may become multidisciplinary requiring the input of knowledge about hydraulic engineering, coastal engineering, geotechnical engineering, and bio-engineering.

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# NZCS 2020 Scholarship award winners

### Duc Nguyen, University of Otago Student Research PhD Scholarship

*Wind flow dynamics and sand sedimentation through coastal foredune notches*

Coastal dunes are natural defenders, protecting coastal amenities from hazards such as flooding and wave attack, as well as being important habitats for rare species and recreational areas for people. Duc's PhD project is examining the effectiveness of excavating notches on foredunes as an innovative intervention for coastal dune management.

During the last century, coastal dunes have been modified significantly by human activity, with one of the consequences of this being the impact on dune stabilisation. As a result, dunes are vulnerable to erosion by storm surges, especially in the context of climate change, with more frequent storms and rising sea levels predicted.

Excavating notches on a foredune aims to de-stabilise it, creating a conduit to facilitate sand transport from the beach to the backdune. Over the long term (years), the notches allow some dune growth to occur landward of the stabilised foredune system, thereby reducing the overall vulnerability of the coastline to erosion. This intervention has been applied recently on coastal dune rejuvenation projects in the UK, France, and the Netherlands.

The study area for this project is St Kilda beach and dune in Dunedin. The foredune at St Kilda is important as it protects both John Wilson Drive from wave attack, and the South Dunedin community, where the elevation is lower than sea level, from flooding. The St Kilda foredune is highly stabilised by marram grass, and is squeezed between storm surges and John Wilson Drive, and has the potential to be completely eroded, such as occurred in 1978 and 2007. Since 2016, multiple notches have been excavated on the foredune by the Dunedin City Council. The project has received considerable attention from the media and coastal managers for its usefulness and unique approach (see www.odt.co.nz/news/dunedin/student-dunes-notches-success).

Duc's research successfully combines field-based experiments and computational fluid dynamics, to investigate how the site's complex wind flows and sand transport affect notch performance and the evolution of dune morphology. The results over four years show that the notches can alter the prevailing oblique onshore winds, redirecting alongshore sand transport through the notches to form depositional lobes up to 2.5 m high behind the otherwise stabilised foredune.

Duc plans to further investigate the effects of notch geometry and backdune morphology on the wind flow and sand sedimentation processes. This would assist dune managers to excavate the notch with an appropriate geometry, as well as apply it to specific locations.

### Cassandra Newman, Auckland University of Technology Student Research MSc Scholarship

*Aroturuki te takutai moana mai i te rangi: Using satellite and UAV imagery to map the dynamics of the coast at sites with anthropogenic debris in Southland, NZ*

The coast is a naturally active margin that forms an important barrier system subjected to the forces of both the terrestrial and marine environment. Coastal erosion has increasingly become an issue as numerous communities and cities in New Zealand/Aotearoa and around the world are located close to the coast as it has long been and continues to be a source of food as well as the hubs for major transportation of goods and commodities. Studies have delved into the dynamics of coastlines; how anthropogenic pressure has influenced these changes and if these changes can be monitored and predicted. The impact of anthropogenic debris along the coast needs to be addressed. Landfills, roads, urban areas, cemeteries, and other modified areas along New Zealand/Aotearoa's coastlines are at risk of being consumed by the threat of rising seas, more extreme weather, and patterns of erosion. Erosion of anthropogenic infrastructure and debris can cause environmental, cultural, economic, and social harm.

Cassandra's study investigates four sites along the southern coast of the South Island/Te Waipounamu, where anthropogenic debris has, or will, become an issue for local government coastal management. The sites analysed are Monkey Island, Colac Bay, Fortrose and Curio Bay. The anthropogenic structures at these sites include concrete and structural rubbish throughout the dunes, an abandoned coastal road, and a housing development on the beachfront. Management and monitoring of these sites is important to prevent the environmental degradation that this debris may cause as the coast changes around it.

3D drone imagery will be captured on these sites quarterly to aid in understanding the annual volumetric changes that occur. Historic imagery captured by satellite will be analysed with GIS software to understand the magnitude of change occurring as well as the dynamic patterns seen throughout the coast. From this, a comprehensive understanding of past and present patterns at each coastal site will be formed, which will aid prediction of future changes and inform restoration and coastal management with consideration to the cultural, political, and ecological values of each area.

**NZCS archive & downloads**

The NZCS website houses an extensive archive of the Society's publications, including back issues of *Coastal News* (from issue 1, 1996) and 'hot topic' reprints of significant articles; newsletter author and article indexes; an author's guide to writing articles for NZCS publications; and copies of the four NZCS Special publications. All these can be accessed at www.coastalsociety.org.nz (under the 'Media>Publications' tab).

# News from the regions

## Northland

*Laura Shaft, Regional Representative*

### Biosecurity goes underwater: marine biosecurity gets traction in upper North Island

In 2013, incursions of highly invasive Mediterranean fanworm (*Sabella spallanzanii*) and the seasquirt *Styela clava* in Auckland and further afield provided the catalyst for what is now called the Top of the North Marine Biosecurity Partnership – a collaborative effort between the four northernmost councils, Gisborne District Council and Hawke's Bay Regional Council, the Ministry for Primary Industries and the Department of Conservation.

Now these organisations work closely together sharing knowledge and tools to detect and respond to incursions of marine pests in their regions. Soon a new policy development will further support their efforts at preventing the spread of marine pests domestically. These regions oversee the area that encompasses about 70% of New Zealand's marine vessel fleet, and its vessel movements account for 90% of marine pest spread.

Following consultation in 2019 that showed support for a common set of rules, a detailed draft plan is being developed by the four councils, in partnership with Biosecurity New Zealand (the Ministry of Primary Industries) and the Department of Conservation. The proposed Clean Hull Plan seeks to prevent marine pests being spread by moving boats. It would be an Inter-regional Pathway Management Plan under the Biosecurity Act and complements other developments in marine biosecurity, such as strict requirements for craft arriving in New Zealand waters.

It includes a clear set of simple rules for boat and marine structure owners which, much like rules currently in place, require craft to meet a biofouling standard when moving, and have requirements on all gear and equipment.

There is also a requirement for operators to provide specific information about hull maintenance and movements. A rule relating to high risk marine structures is being considered.

No decisions have been made yet. Te Tiriti partners, councils and a wide range of key stakeholders have been approached for practical feedback. Once this feedback is taken into account and the draft plan finalised, it will go into a formal consultation process, most likely in the first half of 2022. The consultation process will allow all individuals, businesses, organisations, and groups with interest to input and share their views, before final decisions are made.

For more: www.marinepests.nz/news.html

### eDNA sample surveys

NRC and Kaitiaki from two iwi collected eDNA samples from two east coast estuaries, using kits from Wilderlab, to compliment recent ecological surveys. At the first site 36 different taxa were identified, which included 19 taxa of fish, including several important cultural and commercial species such as such Kanae (mullet), Kahawai, Tāmure (snapper), Ihe (piper), and Kātaha (yellow-eye mullet). In the second sample, a total of 129 different taxa were recorded, including 11 fish taxa, 13 molluscs and 14 crustacean. Again, several important cultural and commercial species were found including Tāmure (snapper) and Kahawai, as well as Whai repo (Southern eagle ray).

## Auckland

*Lara Clarke, Matthew McNeil, Andrew Allison, and Eddie Beetham, Regional Representatives*

### Waitematā Harbour drifter dispersion experiment

A research team from the University of Auckland launched 20 surface drifters (consisting of floating plastic pouches and real-time GPS trackers) to simulate the movement and dispersion of surface buoyant pollutants (such as plastics) in the upper reach of the Waitematā Harbour. Ten drifters were launched near Herald Island and Henderson Creek in five pairs separated along the channel and left in the harbour for two tidal cycles before collection. One experiment was conducted during spring tide (April 28) and one during neap tide (May 5), with low river flow and winds during both experiments.

Project designer, PhD student Mike Chen, has found that stronger tidal currents during the spring tide result in a larger dispersion of the drifters over a wider zone after two cycles: from upper Lucas Creek down to Devonport Ferry. Half of the drifters were trapped. In contrast, during the neap experiment, 80% of drifters were trapped or beached near where they had been launched. Only a few were still floating during the collection. This experiment, supervised by Dr Melissa Bowen, has indicated that over half of surface buoyant pollutants like plastic items floating in the upper streams are likely to be retained in an estuary with even greater retention during neap tides.

Mike is examining how the trapping occurs in the complicated coastal morphology such as branching channels, bays, mangroves, and tidal flats. The next phase of the research will use a numerical simulation of the estuary and give more insight into plastic movement and dispersion in the well-mixed estuaries (like the Waitematā).

### Flood Event, Te Henga, Bethells Beach

On 31 August the Waitakere catchment received in the order of 180 mm of rain. This catchment feeds into the Te Henga coastal wetland, and the Waitakere River, which discharges at Bethells Beach on Auckland's west coast.

The event resulted in significant flooding of low-lying areas surrounding the wetland, and cutting off the community of Bethells Beach. The flooded river washed away a section of the beach access road, deposited large uprooted trees towards the beach, and significantly widened the beach lagoon area (see Figures 1, 2 and 3).

The flooded river also washed away a section of sandy river bank that provided a vehicle access route for the Bethells Beach Surf

*Figure 1: Te Henga wetland and Bethells Road in flood.*

*Figure 2: Bethells Road flood damage under repair.*

*Figure 3: Sediment plume from the flooded Waitakere River mouth.*

Lifesaving Club (BBSLSC) to transport vehicles and equipment to the beach and the BBSLSC beach tower. The widened lagoon area has also restricted BBSLSC vehicle beach access to lower tides.

With BBSLSC patrols due to start at Labour Weekend, works were undertaken to reinstate the vehicle accessway, utilising an existing resource consent that authorises

*Figure 4: Post flood event, vehicle accessway washed away (access route identified in red).*

*Figure 5: Reinstated vehicle accessway, 6 October 2021.*

the transfer of sand within the river and accessway area (see Figures 4 and 5).

With the currently widened river channel, the accessway remains vulnerable, and further reinstatement works may be required over summer.

### Shoreline Adaptation Plans

Auckland Council's Shoreline Adaptation Programme has completed its first pilot, focused on the Whangaparoa Peninsula. The official report will be publicly available in mid-November. Community engagement for the next shoreline area, which covers the eastern Auckland shoreline between Beachlands and Whakatiwai Regional park, began on 26 October and runs until mid-February 2022.

## Taranaki

*Thomas McElroy, Regional Representative*

### DOC marine team update

The Department of Conservation in Ngāmotu-New Plymouth has welcomed two new members to their marine team. Rebekah Gee (biodiversity ranger marine) and Maria Jesus Valdes (marine reserves ranger) have joined Cameron Hunt (senior ranger) and will be looking after the moana around Taranaki. Having a full marine team will allow a greater capacity to service the coastal area. The team will have a particular focus on biodiversity monitoring and compliance efforts in the local marine reserves at Tapuae and Parininihi. Rebekah and Jesu are both qualified marine biologists and have been busy undergoing further training to be ready for a busy summer on the water.

"I look forward to working with the community and mana whenua to develop the monitoring plans for the marine reserves" says Jesu. "I believe conservation is a team effort, and the only way we can achieve it is if we take all points of view into account. I am very passionate about working with people to achieve conservation goals and as I am new to Taranaki, I can't wait to get to know the locals, start building relationships, have yarns about the environment, and work together to protect it."

To find out more, contact Maria Jesus Valdes (mavaldes@doc.govt.nz).

### Kororā monitoring project

It is peak breeding season for kororā (little blue penguin) all over Aotearoa and community groups like the Nga Motu Marine Reserve Society (NMMRS) in New Plymouth are keeping a close eye on the local populations. Over the last two years the Nga Motu Marine Reserve Society has been developing a kororā monitoring project looking at long-term trends with breeding success and recruitment informing our population modelling. We have built upon our experiences and the data collected over the last decade by incorporating electronic burrow monitoring and the cumulative citizen science observations to iNaturalist. Previous 'Curious Minds' projects 'Project Hotspot' and 'Finding Little Blue' laid the groundwork. With Lotteries NZ funding and Department of Conservation permits, this comprehensive project is run by trained conservation volunteers, including Iwi members from Te Atiawa and Ngāti Mūtunga. Since November 2020 the group has performed catch and weigh surveys and microchipped 86 penguins in the research areas. We are also GPS tracking birds from the nesting colonies to discover where they are foraging at sea whilst raising their chicks.

Since connecting with other kororā community groups from around Aotearoa New Zealand at events such as the International Penguin Conference and the Oamaru Penguin Symposium, NMMRS has been able to access resource support and scientific guidance from experienced penguin scientists. This valued help has propelled the Taranaki kororā monitoring into a project with a national significance. The team of volunteers invested in this local project are extremely excited to participate and take the opportunity to share the findings with local schools and residents so as to better protect Taranaki kororā colonies.

To find out more, contact Elvisa Van Der Leden (elvisa@emr.org.nz).

## Wellington

*Ryan Abrey and Verity Taylor, Regional Representatives*

### Chaffers Marina refurbishment

Chaffers Marina was built as an international class floating marina and provides facilities that were previously not available in Wellington Harbour. Both the facilities and proximity to the city mean that Chaffers Marina is unrivalled in location and outlook. However, the marina infrastructure assets were built in 1993 with a design life of 30 years (an exception being the floating breakwater that has a design life of 50 years), which was largely the standard at the time. As such, many of the assets are nearing the end of their useful and/or economic life and, as part of a Long Term Asset Management Plan, work has been undertaken on their replacement and/or renewal. These assets include the walkway, floating piers, piles and services (power and water), wavescreen and boat lift. A significant part of the work has been the refurbishment and/or replacement of the 214 timber piles (which started in 2020). It was decided that refurbishment, by the installation of a HDPE Sleeve, grout filling of the annulus and capping, is a cost effective means to extend the life of timber piles, but pile replacements were also needed. The water depth is approximately 8 to 10 m so piles need to be, on average, 18 m long.

Ten piles needed to be replaced, but as timber piles of this length (and of good quality) are difficult to source, 355nb steel casings were driven with a HDPE sleeve, grout filled and capped. Engineering Services from Picton were contracted to undertake the works, Nautilus Pacific Maritime Contractors Ltd provided the barge, and Wayne Anguis (Undersea Construction Ltd) provided the commercial dive support.

The weather added some challenges, but the barge *Pataki* provided a very stable work platform. Covid Alert Level 4 meant the loss of three weeks, however the works have now been completed and the 10 new piles driven.

### Wellington's new electric ferry

In August, *Ika Rere*, the Southern Hemisphere's first fully electric, high performance passenger ferry was launched in Wellington Harbour. The 19 m carbon fibre-constructed catamaran for East by West Ferries was built by the Wellington Electric Boatbuilding Company, and will carry up to 135 passengers on its daily commute from Queens Wharf to Days Bay at an optimum service speed of 20 knots.

East By West Ferries expect significant savings in their operational and maintenance costs of the ferry, with an anticipated 60% reduction in propulsion energy costs and 50,000 maintenance-free operational hours. They believe their investment is future-proofed through the expected longer in-service life and the fact that the ferry has zero operating emissions. Customers can

Ika Rere *undergoing sea trials in Wellington Harbour (Photo: Simon Hoyle, Southlight Studio).*

expect an improved passenger experience with reduced noise pollution, less vibration and better sea keeping. The ferry is now undergoing sea trials and she is expected to enter service later this year.

## Canterbury

*By Hamish Renni, Lincoln University*

### Jetties and community regeneration

Lincoln University and the Building Better Homes, Towns and Cities National Science Challenge have partnered in a study exploring the role of jetties in the regeneration of small settlements. At the boundaries of the shore and the sea, jetties are characterised by intertwined networks of relationships, between people, built and natural environments. They can provide a basis for established community relationships with the ocean, providing places to recreate and wander, as well as a means for connection between places by boat or ferry. Restoration efforts can also provide a basis for community organising and interaction with local councils. Over this summer, two Lincoln University students (Jess Farrar and Kate Oranje) will join the team of Hamish Rennie, Sylvia Nissen and AgResearch's Mike Mackay to carry out case study reports on community jetties in Takamatua, Church Bay and Governors Bay Jetties, addressing their genealogy and role in regeneration of the communities they serve.

*Hamish.Rennie@lincoln.ac.nz*

## West Coast

*Don Neale, Regional Representative*

### West Coast coastal lizards

*by Don Neale, Lynn Adams, Antje Wahlberg and Kate Simister*

Progress has been made to better protect the critically endangered Kapitia skink that featured in *Coastal News* #73 (Nov 2020: p3-4). Land purchased by the Department of Conservation has been given scientific reserve status to protect one hectare of suitable habitat within their natural range. Currently the site at Chesterfield, just north of Hokitika, is covered in rank pasture grass, which we know can support high densities of this skink. But investigations on what native plant species would be suitable to plant and how skinks use different habitat types are planned for this summer. A predator-proof fenced enclosure has been constructed on the reserve that is impervious to animals as small as mice. The fence has been placed far enough away from the Waimea Creek lagoon that it is expected to be safe, at least in the medium term, from the erosion caused by stream outlet migration in this area. Pest control is underway to remove all predators from the enclosure and create a safe haven for the species. About 65 of the threatened skinks will be reintroduced back to their natural habitat from their current home at Auckland Zoo later this year.

Cobble skinks, like Kapitia skinks, were impacted by coastal erosion and storms and in 2016 were thought to have been lost from their Granity beach home, from a single storm. DOC successfully rescued the 34 animals prior to the storm and they form a breeding programme at Auckland Zoo. A single surviving Cobble skink was found in 2020 at Granity, with a new discovery nearby in 2021 by local DOC staff of a cobble beach area that contains what we hope is a large population of cobble skinks. It's early days for this rediscovery and more work is planned over the 2021-22 summer to better understand the size and extent of this population.

### Whitebait habitat restoration

A project to restore whitebait habitat has been given a funding boost with the October announcement of about $0.5M to create tidal wetland habitat at Wadeson Island (Hokitika River) that will be suitable for adult inanga to grow and spawn. The project is supported by Poutini Ngai Tahu, local whitebaiters, the Department of Conservation, councils and businesses, and will add to the amenity value of the area that has been developed there since the 1990s. The Wadeson Island project involves landscaping to create new channel networks and riparian areas that will be planted by Conservation Volunteers NZ. It follows a similar successful project on the Grey River and it is hoped that further projects will be progressed over coming years on more of the West Coast's renowned whitebaiting rivers.

Additional funding was also announced by the Minister of Conservation for a weed-free South Westland initiative and a catchment restoration of the culturally significant Arahura River, both of which will benefit coastal areas elsewhere on the West Coast.

### South Westland mātaitai reserve applications

Applications under fisheries legislation have been made over parts of south Westland for five mātaitai reserves and two temporary 2-year pāua closures, by the Ngāi Tahu Papatipu Rūnanga that hold mana moana over these areas (Te Rūnanga o Makaawhio and Te Rūnanga o Ngāti Waewae). The applications are currently going through the required public consultation process.

### Historic Hector landfill seawall project

*by Paulette Birchfield, WCRC*

Severe erosion at Hector on the West Coast in 2018 exposed an historic industrial landfill containing asbestos and other hazardous waste material. The site was temporarily protected with a bund wall until funds were secured to protect the landfill site. In September 2020 the government provided project funding of $1 million through the Covid-19 Response and Recovery Fund, and construction began on the 310 m long seawall in February 2021. The project took five months, achieving a significant contribution to community and infrastructure resilience, and by sourcing all required seawall rock from a local quarry, contributed to climate change and sustainability commitments.

*Seawall construction showing geofabric and rock layering (Photo: Paulette Birchfield).*

## Otago

*Tom Simons-Smith , Regional Representative*

### A sandy surprise for the DCC

Coastal management action in the local government context is often influenced by the timing of storms and other such triggers that force or otherwise facilitate a response. Triggers can also come in the form of opportunities, that can serve to unlock or change the timing of planned or unplanned management actions. The Dunedin City Council has been lucky enough to experience such a trigger, which has involved a generous offer of sand from a local developer. The cost to purchase and transport this quantity of sand (nearly 20,000 m$^3$ or about 1350 truckloads) would have exceeded $1.5M. In this case, the DCC has been able to receive (in two stockpile locations) this sand at no cost – outside of the relatively low consenting, and on-site management costs.

This sand will serve to support storm response activities and the short-term avoidance of hard engineering works that could preclude the desired longer-term outcome for the St Clair to St Kilda coast. This sand is also planned for use in dune remediation along this coast – serving to replace contaminated material from the dune crest. The sudden availability of this sand source has enabled this planned dune remediation work to be brought forward – supporting the broader plan being developed for the area.

*Dunedin City Council's sand stockpiling at Kettle Park. A spray-on polymer has been applied to the sand surface to minimise wind-blown erosion (Photo: Tom Simons-Smith).*

# NZCS News

### Annual Conference postponed

Unfortunately, due to ongoing Covid risks and uncertainty around completion of the new conference facility, the 2021 Coasts & Ports Conference has had to be rescheduled to 10-13 April 2022. However, even if travel continues to be restricted due to Covid, the conference will still proceed on these dates regardless, with programme planning from here onwards building in all possible format contingencies. Check the NZCS Conference pages (www.coastalsociety.org.nz/conferences/nzcs-2021) for further information.

### Fifth Special Publication underway

Planning has now started on the fifth in the series of NZCS special publications, with the working title of *'Coastal Adaptation – adapting to coastal change and hazard risk in Aotearoa New Zealand'*.

This new publication will highlight expert perspectives and practical experience to help Aotearoa New Zealand move toward an integrated approach to coastal hazard management. Including submissions and commentary from multiple perspectives (e.g. researchers, Māori, communities, planners, policymakers, and resource managers), it will be generally aimed at readers who are knowledgeable and interested, but not necessarily expert, in the subject of coastal adaptation.

While the project is still in its early stages, the authors and content scope should be confirmed by December. The provisional section topics to be included cover planning, community engagement, engineering, science, and good examples & handy tips, though these may change as the content is refined over the coming weeks. The final publication is expected to be available in early November 2022.

If you would like to contribute to this publication – as author, peer reviewer or proof reader – please contact Don Neale, NZCS Publications Coordinator, at: dneale@doc.govt.nz

If you missed out on any of the previous Special Publications, copies are available for download at www.coastalsociety.org.nz (under the 'Media>Publications' tab).

## *Coastal News* weblinks

One of the most noticeable trends in *Coastal News* over the years has been the rise in the use of web addresses – and their complexity. Obviously, these are an invaluable source of further information for readers, but in the printed version of the newsletter we can't include an active link as we do in the pdf version. We realise that long, complex and non-clickable web addresses can be frustrating (and counterproductive) for readers, so beginning with issue 74 we have been adding a pdf file of all the newsletter links to the NZCS website (www.coastalsociety.org.nz/publications) – so one click will work, rather than readers having to manually copy long strings of seemingly random characters.

To make things even easier, you can access the pdf file using the QR code to the right. The file contains every link published in each newsletter, organised by the pages where they appear, and all are active (clickable) links.

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## Disclaimer

Opinions expressed in *Coastal News* are those of the contributing authors and do not necessarily represent those of the editor, the NZCS management committee, or the New Zealand Coastal Society. While every effort is made to provide accurate and factual content, the publishers and editorial staff, however, cannot accept responsibility for any inadvertent errors or omissions that may occur.

## Contributing to *Coastal News*

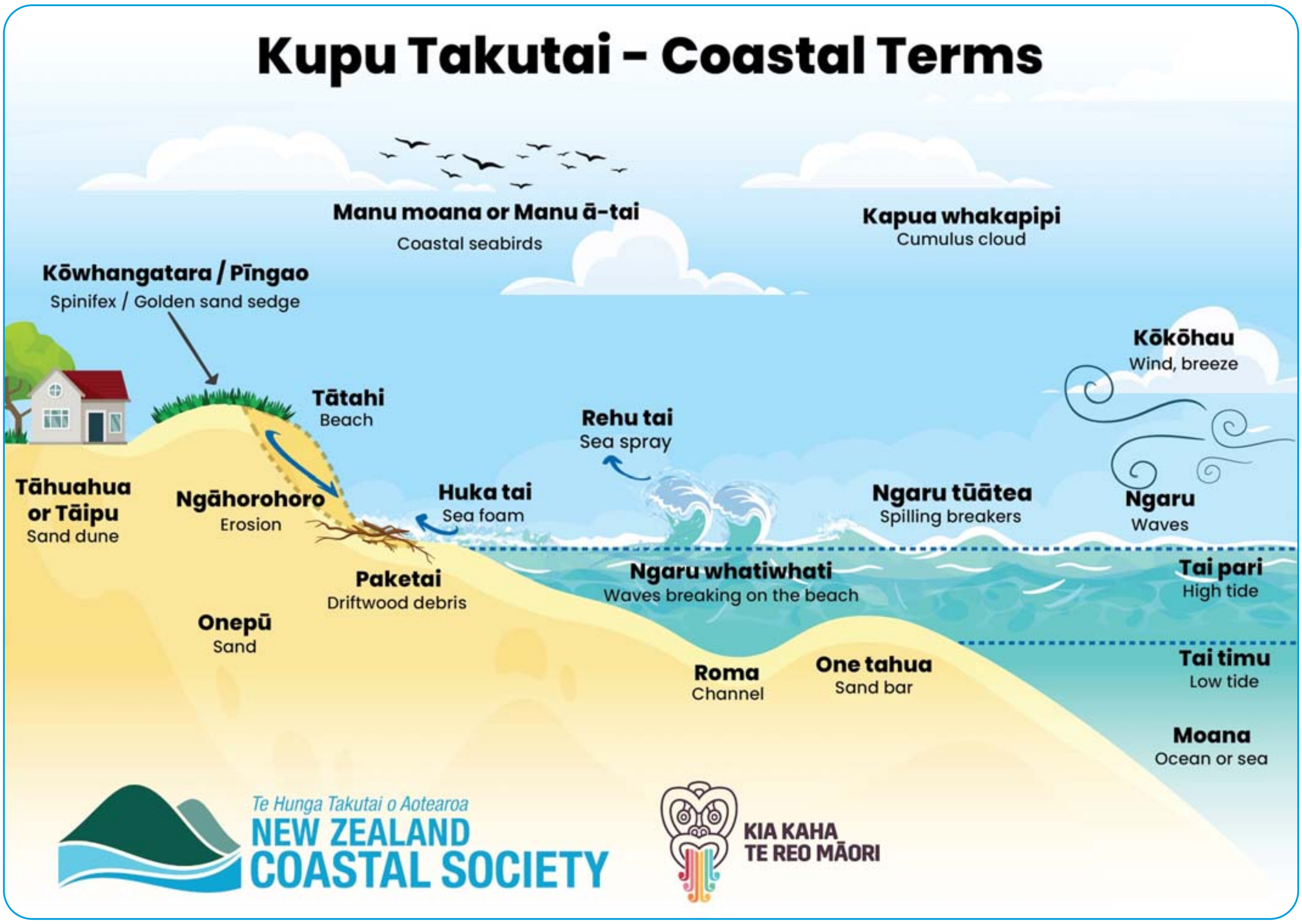
We welcome contributions for forthcoming issues of *Coastal News*. Please contact the Editor, Charles Hendtlass, at cellwairmonk@gmail.com if you'd like to submit an article, contribute a news item, have content suggestions or a photo to share, or to give some feedback on the newsletter.

***The submission deadline for the next issue is 7 February 2022.***

*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. An index of articles previously published is also available for download.*

## Kupu Takutai poster

If you are reading the printed version of the newsletter, you will have found a copy of the NZCS Kupu Takutai (Coastal Terms) poster. Te Hunga Takutai o Aotearoa (New Zealand Coastal Society) has produced this poster to encourage the use of te reo Māori in your mahi and everyday life, and we encourage you to share and display it. If you are reading the online version of the newsletter, a copy of the poster is reproduced below and a full-sized copy can be downloaded from: https://www.coastalsociety.org.nz/news-and-events-2/news/.




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