scope
Contemporary Research Topics

learning & teaching 11:

November 2022

Article

https://doi.org/10.34074/scop.4011014

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Published by Otago Polytechnic Press. Otago Polytechnic Ltd is a subsidiary of Te Pūkenga – New Zealand Institute of Skills and Technology.

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IT'S MUDDY WORK: A SUMMER SCHOLARSHIP RESEARCH PROJECT INVESTIGATING ESTUARY HABITAT HEALTH

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INTRODUCTION

For students studying physical sciences, research experience and know-how are important attributes to ensure success in subsequent postgraduate qualifications, and are also keenly sought after by many employers. Norcross (2014) describes two dimensions of benefits gained by undergraduate learners undertaking research. First, they learn about generating research ideas, literature searches, collecting and analysing data, and textual and statistical reporting. Second, they get to develop and enhance interpersonal skills such as teamwork, consulting, and liaising with academic and community partners.

The lead author had already commenced an approved research project within the Waikareao estuary, incorporating not only shellfish populations, but also vegetation species and water quality monitoring. The Student Summer Scholarship opportunity allowed the project to contract a second-year student from the Bachelor of Environmental Management to assist with data collection and analysis for a subsection of this project: the three shellfish populations. The purpose of the study was to quantify kaimoana by measuring pipi, tuangi and tītiko populations in tidal zones across six sites in order to provide a clear snapshot of the estuary's health and condition. Overall, the experience of carrying out the study provided an example of how research is useful to communities by focusing on the positives of collaboration. This article aims to describe the experience and highlight these positives.

AIMS AND PURPOSE: WHAT WAS THE PREMISE FOR LEARNING?

The learning premise was based on the tuakana–teina concept, a traditional Māori cultural philosophy and practice which literally refers to a family relationship, like siblings, with an older and younger member supporting one another (Smith, 2017). In this model, the outcome should benefit all involved and form a base on which to build future relationships for collaboration and learning. We adopted this model to mark a difference from the teacher–student dynamic which characterises the term-time relationship between the two co-authors of this article. In our discussions prior to the project's commencement, we identified a three-way sharing of knowledge. Our expectations were that there would be learning by the student and the hapū from the researcher; learning by the researcher from the hapū and the student; and learning by the hapū from the student and the researcher.

BACKGROUND

Building student research capability and experience

Reavis and Thomas (2019) note the value of research experience as part of a tertiary qualification, and argue for a scaffolded approach as the most effective way to promote intensive and confident engagement in research. In their model, students learn the theory of research methods in the classroom, then undertake research-focused studies including guided critique, and finally complete a "cumulative senior research project" (p. 1), working closely with faculty. For these American lecturers, "institutional support for focused student research (such as paid opportunities during the summer …) is critical" (Reavis & Thomas, 2019, p. 3). This model, in fact, is a fairly close description of the teaching and learning experience related to research, and the student–faculty collaboration, described in this article.

Each year Toi Ohomai Institute of Technology awards up to ten student scholarships, each worth $6,000. These scholarships are for ten weeks' duration, in which time the student undertakes a research project of relevance to the region, under the theme selected for the year; in 2021, this was Connections. The scholarship requires a staff member to be available to actively supervise the work, which can be part of a larger staff project, but the application must specify and focus on the aims and outcomes of the student research component.

In the latter part of 2021, the lead author was successful in an application to fund an extension to a current, internally approved research project evaluating kaimoana health by measuring pipi, tuangi and tītiko shellfish populations in the local Waikareao estuary's tidal zones. The student researcher would assist with the scientific collection of data, liaise with members of the sponsoring hapū, Ngai Tamarawaho, and provide content for a data dashboard. This tool is in development and will be accessible via a web browser, presenting data in an easier-to-understand format than a traditional report, and hence making them more accessible to a more diverse audience.

The setting: Waikareao estuary

Estuaries are a highly important habitat for shellfish and other marine species, as they provide shelter and a source of food. Not only are estuaries important for surrounding biodiversity, but they are a highly valued part of a catchment for societies, especially for Māori as they traditionally provide a wide range and abundance of mahinga kai (natural food resource/sea garden) including shellfish, fish and even birds (Kainamu-Murchie, 2017).

Studies which attempt to define estuarine environments often look at large-scale influences such as latitude, climate and tidal influence (Hume et al., 2007). Assessment of estuarine sandflats often reveals changes in species' community composition; this is generally termed patchiness (Kotliar & Wiens, 1990). This patchiness not only affects human consumers who rely on these sources as part of their food supply, but also influences food webs, or food chains, whereby other species such as fish rely on shellfish, for instance, as the main part of their diet (Gaston et al., 1998). While research into patchiness has been undertaken internationally, such studies are not numerous and New Zealand studies are rare (Morrisey et al., 1992).

The Waikareao estuary is a shallow, tidally dominated estuary close to Tauranga city centre, surrounded by many walking/cycling tracks and boardwalks. The estuary is approximately 2.5 square kilometres and has a perimeter of approximately 8.3 kilometres. It is a shallow estuary, having an average depth of approximately one metre above lowest astronomical tide (Figure 1).

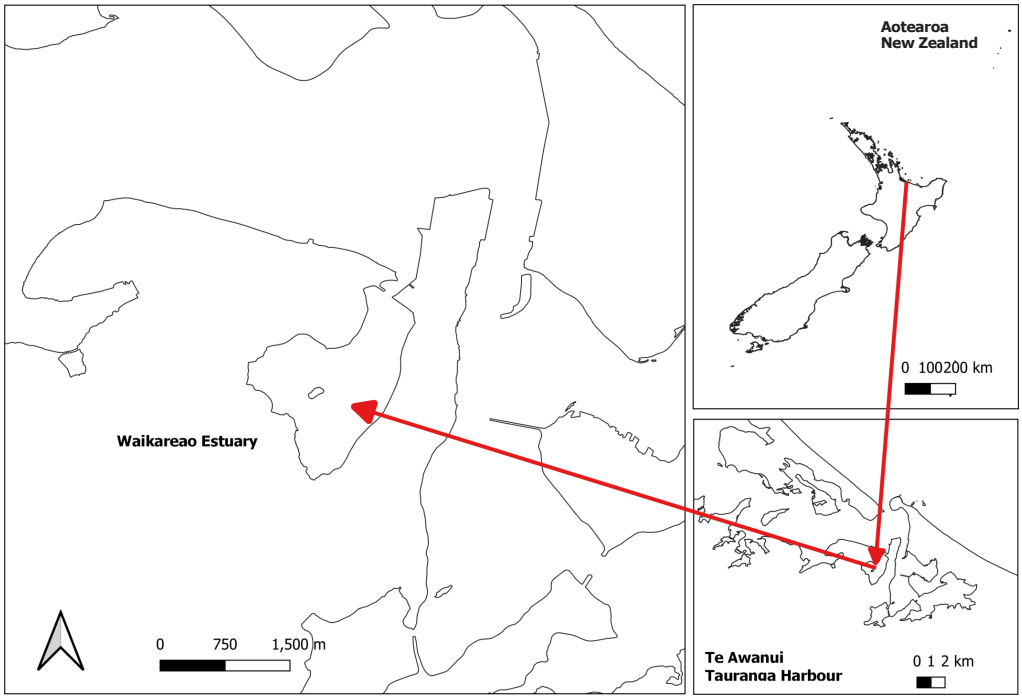

Figure 1. Waikareao estuary, with reference to the wider Tauranga harbour and Aotearoa New Zealand. Contains data sourced from the LINZ Data Service licensed for reuse under CC BY 4.0.

The main environmental impacts are urban stormwater running into streams around the estuary perimeter and runoff from a nearby industrial estate. The western side is considered to be a site of significant ecological interest and is protected as the Waikareao Wildlife Refuge (Cromarty & Scott, 1995). Several recent regional council reports on sediments and contaminants have found higher levels of various contaminants than in unimpacted estuaries, but none exceeded safe levels for human consumption at the time the reports were made (Park, 2003, 2009). The present study aimed to reference and build upon previous studies and provide valuable, updated information on kaimoana health in the estuary.

Kaimoana and its importance to local iwi

Three shellfish species, tītiko (*Amphibola crenata*), tuangi (*Austrovenus stutchburyi*) and pipi (*Paphies australis*), were selected for the study because of their importance to the local communities, and because they had already been identified as an indicator of the cultural health indexes for the region (Taiapa et al., 2013). An added advantage was existing baseline data from wider studies of Tauranga harbour (Clark et al., n.d.; Ellis et al., 2013; Sinner et al., 2011).

Ngai Tamarawaho hapū of Takitimu and Ngati Ranginui origin have manawhenua (authority over territory) over the Waikareao estuary and also along the port of Tauranga. The Waikareao estuary has a high cultural significance for the people of Ngai Tamarawaho as it is considered a pātaka/ketekai (food cupboard/basket) where shellfish was, and still is, traditionally harvested. The iwi's own report (Ngai Tamarawaho Management Plan, 2021) notes that, sadly, the estuary has been subjected to unauthorised and untreated discharges from many sources, contributing to poor water quality and an inferior marine environment. This has also left a serious

and negative impact on the mauri (spirit) of Waikareao. The hapū are now actively promoting their role as kaitiaki (caretakers), seeking to restore their traditional waterways in partnership with local authorities and other stakeholders, and reinstate the abundance of kaimoana:

> All the waterways and water sources within our rohe – large or small – are important to us.
>
> The sea and the waterways have nurtured our people – they have formed our pathways, have been places of sustenance for us for … the estuary and the harbour and sea – our food bowl and garden. (Ngai Tamarawaho Management Plan, 2021, p. 10)

A series of meetings with representatives from Ngai Tamarawaho informed the scope of the survey and the presentation of results, and further discussion will be disseminated in an upcoming hui. Several other research projects have already commenced as a result of the initial success of this study.

METHODOLOGY

While shellfish are not considered a species for ethics approval, the study was designed to have minimal impact. The estuary is already under pressure from surrounding urbanisation and environmental impacts. With this in mind, all species were counted and measured in situ and returned to where they were found. After a few tidal cycles there was very little evidence left of our surveys.

Six sites around the shoreline of Waikareao Estuary were selected; three sites were alongside mānawa (mangrove) and three sites alongside urban rock pathways (Figure 2).

Figure 2. Survey sites 1–6. Contains data sourced from the LINZ Data Service licensed for reuse under CC BY 4.0.

Each site was accessed during a four-hour period, from two hours before low tide until two hours after low tide.

Two transects were conducted at each site. Records were kept for each sampling, including the time and environmental conditions such as weather conditions, low tide time and level. Each 50m transect was placed perpendicular to the shoreline to measure the length of each zone, as identified by the researcher – for example, zone 1= reeds/mangroves, zone 2= mudflat/sandflats. Next, 5 x 25m^2 quadrats were set haphazardly within each zone at each site, and the top 1cm of sediment was scraped back by hand. All live tītiko, tuangi and pipi were counted, photographed, identified and measured at their longest length. Worm and crab holes were also counted. On completion, all organisms were returned to where they were found.

Throughout the site monitoring period, the student researcher liaised with members of Ngai Tamarawaho, who joined her out on the estuary and showed an interest in the data collection and findings. As Māori herself, the student respected how deeply the local responsibility of kaitiakitanga is felt, understanding the principle that the landscape and its resources are the main inheritance we will leave future generations (Harmsworth, 2005). Therefore, viewing iwi stakeholders as partners in the research, and respecting the taonga (treasure) of the local estuary life, were important aspects of the project's methodology.

The learning and teaching methods focused on the collaboration between the student, hapū and researcher. As we learnt and applied the methods for scientific surveying together, we discussed history, cultural significance and personal perspectives and values. Alongside these research skillsets and understanding of our own positioning as researchers, there was time and opportunity to incorporate interpersonal skills (Reavis & Thomas, 2019) as the project brought us into contact with stakeholders external to the research team and our home institute. Assisting with the surveys was open to anyone interested in helping and wanting to learn, providing both partners with the opportunity to teach and learn from a diverse crew of helpers – members of the public, local community groups and iwi.

FINDINGS AND DISCUSSION

Shellfish health

Across the six survey sites completed, tuangi were the most common bivalve species found within the estuary, with over 1,000 individuals recorded. The average length varied within each site, with one location having the largest mean length of 11.32mm, but the overall average was 8.09mm. Pipi were only found at one site, with an average size of 8.79mm. Tītiko numbers were scarce, with only a single population found, at an average length of 10.86mm.

Unsurprisingly, sites closer to the highway had lower numbers, whereas when the transect line was extended further into the estuary, higher abundances were found. However, one site with a healthy population (100) of tuangi actually had the highest visible pollution rate. At this site, discarded plastic, glass bottles, dumped household items and vehicle hubcaps were found. Vegetation zones and other species also varied. Zonation also affected which species were most abundant. For example, horn snails or koeti (*Zeacumantus*) were found in the greatest abundance within the muddy-sand zones of sampled sites and also on various species of drifting algae. Many anemones, barnacles and limpets were observed clinging to many of the tuangi and pipi found near the sand-flat and muddy-sand zonation areas. Purple whelks were also highly abundant in firmer sand areas. Rock oysters (*Saccostrea commercialis* and *Crassostrea gigas*) and black rock snails (*Nerita melanotragus*) were predominantly found near site one, attached to boulders that retain the footpath around the western side of the estuary.

While no ground-breaking results have been realised in the study, it was worthwhile as preliminary research contributing to the project supervisor's larger study, and will feed into an overall evaluation of kaimoana and estuary health when final results are set against measurements from previous studies.

Learning for supervisor and student

First, the exercise of determining quadrat sites using patchiness as a visual clue appeared to work well, showing that that the observer's eye was reasonably reliable in differentiating between habitats. Applying scientific method in the field, having studied the principles in the classroom, is important for students to gain research experience and confidence. All aspects of the research – from planning and scheduling estuary visits around weather and tides to the importance of accurate recording – are useful foundations for the final, independent year three research project and subsequent postgraduate studies.

A second learning related to the relationship which developed between the researchers and the local iwi, Ngai Tamarawaho. The student is local Māori, although from a different marae, but was knowledgeable, mindful and respectful of local tikanga. The study was work that this key stakeholder group wanted undertaken, and they are keenly interested in the final results. Later this year when the entire project is finished, the plan is for a report to be produced for dissemination to Ngai Tamarawaho hapū and the wider community, other stakeholders and supporters including our local councils. In addition, the information retrieved provides a valuable store of knowledge for both the programme and mana whenua with which to review any change over time affecting these taonga, allowing suggestions for interventions.

On a small scale, this research supports what Winiata (2009, p. 4) regards as the three common environmental goals of iwi and hapū:

1. The revival and protection of taonga such as fauna, flora and their marine, freshwater and terrestrial ecosystems
2. The wise, sustainable use of resources in order to sustain their mauri and that of the people
3. To achieve tino rangatiratanga rights and kaitiakitanga responsibilities relating to iwi and hapū resources.

Learning also occurred through the positive tuakana–teina relationship between student and supervisor (Smith, 2017). The tuakana supervisor who held the scientific and academic expertise is an immigrant to Aotearoa New Zealand; the teina summer scholarship student had local and cultural knowledge that they were able to contribute.

Back in the classroom, the learning has extended to the student's peers, as she has been able to speak with authority and confidence about the planning and implementation of applied research in the field that directly benefits the community who hosted it. It has helped her classmates on the 2022 marine and environmental course to expand their understandings of te ao Māori, and has led to further student research projects, currently underway in the estuary.

Outcomes

The student has gained experience and is now in her final year of her Bachelor's qualification. She has a documented project to include in her learning portfolio and continues to be a part of the study, contributing to the drafting of this article with her final report and preparing for a planned co-presentation at a national conference with her supervisor, later this year.

Other students are also benefitting; the project's early indications of success have supported the inclusion of a further five students in later phases of this research, which will be conducted later in 2022. Some of these roles will be fieldwork, but likely others will focus on completing an online 'dashboard' to show data as a graphic representation, rather than text, for public use and easy access. We have also 'bookmarked' our observations of pollution and waste present in the estuary as a possible clean-up project for a staff workday, or the rationale for further research related to restoration and sustainability of natural ecosystems.

Interactions with local iwi, councils and communities have enhanced connections and mana for the institute and the Environmental Management programme.

CONCLUSION

We hope that by sharing this account of a summer fieldwork project, we have been able to demonstrate the value of growing future environmental and marine advocates. Students need practical applications of the concepts they learn about in class and view during field trips. Working within a research project adds authenticity to learning about scientific processes, while developing a range of professional skills such as problem-solving, record-keeping, reliability, responsibility and following one's own initiative. Partnerships between supervisor and student in 'owning' the research and sharing findings, such as this article, help the student find their voice in the academic community. Allowing the student to take the lead in day-to-day communications with local iwi members enhances their mana. Above all, bringing these experiences back to the classroom keeps the programme current and relevant.

It is important that work in local environments connects closely with Māori whose whakapapa (ancestral lineage) has a strong relationship with a defined geographic area. Their expertise, knowledge and perspectives based on traditional culture, beliefs and values must be respected and upheld (Harmsworth, 2005). Resource management is becoming more complex, with multi-layered expectations and requirements for environmental, social, cultural and economic goals and outcomes. The key to achieving balance lies in working productively together (Harmsworth, 2005; Tipene-Matua et al., 2009), and participation which introduces diverse perspectives on an issue and the integration of different types of knowledge lies at the heart of this.

Collaboration with local governance bodies is also critical – for long-term management, but also for immediate control and funding to prevent further degradation of our estuaries. An important action we will be calling for in our final report is that the dumping of rubbish by the public from the highway must be regulated. The breakdown of non-degradable items is not only unsightly and disrespectful, but can also cause leaching, thus creating an unsustainable environment for all biodiversity in and around Waikareao (Scott et al., 2005). Two of the target species monitored in this project are found in only one of six sites where they were previously observed, which means that some of our shellfish populations are already dwindling.

Part of the role of teaching and learning is preparing our students for the world of work. Future employers of our science graduates include local bodies, community groups and industry – all of which are increasingly focused on practices which support Māori–Crown relationships and the principles of te Tiriti. Sustainability and protection of the environment are also critical factors in modern organisational culture. Projects like this one demonstrate the importance of collecting and sharing evidence of local habitat health, and of creating connections through shared concerns and causes. We hope others undertaking student research will be encouraged to find opportunities to likewise connect with communities and councils, and awaken the voice of our next generation of scientists.

David Culliford came to Aotearoa via the Pacific on a sailboat in 1999 and has spent the last 20 years working around Tauranga. About 15 of those years have been involved with research in the Tauranga Moana and wider marine environment. He is strongly interested in the land/water interface and conservation through community.

Amohia Peka was born and raised in Rotorua. Her environmental science journey began in 2020 when she developed a deep passion for marine and freshwater ecology. She finds great interest in working with iwi to help maintain and restore the mauri of culturally significant areas.

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