TUIA 250

ENCOUNTERS

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Editorial
Relaxing the Scientific Paradigm

Peter Knight

This special edition of the new zealand Surveyor honours the Tuia 250 theme of 'Tuia te muka tangata ki uta. Weaving people together for a shared future'. The history, art, technology, and perspectives of different cultures at different times are explored to inform our conversations about, '…the past, the present and how we navigate our shared future'.[1] The writers for this edition offer a wealth of expertise and detail on a number of subjects among them, indigenous Pacific navigation; Cook's charting of New Zealand; and Māori and Pākehā relationships with place and the naming of these places. It is my privilege, and luxury as editor to offer a conversation inspired by this work. I wish to use examples of European art, and American writing in the context of indigenous Pacific navigation and the first European contacts with the indigenous people of the Pacific and the islands of Aotearoa New Zealand to suggest that the Western/indigenous cultural divide is less a divide in spirit than it is in thought. From this viewpoint, early contact between the north and the indigenous people of the Pacific, not always flattering to Northerners, might be assessed in a way that offers more wholeness

to the ongoing Pākehā experience of settlement in Aotearoa New Zealand.

Art, like navigation is concerned with perceptions of time and space. I shall begin my juxtaposition of art with the cross-cultural subjects treated here by looking at an indigenous Pacific way of visualising an ocean journey. I first heard about the indigenous Pacific star navigation concept of *etak* from Stan Lusby during a time in which I helped him illustrate an article on indigenous Pacific navigation. In his small wooden house at Moeraki that I will always remember with the windows and door flung wide open and filled with light from the ocean, Stan discoursed on the difference between 'our' ideas and representation of a boat moving across the sea, and the indigenous Pacific navigator's idea of islands appearing and disappearing around an observer. *Etak*, is a method of spatial orientation used by indigenous Pacific star navigators to mentally keep track of, and visualise their dead reckoning position during offshore passages. Star navigators use the positions of familiar stars at certain times, (usually times of rising) to maintain a heading toward islands out of sight beneath the horizon. Star positions can also be used as a kind of abacus in the sky upon which unseen, but familiar islands—the beads of the abacus—at a convenient orientation to the vessel, are mentally shifted to various positions to note, or keep track of stages in the passage to the destination. The star navigator says to herself, I know from the speed of my canoe, and the time since departure following the star course to my destination that the apparent position of a particular island which I cannot see but I know to be at a certain distance upon my beam will have shifted position from being beneath one particular star to another. It does not matter whether the stars or the island are visible or not. A Western navigator understands *etak* as the star navigator's mental substitute for a line plotted on a chart, a method of mentally visualising spatial progress. A salient characteristic of the *etak* method, in contrast to Western navigation technique, is the Polynesian concept that the *etak* islands move, while the observer remains at rest.[2]

There is a well-known passage in Proust which, I think, illustrates the etak idea of reference markers moving, while the observer's

actual motion becomes secondary. In this passage a young artist is travelling through the French countryside, on a horse drawn carriage in the open air. While true that the observer may be moving, his environmental awareness has shifted from his own transport to the appearance of the world around him.

> Alone, rising from the level of the plain, and appearing lost in the open country, the two steeples of Martinville ascended towards the sky. Soon we saw three: wheeling around boldly to position itself opposite them, the laggard steeple of Vieuxvicq had come along to join them. The minutes were passing, we were going fast, and yet the three steeples were still far away ahead of us, like three birds poised on the plain, motionless, distinguishable in the sunlight. Then the steeple of Vieuxvicq moved away, receded into the distance, and the steeples of Martinville remained alone, illuminated by the light of the setting sun, which even at that distance I saw playing and smiling on their sloping sides. We had taken so long approaching them that I was thinking about the time we would still need in order to reach them, when suddenly the carriage turned and set us down at their feet; and they had flung themselves so roughly in front of us that we had only just time to stop in order not to run into the porch. We continued on our way; we had already left Martinville a little while before, and the village, after accompanying us for a few seconds, had disappeared, when, lingering alone on the horizon to watch us flee, its steeples and that of Vieuxvicq were still waving us good-bye with their sunlit tops. At times one of them would draw aside so that the other two could glimpse us again for an instant; but the road changed direction, they swung round in the light like three golden pivots and disappeared from my gaze. But a little later, when we were already close to Combray, and the sun had set, I caught sight of them one last time from very far away, seeming now no more than three flowers painted on the sky above the low line of the fields.

> They reminded me, too, of the three young girls in a legend, abandoned in a solitary place where darkness was already falling; and while we moved off at a gallop, I saw them timidly seek their way and, after some awkward stumbling of their noble silhouettes, press against one another, slip behind one another, now forming, against the still pink sky, no more than a single black shape, charming and resigned, and fade away into the night.[3]

The artistic intention of Proust has to do with the narrator's perception, and is important enough to occupy a prominent marker in the life of his young protagonist. This because Proust believes that the memory contains a new and different conception of time and space. The narrator's experience, occurs while the narrator was still a boy, and contains an element of primitive naivety, which might be likened to the perspective of an indigenous navigator where, ' … the pahi [canoe] is imaginatively fixed at the centre of a thoroughly dynamic universe'.[4]

My introduction to etak highlighted the difference between an abstract cartesian representation of a two-dimensional coordinate system (i.e. a point defined by coordinates on a plane surface-the map or chart), with an ego-centric, or anthropocentric concept. In the latter the navigator is the central reference of the system, and, like a theatre goer, or Proust's narrator, watches the action unfold around him. However, the observer-centric point of view inherent in *etak* is not strange to European navigation techniques for, as Gell has shown, while there are elements of *etak* that are certainly original to indigenous Pacific navigation—the strongest being the idea that the observer remains at rest while the islands move —European navigation also depends upon the observer adopting an anthropocentric position, at critical navigation moments (e.g. landfall).[5] While much of a voyage may be controlled by the abstract idea of a two-dimensional position on a chart in Cartesian space, at some point the mariner must position herself with respect to features she recognises on the surface of the earth; it is an egocentric perspective that safely guides the vessel to anchorage.[6] Therefore, if we are seeking to understand a truly different perspective from

our normal way of seeing things-the indigenous vision—we must move beyond the simple dichotomy of two-dimensional, cartesian representation of position and space vs anthropocentric conceptions. Proust suggests as much when, at the end of his description of the relative movement of the church spires during his journey, he likens the spires to, '… the three young girls in the legend…'. The spires that had already created a mighty impression on the young artist now become imbued with character, emotion and intention. Proust has created a perceptual change that gives to the external world an ontological importance not so very different from his own existence. It is as though the world around us becomes alive.

A New Zealand writer, Keith Tonkin captures the essence of the world imbued with life in his fictional account of a boy's experience leaving Rarotonga, on the pa'i (canoe) TAKITUMU on a voyage to discover 'Avaiki Tautau' Aotearoa.

> This was my first time beyond the reef. The sea at the southern horizon was even, deep and blue. The sails creaked and strained but I could feel Takitumu lifting to the wind and somewhere beyond, dangling beneath the great sky, was where were were going. With that dream, the sparkling sea around us, the spray on my face and the birds circling us, I felt the power and mana of Takitumu. The pa'i, our pa'i, was gliding and lifting to the winds of Raka and surging fast on the seas of Tangaroa. It seemed in my head that the atua were becoming not just a living part of the pa'i itself, but a living and important part of me, my friends, my kopu and my ivi as well.[7]

A concept of a shared life between the internal world of the observer and the external world—an existence in common, is not completely strange to European culture, but it is a view perhaps more suited to the Middle Ages than a time in which science has dispelled such thought in favour of scientific rationalism. Let us contrast a poem by Geoffrey Chaucer from the European Middle Ages—a time in which European culture may have had more in common with indigenous Pacific culture than it has since the rise of a science oriented culture —with an excerpt from Joseph Banks' Endeavour Journal. Banks'

Endeavour Journal of January 1770 contains his description of the birdsong of Aotearoa New Zealand, and is important in our imaginings of what Aotearoa was like two-hundred and fifty years ago:

> This morn I was awakd by the singing of the birds ashore from whence we are distant not a quarter of a mile, the numbers of them were certainly very great who seemd to strain their throats with emulation perhaps; their voices were certainly the most melodious wild musick I have ever heard, almost imitating small bells but with the most tuneable silver sound imaginable to which maybe the distance was no small addition.[8]

Four hundred years earlier, the English poet Geoffrey Chaucer in his Book of the Duchess also describes a person awakening to birdsong.

Me thoughte thus: that hit was	I thought thus: that it was May,
May, And in the dawning ther I lay,	And in the dawning I lay,
Me mette thus, in my bed al naked:	So I dreamed, in my bed all naked,
I loked forth, for I was waked	And looked round, for I'd been wakened
With smale foules a gret hepe,	By small birds, a great heap,
That had affrayed me out of slepe	That had startled me out of my sleep
Through noyse and swetnesse of hir song;	With sound and sweetness of their song;
And, as me mette, they sate among,	And, as I dreamed, they perched along
Upon my chambre-roof withoute,	My chamber roof there without,
Upon the tyles, al a-boute,	Upon the tiles and all about,
And songen, everich in his wise,	And sang each in its own way
The moste solempne servyse	The most solemn roundelay

By note, that ever man, I trowe,	Of notes that ever man below
Had herd; for som of hem song lowe,	Has heard, for some of them sang low,
Som hye, and al of oon acorde.	Some high: and all of one accord.
To telle shortly, at oo worde,	To tell it briefly, in a word,
Was never y-herd so swete a steven,	Was never heard so sweet a leaven,
But hit had be a thing of heven; --	Unless it were a thing of heaven;[9]

Bank's impression while not lacking poetry—e.g. 'most melodious wild musik'—is very much that of an observer. His Enlightenment[10] perspective has him speaking of 'quarter miles' and 'numbers … certainly very great'. Chaucer in contrast has a submerged, perspective in which the observer is part of a greater environment full of luminous presence. The reader feels Chaucer's participation in a world of wonder, even experiencing 'heven'. Banks is an onlooker, deeply affected, but much more removed from the object of his interest than Chaucer.

Of relevance to this contrast between a pre-scientific wholeness, and the individuated 'modern' man or woman, is Tupaia's watercolour painting of an exchange between a Māori man and Joseph Banks.[11] Tupaia's painting expresses the wider cultural issue that follows from, what I suggest, is a certain distance between Banks and the world that is a result of a scientific attitude, an attitude of which Chaucer, who pre-dates the Enlightenment development of science, and the indigenous Tupaia, are free. In Tupaia's painting a Māori man offers a large crayfish to Banks, who reciprocates by extending a piece of paper.[12] The crayfish symbolises Māori way of being in the world, practically alive, it is an immediate and rich source of sustenance. Banks' paper offering symbolises an abstracted worldview, undoubtedly useful, but, oh! How much less vital! It is not that Banks is incapable of vitality or that his culture is lacking in that respect, rather that a fragmentation has occurred in which matter and spirit have been separated. We have entered the age of the 'expert' in

which we are highly rewarded for knowledge in specific areas.[13] In the context of indigenous Pacific navigation, it is now understood that advances in Western/academic understanding of indigenous Pacific navigation need to be given back to indigenous people to situate within their own understanding of the world.[14] Goodwin's paper in this Special Edition shares this desire for a greater meaning in mentioning the cultural and environmental background in which his investigations of indigenous Pacific navigation take place, and that it is toward helping with these looming issues that the study of indigenous navigation might lead us.

My aim has been to draw out the similarities, affinities and sympathies between European colonisers and the indigenous Pacific Islanders. One difficulty of the focus on Cook's 1769 visit to Aotearoa New Zealand, or Tuia 250, is that Cook's mission had a military component, and while it gave us a great deal of cultural and scientific information, it was also overshadowed by bloodshed. I would like to consider an early encounter with Polynesian people that contained no element of violence: I refer to the description given by Henry Dana Jr. of the Sandwich Island (Hawaiian) people with whom he worked on the coast of California in the 1830s. Unlike Cook, Dana was not a representative of power, he was a labourer, albeit by choice, as he was an educated man from privileged family who had taken to the sea, to live among men of a completely different society and occupation from that in which he was raised. One of the Sandwich Islanders he met told him that his father had 'seen' Cook, and when the Americans tried teasing the Islanders about eating the great man, the Islanders became upset, indicating a certain seriousness and respect surrounding the subject that was absent in the Americans. Dana goes on to provide a glimpse of the kind of people the Polynesians were:

> A considerable trade has even carried on for several years between California and the Sandwich Islands, and most of the vessels are manned with islanders, who, as they for the most part sign no articles, leave whenever they choose, and let themselves out to cure hides at San Diego … . In this way a little colony of them had become settled at San Diego … . [They] were living at the oven

> [i.e. on the beach] in a quiet way; for their money was nearly gone, and they must make it last until some other vessel came down to employ them. … Their customs and manner of treating one another show a simple, primitive generosity which is truly delightful, and which is often a reproach to our own people. Whatever one has they all have. Money, food, clothes, they share with one another, even to the last piece of tobacco to put in their pipes. … This principle they carry so far that none of them will eat anything in sight of others without offering it all round. I have seen one of them break a biscuit, which had been given him, into five parts, at a time when I knew he was on a very short allowance, as there was but little to eat on the beach.[15]

There is a saying that goes, 'If you spot it, you've got it!' While usually used in the negative sense of spotting faults in others, I think it works equally with virtues, and that we have here an example of compatibility between people at the highest level. Cook thought of Māori as, '… a brave open warlike people and voide of treachery'.[16] This essentially spiritual assessment was complemented by professional respect for Tupaia's maritime knowledge.[17] If we are to learn from one another and from other cultures we must begin with this acknowledgement of equality; the next step is up to us in our own ways, and I take my hat off to Tuia 250 for encouraging our efforts.

Notes

[1] https://mch.govt.nz/tuia250 accessed Nov 20th 2019. "Use Tuia 250 as an opportunity to hold honest conversations about the past, the present and how we navigate our shared future." "Tuia te muka tangata ki uta. Weaving people together for a shared future."

[2] Of course, the star navigator knows that she is moving, but her method of keeping track of her position involves the movement of reference objects not movement of her vessel. See David Lewis, *We the Navigators The Ancient Art of Landfinding in the Pacific,* The University of Hawaii Press, 1972 Chapter 5.

[3] Proust, Marcel, *In Search of Lost Time*, Penguin Books 2003 (first published 1913), translator Lydia Davis 2002, pp. 181-182

[4] Eckstein, L., & Schwarz, A. (2019). The Making of Tupaia's Map: A Story of the Extent and Mastery of Polynesian Navigation, Competing Systems of Wayfinding on James Cook's Endeavour, and the Invention of an Ingenious Cartographic System. *The Journal of Pacific History,* 54(1), p.41

[5] Gell, A (1985) How to Read a Map: Remarks on the Practical Logic of Navigation, Man, *New Series*, Vol. 20, No. 2, pp. 271-286.

[6] The electronic chart is an interesting development that incorporates the idea of a world moving past the observer, particularly if the display is set to automatically centre the vessel on the screen.

[7] Keith Tonkin, *Avaiki Tautau,* CP Books, Nelson, New Zealand 2014. P.69.

[8]The ENDEAVOUR Journal of Joseph Banks 1768–1771 [Volume One] January 1770 p.456 http://nzetc.victoria.ac.nz/tm/scholarly/tei-Bea01Bank-t1-body-d7-d6.html Accessed 25th Nov. 2109

[9] Geoffrey Chaucer *The Book of the Duchess, original, The Book of the Duchess* on Librarius.com (middle-english hypertext with glossary). Accessed Nov. 20th 2019. Translation by A. S. Kline, https://www.poetryintranslation.com/PITBR/English/Duchess.php Accessed Nov. 20th 2019. Chaucer is, incidentally, the author of A Trestise on the Astrolabe, the earliest technical manual on a surveying instrument in the English language.

[10] 'The Enlightenment' understood as an 18th Century intellectual

movement, '…marked by emphasis on the scientific method, and reductionism.' https://en.wikipedia.org/wiki/Age_of_Enlightenment. Accessed November 2019.

[11] The British Library Board, 5508/12 Tupaia is the Tahitian who accompanied Cook to New Zealand on the 1769 voyage.

[12] Joan Druett, *Tupaia Captain Cook's Polynesian Navigator.* Praegar, 2011., p. 164.

[13] Sir Joseph Banks, was a naturalist, botanist, and patron of the natural sciences. https://en.wikipedia.org/wiki/Joseph_Banks. Accessed Nov. 2019

[14] Eckstein, L., & Schwarz, A. (2019). The Making of Tupaia's Map: A Story of the Extent and Mastery of Polynesian Navigation, Competing Systems of Wayfinding on James Cook's Endeavour, and the Invention of an Ingenious Cartographic System. T*he Journal of Pacific History*, 54(1), See concluding remarks, p.93.

[15] Dana, Richard Henry (1949) *Two Years Before the Mast,* Collins London and Glasgow. First published in 1840. pp.148-149

[16] Salmond (2003) The Trial of the Cannibal Dog Captain Cook in the South Seas, Allen Lane, 2003 p. 151

[17] Turnbull, D. (2019). Eckstein and Schwarz's Translation of Tupaia's Chart: The Rosetta Stone of Polynesian Navigation?. *The Journal of Pacific History*, p.1

First Contacts in the South Pacific - Cook and Tupaia

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INTRODUCTION

Two thousand and nineteen sees the start of various commemorations of James Cook's first arrival in Aotearoa New Zealand 250 years ago. Cook's exploits in exploring and mapping coastlines are well documented and his New Zealand chart is iconic. He made the first European contact with Māori,[1] some of which was violent, but it was also about constructive trade and developing relationships. Cook claimed the islands of New Zealand in the name of the British Crown and reported back to England about the suitability of these islands for colonisation.

Tupaia was a high born priest from the origin marae of Māori; Taputapuātea on the island of Ra'iātea. He built a personal relationship with the first Europeans to visit Tahiti and became a supernumerary on the Endeavour when Cook left Tahiti bound for southern lands. Tupaia was very influential on this voyage - not least for keeping the Europeans alive when they broke cultural protocols and were threatened. Tupaia's contributions to navigation, art and charting are still being analysed.[2]

Cook's and Tupaia's impact on Aotearoa's history is immeasurable.

But as history is often told by the victors, the Polynesian and Māori stories have often been hidden. We now have an opportunity to reflect on past events and tell stories of people, cultures, and skills, to highlight the stories from Māori. While it is for Māori to tell their own stories,[3] this paper introduces Cook and Tupaia and comments on the roles they each played in this first contact period. The paper reflects on differences and similarities between the European and Polynesian cultures, knowledge, customs and behaviour.

Cook

James Cook (1728-1780), seaman, navigator, surveyor, and explorer, was a 39 year old Royal Navy lieutenant when the Royal Admiralty chose him to lead an expedition to the South Pacific in 1768. Cook first went to sea in the broad-bottomed coal ships trading from Whitby. He then joined the Royal Navy in 1755 and was engaged in hydrographic survey of the St Lawrence River in support of Wolfe's landing for the Battle of Québec, and then a major survey of Newfoundland waters,[4] resulting in an Admiralty chart of such quality that it remained in use well into the 20th Century. His work included astronomical observations and calculations of longitude, which built him a strong reputation for his skill and competence and meticulous attention to detail. He was quickly promoted to master of his ship.

The Royal Society and the Admiralty were jointly keen to promote the advancement of science and an understanding of what lands remained unexplored. They chose Cook to lead an expeditions to the South Pacific. The 1768 expedition was primarily[5] to observe the transit of Venus from King George's Island (Tahiti) - recently 'discovered' by Wallis in the ship Dolphin. The measurements of the transit were a matter of significant concern to the wider scientific community - the greater understanding about the size and proximity relationships within our solar system being the purpose. Such a transit only occurs at long intervals, so the opportunity to observe the 1769 event at multiple locations around the earth was well funded by the Royal Society and the Admiralty.

The ship chosen for the south seas expedition was a Whitby collier with which Cook was very familiar. He had great confidence about the suitability of this ship for such an expedition. The ship was extensively modified to handle the expected conditions, being double sheathed to protect it from tropical worm and newly outfitted with spars, rigging and sails.[6] The ship was renamed Endeavour, Cook was promoted to Lieutenant and all was made ready for the voyage. A huge inventory of stores was loaded: food, water and rum; livestock; multiple spare parts for repairs; and also many trade goods - ironware and cloth principally:

> … put to sea having on board 94 persons including Officers Seamen Gentlemen and their servants, near 18 months provisions, 10 carriage guns 12 swivels with good store of Ammunition and stores of all kinds.[7]

The bark Endeavour sailed from Plymouth on 26 August 1768, south through the Atlantic, around Cape Horn,[8] across the Eastern Pacific and to Tahiti on 13 April 1769, where Cook and his astronomers set up an observatory to observe the transit on 3 June.

After that scientific mission was completed, Cook was instructed to search for Terra Australis, the great southern continent which was expected to balance the northern hemisphere's continents. In the event of new 'discoveries', the secret instructions from the Admiralty advised:[9]

> You are ... to observe the Genius, Temper, Disposition and Number of the Natives, if there be any and endeavour by all proper means to cultivate a Friendship and Alliance with them, making them presents of such Trifles as they may Value inviting them to Traffick, and Shewing them every kind of Civility and Regard; taking Care however not to suffer yourself to be surprised by them, but to be always upon your guard against any Accidents.
>
> You are also with the Consent of the Natives to take Possession of Convenient Situations in the Country in the Name of the King of Great Britain: Or: if you find the Country uninhabited take Possession for his Majesty by setting up Proper Marks and Inscriptions, as first discoverers and possessors.

There was at least some acknowledgement in Britain that care needed to be taken - that the power imbalance between Englishmen and native peoples may play out disastrously. Cook was explicitly on notice about how to behave. James Douglas (14th Earl of Morton, President of the Royal Society which supported Cook's voyage) advised Cook specifically:[10]

> To check the petulance of the Sailors and restrain the wanton use of Fire Arms.
> To have it still in view that sheding the blood of these people is a crime of the highest nature – They are human creatures, the work of the same omnipotent Author, equally under his care with the most polished European, perhaps being less offensive, more entitled to his favour.
> They are the natural, and in the strictest sense of the word, the legal possessors of the several Regions they inhabit.
> No European nation has a right to occupy any part of their country or settle among them without their voluntary consent.
> Conquest over such people can give no just title; because they could never be the Aggressors.

Cook kept a journal - regularly (almost daily) entering position, course and weather details and "Remarkable Occurences" along the way. It is from these journals that we get an insight into Cook's decisions, actions, observations and thoughts on these expeditions.[11]

Cook was a severe disciplinarian and, following Navy rules, was free with the lashes of crew members for petty theft, attempted desertion, and non-compliance with orders. He also used rather extreme force when the Natives did not comply with his expectations - muskets were frequently fired as a threatening display of firepower, and on several occasions offenders were shot and killed.[12] There are numerous accounts of musket fire as the first response to non -compliance by the natives both in Tahiti and later in Aotearoa New Zealand.[13]

Cook was also particular about diet and keeping his crew healthy, ordering crew to partake of his concoctions of gruel and whatever fruit and vegetables were available to ward off scurvy. He had his

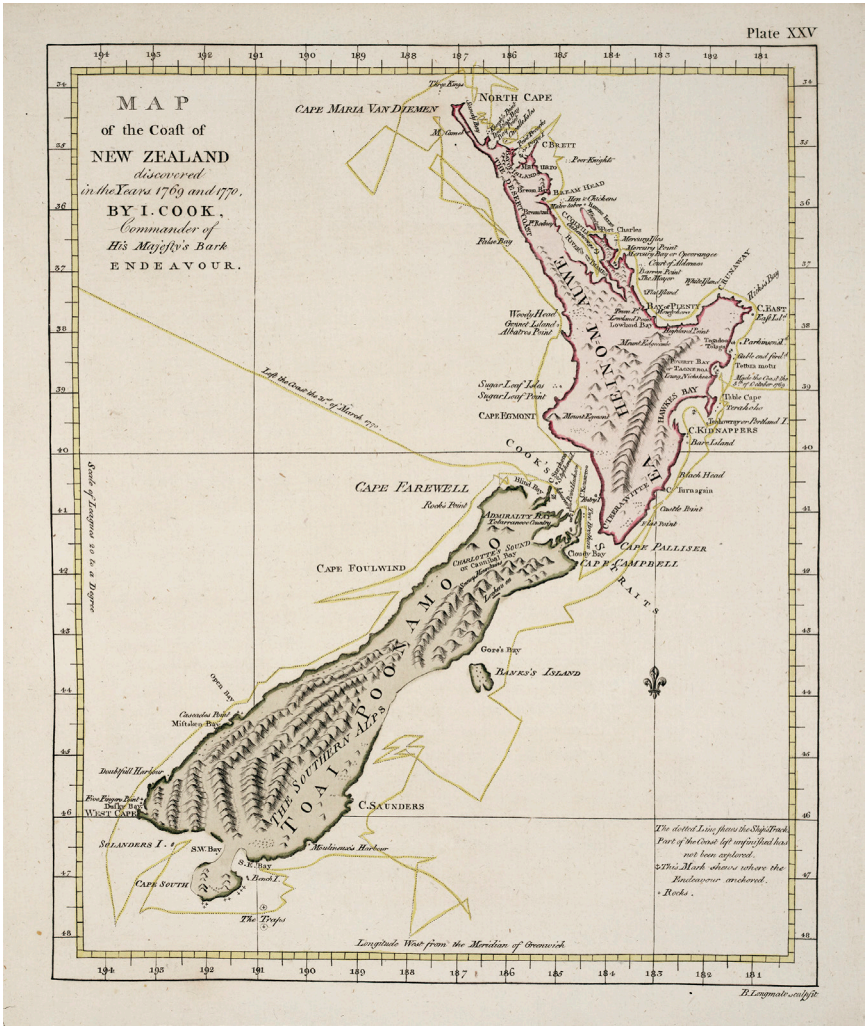
crew's health monitored and was sure none carried venereal disease before arrival in the south seas, but noticed how quickly they became infected upon contact with the Tahitian women. He concluded that earlier French visitors to these islands must have brought and spread these diseases. He was clearly unsuccessful in expecting his crew not to fraternise with the Tahitians,[14] but also observed some immodest sexual behaviour which hinted at different moral standards.

> … an odd Scene at the Gate of the Fort where a young fellow above 6 feet high lay with a little Girl about 10 or 12 years of age publickly before several of our people and a number of the Natives. What makes me mention this, is because, it appear'd to be done more from Custom than Lewdness, for there were several women present … and these were far from shewing the least disprobation that they instructed the girl how she should act her part, who young as she was, did not seem to want it.[15]

Interestingly, later, Cook was perceptive enough to observe the decline of moral standards occasioned by contact with his crew:

> During our short stay in the Sound I have observed that this Second Visit of ours hath not mended the morals of the Natives of either Sex, the Women of this Country I always looked upon to be more chaste than the generality of Indian Women, whatever favours a few of them might have granted to the crew of the Endeavour it was generally done in a private manner and without the men seeming to interest themselves in it, but now we find the men are the chief promoters of this Vice, and for a spike nail or any other thing they value will oblige their Wives and Daughters to prostitute themselves whether they will or not and that not with the privacy decency seems to require, such are the concequences of a commerce with Europeans and what is still more to our Shame civilized Christians, we debauch their Morals already too prone to vice and we interduce among them wants and perhaps diseases which they never before knew and which serves only to disturb that happy tranquillity they and their fore Fathers had injoy'd.[16]

Cook remained aloof to such contact with the natives and was mostly single-minded about his navigation, surveying and map-making, ultimately creating the first useful maps and charts of Tahiti and Aotearoa New Zealand.



Cook, James, 1728-1779. Map of the coast of New Zealand discovered in the years 1769 and 1770, By I. Cook, Commander of His Majesty's Bark Endeavour. B. Longmate sculpsit. [London, 1773]. Ref: PUBL-0037-25. Alexander Turnbull Library, Wellington, New Zealand.

Tupaia

It is only relatively recently that the significance of Tupaia on Cook's Polynesian contacts and on his navigation has been widely recognised. Joan Druett has written a biography of Tupaia that spans this high priest's life through the period on European contact in Tahiti and New Zealand.[17]

Tupaia was born into the priesthood on Ra'iātea and his marae was Taputapuatea. As a young boy he was schooled in the various arts of the priestly cult of Arioi,[18] therefore, he became a travelling entertainer and cultural expert and he wielded significant political power in Ra'iatea. But his most special training was as a star navigator. With his father he had voyaged around many islands, and had learned the wayfinding routes to many others, so he had a vast theoretical and practical knowledge of the Pacific islands.[19]

In 1757 his island was invaded by warriors from Borabora and Tupaia was seriously wounded but escaped into exile on Tahitinui taking with him the god idol Oro. There he became a main confidant of Amo of chiefly lineage, he embedded Oro as the primary God, and he became the lover of Amo's wife, Purea. Purea was of noble rank independent of her husband's power and was a statuesque and powerful woman. By virtue of his relationship with Purea, Tupaia became Tahiti's highest priest.[20]

When Wallis arrived in Tahiti in 1767, the Europeans mistook Purea for the queen of the island. Tupaia took advantage of this mistake and encouraged Purea to play the part, and he became the primary go-between and negotiator of contact. Tupaia was recognised for his considerable power and his genius, both by the islanders and by the Dolphin's crew.

By late 1768, the Paparan war saw Tutaha gain control of the island, and Tupaia saved himself by switching allegiance. However, by the time the Endeavour arrived his status on the island was considerably diminished, to the extent that he initially avoided being identified by these new visitors, ashamed of his lower status. He eventually cultivated a close relationship with Joseph Banks, and saw in this relationship a route to regain his mana. In the journals, Cook only makes very superficial reference to Tupia (Tupaia) who was brought on board to accompany the voyage beyond Tahiti:

> … we resolved to bring away one whose name is Tupia, a Chief and a Priest: This man had been with us the most part of the time we had been upon the Island which gave us an opportunity to know some thing of him: we found him to be a very intelligent person and to know more of the Geography of the Islands situated in these seas, their produce and the religion laws and customs of the inhabitants then any one we had met with and was the likeliest person to answer our purpose.[21]

When Cook left Tahiti, Tupaia[22] persuaded him to explore his home lands, so they visited Ra'iatea and Taputapuatea, where Tupaia only just saved Banks from a very serious cultural insult.[23] Tupaia advised Cook to voyage further west for more island 'discoveries' but Cook followed orders and sailed south for the non-existent Terra Australis.[24] It was while on board that Tupaia helped with a Polynesian vocabulary list and enumerated up to 130 islands,[25] many of which he portrayed on his famous chart.

Aotearoa contact

The first sighting of Aotearoa New Zealand by Cook and crew was on 7 October 1769; the cabin boy Nicholas Young spotted land which Cook later called Poverty Bay,[26] he then named the SW point of the bay Young Nick's Head. The first contact with Māori on the shore was volatile and with both sides well-armed and tensions high, warning musket shots soon turned fatal as one Māori was killed.[27]The following day another trip to the shore with the armed marines lined up, the curiosity of the Māori lead them to grab a sword from the landing party whereupon one was fatally shot and several more wounded.[28] Later a confrontation in the bay aboard boats and canoes "obliged us to fire upon them and unfortunatly either two or three were kill'd" when they didn't comply with Cook's orders for them to come alongside.[29] Cook tried to excuse such a brutal experience of these first encounters:

> I am aware that most humane men who have not experienced things of this nature will cencure my conduct in fireing upon the people in this boat nor do I

> my self think that the reason I had for seizing upon her will att all justify me, and had I thought that they would have made the least resistance I would not have come near them, but as they did I was not to stand still and suffer either my self or those with me to be knocked on the head.[30]

On further exploring this east coast (initially southward) further attempts at engagement with Māori and trade were difficult, and when Tupaia's boy servant was seized and carried away:

> … this obliged us to fire upon them which gave the Boy an opportunity to jump over board and we brought the ship too, lower'd a boat into the Water and took him up unhurt. Two or Three paid for this daring attempt with their lives and many more would have suffered had it [not] been for fear of killing the boy. This affair occation'd my giving this point of Land the name of Cape Kidnappers…[31]

Cook was clearly becoming concerned about the reception he would receive from the natives; he remained quick to resort to musket and cannon fire when he wished to scare the natives away. Māori did not understand that a weapon could do damage so remotely, and Cook was surprised that Māori failed to react to the threats of warning shots.

> Canoes came off to us full of people and kept for some time under our stern threatening of us all the while. … I thought these gentry would be as well out of the way, I order'd a musquet shott to be fired close to one of them, but this they took not the least notice of; a four pounder was then fired a little wide of them, at this they began to shake thier spears and Paddles at us, notwithstanding this they thought fit to retire.[32]

Later at Cooks Beach, where Cook was preparing to observe the transit of Mercury, when someone failed to hand over his trade goods in exchange for cloth he received, "Mr Gore fired a Musquet at them and from what I can learn kill'd the man who took the Cloth … I must own that it did not meet my approbation because I thought the punishment a little too severe for the Crime."[33]

This was such an inauspicious start to Cook's relationship with

Māori, it is a wonder that he recovered any authority at all. Cook was slow to learn that Tupaia could be an effective intermediary between Māori and Cook's crew, but Tupaia did became the cultural advisor and peacemaker - a role which probably saved many conflicts and lives. At Cooks Beach, where Cook spent ten days:

> we cut out upon one of the trees near the watering place, the Ships Name, date etc and after displaying the English Colours I took formal posession of the place in the name of His Majesty.[34]

After proceeding in an anticlockwise direction around the North Island, Cook came to shelter in what he named Ship Cove in Queen Charlotte Sound. Here he stayed for several weeks, trading for meat and vegetables and performed a similar claiming ceremony there.[35]

Proceeding from the Sounds (Thursday 8 February 1770), Cook sailed back up the east coast of the North Island as far as Cape Turnagain, to confirm the extent of the island, then sailed down the east coast of the South Island. He was offshore from Otago Peninsular on Sunday 25 February 1770 and named Cape Saunders and the standout feature Saddle Hill, without landing anywhere and observing little evidence of habitation other than some signs of smoke and fire.[36] He rounded south of Stewart Island, observed the entrance to Dusky Sound, continued up the west coast and returned to Queen Charlotte Sound on 27 February 1770, having now circumnavigated and charted the whole extent of both the North Island and South Island.

Cook would have felt his assignment (to determine a southern continent) was complete had he sailed back east in higher latitudes to Cape Horn, but was concerned that the Endeavour was not in a fit state to cope with such conditions in the Southern Ocean. He thus decided to head west,[37] sail and chart (again for the first time) the east coast of Australia (or New Holland as it was then known). After a grounding, damage and repair inside the Great Barrier Reef, the vessel proceeded to Batavia (modern day Jakarta) and relative civilisation again, although it was actually a disease infested town. During this voyage several of Cook's crew developed symptoms of scurvy as fruit and vegetables were scarce. When the Endeavour arrived in Batavia it was docked for repairs and the crew was only

too anxious to camp on land. Several crew members died from a combination of poor health from scurvy, dysentery and malaria. Tupaia and his assistant Taiata suffered terribly and died and were buried, missing the opportunity to find out what England was all about.[38] Cook remained very uncharitable about Tupaia's contribution to this voyage.[39] The voyage continued across the Indian Ocean, around Cape of Good Hope, north in the Atlantic and returned to the Thames estuary in Kent on 13 July 1771.

Tupaia's influence on Māori

Tupaia's mana amongst Māori was high compared to his on-board status. Initially, Māori were surprised to find a man dressed as a European who could speak and be understood in Te Reo, but they came to regard him as the leader of this expedition and sought him out for cultural information. They saw him as a great tohunga and ariki. At Uawa / Tolaga Bay, the iwi Te Aitanga-a-Hauiti lived in relative isolation. Sometime in the fifteenth century, their people and their tohunga had been decimated by tsunami[40] resulting in a significant loss of life and cultural knowledge, and they listened intently to Tupaia's stories of the mythical homeland Hawaiki and the origin marae, Taputapuātea.[41] This new knowledge was enthusiastically welcomed and lead to a cultural revival for this iwi. It also lead to an elevation of Tupaia's status. Not only was Tupaia considered the admiral of this strange visitation, but he was venerated because of his cultural and religious teaching and it was Tupaia who 'everyone clamoured for' and mourned for so deeply[42] when Cook returned without him on his second voyage.

Diplomacy and trade

The nature of the contact between the Polynesians and Cook and crew was obviously one of wariness and curiosity. Each were sounding out each other - trying to understand what each could supply and what they valued. Initially, Cook needed trade for fresh food - meat, fruit and vegetables. The Tahitians clearly valued the hatchets that were offered and also the cloth. But values and needs changed with further trade:

> People who but two years ago perfer'd a spike Nail to an Axe of any sort, have now so far learnt the use of them that they will not part with a pig of 10 or 12 pounds weight for anything under a Hatchet and even those of an inferior or small sort are in no great esteem with them … but Beeds particularly white cut glass Beeds are much Value'd by them.[43]

A similar situation prevailed when Cook arrived in Aotearoa New Zealand. Here Tupaia was a godsend (although still under-appreciated by Cook), negotiating trade deals and peace when he could, and pacifying the Māori to return to trade.[44]

Apart from the fact that Polynesian and European moral values differed, their economic values were very different and were contested. Furthermore, values changed rapidly as Māori learned the utility of some goods:

> … several of the natives came off to the Ship in their Canoes and began to traffic with us, our people giving them Georges Island Cloth for theirs, for they had little else to dispose of. This kind of exchange they seem'd very fond of and prefer'd the Cloth we had got at the Islands to English Cloth, but it fell in its value above 500 per cent before night.[45]

It is difficult to avoid the conclusion (although not explicitly acknowledged by Cook) that on the one hand, Māori were confused about the nature of the gift giving and trade of 'trinkets' and 'trifles', and on the other hand, Cook expected that the European goods would serve to pacify the natives and make them grateful for what was offered. For Cook's part, and from the perspective of the technologically advanced English, it was felt that Māori should unquestioningly welcome English goods, be grateful for the opportunity to develop technologically, and in return offer whatever food supplies they had.

Cook actively selected Māori of apparent high standing to be provided with presents – tools especially. He also offered such goods to others on the condition of receiving trade goods – food especially. When Māori coming aboard the Endeavour were exposed to the large stores of trade goods they reasonably expected that those goods

were there for the taking. This confusion lead to most of the serious altercations between the British crew and local Māori.

It was no inconsiderable task to feed up to 100 men and the demand on local resources (including timber for spar repairs and ship maintenance) was a heavy burden on Māori. Cook certainly became irritated when supplies were not made available. Similarly, in the process of collecting artefacts for scientific record, Cook seemed not to understand the value of cloaks, weapons, canoes and other property.[46]

Naming and Language

The naming of the coast of Aotearoa New Zealand was an important part of the claiming process Cook was engaged in. He made few attempts to determine any Māori names for the features he was observing. On the voyage from Tahiti, the Endeavour crew had worked with Tupaia to build up a Tahitian vocabulary, and Tupaia was being coached in English grammar. Cook recognised Tupaia's place-based knowledge of islands of the Pacific, but seemed not to seek out his assistance with Aotearoa names. However, having Tupaia with him for this first voyage around Aotearoa New Zealand gave Cook an entré into the Polynesian languages, so any transcription of Māori names onto paper would also have been second hand, mediated through Tupaia's Tahitian version of the language.

As this was the first exposure of Europeans to the Māori tongue, and no linguist was aboard and no coordinated study of the language was carried out, the sounds of the native speakers were heard in many different ways. Local dialects, individual speech mannerisms, different emphasis on syllables, different sounding consonants (and fewer consonants) all played a part in making transcribing difficult. As one authority has commented:

> The Europeans who came in contact with the Māori before 1814 wrote Māori words just as they seemed to sound to them. Usually, no other, but the individual who wrote the word, understood what it was all intended to represent. It is appropriate to insert here an extract from "John Rutherford, the White Chief"—Drummond, which puts the case rather pertinently: "The slightest

> examination of the vocabularies of barbarian tongues which have been collected by voyagers and travellers will convince everyone of the extremely imperfect manner in which the ear catches sounds to which it is unaccustomed, and of the mistakes to which this and other causes give rise in every attempt which is made to take down the words of a language from the native pronunciation, by a person who does not understand it."[47]

John Nicholas[48] comments thus on the Māori language:

> I observed when at New Zealand that the missionaries would not only differ from each other in the spelling of the same words, but likewise in the pronunciation of them; a circumstance which must always happen when a new language is to be learned with no other standard of instruction than the ear.[49]

Various attempts were made in the early years of settlement of Aotearoa New Zealand, particularly by the Church in their mission to deliver their Christian message to Māori, to develop a consistent written vocabulary and grammar. The Church Missionary Society sent Mr Kendall as a missionary and he set to work compiling a vocabulary.[50] Subsequently, in England, Rev. Samuel Lee, a professor of Oriental languages[51] was charged with standardising "the spelling, pronunciation and construction of the new language."[52] So it was not until 1820 that any formalised account of written Māori was produced.

When we read Cook's journals, we observe that Cook himself is far from consistent with his spelling and usage of English. He was not of the aristocratic class like Joseph Banks, he probably spoke in a rustic style and of course English has changed considerably in the last 250 years. Similarly Māori as it was spoken by different hapu was affected by different intonation and stress, and dialects varied across the islands - particularly obvious between Ngai Tahu and North Island iwi. All of these led to variations in what was heard and what was subsequently written down. As Hatfield observes:

> Speakers will find the closest match in their language that they can to the language being heard. Each language

> can be composed into a discrete set of sounds. English has 30-something phonemes. Te Reo will have less than 20, depending on how certain vowels count. … English has matches for most of these, so those will generally be expected to be perceived accurately. There are some items that English doesn't have or doesn't have in the same way. These will be the tap and the 'ng' sound. English actually has both of those sounds, but only in certain phonetic environments. Speakers have difficulty producing and perceiving sounds that do not occur at all or only occur in certain phonetic environments. The exact way people solve these problems can vary depending on acoustics and many other linguistic patterns.
>
> Te reo uses a lot more vowels per word than English. This is mostly because te reo only allows one consonant per syllable, while English can allow multiple. This could trigger some odd transcriptions. Finally, te reo has long and short vowels, and English doesn't in the same way, so that could cause problems.[53]

Cook and the Endeavour's first couple of weeks on the coast of Aotearoa New Zealand was marked by some acrimonious contact with local Māori, such that there were few constructive conversations, so few opportunities to engage in a way that provided names. Furthermore, many places were apparently unoccupied (especially in the South Island).

When Cook put in at the "Bay of Tegadoo" searching for water to recharge the casks, he was informed about a bay slightly south where water was easily accessible.[54] Cook records this bay as Tolaga Bay.[55] These appear to be the first Māori place names recorded. Tolaga Bay is still named such, and the Bay of Tegadoo may be what is now known as Tokomaru.[56] Further around the coast in the Bay of Plenty, Cook identifies the island Mowtohora (present day Moutohora).

From Queen Charlotte Sound, Cook observed the strait between the North and South (later named Cooks Strait) – that this land was two islands. They questioned an old man:

> who said that it consisted of two Wannuaes, that is two lands or Islands that might be circumnavigated in a few

> days, even four. This man spoke of three lands, the two above mentioned which he call'd Tovy-poenammu which signifies green Talk or stone such as they Make their tools on, oramints etc and for the third he pointed to the land on the East side of the Strait, this he said was a large land and that it would take up a great many moons to sail round it, or some thing to the same purpose - this he calld *Aeheino mouwe*[57] a name many others before had call'd it by, that part which borders on the strait he called Teirawhitte.[58]

The process of naming was a deliberate effort to imprint the land as British territory and overwrite Māori traditional knowledge.[59] Lords of the Admiralty and supporters of this expedition are well represented in the place names assigned by Cook. But many other names are trivial - Cape Turnagain and Poverty Bay are examples that highlight not just a lack of imagination but irrelevant references that are well past their use-by date. Recently Ngāi Tahu have created an atlas recording over 1000 place names in their rohe of Te Wai Pounamu[60] which demonstrates the cultural and historical wealth recorded in place names.

Other Customs

Cook and his crew were apparently fascinated by Cannibalism. They sought out evidence of this practice and reported it at length. They found examples of groups eating their dead enemies.[61] The irony of their own actions to this interference with the dead seemed to have escaped them. Banks keenly traded for the heads of dead enemies:

> Some of the Natives brought along side in one of their Canoes four of the heads of the men they had lately kill'd, both the Hairy scalps and skin of the faces were on: Mr Banks bought one of the four, but they would not part with any of the other on any account whatever, the one Mr Banks got had received a blow on the Temple that had broke the skull.[62]

Cook's crew were even more fascinated by sex. The open displays of nakedness and sexuality were a source of great interest for the British

sailors. Confined as they were in close quarters with limited food, water, toileting facilities, they must have been a miserable sight as they arrived in Tahiti and then New Zealand, although not without a certain amount of fascination from the local inhabitants they came across. The open displays of sex as offered in Tahiti were a little disconcerting for the more prudish British, but that rarely stopped these sailors and scientists taking advantage of every opportunity for sex. They found Māori women in Aotearoa New Zealand much more discrete and private and less obviously available, at least until friendly relations and trade was established.

On both these issues there were significant moral dilemmas that provided conflicting attitudes about civilisation and savagery and in many instances of many of the contacts between these different peoples, it was unclear who were the savages and who were the civilised people.

Why was Aotearoa New Zealand 'discovered' so late?

The Polynesians were a maritime people, well skilled in long ocean voyaging and with a long history of navigation. Principal amongst the navigators voyaging to New Zealand and back (perhaps in the 900s AD) was Kupe.[63] Navigation skills were passed on by a select class of priestly experts. The Polynesians regularly voyaged around the islands of the Pacific[64] and Tupaia, for example, could identify over 100 islands, many of which he had visited, but many more he knew of by his training. Navigation techniques and the wide range of wayfinding indicators is told elsewhere, but Polynesian knowledge included positions and relative movements of the stars, planets and the moon; detailed knowledge of sea-states - currents, swells, wave types and directions; and observation of winds, clouds, sea colour reflections and bird flights.[65] It seems as if they had not travelled as far west as to encounter Australia, which seems from our present view of the Pacific to be rather surprising. It is no surprise, however, that the millennia long occupation of Australia by the Aborigines did not produce further discoveries east into the Pacific. The Aborigines used very basic small canoes for inshore fishing but were otherwise very content to remain land based in their customs and lifestyles.

The Chinese have a long history of trade around south Asia and

possibly around the Pacific rim. There is however, little evidence of explorations around Polynesia or New Zealand, although some writers hint at some early contacts.[66]

The passages south of the continents of South America and Africa were well explored and known to Europeans by Cook's time. The Portuguese had a long history of exploration. Furthermore, the Dutch had a well-established colony at Batavia - current day Indonesia. It is interesting that there had been so few exploratory voyages into the greater Pacific. To some extent, political power was asserted by European nations by the length of their colonial reach and therefore their direct access to exotic resources for trade. It has been suggested that for the Portuguese and possibly the Dutch, the further reach into the Pacific was too much of a stretch - if they discovered new lands, how would they maintain their control over them? So even Tasman's 'discovery' of the west coast of New Zealand in 1642 failed to encourage further expeditions.

The scientific advancements[67] of the English enlightenment and developing industrial capability assisted British expansion and ultimately its dominance over the oceans. British colonial reach therefore had to leapfrog other European nations and the Pacific appeared to provide the greatest opportunity for expansion and global power. Cook's voyages were therefore well funded[68] and vital for British imperialism, and not coincidentally, for scientific advancement.

The British frigate Dolphin under the command of Samuel Wallis arrived in Tahiti in 1767, and in spite of some violent and lethal first contacts eventually settled on good relations mostly surrounding the trade of iron nails for sex. It was here where Tupaia was recognised as a powerful political figure as advisor to the Queen Purea. Wallis's mission was to explore for the great southern continent, but he did not proceed south and returned to Britain having failed in his mission, but with wonderful stories of the women of Tahiti. Wallis got credit for this 'discovery' which apparently rankled Cook who considered his achievements of only minor importance, having only mapped already known islands.[69]

The Legacy of Cook and Tupaia

Cook's story has been well told and he has been immortalised in statue, monument, literature, art, coins, stamps, and perhaps most significantly in the brilliant map of New Zealand that he produced from his meticulous surveying of the coastline. However he was also the forerunner of the colonial project around the Pacific. For most of the last 250 years his discovery story has been promulgated relatively unquestioningly. For the bi-centennial, replicas of the Endeavour were at the centre of celebrations, Cook was viewed as the hero of Empire, and surveyors were rightly celebrating his remarkable achievements.[70] In reviewing the full effects of colonialism with a more critical eye, we can now, on the one hand celebrate his surveying, navigational and seamanship skills, while expressing regret for the violence of the first encounters[71] and for the negative impact on indigenous cultures proceeding from this initial adventure by the British into the South Pacific.

Tupaia was granted only a minor part in the journals of Cook and Banks, but recent re-evaluations celebrate Pacific peoples' navigational prowess, traditional knowledge and more particularly the role that Tupaia played in negotiating early contacts and explaining Polynesian culture. His island chart is still being researched and interpreted,[72] but it is rapidly achieving iconic status alongside Cook's charts. It has recently been recognised that many of the watercolour illustrations of Tahitian life, ornamentation and customs are the work of Tupaia. Tupaia's status and his story are now widely told in biography, film, and art.

The power imbalance between industrialised Europeans and Māori who were in the early stages of agricultural production was exploited to the full. The trade in industrial world trifles (iron and cloth) with essential life support goods (meat and fruit) typified the first contacts between these peoples and was a forerunner of later trade: trivial amounts of money and goods for highly valued land. The advantage has always been with the Europeans. While Cook was not necessarily responsible for what followed, he set the scene for colonial exploitation. Little wonder the 250 anniversary now opens old wounds and remains contested.

Notes

[1] In 1642 Abel Tasman and Māori of Golden Bay had confronted each-other violently and sometimes lethally, but there was no landing, conversation or trade.

[2] See footnote 72.

[3] See for example Lala Rolls (director) 2017. Tupaia's Endeavour. 3 part television series. https://micheltuffery.co.nz/tupaias-endeavour/

[4] Edwards, P. (Ed) 2003. *James Cook. The Journals.* The First Voyage. Introduction at p 10.

[5] Further secret instructions revealed the additional purpose – to explore for a southern continent and "with the Consent of the Natives to take possession of Convenient Situations in the Country in the Name of the King of Great Britain."

[6] Edwards, 2003 at p 10.

[7] Journal entry Friday 26 August 1768.

[8] So a westerly direction passage.

[9] Daley, P. When Celebrating Captain Cook, let's remember the advice he ignored. *The Guardian*. July 23 2018.

[10] Ibid.

[11] The fullest version of these journals has been transcribed and published by Beaglehole, but condensed/abridged version is accessible as Edwards, P. (Ed). 2003. James Cook. The Journals. Penguin Books. London.

[12] For example a Tahitian managed to grab a musket from a shore base and was immediately shot dead - Journal entry Saturday 15 April 1769. Cook was also quick to confiscate canoes or kidnap individuals to be held as ransom for stolen goods - e.g. Journal entry Wednesday 14 June 1769, and Monday 10 July.

[13] And see below FN 27.

[14] "the Women were so very liberal with their favours, or else Nails, Shirts etc were temptations that they could not withstand …" Journal entry Tuesday 6 June 1769.

[15] Journal entry Sunday 14 May 1769.

[16] Cook's second voyage: Journal entry Thursday 3 June 1773.
[17] Druett, J. 2011. Tupaia. T*he Remarkable Story of Captain Cook's Polynesian Navigator.* Random House. Dame Anne Salmond had previously written extensively about Tupaia in Aphrodite's Island. The European Discovery of Tahiti. 2009, Penguin Books. The descriptions that follow are largely drawn from Druett's book.
[18] Druett describes "the pleasure-loving arioi cult."
[19] Druett. Chapter 1. In the Beginning.
[20] Druett. Chapter 1. In the Beginning.
[21] Journal entry Thursday 13 July 1769.
[22] with his protégé nephew Taiata accompanying him.
[23] See Druett Chapter 10. Return to Raiatea; "the whole party would have been slaughtered if they had not been under Tupaia's protection."
[24] Cook remained reluctant to credit Tupaia with special knowledge and skills. Druett (Chapter 11 Tupaia's Map) notes: "Considering that Cook and Tupaia were both master navigators within their own societies, James Cook should have felt comfortable with the idea of consulting with the noble, highly educated Polynesian, but it seems it was impossible for him to credit that a man who worked with a mental library could be the equal of a European who was armed with sextant, almanac and compass."
[25] See Druett quoting Cook's journal "he [Tupaia] at one time gave us an account of near 130 islands but in his chart he laid down only 74."
[26] "because it afforded us no one thing we wanted" Journal entry Wednesday 11 July 1769.
[27] Journal entry Monday 9 October 1769.
[28] Journal entry Monday 9 October 1769.
[29] Journal entry Tuesday 10 October 1769.
[30] Journal entry Tuesday 10 October 1769.
[31] Journal entry Sunday 15 July 1769.
[32] Journal entry Friday 13 October 1769. Similarly, on 4 November, "They dispers'd but not before we had fired a few Musquets and one great gun, not with any design to hurt any of them, but to shew them what sort of

Weapons we had that could revenge any insult they offer'd to us."

[33] Journal entry Thursday 9 November 1769.

[34] Journal entry Wednesday 15 November 1769.

[35] Journal entry Wednesday 31 January 1770.

[36] Journal entry Sunday 25 February 1770.

[37] Departing Aotearoa New Zealand on Sunday 1 April 1770.

[38] And significantly all Tupaia's customary knowledge of navigation and tikanga was lost with his death

[39] Journal entry Wednesday 26 December 1770 "He was a Shrewd Sensible, Ingenious Man, but proud and obstinate which often made his situation on board both disagreeable to himself and those about him, and tended much to promote the deceases which put a period to his life."

[40] For discussion about the effects these tsunamis had on Māori coastal communities see McFadgen, B. 2007. *Hostile Shores. Catastrophic Events in Prehistoric New Zealand and their Impact on Maori Coastal Communities.* Auckland University Press. Chapter 10 Waves of Destruction.

[41] See Druett "And here, Tupaia rewrote history. Later, he told Cook that the Maori people knew little of their ancient religion, or the traditions of Hawaiki."

[42] See Druett "Tupaia's name was apparently known throughout New Zealand, and was as familiar to those who had never seen him as to those who had listened to his stories."

[43] Journal entry Thursday 20 April 1769.

[44] For example, in the Bay of Islands when Cook felt threatened by the overwhelming numbers of wishing to approach his ship, fired upon them to scare them off, which would have put a stop to trade "if it had not been for Tupia who soon preavaild upon them to return to the Ship." Journal entry Thursday 30 November 1769.

[45] Journal entry Sunday 22 October 1769, and further Wednesday 15 "Neither the Inhabitants of this place or any other where we have been know the use of Iron, or set the least Value upon it, preferring the most trifleing thing we could give them to a nail or any sort of Iron tools."

[46] It is now believed that most of the valuable Māori artifacts delivered to the British Museum by Cook and Banks were probably gifts to Tupaia.
[47] Smyth, P. 1946. *Pronunciation and the Evolution of Written.* Whitcombe & Tombs. Christchurch. At p17-18. Accessed Jan 2019 at http://nzetc.victoria.ac.nz/tm/scholarly/tei-SmyMaor-t1-body1-d4.html
[48] John Liddiard Nicholas in his "Narrative of a voyage to New Zealand, Performed in the Years 1814-1815 in Company with the Rev. Samuel Marsden, Vol. II, published in 1817.
[49] As quoted in Smyth 1946;18-19.
[50] Smyth 1946;21-22. This vocabulary may have been strongly influenced by the Tahitian language as Kendall "derived considerable assistance from a copious collection of words in the Otaheitian language with which he was furnished by one of the missionaries."
[51] Some Māori individuals were sent to England to assist Lee's understanding of Te Reo Māori.
[52] Smyth 1946;24
[53] From email communication with Dr Hunter Hatfield, Department of English and Linguistics. University of Otago. January 2019.
[54] Journal entry Monday 23 October 1769.
[55] Journal entry Sunday 29 October 1769.
[56] This is my speculation but seems a reasonable likeness.
[57] Note; the chart produced from this expedition showed the North Island labelled Eahei no Mauwe which more accurately should be He Ahi No Maui (the Fire of Maui).
[58] Journal entry Wednesday 31 January 1770.
[59] In a brief reflection on renaming, Bridget Reweti, "Renaming Aotearoa New Zealand." https://www.bl.uk/the-voyages-of-captain-james-cook/articles/renaming-aotearoa-new-zealand comments "many of his names smothered the original ones, layering irrelevant meanings from a distant country onto a landscape already known and named. It is difficult to reconcile such a steadfast practice of disregarding Māori knowledge."
[60] See Kā Huru Manu www.kahurumanu.co.nz .

[61] Journal entry Wednesday 17 January 1770.

[62] Journal entry Saturday 20 January 1770.

[63] Te Matorohanga. 1913. The Discovery of New Zealand by Kupe. The Lore of the Whare-Wānanga Pt II Chapter III. Written out by H.T. Whatahoro, Translated by S. Percy Smith. *Journal of the Polynesian Society.* Vol 22 No 87;107-133.

[64] See Druett quoting Banks' journal "they make very long voyages, often remaining out from home several months, visiting in that time many different islands."

[65] Tupaia was an acknowledged expert in such indigenous Pacific navigation.

[66] See for example Gavin Menzies, 2002, *1421 The Year China Discovered the World.* Bantam. London.

[67] For example, Harrison's development of accurate timepieces.

[68] It seems not too much of a stretch of fact to compare the unlimited budget available to Cook (especially for his second voyage) and the Endeavour and Resolution, with the funding for NASA to land on the moon in the 1960s. Also of interest is that a Space Shuttle was named Endeavour (in commemoration of Cook's ship - including with the English spelling) in the 1990s.

[69] William Frame & Laura Walker. 2018. *James Cook. The Voyages.* McGill-Queen's University Press. Chicago at p102: "Cook had written to the Admiralty from Batavia that 'the discoveries made in this Voyage are not great' and explaining he had 'failed to discover the so much talk'd of southern continent (which perhaps do not exist)'."

[70] An article in the 1969 New Zealand Surveyor: Smith, W.J.L. "James Cook as Navigator and Mapmaker" discusses Cook's mathematical training (mostly self-taught) and his navigation and surveying skills.

[71] As the British High Commissioner, Laura Clarke, has recently done. See Graham-Mclay, C. 2019. UK expresses 'regret' over Māori killings after Cook's arrival in New Zealand. The Guardian. 2 October 2019. https://www.theguardian.com/world/2019/oct/02/britain-expresses-regret-over--

killings-after-captain-cooks-arrival-in-new-zealand.

[72] See for example: Anne Di Piazza & Erik Pearthree. 2007. A New Reading of Tupaia's Chart. Journal of The Polynesian Society. Vol 116 No3; 321-340; and Lars Eckstein & Anja Schwarz. 2019. The Making of Tupaia's Map: A Story of the Extent and Mastery of Polynesian Navigation, Competing Systems of Wayfinding on James Cook's Endeavour, and the Invention of an Ingenious Cartographic System. *The Journal of Pacific History*, 54:1, 1-95, DOI: 10.1080/00223344.2018.1512369.

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European and Polynesian Star Navigation - More than a Matter of Degree?

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INTRODUCTION

This paper compares and contrasts Polynesian navigation methods with European methods in the eighteenth century. It begins by reviewing navigation in Polynesia and the wider Pacific from three different perspectives: first, the methods used to gauge latitude and azimuth; second, the influence of precession - the apparent change in star positions caused by movement of the earth's pole; and third, ways of teaching, learning and memorising star data. The paper then speculates about whether the comparison could offer any insights for a different way of thinking about our environmental crisis today.

Background

On Captain Cook's first voyage (1768-1771) he took with him a pendulum clock, which he set up in a tent at Point Venus on Tahiti and used for his transit of Venus observations (Robson, 2004:32). But pendulum clocks cannot keep time at sea, and throughout that voyage, Cook determined his longitude by the method of lunar distances. Lunar distances were not a new idea, but a number of

requirements standing in the way of their effective use were only overcome in the eighteenth century. Star and moon coordinates, systematically collected since the first Greenwich observatory was set up in 1675, were first officially published in the Nautical Almanac in 1766, with data for 1767. The Octant was invented around 1730, and its successor, the sextant, in 1757 (Robson 2004: 205). Tobias Mayer's lunar tables were given to the British Government in 1755, and Nevil Maskelyne's handbook for lunar distances was published in 1763 (Robson, 2004:140). At the date of Cook's first voyage, circumstances had never been more propitious for determining positions astronomically.

However, a radically different method of longitude determination was already available when James Cook set sail for the Pacific, developed by John Harrison, a carpenter who devoted much of his life to making a series of marine chronometers. Harrison completed his H4 chronometer in 1761 and submitted it for the longitude prize offered by the British government,[1] and on Cook's second voyage (1772-1775), he took a copy of H4 made by Larcum Kendal, and three chronometers made by John Arnold, another watchmaker, to compare their results with longitudes determined by lunar distances (Robson 2004:139-140). By the end of that voyage, the chronometers were on trial no longer, Cook was "a committed champion" (Robson 2000: 103), and the method of lunar distances was already obsolete for anyone who could afford a chronometer and obtain one. There was still a long way to go to get to the Global Positioning System, but modern positioning was well on its way.

Clearly, Cook lived in a century when positioning at sea took enormous strides forward, and he could be forgiven if he felt superior when comparing his navigational science with the wayfinding methods he encountered in Polynesia. There, he would have found navigators who were masters in the use of near-horizon stars and the sun for azimuth determination, and of stars in other positions to provide a rough gauge of distance north or south of the equator,[2] but who could not determine longitude and who lacked instruments comparable with the astrolabe, quadrant and compass, and the writing and mathematical skills necessary for their use. Cook might

well have dismissed Polynesian methods as primitive, but one phenomenon must have intrigued and perplexed him, namely that Tupaia, his Ra'iātean navigator, could always point towards his home in Tahiti (Forster 1996: 309). For Cook, in an age where technology was radically changing the face of positioning, Tupaia's ability must have been as inexplicable as the direction instinct in migratory animals and birds (Gill et al. 2014). James Chapman and Thomas Baines in the next century would be similarly intrigued when they took "bearings of different places from the way the Khoisan people in Southern Africa point to them" and compared these with their calculated bearings, concluding that the Bushmen could "in general point very truly" (Baines 1864: 444, 456). We still do not have an adequate explanation for either today.

Aside from that quirky knack of Tupaia's, what was the basis of Polynesian navigation? Navigators would have relied heavily on simple dead reckoning (an estimation of position based on approximate distance travelled in a particular direction), though Cook could hardly fail to be impressed at how their dead reckoning was supplemented by an impressive working knowledge of currents, swells, cloud formations, winds, birds, and techniques for expanding landfalls, which are beyond the scope of this article (e.g., Evans 2011: 55-72; Lewis 1994). Stars and sun were vital to a navigator's art, because out of sight of recognisable land, if a vessel went faster or slower than reckoned, or was pushed further sideways than expected by a current, celestial latitudes gave the best chance for navigators to recalibrate their position, and heavenly bodies were also the best way of determining azimuth. Sir Joseph Banks said of the Tahitian use of stars:

> …these they know a very large part by their Names and the clever ones among them will tell in what part of the heavens they are to be seen in any month when they are above their horizon; they know also the time of their annual appearing and disapearing (sic) to a great nicety, far greater than would be easily beleivd (sic) by an Europæan astronomer (Beaglehole 1962: 368).

Polynesian Navigation Methods

This section reviews four methods of non-instrument latitude determination in the Pacific, followed by azimuth determination. A coarse measure of hand-spans and finger-breadths were used for determining the angle of stars and asterisms above the horizon as they crossed the observer's meridian (Low 2006: 191), and movement north or south of a known position was also determined by visually gauging zenith stars in the meridian, vertical star pairs (or pillars), and simultaneous rising or setting of star pairs, all of which are discussed further below. To enhance these approximate techniques, it is probable that Polynesian navigators used the same "work-arounds," that European navigators had always done, such as deliberately aiming too far upwind when returning home and then sailing a line of constant latitude (Finney 2006: 169; Lewis 1994: 286-87).[3]

Latitude by the Altitude of Stars in the Meridian

With suitable tables and instrumentation, it is a relatively simple matter to calculate latitude by measuring the zenith distance of a star in the meridian and adding or subtracting its declination. If a numerical value of declination is unavailable, and in the absence of an instrument capable of measuring angles at sea, the angle above the horizon can be gauged approximately by finger-breadths or extended fingers at arm's length, or by knotted string. Such methods are sufficiently precise for navigators to know roughly when they have reached a particular latitude, such as the one they started out from or have visited previously (Chauvin 2000: 106-7; Lewis 1994: 293; Low, 2006: 191). Even in the 20th century, Lewis was told by senior navigators of the Micronesian island of Satawal that the height of the Pole Star is still "judged by eye or by the span of the fingers loosely extended at arm's length", with one hand-span being the measure of one ey-ass, equal to about 15° (Lewis 1994: 277). In the Northern Hemisphere, Polaris (or alternative pole stars over the centuries as precession altered the position of the Earth's pole on the celestial sphere) has always been a convenient mark because it is always roughly in the meridian and its declination is always approximately 90°, meaning that its altitude above the horizon is a direct measure

of latitude. In the Southern Hemisphere, where there is no suitable pole star of sufficient magnitude, the angle of other stars crossing the observer's meridian is also a measure of latitude, for example, stars in the Southern Cross when its longer axis is roughly vertical (Thompson 2016: 2). However, the disadvantage of this is that stars will only cross the meridian twice in 24 hours, once at upper transit and once at lower transit. Having said that, some constellations lend themselves to use in different positions. For example, five positions of the Southern Cross were used: at rising, half-way to the meridian, at meridian crossing, half-way way to the horizon, and setting (Di Piazza 2010: 380).

Latitude by Zenith Stars

Zenith stars, which pass overhead of an observer, are a special case of stars in the meridian. In order to pass through the observer's zenith, these stars must have a declination equal to the observer's latitude. For example, today Sirius is a zenith star for Fiji, passing directly overhead of Vanua Levu once in 24 hours. In theory, zenith stars can be used as a rough yardstick of latitude by estimating whether they pass directly overhead or to the north or south. In other words, if voyagers know that a star passes over their home island, they have only to sail until the star is again overhead to know they are back on their starting latitude. Lewis writes that for latitudes south of the equator, where the Pole Star is not visible, the most significant means of fixing latitude was "by means of overhead or zenith stars" (Lewis 1994: 277). Zenith stars at their highest point could also provide a very rough initial bearing, but their principal use was to give latitude. (p279). In practice, Lewis found that by allowing for the rake of the mast it is possible to estimate closeness to the zenith within about a degree of latitude, and with practice this could be improved to about 30' where observations are made in good weather from a stable catamaran (p288). Although the usefulness of this method is confirmed by Finney (2006: 169), other navigators have expressed a preference for alternative methods described below.

Another facet to the use of zenith stars is the way in which Polynesian cosmogonies featured stories that linked bright stars, and also groups of stars, with important islands over which these pass.[4]

Kyselka (1987: 7-9) suggests that significant stars or asterisms may have inspired Pacific explorers to voyage in search of the islands that they were presumed to mark.

Latitude by the Verticality of Star Pillars

Star pillars were another means of determining latitude. The term "star pillars" has been used to describe both single stars and also pairs of stars comprising a near-horizon star and a star vertically above it. For the former use - as single stars - Teuira Henry quotes Rua-nui, "a clever old woman" (Henry 1928: 359), who referred to "great twinkling stars in the heavens" as pillars of the sky (361), and David Lewis (1994: 284) also appears to use the term "star pillar" synonymously with (single) zenith stars. In contrast, Lusby et al. (2009: 22-23) note that carved pillars were a feature of Tahitian architecture, and these authors explore the possibility of "star pillars" referring to pairs of stars, with one star representing the base of an upright pillar and the other its top. Vertical star pillars can be used as an indicator of latitude because they tip up according to how far north or south of their vertical position an observer is, either of which causes one or other of the celestial poles to climb in the sky (see Figs 1 and 2). An important rider is that the verticality of such pillars is influenced by precession as well as alterations in latitude. In other words, star pillars will be vertical at different latitudes in successive centuries on account of precession.

Latitude by Simultaneously Rising or Setting Stars

Latter-day non-instrument navigators such as Nainoa Thompson sometimes favour using pairs of simultaneously rising or setting stars (i.e. with similar altitudes) as a gauge for changes in latitude (Chauvin 2000: 111; Low 2006: 190-92). Star pillars and synchronous stars to the east and west of observers are illustrated in the following figures:

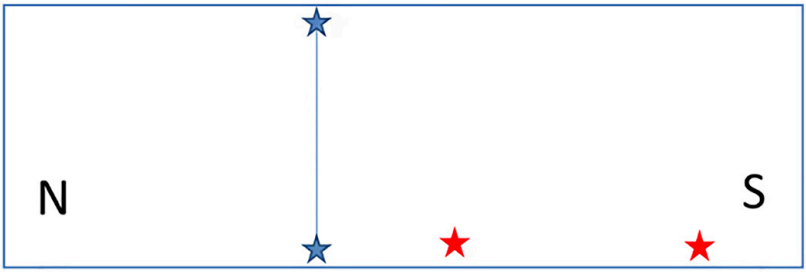

Figure 1: A vertical star pillar and a pair of near-horizon stars viewed to the east (rising).

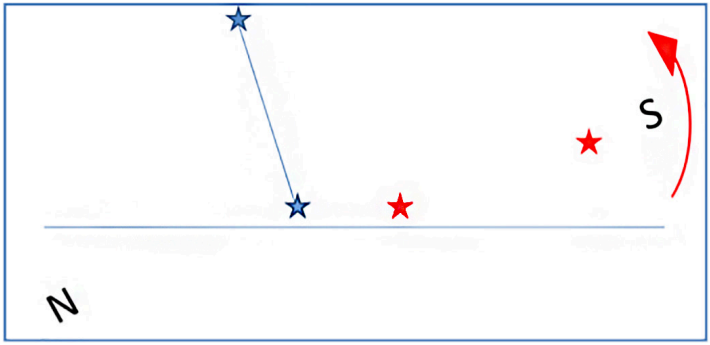

Figure 2: On moving south, the south celestial pole and star pillar will tip up in the sky, and one near-horizon star will rise before the other of the pair. The identical effect may be produced by precession.

Azimuth

And finally, azimuth. Voyages can be made without a knowledge of latitude and longitude; all that is needed is to know how many days of sailing in a certain direction from a particular starting point will get you there. Bearings of stars at low altitudes were the principal means of determining heading. Polynesian navigators used a series of stars spaced throughout the hours of darkness. Although stars rise about four minutes earlier each night, "the points on the horizon where they rise and set remain the same throughout the year" (Lewis 1994, 82). Stars at various angles to the course can be used (p96). For

near horizon stars, where the zenith distance (ZD) is approximately 90° (i.e. the angle measured from directly above the observer down to the star), and the Sin of ZD approximately equals 1, so that:

$$\text{Cos (AZ)} = \text{Sin } (\delta) / \text{ Cos } (\Phi)$$

Thus, changes in azimuth (AZ) are a function of changes in latitude **(Φ)** and of the declination of stars (δ, i.e. celestial latitude), with the effect on azimuth being greater for higher declinations and latitudes.

The Effect of Precession On Latitude and Azimuth Determination

The apparent position of stars alters over time by the action of precession, which is the movement of the earth's axis of spin relative to the stars over a period of about 25,800 years, like a spinning top (Ruggles 2015: 473-74). A precessional change that alters the verticality of a star pillar used in navigation by about 32' per century will change 1' (and therefore be visible to the human eye (Chapman 1983:135) within about three years, and so in a generation of 25 years it will change by eight times this. It therefore seems likely that Polynesian navigators would have been aware of the gradual changes in apparent star positions through precession, although trends would have been perceived far more approximately than the precise rendering of precession implicit in Nautical Almanac coordinates.

Precession manifests itself differently for stars in different parts of the sky. Right Ascension (i.e. celestial longitude) shows itself by changes in time, which would be unnoticeable without sophisticated time-keeping technology. In contrast, changes in declination are independent of time, and, depending on where stars are situated in the sky and which of the latitude methods described earlier are being used, these changes may be discernible to the human eye, which as we have seen is able to resolve angles of about one minute of arc. For instance, the effect of precession on declination can cause a zenith star that passes over an island at one epoch not to do so at another epoch, or it may alter the tilt of star pillars discernibly or affect the synchronicity of simultaneously rising star pairs. It is

possible to quantify how precession influences the latitude methods, for example, how much a navigator's latitude needs to change in order to make a star pillar vertical at a different epoch, or to make simultaneously rising stars again rise synchronously. The influence of precession ranges from 1' up to about 36' per century - i.e. about 2km to 70km in a century – with the sign depending on whether pillars are observed to the east or west (Goodwin 2017). It is possible to ascertain the influence of precession on simultaneously rising stars and stars in the observer's meridian, including zenith stars (Goodwin 2017).

For azimuth, precessional changes would be swamped by factors such as currents and shifts in the wind, but an interesting factor of which we should be aware (e.g. in archaeological work), is that while bird migration paths may have inspired voyages,[5] in practice stars would then have been used to sail a constant course. As Lewis writes, "The direction of the birds' flight would be perceived in star compass or analogous terms" (Lewis 1994: 215). In other words, even if following a bird migration path is cited as the means of orienting a voyage, stars are likely to have been used in the day-to-day navigation, and while migration paths would be independent of precession, the stars used as a bridging mechanism for navigation would alter over the years.

This may be most easily illustrated by an example. Consider a scenario where a bar-tailed godwit (Limosa lapponica) approaches the great navigation temple or marae of Taputapuātea on Raʻiātea (see Goodwin 2018) on a direct line from the Matariki constellation as it rises in the evening early in November, the time of Matariki in the east Pacific (Druett 2013, 198,199), during the late 13th century (a reasonable colonisation date of New Zealand according to Wilmshurst et al. 2008). Although the normal flight path for godwits is further west (Gill et al. 2014: 119), they have been observed even further east than the Society Islands (Gill 2015), and passing over Raʻiātea is plausible. If this godwit flew on to New Zealand, it would fly in the direction of the setting Maui's Fishhook (Chauvin 2000: 96), or in other words, towards the tail of Scorpio. If the assumption was made that the godwit was making for distant land, and a voyage was undertaken to find that land, keeping Māui's Fishhook ahead and the Matariki constellation dead astern, then the North

Island of New Zealand—Te Ika-a-Māui (Māui's Fish)—would have presented a forgivingly broad target. From a landfall at, say, Whakatāne, Māui's Fishhook would now pass directly overhead, Scorpio would form an elegant bridge connecting the North Island with Raʻiātea, and the Matariki constellation in the north-eastern sky would be approximately in line with Raʻiātea, something that might well be captured in oral tradition. However, although centuries later Raʻiātea would be in the same direction relative to standing stones or buildings or land marks, the bearing of Matariki would have altered due to the action of precession. To give an idea of the magnitudes involved, the azimuth of the Pleiades between AD 1300 to the present changes by a little under half a degree per century due to precession. Thus if a meeting house was built in Whakatāne in AD 1300, and was oriented towards Matariki (and so, Raʻiātea), and subsequent meeting houses were built on the same footprint up to the present - seven centuries later - then the azimuth to Raʻiātea should still be identical (other than for minute tectonic movements) but the azimuth to Matariki would have altered by about three degrees.

Teaching, Learning and Memorising Star Data

Polynesian methods relied on memorising copious star data, and this section reviews methods of teaching, learning and memorising star data. Especially at higher latitudes, where stars follow increasingly inclined trajectories, they are only useful in azimuth determination for a short time after rising (Evans 2011: 64) and then other stars need to take their place, meaning that the star compasses used throughout Polynesia relied on detailed knowledge of the movements of a great many stars (Evans 2011: 56; Finney 2006: 162; Di Piazza 2010: 377). In the absence of written records, star knowledge needed to be memorised, and Evans writes that it was common for boys to have to recite the names and positions of over 170 stars as a step on the way to becoming navigators (Evans 2011: 56).

Alkire, in his study of Woleai Atoll in the Caroline Islands, writes that the first step in navigational training is 'memorization of the "paths of the stars"...' (1970: 41). Instruction includes small stones representing stars being placed on the ground or on a mat, a practice presumably provided a mental picture to assist memory. Alkire finds

it "important to note that the stones are laid out in a rectangle rather than a circle", which is of possible significance in any discussion about whether standing stones on a rectangular marae might have been placed so as to line up with stars (see below). Star names are then memorised by way of a mnemonic with four sets of eight stars (p44). Next, an apprentice navigator learns to recite rising and setting stars, and then stars and their opposites, which "enables him to recall immediately the return course to set for any which is sailed" (p44). Thereafter, apprentices learn to recite islands associated with star courses (p45). Alkire says that "where a navigator has memorized 18 Island Charts he has memorized 270 separate items of information" (p47).

It is beyond the scope of this chapter to go into further detail, but Alkire writes of instruction on waves and swells; and the use of a bamboo pole "which aids the apprentice in committing data to memory" (p49); a kind of "Trigger-Fish Chart" (p51); and instruction in the etak system. One of the most succinct articulations of the etak system must be that of Neisser (1976:122):

> The etak principle is highly abstract. The reference island is never in sight, and the star positions under which it "moves" are rarely visible either. Most of the relevant information really comes from dead reckoning, seamarks, wave patterns, and birds, but the navigator refers it to the imaginary movement of a remote island under the unmarked rising positions of invisible stars. It is not surprising that Westerners have had great difficulty in understanding such a system.

Neisser notes that Westerners have sometimes reached the wrong conclusions about etak islands and "we have too often jumped to the conclusion that they are poorer thinkers than we are" (p122).

A variety of other memory aids and devices were and are used in teaching navigational lore, including a stone canoe (Lewis 1994: 34, 229); stick charts of swells (Lewis: 245 - 249); and passed-down chants (Lewis: 281; Henry 1907, 1928). Although speculative, the possibility has to be considered of whether standing stones on maraes in the Pacific could have been lined up with voyage destinations, or

placed to commemorate significant voyages, or could have formed an analogue "star compass" of directions where significant navigational stars rise and set (Goodwin 2018). For the last possibility, stones could have formed a graphical layout of stars when they are close to the horizon, which could occur at different times of day or night and spread throughout the year, or else stones could have lined up with important stars at a significant epoch of the year, for example, at a particular time on the day of an important festival. In this kind of "freeze-frame" or "snapshot" scenario, stars could be at differing altitudes (i.e. angles above the horizon), not necessarily rising or setting (Goodwin 2018). There is a surprising lack of archaeoastronomical research in Polynesia (Kirch 2004: 102; Esteban 2002: 31), and there is a case for more surveys to establish relative positions of standing stones on maraes in the Pacific, and the testing of stones for possible significance in their placing. It is also important to gather oral history about the placing of standing stones, before it is lost, with one object being so that possibilities suggested through analysing azimuths can be independently verified. The concluding section then looks at advantages of Pacific navigation methods and discusses whether any lessons emerge from the comparison that could inform our thinking today.

Discussion and Concluding Thoughts

To conclude, the wayfinding methods Cook found when he arrived in the Pacific differed in two important respects from his own. First, methods were more holistic. Navigators needed to be sensitive to everything from ocean swells against the side of a canoe, to the smell of different winds, to alterations in water colour, to birds and their habits. Because navigators accepted that their methods were approximate, and that star paths changed gradually over time, they knew that they had to be constantly watchful for quite subtle signs from a variety of sources.

Second, although not considered earlier under the description of Pacific navigation, it is relevant to note that Tupaia came from a socially-based land tenure system where rights to land and resources are only as secure as the network of relationships between people. Thus, he would have been attuned to the importance of building

relationships with people whom the expedition encountered, and he would have been ultra-sensitive to names and beliefs and hierarchies. We know, for example, that he was horrified when Banks put his hand into a thatched god-house at Opoa and pulled out a sacred object, which he proceeded to unwrap (Druett 2013, 249). For Tupaia, constantly on the lookout for points of connection with Māori and other islanders, human ties would have been in the same category as wayfinding and of comparable importance, because he came from a society where if you do not respect and nurture people connections then you may as well be dead (Goodwin 2011). "Umuntu, ngumuntu, ngabantu," is a Southern African expression from a comparable socially-based tenure system: "a person is a person because of other people", and in New Zealand the same idea might be couched as an answer to the question of what is most important in life: "He tangata, he tangata, he tangata"; "The people, the people, the people." It is suggested that Cook, despite using more accurate methods, and possessing tables that took precession into account, tended to put human relationships and responsibilities to others into a separate category from wayfinding, and Salmond shows how, despite Cook's navigational skills continuing to be outstanding, he "became increasingly cynical, and prone to violent outbursts of anger" (Salmond 2004, 91, 92).

Could the radically different nature of Polynesian wayfinding offer any insights for a different way of thinking about our environmental crisis today? Einstein argued that problems cannot be solved using the same thinking which created them, and we certainly need to be on the lookout for fresh thought paradigms. To this end, three observations are offered by way of a conclusion, all of them speculative. First, it is probably fair to say that western thinking has tended to put human factors in a different silo from scientific knowledge, far more than Tupaia would have been accustomed to. This has probably been a mistake, and we would do well to strive for a better balance, because human issues such as egotism and greed and apathy have to be at least as important as science in the future of our planet. Indeed, sometimes we may look aghast at the apparent indifference to the environmental crisis of our leaders, and cry (along with Philip Larkin): "it's strange: Why aren't they screaming?". However, short-term thinking seems axiomatic to democracy, with its

finite terms of office and economic bias for decision-making, and it is by no means trivial to break away from such thinking.

Second, in formal western tenure we have also largely separated rights from responsibilities, in that land rights are generally not compromised by being a bad neighbour. For Tupaia, the right to use land stemmed from being part of a viable group of people, and if responsibilities to neighbours were not met, use rights would be threatened. Somehow we need to rebuild a culture where responsibilities are viewed as at least as important as rights.

And third, it could be argued that sophisticated technology has given us an illusion of security and supremacy. We have taken a step away from a survival mentality and as a result have become more vulnerable. What may reproach us and remind that we do not have all the answers, and prod us to continue searching, is conundrums such as Tupaia's ability to point towards home. We are more likely to survive globally if we proceed with open minds and with humility; with a recognition that we are now in survival mode, and the whole of humankind is now our tribe.

Notes

[1] Huge prizes were offered by several Governments for a method of finding longitude at sea - a prize of £20,000 by the British Parliament for an accuracy of only about 50km (Robson:2004:60). John Harrison's H4 met and far exceeded the requirements for winning, and he collected the last of his prize money at the age of eighty, though he only lived three years to enjoy it.

[2] Numerical values for latitude were not determined, but it seems very likely that Polynesian navigators were highly tuned to how star paths looked from their home islands, and how these changed when sailing north or south. For example, Elston Best quotes sailing directions from Hawaii to Tahiti as follows: "you will lose sight of Hokupaa (North Star), and then Newe (Southern Cross) will be the southern guiding-star, and the constellation of Humu will stand as a guide above you" (1922:32). These directions demonstrate an appreciation that when moving in the direction of the Pole Star or the Southern Cross they go up or down in the sky and a different set of stars was visible.

[3] Although Akerblom points out that there is no proof that the Polynesians navigated by latitude sailing (1968:47), (i.e keeping a constant latitude), it would be unlikely that Polynesian navigators were unaware of the different effect on star paths of sailing N/S or E/W (see also Endnote 2).

[4] Star groups may comprise either official constellations recognised in European tradition or else asterisms, with the latter being stars comprising a subset of constellations or sometimes stars from more than one constellation that have been grouped by different societies.

[5] For example, David Lewis was told in 1966 of a tradition in the Solomon Islands of islanders deducing the presence of a previously unknown island by the behaviour of birds, and following their flight path to discover and settle that land (Lewis 1994:215).

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Knowing your Place- Indigeneous Knowledge and Spatial Mapping

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INTRODUCTION

In Aotearoa New Zealand there are two languages that have been used to name and give meaning to landscape –te reo Māori and English. Both talk to how people know themselves to belong to places and occupy the spaces within them. Often belonging is achieved through place names, whether on official maps and signs or within oral traditions passed on inter-generationally and confirmed through consistent activities in the named places. This article will focus on how place names confirm this aspect of linking people with places and the spaces within them. Place names are key to understanding spaces within the environment as "a place begins to exist when people give it a name and a meaning, thus differentiating it from the larger, undifferentiated space" (Boillat et al. 2013, p. 664). Helander suggests that the theory of structuration can be applied to spatial aspects because "structuration means conditions governing the re/production of social systems" and as such, links locality to social and cultural structures like place names (Helander 1999, p.8). She goes on to suggest that locality is a space for action, and people can orient themselves in a spatial world via symbols, the most multi-dimensional symbol being place names.

Firstly, I will address what makes place names important markers within the landscape (in a general sense) within Aotearoa New Zealand. Notions of spaces as places for action are informed through a cultural or social system. Place names are one symbol of the cultural and social system that indicate people have used the places over a long period of time. I will discuss the importance of place naming in locating cultural and social systems and processes through landscape symbols such as place names.

Secondly, I will discuss maps as ways of imagining landscapes, and then explore what makes spaces Māori spaces. The discussion will engage with oral traditions (stories, songs, sayings) that explain the origins of place names and how these provide a rich mosaic of understanding land and land use (Carter 2004a). We map and record places but the best way to recognise our spaces within places is through the stories and subjectively-determined understandings of belonging. The way we interpret our associations with landscape has implications for how we go about planning, designing and surveying urban and semi-urban spaces. Māori in particular have their own ways of constructing habitable spaces around Māori cultural values, beliefs and social systems. It will be necessary to incorporate these into planning when understanding how to shape future spaces and land use in our increasingly shared places.

Thirdly, I will use an important named landmark as an example of how different perspectives and discourses can challenge people's access, use and connections to landscapes in Aotearoa New Zealand. This year marks the 250 years commemoration of James Cook's visit, so it is appropriate to also discuss the place that most reminds Maori and other New Zealanders of his presence on our landscape. The way that Cook started the reinterpretation of the maps and landscapes will be discussed through the stories surrounding our tallest mountain, Aoraki/Mt Cook.

Knowing Land

Indigenous people talk about a place in ways that are relevant to how they best understand their particular connection and histories,

which Helander claims comes from "terminology connected to the long-term success…" of customary activities on the land (Riseth et al. 2011, p. 203). She further insists that notions of space and place are not fixed in temporal and spatial terms, and that symbols such as place names open up means "to imagine, make available and explain far-away places, people, and animals" without being physically located in the named place (Helander 1999, p. 10; Carter 2004a). Names help a person to decide the importance or use of the named place, and "tell us that the places have been intensively used over a long time period" (Helander 1999, p. 10). Place names and the accompanying knowledge allow us to imagine and remember places. This enables a circular time-space flow that develops through a lived experience of the world and creates an understanding of the world around us.

Henshaw in her work on Inuit toponyms, discusses how place names are "rich with visual imagery and metaphorical references that illuminate Inuit understandings of the surrounding world. All names indicate 'where things happen' and by association things that have occurred over generations" (Henshaw 2006, p. 59). Names recall the places; the places recall the reasons for the naming—resource area, battles, settlements, meeting places, famous ancestors and so forth. The relationships between the landscape and the names are recalled through speech that demonstrates how people recognise they belong to a named place. The way places are talked about may change and take on new meanings as "successive generations traverse the land" (Henshaw 2006, p. 59). Henshaw notes that places are also multi-sensory and "bring to light the unique way [Inuit] experience a place" and "make reference to other senses including smell, touch and sound" (Henshaw 2006, p. 57). For example, "Miaggujuqtalik, an island where you can hear something howling; Tatsiumajuq, a place where you feel your surroundings through touch" (Henshaw 2006, p. 57). This multi-sensory nature of place names opens up the landscape to a fuller connection with and within places and occupied spaces. It allows indigenous peoples to experience landscapes that are alive and very much part of them through the relationships with other elements of the ecosystems that make up the places. It is also

intergenerational and the speech surrounding places and landscapes develops, swings and flows from one experience to another.

Through changes in experiences with places, place names can also indicate social, environmental, economic and cultural changes over time. In the case of the Waikōuaiti river near my marae (tribal community space) at Karitane, the stories surrounding the name trace history, traditions, engagement, and the importance of intergenerational practices and knowledge between Kāti Huirapa (hapū; tribal group) and the local environment, Kāti Huirapa and the resources, and the resources and the environment. We can recall the conditions of the river (Waikōuaiti) and the way it smells, feels and looks as the seasons change. We know when something is wrong through the way it smells and flows, just as we know when the appearance indicates the start of the whitebait season, or the mullet start to run. All these ways of knowing the river are transmitted through intergenerational knowledge and form part of our relationship with the river.

Place names are key indicators of human presence on the landscape (Carter 2004a), because they anchor people's associations and claims to a landscape. Helander notes that "one linguistic category that reflects geographical and environmental knowledge is place names" (Helander 1999, p. 10). Once we are anchored in a place, the name then takes a back seat to further activities within the place itself – until we want to vocalise our association with it. Place names are abstract in nature, meaning the reasons for naming are not always apparent. People talk about a place in ways that are relevant to how they best understand their particular connection and histories. Often these descriptions define different arrivals and departures, and associated layers of speech provide a rich mosaic of understandings and ultimately land and resource-use changes over time (Carter 2004a).

Landscape Mapping

As constructed landscapes, maps are the map maker's way of knowing and thus they contain the maker's language. For the sake

of this article I am going to pursue the idea that likens place names to maps in that they construct landscape and, as such, provide a way of unlocking how Māori understand and know their places. Maps, like place names, are historic and contemporary, provide histories, perceptions and purpose for claiming the landscapes they imagine. As Giselle Byrnes noted, "landscapes are perspectives of land—subjective views of land—as well as existing codes and constructed texts" (Byrnes 2001, p. 11). In other words, landscapes are "cultural constructions" where perspective allows people to "mentally or geographically orient themselves" (Byrnes 2001, p.11). It is for this reason that place names, like maps, represent Māori landscapes and will be discussed in this article to better inform and orient non-Māori readers to the way that Māori perceive and construct their landscapes. Place names act as whai take (reference markers) for the wider resource catchment areas. The names themselves orient, rather than pin point, people to specific areas of importance. Within the wider areas are further place names that help to locate specific resources and/or land-use. Names of prominent landmarks (such as rivers, mountains, lakes) allow people to use names "like a map in the mind" and in ways that "make history in a sense of carrying underlying narratives associating people with places" (McRae 2017, p. 74). Names then are geospatial tools for locating and informing about landscape.

Geospatial tools build multidimensional layers across the mapped landscape so we can build knowledge frameworks that intersect, and give layered structure to how we understand our place. Geospatial tools build the histories; associate these with the living; and assist with planning for the future to ensure that the landscape can link us at all times and in all contexts. The landscape then can help with planning for the future through utilising the layers of information and data contained within the tools. For example, the tools allow data about environmental change and challenges over time; spatial movements and occupation; contemporary uses and specific land use areas. Maps then are "a social construction of the world expressed through the medium of cartography" (Harley 2001a, p. 35) that describes the world according to the map maker. They are

therefore the product of both individual minds and wider cultural values in particular societies, and subject to bibliographical control, interpretation, and historical analysis (Harley 2001a, p. 35).

In Aotearoa New Zealand and across the indigenous world, Māori felt the intrusion of mapping that hid their landscapes, places, spaces and names under a blanket of 'otherness'. Mapping relegated indigenous landscapes to "hidden landscapes" (Harley 2001b, p. 171) and was a way of subjugating knowledge, use claims and presence on landscapes that were desired for imperialist economic growth and dominance. One way to facilitate the assimilation of a people's culture is to change the way a country is perceived, valued and utilised. In terms of relations of power, cultural practices, preferences, and priorities, maps have it all. Indigenous people were excluded from mapped landscapes but as Harley points out, ironically it was [indigenous] people's associations with early surveyors and explorers that enabled vast interior places to be mapped and explored: "what would America have looked like without the Indians?" (cited in Harley 2001b, p. 171). Harley ponders on how the maps may have turned out if the English and other early explorers to America had arrived in an empty land. He suggests that the mapping experiences of early explorers and indigenous peoples as a reciprocal arrangement has only been recently recognised, and that indigenous peoples were "prolific cartographers"—something the early explorers themselves recognised and used to advantage (Harley 2001b, p. 171). He noted: "during much of the French and English exploration of the coast of North America, the presence of Indian guides - who sometimes made maps - was a matter of routine" (Harley 2001b, p. 171). The resultant maps though were drawn in ways that Europeans perceived the world they were shown, despite having entered into another world entirely as depicted through indigenous beliefs, values and practices.

The remapping of indigenous spaces was not confined to America. Indigenous people here in Aotearoa New Zealand also acted as guides and map makers to explain the interior lands, resources and settlement patterns. Stories of early surveyors and explorers often name the informants used to access previously unknown areas across both North and South Islands. Some Māori guides drew maps of

specific areas of importance to them. At this point the languages that spoke about the land were both Māori and English. The combinations of language and understanding landscapes were later realigned to open up the lands for settlement, economic exploitation of resources, and mono-cultural governance and management. What this process did was to carve a set of pathways across landscapes that became European landscapes in name, use and appearance—socially and economically. The language that spoke about the land became English and with it, the English ways of knowing, naming and explaining—Aotearoa and Te Waipounamu became New Zealand.

The use of either Māori or English language in place naming signifies the two distinct cultural origins and differing stories of how New Zealanders know themselves to occupy their place. That occupation is manifest in the stories that reveal origins of the names. In Aotearoa New Zealand the stories conflict and merge depending on which community is speaking. It is evident then that placing a name on the landscape shapes the discourse surrounding the landscape. The values, beliefs and knowledge that underpin each community's awareness of their place within the landscape are the starting points for this understanding. Often though, these differ between communities, and this is evident when conflicts arise as groups vie for dominance. Parallel lenses that view the same landscapes will always be in conflict because of the perceptions and perceived values that are associated with names. Naming then is claiming—the landscape, the history, the occupation and the future shaping of the named places—thus politicising the landscape (Carter 2004a).

In 1769 James Cook arrived to carry out scientific observations of the transit of Mercury. Cook renamed the Coromandel location where this occurred and the name, Mercury Bay, still remains today. Cook made two visits to Aotearoa New Zealand and following his second voyage his recordings of the economic value here (timber, seals, whales) led to the arrival of the sealers and whalers. Cook (re) named the coastline as he sailed around it and many of these names remain today—Queen Charlotte Sound, Young Nick's Head, Cape Kidnappers, Alderman Islands, Doubtful Sound, Milford Sound

and so on. European settlers bestowed Cook's name on our tallest mountain—previously known as the Kāi Tahu ancestor, Aoraki - to commemorate Cook's explorations.

Aoraki is key to understanding the origin of the South Island and the Kāi Tahu connections to it. The original name for the South Island was Te Waka o Aoraki, and the story surrounding the name explains how Aoraki and his brothers came into this realm.

When Aoraki and his brothers were returning to their own realm a mistake occurred in the karakia (prayer, chant) for the homeward journey, and the great waka crashed onto an undersea reef. Aoraki and his brothers climbed to the high side of the waka and waited in vain to be rescued. When no rescue came, the waka and the brothers became part of the reef: Aoraki sitting the highest in the waka became the highest point of the land. His brothers became ridges and mountains surrounding him. The story goes on to explain how Tūterakiwhānoa arrived, and when he saw what had happened, his many tears created the waterfalls and rivers that flow down the mountains, across the land and to the sea. Tūterakiwhānoa is credited with shaping the land to make it habitable for coming generations including the contemporary Kāi Tahu who live here today. Following the European renaming to commemorate Captain James Cook, Aoraki became Mt Cook and his brothers Rararakinui, Rakiroa, and Rakinui were named Mt Tasman, Summit Rocks, East Ridge, Linda Shelf and so on.

For Kāi Tahu, Aoraki is the supreme ancestor and is revered. For European settlers and adventurers, the mountain became something to conquer. It was considered a challenge to be the first to stand on the summit and claim victory and dominance over the mountain. The first to attempt the ascent was the Rev. William Green, and newspapers of the day quipped "most cooks do greens, but this green's done cook' (Grzelewski 1996, p. 68). Following Green's unsuccessful attempt, a siege-like mentality set in against the mountain between 1886 and 1894. When it was announced in 1894 that the Swiss guide Mattias Zurbriggen was coming to New Zealand to attempt the climb, climbing Mt Cook became 'a matter of national pride' to be carried out by a local man (Grzelewski

1996, p. 71). Graeme Dingle said that conquering of Cook became 'an evolutionary necessity, something to keep us on our toes, fit to deal with unforeseen challenges to our survival as a species' (cited in Grzelewski 1996, p. 82). Thus, when Aoraki became Cook, the mountain became a Pākehā rite of passage for proving endurance and stamina against all odds. The discourses surrounding Cook completely subsumed the whakapapa stories from Kāi Tahu (Waymouth 1998). This was a pattern to be repeated across Aotearoa as British settlement progressed.

British settlers transformed landscapes once resplendent with Māori ancestors' deeds, battles, loves and adventures; resplendent with Māori environmental knowledge and lifeways; into the green and pleasant lands of Great Britain. The landscape was recloaked with other stories, other exploits and other histories and the values which underpinned the land use also changed. The English names became symbolic of the other people's history and connections as they recreated their homeland, oblivious to the ways by which places were already known.

The process of re-imaging brought about re-membering and re-positioning through discourse that spilled over into the political, economic and cultural domination of Māori tribal groups. Māori tribes struggled to continue utilising the landscape through the many relationships they had with it. They were locked out from tribal lands, forests, rivers and lakes—wetlands were drained for agriculture, and forests were milled for timber to export and for the building boom to house settlers. Forests were also burnt off for pastureland and introduced species (flora and fauna) were transplanted from 'Home' to make the landscapes resemble the familiar landscapes back in England. Avril Bell links the notion of transplanting another culture to imposing inherent characteristics of the original home environment and in turn bringing transplanted values, ideologies and understandings of other landscapes (political, physical and social) (Bell 2002, p. 1). Bell states that the word 'culture' originated from 'cultivation' and she links non-Māori identity formation in New Zealand to ideas such as 'roots firmly planted' in a new land, and indeed in 1865 Hochstetter linked the inevitable extinction of Māori

to the analogy of introduced species subduing native grasses (quoted in Bell, 2002). The changing landscape echoed the sentiments that assimilation of landscape would change the way spaces and places were occupied, utilised and thought of. As a footnote to the story about Mt Cook: following the Ngāi Tahu Claims Settlement Act, 1998, the name Aoraki was once again recognised, and is now acknowledged as both ancestor for Kāi Tahu and as part of New Zealand's national identity. The mountain now officially carries a dual-name, Aoraki/Mt Cook.

The switch from Māori language to English language in naming the land proved to be invasive and colonising. However, Māori place names persisted and this allowed a continuance of cultural and socially constructed ways of remembering places that had intergenerational significance.

Māori maps and landscape perceptions

Prior to European arrivals, Aotearoa and Te Waipounamu were criss-crossed with whakapapa. This concept of genealogy applies not only to humans but to everything that is in the Māori world—it underpins a Māori world view. Thus geographic symbols such as mountains or wetlands are a recognisable position within wider catchment areas that may be important for a variety of reasons. The following words explain this reasoning:

> The place recalls the name
> The name recalls the whakapapa
> The whakapapa recalls the things past and the things present
> The things past and the things present give pride and identity (Carter 2004b, p. 70)

The whai take (reference points) are explained through stories, songs and whakataukī (tribal sayings) that link the whakapapa together, thus providing a mesh of relationships across the landscape. Each feature (be it mountain, river, wetland or settlement) plays a part in engaging with various ecosystems that make up particular environments in social, cultural, environmental and economic

contexts. The rules for engaging with these relationships are developed in past histories, knowledge and practices with ancestors. Everything in a Māori world view can be linked to an ancestor, or is one. This means that everything is related and can be explained through such thinking. Therefore a holistic understanding of relationships needs to be understood in order to engage with the way that Māori understand their places and their spaces within those relationships. Māori see themselves as tangata whenua (people from the land), with their origins coming from early ancestral deeds that shaped the first human, formed from the soils of Papatūānuku (the earth parent). The relationships that Papatūānuku had with firstly Takaroa (the ancestor of oceans and waterways), and then Rakinui (the sky parent), and her children Tāne (forests and birds), Tāwhirimātea (weather and climate), Rongo (peace and cultivated foods), Haumia (uncultivated foods), Tūmatauenga (war-like nature of humans), and Rūaumoko (earthquakes), gave humans the world and resources for establishing life ways. All of this is informed through ways to practice the relationships (tikaka or the rules for engagement) and the ways to sustain them in mutually beneficial ways such as kāitiakitaka (guardianship), whanaukataka (care and responsibility), tino rakatirataka (governance and management), and spiritual concepts such as mauri (life force), tapu (restrictions to access) and noa (opening access). All of these relationships are interconnected through whakapapa and it is the tikaka (rules for engagement) that set up the ways we conduct ourselves. The relationships are developed and practiced according to connections to specific places and spaces within them. For example, as stated earlier, my marae is at Karitane (to the north of Dunedin) and my hapū is Kāti Huirapa. All my ancestral connections are part of this place. When I and other whānau walk the land there, we are walking in the footsteps of ancestors linking us to our past ancestors. As these ancestors still exist (for example Takaroa: the oceans, rivers, estuaries and Papatūanuku: the land itself), they continue to be part of our present. We are not only part of a long-ago time but also still very much part of this one. Therefore, the lessons those ancestors gave to us still shape our present day relationships and activities.

All the lessons passed down over generations of ancestors are part of how we know ourselves to belong in this place Karitane (the place

recalls the name, recalls the whakapapa). The past therefore is the present and provides knowledge for growth into the future: titiro whakamuri, kōkiri whakamua—look back and reflect in order to guide your journey ahead. One group of place names that construct a map of the East Otago coastline are a case in point.

Te Tapiri. Past Moeraki Point There is a story about this point.
Tokaatara. A reef outside Moeraki
Otawheroko. A little bend where the cemetery is.
Aramoa. The peak where Mamaru used to live (another form of that name near Port Underwood ?)
Poutaiki. Where Charlie Harding lived at Moeraki.
Te Koerepatiki. Point coming towards Potiki south of Kaik [kainga].
Tokiamaru. Reef outside
Putakerua. Another reef; his wife.
Hau kiekie. little inland point this side of Flagstaff near Port Moeraki.
Whatiwhatipoika. A stone just off the light house.
Kaiteihi. That is where they had a battle on the top of the hill (note as the battle was in later times it not supported that "they" means these people).[154]
Pakihiwitahi. One Horse Range.
Puketapu. near Palmerston. was a slave - mokai.
Rua Papaku. Mount Royal.
Katawaiaki, a Hei kura. Two peaks at Douglas.
Te Wai o te Ao. Near Waikouaiti
Ka iwi o te Weka. Creek and hill near Waikouaiti.
Okauia. Bluff and creek by Hecklers?
Ohikororoa. Mt Walker
Ohiwiamio. Jones' Head.
Pakatata. point at mouth of Waikouaiti.
Te Wai Paepae. The other side of Ab ? River. Long Bush.
Ōtewhata. Mt Royal B ?
Te Umurua = Point. Bobby's Head.
Ohine Maru. Busby Park?
Kotahuanini. That is the stone area for grinding greenstone. A sort of hollow you pass by the train on the Horse Range. This side nearly opposite Mt Read/Peal ?
Te Wai tu a papa. The bend this side of Shag point Railway Station. i.e. The Shag Point track out to the Point. That is the sail of Araiteuru.
Pakateaio. The ? for the rudder i.e. the stern post. Right out at the very point, At side facing the Shag river.
Kawataurua. Up country near Aoeaupi. The Araiteuru (island?) at Port Chalmers also so called is "only a name" i.e. it is not the original name.
Te Kohai. At mouth of Pukaki.
KuraMatakitaki. At mouth of ? A hill.
Otumaihi. At Tumai.
Kaiwaka. A rock south side of Pleasant river. wife of Tumaihi
Rakiteoraora. A white stone - a pumice rock at the back of Harpers at Puketeraki.
Maraitewheta. The other white pinnacle.
Omakau. Pratts Beach
Te ruakarehu. Back swamp near George Harpers, Karitane.
(last two, children of Tuterakioraora)
Orereto. Beach beyond Mt Kenzies. ?

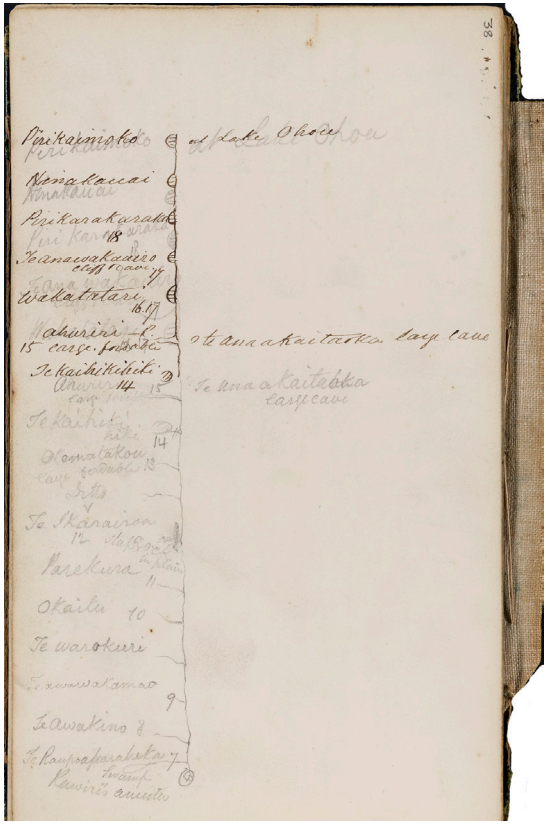
Fig. 1. Te Arai Te Uru whakapapa. Source: Tare Wetere te Kahu, George Chapman Collection, MS416Aa. As transcribed in Carter 2004b, p. 178. The bracketed words are in Chapman's original script

This map (Fig 1.) is a whakapapa list of crew members off the Arai Te Uru waka (voyaging canoe) as it journeyed along the Otago coastline (Tare Wetere te Kahu, George Chapman Collection, MS416Aa). The coastline is now named Te Tai o Arai Te Uru (the tide of Arai Te Uru). As it journeyed along, crew members disembarked at various places which are recognised through each crew member's name. The waka's name and the crew names claim the coastline for contemporary descendants through whakapapa association. The full whakapapa starts in Kaikōura and continues south as far as Matakaea (Shag Point), which is where the waka ran aground and broke up. Chapman added some short explanations of where each name sits geographically and added its English name. However, his account does not have the stories of the waka's journey or explain more about the history of the places and the people they are named for. This is only known through the stories that are accessed through knowing the whakapapa. For example, one name, Puketapu, is given to a hill to the east of the township of Palmerston. Puketapu was on the waka when it grounded and broke up at Matakaea (Shag Point). She went in search of firewood and other resources to help the survivors of the wreck. Puketapu discovered vast areas of harakeke (flax) and manuka. As she returned to the coast she realised she may be caught out in the darkness and in her hurry to return she dropped parts of her bundles along the way. The story describes several things. Firstly, the reason for the name of the hill that bears her name and commemorates her journey and how she came to be there. Secondly, it places the whakapapa in the landscape and allows descendants to claim the resources and spaces there. And thirdly, it acknowledges that at least two resources grew in abundance here—harakeke and manuka.The name associates the wider catchment with the whakapapa and the reason for the importance of the surrounding area. This association is repeated 120 times along the coastline and inland areas where each crew member's name is still prominent. The information that exists explains original conditions of the lands around this coastline associated with place names—wetlands (Matainaka), areas prone to slipping (coast road between Karitane and Warrington), areas where the sea constantly eats away at the land (Huirawa), the best settlement sites and so forth. Whakapapa from the Arai Te Uru and the place names that commemorate each

ancestor map the coastline with human associations, and mahika kai (resource gathering places). The one whakapapa from the crew of the Arai te Uru waka opens up the multi-sensory, multi-purpose understanding of the spaces along the coastline. These associations still exist and indicate relationships that are on-going and will be current for future generations.

Sharing the Land

In the nineteenth century, Māori were approached to help with discovering the inland areas and coastal areas that had previously remained unexplored by Europeans. As in the North American examples, Māori were used as guides and in some cases drew images of interior routes, geographical features and places that held special significance.



Mantell, Walter Baldock Durrant (Hon), 1820-1895. Mantell, Walter Baldock Durrant, 1820-1895 and te Wharekorari :[Diagram of Waitaki River - Map drawn by Te Wharekorari. 1848]. Ref: E-333-038. Alexander Turnbull Library, Wellington, New Zealand. /records/22772156

Te Wharekorari dictated a list of names to Walter Mantell in 1848 who added them to this simple map (Fig 2). Te Wharekorari knew the Waitaki river through the mahika kai places from the coast through to Lake Ohau that legitmated Te Wharekorari's connections along the river. Each name indicates an activity that has given the place its name and talks about land-use and conditions that determine specific uses. The names may indicate the environmental conditions necessary for those ecosystems to flourish, and are part of the stories about the naming. Hence stories often talk about environmental conditions for successful life ways.

Both the ancestral map examples used previously, name areas and provide reference points to the importance of the landscape and its use—past, present and future potential. The past is useful for building unbroken connections; the present is useful for asserting claims and access; and the future is useful for intergenerational development and continued access, use, and cultural presence on the particular landscape. The names often indicate the continual obligations and responsibilities that go with being part of the whakapapa. Most importantly, names describe how one group of people associated with those places understand themselves to belong: past, present and future. They provide a te reo Māori perspective of places and spaces within them in Te Waipounamu.

Present and Future Relevance

This article has focused on Māori language defining places and spaces in ways that incorporate past, present and future generations of experience and use in Aotearoa New Zealand landscapes. Landscape stories change, conflict and merge depending on which community is speaking either in te reo Māori or English. It is evident then that placing a name on the landscape shapes the discourse surrounding the landscape, and as Helander reminds us, places begin to exist and are differentiated from other places once they are named. The values, beliefs and knowledge that underpin each community's awareness of their place within the landscape are the starting points for this understanding. Often though, these differ between communities and this is evident when conflicts arise as groups vie for dominance. Parallel lenses that view the same landscapes will always be in conflict

because of the perceptions and perceived values that are associated with names.

In the contemporary world, Māori often seek to incorporate Māori ways of knowing into their contemporary settlements and dwellings, to renew the relationships they have with their named places. The purpose, the activities, the relationships and how these are enmeshed within modern land development are in effect bringing the past into the present in ways meaningful to that particular group and its association with the defined spaces. The information can also utilise past knowledge of what shaped the named places and the future problems that would need to be mitigated and/or adapted to, such as erosion-prone areas; flood areas and so on. Understanding the history of events, associations and important relationships leads to understanding how we shape places for future intergenerational needs and aspirations. For example, ensuring healthy living environments that consider the needs of older generations (socially and culturally). The shape and type of housing that meets the cultural needs, and is informed through cultural values and beliefs, are also important considerations. The very landscape itself needs to be considered, as it is here that the social and cultural systems reproduce and inform ways people engage within it. Understanding intergenerational relationships with places and the spaces within them builds a set of tools that will help guide a plan for future development. Māori, as an integral part of the land through whakapapa, have that knowledge, which is accessed through place names. Successful planning and development that utilises Māori intergenerational knowledge of place and space ensures interconnecting social, cultural, environmental and economic factors are given balanced consideration to meet the needs and future aspirations for Māori communities. The way we interpret our associations with landscape has implications for how we do future surveying for land use planning, urban/semi-urban design and housing. The land is one constant in the mix, and as such, what we know about Māori places within it will better inform and acknowledge Māori culturally driven interpretations for inhabiting it.

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Cook : Our Professional Ancestor

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ABSTRACT

Two thousand and nineteen marks a turning point for our nation: Two hundred and fifty years of dual Māori and European history, since the crew of the Endeavour visited Aotearoa New Zealand. It is an important time for those in the surveying and spatial realm to reflect on their professional histories and specialisms. We consider the development of the hydrographic surveying profession in Aotearoa New Zealand by contrasting the current experiences of modern day hydrographers with those of Cook and crew two hundred and fifty years ago. Through consideration of Cook's journals and 51 responses to a nationwide questionnaire, we present the stories of New Zealand hydrographers today; their backgrounds, influences and aspirations, how they undertake their work and their perspectives on the past and future of the profession.

INTRODUCTION

TWO HUNDRED AND FIFTY YEARS AFTER the first meetings between Māori and Europeans during James Cook's visit to Aotearoa New Zealand, New Zealanders are being encouraged to consider connections to their past and their visions for the future of our country. Reflecting on these connections provides a moment for hydrographers (surveyors who make measurements above and underwater, and describe the physical

features of water bodies (IHO, 2018)) to consider their professional histories and the developments that have occurred in their specialism since Aotearoa New Zealand was first charted. Here, we examine the experiences of contemporary hydrographers through a nationwide questionnaire and compare these with those of professional ancestors such as Cook. In doing so, we hope to celebrate hydrography by sharing insights into the experiences of these relatively unknown professionals - whose work is fundamental to many elements of our lives in Aotearoa New Zealand, but by its nature is often undertaken out-of-sight and thus perhaps out-of-mind?

Background

A very short outline of hydrography and charting in Aotearoa New Zealand is given here to provide some background to the experiences of our questionnaire respondents. The references listed provide useful reading to those wishing more detail.

Hydrography

Hydrographers are involved in a wide variety of activities on our water covered planet. Traditionally, projects involved depth, positioning and tide measurements for the creation of charts for safe navigation (Bencker, 1994). Over time this has expanded to include: resource exploitation, environmental protection and management, maritime boundary delimitation, national marine spatial data infrastructures, recreational boating, maritime defence and security, tsunami flood and inundation modelling, coastal zone management, tourism and marine science (IHO, 2018). The benefits for a nation undertaking hydrography are covered by the concept of a "Blue Economy", part of which recognises the value of the underlying hydrographic data that supports "… the sustainable use of ocean resources for economic growth, improved livelihoods and jobs, and ocean ecosystem health" (Meissner & McAtamney, 2019). A 2015 investigation by LINZ found that the marine economy contributed $3.3 billion (3% of GPD) to the total economy of Aotearoa New

Zealand in 2002, while the return on investment for having hydrographic services was between 1:3-1:9 and the return for having good bathymetric data provision between 1:2-1:6 (LINZ, 2015).

Charting Aotearoa New Zealand

Cook was the first European to circumnavigate the three main islands of Aotearoa New Zealand on his voyage sponsored by the Royal Society and British Admiralty. The official purpose of his initial voyage was to observe the transit of Venus—which he did in Tahiti. Secret instructions, opened after sailing, then sent him south where he landed on Aotearoa New Zealand, established reliable longitude by observing the transit of Mercury and made the first charts of the coastline (Maling, 1996). Cook's charting skills were developed prior to this voyage, on naval training in Newfoundland. But he would also have used "the art of swinging the lead" measurements during his initial five year nautical apprenticeship onboard coastal coal boats in the North Sea, Baltic and English Channel before joining the Royal Navy aged 26 (Collingridge, 2002). Cook's first visit in 1769 saw him arrive nine weeks before Frenchman Jean-Francois-Marie de Surville. Surville's chart of Lauriston Bay (Doubtless Bay) became the first official Admiralty chart for Aotearoa New Zealand, when published by Alexander Dalrymple in his position as the first Hydrographer of British Hydrographic Department in 1795 (Maling, 1996). Some data from Cook's observations remained on Aotearoa New Zealand charts until the 1990s (Robbins, 2011).

The next concentrated hydrographic survey effort in Aotearoa New Zealand occurred in 1848-55 onboard the HMS Acheron (one of the first steam ships in the country) and HMS Pandora (sail only). The resulting 250 "fair tracings" sent to the Hydrographic Office supported demand for charts driven by increased settlement by the New Zealand Company and then war beginning in the North Island. The first New Zealand Pilot was created in 1856 from the results of this survey work. During this "age of the professional hydrographer" the crews undertook summertime data collection and winter office

work in Wellington (Maling, 1996; Ross, 1969).

In the early 1900s HMS Penguin worked the coastline of Aotearoa New Zealand, followed by others attempting to fill the remaining gaps. In the 1940s with responsibilities for Aotearoa New Zealand's charting now under the auspices of the Royal New Zealand Navy (RNZN), concern was raised that most charts were still using the century-old survey data from HMS Acheron and HMS Pandora. Extensive survey work by the HMNZS Lachlan from 1949-1960 was used to update many areas (Ross, 1969). Today, much of the hydrographic surveying in Aotearoa New Zealand is done by only a handful of operators. The RNZN maintains a Military Hydrographic Group (MHG)(RNZN, 2019a), but the responsibility for national nautical charting is managed by Land Information New Zealand (LINZ) who contract out the hydrographic surveying acquisition and processing activities (LINZ, 2017). As the field of hydrography continues to expand beyond nautical charting, local hydrographers may also work on other hydrographic tasks such as oil and gas exploration, construction, engineering and port management for commercial companies, and environmental mapping and science activities for—and sometimes in partnership with—local and regional councils, universities, government departments and Crown Research Institutes (CRIs).

Hydrographers - Methods and Training

When Cook began his naval hydrographic training in the late 1750s, the methods he used were unpublished. It wasn't until the 1774 publication of Treatise on Maritime Surveying and Dalrymple's essay, Most practical methods for making Maritime Surveys, that descriptions were printed (Bencker, 1994). Thus, Collingridge (2002) suggests that Cook began his work during a new era of "scientific navigation" when using reliable charts became more preferable than referring only to the traditional Sailing Directions. Today, hydrographic surveyors are typically educated by a navy (see (RNZN, 2019b)) or at university (such as the University of Otago's School of Surveying in Aotearoa New Zealand (School of Surveying, 2019). In the latter part of the 20th century, the more common routes were

through naval training or on-the-job cadetships.

Questionnaire

To investigate the experiences of contemporary hydrographers a questionnaire was devised involving four main themes:

1. Demographics: who are our participants? Where do they work and their past experiences.
2. Life as hydrographers: What is the lifestyle and the work itself like?
3. Hydrographic work and technology: What they do and how; methods used and technical changes they have experienced.
4. The legacy and future of hydrography: Why do they do their work? Their influences, aspirations and perspectives. Do they consider their work in relation to who went before them? What are their views for the future?

Specific survey questions allowed us to relate our results to our analysis of Cook's diary and other records of hydrography in Aotearoa New Zealand. These can be seen in the Appendix.

Methods

For this investigation, we initially analysed Cook's diaries and research on his work. We focussed on records that mentioned charting and hydrographic surveying operations, as well as day-to-day life onboard. Categorised notes were kept so that future analysis could determine which of the recorded elements either complimented or contrasted with the reported experiences of our contemporary hydrographers. The notes taken were used in conjunction with the four main themes listed earlier to develop our questionnaire of 33 questions (~15min completion time). The questions included a range of closed and open-ended questions with both multi-option and free-form typed responses (see Appendix). The questionnaire was reviewed and approved under the University of Otago Human Ethics Committee Category B.

The questionnaire was set-up online using Survey Monkey and

distributed to members of the Australasian Hydrographic Society (AHS) and Hydrographic Professional Stream of Survey+Spatial NZ (HPS S+SNZ, formerly NZIS) as well as contacts at the Royal New Zealand Navy (RNZN), Land Information New Zealand (LINZ) and the National Institute of Water and Atmospheric Research (NIWA). Additionally, some individuals known to the Aotearoa New Zealand hydrographic community, but who are not members of any groups listed, were also targeted.

In February 2019 an email with the project outline, questionnaire link and tacit consent was sent to those listed above. Respondents were given four weeks to respond. Responses from the questionnaire were anonymous and downloaded to University of Otago servers. Analysis of the questions involved a mixture of statistics and plotting of results for closed-ended questions and word clouds and researcher analysis for open-ended free-form responses. For word-cloud creation all text was made lowercase.

Questionnaire Results

The main questionnaire responses from each of our four themes are outlined here, complimented by graphics where appropriate.

Respondent demographics

84% of our respondents were male, 16% female (8 of 51). 30 of our respondents were under the age of 40. After this majority, we had a slightly bi-modal age distribution, with peaks in the 31-40 age group (16 respondents) and another in the 61-70 age group (8 respondents). A large number of early-career professionals responded (perhaps filling time while offshore?!) with 43% of respondents having fewer than 10 years' experience in the industry, but we were grateful to also hear from the 25% of respondents with 30 years or more experience.

For ethnicity classifications we used the latest NZ Census. 82% of respondents identified as NZ European. Of the remaining 18%, 9 were 'other' (Filipino, French, European, British, South African or Sri Lankan), with only 1 Māori and 1 Samoan hydrographer.

The majority of our hydrographers (74%) currently work for private NZ or International companies, with five or fewer choosing

Government, Military, Research, Student and Retired options (Figure 1). However, Figure 1 demonstrates that while many currently work for private companies, several 14 worked for the military for several years each at some point in their careers.

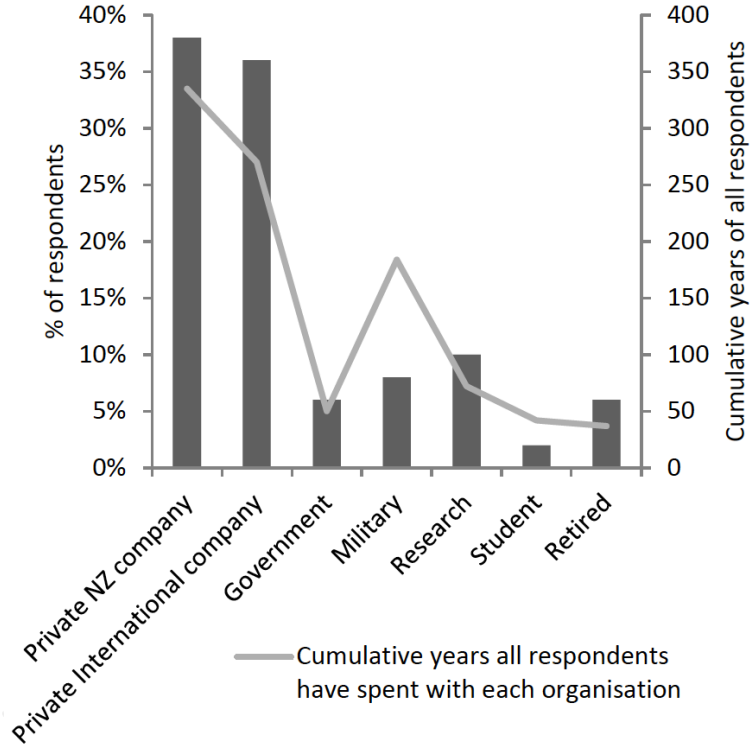

Figure 1 - Results from Q4 "Who do you currently work for" and Q9 "How many years have you worked for each of the following?". Note: for Q4 there was inadvertently no option for 'public' international companies, 1 person did not respond to this question, others may have simply selected the 'private' international option to cover this category.

Representing the international nature of our profession, 24% had never undertaken a hydrographic survey in Aotearoa New Zealand, while 86% had taken part in a hydrographic survey overseas, meaning 32 respondents have worked both in Aotearoa New Zealand and internationally.

Figure 2 uses the International Hydrographic Organisation's s5 categories of survey, with many respondents having worked

in Nautical Charting (68%), and Port Management and Coastal Engineering Surveys (72%) as well as all other s5 categories and additional self-identified options. It may be argued that many self-identified "Other" types could be considered combinations of existing categories - such as a cable route and cable surveys including Coastal Engineering, Offshore Seismic and Construction techniques, or waste treatment ponds as work in Inland Waters—but these 10 responses are left as 'Other' in Figure 2 and individual responses are listed in the caption.

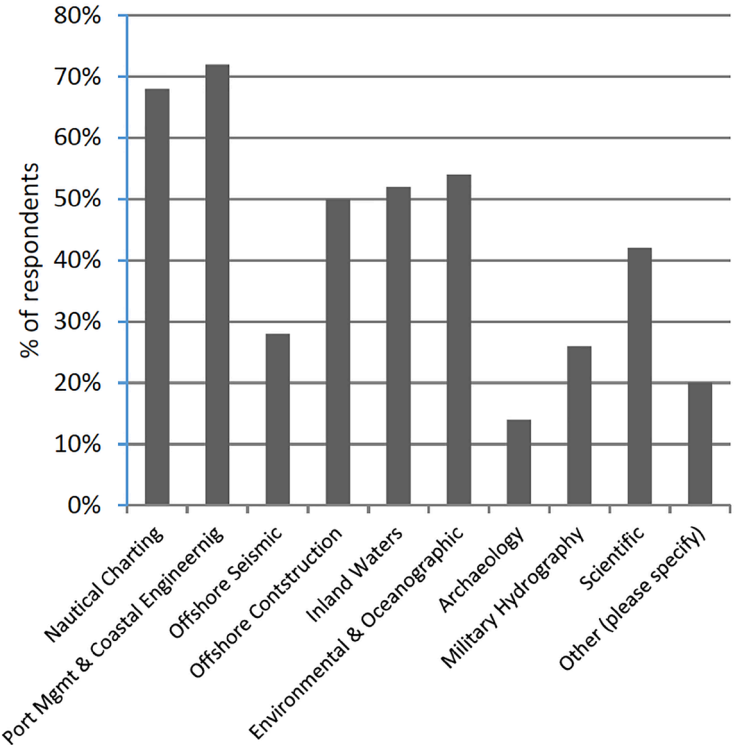

Figure 2 - Q7 results "What types of hydrographic surveying have you been involved with? (Select all that apply)". Other included: as-built pipeline survey, unexploded ordinance (UXO) surveys, as-built gas pipelines and inspections, National Policy Programme and Specification development, cable lay, trenching and ploughing, waste treatment ponds, search and rescue, oceanic cable survey.

Figure 3 demonstrates the sizes of vessels and numbers of personnel onboard. 56% typically work on boats 5 - 25m in length (~16 – 85'), fewer than 6% work on vessels smaller than 5m, 20% on vessels 25 - 50m (~85 – 164') and 18% on ships greater than 50m length. The number of people onboard is typically 1-5 (38%) or 10-50 (34%), with fewer working with 5-10 (18%) or 50+ (10%). Surveyed hydrographers are usually at sea for 1– 2 months (38%), 1 week - 1 month (30%) and less than a week (26%). Only 3 respondents were typically away for 2 - 4 months, and none for longer than that. The following question asked the length of longest continuous trip, with a peak of 36% working 1 - 2months, 32% for 2 - 4 months and 2 working for over 4 months (4%).

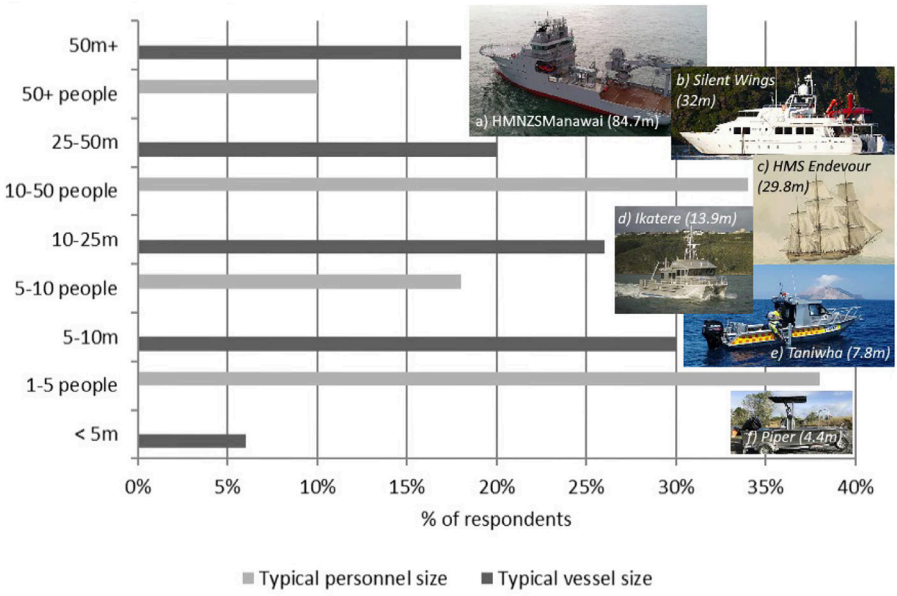

Figure 3 - Results from Q10 "What size vessel do you typically work on?" and Q11 "Typically, how many people are onboard the vessels you work on?", with images of NZ survey vessels: a) HMNZS Manawanui (84.7m) http://www.ahs.asn.au/Articles/10%20RNZN%20MANAWANUI%20new%20vessel.pdf; b) Silent Wings (32m) https://pacific7.co.nz/luxury-workboat-silent-wings/; c) Endeavour (29.8m): Samuel Atkins painting c.1794, National Library of Australia public domain image; d) Ikatere (13.9m) https://niwa.co.nz/services/vessels/niwa-vessels/ikatere; e) Taniwha (7.8m) f) Piper (4.4m) (e&f from https://www.dmlsurveys.co.nz/page/vessels-for-hydrographic-surveying-nz/).

The word clouds in Figure 4 - Figure 6 were used to analyse various considerations that are part of working on a vessel. Figure 4 shows the high use of modern technology for communication ashore with 'cellphone', 'email' and 'internet' featuring. Variations of 'radio' as well as 'cellphone' were combined as representing similar technologies. Mentioned once only were 'letters', traditional 'phone' and 'Skype'.

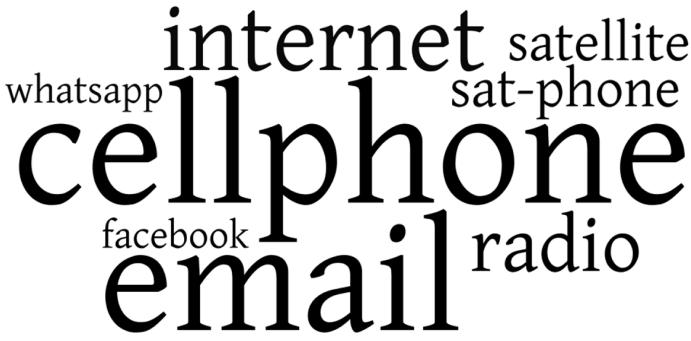

Figure 4 - Results from Q14 "How do you typically communicate with people onshore while working on vessels?" where larger text indicates more respondents used these words in their free-form answers.

Figure 5 shows why those surveyed enjoy living and working on boats. They get to travel to new and remote places, earn good money, enjoy nature while working at sea surrounded by the marine environment and they spend time with interesting teams of people. They avoid going to a traditional office and "see" and experience many parts of the world. Comradeship and friendship are mentioned four times. While some respondents who do day-work do not live onboard, at least four others mentioned a "short commute" from bunk to workstation on larger vessels!

Figure 5 - Results from Q15 "For you, what is the best part of living and working on a boat?" where larger text indicates more respondents used these words in their free-form answers.

What do hydrographers not like about living and working on a boat? Figure 6 clearly shows that being away, working long hours and missing family, friends and home factors highly. Many outlined 'what they can't do'; such as go running, commit to sports or other clubs, or join in with things at home. Some specific comments perhaps show differences in employee attitudes and employers, from "I don't get the … feeling that you are making a positive difference to people and not just making money for a big company" to "There were no hard parts because we were doing a job".

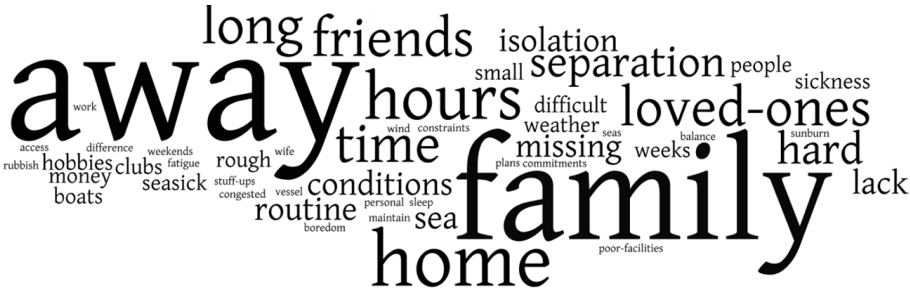

Figure 6 - Results from Q16 "For you, what is the hardest part of living and working on a boat?" where larger text indicates more respondents used these words in their free-form answers.

Our respondents have been part of many important maritime events which they listed when considering challenges they have faced. Some are: being at the Deep Water Horizon site; conducting the MH370 missing aircraft search; dealing with pirates; searching for Piper

Alpha survivors, and, riding out Hurricane Katrina. More common challenges mentioned can be seen in Figure 7, where weather is clearly the largest concern, followed by grounding and then four human-related challenges: conflict ashore, different local customs and corruption, mental-health and relationships with colleagues.

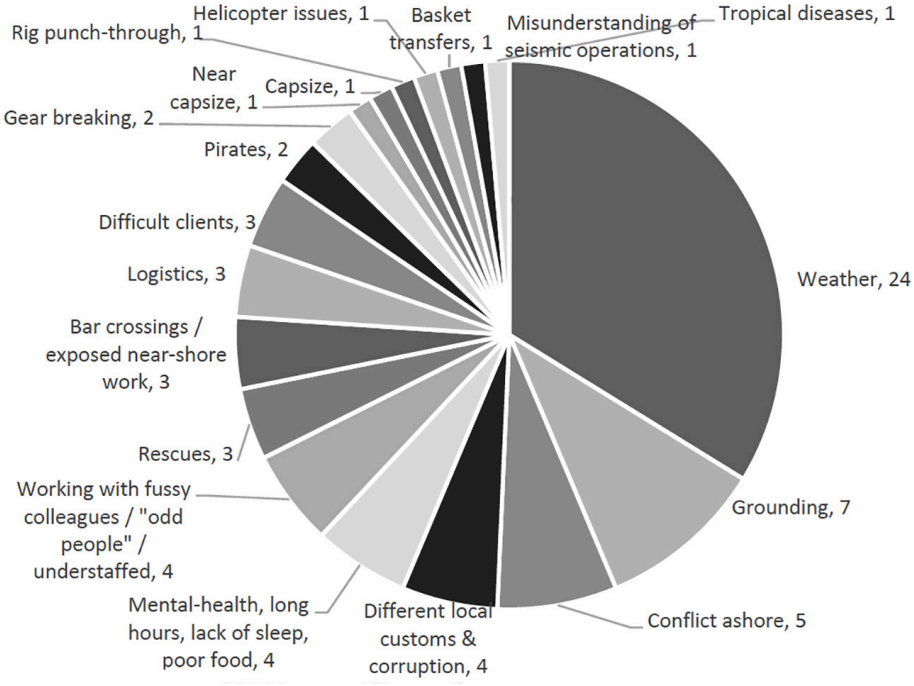

Figure 7 - Results from Q17 "Work at sea can create challenges that arise from aspects such as the environment (e.g. poor weather); vessel use (e.g. sinking, grounding); and, others (e.g. protesters, pirates). If applicable, please describe a challenging situation(s) you have faced."

Mental health was mentioned by four respondents, with one stating "During some swings every day can feel like ground-hog day, or you might not want to work but that option isn't there. When you are home you really need to do things that make you happy. You don't want to be burnt out going into the start of a new swing".

Hydrographic work and technology

The surveyed hydrographers tend to work with their clients to create measurement and reporting specifications. 73% reported they have some professional freedom on this. 17% have no freedom, and 10% tell their clients exactly what is needed to meet their needs. When given space to elaborate on this, many advised that each project is different and depends a lot on what the client wants - or thinks they want - as a final product. Some noted that even when they are provided with stringent criteria, in their opinion these are not always relevant. One stated that overly prescriptive methodologies seem to be easing with time while another mentioned that clients need education so they will be willing to consider changing their required methods to keep up with modern technology and methods.

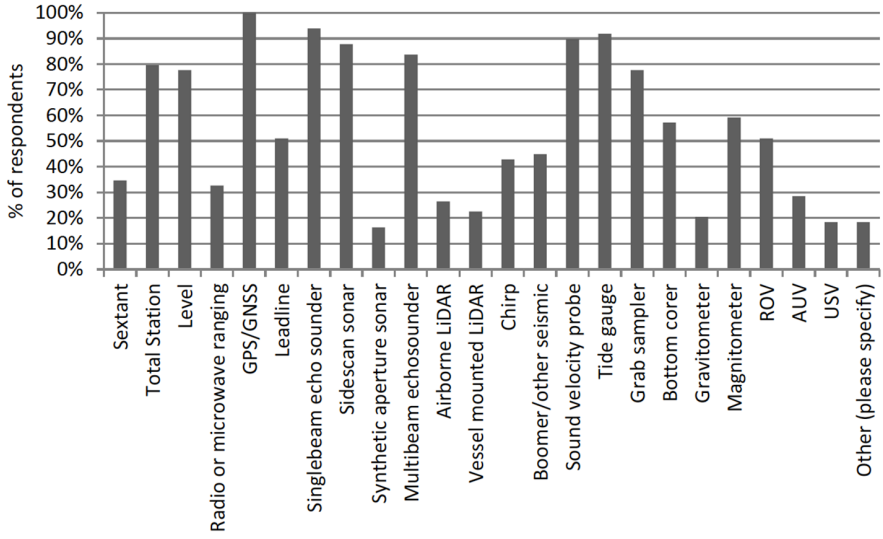

Figure 8 - Results from Q20 "What instruments have you used to complete a hydrographic survey?". Other included: interferometric SSS, deep tow, wire sweep, stereoplotter, theodolites, USBL/LBL, gyro compass and MRU.

Figure 8 demonstrates that the range of equipment used by our respondents is vast; the most common used being GPS/GNSS, singlebeam echosounder, sidescan sonar, multibeam, sound velocity probe and tide gauges. 51% have used a leadline - the same technology as Cook - for the reasons shown in Figure 9. Astronomical observations may be fading from practise for positioning. Of the 12 who have used astronomical measurements, 9 of these were sun observations to calibrate a gyro-compass - usually

on an exploration platform. 3 have done astronomical observations for positioning of remote islands, but not recently.

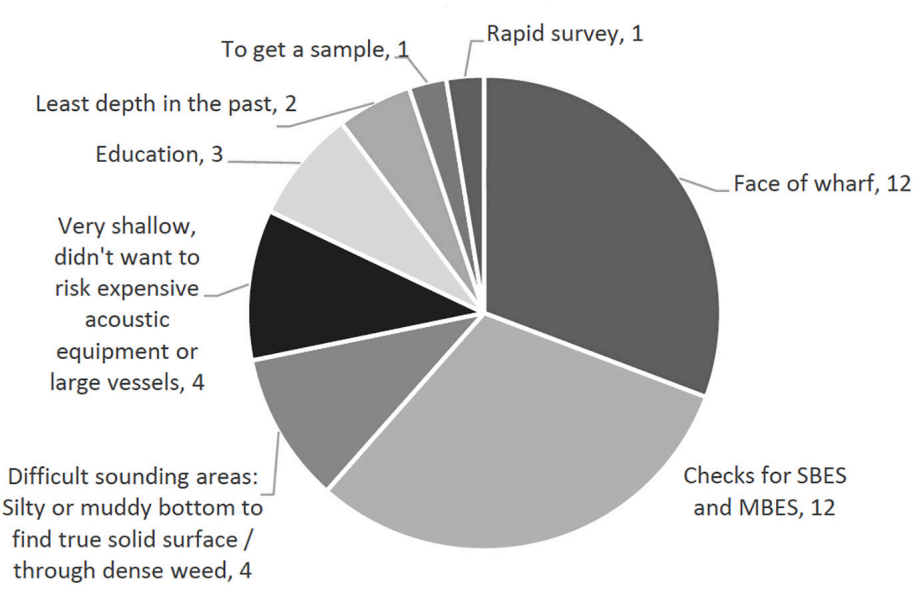

Figure 9 - Results from Q21 "If you answered 'Yes' in question 19 to using a leadline, please explain why you used it and how?".

Land features are surveyed with GNSS by 80% of our respondents. This is closely followed by aerial and satellite photography (75%) and photography (61%). Traditional tools such as theodolites, sextant, compass, laser distance measurer or sketch are all used by fewer than 25%. Unmanned Aerial Vehicles (UAV)/drone and vessel mounted LiDAR/laser scanner were all mentioned specifically by respondents as tools they use for coastline observations and features.

Sixty persent of respondents have been the first hydrographer to collect data in an "unsurveyed" location. Locations from the Baltic Sea, Papua New Guinea, NZ, Fiji, Tonga, Libya, Guyana, Indonesia, Alaska and the South Pacific were mentioned, as was the 'discovery' of several wrecks around the globe. Some have used satellite imagery to help operations in reef areas. Others noted that with modern multibeam swath systems they are usually the first to collect a full image of the seafloor, even if it has been 'surveyed' previously, as earlier methods were single-point measurements only.

Twenty nine percent of respondents have worked with data from Cook, particularly in Fiordland - one respondent was in fact involved in working over the last of Cook's original work in the area. When discussing the age of data they have worked from, hydrographers were keen to point out that a knowledge of past methods and limitations is useful when working from dated material. One respondent who ran aground was working from measurements made in the late 1700s! Some have used charts from the late 1800s, while many mention the Pacific Islands and Fiordland as areas with older data. Another stated that "Random tracks from - 1850" are on a lot of charts they've worked on in Aotearoa New Zealand.

Fifteen percent of our respondents have been involved in naming land and sea features. A RNZN representative on Undersea Features Names Committee responded, as did other naval hydrographers who noted that of the many names they and others proposed, not many got final approval from geographic naming boards. One respondent mentioned that recently local fishermen have been consulted for their thoughts on feature names in Fiordland. 33% took time to comment on the visual style of older charts compared to modern paper and electronic versions. 12 of these 16 respondents mentioned the "beautiful" and "artistic" nature of older charts, with more disparaging comments about the functional modern copies today; "They were true artists. Modern charts are merely data"; "The old charts were true works of art and had a real beauty to them. Modern charts can also look attractive, but rarely provide the sense of admiration or awe that the early charts do". Another considered the layering of electronic charts to be beneficial as they show much more information than a paper chart, but then noted their use may require more training.

The legacy and future of hydrography

The five most common words used to describe the profession of hydrography were: 'interesting', 'challenging', 'exciting', 'rewarding' and 'adventurous' (Figure 10).

Figure 10 - Results from Q29 "Please write down five (5) descriptive words you would use to explain your profession as a hydrographer." where larger text indicates more respondents used these words in their free-form answers.

The question on the main reasons hydrographers enjoy their career further develops the answers from Figure 5 (the best parts of living and working on a boat). Clearly hydrographers enjoy being at sea, travelling and being paid, but several comments such as "contributed to the greater good and to NZ and the region"; "brings the real world into perspective"; "provides information that can be used to enhance or change how we use and impact the environment"; "being part of large projects that have the ability to change nations"; "help people understand their environment"; and, "being part of a greater whole" show a deep sense of pride regarding the value of their work.

Despite one confident response that there are no challenges facing hydrography today, the main concerns highlighted by the word cloud in Figure 11 are: 'data', 'technology', 'automation', 'lack' and 'management'. The use of the word 'lack' links to comments about "lack of understanding limitations", "lack of public interest", "lack of tertiary education"(x2), "lack of trained and experienced personnel"(x2), "lack of public buy-in"; "lack of students wishing to study"; and, "lack of stable job opportunities". 'Management' generally referred to the management of multi-point data tools, large datasets, and automated equipment and processing.

Figure 11 - Results from Q31 "What are the three (3) biggest challenges you think hydrography faces today?" where larger text indicates more respondents used these words in their free-form answers.

Finally, 37% of respondents do see themselves on a continuum from early explorer/surveyors like Captain Cook or Tupaia (the Polynesian navigator who joined Cook's voyage and created a map for him of the relative locations of several Pacific Islands (Robson, 2004)). Some example comments from these respondents are "every time we go out it is an adventure… there is still a level of risk and danger in parts of the work we do"; "we're doing the same thing, just with more modern technologies"; and, "measuring the same things, there have just been incremental improvements at every stage of the data collection". Contrasting the idea of incremental change, another respondent thinks the transition to GPS (having begun their hydrographic work with sextants) is so great it may never be surpassed. Others said "absolutely - Cook set such a standard and defined the profession [hydrography]. It's great to push its boundaries with increased accuracy and coverage" and "knowledge develops of the coast and oceans over that continuum. I spent most of my career bouncing around the same areas as Cook". Many respondents would surely hope to identify with this description of Cook as:

> "A man who aimed at perfection in all that he undertook, and who established certainties where hitherto there had been doubts" (Snowdon, 1984).

Discussion

We were delighted to receive 51 responses to our questionnaire and while this subset cannot be said to speak for all hydrographers in Aotearoa New Zealand, we are comfortable making some further commentary about the responses received.

Demographics

There were no females onboard Cook's voyages. The Women's Royal New Zealand Naval Service (WRNZNS) was established in 1942 and integration of females into the RNZN itself began in 1977. In 2010 the RNZN was 22% female (RNZN, nd), while typical female participation in the Bachelor of Surveying at the University of Otago over the last 15 years has ranged from around 9-18%. However, these values include females from both the naval and academic sectors who do not specialise in hydrography. The percentage of females on the latest list of certified hydrographers in Australasia is 6% (AHSCP, 2019b), but as this certification is not yet widely required it is likely not indicative of the total number of female hydrographers in the region. At 16% the female response to our questionnaire is higher than current certification records, so is likely high for the hydrographic population, but fits with recent more general Naval and Survey Student demographics.

Our respondents are overwhelmingly NZ Europeans, and many have worked for a navy at some point in their careers (Figure 1). This was traditionally the standard route for hydrographers from Cook through to the charting done on HMS Acheron, Pandora and then HMNZS Lachlan. Today, internationally recognised hydrographic training courses such as the FIG/IHO/ICA's Category A or B are run by naval academies, universities and other training institutions (IBSC, 2019). As civilian training grows in the Australasian sector, as this route is recognised in certification pathways (AHSCP, 2019a) and as the desire for certification itself grows, it seems likely that time in the military before a move to civilian/commercial work may decrease.

It is not surprising that many of our responding hydrographers work overseas, given the seasonality of some operations, fickle oil

and gas markets, limits to national funding for charting and research work, and the growth of large multi-national companies operating in several oceans around the world. Cook and those following explorers travelled the world in their work to map our oceans, and hydrographers continue to do so with greater detail, as technological developments allow. However, the focus of the work is changing: Figure 2 shows that more respondents work in port management and coastal engineering than nautical charting these days, and there is a wide array of other projects they have participated in. In Aotearoa New Zealand, we think the categories Port Management and Coastal Engineering, Inland Waters, Environmental and Oceanographic as well as Scientific are likely to continue to grow.

Life as a hydrographer

There are issues with our questions asking about 'typical' vessel and crew size, and survey length. It is recognised that it may be hard to answer questions about 'typical' operations due to such a wide variety of jobs undertaken by hydrographers today, which may in fact change during the day itself. For example, does the vessel size selected by respondents include the smaller vessels (or even unmanned or autonomous surface vessels (USV/ASV)?) that are deployed from a larger mothership for surveying? Cook and crew had a very similar situation to this. They lived and worked onboard the HMS Endeavour, but at times sent out a smaller exploratory pinnace to get more soundings in shallower areas and to check unknown waters ahead of the larger vessel (Cook, 1771). Nevertheless, for general comparative purposes (see Figure 3), the Endeavour was 97'8" long (~29.77m) and carried 94 personnel (Moore, 2018). 38% of our respondents have worked on vessels of a similar size or larger, but with much smaller numbers of crew, and generally for no longer than 4 months total (and that for only a small percentage of respondents). Even when the slightly longer "longest continuous voyage" questionnaire results are taken into account, there aren't many that have worked at sea for more than 4 months. Cook's first voyage took nearly three years (Frame, nd). This further highlights the evolution of the profession as shorelines on global charts were filled in and the focus moved to obtaining greater detail along the coast, allowing

personnel to do shorter "swings" at sea, or even undertake daily operations from a shore-base for hydrographic work in areas such as ports and inland waters. However, "The surveyor's day is a long one" quoted by Ross (1969) in regards to the HMNZS Lachlan survey is surely still recognisable today.

Cook kept a detailed diary. In this we can see commentary that is similar to that in a Daily Operations Report (DOR) today; weather, survey times, depths, bottom type, anchorage details, other features of note and issues arising (Cook, 1771). The difference is the means by which this is shared with those onshore! Today communication from vessel to shore is important for project updates and timely reporting. The mental health benefits of maintaining connections with family and friends are also recognised by questionnaire respondents. Many hydrographers obviously work close to shore, as using a cellphone is the predominant way to keep in touch (Figure 4). Other answers also indicate that internet connections (email, WhatsApp, Facebook) are important, recognising that once further out to sea these are only possible through expensive and/or slow satellite connections - although costs continue to decrease while speeds increase. Nevertheless, it appears all communication methods remain backed up by marine radio options, with radio being one of the fourth most common words used by respondents, while mention of past methods such as posting recorded messages, letters and shore-based phone use was limited or non-existent. Interestingly, when we move to consider life onboard, it appears that increased online connectivity may not always be beneficial to mental health and may sometimes make being away from home worse - some respondents noted they feel left out or sad when they 'see' their friends are at events or BBQs in the weekends when they're not home (Figure 6). But, maybe it is sometimes just plain hard work. Admiral Ross comments about the work onboard the HMS Acheron and Pandora:

> "It was a task that was tedious beyond description. It is possible only to refer in very general terms to the many months… the long hours of pulling and sailing craft, sounding and plotting, to make the seas of New Zealand safe for the mariners who followed them" (Maling, 1996).

Many of the challenging situations listed by our respondents, and shown in Figure 7, would have been familiar to Cook. Weather and grounding are important considerations for all mariners - but for hydrographers whose job it is to chart unknown areas and find the safe water for mariners following them, it is often inevitable they will truly find the bottom at some point. Those working today should spare a thought for Cook and crew working methodically but slowly with their lead, on a completely blank canvas and with no engine available to move rapidly away from danger. In the past the ability to read the sea surface and other tells of shoaling water (as well as operating with extreme caution) would have been useful talents. As graduates from universities and other training institutions may enter hydrography with less maritime experience to complement their surveying skills (recognised by additional sea-time requirements for certification (AHSCP, 2019a)), as our electronic and acoustic sensing equipment continues to improve, and as the automation of data collection methods continues to advance, it is possible some of these nautical skills may become further diminished over time. One commentator who stated "It is an isolated environment so when something goes wrong such as an incident, or equipment malfunction, logistics can be hard to arrange" must surely have admiration for those hydrographers of the past.

Other issues such as conflict with local people ashore (one of our respondents was threatened with guns) and working with those who have different customs would also have been recognisable to Cook. Cook also dealt with poor food and fussy colleagues. Here though, the solution to the challenge hopefully differs today, as Cook's diary records the lashing of crew members for "refusing to take their allowance of Fresh Beef" (Cook, 1771). Different challenges mentioned by our respondents reinforce the diversity of modern hydrographic work, such as a rig punch-through, helicopter issues and basket transfers (to/from a platform to a vessel). "Misunderstanding of seismic operations" highlights the need for public education on hydrographic practices and the standards (including health, safety and environmental constraints) that hydrographers work to, for example, the Code of Conduct for Minimising Acoustic Disturbance to Marine Mammals from Seismic Survey Operations (DoC, 2013).

Hydrographic work and technology

For his survey work Cook took quadrants, sextants and compasses, a theodolite, Gunter's chain and plane table (Snowdon, 1984) as well as sounding or leadlines. Our questionnaire shows that many different pieces of equipment are used today (Figure 8), including use of traditional terrestrial gear such as levels and total stations. While it seems that we can see the growth and dominance of acoustic depth measuring tools, it is fascinating that the leadline is still being used. Leadline use (Figure 9) highlights the limitations of modern equipment; from the acoustic properties of a sounder where the large beamwidth of a singlebeam will give a false shallow reading from a first-return alongside a wharf, to the fact that hydrographers don't want to risk expensive multibeam gear in shallow waters. Responses also show that there is obviously no easier way to check your acoustic equipment and integrated setup than dropping a lead right beside it to physically confirm the true distance to the seabed! GNSS has obviously overtaken astronomical observations for positioning, although sun shots remain reasonably common for gyro-calibration. It will be interesting to see if this fades over time, as GNSS equipment becomes more affordable and positioning corrections available at longer distances.

Considering the methods used, Cook's shoreline information is remarkably detailed and he was honest in reporting areas where he thought errors may have occurred, such as in poor weather and when he was unable to sail closer to the shore (Maling, 1996). Our respondents mentioned the use of UAV and vessel mounted laser scanners in shoreline data collection today. This again compliments the move from pure nautical charting (where the coastline and some obvious features are all that mariners are given on a chart) to more diverse hydrographic operations, which see the value in collecting and integrating marine and terrestrial datasets. The fusing of these datasets provides a multitude of benefits, particularly for coastal engineers, planners and researchers working at the land-sea interface. This type of work clearly links with a LINZ focussed project Joining Land and Sea (JLAS), where the first phase is to integrate the variety of vertical datums around the country, thus enabling more

straightforward combinations of datasets (Blick, 2018).

Despite our modern technology (and the appearance of many global maps), much of the world's 71% of ocean remains virtually "unmapped, unobserved, and unexplored" (Mayer et al., 2018). That is, when the seabed is divided into a grid at 30 arc-seconds (926m at the equator), only 8% of these grid cells contain at least one sounding point! Our global maps contain a lot of interpolation (Mayer et al., 2018). As in Cook's time, hydrographers remain the 'explorers' of our world and many of the responding hydrographers have been the first to map parts of it. The global Nippon Foundation-GEBCO Seabed2030 Project referenced by Mayer et al. (2018) has called for greater collaboration and integration between data collectors, as their calculations show it would take ~970 years for one survey vessel to generate at least one sounding in each of the variable grids desired by the Seabed2030 Project (these range from 100x100m in 0-1500m depth up to 800x800m depth in depths greater than 5,750m). Thus, even after this project is completed - i.e. when we fill the grids for each depth band - hydrographic work will continue, as technology, methods and hydrographers keep pace with our desire to map the planet at an increasing density and with greater accuracy.

Measurements taken by Cook remained on charts in the Fiordland until the 1990s when the RNZN surveyed the area. However, to recognise the significance of this survey and to keep Cook's legacy alive, a small cartouche of Cook's Pickersgill Harbour ("a contemporary original reproduced by permission for historic interest - not to be used for navigation") was retained as an inset on the RNZN publication of Chart NZ7653, and remained in place until a 2009 LINZ update (Robbins, 2011). Our questionnaire respondents working from older data mentioned positioning errors and that large shoals were completely missed in some places due to the limitations of the technology of the day. One stated that when compared with their own work, depths measured in the 1950s appear to be accurate, but positioning issues existed until GPS began to be used. Hydrographers reported relying on chart source diagrams as their beginning when planning projects, as these gave them an indication of the measurement history of an area.

A true sense of loss comes through in comments from respondents discussing the lack of artistry in modern charts. Some explained they

had spent considerable time on their pen-style and handwriting in the past, so the fairsheets created prior to a chart were also works of art themselves. There were also some practical comments regarding charts – such as one who felt that older-style hatching and detailed relief shown on charted terrain in the past was more useful to them as a navigator than modern charts which now have this level of detail removed.

Cook and other early explorers had a lot of influence over naming conventions used on charts. Cook used a mixture of local Māori names (spelled phonetically), names of people (such as notable sponsors) and what he observed in the landscape. An example of the latter being "5 high peaked rocks, standing up like the 4 fingers and thumb of a Man's hand ; on which account I have named it Point Five Fingers" (Cook, 1771). Today's naming process is more rigorous, formalised through the New Zealand Geographic Board Ngā Pou Taunaha o Aotearoa (LINZ, 2018) and globally the Sub-Committee on Undersea Features Names (SCUFN) (GEBCO, nd). Through initiatives such as the Seabed2030 Project it is likely hydrographers will continue to find new features and should be encouraged to propose names for them. The search for missing airline MH370, which covered over 279,000km3 found four times more seamounts than estimated for the region (Picard et al., 2018).

The legacy and future of hydrography

Hydrographic links to the past remain strong. It is only 14 years since the record of Captain Cook's data was removed from charts in Aotearoa New Zealand. Words our respondents used to describe their profession such as 'interesting', 'challenging', 'exciting', 'rewarding' and 'adventurous' (Figure 10), would surely be acceptable to their predecessors. Even when looking forward (Figure 11) hydrographers' professional ancestors may in fact recognise concerns that have probably continued through time, with only the specifics changing. For example, how do we deal with more data and new technology? Over the time period of Cook's three Aotearoa New Zealand voyages he was able to begin using the new chronometer, and thus measure longitude on later voyages more accurately than before… as well as bringing home an entirely new set of charts of an area of the globe

that had previously been empty (to Europeans). In the 1950s a string of singlebeam data-points below the vessel track generated a lot more measurements than the leadline used previously. From the 1990s the addition of GNSS positioning increased data volumes again, and today we have to deal with the billions of points collected by simultaneous multibeam, laser scanner and LiDAR operations (and their associated motion sensors, positioning and tide-gauges). No doubt in the future this will continue to grow with the advent of autonomous technologies and satellite-based measurements, and as our respondents point out, we need trained and experienced hydrographers who can understand and work with this data. A recent report Future of the profession by the UK's Royal Institution of Chartered Surveyors (RICS) echoes our respondents' comments, with notes on upcoming changes in data collection, understanding and use, technology, connectivity with other professions, and the need to tackle barriers to entry, education and accreditation for the profession (RICS, 2019). Science-based-hydrography was mentioned by a respondent, and given the value hydrographers place on their work being able to "change nations" or "help people understand their environment" (Figure 10), as well as international attention such as the UN's Ocean Decade 2021- 2030 ("The Science We Need For The Ocean We Want") (UNESCO, 2019) and the Seabed2030 Project, we are sure this area will continue to develop.

Conclusion

Hydrographers have a long professional history in Aotearoa New Zealand. Our questionnaire shows that they are proud of the wide variety of work they have done and the experiences they have had. Some of these experiences are very similar to those of Cook and later hydrographers who worked on the large project of charting of Aotearoa New Zealand's waters. This cumulative charting project is being continued by the hydrographers of today and will continue to be added to into the future, while work in other areas such as engineering, research, inland waters and military applications increasingly shows other sectors appreciating the value of involving hydrographers in their projects.

Work as a hydrographer can be tough – you may be away from

home for long periods of time, work long hours, feel isolated, run aground, into bad weather or pirates... but to balance this you get to have adventures, travel, work in amazing environments with amazing new technology (and not in an office) and see a lot of beautiful sunrises and sunsets! This small profession has adapted well to changes over time, and comments from our questionnaire respondents suggest they have considered likely developments for the future. Responses also suggest the profession would benefit by building more public awareness of their activities and facilitating and growing the entry of new hydrographers into this diverse and interesting field of work.

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Biographical Note

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Appendix

Online Questionnaire

Online Questionnaire
Italics = ET comments (not included in questionnaire, but useful when building it)

Thank you for participating in this questionnaire about hydrographic surveying. We are interested in responses from those currently practising, as well as those who have retired and those who are just starting to study hydrography. Please answer the questions in terms of your involvement in hydrography – whether this is recent or in your past.

Demographic Questions

1. What is your gender?
Male, Female, Gender Diverse

2. What age range do you fall into?
15-20, 20-30, 30-40, 40-50, 50-60, 60-70, 70+

3. Which ethnic group do you belong to?
NZ European, Māori, Samoan, Cook Islands Maori, Tongan, Niuean, Chinese, Indian, Other (please state)
** groups from 2018 NZ census*
**multiple options allowed*

4. Who do you currently work for?
Private NZ company, Private International company, Government, Military, Research, Student, Retired

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Hydrography Questions - Demographic

5. Have you taken part in a hydrographic survey in New Zealand?
Yes, No

6. Have you taken part in a hydrographic survey overseas?
Yes, No

7. What types of hydrographic surveying have you been involved with? (Select all that apply)
Nautical Charting, Port Management and Coastal Engineering, Offshore Seismic, Offshore Construction, Inland Waters, Environmental and Oceanographic, Archaeology, Military Hydrography, Scientific, Other (please specify)
*from IHO s-5 doc
*multiple options allowed

8. How many years have you been practising in the hydrographic industry?
0-10,10-20,20-30,30-40,40-50,50+

9. How many years have you worked for each of the following:
Private NZ company, Private International company, Government, Military, Research, Student, Retired

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Hydrography Questions - Life onboard

10. What size vessels do you typically work on?
<5m, 5-10m, 10-25m, 25-50m, 50m+

11. Typically, how many people are onboard the vessels you work on?
1-5, 5-10, 10-50, 50+

12. What is the typical length of your hydrographic voyages?
<1 week, 1week-1month, <2months, 2months-4months, 4months+

13. What is your longest continuous offshore trip?
<1 week, 1week-1month, <2months, 2months-4months, 4months+

14. How do you communicate with people onshore while working on vessels?
Open answer

15. For you, what is the best part of living and working on a boat?
Open answer

16. For you, what is the hardest part of living and working on a boat?
Open answer

17. Work at sea can create challenges that arise from aspects such as the environment (e.g. poor weather); vessel use (e.g. sinking, grounding); and others (e.g. protesters, pirates). If applicable, please describe a situation(s) you have faced.
Open answer

Hydrography Questions - Technical

18. Generally, how much professional freedom do you have when undertaking a survey?
No freedom - the client dictates measurement and reporting specifications, Some freedom - the client and I work together to finalise the best methods and outputs for their needs, Total freedom - I advise the client what should be done to meet their needs.

19. If you wish to comment further on question 19 please do so here.
Open answer

20. What instruments have you used to complete a hydrographic survey?
Sextant, Total Station, Level, Radio or microwave ranging, GPS/GNSS, Leadline, Singlebeam echo sounder, Sidescan sonar, Synthetic aperture

sonar, Multibeam echosounder, Airborne LiDAR, Vessel mounted LiDAR, Chirp, Boomer/other seismic, Sound velocity probe, Tide gauge, Grab sampler, Bottom corer, Gravitometer, Magnitometer, ROV, AUV, USV (unmanned surface vessel), other (please specify)
*multiple options allowed

21. If you answered 'Yes' in question 19 to using a leadline can you please explain why you used it and how?
Open answer

22. Have you used astronomic observations while undertaking hydrographic surveying?
Yes (please explain), No

23. How do you survey and record prominent land features?
Aerial/Satellite photography, Unmanned Aerial Vehicle (UAV/Drone), Photography, Landscape sketch, GNSS/GPS, Total Station, Theodolite, Sextant, Compass, Laser Distance Measurer, other (please specify)

24. Have you ever collected data in an "unsurveyed" location - i.e. you were the "first" hydrographer to map this place?
Yes (please comment), No

25. What is the oldest chart or data you have used in your work? Do you have any comments about its accuracy?
Open answer

26. Have you ever worked with any data collected by Captain Cook during your career as a hydrographer?
Yes (please explain), No

27. Cook discussed naming terrestrial features in his journal. Have you been part of naming a land/sea feature(s)?
Yes (please explain), No

28. Do you have any comments about the visual style or presentation of older charts when compared to those today (paper and/or electronic versions)?
Yes (please explain), No

Hydrography Questions - Legacy

29. Please write down five (5) descriptive words you would use to explain your profession as a hydrographer.
Open answer

30. Please write down the main reasons you enjoy your career.
Open answer

31. What are the three (3) biggest challenges you think hydrography faces today.
Open answer

32. Do you see yourself on an historical continuum from the early explorer/ surveyors like Captain Cook or Tupaia?
Yes (please explain), No

33. Are you willing to be contacted for follow up questions or possibly an interview? Please provide your name, email and phone number below. (This will be stored in a separate location to your answers from this survey).
Name, Email, Phone

Thank you for your time. We look forward to sharing our results with you.

Cultural Aspects of Māori Geographic Naming in New Zealand

Geographic names as culture, heritage and identity (including indigenous, minority and regional language names)

Mark Dyer and Wendy Shaw

ABSTRACT

PEOPLE, PLACES, LANGUAGE AND STORIES all come together in geographical place names. They contribute to the process of nation building. Geographical place naming as an administrative system enables geographical place names to be a fundamental spatial dataset supporting functions of location and navigation, state administration, and cultural and heritage functions.
This paper sets out the cultural origins of Māori geographic naming, the administrative context of official naming including the role of early surveyors and the Treaty of Waitangi, and describes technical and cultural aspects of Māori geographic naming in contemporary New Zealand as implemented by the New Zealand Geographic Board Ngā Pou Taunaha o Aotearoa.

Keywords: geographic names, New Zealand Geographic Board, Māori, Treaty of Waitangi

INTRODUCTION

New Zealand's geographic names reflect the cultural diversity of people past and present. They record New Zealand's history and the different people who have lived here. Geographic names give context to space, help us to navigate from one place to another, enable communication, link the stories associated with places, express identity and assert rights. Deeper still, they can revive or add to our knowledge of the heritage and events that occurred at a place. They provide a foundation, a place in the world, a home. They give meaning, whether metaphorical, descriptive, economic, or commemorative. Capturing these qualities in a single geographic name can be a challenge.

Geographic names have existed in New Zealand from the time of the first exploration by Māori. Layers of history, conquest, and seasonal migration have at times introduced multiple Māori names for features and places.

Te reo Māori, as an official language of New Zealand, is in common use together with the more widely used English language. This has posed challenges about what to show on modern maps, charts, signs, and other official documents, that is, whether to use the most commonly used contemporary toponym[1] (whether Māori or non-Māori) or to restore an original Māori name. Names can change over time as occupation takes place, or if there are landscape changes, for example as a result of tectonic activity. It is important to discover past names no longer in use as a way to recall and preserve history, heritage and cultural identity.

The role of deciding on official geographic names rests with an independent statutory board, the New Zealand Geographic Board Ngā Pou Taunaha o Aotearoa. While names have been used in official publications since the time of exploration by Europeans, and in particular the British, the cultural aspects of Māori geographic names appearing in the official record has a chequered history, generally reflecting the loss of land and language of Māori. Within a broader context of a partnership between the Crown (represented by the New Zealand Government) and Māori, the New Zealand Geographic Board has an important role to play in recognising Māori

cultural and heritage values associated with geographic feature naming.

New Zealand's geographic names indicate the cultural diversity of people past and present. They reflect New Zealand's history and the different people who have lived here. Of these people, Māori lived here for many centuries prior to European settlement, and are responsible for many of the geographic names in New Zealand.

Geographic names give context to space, help us to navigate from one place to another, enable informative communication, link the stories behind them, provide identity and assert rights. Deeper still, they can revive or add to knowledge of the heritage and events that occurred at a place. They are a foundation, providing a place in the world, a home. They give meaning, whether metaphorical, descriptive, themed, economic, personal, or commemorative. The physical representation of 'real world' geographic names on maps and charts are important as a fundamental cultural theme. Capturing all of these qualities in a single geographic name can be a challenge. A further challenge for New Zealand is that Te reo Māori is an official language and is used along with the commonly used English language.

Māori geographic names have been established from the time of the first exploration by Kupe and Toi and the great migrations in 1300 - 1400 CE (IRWIN). Layers of history, settlement, conquest, integration and seasonal migration would sometimes introduce multiple Māori names for a feature or place. This has posed challenges for what to show on modern maps, charts and other official documents, that is, whether to use the most commonly used toponym (Māori or non-Māori) or to restore an original Māori name. The desire to acknowledge, promote and encourage the use of existing Māori geographic names has been important since early European exploration, and is etched in New Zealand's present day geographic naming legislation. It is important to discover past names no longer in use as a way to recall and preserve history, heritage and cultural identity. For Māori geographic names, the New Zealand Geographic Board has some specific statutory functions to provide for appropriate recognition to be given to the cultural and heritage values associated with geographic features: to collect them, to encourage their use on official maps and charts, to make sure that standardized

orthography is applied, and to ensure that the Board's membership has Māori representation.

The legislative rules for geographic naming in New Zealand have evolved and developed over many years, with a current strong emphasis on preserving and restoring original Māori names. Restoring original names can have the consequence of displacing names representing later occupation stories whether Māori or non- Māori.

Oral traditions and history remain strong in Māori culture today, with connections to the land and its names being important to unlock past stories, events and mythologies, helping to preserve the creation traditions, and providing a sense of belonging and identity. Understanding names and their origin and meaning enabled people to understand and survive in the environment in which they were living. They had no writing, and the important information was held in the heads of kaumātua and passed onto younger generations. Landscape features were important reminders in this transmission of information.

The written record introduced by early Europeans sometimes omitted Māori geographic names, but those names have remained known through oral traditions and continue to be used by Māori today. Since the 1970s there has been a steady move towards greater recognition of the significance of Māori geographic names in New Zealand's history and culture. Milestones include the 1975 Treaty of Waitangi Act, the 1987 Māori Language Act, and the 2016 Te Ture mō Te Reo Māori (Māori Language Act). These led to a resurgence of interest in Māori geographic names, particularly through Treaty of Waitangi settlements, which have included the restoration of original Māori geographic names as part of cultural redress.

Fig. 1: Contemporary signs showing Māori geographic names in New Zealand.

History of migration and oral traditions

The arrival of the first migration canoes (waka) to New Zealand of the Polynesian ancestors of Māori was between 1300 - 1400 CE. Oral history, contained in songs (waiata) and traditional stories bear witness to this migration. Descendants relate their genealogy (whakapapa) back to their migration waka such as Arawa, Tainui, Mataatua, Aotea, or Tokomaru (Wilson 1999).

Ancestral Māori lived in very close harmony with the natural world, especially the land and its resources. Almost every stretch of river, swamp, bay or bush used as a food source was named for practical identification to aid with food gathering. So those toponyms[2] represented an economic value. Many other places and features were named to commemorate events or people, often connecting people together.

Understanding Māori names requires an understanding of context. It is their connection to other names and places, the land and its resources, and the memorised stories that link these places together that provides meaning. Reciting these stories keeps history alive. As people migrated they took their stories with them applying the stories in new settings using the same names or group of names (DAVIS et al).

Context for official Māori geographic feature naming

The Treaty of Waitangi, the agreement signed by representatives of the Queen of England and leaders of most Māori tribes when Great Britain first claimed New Zealand as a colony in 1840, has a fundamental influence on New Zealand's geographic naming policy. Orange (2012) records: '*The Treaty of Waitangi, New Zealand's founding document, was a written agreement between the British Crown (the monarch) and more than 500 Māori chiefs. After that, New Zealand became a colony of Britain and Māori became British subjects. However, Māori and Europeans had different understandings and expectations of the treaty.*'

Fig. 2: Ngāi Tahu ancestor, Rākaihautū, who traversed Te Waipounamu (South Island) with his famous kō (digging stick named Tūwhakarōria) and mythologically 'created' and named the southern lakes. (Artwork by Cliff Whiting, New Zealand Geographic Board copyright.)

Instructions to early European surveyors

Following the signing of the Treaty, it was necessary for surveyors to work alongside, and be dependent on, Māori to explore and map the land. It was recognised that Māori had intimate knowledge of the land and its resources and there was value in capturing this information. Formal instructions were issued to surveyors to facilitate the systematic collection of original Māori geographic names, to ensure their preservation.

In 1874 the Colonial Secretary instructed surveyors that '…special attention should be given to the subject of nomenclature and care taken to adhere in all cases to accurate Native names: this is a matter of great philosophical and antiquarian importance…' (Palmer 1874). The 1885 survey regulations directed surveyors to fix *'the positions of all remarkable hills, ridges, pa's, eel-weirs, native cultivations, tracks, battlefields, villages, etc., as well as rivers, forests, lakes and coastlines'.* The surveyor was also required to ascertain '*the Native names of all boundaries or natural features' within the block surveyed'.*

Fig. 3: Surveyors sketch plan of Rangiwaea Block, Māori Land Plan 1166 (1895)

Historic survey plans, field books and maps are a fundamental resource relied on by Māori and the Crown alike in the research of original Māori names. When considered alongside oral history and other evidence, orthography or location can be corrected. It is evident that some English names displaced the Māori names of features that were significant to Māori, with little regard to those original names.

Treaty of Waitangi grievances/breaches

Today there is the Office for Māori Crown Relations - Te Arawhiti, formerly the Office of Treaty Settlements, within the New Zealand Ministry of Justice Tāhū o te Ture, responsible for negotiating historical Treaty of Waitangi claims. They also advise and help claimant groups so they are ready to enter negotiations.

The Office of Treaty of Settlements' Red Book Ka tika ā muri, ka tika ā mua-Healing the past, provides context for those engaged in the Treaty process. It acknowledges that the intent was to treat Māori fairly and this did not occur in many cases. Land alienation led to social and economic loss, including loss of access to traditional resources, a place to belong, and places of spiritual and cultural value.

Many of these features and places have geographic names. Combined with dramatic decline in the Māori language, the inherent relationship between Māori and the land, through place names and oral history, was jeopardised.

Treaty of Waitangi Redress

These historical events form the basis of the grievances of Māori that are being heard and addressed today through the Waitangi Tribunal and negotiations processes.

Milestones for New Zealand's response to acknowledging and putting right past wrongs have been enacted through the Treaty of Waitangi Act 1975, the Māori Language Act 1987, the Te Ture mō Te Reo Māori (Māori Language Act) 2016, and the 2008 New Zealand Geographic Board (Ngā Pou Taunaha o Aotearoa) Act, along with numerous Treaty Settlement Acts.

The Waitangi Tribunal has conducted hearings into many matters relating to Māori land and the economic and social impacts of land dealings from 1840 onwards. Under Treaty settlement legislation, the cultural redress part almost always includes geographic names, whether restored, corrected or made official. This may result in the displacement of a name for a place or feature that is significant to non-Māori, or to other Māori iwi or hapu who are not the claimant group. The New Zealand Geographic Board Act 2008 honours the partnership principles of the Treaty by:

- conferring on the Board the function of collecting original Māori names of geographic features for recording on official charts and official maps,
- conferring on the Board the function of encouraging the use of original Māori names of geographic features on official charts and maps,
- conferring on the Board the function of seeking advice from Te Taura Whiri i te reo Māori (the Māori Language Commission) on the correct orthography of any Māori name,
- requiring two persons to be appointed to the Board, on the recommendation of the Minister of Māori Affairs, and
- providing for the appointment of one person nominated by Ngāi Tahu.

Technical and cultural aspects of Māori geographic feature naming. Original and contemporary Māori geographic names

In the context of Māori place names 'original' generally refers to a Māori name that existed prior to European settlement, noting that there may have been more than one name given depending on the layers of discovery, history, migration and conquest. However, unnamed geographic features and places can be, and are, regularly given contemporary Māori names.

It is not uncommon for an original Māori name to be examined as the correct spelling of the name may be doubted. Examinations consider the history, origin and meaning of the name and may

result in an altered form or spelling of the name (e.g. Taupō, formerly Taupo; Whangārei formerly Whangarei), or a new name that correctly represents the original name (Aniwhenua Falls was corrected to Āniwaniwa Falls).

Managing more than one name

In New Zealand dual and alternative names are used and have been from the start of European exploration and settlement. A dual name has two parts and each part is usually from a different language, e.g. Māori and English. Both parts of the name form the full name of the feature or place, each part having equal status commemorating their associated stories. The Māori name is usually, but not always, written first to reflect rights of first discovery.

For example:
- Whakaari / White Island
- Matiu / Somes Island
- Aoraki / Mount Cook
- Steeple Rock / Te Aroaro-o-Kupe
- Hauraki Gulf / Tīkapa Moana

Alternative naming means that either one or more of the names may be used as the official name. This will usually arise when the name for a single feature or place in Māori and non-Māori are both in general use, or arising out of a Treaty Settlement. The depiction on official documents of one or more of these alternative names will comply with the legal requirement for the official name to be used. If more than one name is used it is recommended that they be separated by the word 'or'.

For example:
- Mount Taranaki or Mount Egmont
- South Island or Te Waipounamu
- North Island or Te Ika-a-Māui

Both dual and alternative names recognise the equal and special significance of Māori and non-Māori names, reflect the common and official written languages of New Zealand, meet the government's Treaty of Waitangi partnership obligations, and allow for restoration

of mana and identity.

The United Nations Group of Experts on Geographical Names (UNGEGN) initially was of the view that there should be only one official name (not necessarily one word) for one place - the principle of univocity. The principal has evolved over time to one official name for each language for a feature. This enables appropriate recognition of the right for cultural groups to retain both languages and the place names that flow from them. Nevertheless, the New Zealand Geographic Board does not take the decision lightly to apply more than one name.

The two names are not intended to be translations of each other, but to be independent and uphold their uniqueness. For Steeple Rock / Te Aroaro-o-Kupe, the Māori name means the presence of Kupe, who was a famous Māori navigator and explorer, and the English name is descriptive of a church steeple.

Dialect

Dialectical differences between tribal groups exist and so they are also considered. New Zealand has standardised orthographic conventions for the Māori language, which the New Zealand Geographic Board upholds. However, the home people's views are considered in determining spelling, formatting and macrons. For example, New Zealand's highest mountain is officially named Aoraki / Mount Cook. In Ngāi Tahu dialect the [k] is used over the standardised [ng]. The standardised orthography would be 'Aorangi'.

Māori generic geographic terms

Many Māori geographic names are compound words that include the generic term, for example, Tararua Peaks, where the specific part translates as 'two peaks'. In this example the added English generic creates a tautology - the use of two words or phrases that express the same meaning, in a way that is unnecessary. Other examples are Mount Maunganui (Maunga lit. Mount) and Lake Rotoiti (Roto lit. Lake). Acceptance and familiarity of Māori generics, including when they form part of a name, will help move away from unnecessary tautologies.

In 2016 the New Zealand Geographic Board noted that it may apply a Māori generic term rather than an English generic term, if one is required Maunga Kākaramea - Maunga being the Māori generic for mountain. The application of an appropriate Māori generic will be on a case by case basis, in part reflecting the revitalisation and increased everyday use of the Māori language in New Zealand society.

The New Zealand Geographic Board has published a generic geographic feature list available on the Board's host government agency Land Information New Zealand website as a way of promoting understanding/education of Māori generic terms for different landforms. Line drawings will be published to compliment the list.

Literal translations

Literal translations of Māori geographic names should be treated with caution as many compound words have their own distinct meaning. For example, Whairepo (whai lit. stingray, repo lit. swamp). However, Whairepo is an Eagle Ray, and is now the name of the lagoon on Wellington's waterfront, where the Eagle Rays feed and shelter from Orca whales.

Long Māori names

Many Māori geographic names are long because they tell a story. The New Zealand Geographic Board does not generally encourage long names, but may accept them case by case. When considering a proposal for a long Māori geographic name, the New Zealand Geographic Board will take account of:

- the usability of the name,
- its euphony (how it sounds),
- impacts for emergency management and response, and
- the history of the proposed name and its cultural, traditional or ancestral importance to the whole community.

Selected Māori names and their geographic features

Fig 4: extract from NZMS 346 map, Source: The New Zealand Geographic Board, Crown Copyright Reserved.

The Crown has restored many original Māori geographic names in their full form and the expectation is that they will be used in that full form. The risk for the New Zealand Geographic Board and Māori is that the cartographic challenges of long Māori geographic names may lead to cartographers deciding not to show them on maps and charts. The obligation is to use the official names when they appear on official documents, but publishers have discretion as to whether they are shown or not.

An example of a well-known long Māori geographic name is: *Taumatawhakatangihangakōauauotamateapōkaiwhenuakitānatahu,* which translates to 'the place where Tamatea, the man with the big knees, who slid, climbed and swallowed mountains, known as land eater, played his flute to his loved one (Taonui 2008)'.

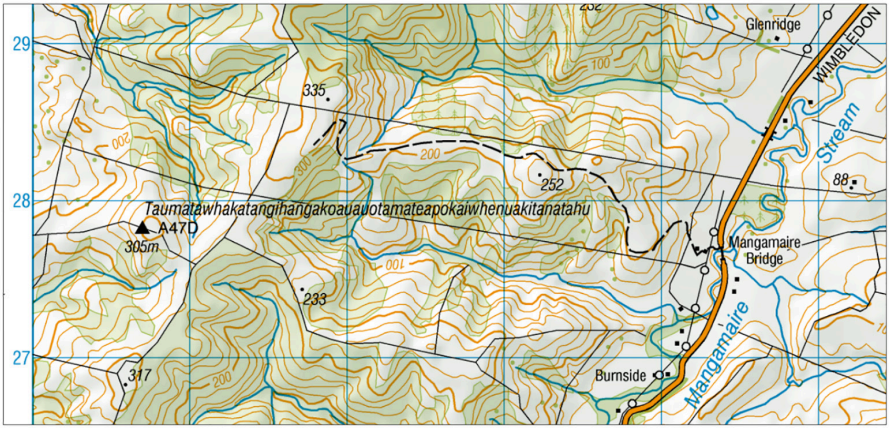

Fig. 5: NZTopo50-BM38, Source: Land Information New Zealand, Crown Copyright Reserved

Technical considerations - Dual naming conventions

What is the format?	• The two parts are joined by a solidus, commonly known as a forward slash (/) with a space either side • Past depiction of dual names was to use brackets around the second name
What does a forward slash do?	• It indicates the separation between the two names from two different languages • It expresses that both parts of the name have equal status and a different story • The forward slash (/) is shorthand for 'and', it does not mean 'or'
What if there are two names from the same language?	• Two Māori or two non-Māori names are not generally acceptable, though there are exceptions, e.g.: - Wellington Harbour (Port Nicholson), and - Hauraki Gulf / Tīkapa Moana
Why does New Zealand use a forward slash instead of a hyphen to separate dual names?	• A hyphen is used in New Zealand's indigenous language, Māori, to clarify parts of words: Te Aroaro-o-Kupe (translates to 'the presence of Kupe') • It would be confusing to use hyphens in the Māori name and a hyphen to join the two languages of a dual name • Using a forward slash clearly shows the two parts of the name from two separate languages that have equal status: Te Hauturu-o-Toi / Little Barrier Island

Table. 1: Dual naming structures and conventions

Engagement with Māori

One of the legislative purposes of the New Zealand Geographic Board is to provide effective notification, consultation, and decision-making procedures for naming geographic features. This applies for all geographic names, but there are some additional processes followed for Māori geographic names. For example: the New Zealand Geographic Board's own kaupapa for Māori place names; Minister's Accords post treaty settlement; and agreements with Crown agencies including with Land Information NZ, Te Arawhiti, Department of Conservation, Te Puni Kōkiri, and Te Taura Whiri i Te Reo Māori.

The New Zealand Geographic Board also comments on geographic names proposed by Māori claimant groups through Te Arawhiti as part of the Treaty settlement process. The New Zealand Geographic Board makes sure that all proposed Treaty of Waitangi names meet its naming principles wherever possible. Once official, a Treaty of Waitangi settlement name can only be altered with the written consent of the relevant Treaty of Waitangi settlement governance entity thus protecting the name from future change.

Conclusions

The rules for geographic naming in New Zealand have evolved and developed over many years, with a strong emphasis by today's New Zealand Geographic Board on preserving and restoring original Māori names. Since the 1970s there has been a steady move towards greater recognition of the significance of Māori geographic names in New Zealand's history and culture. Legislation has supported this. This has led to a resurgence of interest in Māori geographic names, particularly through Treaty of Waitangi settlements, which have included the restoration of original Māori geographic names as part of cultural redress. There is a close relationship between the acceptance of Māori place names and revitalisation of the Māori language within the broader context of recognition of cultural and heritage values.

There is increasing acceptance by the general community of both te reo Māori and of Māori place names. This is reflected in the widespread use of Māori place names in day to day communication within communities and particularly local government, and in media channels such as television news and weather. In June 2019 the New Zealand Geographic Board notified standardised orthography for 823 Māori place names, many with macrons. Communities were positive about the changes with numerous media articles reporting people's delight in having their places correctly spelled and made official, e.g. Lake Wānaka, Whakatāne, Ruakākā, Māpua, Tāhunanui.

Oral traditions and history remain strong in Māori culture today, with Māori place names being important to unlock past stories, events and mythologies and a sense of belonging and identity. Place names help to conceptualise and evoke images in our minds of where we have come from, where we are, and connections to other people, places and times - ngā pou taunaha o Aotearoa - the memorials markers of the landscape.

Notes

[1] Proper noun applied to a topographic feature.

[2] Toponym: a place name, especially one derived from a topographical feature.

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Biographical Notes

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Charting Our History

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ABSTRACT

This second part of our contribution to Tuia 250 commemorations celebrates the hydrographic surveying methods and charting outputs of our 'professional ancestors'. Through analysis of technological change and nautical chart evolution, we highlight the major developments in hydrography and consider likely future directions.

INTRODUCTION

Nationwide there are commemoration events and projects that recognise 250 years since the interactions of Māori and European on James Cook's first voyage to Aotearoa New Zealand. As part of this, the Ministry of Culture and Heritage established Tuia-Encounters 250 to "…encourage discussion and debate, reflection and contemplation and bring a broad range of perspectives to the stories we will tell of this place we call home" (National Services Te Paerangi, 2018).

Many nautical charting activities occurred on Cook's voyages, so here we reflect on the changes that have occurred in hydrography[1] and charting since his time. Nautical charts are a vital component of a nation's Blue Economy (LINZ, 2015). They provide mariners with information that enables the safe navigation of vessels and

subsequently support all that we rely on in the marine realm, including national transportation (notably of fuel and food), import/export operations, fishing, tourism, recreation, resource use and marine protection.

After some background on charting and our study methods, this paper is presented in sections that relate to the hydrographic technology and methods used in a given time period. These are 1) Pre-acoustic; 2) Acoustics and Satellite Positioning; and 3) Today and Tomorrow…?. Each of the technological change periods are combined with our inspection of similarly-aged nautical charts, as a way to visually demonstrate some of the evolutions and transformations experienced in hydrography over the last 250 years.

Background

Hydrographic services and products are a legal requirement of signatories to the International Maritime Organisation (IMO) Safety of Life at Sea (SOLAS) Convention (IHO, 2018). Since 1996, the authority responsible for this in Aotearoa New Zealand is Land Information New Zealand (LINZ). LINZ produces the official nautical charts for the country, as well as areas of the South-West Pacific and Antarctica. Charting priorities are determined through a Hydrographic Risk Assessment and detailed in the LINZ document HYPLAN (LINZ, 2017). In the past, nautical publications for Aotearoa New Zealand fell under the authority of the British Admiralty and later the Royal New Zealand Navy (RNZN).

Donated Charts (late-1700s)

In recognition of the importance of the 250 year commemorations in 2019, Ron Tyson generously donated three Cook-era charts (Figures 1-3) to the University of Otago's School of Surveying. Ron made contact with us through his work on the executive committee of the New Zealand Region (NZR) of the Australasian Hydrographic Society (AHS). The charts were acquired for his personal collection when he was in the United Kingdom and sent to us with accompanying notes regarding the chart's likely age and creators, as well as highlighting notable attributes. Advice from University of

Otago's Hocken Collections was sought to determine the best way to physically store the charts and they were digitally photographed at high-resolution to enable them to be shared with a wider audience.

Figure 1 is a chart showing three plans from Cook's voyages. The sheet (dated c1795) is printed from engraved copper plate with original hand colouring and were produced for the Dutch from Cook's Voyages. Depths are indicated on all three plans, and there are scale bars for both 'English miles' and 'Sea miles'.

Figure 1 – Dutch sheet of "Cook's voyages" (c.1795) showing three of Cook's plans in Firth of Thames, Mercury Bay and Tolaga Bay, which he surveyed in 1773 (Donated by Ron Tyson).

Figure 2 shows the initial work of James Cook in the area of Cook's Strait: engraved and hand coloured. Phonetic Māori and English names are recorded for islands, sounds and bays. Depths are shown in 'Queen Charlottes Sound'. The label 'West from Greenwich' can be seen in the bottom left. The central lower note states this was 'Published by Alexr Hogg' who also published the journals of James Cook.

Figure 2 –Chart of Cook's Strait in New Zealand c.1795 from "Cook's Voyages" (Donated by Ron Tyson).

A collection of South Pacific islands is depicted in Figure 3, once again printed from an engraved copper plate and hand coloured. This French chart is dated c1790. A note at the bottom indicates the longitude is based on the Paris meridian. The lower left image is of Dusky Sound in Fiordland, with an inset for Pickersgill Harbour, which Cook surveyed in 1773 (Robbins, 2011).

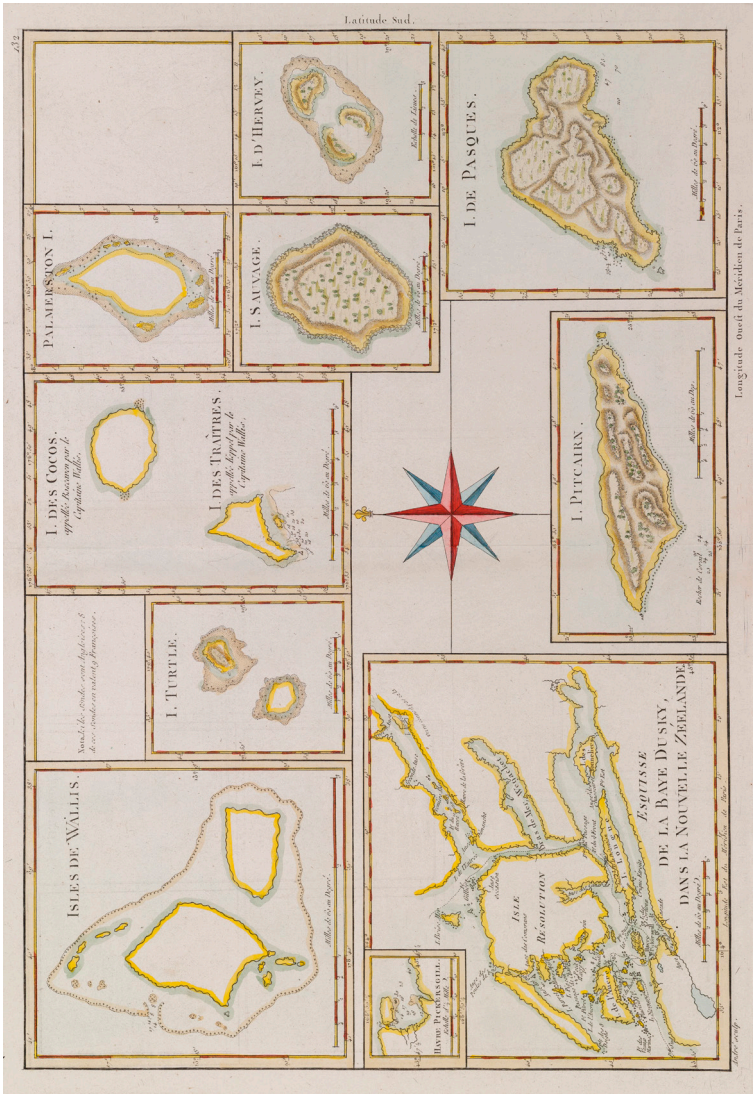


Figure 3 – Islands in the South Pacific c.1790, with Dusky Sound and Pickersgill Harbour inset in the lower left (Donated by Ron Tyson).

Nautical Charts (1850s to today)

The three late-1700s charts provided three focal points around the country - Firth of Thames/Coromandel Peninsula/Hauraki Gulf, Cook Strait/Queen Charlotte Sound and Dusky Bay/Fiordland. To gather information to inform our discussions we searched the LINZ Data Service (https://data.linz.govt.nz/) for the latest chart in each of the three areas. Then, we contacted LINZ and requested all of the archived charts on record in each of our focus locations. Many of the older charts sent to us were un-georeferenced tiff images that had been scanned from original paper copies. We used all charts in our analysis and display a selected sample[2] here.

Our Investigation

Every chart was checked for embedded spatial information, georeferenced if required and catalogued. We then analysed each chart for features that link to the collection of data such as: surveyors, duration of survey, sounding and positioning methods, ancillary measurements and vessel. Following this we focussed on aspects related to the final chart such as the projection, chart datum, contours, soundings, age of data on chart, names of features and specific visible features. The results of each of these analyses were combined with a literature review of past and present hydrographic technology and methods.

Pre-acoustic Technology and methods

Surveyors, navigators and explorers making measurements of water depths are recorded in Egyptian paintings dated to 1800 B.C., Greek writings by 400 B.C. and the New Testament around 50 A.D. Images show the use of sounding poles in shallow water and weights on a line for deeper depths, and there are written references to 'sounding'.[3] Subsequently, incremental technological changes occurred that improved both charting and navigation, including the use of magnetic compasses for navigation by westerners from the 1100s (but invented much earlier in China); vessels that could sail closer to the wind; and, samples of the seabed taken at the

same time as depth by filling a divot in the sounding lead with tallow or wax. Well into the 1800s and early 1900s these tools and hydrographic methods were used for coastal exploration as well as deep ocean observations. Methods for the latter were improved with the development of mechanical winches with a weighted wire for sounding (Ross, 1969; Theberge, 1989).

Through the 1700s, depth sounding methods were complimented by improved positioning techniques such as onshore astronomical observation (a publication of new lunar tables was accurate to ±1 mile (Ross, 1969)) and observation of these points from vessels (Theberge, 1989). Following this, the use of onboard chronometers then allowed determination of longitude (Collingridge, 2002; Ross, 1969). The meridian at Greenwich was designated the world meridian in 1884 (Royal Museums Greenwich, nd).

The time period of our donated charts (Figures 1-3) was an era of exploration, well summed up by Allen Curnow in the opening lines of his 1942 poem Landfall in Unknown Seas:

> "Simply by sailing in a new direction
> You could enlarge the world." (Curnow, 1942)

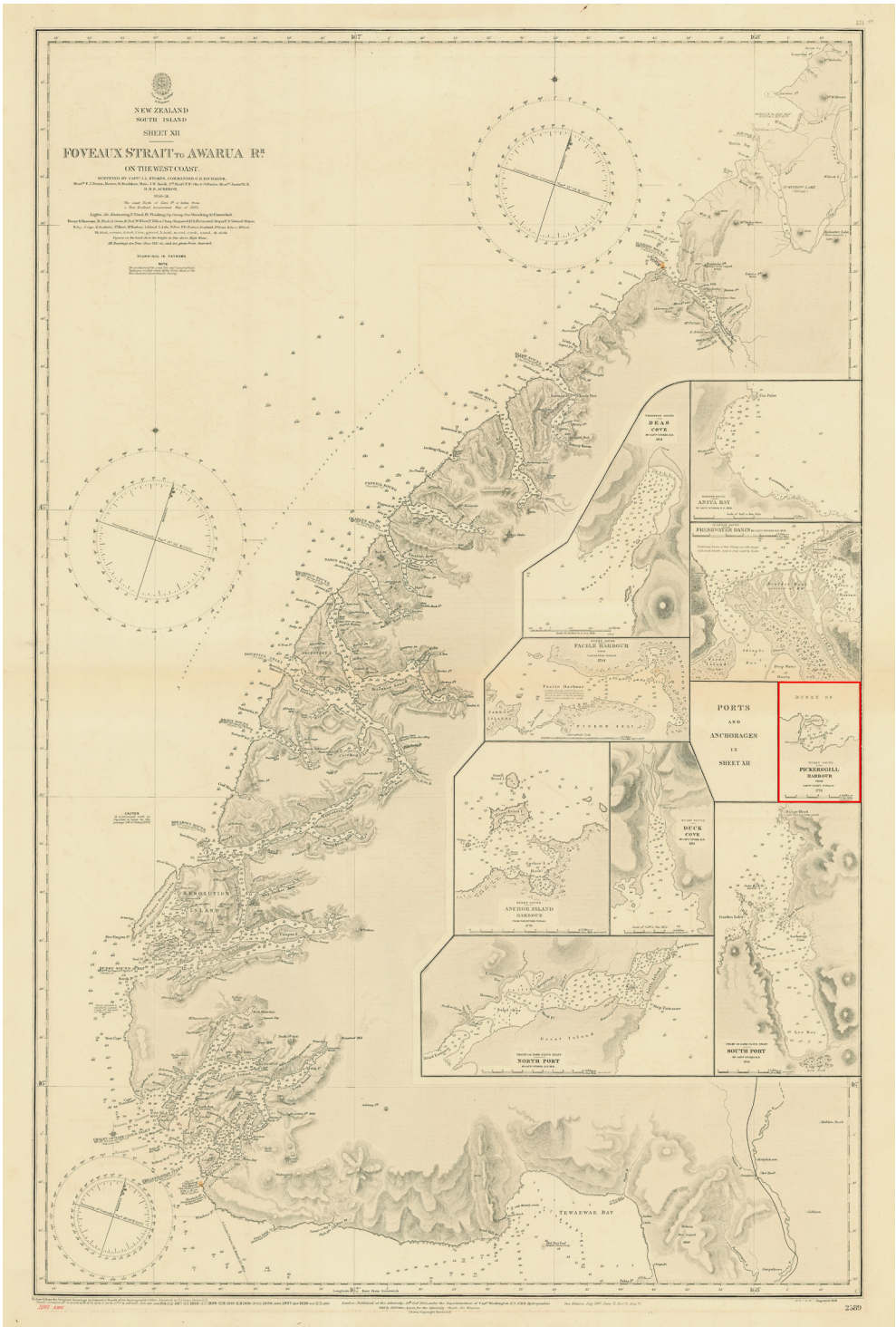
However, it was also a time in which hydrographic methods were beginning to be formalised and recorded (Bencker, 1994).[4] Many charts from this time are the creation of those on an exploratory voyage, or copies of these (as in our donated charts). In 1795 the British Hydrographic Department was established. One of their responsibilities was managing the navigational charts and pilot information for Aotearoa New Zealand (Maling, 1996). Data collection for Admiralty charts from the mid-1800s is attributed to the 'Royal Navy', and there is mention at this time of tide and astronomic observations as well as accompanying naturalists and NZ Company men (Ross, 1969).

Charting

In Figure 1 we can see ship tracks and depths shown on the Firth of Thames, but not on the smaller Mercury and Tolaga Bay plans. In Figure 2 and 3 there are again no ship tracks in either Queen Charlotte Sound or Pickersgill Harbour, the accompanying notes

for the charts speculate that the areas with no ship tracks may indicate the soundings were taken by the smaller ships boats. Use of smaller vessels (yawl, pinnace, longboat and two skiffs) for surveying are mentioned by Cook (Cook, 1771). In Figure 3 there are a few soundings at the heads of bays and off some peninsulas, which matches Cook's original, but depths displayed do not follow the plotted ship track as they do around the Coromandel Peninsula. Depth units on our donated charts are recorded as fathoms in Figure 1 and in Figure 2 longitude is displayed "West from Greenwich". In all donated charts, there are symbols for rocks with the key on Figure 1 indicating that '+' represents "Rocks under Water" as it does today: "… underwater rock… dangerous to navigation" (NOAA & NGIA, 2013). The entrance to Tory Channel is missed in Figure 2. Hatched lines along the coast in the Hauraki Gulf (Figure 1) indicate "Parts unexplored", while shading inshore of the surveyed coastline may indicate some attempt at terrestrial morphology, as areas around rivers and plains are not shaded. Rounded hillocks of shading along the southern edge of Queen Charlotte Sound show a more detailed attempt at topography.

Figure 4 - Evolution of the chart in Fiordland area "Foveaux Strait to Awarua Rr on the West coast ", published 1858, British Admiralty. Inset highlighted in red: "Pickersgill Harbour from Captn Cook's Voyage 1773".


NEW ZEALAND
SOUTH ISLAND
SHEET XII
FOVEAUX STRAIT to AWARUA Rt
ON THE WEST COAST.
SURVEYED BY CAPTN J.L. STOKES, COMMANDER H.C. RICHARDS.
DEAS COVE
ANITA BAY
FRESHWATER BASIN
FACILE HARBOUR
PORTS AND ANCHORAGES IN SHEET XII
PICKERSGILL HARBOUR
BUCK COVE
ANCHOR ISLAND HARBOUR
NORTH PORT
SOUTH PORT
RESOLUTION ISLAND
TEWAEWAE BAY

Later charts, dating to the mid-1850s and early-1900s, still belong in this era as they use leadline, sextant and chronometer observations by the Royal Navy. In Figure 4 we see sounding densities increasing in the sheltered harbours of Fiordland as well as transit and exploratory deep water lines running away from the coast. In 1858 the deepest depth charted off Fiordland was 288 fathoms. Depths in Figure 4 are in fathoms on an unspecified datum, heights are shown in feet above High Water. Longitude is now "East from Greenwich". The 1858 chart of Fiordland uses some topographic mapping (from "a New Zealand Government Map") to plot the coastline. This chart has several larger-scale plans, and the one highlighted in red in Figure 4 is Pickersgill Harbour from Captn Cook's 1773 survey. Also inset are two areas containing survey data from "Vancouver's Voyage" in 1791. Captn Stokes' 1851 work on the HMS Acheron is the survey that collected the remainder of the data on this chart, including that in the other six insets. On both Figure 4 and 5 the names of the captains and assistant lieutenants as well as the vessel names and survey dates are listed in the header, with the supervising hydrographer's name beside the publication details at the bottom.

Other Admiralty charts from our focus areas have similar characteristics. A 1907 version of the northern Hauraki Gulf (the blank area to the west of the Firth of Thames in Figure 1 uses measurements by survey ship HMS Penguin from 1904-05, as well as data from HMS Acheron in 1849. The coastline is detailed. Depths are evenly spaced in deeper parts of the Gulf, but become sparse to the east of Great Barrier Island and on both sides of the Coromandel Peninsula. The deepest depth shown is 124 fathoms. Seabed descriptors and types are recorded: coral, dark, fine, green, grey, mud, rock, sand, shells and stones.

Figure 5 - Evolution of the chart in the Firth of Thames and Mercury Bay area "Great Barrier Island to Mayor Island including Hauraki Gulf", published 1943, British Admiralty.


NEW ZEALAND
NORTH ISLAND - EAST COAST
GREAT BARRIER ISLAND to MAYOR ISLAND
INCLUDING
HAURAKI GULF
Surveyed by
CAPTAIN A.D.N. WYATT, R.N.
AND THE OFFICERS OF H.M. SURVEYING SHIP "ENDEAVOUR" 1931
SOUNDINGS in FATHOMS
CAUTIONS
HAURAKI GULF
COLVILLE CHANNEL
JELLICOE CHANNEL
BROWNS CHANNEL
MERCURY ISLANDS
MOTU MAHOE GROUP
PORT OF THAMES
Longitude 175° East from Greenwich
3797
RESERVE PROOF

The 1943 chart of a similar area (Figure 5) shows the addition of more depth data collected in 1937, which extends sounding density to a continuous 100 fathom contour in the east, and has some deeper soundings further offshore (the deepest at 1300 fathoms). The datum for soundings is now displayed as "approximately 1ft below the level of Mean Low Water Springs" and the heights are now above High Water Springs. Seabed types are still present, tabulated tide information is added for the mariner, and cautions are made regarding submarine exercises and a telegraph cable in Rangitoto Channel.

Acoustics and Satellite Positioning
Technology and methods

Laborious techniques using lead and wire lines with angular positioning to shore stations or known landmarks continued to the early 1900s (Collingridge, 2002; Ross, 1969; Theberge, 1989). Then, in the 20th century, two major technological developments impacted hydrographic surveying. Firstly, came the use of sonar to measure ranges by transmitting an acoustic wave and recording the time for the echo to return back from the seafloor. While sound had been used much earlier to determine the speed of sound in water,[5] underwater acoustic use for military signalling and object-detection purposes began in the early 1900s, and depth measurement techniques followed. The first hydrographic surveys utilising echo sounding are said to be a 1922 cable route in Europe and a bathymetric survey in the United States (Theberge, 1989). Early echo sounding systems relied on skilled operators to listen to the transmit and return signals and continuously fine-tune their system, so further developments worked to reduce this human input. From the 1960s other underwater technological developments used by hydrographers began to emerge, including sidescan sonar for seafloor 'images', magnetometers and underwater acoustic positioning methods. Initial development of swath mapping technologies (which would become multibeam systems) also began (Theberge, 1989).

The second major 20th century evolution to affect hydrography came in the latter part of the century with the development of electronic positioning methods. These evolved from radar ranging

(Hall et al., 1958; Ross, 1969), to microwave, radio and range-range systems and culminated in the Global Positioning System (GPS) network in 1995 (IHO, 2012). A methods paper on the use of radar by the RNZN mentions that when surveying at 12 knots a fix was required every two minutes (Hall et al., 1958). With electronic recording this fix rate would eventually increase to several times a second.

The early use of singlebeam echosounders by hydrographic surveyors required multiple personnel and methods that combined the individual efforts of each. Archive footage of hydrographic operations onboard the HMNZS Lachlan in 1953 (Carter, 2006) shows two hydrographers taking simultaneous horizontal angles to known points on land (landmarks or perhaps trig points established in conjunction with land surveyors). In the footage, the sextant angles are verbally reported to the Commander who uses a station pointer (three-armed protractor) to plot a numbered fix at the intersection of the two observations on a field board. Simultaneously, the same numbered fix is recorded manually onto the paper trace of the echosounder. At a later time the paper trace is removed, and the sounding value for each fix is obtained. Similar operations also occurred on smaller survey boats (Ross, 1969). Understandably, this method (using at least 4 personnel at once) did not result in a very high density of soundings when compared to modern methods. It did, however, provide an increase on the traditional leadline approach as the echosounder was continuously sounding, so observing changes in the bathymetry below the vessel was possible. The addition of electronic positioning initially mirrored the HMNZS Lachlan surveying method outlined earlier (Hall et al., 1958), with a requirement for manual timing and recording. Improvements to computing power and storage then enabled echosounder depth soundings and GPS positions to be recorded electronically, with electronic time synchronisation as well as automated tide reductions and statistical quality control checks.

Charting

For our chart analysis of this time period we found a migration of depth units from fathoms to metres in the 1970s and 1980s.

In both Coromandel charts from 1975, and those of Cook Strait and Fiordland from the 1980s the depth datum was Chart Datum - approximately Lowest Astronomic Tide. The first Source Data diagrams appear on our charts. These insets indicate the vessel, date and scale at which survey data in each part of the chart was collated. By analysing these diagrams we found that throughout the 1900s the oldest data on the South Island charts typically starts around 1854-55 (excepting Pickersgill Harbour discussed earlier). The area around the Coromandel was updated more regularly and sections of charts in this area only hark back to surveys in the 1930s and then 1960s. Summing up the difficulties of working with single-point depth measurements (lead and echosounder) the Admiralty chart in Cook Strait from 1954 has the published note: "Owing to the exceptional pinnacle formation of underwater features in these waters it cannot be certain that all have been discovered."

An example of the later portion of this era (1992) is shown around Queen Charlotte Sound in Figure 6. Here, the age of the data ranges from some areas by HMS Pandora in 1854-55 to the most recent survey areas by the RNZN from 1987-89. The names of the higher ranked crew of the survey vessels are no longer recorded on the chart, although the publishing hydrographer remains in the footer. On the notes for this chart we see that the topography is again reliant on Department of Survey and Land Information. Tabulated tide data remains. There is also commentary about marine reserves, marine farms, a voluntary code for oil vessels to keep offshore, the Cook Strait ferries and corrections required by mariners who are using Satellite Navigation Systems on WGS84. Radio towers and roads are symbolised, as are the Cook Strait cables.

Figure 6 - NZ615 "Marlborough Sounds", published 1992, RNZN.


NZ 615
DEPTHS IN METRES
NEW ZEALAND
SOUTH ISLAND - NORTH COAST
MARLBOROUGH SOUNDS
DEPTHS IN METRES
SCALE 1:150 000 (at 41°)
D'URVILLE ISLAND
Rangitoto ki te tonga
QUEEN CHARLOTTE SOUND
TORY CHANNEL
COOK STRAIT
PELORUS SOUND
KENEPURU SOUND
PICTON
CLOUDY BAY
Published at Auckland, April 1992, by the Hydrographic Office of the Royal New Zealand Navy under the superintendence of Commander W.D. Frisken, R.N., Hydrographer.
DEPTHS IN METRES
NZ 615

Underwater acoustic technology is still used today in multibeam echosounders (MBES). MBES differ from the singlebeam echosounder by having separate transmit and receive arrays and the ability to collect hundreds of points across each sounding 'ping'. MBES systems are integrated with high-quality positioning and motion sensing by processing computers which enable rapid real-time beam-forming and generate a swath of soundings (Mayer, 2018). Other depth measuring methods now include vessel-based interferometric sounding and synthetic aperture sonar as well as aerial Airborne Lidar Bathymetry (ALB) and Satellite Derived Bathymetry (SDB). ALB using plane mounted Light Detection and Ranging (LiDAR) system were developed from the 1960s, with systems being used for hydrography shortly after, including the 1990s LADS system in Australia (Guenther, 2004). The Australian LADS airborne LiDAR system was deployed in New Zealand for a survey of the Snares and Solander Islands in 1999. ALB systems can generally measure up to 40m water depth, depending on water clarity. SDB is an umbrella term for any method using ocean data collected by satellite. This may be ocean-scale observations from altimetry measurements of the sea-surface which can be a proxy for the geological structure and thus bathymetry (Mayer, 2018), or processing of multi-spectral imagery closer to shore using known reflectance and depth penetration values to derive depths and seabed types. A benefit of both of these distant remote sensing tools is the potential for seamless data collection from both terrestrial and underwater landmasses. This is something a vessel mounted acoustic system cannot do alone, requiring, for example, combination with laser scanner and unmanned aerial vehicle (UAV) observations.

Positioning using GPS has developed into Global Navigation Satellite Systems (GNSS) utilising multiple constellations such as the Russian GLONASS, Chinese BeiDou and European Galileo systems as well as other smaller national satellites or networks (such as Japan's QZSS). The results from these systems are often combined with broadcast corrections from a network of ground stations which provide world-wide real-time decimetre positioning (to centimetre level if using Real Time Kinematic (RTK) methods or

post-processing). Future projects, such as Seabed 2030 (Mayer et al., 2018) envisage a requirement for the improvement of SDB methods as well as foreseeing an increase in the use of autonomous vessels (and continuing reliance on GNSS) in order to cover the large tracts of unsurveyed ocean (Mayer, 2018).

Advancing technology has changed methodologies, and often enables safer working conditions for hydrographers. Many projects now run SDB and then ALB over an area first, then the processed data from these operations is used by surveyors using MBES onboard vessels to know in advance where dangerous shoaling areas are in their survey area. LINZ recently ran a nautical charting campaign in Tonga following this step-wise approach (Price, 2019). Modern technologies also gather increasingly more data, now enabling the collection of terabytes or billions of data points per day. Each of these points requires processing and storage. Hydrographic software programmes now all offer various statistical spatial processing options (e.g. spline filters or the Combined Uncertainty Bathymetric Estimator (CUBE) tool (Calder & Mayer, 2003)) but we are likely to see further developments in the use of Artificial Intelligence (AI). Such developments will greatly speed up the turn-around time for final product creation. One hydrographic technology company recently stated that the traditional 40mins of office processing time per one hour of fieldwork is reduced to 6mins using their AI methods (Kruimel, 2019).

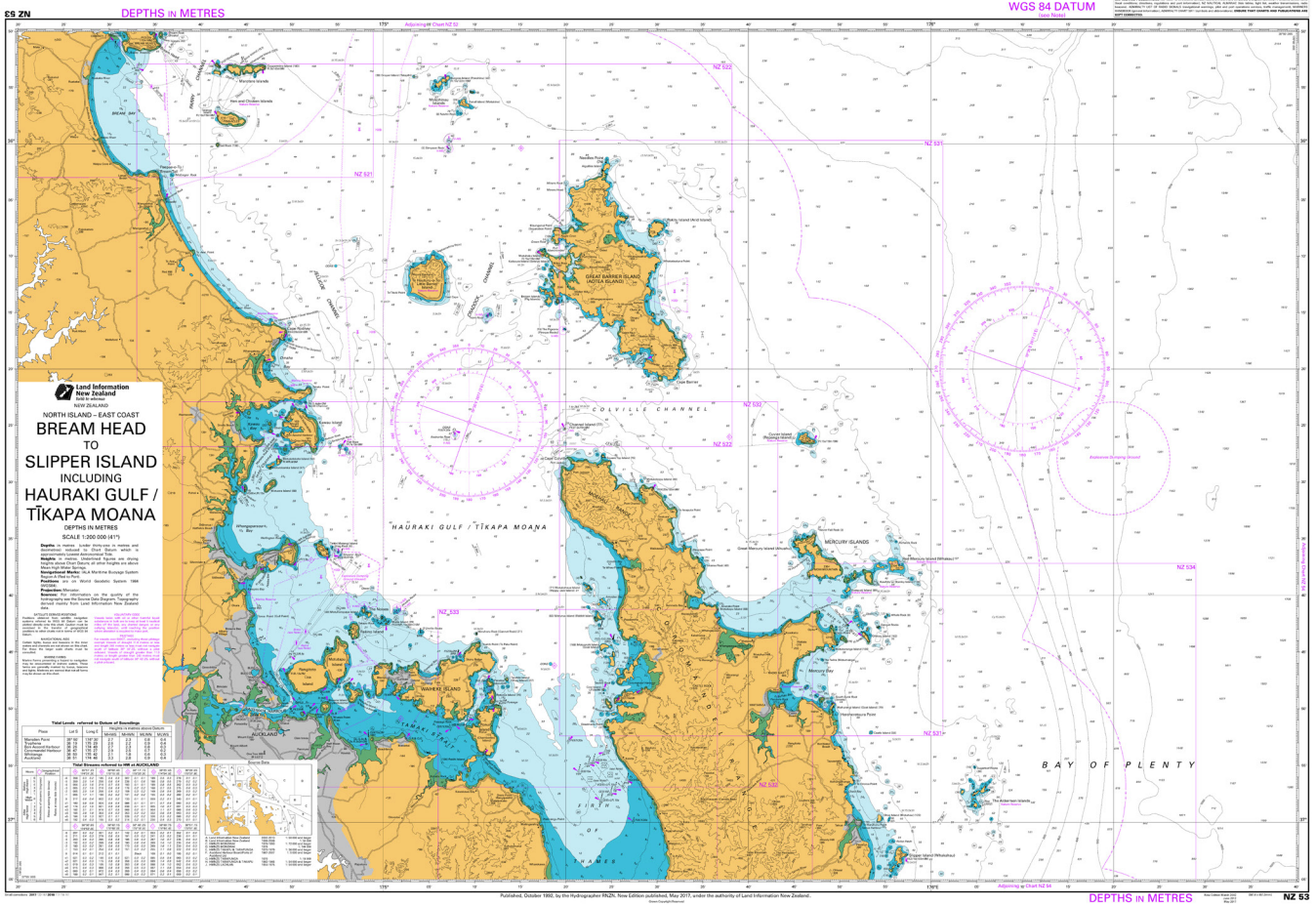
International documentation such as the IHO's Standards for Hydrographic Surveys (s44) and national specifications such as LINZ's HYSPEC document provide clear information for contractors undertaking nautical charting work (IHO, 2008; LINZ, 2016). The s44 document is currently being reviewed and the update is expected to expand to consider more technology and tighten the uncertainty requirements for some applications. In slight contradiction to this concept of higher accuracy, but certainly in line with other initiatives such as the Global Bathymetric Chart of the Oceans (GEBCO), is the increasingly popular concept of crowd-sourced bathymetry (CSB). Organisations such as OpenSeaMap, TeamSurv or ARGUS already undertake processing of data collected by commercial or recreational vessels who use their systems (Panayotov, 2019), and an

IHO Working Group established in 2015 has produced guidelines for the use of CSB for charting and non-navigational mapping activities (IHO, 2019).

Charting

Investigation of the most modern charts in each of our areas shows changes in their availability – all are available as paper or digital versions which allow integration into an Electronic Chart Display and Information System (ECDIS). In these modern charts we see a change in colour palette (Figure 7). Land is now yellow (or grey over cities) and the 10 and 30m contours are clearly shown with areas shoaler than these values highlighted in two different shades of blue. In the Hauraki Gulf (Figure 7) there are fewer depth values present than in the past (Figure 5), and over time hatching and then contouring of the land has decreased. The Māori name Tīkapa Moana/Hauraki Gulf is now used in the title of the chart in Figure 7.

Figure 7 - Current chart: NZ53 "Bream Head to Slipper Island including Hauraki Gulf / Tīkapa Moana", published 2017, LINZ.


NZ 53
DEPTHS IN METRES
WGS 84 DATUM
Land Information New Zealand
NEW ZEALAND
NORTH ISLAND – EAST COAST
BREAM HEAD
TO
SLIPPER ISLAND
INCLUDING
HAURAKI GULF / TĪKAPA MOANA
DEPTHS IN METRES
SCALE 1:200 000 (41°)
HAURAKI GULF / TĪKAPA MOANA
COLVILLE CHANNEL
BAY OF PLENTY
GREAT BARRIER ISLAND (AOTEA ISLAND)
MERCURY ISLANDS
WAIHEKE ISLAND
AUCKLAND
Published, October 1992, by the Hydrographer RNZN. New Edition published, May 2017, under the authority of Land Information New Zealand.
DEPTHS IN METRES
NZ 53

Source Data diagrams and tide information persist. No fishing zones appear in Fiordland charts, symbols for wind turbines appear on the south-west coast of Wellington adjoining Cook Strait, and there are more radio masts and marine farm symbols in both our northern areas. Unlike the 1993 chart of Marlborough, highlighted in Figure 6 earlier, there is a note stating that mariners using satellite positioning on WGS84 no longer need to undertake positioning corrections as the new charts are on the same datum.

Charts are now produced under the authority of LINZ, who are the only named organisation on new charts. The names of contracting surveyors who undertook the field work for LINZ, their companies and the vessels used, as well as the publishing hydrographer are no longer mentioned individually, although past vessel names remain. The cartouche showing Cook's soundings in Pickersgill Harbour was removed from the 2006 edition of the Breaksea Sound and Dusky Sound (Fiordland) chart (Robbins, 2011).

Reporting on modern-day charting surveys indicates a larger number of scientific, engineering and environmental measurements taking place during voyages. These have included sound velocity and conductivity, temperature, depth profiles (SVP and CTD), seawater samples, bird and fish movements and underwater photography, as well as the use of tools such as: Acoustic Doppler Current Profilers (ADCP); Remotely Operated Vehicles (ROV); magnetometers; sub-bottom profilers (SBP); and laser scanners (DML, 2015; NIWA, 2012). Recognising the significant cost of hydrographic data collection and the benefits this information can provide for many other uses, scientific partnerships with traditional nautical charting operations are increasing. One example is the recent Marlborough District Council (MDC) and LINZ partnership that produced the 2016 Queen Charlotte Sound survey, with the full bathymetry shown in Figure 8. Here the hydrographic data collected supported updated charts for LINZ, but also enabled projects such as habitat analysis of the Sound for the Council (MDC, nd).

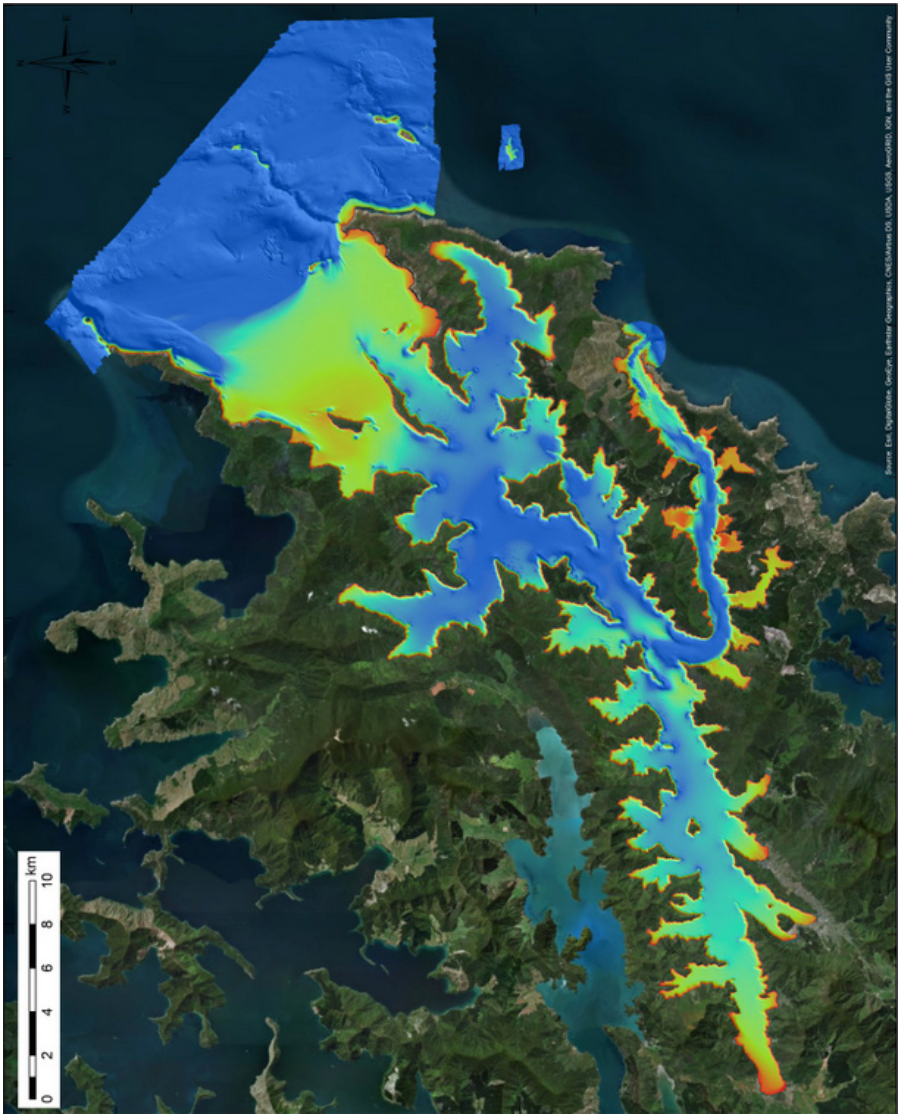


Figure 8 - Screenshot from Marlborough District Council (MDC) online "Seabed Habitat Maps", showing the bathymetry of the Queen Charlotte Sound/Tōtaranui in a 2m sun-illuminated digital elevation model (warm colours are shallower) (MDC, nd). This area was surveyed with multibeam echosounders (swath and interferometric systems).

Over the last 250 years we have moved from manual measurement techniques to fully digital and many automated operations. We gather much more data than in the past, faster, at much higher accuracies and precisions. The relatively recent combination of acoustic depth measurement and multi-constellation satellite positioning, along with laser and satellite-derived depths has enabled hydrographers to map the seafloor like never before. This trend will continue through the use of unmanned surface and underwater autonomous vessels (USV and AUV). AUV can get much finer resolution measurements by travelling closer to the seafloor than any ship, plane or satellite. Challenges in underwater positioning that affect AUVs continue to be worked on, and this is important as noted in IHO Manual on Hydrography's comment "… an error in position is often more misleading than an error in depth" as mariners are unlikely to navigate their vessels directly over any measured feature they have concerns about (IHO, 2012). To utilise autonomous systems hydrographers will need to adapt their methodologies, possibly spending more of their time onshore monitoring remote unmanned data collection operations, and certainly spending more of their time on planning and quality control than the actual data collection itself. It is clear that over time data collection and processing speed has increased. While Cook's data remained on charts for well over 100 years in many areas, it seems that with the increase in speed and the automation of hydrographic collection and processing it is less likely to be the case for any data collected today.

Beyond the traditional depth, position and tide measurements, the collection of ancillary data remains part of the hydrographic task. Cook took a variety of ancillary observations which complimented his charting work: tides, currents, winds, magnetic declination, gravity (by pendulum), sea temperature and salinity (Skelton, 1968). Seabed samples (of direct importance for anchoring) also appear in our early charts. Samples continue to be collected today for both anchoring and scientific information, although they may be photographic rather than physical in some areas. The coastline and topography has been obtained from topographic survey departments since the 1850s (Figure 4). Some charted symbols such

as the submerged rocks ('+') on our donated charts continue today, although others (marine farms, wind turbines, submarine cables) are obviously modern requirements that are represented by newly developed cartographic symbols.

The charts we have analysed show an evolution of rationale from exploration (1700s to mid-1850s) to those based on some form of risk-based analysis of where to chart next (thus more repeated surveys in the busy Hauraki Gulf approach to Auckland (Figure 5 and Figure 7)). However, we do not think that the charting intentions have particularly altered the hydrographic methods used. Notes on Cook's survey methods highlight his meticulous, precise and scientific work and his honest reporting where he felt his methods were compromised (often due to weather) (Collingridge, 2002; Maling, 1996; Snowdon, 1984). Specifications such as the IHO's Standards for Hydrographic Surveys (s44) and LINZ's HYSPEC today demand the same from modern hydrographers.

By analysing reports of hydrographic surveys in Aotearoa New Zealand since Cook's time, it is clear that hydrographic operations have often involved other parties. In the past hydrographers have been accompanied by botanists, artists, meteorologists and New Zealand Company men looking for suitable settlements (Ross, 1969). Nowadays scientists often accompany hydrographers, or participate in fieldwork planning to ensure the maxim "collect once, use many times" is achievable. As the benefits of multidisciplinary studies are shared more widely it is likely this collaborative work will also increase - see the work that created Figure 8 (MDC, nd). It is also likely hydrographers will continue to expand their work into fields beyond nautical charting.[6]

Charting

We suggested earlier that charting efforts in Aotearoa New Zealand have moved from exploration to risk-based analysis. However, perhaps there is not actually a difference as each time period had an economic basis behind the reason for charting: firstly to find (and claim) the great southern continent, then to support shipping and colonisation efforts, and now in support of the Blue Economy.

Regardless of the requirement behind each chart, some aspects of charting appear to have remained fairly constant. Interestingly, it seems that the jumps in technology and methods used by hydrographers for nautical charting are not immediately visible in a study of modern-day charts. The display of the depth soundings, contours of coastline, topography and bathymetry are only minimally changed and we feel that navigators of Cook's time would have no issues using modern charts – once the units used were explained of course. It is only when one looks closer that indications of modern technology appear. One of these is the use of fewer depth values, but more detailed depth contours. This development matches a move from single-point depths from the likes of a leadline or singlebeam echosounder to MBES/LiDAR swath systems which provide full ensonification of the seafloor. A cartographer can be more comfortable they are definitely highlighting the shallowest points to the mariner if the latter tools have been used. In the past, due to the spacing of survey measurements there was perhaps more generalisation of contours and a shoal bias (i.e. moving shoaler contours seaward where uncertainty existed) that influenced cartographic decisions.

Source Data diagrams continue on charts and provide a fascinating insight into the longevity of data. In the authors' experiences, many of those who use charts for non-navigational work (such as research, engineering or planning) are unaware of the multi-generational age of data on charts. One danger with the Source Data diagram is that in order to be able to ascertain the quality of the measurement, the chart user needs some appreciation of the technology and methods available in the time periods mentioned, and then to assume which of these was used if no other information on the surveys can be found. This is where the more modern Zones of Confidence (ZOC) are preferable as they provide accuracy values derived from professional analysis of the technology and methods themselves (Smith & Cox, 2007). These are typically used for electronic chart applications. It will be interesting to see if they appear on physical copies of nautical charts in the future.

Indeed, why do we still have paper charts? Since 2018 it has been mandatory for large commercial vessels (>3,000gt or 10,000gt if built before 01/07/2012) to use ECDIS systems. However, in order to be

completely paperless the International Maritime Organisation (IMO) requires vessels to have two independent ECDIS systems onboard a vessel. For some, the installation and maintenance cost of this has been prohibitive, for others there have been delays with crew training on electronic systems (Latarche, 2017) as well as a generational reluctance. We can see two likely developments for electronic charting. One is the use by autonomous shipping, so the chart must be machine readable but may not make sense to a human. The other is to actually use the vast quantity of data collected by hydrographers. Even on the 1950s HMNZS Lachlan survey it was noted that only a fraction of the data collected ever made it to publication on a nautical chart (Ross, 1969). Considering the large volumes of data collected today, this fraction is even smaller on modern charts. Therefore, surely we will soon see a move to 3D and virtual-reality-type charting systems, enabling mariners and other users to utilise the entirety of the collected data. As in data collection and processing, automation of charting outputs is also likely.

Chart production in Aotearoa New Zealand has moved from the distantly located British Admiralty, to The Royal New Zealand Navy (RNZN), and most recently to the government department LINZ. One of the changes evident on charts after the move to LINZ is the removal of the names of surveyors, vessels and superintendents supervising chart publication. In some ways this seems to down-play the efforts of modern-day hydrographers in their charting work, or at least appears to remove links to their relatively well-known ancestors, such as Captain Stokes on the HMS Acheron whose name appeared on our charts for over a century (see Figure 4 for an example). The removal by LINZ of the Cook cartouche for Pickersgill Harbour reinforces this (Robbins, 2011). However, if we are to move to incorporating Crowd-Sourced Bathymetry (CSB) in our charts - and thus add many more contributors - this more de-personalised presentation of data may make sense.

Conclusion

Reflecting on the changes in hydrographic technologies and methods, and the nautical charts they produce provides us with one way to consider the development of hydrography in Aotearoa New Zealand.

In some ways the changes have been exponential, such as when we consider depth measurement as isolated points manually felt through leadline deployment, to strings of echosounder tracks, to the full seabed imagery possible with today's technologies. In other ways requirements have remained reasonably similar: pay attention to the weather, be precise in method and reporting, and observe and report on ancillary measurements such as seabed type or currents.

We cannot include all charts analysed in this paper (see Footnote 2), nor did we wish to provide a comprehensive study of the development of nautical cartography – a subject large enough for its own project. Instead we have considered the technology and methods of the hydrographers who collect the data before the creation of the nautical chart, and then highlighted pertinent changes observed in charts in matching time periods. It appears that modern paper-versions of charts are still reasonably similar to those from the past.

In the future we anticipate automation of many aspects of the hydrographic data collection, processing and charting process. Collaboration with scientists and other users of hydrographic data should continue for the benefit of the nation. Finally, we hope to continue to see developments in the final product(s) created from data collected for nautical charting. Obviously the traditional (and vital) safety of navigation lens must persist for nautical charting. However, we hope to see other outputs that enable detailed 3D visualisations and sharing of the entirety of a hydrographic dataset. These outputs will provide significant benefits to areas such as habitat mapping, scientific modelling, engineering and other aspects of our Blue Economy.

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Notes

[1] The International Hydrographic Organisation (IHO) definition of hydrography is "… the branch of applied sciences which deals with the measurement and description of the physical features of oceans, seas, coastal areas, lakes and rivers, as well as with the prediction of their change over time, for the primary purpose of safety of navigation and in support of all other marine activities, including economic development, security and defence, scientific research, and environmental protection."(IHO, 2018)

[2] We intend to display charts used in our analysis in an interactive online webmap at a later date, please contact the authors for more information. All charts after Figure 3 that are used in this discussion come from LINZ. LINZ's hydrographic data are licensed for reuse under CC BY 4.0.

[3] A note on the word 'sounding' which obviously does not relate to the use of more modern acoustic equipment that use sound waves to measure depth. It is an interesting coincidence that the term used for centuries to describe the act of 'measuring the depth', and which links to the Old French sonder, from sonde 'sounding line' is the same as the term relating

to actual 'noise', derived from soun from Old French son 'sound, musical note, voice', from Latin sonus 'a noise' (Online Etymology Dictionary, 2019).

[4] See also our first article "Cook: Out Professional Ancestor".

[5] A crucial component of acoustic measurements at sea is the understanding of the speed of sound in water, as this affects the propagation of the wave that is used for the range measurement. Experimenters from 1820s were measuring this, obtaining the still-recognised average of 1500ms-1 in seawater off Marseilles (Theberge, 1989).

[6] See also our first article "Cook: Out Professional Ancestor".

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