



**Title:** 'Progress?'

**Description:** The extension to Waikawa Marina under construction

**Photographer's name:** Noelle Bennett

**Where and when:** Waikawa Marina, Marlborough. August 2021.

**Sustainability:** We keep our boat at Waikawa Marina in Queen Charlotte Sound, Marlborough Sounds. Queen Charlotte Sound waters are a marine mammal's paradise – they harbour sub-populations of the nationally endangered bottlenose dolphin and orca, as well as the nationally vulnerable Hector's dolphins. Other marine mammals found here include dusky dolphin, common dolphin and New Zealand fur seal. Southern right whales, humpback whales and deeper water species such as pilot whales are less frequent seasonal visitors, but mainly near the Sound's entrances.

Queen Charlotte Sound also boasts a plethora of boaties, and there-in lies a potential conflict. There are two marinas - Picton Marina which has 254 berths and Waikawa Marina with 600 berths. They are about 4kms apart by road and possibly double that by sea because of the need to go around the wonderfully, and rather aptly, named 'Snout' to float from one marina to the other. All berths in both Marinas are full and many boat owners are wait-listed to lease a mooring. So how do you solve that issue? Well obviously, you make one of them bigger! Final resource consent was granted back in 2019 for an extension to Waikawa Marina to add another 250+ berths, which will make it the country's second largest marina behind Auckland.

Work on the Waikawa extension began in mid-2020 starting with land reclamation. A road was constructed where seashore, beach and sea used to be. Huge trucks rumbled down the marina every day to empty their load of rocks and 'in-fill' into the sea. All was duly worked into place until the road was functional and the sea was kept at bay by a rock wall. Then it was time to start building the breakwater and installing the jetties - cue the arrival of the pile driver! The rumble of the trucks was replaced by the double thud from the pile driver, day after day, for hours on end. 'I wonder why we hear the thud twice?' I asked my other half. 'Because sound travels through water quicker than through the air, and we're hearing both because we're in the boat' he said, with a degree of confidence that made me realise he wasn't winding me up!

And then I started thinking, not only about the science, but also about the impact all this could be having on the marine creatures that the Sounds supports. Impact pile-driving is usually carried out using a hammer or drop weight which produces an impulsive, repetitive sound. This sound is among the loudest underwater sounds, particularly when steel piles are being driven. Boat engines are producing a more constant rumble that in some circumstances can be heard km away underwater.

Sound is actually a pressure wave, but this wave behaves slightly differently when it travels through air compared to when it travels through water. Water is denser than air, so it takes more energy to generate a sound wave in water. But once a wave has started, it will travel faster than it would do in air. It works a bit like a relay race but in the case of sound, the runners are particles and the baton they are passing along is the energy of vibration. In a sound wave, a particle picks up some energy and keeps it until it bumps into a neighbouring particle. The next particle will then pick up the energy and transfer it to the next one in the chain and so on. This happens extremely quickly and is detected as a wave of pressure. And that's why sound won't travel in a vacuum, because there are no particles to bump together to transmit the vibration. Water temperature and pressure affect underwater sound transmission and can in some places funnel the sound wave into a "sound channel" which allows sound to travel thousands of miles without the signal losing considerable energy. Hydrophones, or underwater microphones, if placed at the proper depth, can pick up whale songs and human-made noises from many kilometers away.

Most of us remain unaware of the long-distance transmission of underwater sounds because we mainly hear sound waves transmitted through air. Air (gas) particles are generally further apart than they would be in water, so an energated gas particle has to travel further before it bumps into another particle and passes its energy parcel onward. There is not much resistance to movement in air, so it doesn't take much to start a sound wave in air, but then it doesn't travel as fast i.e. water particles are much closer together and can quickly transmit vibration energy from one particle to the next so sound travels over four times faster than in air. Just to put some numbers around the theory, the speed of transmission of sound in air at 20C is 343 metres per second (m/s), which is also known as Mach 1, whilst the speed of transmission of sound in water at 20C is 1,482 m/s. Water is about 15,000 times less compressible than air, but is also about 800 times more dense.

So what impact would this so-called anthropogenic noise (noise originating from human activity) be likely to have on marine mammals? A Lyttleton study (Leunissen & Dawson 2018<sup>1</sup>) suggested that marine mammals could potentially suffer hearing stress and injury as well as habitat avoidance due to the associated increase in underwater noise production. That study further noted that Hector's dolphins may be particularly sensitive to piling-generated noise. However, there have been no studies looking at the long-term effects of exposure to pile-driving noise. Short-term avoidance reactions may not necessarily lead to long-term effects, or more lasting population impacts (these require survival and reproduction to be disrupted). A related dilemma centres on "cumulative risk" – it is sometimes very hard to predict the impact of one more initiative when its potential impact joins a multitude of earlier or surrounding impacts.

The potential impact of the Waikawa marina extension illustrates a depressingly common dilemma in environmental risk management – absence of evidence of impact is not the same as evidence of absence of impact! A debate about whether to proceed with a development rapidly leads to a debate about uncertainty and who holds the "burden of proof". The "Environmental Precautionary Principle" asserts that when uncertainty exists and irreparable damage to the environment is possible, decision makers should always err on the side of protecting environment. In practice, lack of firm evidence of environmental impact usually gives enough wriggle room for developers to be given warrants to proceed.

What seems to be clear is that noise can have various negative effects on marine mammals. Should it therefore follow that it is important to establish safe limits for anthropogenic noise in the ocean? There are currently no national or

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<sup>1</sup> Leunissen EM, Dawson SM. Underwater noise levels of pile-driving in a New Zealand harbour, and the potential impacts on endangered Hector's dolphins. *Mar Pollut Bull.* 2018 Oct;135:195-204. doi: 10.1016/j.marpol-bul.2018.07.024. Epub 2018 Jul 14. PMID: 30301031.

standard guidelines for pile-driving activities within New Zealand waters. But I guess it is challenging to define a 'safe' limit because it is difficult to know to what extent a reaction to noise – whether behavioural or physiological – represents a significant problem for animals in the wild. But, for me anyway, that doesn't mean we should just pretend there is no impact.

I think I'll call on Einstein for a bit of help here. He summed things up so well when he said, *"A human being...experiences himself, his thoughts and feelings as something separated from the rest, a kind of optical delusion of consciousness. This delusion is a kind of prison for us, restricting us to our personal desires and to affection for a few persons nearest to us. Our task must be to free ourselves from this prison by widening our circle of compassion to embrace all living creatures and the whole of nature in its beauty."*

**Photographer's notes:** I was going to call this image 'X marks the spot' but that title really didn't convey what I was trying to say. This commentary does feel slightly two-faced because, after all, we have our boat here. But I don't think I had ever really thought about how marinas come into being...and I suspect that's a common theme for many things. We simply don't understand what is involved in creating something and don't grasp the potential impacts.

The posts you can see in this image are just a few of the piles that are being driven into the sea floor. There will have been 264 in total driven into place to complete the breakwater and jetties. Over a period of about 10 months, 188 of them have been added so there are still another 76 to go. I often feel that nature is viewed as something simply to be used, but surely that is a flawed attitude. Nature is not a commodity. As a photographer, I need to feel part of it because it's so very much a part of me...and indeed of all of us. Truly seeing nature is about empathy and awareness. Truly seeing nature is about caring for the scene in front of us.

**Photo specs:** I wanted to add a bit of extra moodiness to this image so did a longer exposure to soften the effect of the sea. Technical specs: The image was taken using a Panasonic DC-G9 camera and a Panasonic Lumix G-Vario 12-35mm f/2.8 lens. Exposure details - 4ec at f/8 with an ISO of 100 and a focal length of 26mm (52mm full frame equivalent).

**Digital specs:** 7128 x 4315 pixels (30.76MP) @ 300dpi

**Key words:** sea, pile driving, marina, Waikawa Marina, sound, sound waves, sound pollution, Queen Charlotte Sound, extension, Ecological Precautionary Principle, burden of proof, Noelle Bennett, Ecosystems Photography, sustainability.

**Price:** \$200 (incl. GST) for use of the digital image. Visit [www.ecosystemsp photography/sales](http://www.ecosystemsp photography/sales) for details & to order, or to get a quote if you would like a high-quality print.

**Donation:** The price includes a \$100 donation to a sustainability organisation or project of your choice, or otherwise for WWF-NZ [https://www.wwf.org.nz/what\\_we\\_do/](https://www.wwf.org.nz/what_we_do/)

We recommend that the donation goes to WWF-NZ because of their action longstanding work to protect Hector's Dolphins and for marine ecosystem health. They apply evidence-based environmental advocacy and support education and community-led action.

**Image ref:** NB#041 (please use this reference in all orders and correspondence).

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