Before the Decision-Making Committee of the Environmental Protection Authority At Wellington

Application for Marine Consent by Trans-Tasman Resources Ltd

IN THE MATTER OF	the Exclusive Economic Zone and Continental Shelf (Environmental Effects) Act 2012
AND	
IN THE MATTER OF	An application by Trans-Tasman Resources Ltd for a marine consent application made to excavate iron sand from the seabed of the exclusive economic zone in the South Taranaki Bight, process that sand to remove iron particles and return the remaining sand to the seabed.
	Kiwis Against Seabed Mining Incorporated (KASM)
	Submitter

Further Evidence of Professor Elisabeth Slooten

On Behalf of Kiwis Against Seabed Mining Incorporated

Dated 15 March 2017

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Introduction

1. My name is Elisabeth Slooten.

2. I prepared evidence (dated 24 January 2017) in these proceedings, which I presented to the DMC (on 21 February 2017). The purpose of this statement of further evidence is to provide the additional information I undertook to provide in response to some of the DMC's questions. I will also clarify a few points in my evidence, which are touched on in the Joint Statement of the Marine Mammal Experts (dated 4 March 2017).

3. I have read the Code of Conduct for Expert Witnesses Environment Court's Consolidated Practice Note (2014). In so far as I express expert opinions, I agree to comply with that Code. In particular, except where I state that I am relying upon the specified evidence of another person as the basis for any expert opinion I have formed, my evidence is within my sphere of expertise. I have not omitted to consider material facts known to me that might alter or detract from the opinions which I express.

Impacts of fishing on Maui dolphins

4. The DMC asked if I could provide further information on the location of fishing effort and dolphin deaths in fishing nets (gillnets and trawling). The gillnet fishing data in the maps I showed were from the years 2006-2012. I believe the trawling data were from the same time period, but have not been able to verify that. I would be happy to request this information from MPI (these kinds of requests are normally treated as Official Information requests and can take several months to resolve).

5. The location of dolphin deaths (and the location of the fishing effort) is often only known at the level of relatively large geographical areas. I have not been able to find information on whether or not any dolphins have been caught in the proposed mining area or the wider area that would be affected by noise, sedimentation and ecological impacts resulting from mining. The reporting

rate for dolphin bycatch (by fishermen and government observers) is very low, partly due to the very low level of observer coverage (about 2% in Maui dolphin habitat).

Publications showing TTR noise assessments are simplistic

6. The DMC asked me to provide copies of the scientific papers I mentioned when I presented my evidence on 21 February. They are attached.

7. The pre-press abstract of Forney et al. (2017) has been published online http://www.int-res.com/prepress/n00820.html The full article will appear on the website of the scientific journal Endangered Species Research sometime in the next few weeks. The final version of the paper, as accepted by the journal, is attached.

8. Forney et al. (2017) outline potential impacts on marine mammals that are displaced from their habitat by noise. These include stress, reduced feeding success and impacts on survival and reproduction. Maui dolphin is one of the case studies in this paper. As I mentioned at the hearing, one of the other case studies is harbour porpoise off the coast of California where a proposal for a seismic survey was rejected to protect the local population of 2,000 to 3,000 harbour porpoises. This species if widely distributed around the Northern Hemisphere and the Californian population is not listed as Threatened or Endangered under US legislation. The seismic survey was scheduled to last 82 days. The environmental impact report for the seismic survey identified a zone in which noise levels were expected to exceed 180 dB and 160 dB (re 1µPa RMS) with 160 dB exceeded in an area of 1,820 square kilometres. This meant potential injuries for harbour porpoises remaining in their habitat and being exposed to noise. Porpoises avoiding the noise by moving tens of km, as documented in other research (see below), would be forced out of their core habitat where prey may be less common or they could be exposed to other risks such as predation or entanglement in fishing nets. The US government concluded that harbour porpoise could be exposed to significant harm, whether they remained in the area and were exposed to loud noise or avoided the noise by leaving the area. Initially, the US government required the project

to be scaled back to a smaller area and time period, and required a detailed monitoring and mitigation plan, including replicated "before, during and after" population surveys, a network of passive acoustic monitoring instruments and beach surveys to detect any stranded animals. The primary goals were to establish baselines of porpoise distribution and stranding rates, allow detection of changes in distribution and behaviour and document any strandings quickly enough for the noise to be stopped. Even this detailed monitoring plan would have had the ability to detect only severe, broad scale impacts (e.g. displacement of large numbers of porpoises, mass strandings). The final US government decision was to deny approval for the seismic survey.

9. Slide 18 of the powerpoint presentation I used on 21 February (and submitted as a hearing document) shows a map (from Forney et al. 2017) of the area within which noise was expected to be 160 dB and a 20 km buffer zone because harbour porpoise are now known to be displaced over this distance by these noise levels. It would be very useful for TTR to produce a map of expected noise levels in the STB if the proposed mining operation is approved. This would make it possible to assess the impacts of these expected noise levels on marine mammal species including Maui dolphins and blue whales.

10. At the hearing I presented information from Dyndo et al. (2015; attached). This is one of several recent studies showing that harbour porpoise are much more sensitive to noise than would be predicted from their audiogram. Dyndo et al. (2015) showed that harbour porpoise react strongly to shipping noise, which (like mining) has most of its energy in the low frequency range and has until recently been thought to be of relatively little importance for harbour porpoise, Maui dolphins and other species that produce high frequency sounds. Dahne et al. (2013) show that pile-driving noise can affect harbour porpoise at distances on the order of tens of kilometres. This is consistent with earlier research by Kastelein et al. (2011) who showed that harbour porpoise are sensitive to noise over a wide frequency range. For example, they do not have poor sensitivity at 500 Hz (and 95 dB) and even at 250 Hz (about 110 dB). Harbour porpoise show increased sensitivity for noise of longer

durations. Likewise, Pirotta et al. (2013) shows that dredging can displace dolphins from feeding habitat.

11. The simplistic approach used by Childerhouse for predicting the sensitivity of different species to noise is now outdated. It was already clear from the Southall et al. (2007) study that there is no clear cut off (whether 120 dB or 135 dB) above which one should expect a behavioural response and below which there will be little or no response.

For this reason, Southal et al. (2007) never proposed a threshold exposure level for behavioural response: "It is clear that behavioral responses are strongly affected by the context of exposure and by the animal's experience, motivation, and conditioning. This reality, which is generally consistent with patterns of behavior in other mammals (including humans), hampered our efforts to formulate broadly applicable behavioral response criteria for marine mammals based on exposure level alone. ... For other anthropogenic sound types (multiplepulses, nonpulses) [ie continuous sound], we conducted an extensive review of the available literature but were unable to derive explicit and broadly applicable numerical threshold values for delineating behavioral disturbance." (quote from Southall et al. 2007)

For the same reasons, the recent US National Oceanographic and Atmospheric Administration guidelines (NOAA 2016) do not specify a threshold (such as the proposed condition 12). Southall et al. (2007) documented some very strong responses to noise that was either not very loud or not within the frequency range one would expect the species in question to be sensitive to. The more evidence is gathered, the clearer it becomes that a simple noise cut off is too simplistic (Southall was one of the co-authors of the Forney et al. 2017 paper). The duration of the noise, the frequency spectrum, the acoustic environment are other important factors. For example, Miller et al. (2012) found that exposure to a European naval sonar system using Low Frequency Active Sonar (LFAS), at frequencies of 1-2 kHz, resulted in both a greater number and more severe reactions in killer whales than Mid-Frequency Active Sonar (6-7 kHz). This despite the behavioral and electrophysiological audiograms of 3 killer whales showing 10-40 dB less sensitivity at 1-2 kHz than 6-7 kHz. Miller et al. (2012) also noted that sperm whales showed greater sensitivity to noise at MFAS frequencies than LFAS frequencies based on electrophysiological data, yet responded more often and more strongly to the 1-2 kHz LFAS than the 6-7 kHz MFAS, mimicking the trend for killer whales (Miller et al. 2012).

Though seismic airgun surveys emit predominantly low-frequency noise, small odontocetes, who tend to be high-frequency specialists, showed the "strongest lateral spatial avoidance" of active airguns across all other cetacean species, with avoidance "extending at least as far as the limit of visual observation" (Stone and Tasker 2006). Weir (2008) also found that Atlantic spotted dolphins showed the most marked overt avoidance of airgun noise in comparison to sperm and humpback whales, contrary to what one would expect based on audiograms. Dolphins appear to be able to detect low-frequency sound through a mechanism other than conventional hearing. Turl (1993), for instance, discovered that a bottlenose dolphin responded to 50-100 Hz sounds perhaps by detecting particle velocity or a combination of pressure and velocity in the near field. He cited studies showing how innervated and sensitive to vibrations the skin of the dolphin is. Various areas on the head can detect small pressure changes, and mechanoreception might be another sense dolphins use to detect low-frequency sound (Turl 1993). Another complication is that most of the hearing ranges reported by Childerhouse are constrained not by the hearing sensitivity of the marine mammals tested but by the range of frequencies tested. Some of the older studies in particular used equipment with a relatively narrow frequency range.

12. Harbour porpoises and beaked whales are more behaviorally and acoustically reactive than would be expected.

There are substantial differences in how reactive various cetacean species are, which has little to do with their sensitivity across frequencies. Certain species are often characterized as more "shy", "skittish", or "nervous". Even if harbour porpoises are not low-frequency specialists, they may be behaviorally more reactive and thus sensitive to low-frequency sound. Bain and Williams (2006) note that harbour porpoises are "...generally considered more shy..."

than Dall's porpoises. There are ecological reasons why smaller species might be more skittish than larger ones, as they are more vulnerable to predators. In any case, there are no data to support harbour porpoises not being at least as reactive to low frequencies as low-frequency specialists. The Navy itself (DON 2008) noted, for harbour porpoises, the "...very low threshold level of response for both captive and wild animals..." (p. 4-61). It devoted a whole section (4.4.5.3.9) to "Specific Consideration for Harbour Porpoises" (p. 4-61).

There are many studies that show disturbance to high frequency cetaceans from noise with most of its energy in the low frequency range, such as pile driving and harbour porpoise (Carstensen et al. 2006, Tougaard et al 2009, Brandt et al. 2011, Brandt et al. 2016, Dahne et al. 2013). Pile driving noise (also broadband) has the highest energy in the the same range as mining (around 100-500 Hz) yet harbour porpoise are clearly disturbed by the noise, even though their most sensitive hearing is at a much higher frequency.

13. Maui and Hector's are high frequency specialists, like harbour porpoises. Harbour porpoise respond to low frequency noise down to 250 Hz. This means there is substantial overlap with mining sounds. Moreover, low frequency sounds can be felt (via skin sensation, resonance with air sacs, etc.) as well as perceived strictly through auditory means. Animals do not always respond most strongly to sounds in their best sensitivity range. There are now numerous examples of marine mammals that are not expected to react to sounds as they are outside of their best hearing sensitivity, yet react they do, and often strongly (gray whales and HF whale-finding sonar, dolphins and airguns, beaked whales and naval sonar, etc.).

14. The suggestion that mining noise is similar to vessel noise does not make sense. Vessels are transitory whereas mining operations represent a long-term noise source. Mining is therefore likely to be more damaging, especially if located in important feeding, resting, or breeding habitat. Furthermore, the proposed mining operation would be additional to shipping noise, and would increase the amount of shipping activity in the area. It will be important for the DMC to consider the cumulative impact of the existing impacts on marine

mammals in the area (including shipping and fishing) and the newly proposed activity, added together.

15. In summary, a much more sophisticated approach to evaluating the potential impacts of noise is required before the DMC can make an informed decision on the mining proposal. The literature on this topic (including the articled mentioned here and in my primary evidence) provides ample examples of thorough studies of human-made noise and its effects on marine mammals.

16. I have double checked the paper by Hatch et al. (2012). Right whales do not appear to avoid ships. Collisions between ships and right whales are relatively common in the north Atlantic. However, right whales have lost on average 63-69% of their communication space. One or more of the whales in the study area (near Boston) was exposed to noise levels higher than 120 dB by ships for 20% of the month and up to 11 whales were exposed to noise at or above this level during a single 10 minute period. This is one of an increasing number of studies that has demonstrated the limitations of setting an exposure threshold (such as the 135 dB in the proposed conditions). Without more information about both the noise characteristics of the proposed mining operation and the presence of marine mammals in the area where this sound would be audible, it is not possible to estimate these kinds of metrics for the TTR operation (e.g. noise level at a range of distances, number of marine mammals exposed to specific noise levels, for what length of time, etc).

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