Before the Environmental Protection Authoritby OMV Ltd

IN THE MATTER OF	the Exclusive Economic Zone and Continental Shelf (Environmental Effects) Act 2012
AND	
IN THE MATTER OF	An application by OMV Ltd for a marine consent application to drill for oil in the South Taranaki Bight.

Evidence of Associate Professor Elisabeth Slooten

30 September 2014

STATEMENT OF EVIDENCE OF ASSOCIATE PROFESSOR ELISABETH SLOOTEN

Qualifications and experience

1. My name is Elisabeth Slooten. I am an Associate Professor in the Department of Zoology at the University of Otago in Dunedin, where I have worked since 1990. I have undertaken extensive research on marine mammals in New Zealand coastal waters since 1984, including research on New Zealand dolphins (Hector's and Maui's dolphins), bottlenose dolphins, sperm whales, right whales and New Zealand sealions.

2. I hold Bachelor of Science and Master of Science (first class honours) degrees in Zoology from Auckland University, and a PhD in Zoology from Canterbury University.

3. My research includes population surveys to study the abundance and distribution of marine mammals, estimation of survival and reproductive rates, behavioural research, population viability analyses and risk analyses to quantify the impact of fishing, tourism and other human activities on marine mammals. The population survey work includes boat surveys, aerial surveys using planes and helicopters, acoustic surveys using towed hydrophone arrays, directional hydrophones and passive acoustic data loggers. I was invited to join an overseas, large-vessel, whale and dolphin survey in order to train scientists from the United States National Marine Fisheries Service in the use of some of these techniques.

4. I have published two books, more than 100 peer-reviewed papers in scientific journals, chapters in scientific books, encyclopedia chapters and over 40 invited or contracted reports and papers on these topics. The books and more than 40 published papers have been specifically on the biology, behaviour and conservation biology of the New Zealand dolphin.

5. I am the co-director of the Otago University Marine Mammal Research Group. Other researchers in this group also directly involved in research on Maui's dolphin include Associate Professor Stephen Dawson, Dr William Rayment, Trudi Webster, Tom Brough, Marta Guerra-Bobo, Maddalena Fumagalli and David Johnston.

6. I was awarded the Sir Charles Fleming Award for outstanding contribution to environmental science in 2004, by the Royal Society of New Zealand. This award is made once every three years, and was awarded to me jointly with Professor Stephen Dawson.

7. I have represented New Zealand on the Scientific Committee of the International Whaling Commission (since 1992) and am a member of the Cetacean Specialist Group of the IUCN (since 1991). I am regularly invited to examine PhD theses from New Zealand and overseas universities, invited to participate in national and international conferences and workshops about marine mammal science and threats to marine mammal populations, and invited to referee scientific publications in a range of New Zealand and international scientific journals. I have been the Secretary and President of the New Zealand Marine Sciences Society. I am regularly commissioned by government departments and commercial clients to prepare reports on the potential impacts of human activities on marine mammals. I chaired the organising committee for a major international conference of the Society for Marine Mammalogy held at Otago University in 2013.

8. I teach graduate and undergraduate courses at Otago University on the biology of marine mammals, marine vertebrates, marine conservation biology, ecology, population viability analysis and statistics. I have supervised 51 graduate student projects, including 17 MSc and 20 PhD projects. My role at the University of Otago has included setting up and being the Director of a graduate programme in Environmental Science.

9. I have previously provided expert evidence at Regional Council Hearings, Environment Court Hearings, the EPA hearing on the TTR sand mining proposal and other Expert Panels and Advisory Panels.

10. I confirm that I have read the 'Code of Conduct for Expert Witnesses' as contained in Schedule 4 of the Judicature Act 1908 and the Environment Court Consolidated Practice Note 2011. I agree to comply with these Codes of Conduct. Except where I state otherwise, this evidence is within my sphere of expertise and I have not omitted to consider material facts known to me that might alter or detract from my advice.

Key points in this evidence

11. Marine mammal species known to use the South Taranaki – Cook Strait area include Maui's dolphin, blue whales, bottlenose dolphins, common dolphins, dusky dolphins, Risso's dolphins, killer whales, false killer whales, fin whales, humpback whales, pilot whales, minke whales, sei whales, right whales, Bryde's whales, sperm whales and NZ fur seals (Mac Diarmid et al. 2011, Torres 2012, McConnell 2014).

12. The information on marine mammals provided by the applicant is inadequate. Like the information provided for the TTR sand mining proposal, it is essentially a list of marine mammal species known to occur in the area. Most of the marine mammal data are anecdotal, based on reports from cargo vessels and members of public.

13. A scientifically robust survey, using a combination of visual and acoustic methods, would need to be carried out in order to assess the potential effects of the proposed mining on marine mammals in the area. This survey should be designed to provide data on marine mammal densities and habitat use in the area. In the absence of such data, it is not possible to accurately assess marine mammal densities and habitat use, and therefore the potential impacts of the proposed project on marine mammals.

14. The proposed mining activity includes the drilling of up to seven new oil wells. This would occur inside the habitat of New Zealand (Hector's and Maui's) dolphins, in waters less than 100 m deep.

15. As indicated in the EPA staff report, any oil spills caused by the proposed drilling of oil wells have the potential to cause severe environmental impact. The relatively small oil spill caused by the grounding of the vessel Rena highlights the potential impacts of such pollution events, especially given that there are several endangered species of marine mammals in the area.

16. Research following the Gulf of Mexico oil spill has provided a large amount of additional data on the impacts of oil spills. Impacts on marine mammals are caused by inhalation, direct contact with oil (e.g. with skin and eyes), and ingestion of oil in or on prey. The health impacts include bronchitis and other lung disease, tooth loss, inflammation, compromised adrenal function and other changes to metabolism (e.g. Schwacke et al. 2014).

17. The recent abandonment of an oil well off Gisborne by TAG Oil (the Waitangi Valley-1 well), because the company encountered gas under very high pressure, highlights the uncertainties and risks associated with drilling oil wells in New Zealand waters.

18. The potential impacts of the proposed oil drilling include noise, collisions with vessels and mining equipment, habitat displacement. Oil spills and other forms of pollution (e.g. antifouling agents) would have direct impacts on marine mammals and indirect ecological effects. These include impacts on benthic organisms, which affect higher trophic levels including fish densities and/or movements, affecting prey availability for marine mammals. These impacts are predicted to occur within the mining area itself and in the area affected by oil spills and increased vessel traffic.

19. Cumulative impacts of the proposed oil drilling need to be considered in combination with other, existing impacts on marine mammals in the area. These other impacts include fishing, seismic surveys, ship strike and other activities. For example, Maui's dolphin is already Critically Endangered. Fishing is the most serious impact to date and still has not been effectively managed. The international science community, including the Scientific Committee of the International Whaling Commission has urged NZ to fully protect Maui's dolphins from gillnet and trawl fisheries. This recommendation was endorsed by the full International Whaling Commission earlier this month. At this stage, the addition of any further impacts would mean that there is little if any chance of NZ reaching its goal of ensuring the long term viability and recovery of Maui's dolphin.

Marine mammals found in the South Taranaki - Cook Strait area

20. Marine mammal species known to use the South Taranaki – Cook Strait area include Maui's dolphin, blue whales, bottlenose dolphins, common dolphins, dusky dolphins, Risso's dolphins, false killer whales, fin whales, humpback whales, killer whales, pilot whales, minke whales, sei whales, right whales, Bryde's whales, sperm whales and NZ fur seals (Mac Diarmid et al. 2011, Torres 2012, McConnell 2014).

21. The information on marine mammals provided by the applicant is inadequate. It is essentially a list of marine mammal species known to occur in the area. Most of the data used are anecdotal, based on reports from cargo vessels and members of public.

22. Where a sighting was made, we can be confident that a marine mammal was present, but not necessarily that the species identification was correct.

23. In a location where no sightings were made this can be for a number of possible reasons, including:

23.1 No ships travelled through this area

23.2 The only ship time in the area was at night or in other conditions where visibility was limited (e.g., fog)

23.3 No observer was on watch

23.4 Insufficient observers were available to keep a watch during all daylight hours

23.5 An observer was available, but had already been on watch for a lengthy period and was missing sightings

23.6 A well-rested observer was available, but insufficiently trained to spot marine mammals or to be confident of species identification

23.7 Two trained, well rested observers were on watch, together with a recorder (normal survey protocol for marine mammal observers) but the marine mammal was underwater and therefore not "available" to be sighted when the ship passed through the area

23.8 Two trained, well rested observers and a recorder were on watch and the marine mammal was at the surface, available to be sighted but too far away from the ship to be seen or to be identified correctly.

23.9 Two trained, well rested observers and a recorder were on watch and the marine mammal was at the surface, available to be sighted but was not noticed by the observers because they were looking elsewhere at the time and the surfacing was too brief and cryptic to draw attention.

In a normal marine mammal survey the three last factors are estimated. It is standard practice for the proportion of individuals, for each species, that are detected by observers to be reported. For the anecdotal data used by OMV, it is impossible to estimate the proportion of individuals missed. This means there is considerable uncertainty in terms of the assessment of potential impacts on marine mammals. Likewise if the proposed mining were approved it would be impossible, with the currently available data, to detect impacts on marine mammals. Finally, it means that the data reported by OMV represent an absolute minimum indication of the range and occurrence of marine mammals in the area. For example, beaked whales spend very little time at the surface and have very low levels of detectability in visual surveys, especially those carried out by members of the public. It is extremely unlikely for a member of public to see, let alone be able to identify a beaked whale. This does not mean that beaked whales do not use the area, nor that they would be unlikely to be impacted by the proposed mining. An acoustic survey would be required to assess the use of the area by marine mammals, in particular beaked whales and sperm whales.

24. The information reported by McConnell (2014) include data published in peer reviewed scientific journals, but also estimates that have either not been peer reviewed or for which serious errors were identified during peer review. For example, the estimates of Clement and MacKenzie (2014), Clement et al. (2011) and Du Fresne et al. (2012) include several aspects of double counting. In the case of the Clement and MacKenzie (2014) estimate, the most likely problem is the circle backs used to estimate the proportion of dolphins missed by the observers (IWC 2014). For both Clement et al. (2011) and Du Fresne et al. (2012), it is now known that data from both front and rear observers in the plane were (incorrectly) used in estimating population size, resulting in at least partial double counting. In the case of Clement and MacKenzie (2014) this may be partially compensated for by the use of mark recapture distance sampling. But this is not the case for Clement et al. (2011) and Du Fresne et al. (2012). The Ministry for Primary Industries have not yet released the data from the publicly funded survey by Clement and MacKenzie, carried out between January and August 2013, but have indicated that these data will be made available in December 2014. Once these data are publicly available, it will be possible to determine to what extent these surveys over-estimate the population of South Island Hector's dolphins.

25. The lack of systematic survey data (Childerhouse 2014) means that the available information is insufficient to determine the biological importance of the proposed mining area, or the potential oil spill area, to marine mammals.

26. The proposed mining activity includes the drilling of up to seven new oil wells. This would occur inside the habitat of New Zealand (Hector's and Maui's) dolphins, in waters less than 100 m deep. The proposed oil drilling area is about halfway between North and South Island, in the area that has been referred to by scientific experts as the conservation corridor or genetic bridge between North and South Island populations of NZ dolphin (e.g. Hamner et al. 2012). Here I use the term NZ dolphin to describe the species as a whole, and the terms Hector's dolphins and Maui's dolphins to describe the South and North Island subspecies, respectively.

27. Any habitat damage to this area is a risk in terms of reducing the potential for recolonisation of Maui's dolphin habitat by Hector's dolphins from the South Island. More importantly, any oil spills and other pollution resulting from the proposed drilling would reach well into both North and South Island habitat of this endangered species.

28. The total population size and conservation status of these species is critical in terms of assessing the population level impacts of the mining proposed. Endangered, and especially Critically Endangered species require the most precautionary approach. If the species or population in question is Critically Endangered and already declining due to other human impacts, which is the case for Maui's dolphin, then an additional impact (in this case mining) has the potential to make the difference between extinction and recovery. Maui's dolphin, being Critically Endangered, may go extinct unless existing impacts (including fishing) are removed immediately. In this context, any additional impacts on Maui's dolphins, their prey or their habitat are likely to have irreversible consequences.

29. The oil spill trajectory modeling indicates that oil is expected to affect inshore waters, right to the shoreline. The Maui's dolphin Expert Panel, convened by DOC and MPI, concluded that Maui's dolphins range south at least as far at Whanganui (Currey et al. 2012). It is now well recognised that the distribution of both Hector's and Maui's dolphins ranges offshore to the 100 m depth contour (e.g. Slooten 2014). This means that the mining and especially any resulting oil spills will impact Maui's dolphin habitat.

Conservation status of Maui's dolphin

30. Maui's dolphin is listed as Critically Endangered by the IUCN (2008) and by Department of Conservation (DOC & Mfish 2007). The definition of Critically Endangered is that the species is "*facing a very high risk of extinction*" (see IUCN 2008).

31. The total population was estimated at 55 individuals over 1 year of age in 2011 (95% Confidence Interval 48-69; Hamner et al. 2012). The geographic range of Maui's dolphin extends from Maunganui Bluff (north of Dargaville) to at least as far south as Whanganui (Currey et al. 2012, also see Slooten et al. 2005 and Slooten 2014). Hamner et al. (2012) emphasize that it is important to protect the corridor that connects Maui's dolphin with South Island populations of the other NZ dolphin subspecies (Hector's dolphin).

32. Maui's dolphin is listed as "*facing an extremely high risk of extinction*" on the basis of its extremely small population size, existing impacts and the rate of population decline. The 1970 population of Maui's dolphin was estimated at more than 1700 individuals (1729, CV 51%; Slooten & Dawson 2010). This had declined to around 100 individuals by 2004 (111, CV 44%; Slooten et al. 2006). A population of this size is extremely vulnerable and literally on the brink of extinction. Approximately 27 of the 55 individuals in the population would be expected to be female. Of those, approximately half i.e. 14 individuals are expected to be of breeding age (e.g. Slooten et al. 2000). Females breed every two to four years and the maximum population growth rate is estimated at 1.8% per year. The death or injury of a single breeding female from this population, or any reduction in their reproductive rate (e.g. due to reduced feeding success) would substantially delay the recovery of Maui's dolphin. A single death or injury would be very difficult to detect (see below), but would have serious biological implications. Reductions in feeding success or reproductive rate would be even more difficult to detect. This makes it even more important than usual to take a precautionary approach.

33. Existing impacts have been identified in the Threat Management Plan for Hector's and Maui's dolphin (DOC & Mfish 2007) and the Maui's dolphin Threat Management Plan (MPI and DOC 2012) to include fishing (in particular gillnet and trawl fisheries), pollution and mining. The total level of human impact on Maui's dolphin would need to be kept **below** one dolphin death every 10 to 23 years to allow the population to recover from Critically Endangered to Endangered and eventually to non-threatened (see Currey et al. 2012). This is based on a method developed in the United States to set sustainable levels of total human impact on marine mammal populations (see Slooten & Dawson 2008 for more information). The high level of extinction risk and the low level of sustainable impact for this population led the Ministry of Fisheries in 2001 to put in place fishing regulations to reduce the number of dolphins killed in gillnets and trawling and in 2008 and 2013 to increase the level of protection.

34. In addition, the Department of Conservation has put in place a Marine Mammal Sanctuary to protect Maui's dolphin, from Maunganui Bluff (north of Kaipara Harbour) to New Plymouth. These new protection measures are a substantial improvement over past conservation management. However, population recovery is still highly uncertain. For example, gillnet fishing is still allowed inside the harbours on the North Island west coast. The level of gillnet fishing effort in these harbours is approximately three times higher than the level of gillnet effort on the North Island west coast outside the harbours before the first dolphin protection measures were put in place in 2001.

Likewise, trawling is still allowed in much of the Marine Mammal Sanctuary (see DOC & Mfish 2007; Burkhart & Slooten 2003; MPI and DOC 2012).

35. The cumulative impacts of existing human activities on Maui's dolphin are not sustainable (Currey et al. 2012). Currently, the impact from continued bycatch in gillnet and trawl fisheries is estimated at 3-4 Maui's dolphins per year (Slooten 2014) and the population is already declining.

36. To ensure that Maui's dolphin recovers from Critically Endangered to non-threatened in the foreseeable future, would essentially require the removal of **all** human impacts to the extent technically possible. The International Whaling Commission has recommended that Maui's dolphins be fully protected throughout their habitat from gillnet and trawl fisheries (IWC 2014).

37. Any increase in the length of time Maui's dolphin spends at the current critically low population size, substantially increases the risk of extinction. Some of the impacts are more difficult to avoid or reduce than others. For example, some pollutants (e.g. DDTs, PCBs) continue to leach into the marine environment even after their production and use is stopped. Other impacts (e.g. fishing, mining, energy generation) are relatively easy to remove or avoid. Any consent for new activities in the area need to be considered in this context. Data on the cumulative impact of existing human activities are required in order to evaluate the additional impact of a new activity. In addition, a high standard of evidence that a new activity has little or no impact on dolphins would be expected before allowing the activity in the habitat of a Critically Endangered species. Such evidence has not been provided by the applicant. Available evidence from overseas indicate that the proposed activity carries a high risk of impacts on marine mammals (e.g. Schwacke et al. 2014).

38. Given the critically endangered status of Maui's dolphin and the existing threat they face from current human activities, increasing the level of human impact on their environment could lead to extinction (e.g. Martien et al. 1999; Burkhart & Slooten 2003; Slooten 2007; Slooten et al. 2000; Slooten & Lad 1991). Bycatch in fishing gear has reduced this population to less than 10% of its original numbers (e.g. Slooten 2007; Slooten & Dawson 2008a), and there is recent evidence of a contraction in range (Dawson et al. 2001). With this history and at this population size, the population cannot be expected to be able to sustain additional human impacts.

39. For very rare species, low population size itself is a serious risk factor. Chance events, including natural events such as a particularly poor year in terms of food availability and human impacts such as oil spills, are a relatively higher risk for a small population. In addition, reproductive rates and

survival rates tend to be lower in very small populations due to factors such as inbreeding and reduced success in finding mates, foraging and predator defence.

40. The Marine Mammal Protection Act specifies that threatened marine mammals should be managed to ensure their recovery to non-threatened status as soon as practicable and in any case within 20 years. Recovery of Maui's dolphin to non-threatened status within 20 years would require a substantial reduction of existing impacts. Adding further impacts within their range would at best further lengthen recovery time and would make the statutory goal of recovery within 20 years unachievable. At worst, additional impacts could lead to extinction.

Conservation status of blue whale

41. Blue whales, *Balaenoptera musculus,* are listed as Endangered by the IUCN (Reilly et al. 2008). The IUCN assessment notes that the level of depletion (70-90% of the population lost over the last three generations (1914-2007) means that the species meets the criterion for Endangered and probably meets the criterion for Critically Endangered. The definition of Endangered is that the species is "*facing a very high risk of extinction*" and the definition of Critically Endangered is that the species is "*facing an extremely high risk of extinction*" (see IUCN 2008).

42. The global population of blue whales is estimated at 10,000-25,000 corresponding to approximately 3-11% of the 1911 population size (Reilly et al. 2008). The worldwide population is fragmented into many local populations. Reilly et al. (2008) identify "local populations that inhabit waters with significant levels of human activity" as being of special concern given potential threats "such as disturbance from vessel traffic, including ship noise".

43. The Antarctic blue whale, *Balaenoptera musculus intermedia,* is the subspecies found in New Zealand waters. This subspecies has been reduced by more than 97%, to less than 3% of its original population size, and is listed separately as Critically Endangered (Reilly et al. 2008).

44. Blue whales are not afforded the same level of protection as other large whales in New Zealand as they are considered to be a migrant species. However, recent research has shown that they are spending much more time in the South Taranaki Bight than was previously known (e.g. Torres et al. 2014).

Potential direct and indirect impacts on marine mammals in the area

45. The potential impacts of the proposed mining include collisions with vessels and mining equipment, displacement of marine mammals from their habitat, indirect effects such as pollution (e.g. antifouling agents, oil spills, etc.) and ecological effects (e.g. direct and indirect impacts of mining on benthic organisms, which affect higher trophic levels including fish densities and/or movements, affecting prey availability for marine mammals). These impacts are predicted to occur inside and outside the mining area, in particular in the event of an oil spill (McComb 2014).

46. It would be difficult to determine if the marine mammals avoid the area when mining takes place, or avoid mining areas altogether (in preference of areas where no such activity is taking place). BACI (Before, After, Control, Impact) research of marine mammal use of the area would be needed to establish that. In the case of species present in very low densities (e.g. Maui's dolphins) acoustic data loggers would be the preferred, main research tool. Visual surveys, by boat and/or aircraft, would be a useful secondary tool in such investigations. Photographic identification of individuals could also be carried out during boat surveys.

47. It would be even more difficult to detect effects on survival, reproduction, feeding success and population size of the dolphins. These data are much more important in terms of the conservation management of endangered species such as Maui's dolphin. However, these data would take a decade or more to collect.

48. Data on the ecological links between infauna (organisms living in the sediment), epifauna (organisms living on the sea floor) and marine mammals in the South Taranaki – Cook Strait area is essential in order to determine the likely indirect effects of mining on Maui's dolphin, blue whale and other marine mammals in the area. It is very important to establish how the benthic community interacts with the fish fauna in the area. That will help establish the indirect effects of mining on fish and fish predators, including marine mammals and seabirds.

49. It is important in evaluating research and monitoring programmes to consider statistical power, i.e. to ensure that sufficient data are collected to be able to detect environmental effects. In the case of critically endangered species like Maui's dolphin, even very small effects would be biologically meaningful. Therefore, sample sizes and the duration of the study would need to be much larger to be able to detect biologically meaningful effects.

50. One of the risks is injury or death caused by encounters with the mining equipment and vessels associated with the mining operation. New Zealand dolphins are regularly injured or killed in encounters with other human structures including gill nets, trawl nets and boat propellors (Dawson

1991; DOC & Mfish 2007; Stone & Yoshinaga 2000). A gillnet is a static fishing gear and makes little noise while deployed. By contrast trawling and boating are relatively noisy activities and there is no doubt that the dolphins are well aware of the presence of a trawl net when they are caught and of the presence of a boat when a boat strike occurs. In each of these cases the problem is not that dolphins are unable to detect fishing nets or boats but that accidents happen and they are injured or killed despite their sensory abilities. Human road accidents provide an analogy in that they are usually caused by error, rather than sensory disability. In the case of marine mining, dolphins may collide with the structures if they are: a. Unaware of the presence of the equipment or vessel, b. Aware of their presence but don't perceive them as a risk, c. Unable to avoid the equipment or d. Make a mistake and collide with mining equipment or vessels despite being aware of their presence.

51. The impacts of marine mining on marine mammals have been identified as an important conservation issue in the scientific literature, especially for populations already impacted by other human activities such as fisheries (e.g. Nairn et al. 2004). Benthic and fish communities, and therefore marine mammals that rely on these communities, can take long periods to recover. Of course this assumes that the marine mammal populations in the area being mined were at healthy levels before mining began. These impacts have led to mining being prohibited in most Marine Mammal Protected Areas (Hoyt 2011). The potential impacts include marine mammals being displaced from their current habitat, due to direct disturbance (e.g. noise caused by mining, vessel traffic, sediment dumping and unusual levels of turbidity) and/or indirect impacts (in particular ecological effects on dolphin prey). These direct and indirect impacts are likely to further increase fragmentation of Maui's dolphin populations and may slow the recovery of a range of marine mammal species, including humpback whales, right whales and the blue whales.

52. As pointed out by McConnell (2014), health effects of exposure to hydrocarbon products is expected to have the following impacts on wildlife:

52.1 Dehydration

52.2 Anaemia

52.3 Organ damage

52.4 Intestinal ulceration

52.5 Immunosuppression

52.6 Respiratory disease

52.7 Impaired growth and reproduction

52.8 Food source contamination

52.9 Habitat loss

Impacts caused by secondary effects of "clean up" operations include disturbance, displacement, habitat loss and degradation, ship strike and pollution caused by any dispersants used.

53. Until recently, relatively few scientific data were available on the health effects of oil on whales and dolphins. However, the Gulf of Mexico oil spill has led to detailed studies of the impact of oil on marine mammals and other marine biota. For previous oil spills very few fresh carcasses were recovered. In part, due to fewer deaths from earlier spills and in part due to insufficient effort to collect dead marine mammals before they decomposed.

54. Whales and dolphins are exposed to oil through:

54.1 Oil contacting their skin and eyes

54.2 Ingestion of prey and incidental ingestion of water (accidental and while feeding)

54.3 Inhalation

55. Toxic fumes from oil are more concentrated close to the water surface (because these fumes are heavier than air). This is exactly where marine mammals, turtles and sea snakes breathe. In a detailed study of the effects of oil on bottlenose dolphins, Schwacke et al. (2014) captured dolphins, carried out a detailed health check and released them again. The health of dolphins in the oil spill area was compared with a control area away from the oil spill and with data from before the oil spill.

56. Health impacts included (Schwacke et al. 2014):

56.1 Dolphins in poor condition, with 25% of the individuals underweight

56.2 Fetus not viable in one of ten pregnant females (no heartbeat or movement in ultrasound). The mother had lung disease and a poor prognosis herself.

56.3 Three of 33 dolphins in the oil spill area had complete or near complete tooth loss

56.4 Gum disease

56.5 Moderate to severe lung disease was more common in the oil spill area, and affected a wider age range - about 5 times more likely to have lung disease than in the control area

56.6 Inflammation, hypoglycemia, altered iron metabolism and liver/bile disease more common or only present in oil spill area

56.7 Lowered adrenal hormones, cortisol (affecting 44% of dolphins) and aldosterone (53%) associated with compromised adrenal function, causing problems in retaining sodium and excreting potassium

56.8 Of the dolphins in the spill zone, 48% were given a "guarded" or worse prognosis, compared to 7% in the non spill area

56.9 Poor or grave health outcomes were expected for 17% of the dolphins, which were not expected to survive

57. Schwacke et al. (2014) diagnosed several relatively uncommon disease conditions, consistent with effects in marine life for other oil spills and in experimental studies. Inhalation and ingestion of petroleum derived hydrocarbons led to bronchitis, airway inflammation, pneumonia and other lung disease.

58. Unfortunately, no data appear to exist on the noise made by drilling platforms in New Zealand waters. This generates considerable uncertainty about the noise that would be produced, and how audible it would be to marine mammals in the area. Childerhouse (2014) has had to rely on information from a desktop exercise, about drilling noise in other countries.

59. The discussion of noise impacts (Childerhouse 2014) ignores the fact that in addition to active echolocation and communication, marine mammals also use passive listening to interpret their environment. For example, cetaceans that make relatively high frequency sounds for echolocation and communication are able to hear sounds well outside this range.

60. As pointed out by Childerhouse (2014), the US National Marine Fisheries Service (NMFS) and National Oceanic and Atmospheric Administration (NOAA) use a 180 dB re 1μPa SPL for predicting injuries from exposure to impulse noise and a 160 dB re 1μPa SPL based on behavioural

responses to airguns. However, Childerhouse (2014) fails to mention that NMFS uses 120 dB re 1μPa SPL as a threshold for behavioural disruption for non-pulse noise such as drilling. Furthermore, there is potential for masking and other impacts at levels below 120 dB re 1μPa SPL.

61. Southall et al. (2007) has been superceded by more recent research, including the latest US guidelines (NOAA 2013) and expert comments during consultation on those guidelines.

62. Finneran and Jenkins (2012) is not peer-reviewed and has been heavily criticised during the NOAA effort to establish acoustic guidelines for injury. It is heavily based on one aging bottlenose dolphin in captivity. The resulting weighting curve does not adequately reflect the hearing sensitivities even for bottlenose dolphins (e.g. Johnson, 1968).

63. Childerhouse (2014) fails to include the German noise standards for pile driving (Childerhouse, para 67). His approach could certainly not be described as "conservative" (Childerhouse, para 68). For example, behavioural responses would be expected well beyond 200 m.

64. The applicant certainly has not provided any evidence of habituation of marine mammals to the existing marine mining in the area. Even if there were evidence of habituation or simply indicate that there are substantial resources for marine mammals in the area (e.g. this is an important feeding area or migration route). This does not necessarily show that there is no biological cost associated with the noise (e.g. Wright & Kuczaj, 2007; Wright et al., 2007a,b; Bejder et al., 2009; Weilgart 2007). Furthermore, the substantial increase in mining proposed in the OMV application and other applications for resource consent may be sufficient to push the local environment past a 'tipping point' in terms of its suitability for marine mammals.

65. Permanent and temporary deafness of marine mammals (permanent and temporary threshold shifts) and detectable behavioural responses tend to occur relatively close to the noise source, as indicated by Childerhouse (2014). However, masking and stress responses occur over a much wider range (e.g see Hatch et al. 2012).

66. The effects of noise on marine mammals include physiologically induced and behaviourally induced impacts (Nowacek et al. 2007). Physiological effects of noise include direct damage to organs and tissues, permanent or temporary hearing threshold shifts and stress (e.g. Finneran et al. 2000, Popov et al. 2007). Behavioural effects of human-made noise include disruption of activities, exclusion from habitat and masking of vocalisations or interference with communication and

echolocation (e.g. McCarthy et al. 2011, Castellote et al. 2012, Iorio and Clark 2010, Nieukirk et al. 2012, Tyack et al. 2011, DeRuiter et al. 2013, Goldbogen et al. 2013, Dunlop et al. 2013).

67. Simple threshold criteria based on exposure level are not useful (Melcón et al. 2012, Risch et al. 2012, Ellison et al. 2012, Castellote et al. 2012, Robertson et al. 2013). Data on actual responses of dolphins or other marine mammals to marine mining of the type proposed are required in order to assess the potential impact on marine mammals. Such data should be gathered using a BACI (Before, After, Control, Impact) design. Data on the responses of (non-threatened) dolphin species in other areas where this type of marine mining is used would be required in order to assess the likely impacts of the development proposed. Determining whether dolphins avoid areas with marine mining would take at least three years of "before" and three years of "after" observations, following a rigorous experimental design.

68. It is important in designing research and monitoring programmes to consider statistical power, i.e. to ensure that sufficient data are collected to be able to detect environmental effects. In the case of critically endangered species like Maui's dolphin, even very small effects are biologically meaningful but difficult to detect. Sample sizes and the duration of the study need to be much larger to be able to detect biologically meaningful effects in a small population.

69. A minimum of three years of research would be required in order to describe biological and physical processes in the area to be mined (e.g. distribution, abundance and movements of marine mammals, fish, elasmobranchs, tidal patterns, currents and sedimentation processes). This is partly because these vary from year to year (e.g. Rayment et al. 2009; Slooten et al. 2006).

70. Obtaining data on several key biological parameters, in particular survival rates, reproductive rates and trends in population size, would take at least 10 years of research. The results from this research would provide decision-makers and the public at large with the information needed to support a science-based decision on whether or not the proposed development is sustainable (including data on the actual amount of energy likely to be generated and the likely biological and physical effects

71. Shorter periods of data collection on dolphin populations before mining (e.g. 1-3 years), would result in a monitoring programme with little if any chance of detecting impacts on marine mammals. From a scientific point of view, three years of baseline monitoring is the minimum required to collect baseline data on distribution and abundance of marine mammals and this is also required to provide a realistic chance of detecting effects on other species and on physical

oceanographic processes. At least ten years of research is needed to estimate survival and reproductive rates (e.g. Cameron et al. 1999; Gormley et al. 2012). These baseline data can then be used to carry out a power analysis, to estimate the probability of detecting biologically meaningful effects.

72. Marine resources are often managed such that new developments are declined only when harmful effects on other environmental or economic interests can be demonstrated (Thompson et al. 2000). This approach poses particular problems for the conservation of coastal marine mammal populations, partly because there are often several threats affecting the same species. It is often difficult to demonstrate the effects of individual threats and even more challenging to determine the total, cumulative impact of all human activities in the coastal environment on a particular species. Added to that, the challenges inherent in studying marine mammals often result in estimates (of parameters like survival and population size) with relatively low levels of precision and low statistical power to detect environmental impacts. Because marine mammals are long-lived, long-term studies are needed to estimate population parameters and to detect changes in those parameters. During the time taken to detect a change in population size, survival or reproductive rate, it is therefore possible for a population to decline to such low population levels that the risk of extinction (and difficulty in detecting impacts) is substantially increased. Marine mammals are inherently difficult to study. The variances on estimates of population size, and other population parameters such as reproduction and survival are usually high. In response, many countries are adopting precautionary management principles.

73. In conclusion, this development involves a number of potentially serious impacts on Maui's dolphins, blue whales and other marine mammals. The potential high risk and lack of data on critical issues (e.g. response of non-endangered marine mammal species) require a precautionary approach. A more rigorous environmental impact assessment would be needed to carry out a scientifically robust assessment of the potential impact of this development on marine mammals in the area.

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