Before the Board of Inquiry
Hauauru Ma Raki Wind Farm Proposal

Under	the Resource Management Act 1991
In the matter of	Resource consent applications by Contact Wind Limited relating to the Hauauru Ma Raki Wind Farm Proposal
And	
In the matter of	Notices of Requirement and a Resource Consent Application by Contact Energy Limited relating to the Hauauru Ma Raki Wind Farm Proposal

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Statement of evidence in chief of Philip Frank Battley

Dated: 27 March 2009

Date of hearing: ***[Commencing 27 April 2009]***

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STATEMENT OF EVIDENCE IN CHIEF OF PHILIP FRANK BATTLEY

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INTRODUCTION

1 My full name is **Philip Frank Battley**.

2 I am a Senior Lecturer in the Ecology Group, Massey University, Palmerston North. I have Bachelors and Masters of Science degrees in Zoology from Massey University, and a PhD from Griffith University, Brisbane, Australia. My PhD research was on the physiology and timing of migration of Great Knots (*Calidris tenuirostris*) in northwest Australia. Prior to my current position I worked as a Postdoctoral Fellow through the University of Otago researching the population biology and movements of Arctic-breeding shorebirds (Bar-tailed Godwits (*Limosa lapponica*, hereafter godwits) and Red Knots (*Calidris canutus*, hereafter knots)) in the Firth of Thames (2003-2006). Before that I was a Postdoctoral Fellow at the Netherlands Institute for Sea Research.

3 I have been studying the biology of migratory shorebirds for over 15 years, and have field research experience in New Zealand, Australia, South Korea, China, the United States, Russia, The Netherlands, Mauritania and Ghana. I have visited most of the estuaries and harbours in New Zealand that support substantial shorebird populations. I have particular experience at the Firth of Thames, Manawatu Estuary and Farewell Spit, NW Nelson (where I conducted my masters research and a subsequent intertidal invertebrate survey[1]).

4 From 2005-2008 I was the Principal Investigator in a project run by the Ornithological Society of New Zealand (OSNZ) on the movements of Arctic-breeding wading birds in New Zealand. This was funded by the Department of Conservation, which had identified that there was a lack of knowledge about the degree to which intertidal habitats formed networks used by birds. The results from this work are currently in press[2].

5 I have published over 40 scientific papers, reports and book chapters, and one co-authored book, most of which have been on migratory shorebirds. I am an Associate Editor for the journal of the British Ornithological Union, *Ibis*.

6 I am a member of OSNZ, the Ecological Society of New Zealand, the Australasian Wader Studies Group, the International Wader Study Group and the Waterbird Society. I am a council member of OSNZ, and former council member of the Miranda Naturalists' Trust.

7 I am familiar with the proposal that is the subject of the resource consent applications and notices of requirement. I visited the site on

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[1] Battley, P.F., D.S. Melville, R. Schuckard & P.F. Ballance. 2005. Quantitative Survey of the Intertidal Benthos of Farewell Spit, Golden Bay. Marine Biodiversity Biosecurity Report. No. 7. 119 pp.

[2] Battley, P.F., R. Schuckard & D.S. Melville. 2009. Movements of northern hemisphere waders within New Zealand. Science for Conservation, *in press*.

23 March 2009, guided by Gerry Kessels and Ingrid Stirneman of Kessells and Associates.

8 I have read the Environment Court's Code of Conduct for Expert Witnesses, and I agree to comply with it. My qualifications as an expert are set out above. I confirm that the issues addressed in this brief of evidence are within my area of expertise.

9 I have not omitted to consider material facts known to me that might alter or detract from the opinions expressed.

SCOPE OF EVIDENCE

10 My evidence will deal with the following:

- Movements within New Zealand of northern hemisphere-breeding shorebirds and the likelihood of these species passing the proposed Hauāraki mā Raki (hereafter HMR) wind farm site. The evidence I provide is drawn largely from data collected by the Ornithological Society of New Zealand or myself that are not yet published. This involves:
    - Evidence of long-distance movements of individually colour-banded birds from an OSNZ wader movements project. This involved over 800 godwits and over 300 knots being individually colour-banded around New Zealand, and observers making special efforts to locate and identify colour-banded birds. Around 9500 resightings of godwits and 1500 resightings of knots were made during the project.
    - Census results that assist in estimating the possible magnitude of any movements.
    - Observations of godwits moving within New Zealand.
- A summary of international agreements relating to international migrants, and a brief summary of the major threats faced by these species.
- An evaluation of the evidence and recommendations provided by Gerry Kessels and Dr Richard Seaton in relation to movements of northern hemisphere shorebirds through the proposed windfarm region.
- Conclusions and recommendations

SPECIES OF RELEVANCE

11 Several species of shorebird breed in the northern hemisphere and migrate to New Zealand for the non-breeding season. They typically arrive in September-October and depart in March-early April. Immature birds remain year-round in New Zealand. While here, they

use the same tidal flats and adjacent coasts used by New Zealand-breeding species such as pied oystercatchers (*Haematopus finschii*) and wrybills (*Anarhynchus frontalis*).

12 Of these northern hemisphere shorebirds, only three are at all numerous in New Zealand – **bar-tailed godwit** (population c. 80,000), **red knot** (population c. 45,000) and **ruddy turnstone** (*Arenaria interpres*, population c. 2500). None has a formal New Zealand threat listing, as the New Zealand Department of Conservation does not consider international migrants in their threat listings (Hitchmough et al. 2007; Miskelly et al. 2008). Wetlands International recently revised their estimates of population sizes for shorebirds in the East Asian-Australasian Flyway (which includes New Zealand) (Bamford et al. 2008) but do not list any population trends or give a threat status. An earlier assessment (Wetlands International 2006) listed a trend only for godwits.

13 Only godwits and knots are common enough and well studied enough to allow detailed consideration here in the context of as being at risk from the Contact proposal. Turnstones are much less common than godwits and knots, and there is virtually no information on their movements within the New Zealand.

14 Godwits breed in western Alaska and knots breed in eastern Russia. Satellite-tracking has recently confirmed that after breeding godwits migrate direct across the Pacific to New Zealand (Gill et al. 2008). In contrast, knots migrate to New Zealand via Asia and Australia (the latter confirmed by banding data: Riegen et al. 2005).

15 The northward migration for both species is via eastern Asia, in particular the Yellow Sea. Godwits migrate there directly in a single 10,000 km flight (P.F. Battley et al., unpubl. data), but the precise routes and numbers of stopovers of knots are not well known. Knots from New Zealand have been recorded in northern Australia and West Papua on migration (Riegen 1999; Riegen et al. 2005), and these regions are probably important stopover sites for this species.

16 Not all individuals of either species return to the northern hemisphere in March/April to breed. Immature birds (which may be 1-3 years old) usually stay in New Zealand, so some birds are present year-round in New Zealand.

17 In the evidence below I will outline the international agreements relating to international migrants and briefly discuss the species' conservation status, then summarise the best available information for godwits and knots on:

- Population size and trend.
- Distribution in New Zealand, noting in particular the numbers that occur south of the proposed HMR wind farm site.
- Evidence for migratory movements within New Zealand.

- Evidence for non-migratory but nevertheless long-distance movements within New Zealand.

- The numbers of birds that potentially will pass the HMR site annually.

INTERNATIONAL OBLIGATIONS AND ISSUES

18 New Zealand has obligations under several Acts or Conventions that include migratory shorebirds and their habitats. Basic protection is afforded to Northern hemisphere migrants in New Zealand under the Wildlife Act (1953).

19 New Zealand is a signatory to the Bonn Convention (Convention on the Conservation of Migratory Species of Wild Animals), an intergovernmental treaty that aims to conserve terrestrial, marine and avian migratory species throughout their range.

20 New Zealand is also a Contracting Party to the Ramsar Convention, an intergovernmental treaty that provides the framework for national action and international cooperation for the conservation and wise use of wetlands and their resources. Of New Zealand's six designated Ramsar sites, three (Firth of Thames, Manawatu Estuary and Farewell Spit) are important habitats for migratory shorebirds including godwits and knots.

21 Globally, an assessment of the population trends of waders found that of populations for which there was information, 44% were declining and just 13% were increasing (Zockler et al. 2003). Counts made by OSNZ in New Zealand show that northern hemisphere shorebirds have declined in New Zealand (Battley et al. 2007; Southey 2009). If godwits and knots were classified in the threat categories currently used for New Zealand birds (Miskelly et al. 2008) they would be considered as declining (population 20,000-100,000, total population trend of 10-30% decline).

22 On migration godwits and knots pass through one of the most heavily populated regions of earth, eastern Asia. Human pressures on tidal flats there are extreme, with reclamation projects in progress that would be unthinkable in New Zealand. In South Korea in 2006, the Saemangeum Project completed a 33-km seawall that enclosed 41,000 ha of tidal flat and shallow water. To that date the site had been the single most important site recognised in Asia for shorebirds, holding an estimated 400,000 birds through the year. Surveys before and after seawall completion demonstrated the loss of over 100,000 birds from the system during northward migration, and that only a fraction of these birds had been able to be accommodated elsewhere in South Korea (Moores et al. 2008). The conclusion is that most had died. Saemangeum is not the only large reclamation project underway – an 80 km^2 industrial reclamation is planned for one of the few sites known to hold substantial knot numbers in China (Yang et al. 2008). New Zealand knots have been recorded there. The habitats of godwits and knots on migration are increasingly threatened.

BAR-TAILED GODWIT

23 In the 1980s the New Zealand population estimate was 102,000 (Sagar et al. 1999), but annual summer national census counts in the 2000s have declined to around 80,000 birds (OSNZ, unpublished data; Southey 2009). In winter, on average 7,851 birds were counted from 1994-2003 (Southey 2009); from 1984-1994 the equivalent figure was around 15,000 birds. While New Zealand's godwit population is listed by Wetlands International as "Stable", this is not supported by recent data and the species has evidently been declining.

24 Godwits are widely distributed around New Zealand but are concentrated around northern harbours and inlets (including the Kaipara and Manukau Harbours and the Firth of Thames), the northern South Island, Canterbury, Otago and Southland. The most recent full national summer OSNZ census (November 2007) recorded 79,210 godwits.

25 3493 of these were in the Waikato Harbours, just south of the proposed HMR wind farm site, and 19,969 were in the South Island (4.5% and 25.9% respectively of the total count). In February 2008, 23,204 godwits were counted in the South Island out of 70,830 (33.2% of the total; this was not a complete national census, and only Raglan Harbour in the Waikato was counted).

26 Overall, and on the basis of the above figures, one quarter to one third of New Zealand's godwits currently occur south of the proposed HMR wind farm site. It should be recognised that the number of godwits in the Waikato Harbours is lower now than it has been in the past. For example, in 1999 the total godwit count for Kawhia and Aotea Harbours was 9628 birds. There is therefore the potential for 3500-10,000 godwits from the Waikato Harbours to pass along the western Waikato coast in different years. In addition, some proportion of South Island godwits (that total 20,000 or more birds) could potentially pass along the coast. This is discussed further below.

Northward migration

27 Northbound godwits appear mostly to leave directly from their non-breeding site rather than moving northwards within New Zealand before departing. This has been demonstrated via standardised observations (e.g. Farewell Spit: Battley 1997) and satellite tracking (P.F. Battley et al., unpublished data). The OSNZ wader movements project detected just one South Island godwit in the Auckland region during the northward migration period.

28 However, a small flock of adult godwits in breeding plumage was observed flying north and landing on the beach at Port Waikato on 14 March 2009 (J.E. Dowding, pers. comm.), suggesting that there is some premigratory movement along the Waikato west coast.

Southward migration

29 The southbound journey of godwits from Alaska to New Zealand involves the longest migratory flight documented in any bird – 11,700 km in the one satellite-tagged godwit tracked for an entire journey (Gill et al. 2008). It has generally been assumed by ornithologists that most birds fly directly to their non-breeding sites, though it is not clear at what altitude birds arrive in New Zealand at. There are records of shorebirds on migration at high altitudes (e.g. 500-4000 m; Alerstam & Gudmundsson 1999, Gudmundsson et al. 2002; Battley & Horn 2006) but there are also records of godwits on migration at sea level (A.C. Riegen and R.E. Gill, pers. comm.).

30 Recorded evidence indicates that not all godwits reach their final non-breeding ground destination in a single flight from Alaska, however:

(1) The OSNZ wader movements study detected 13 South Island and three Manawatu Estuary godwits making stop-overs in the Auckland region in the September-November arrival period. Thirteen of these were confirmed back in the South Island or Manawatu Estuary in the same or subsequent seasons.

(2) Dataloggers that determine position based on day length indicate that three of eight tagged godwits from the Manawatu Estuary stopped off in northern New Zealand before moving south back to the Manawatu (J.R. Conklin and P.F. Battley, unpubl. data). Two other colour-banded birds (of 53 in total) from the same site are known to have been elsewhere in New Zealand before returning to the Manawatu. One was at Christchurch for at least 8 days before returning to the Manwatu; the other arrived late in the season having started wing moult, indicating that it had made a stopoff (wing moult in this species is not initiated until after the major migratory flights have been completed). The fact that only one of the three data-logged birds known to have made a stopoff had started wing moult suggests that the true rate of stop-offs is higher than the banded bird data suggest.

(3) Satellite-tracking of godwits tagged in New Zealand recorded three birds deviating from their flights towards New Zealand and making landfall in islands on the western Pacific (Gill et al. 2008). One of these was seen in Australia and then back at its capture site late in the same season.

(4) Colour-banded godwits have been seen on the east coast of Australia during southward migration; some of these have been confirmed back in New Zealand later the same season.

(5) OSNZ censuses from the northern South Island usually record 2000-3000 more godwits in February than in November (Schuckard 2002; OSNZ unpubl. data), indicating that some birds 'trickle' in to non-breeding sites well after the population has left Alaska and the bulk has arrived in New Zealand. This may involve both adults and juveniles. It is not yet clear what proportion of these birds have moved within New Zealand and what proportion has arrived from other countries.

31 These records indicate that godwits may initially stop short of their target or final non-breeding destination during migration. The

number of birds doing so likely varies between years with different weather conditions, as wind conditions affect flight durations greatly.

32 The likely route that godwits take when moving from northern New Zealand, especially the Auckland region, to the Waikato Harbours or the South Island is along the west coast of the North Island. This route has recently been confirmed as the major flyway for pied oystercatchers flying to and from the South Island (Fuller et al. 2009). Major landmarks that could be used for navigation include Mt Karioi in the Waikato and Mt Taranaki.

33 As a result, it is likely that from the total number of birds that migrate to destinations south of the HMR wind farm site, an undefined portion staggers their journeys south, and may pass the proposed HMR wind farm site. Those that migrate directly to more southerly sites could still pass the proposed HMR wind farm site if they flew at low altitude along a coastal route; alternatively if they flew at altitude or offshore they would not be at risk. The shortest route from Alaska to the northern South Island would cross the North Island between the Kaipara Harbour and the Firth of Thames, so it is plausible that South Island birds pass by or over the northern North Island.

34 The numbers of South Island birds recorded in the Auckland region on southward migration during the OSNZ study were low relative to the pool of marked birds available for resighting (13 records from 157 adults banded by 2005, 373 by 2006 and 391 by 2007). It should be recognised that such records are likely to be underestimates of the true frequency of stopovers, for three reasons: (1) they relied on the presence of volunteer birdwatchers, who typically could make observations only on weekends, (2) not all colour-banded birds present will be located and identified, and (3) most observations were made around Auckland, so any southern birds stopping off in Northland or the Far North are unlikely to have been located.

Non-migratory movements

35 Adult godwits are generally very site-faithful on the non-breeding grounds, and only small numbers of 'local' movements (within a single estuarine system, or between adjacent systems) were detected in the OSNZ study. Such movements (e.g. Firth of Thames birds recorded in the Manukau Harbour; movements within Golden and Tasman Bays) were recorded in 6% of adults.

36 Movements between sites were more frequent in immature birds (20% of colour-banded immatures). These included such long-distance movements as a bird from the Firth of Thames that made a visit to Invercargill, Southland, and returned to the Firth of Thames.

37 It is difficult to assess how many birds may be involved in such movements. Detailed counts at the Manawatu Estuary in 2007-2008 detected temporary influxes of around 30 probably juvenile or immature birds in mid-summer, and in winter the population varied between 35 birds and zero (J.R. Conklin, Massey University,

unpubl. data). It is likely that such movements involve fairly small groups of birds but the frequency of these movements is unknown.

38 Small flocks of birds are occasionally seen flying along the west coast of the North Island and may involve young birds such as these. These records include seven flocks totalling 40 birds in the HMR stage 2 migratory shorebird monitoring (Stirnemann and Kessells 2009), and 10 flocks totalling 143 birds (including a flock of 85 birds) further south at Taharoa during coastal shorebird monitoring in January 2008 (Fuller et al. 2009). At Rahotu, Taranaki, 20 godwits were seen flying south on 27/10/2000 (there are no large resident godwit populations in Taranaki) (Parrish 2002). Of the 40 birds recorded in the HMR stage 2 monitoring, 27 (68%) were inland. A flock of c. 50 godwits was seen flying north over Glen Massey, inland east of the southern end of the proposed HMR wind farm site, in January 2002 (D. Riddell, pers. comm.).

39 The source population that would arguably have the greatest risk of crossing the proposed HMR wind farm site is that from the Firth of Thames. There are observations of three small flocks of godwits leaving Miranda in the Firth of Thames on 12 October 2008 in the late afternoon, in a south to southeast direction (down the Hauraki Plains; A.M. Habraken, pers. comm.). They followed a flock of pied oystercatchers that were presumably starting migration towards the South Island. While these birds could have been flying towards the Waikato coast or the Bay of Plenty, it is evident that godwits do migrate overland in the northern Waikato. It is not known whether these were adults still on migration or immature birds.

40 An overland movement has also been confirmed in a satellite-tagged godwit that moved from Okarito Lagoon to the Manawatu Estuary, Wanganui Estuary and up to the Auckland region. Heading north from Wanganui it went inland north of Waverly and crossed the Taranaki region around 30 km east of Mt Taranaki (P.F. Battley et al., unpubl. data). The ground elevation along its flight path reached 280 m.

41 These observations, together with those of birds at Glen Massey and over the proposed HMR wind farm site, confirm that godwits readily cross land when moving around New Zealand. This should be no surprise, as despite their coastal non-breeding habits godwits are inland rather than coastal breeders.

RED KNOT

42 Knots are the 2nd-most common Arctic wader in New Zealand, with 37,000-50,000 present in summer (OSNZ, unpublished data, Southey 2009). These recent estimates are lower than the 59,000 birds estimated in the 1980s (Sagar et al. 1999). In winter on average 3000 birds were counted from 1994-2003 (Southey 2009). This is lower than the 5800 birds recorded in the 1980s (Sagar et al. 1999). The population has evidently declined over the past 20 years.

43 Knots are more restricted in their occurrence around New Zealand than are godwits, and are found principally in the harbours and embayments from the Far North to South Auckland (including the Manukau Harbour and Firth of Thames), and on Farewell Spit. They are generally scarce in the Bay of Plenty and virtually absent from the Waikato and eastern South Island. In the OSNZ February 2008 census, 12,164 knots were recorded south of the proposed Waikato wind farm, in the Manawatu region and South Island (26.8% of the national total of 45,320 birds).

Northward migration

44 Departure directions of flocks seen leaving Farewell Spit were consistent with a direct flight towards Australia (Battley 1997). Flocks seen departing from the Firth of Thames on migration usually headed towards (and presumably over) the Hunua Ranges (300-600 m elevation) (P.F. Battley, unpubl. data). That path would take them over the Manukau Harbour on a line with northeast Australia. There is no evidence for substantial movements northwards within New Zealand before departure, though there has not been a large pool of colour-banded knots in the South Island from which to detect any such movements.

Southward migration

45 There are no direct data on arrival patterns of knots in New Zealand. However, they will approach New Zealand from the northwest (if flying from northern Australia or eastern Asia) or the west (if flying from southeast Australia, as many young birds do: Riegen *et al.* 2005) rather than the north. Adult knots banded at the Manawatu Estuary have been seen in the Auckland region and again in the Manawatu in the same season, confirming some southward movements within New Zealand.

Non-migratory movements

46 The OSNZ wader movements project recorded 272 of 345 knots (banded mostly around Auckland) away from their banding site. Most of these involved movements between the large Auckland tidal areas (Kaipara Harbour, Manukau Harbour and Firth of Thames) but birds were also recorded in the Far North (Parengarenga and Rangaunu Harbours), Northland (Whangarei Harbour), Bay of Plenty (Maketu), Golden Bay (Puponga and Farewell Spit) and Tasman Bay (Motueka Sandspit, Waimea Inlet).

47 Young birds (juvenile/immature) moved more than adults, though all age classes were more mobile than equivalent godwits (93% of young knots and 72% of adults were seen away from their banding site). Long-distance movements (Auckland region to the northern South Island, Manawatu Estuary to the Auckland region) were recorded in 14 adults (6.4% of those banded) and 14 juveniles/immatures (11.4% of those banded). This indicates that the propensity to move widely within New Zealand, as well as locally, is higher for knots than for godwits. It should be borne in

mind that few knots were caught in the South Island, so there was little opportunity to document any movements of southern birds.

48 As with godwits, knots moving between the Auckland region and the northern South Island are likely to travel down the west coast of the Waikato region, giving the potential to pass or cross the proposed HMR wind farm site. That potential would be greatest for birds from the Firth of Thames. There are no data to indicate whether those birds fly to the Manukau Harbour first (potentially then crossing the northern end of the proposed wind farm site when heading south), southwest to the west coast (crossing the footprint of the proposed wind farm south of Port Waikato), or further south, reaching the west coast at the Waikato Harbours.

49 There is a single observation of knots flying south from the Firth of Thames. On 12 October 2008, a flock of about 60 knots were seen in the late afternoon flying south to southeast from Miranda, along a similar path to that taken by pied oystercatchers and godwits the same day (A.M. Habraken, pers. comm.).

SUMMARY OF ABOVE FINDINGS – GODWITS AND KNOTS

50 In light of the above data, I make the following conclusions about the movements of godwits and knots in New Zealand before discussion of what this could mean for the HMR wind farm site:

(1) Some godwits that spend the non-breeding season in the Waikato Harbours are likely to pass along the northern Waikato coast when arriving in New Zealand.

(2) A portion of adult godwits and some knots are likely to migrate in a staggered manner from northern New Zealand to the South Island or southern North Island during the September - November period (and this may vary between years depending on wind conditions during migration).

(3) A portion of godwits (predominantly young birds) may move around New Zealand at any time of the year.

(4) Most knots will make some short- to medium-distance movements while in New Zealand, in summer (adults) or throughout the year (juveniles and immatures).

(5) Some knots, both adults and juveniles/immatures, will make long-distance movements that will involve passing the Waikato coast.

(6) In all cases, there is a strong case that some of these birds will cross the proposed HMR wind farm site. As with New Zealand-breeding internal migrants, birds moving to or from the Manukau Harbour have the potential to cross the northern sector of the proposed wind farm, while birds from the Firth of Thames could cross anywhere along the length of the proposed site. Whether some Firth of Thames birds travel further south to the Waikato

Harbours before reaching the coast, thus avoiding the proposed HMR wind farm site altogether, is completely unknown.

NUMBERS OF BIRDS INVOLVED

51 There are no data gathered by Contact Energy or others in the proposed HMR wind farm site or along the Waikato coast that can adequately estimate the numbers of northern hemisphere waders passing through or by the region. In lieu of this, below I provide a range of estimates based on the number of adults occurring in the Waikato Harbours, the number of South Island adults estimated to make stop-offs in northern New Zealand, and the number of immatures expected to make long-distance movements annually. Given the uncertainty in the proportion of birds that makes stop-overs in northern New Zealand each year, and bearing in mind that this may vary in different years, in the calculations I assume a range of values for the proportion of birds stopping off. With the uncertainty in these estimates, they should be used as indicators of the potential magnitude of movements rather than as precise estimates.

Godwits

52 The proportion of South Island godwits stopping north of the Waikato is unlikely to be overly large, but the finding that counts in February in the South Island are 2000-3000 birds higher than in November suggests that late-arriving birds can account for 13% of the total count (of 23,000). These would not include birds moving south in the main arrival period of September-October, but could include birds arriving via Australia (and will probably involve some juvenile birds). I therefore used stopover values for adults of 5%, 10% and 15% when evaluating potential populations relevant to the proposed HMR wind farm. These are applied to a South Island population of 20,700 adults (assuming 10% immatures in the population).

53 3500-10,000 godwits spend the non-breeding season in the Waikato Harbours and potentially may pass the proposed Waikato Wind Farm site upon arrival in New Zealand. These figures will include a portion of non-migrating immature birds (assumed here as 10% of the total population). I therefore used adult populations of 3000, 5000, 7000 and 9000 in the estimations.

54 8000 immature birds 'overwinter' in New Zealand rather than migrate and can potentially move year-round. I assume that these birds return to their initial site so will pass the proposed HMR wind farm site twice per year. I assumed that 5%, 10% or 15% of immatures made non-migratory long-distance movements each year. Cumulatively, 20% of immature godwits were recorded in the OSNZ wader movements study making long-distance movements at some stage. I assume that no adults make these movements.

55 Table 1 below summarises these estimations. The indication is that approximately 5000-14,500 godwits could pass or cross the proposed wind farm site. In this exercise the South Island and

immature populations remained the same even though the Waikato Harbours varied in population. In reality, at times when the Waikato populations are high, South Island and national populations will also be higher so all values would be expected to rise.

Table 1. Estimated numbers of godwits potentially passing the proposed HMR wind farm site. Movement rate relates to South Island adults and immatures nationally. Assumed populations are 80,000 birds in total, with 23,000 in the South Island and 8000 overwintering immatures nationally. Movements by immatures are assumed to be two-way.

Movement rate	Waikato adults	South Island adults	Immatures	Total
5%	3000	1035	800	4835
10%	3000	2070	1600	6670
15%	3000	3105	2400	8505
5%	5000	1035	800	6835
10%	5000	2070	1600	8670
15%	5000	3105	2400	10505
5%	7000	1035	800	8835
10%	7000	2070	1600	10670
15%	7000	3105	2400	12505
5%	9000	1035	800	10835
10%	9000	2070	1600	12670
15%	9000	3105	2400	14505

Knots

56 For knots, there are no Waikato harbour populations to account for, leaving South Island adults on migration and wandering adult and immature birds to consider. Given the higher movement levels in knots than godwits, adult movements in summer need to be accounted for.

57 Equivalent calculations to those of godwits are given for knots in Table 2. Numbers estimated to potentially pass the proposed HMR wind farm site vary from around 5000 to 15000 birds. Most of these predicted movements are of adults (of which there are 42,000 assumed in New Zealand). The number of movements of adults seems high relative to the total population, but would it require only 10 flocks per week (either direction) of 42 birds, spread across five months to total 8400 movements (the 10% movement estimate). Given that migrating knots typically leave in the late afternoon or early evening (Battley 1997), if birds moving within New Zealand did the same then such movements could be readily overlooked or not detected.

Table 2. Estimated numbers of knots potentially passing the proposed HMR wind farm site. Movement rate refers to South Island adults and immatures nationally. Assumed populations are 45,000 birds in total, with 12,000 in the South Island (including 11,200 adults) and 3000 overwintering immatures. Movements by non-migrating adults and immatures are assumed to be two-way.

Movement rate	South Island adult stopovers	Adult non-migratory	Immatures	Total
5%	560	4200	300	5060
10%	1120	8400	600	10120
15%	1680	12600	900	15180

58 It is worth noting that such movements would not be restricted to tight 'migration windows' but could occur throughout the year. Birds passing on southward migration would peak in September-October.

59 In terms of flight directions to or from non-breeding sites in the Auckland region, birds from the Firth of Thames are most likely to travel through the proposed HMR wind farm site, given that this spans 40 km of coastline to the west and southwest of the Firth. Birds from the Manukau Harbour have a high chance of crossing the northern part of the proposed HMR wind farm site.

Summary

60 Calculations based on the populations of birds south of the proposed HMR wind farm site and the proportion of birds of different ages likely to make long-distance movements within New Zealand each year were made. Because there is little information available on the frequency of these movements, I assumed that 5%, 10% or 15% of birds in the different categories moved along the Waikato coast. This resulted in estimates that for both species ranged from around 5000 birds to 15,000 birds each year. As an indicative tool, these estimates suggest that the number of northern hemisphere migrants using the Waikato coast is much lower than the number of pied oystercatchers doing so, but may be comparable to or exceed the number of wrybills doing so.

61 There is currently no external information that can be used to validate, negate or refine these estimates. Nor is there information that can elucidate what flight paths these birds would take when moving down the North Island's west coast. It must be recognised that a portion of these is highly likely to cross the proposed HMR wind farm site, particularly those birds originating at or heading to the Manukau Harbour and Firth of Thames. Data on these issues seem to me to be critically important in evaluating the potential impact of the wind farm on migratory birds.

POTENTIAL IMPACTS OF THE HMR WIND FARM

62 Given the evidence presented that indicates the likely passage of godwits and knots through the proposed HMR wind farm, it is evident that there is a risk of turbine strike to some godwits and knots each year. General issues about flying bird strike are discussed by Dr Percival in his evidence (Percival 2009), in

particular in relation to pied oystercatchers. In my opinion, comments made in relation to oystercatchers are also applicable to godwits, given the similarity of their flight behaviour, and to a lesser degree to knots, which are substantially smaller than oystercatchers.

63 In the evidence of Dr Dowding, it is noted that the impact of even low levels of extra mortality can be significant to long-lived species with low productivity and slow maturation (Dowding 2009). He makes the point that these demographic characteristics occur in many New Zealand-breeding waders. They are also true of godwits (which breed first at age 3 or 4 and can live to >20 years) and to a lesser degree knots (which probably also breed first around age 3).

64 In the absence of direct data on the movements and flight behaviour of godwits and knots passing over the proposed HMR wind farm site, the only approach possible when investigating collision risk is to model the risk of turbine strike assuming similar parameters for oystercatchers and godwits and knots. This has been done by Dr Percival for godwits in his evidence (Percival 2009). His prediction based on a worst case scenario of 15,000 godwits passing the site per year is on average 13.8 (95% confidence range 1.2-31.4) fatalities per year.

65 Unlike with pied oystercatchers and wrybills (Dowding 2009), these predicted fatality levels cannot be incorporated into predictive populations models to project the long-term impacts. There are no data on productivity of New Zealand's godwits and knots, or published survival rate estimates of these species in New Zealand.

66 In the context of the national populations of these species, however, there is evidence that they have declined in number in New Zealand over the past 20 years (Battley at al. 2007; Southey 2008) and their habitats are increasingly threatened along their migration routes, particularly through reclamation and reduction of sediment flows into the Yellow Sea (Barter 2003; Moores et al. 2008).

67 Mortality occurring in New Zealand via turbine strike would be additional to existing mortality and would be unlikely to be compensated for by increased reproductive output (as can happen in species where breeding success decreases at high densities of birds).

68 The lack of basic data on the risk of collisions in the proposed HMR wind farm, and on the population biology of godwits and knots, make it difficult to interpret the significance of the predicted annual mortality. A preliminary assessment is to express the predicted annual mortality in relation to the existing annual mortality. Assuming 90% survival for godwits and a population of 80,000, expected annual mortality is 8000 birds. The additional mortality of for example 13.8-31.4 birds would be 0.17-0.39% of baseline mortality. While this is small, calculations for wrybill and pied oystercatchers in relation to the Taharoa wind farm suggest that such levels could cause the population to decline by an additional c. 2-4% over baseline levels in a 50-year period (Fuller et al. 2009).

COMMENT ON CONTACT WITNESS EVIDENCE

Mr Kessels

69 In Appendix II in Stirneman and Kessels (2008) (exhibit GK1A) (Pre-production monitoring report of migratory shorebirds: Stage 1), it is stated in relation to godwits and knots that *"...the majority of these birds have been tracked as entering the Firth of Thames from the north on their migratory route into NZ (P Battley[3], pers. comm)."* In fact, only a single bird has ever been tracked arriving in New Zealand, a godwit that passed west of North Cape. The next set of signals from that bird's satellite-transmitter (which signalled only periodically) was from the Firth of Thames. It is likely, however, that godwits at least do mostly approach New Zealand from the north, including birds that inhabit the Waikato Harbours.

70 In Stirneman and Kessels (2009), results from radar and observational monitoring of bird movements through and past the proposed HMR wind farm site in early January-early February 2009 are presented. The only northern hemisphere migratory shorebirds detected were seven flocks of godwits totalling 40 individuals. It is stated that 22% of the birds sighted were recorded over pasture, 11% over the beach and 67% over the ocean.

71 These values seem to have been derived from the number of flocks recorded over different habitat types, with a flock counted twice if they crossed habitat types. The godwit data are thus calculated from nine 'flocks', with two over pasture. If equivalent calculations are made with the number of individuals (of which 27 birds in two flocks were over pasture), then 40% of individuals were recorded over pasture.

72 The daytime visual surveys conducted by Kessells & Associates confirmed that small numbers of godwits can be detected making non-migratory movements along the Waikato coastline in the middle of the non-breeding season. This agrees with the evidence for such movements based on movements of marked birds. It also confirms that godwits are not restricted to the beach and ocean zone.

73 The numbers of birds recorded in the HMR stage 2 survey is likely to be an underestimate of true numbers passing for several reasons:

a. Godwits and knots are pale grey-brown birds that are not as visible as the larger black and white pied oystercatchers, and godwits can be mistaken for oystercatchers if they are distant and light conditions are not good.

b. Knots are much smaller than oystercatchers so may be less detectable.

c. Godwit and knot calls are not as strident as those of oystercatchers so birds will not be as readily detected from calls.

d. Radar work assumes that most trails are attributable to oystercatchers. Flocks of godwits or knots that are not confirmed visually will be treated in analyses as oystercatchers.

e. As discussed in Dr Dowding's evidence (Dowding 2009), radar work using the same type of radar as in the HMR monitoring is known to detect only a portion of flocks passing.

f. The timing of passage of locally-moving godwits and knots will not necessarily match that of New Zealand-breeding waders migrating north or south.

74 The Stage 2 monitoring report states that *"considering that other migratory shorebirds spend the winter in similar locations to SIPO it may be reasonable to assume that the cues they use to navigate and routes they take would be similar"*. I agree that the navigational cues shorebirds of different species use will be similar, but it should be recognised that a substantial amount of the movements likely to be made by godwits and knots will involve birds not necessarily familiar with the area (for example, adults forced to make a stopover in northern New Zealand, and immature birds with no prior experience wandering around harbours and estuaries).

75 The report states that the monitoring will continue for another northward and two southward migrations. It is imperative that southward migrations are monitored in detail, but the timing of proposed surveys targeting New Zealand migrants (July-August) will not overlap with the period in which northern hemisphere migrants arrive in New Zealand (September-October). Unless this monitoring is extended, no new information on migration-related movements of godwits and knots will be available from which to assess risk of turbine strike. This is a major shortcoming of the proposed monitoring.

Dr Seaton

76 Dr Seaton notes in relation to godwits, knots and turnstones that *"there is the potential for large numbers of all of these species to pass through the region"* (paragraph 10.6). I agree, and have provided evidence to indicate that this may involve some thousands of godwits and knots. Turnstones were not assessed because of a lack of basic information. With a population of around 2500, the numbers passing the proposed HMR wind farm site are expected to be small in comparison with those of godwits and knots.

77 Dr Seaton acknowledges that the primary issue at the proposed HMR wind farm site is potentially with migratory birds and that further monitoring should be completed before operation of a wind farm (paragraphs 11.7 and 11.8). He notes (paragraph 10.6), however, that the main period of monitoring of oystercatchers does not cover the key migration periods of Arctic-breeding waders, and suggests modelling risk under a range of scenarios may be the most informative option at this stage. I concur with his point that the

monitoring proposed does not overlap with the period of greatest potential movement of northern hemisphere waders, and also note that there is a high likelihood of ongoing movements of young birds throughout the year that also will not be detected.

78 Dr Percival has made a preliminary attempt to model the risk to godwits migrating through the site (as suggested by Dr Seaton), albeit in the absence of any robust data on flight paths of this species over the site (discussed above).

79 In section 10.9 it is stated that Mr Kessell's evidence discusses that the radar work indicates that *"bad weather conditions, particularly strong offshore winds, cause more birds to come inland"*. The Stage 2 monitoring report states that southerly and easterly winds increase numbers of birds, but it does not say anything about numbers over land as opposed to over the coast, as far as I could tell.

80 Section 12.4 lists a number of options that are available to avoid any effects if it is established that *"there is a significant risk that these birds will be negatively affected"*. These are:

a. Do not build turbines in areas where high densities of migrating birds are passing through.

b. Ensure wide "corridors" with no turbines are available for migrating birds to pas through the wind farm.

c. Switch off turbines at times of high bird migration.

d. Switch off high risk turbines at times when high bird migration and inclement weather conditions coincide.

81 These are discussed by Dr Percival in his evidence (Percival 2009). In relation to northern hemisphere migrants, it should be noted that there are currently no data with which to identify flight routes of birds or high risk turbines. The proposed monitoring program will not be adequate to identify these for godwits and knots, given that it will cover times outside the predicted peak period. Any birds approaching the west coast from the Firth of Thames will likely be very difficult to locate.

82 A number of options for mitigation are also presented (section 12.5), though it is stated that further research is needed before the suitability of these options can be assessed:

a. The implementation of predator control programs at key breeding and wintering sites for migratory birds.

b. Intensive, sustained and targeted predator control and habitat enhancement for bush and wetland birds (at Punga Punga Wetland).

c. Predator control in and habitat enhancement of local areas of bush (particularly for kereru).

d. Providing funds and facilitating long-term formal legal protection of affected key natural features on private land within the Waikato Wind Farm study area.

e. Long-term funding of a shorebird study group whose objectives are to describe the major pathways of migratory birds around New Zealand (similar to the Department of Conservation "Project River Recovery" funded by Meridian Energy Ltd).

83 None is specifically targeted at international migrants. Predator control programs at wintering sites for New Zealand-breeding waders may well benefit these species, which have been documented to experience some predation from introduced mammals (Dowding & Murphy 2001; Battley & Moore 2004). In contrast there is no evidence that introduced predators are a major threat to Arctic-breeding waders in New Zealand (though cat predation on a godwit has been recorded: Taylor and Parrish 1994).

84 Predator control on the breeding grounds is recognised as an effective way to increase productivity in some situations, and this is proposed here as a possible method of mitigation for migratory birds. The northern hemisphere waders at risk from the proposed HMR wind farm breed over vast areas at very low densities in otherwise uninhabited regions. Boosting productivity through predator control on the breeding grounds is impossible for these species.

85 Long-term funding of a research group to study the movements of waders around New Zealand could increase the knowledge on international migrants. Given that the greatest threat to these birds is probably habitat loss on staging grounds in Asia, research aimed at identifying key stopovers sites used on migration would probably do more to mitigate any losses in New Zealand in the long term.

CONCLUSIONS AND RECOMMENDATIONS

86 There are strong reasons to expect that quite large numbers of godwits and knots pass the proposed HMR wind farm site each year, during migration of adults (in particular southward migration) and throughout the year (by both adults and young birds). This has been established in an intensive 3-year research program recently completed by the Ornithological Society of New Zealand.

87 The timing of such movements will not be as clear-cut as those of New Zealand-breeding waders. Young birds that do not migrate away from New Zealand could move year-round; adults should peak during southward migration in September-October and lower numbers continue to make local movements through the summer.

88 Existing monitoring work is unlikely to document these movements well. Radar work is likely to not detect flocks of godwits and knots, and instead record these as pied oystercatchers. Visual observations will probably under-record these species.

Nevertheless, visual migration monitoring has recorded small numbers of godwits at both Taharoa (south of the proposed HMR wind farm site) and the HMR site itself.

89 While it is difficult to estimate the numbers potentially involved, calculations given here suggest that it may involve in excess of 5000 or even 10,000 or more godwits and knots.

90 The risk posed by the proposed HMR wind farm is arguably greatest for godwits and knots moving to or from the Firth of Thames, though birds from the Manukau Harbour may cross the northern part of the proposed wind farm site.

91 There is currently inadequate information on which to assess the true risk to northern hemisphere waders and to evaluate mechanisms to reduce this risk. In particular, the numbers of birds passing the proposed HMR wind farm site and the flight paths taken have not been documented directly, and these are the two crucial pieces of information required.

92 It is recommended that winter shorebird monitoring be extended through September and October, specifically to evaluate the numbers of godwits and knots that pass through the proposed wind farm site on southward migration. Adult godwits typically arrive in New Zealand in mid-late September, but juveniles do not start to arrive until the start of October (P.F. Battley, unpubl. data). Hence, monitoring through October would be beneficial for detecting movements of juveniles.

93 However, there is concern about the ability of any monitoring to adequately detect flocks of godwits and knots making local movements, given that radar work has not yet been demonstrated to be also to separate shorebird species or detect small groups of knot-sized birds. It is likely that visual observations will also not detect all flocks of godwits and knots, particularly if a portion of the movements occurs at night.

94 If a significant risk of mortality is deemed probable, methods to reduce the mortality or mitigate any mortality are required. Godwits and knots are both species with demographic characteristics that mean that populations cannot readily compensate for additional mortality. This has been established for pied oystercatchers and wrybills in modelling based on the Taharoa wind farm (Fuller et al. 2009), in which increases of as little as 0.3-0.4% per annum caused a discernible increase in the rate of population decline over a 50-year period.

95 Mitigation options are not straightforward. Most mortality of northern hemisphere waders occurs away from New Zealand, including while on migration, so there are no simple manipulations that can address this. All breeding occurs overseas, and boosting productivity through predator control is impossible.

96 However, high tide roosting options are increasingly limited around New Zealand and are threatened by exotic (e.g. weeds, grasses)

and native (e.g. mangrove) vegetation, as well as by human disturbance. Encroaching vegetation affects birds directly (making areas unsuitable for roosting) and indirectly (through providing shelter for predators such as cats). Mitigation through habitat protection and improvement may be an option in relation to Arctic waders, as a way of minimising disturbance during migratory fuelling. This could involve ongoing vegetation clearance on shellbanks in places such as the Firth of Thames or Manukau Harbours, or habitat creation at places were undisturbed high tide roosts are lacking or under threat. The success of such work could only be evaluated in relation to continued use of the sites by shorebirds. It would be impossible to determine if there actually were survival improvements.

97 Research funding to study the migratory pathways and habitat use of godwits and knots on migration could also lead to conservation benefits for the species. A major gap in knowledge currently is where red knots stop-over on migration. It should soon be possible to use light-sensitive geolocator dataloggers on knots to help identify the sites used on migration. Research funds administered by a suitably qualified shorebird research group could be used for such research, or for funding surveys at potential stopover sites (such as North Korea).

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