60 YEARS OF MIGRATORY BIRD MANAGEMENT ON THE MANUKAU

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ABSTRACT

The Manukau Harbour is the single most important harbour for migratory wading bird species in New Zealand. Approximately 25% of the national population of wading birds use the harbour at any given time and about 60% of the wading bird population pass through it at some time in their life. From 1960 the city of Auckland used a small part of the harbour to treat it's wastewater through 515 hectares of oxidation ponds. This comprised of land based treatment followed by four large ponds separated by pond walls (serving as access roads). After the ponds were constructed it was discovered that thousands of migratory wading birds found these walls to be excellent places to roost. Since then, about 20% of the wading bird population that feed in the Manukau Harbour roost adjacent to the Mangere WWTP. The plant staff inadvertently found themselves to be caretakers of some of the best roosting sites in New Zealand. When these ponds were decommissioned and returned to the harbour in 2003 a considerable amount of care was taken to ensure that the birds had viable places to roost. This involved the construction of the largest 'artificial' islands roosts in New Zealand. The roosts are actively managed to control weeds and predators, and reconstruction activities are periodically undertaken to remedy the effects of wind and wave erosion. The management of these roosts reflects Watercare's vision and commitment to operate in a sustainable manner.

This paper reviews the close relationship that these birds have had with the treatment plant since it was commissioned in 1960. It summarises the human history of the harbour and how this has affected these bird populations. It shows the importance of the managed roosts by using data from annual census, providing species specific examples. In addition, this paper discusses how Watercare staff work with ornithological experts to manage these roosts. Involving members of the public to help look after these roosts has been an important community linkage which helps to ensure the conservation work is valued and ultimately successful. Projects continue to involve local groups, schools, and churches who have become involved in conservation and restoration work on and around the roosts. These projects were not only great for conservation, but also great fun for the local community.

KEYWORDS

Migratory wading bird, roost, harbour, environment.

PRESENTER PROFILE

Christopher Garton is a Senior Environmental Scientist at Watercare Services Limited. Chris ensures that the bird roosts at the MWWTP are managed effectively and has initiated many community projects involving local schools and community groups.

1 INTRODUCTION

"The truth is the natural world is changing. And we are totally dependent on that world. It provides our food, water and air. It is the most precious thing we have and we need to defend it." David Attenborough. Interview with Robin McKie, www.theguardian.com. October 27, 2012

The Mangere Wastewater Treatment Plant (MWWTP) is one of the largest wastewater treatment plants in the world. It treats the majority of the residential and commercial wastewater from the Auckland region and releases the treated water in to the Manukau Harbour on the outgoing tide. The average daily flow of 380,000 m^3 would

be a catastrophe to the receiving environment if it was not treated to a very high standard. Project Manukau, the upgrade project for the plant, lifted the treatment capability of the facility to that of world class. The treatment standard does not pose a threat to the receiving environment but the facility needs to be carefully managed to ensure that Watercare continues to meet its social and technical licence to operate.

Every day more than 30,000 thousand wading birds feed on the mudflats of the Manukau Harbour (Southey, 2009) with about 20% roosting on the artificial bird roosts adjacent to the MWWTP (Birds NZ census data). The main species that use the bird roosts are apex predators of benthic life and their continued use of the harbour is an indicator of its health and carrying capacity. Between tides the birds cannot feed and will roost in a safe place. This time is precious to the birds because they use it to sleep and rest. If this rest is disturbed then this will become seriously detrimental to their health and the viability of the population.

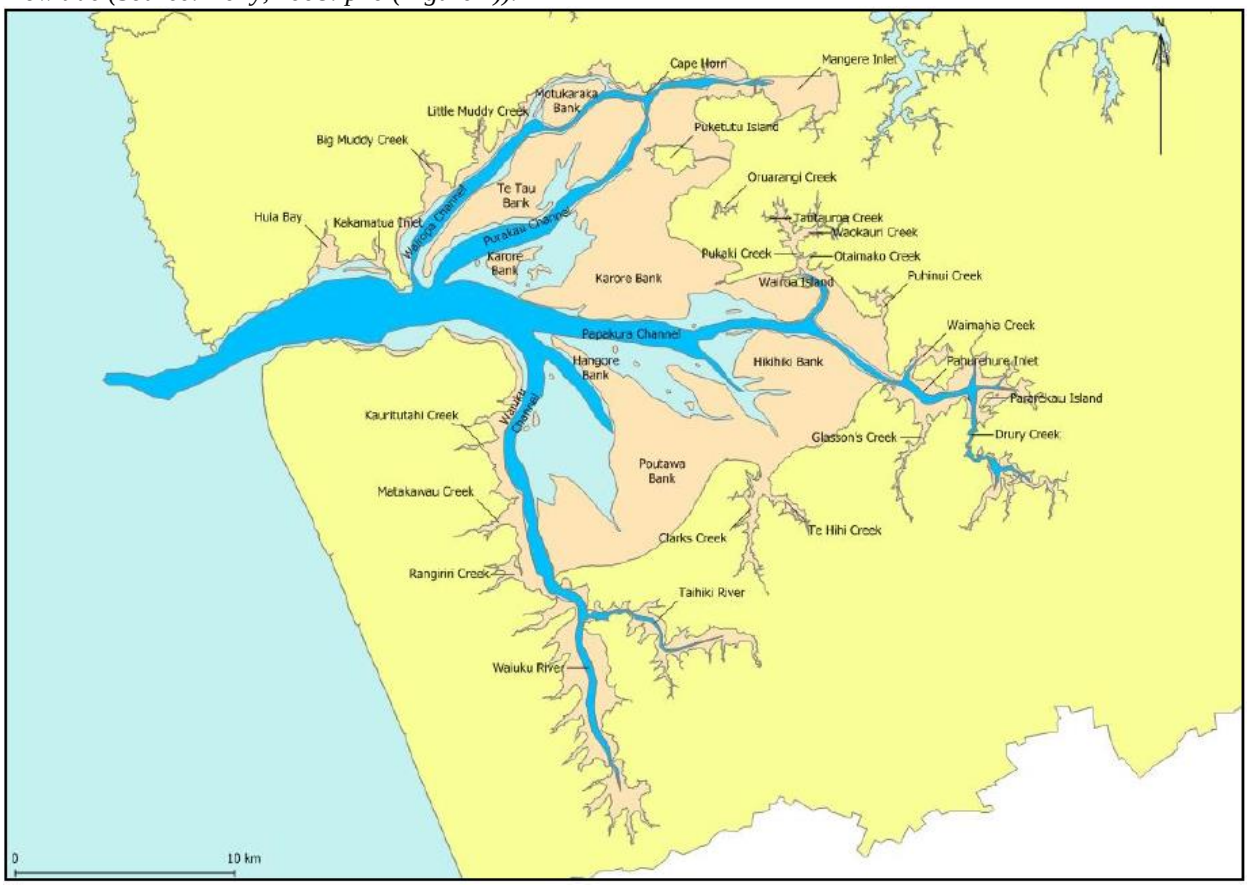
Photograph 1 Eastern bar-tailed godwits, pied stilts, and pied oystercatchers using one of the artificial bird roosts located at the Mangere Wastewater Treatment Plant

2 DISCUSSION

2.1 THE MANUKAU HARBOUR

The Manukau Harbour is located to the west of the Auckland Isthmus and is New Zealand's second largest harbour. It has a surface area of 365 km^2, a shore length of approximately 460 km^2, a spring tide volume of around 221.5 million m^3, and a total catchment area of approximately 895 km^2 (Kelly, 2008). It is separated from the Tasman Sea to the west by a Quaternary dune barrier (Awhitu Peninsula), is bounded in the north by the volcanic Waitakere Ranges and Auckland volcanic field, and to the east and south by the Puketoka Formation. The harbour mouth is 9km long and 2.3 km wide with an extensive ebb-tide delta created from tidal flows and littoral drift which extends approximately 5km offshore with a large sand volume of 1,250 x 10^6 m^3 (Hicks & Hume, 1996). The four channels are the Wairopa and the Purakau Channels in the north leading to the Mangere inlet in the northeast, the Waiuku Channel in the south leading to the Waiuku River, and the Papakura Channel in the southeast leading to the Pahurehure inlet (Kelly, 2008). It is a relatively shallow harbour with 65% of the harbour beds exposed at low tide. These exposed banks provide excellent habitat for many benthic species and are 'intertidal food factories' for the wading birds that feed on them (Woodley, 2012: p45).

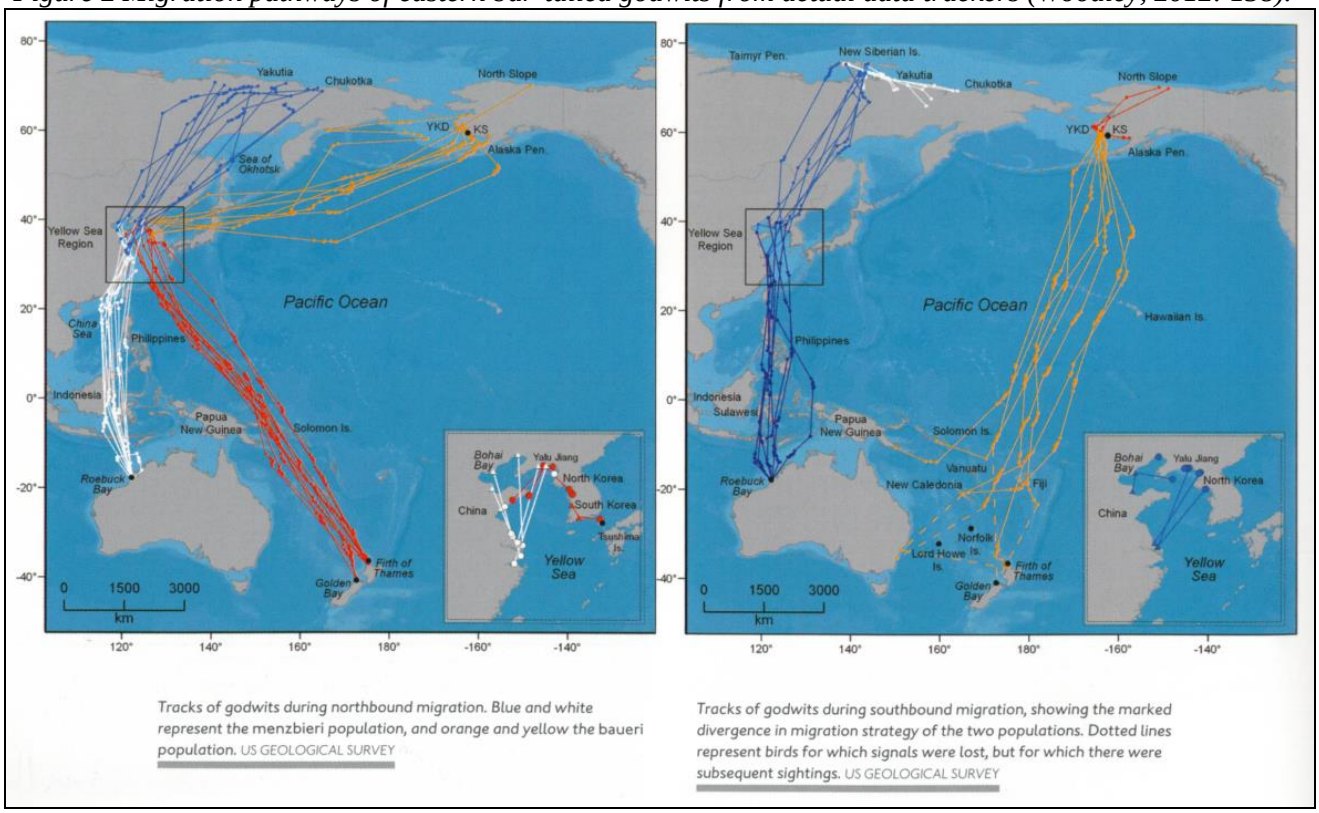
Figure 1 Map of the Manukau Harbour identifying the main channels, creeks, harbour mouth, and banks exposed at low tide (Source: Kelly, 2008: p10 (Figure 2)).



2.2 THE IMPORTANCE OF THE HARBOUR TO THE BIRDS

In the summer of 2009, Birds NZ (formerly the Ornithological Society of New Zealand) counted more waders in the Manukau Harbour than any other harbour in New Zealand. The Manukau Harbour is extremely important to endemic and transient wading bird populations in New Zealand and routinely has the highest proportion of waders compared to other harbours (Veitch & Habraken, 1999). Census data from Birds NZ shows that the harbour supports more than 20% of the total wading bird population at any given time and an estimated 60% of all New Zealand waders will transit through the harbour at some stage in their lives (Watercare, 2008). The harbour is also very important for international migration because New Zealand lies at the southern end of the East Asian-Australasian flyway for waders (Williams et al., 2006). Species such as the Eastern bar-tailed godwits make the flight from Alaskan and Siberian breeding sites to New Zealand in one go without stopping. Up to two hundred thousand migrant waders arrive in New Zealand each summer with many making the Manukau Harbour their final destination. Others simply stop in the harbour to recover and 'refuel' before heading further south (Williams et al., 2006).

Figure 2 Migration pathways of eastern bar-tailed godwits from actual data trackers (Woodley, 2012: 158).



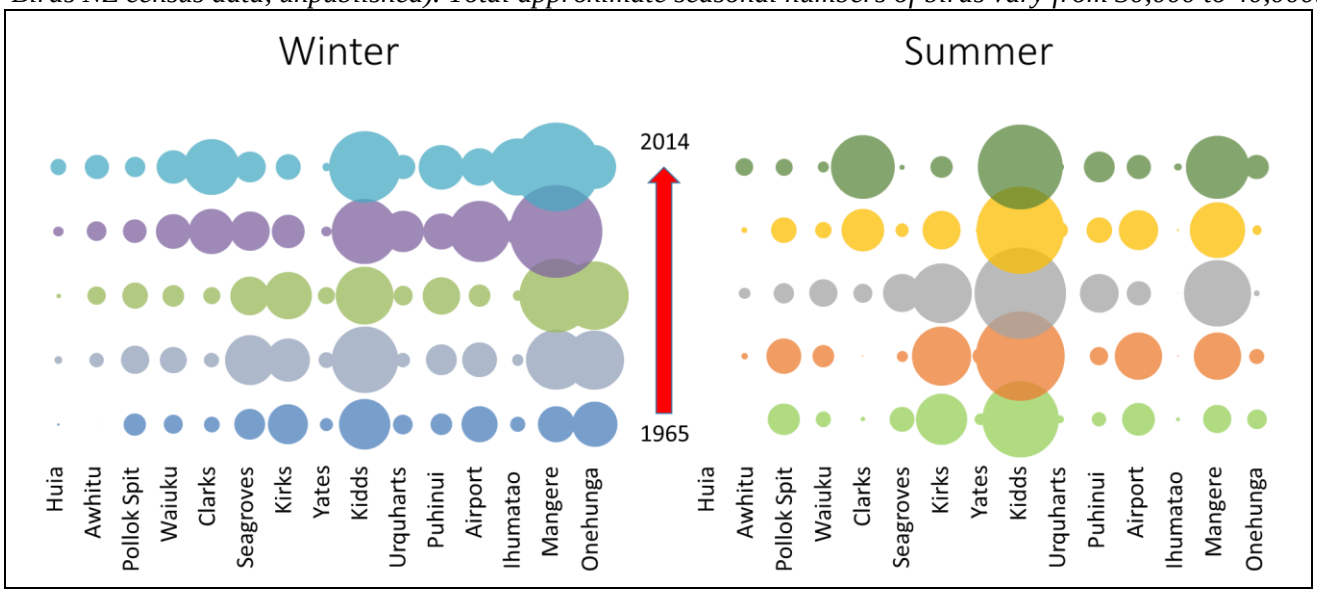
Tracks of godwits during northbound migration. Blue and white represent the menzbieri population, and orange and yellow the baueri population. US GEOLOGICAL SURVEY

Tracks of godwits during southbound migration, showing the marked divergence in migration strategy of the two populations. Dotted lines represent birds for which signals were lost, but for which there were subsequent sightings. US GEOLOGICAL SURVEY

The proportion of wader species changes with the seasons. In the summer the most populous species are the artic migrants of eastern bar-tailed godwits and red knots (lesser knots), with a smaller number of ruddy turnstones (Southey, 2009). At the end of summer the majority of these migrants leave for their breeding grounds in the northern hemisphere but there are always some who remain behind because they are too old or weak to make the journey. However, prior to their departure and around the middle of summer, large numbers of South Island pied oystercatchers, pied stilts, banded dotterels, and wrybills journey from their breeding grounds on the braided rivers of the South Island to the Manukau Harbour (Dowding & Moore, 2006). The braided river systems are not as productive in the winter and these birds make this internal migration to ensure that they have sufficient food. At the end of summer these two groups overlap and the Manukau Harbour is full of avian life.

There are six indigenous species that frequently use the Manukau Harbour: New Zealand pied oystercatcher, variable oystercatcher, pied stilt, New Zealand dotterel, banded dotterel, and the wrybill. Of these the endemic wrybill is the only species in the world to have a bill that curves to the side and always to the right (Woodley, 2012). There are only about 5,000 alive in New Zealand (and the world) and about 90% of them spend the winter in the Manukau Harbour and Firth of Thames (Veitch & Habraken, 1999). These birds move between the Firth of Thames and the Manukau Harbour quite frequently but at any given time the numbers are about even (Birds NZ census data, unpublished). Of the population that frequent the Manukau Harbour, the majority spend their time in the northern coasts of the harbour and at any given time in the winter, about 25% of that world population rest on Watercare's bird roosts and feed in the mud outside the MWWTP (Birds NZ census data, unpublished). The main roosting site in winter is the Mangere WWTP and in summer the main roosting site is at Kidds near Karaka.

Figure 3 Average birds per site for summer and winter for each 10 year period starting from 1965 (source: Birds NZ census data, unpublished). Total approximate seasonal numbers of birds vary from 30,000 to 40,000.



Aside from the thousands of godwits, knots, wrybills and oystercatchers that use the roosts every year, some threatened species use the roosts as well. In the summer of 2017-18, from only eight breeding pairs of New Zealand dotterels there were five confirmed fledglings with another two as being highly probable (but unconfirmed). The national average is less than 0.5 per pair per season, making this an excellent result. There are only about 2,000 New Zealand dotterels alive today and they are classified as 'conservation dependant', which means that their continued existence as a species is dependent on the conservation work of humans.

Birds have been visiting New Zealand for millions of years. However, the Manukau Harbour has undergone dramatic changes in the past thousand years and in particular the last one hundred. The changes include the intensification of people, introduced mammalian predators, land use change from native forest to scrub then to modern farming and urban land uses. This has increased the amount of sediments discharged into the harbour which has increased the amount of fine particles in the upper estuary arms. This has caused changes to habitat conditions, benthic life, and accelerating mangrove expansion (Matthews et al., 2005). The total load of nutrients has increased with the change of land use and the discharges from urban waterways. The urban and road infrastructure has increased the discharge of harmful contaminants such as heavy metals (Kelly, 2008). The 'anthropocene' has arrived to the Manukau Harbour and what we do next will shape its future.

2.3 THE IMPORTANCE OF THE MANUKAU HARBOUR TO ITS PEOPLE

According to local *iwi* and many historians, Māori first arrived in Aotearoa between 1200 and 1300 CE (AD) (King, 2012). Ecologically, their arrival coincided with the first introduced mammalian predators (notably the pacific rat or *kiore*). The subsequent arrival of Europeans in the 17th century brought additional introduced predators which set off another wave of extinctions, which is still on-going (Melville & Battley, 2006). These mammalian predators stalk wading birds while they are roosting at high tide and while nesting. The wading bird species that have survived these predators have done so by being successfully isolated from them. This has meant that since the arrival of humans to New Zealand, roosting areas that are removed from the mainland at high tide have become extremely important.

There are several competing theories on the name of the Manukau Harbour itself but the leading one is that it means 'wading birds'. In Te Reo Māori, 'manu' means 'bird' and 'kau' can mean 'to swim or wade' and the harbour has abundant wading sea bird populations (Te Ara, 2018). The popularity of this name may be attributed to the fact that the wading birds were excellent *kai* (or food). The Manukau Harbour was always a productive source of *kai moana* (sea food) with substantial shellfish, fish, and shark. The banks and foreshores such as Ihumatao and Whatipu provided sheltered areas for growing vegetables and Māori had many settlements around the harbour. The northern harbour foreshore and Waitakere forest allowed the gathering of seabirds, forest birds and eggs, plants for traditional medicine, and food such as fern roots, eels, and berries from the forests and streams. The forest also supplied tree trunks for canoes which plied the harbour and were transported to the Waitemata Harbour and Waikato River across numerous portages.

With the arrival of European settlers, the Manukau Harbour became a place on intensified settlement and the harvest of kauri logs in the Waitakere Ranges. Before Onehunga was established in 1847 more than 500 canoes transported wheat, flax and flour, pigs, fish, firewood and kauri gum to the growing settlement in Auckland (Harvey & Scott, 1998: 26). The harbour became an important source of food and as a means to transport goods. Direct access to Australia meant that Onehunga was Auckland's first port. Up until the rail line was built through the Central Plateau in the early 20th Century, Onehunga provided regular passenger and freight service to New Plymouth, Wellington and Lyttleton as well as Waiuku. As populations expanded around the harbour however, the ecological impact of human activities on the harbour increased.

The combined effect of deforestation and land use change to farming and urbanisation has increased the amount of sediment and nutrients in the Manukau Harbour (Kelly, 2008). Due to the hydrodynamics of the harbour, this additional sediment has mostly settled in the upper arms of the estuarine channels. In places this has changed the composition of the sediment from 'sandy-mud' to simply 'mud' (Matthews et al., 2005). The negative consequences of increased sedimentation can include the smothering of benthic life, ecosystem shifts to tolerant species, a reduction in the number of species, and a loss of ecosystem function and processes (Castro & Huber, 2008). In addition, increased sedimentation appears to be a major factor in mangrove expansion due to the increased bacterial mineralisation of sediment carbon (Lovelock et al., 2007). The loss of benthic life and the increased growth of mangrove forests have impacted negatively on wading bird species by reducing the amount of viable feeding areas in the harbour.

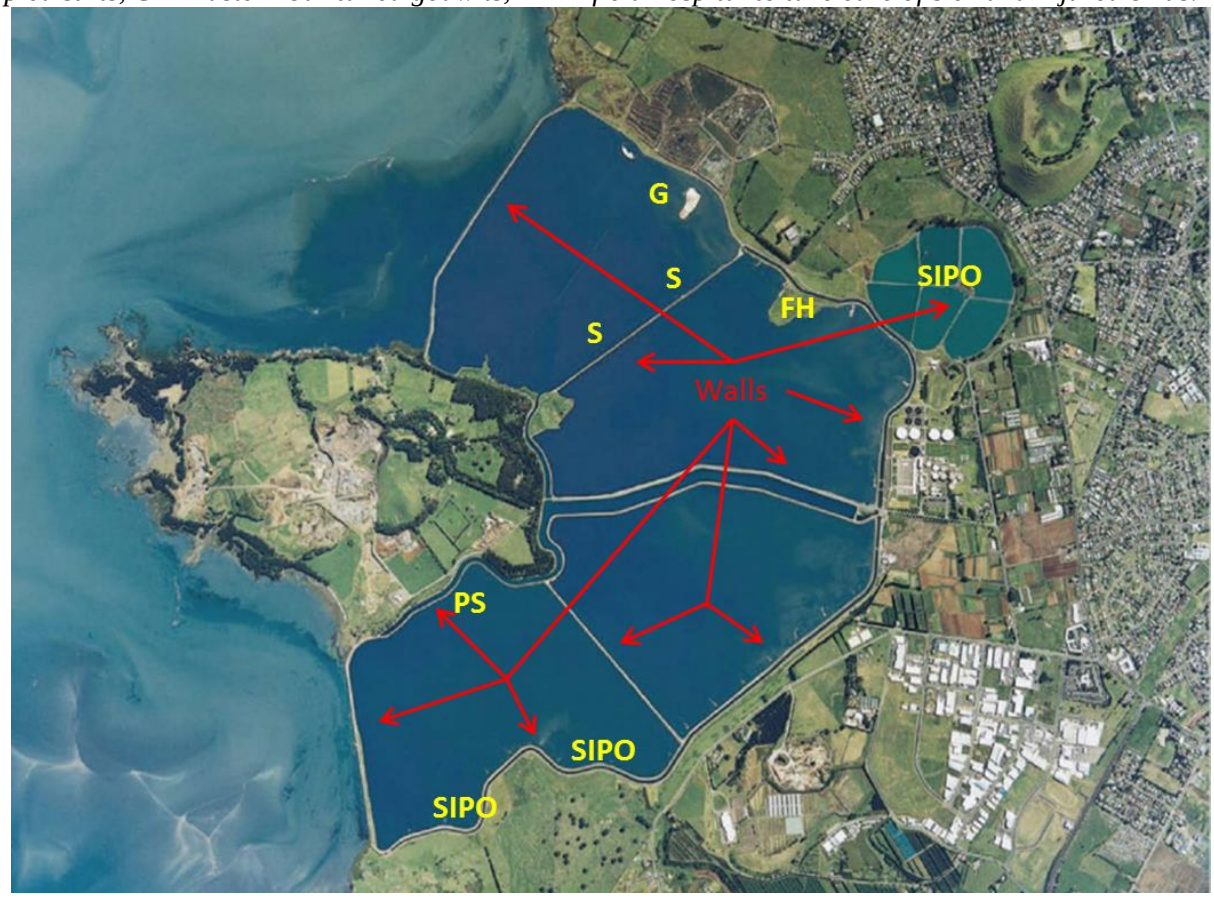
For more than 100 years there were multiple population centres that discharged untreated wastewater directly in to the harbour including the many industries located in Ōtāhuhu and Onehunga. From the 1900's onwards some of the types of direct industrial discharges to the Mangere inlet included three large meat works, an abattoir, three phosphate fertiliser works, two wool scours, fellmongers, soap and candle works, a wood-pulp works, a battery works, a woollen mill, a tannery, a glue works, Middlemore hospital, leachate from various refuse tips, run-off from the Ōtāhuhu railway workshops, discharge from Pacific Steel, and discharge from Ōtāhuhu borough council septic tanks (Glasby et al., 1988; Kelly, 2008; Williamson et al., 1992). These discharges had a catastrophic ecological impact on the Mangere Inlet with anoxic zones depleted of oxygen which caused the death of fish species such as mullet (Ray Clough, pers. comm.). The history of this discharge is still present in the sediment of the inlet with elevated levels of heavy metals (Kelly, 2008).

2.4 THE ROLE OF THE TREATMENT PLANT

The MWWTP (initially called the Manukau Sewage Purification Works) was commissioned in September 1960 and treated these collected wastes and others by using 515 hectares of oxidation ponds. When it was built it was the biggest of its kind in the world and it greatly improved the ecological state of the Mangere Inlet and the Manukau Harbour. Prior to its construction 675,000 litres of untreated sewage were discharged daily in to the Manukau Harbour (Watercare, 2002). The oxidation ponds covered the area between the mainland and Puketutu Island and they were separated by earthen barriers armoured with rock riprap.

Although the walls that separated the ponds were designed by humans for a specific operational purpose, many wading bird species saw these creations very differently. As far as they were concerned, these walls were prime real estate for roosting at high tide. Being relatively isolated from the mainland they provided a degree of safety from predators, they were not flooded during storm surges, and they were visited infrequently by the humans that built them because access to the public was restricted. As a result the numbers of birds occupying the roosts at each high tide numbered in the thousands and the staff at the facility unintentionally found themselves to be caretakers of some of the best bird roosts in the country. Fortunately, simply maintaining the road and wall structures in good condition was enough to keep them attractive. As there were plenty of roosting spaces to choose from many of the species spread themselves about and settled in favourite locations.

Figure 4 The MWWTP oxidation ponds with just a few of the many species' favourite roosting locations identified (Ray Clough, pers. comm). SIPO = South Island pied oyster catchers, S = Shags (all sub species), PS pied stilts, G = Eastern bar tailed godwits, FH = field hospital to take care of sick and injured birds.



Prior to the construction of the oxidation ponds, this area was already used by many wading bird species. During the construction of the ponds the marine sediment needed to be excavated and placed somewhere. Two natural lava flows in pond 4 were suggested as places to deposit the sediment in order to build them up as roosting sites for these birds (Ray Clough, pers. comm.). These islands can be seen in Figure 6 above next to the 'G' and later became known as 'Big Shell' and 'Little Shell' when they were capped with shells material during the treatment plant upgrade known as Project Manukau.

Project Manukau was the largest coastal rehabilitation project in New Zealand's history and involved removing the oxidation ponds and allowing the harbour to reclaim the mudflats. Construction work started in 1998 and the ponds were fully removed by 2003. The treatment that the ponds provided was replaced with a new land based process which provided treatment that was better by orders of magnitude (99.997% reduction in pathogens). During the upgrade 13 km of coastline was restored, 7 artificial beaches were created and over 300,000 trees planted in the immediate foreshore (Watercare, 2002). Of special consideration during this restoration work was taking care of the roosting habitat for the birds. In order to ensure the best actions were taken for the birds, a panel of ornithological experts called the Bird Roost Advisory Group (BRAG) was established. BRAG members have met every 6 months since 2007 and are heavily involved with the Bird Roost Management Plan (Watercare, 2008). The document is required by consent and details how the roosts should be maintained, the reasons for doing so, and how the roosts are actively managed with the three main threats kept under control: weeds, predators, and erosion.

2.5 PRESENT DAY BIRD ROOST MANAGEMENT

2.5.1 WEED CONTROL

It is important to keep the weeds under control because the wading birds will only use the roosts if they can maintain good visibility around them. They need this visibility in order to feel safe from land based predators which could hide in the vegetation to get within striking distance of the birds. The aim of the weed control

program is to maintain the roosts free of vegetation above the high tide mark (low lying vegetation growing in the intertidal area is not an issue). An environmental safe spraying program using Green Glyphosate 510 applied by non-invasive knapsack application is used to minimise any disruption to the surface of the roosts that can be caused by dragging hoses. This is particularly important during the summer when the roosts are used by New Zealand dotterels and variable oystercatchers for nesting. When these birds are nesting, the nests are identified, avoided, and the contractors cycle their work by spending 10 minutes on and 10 minutes off the roosts. This practice is done to allow the parent birds to return to the nests in order to keep the eggs warm and viable. Additionally, mangroves are controlled at a suitable distance from the roosts to allow unobstructed flight paths and maintain good visibility.

2.5.2 PREDATOR CONTROL

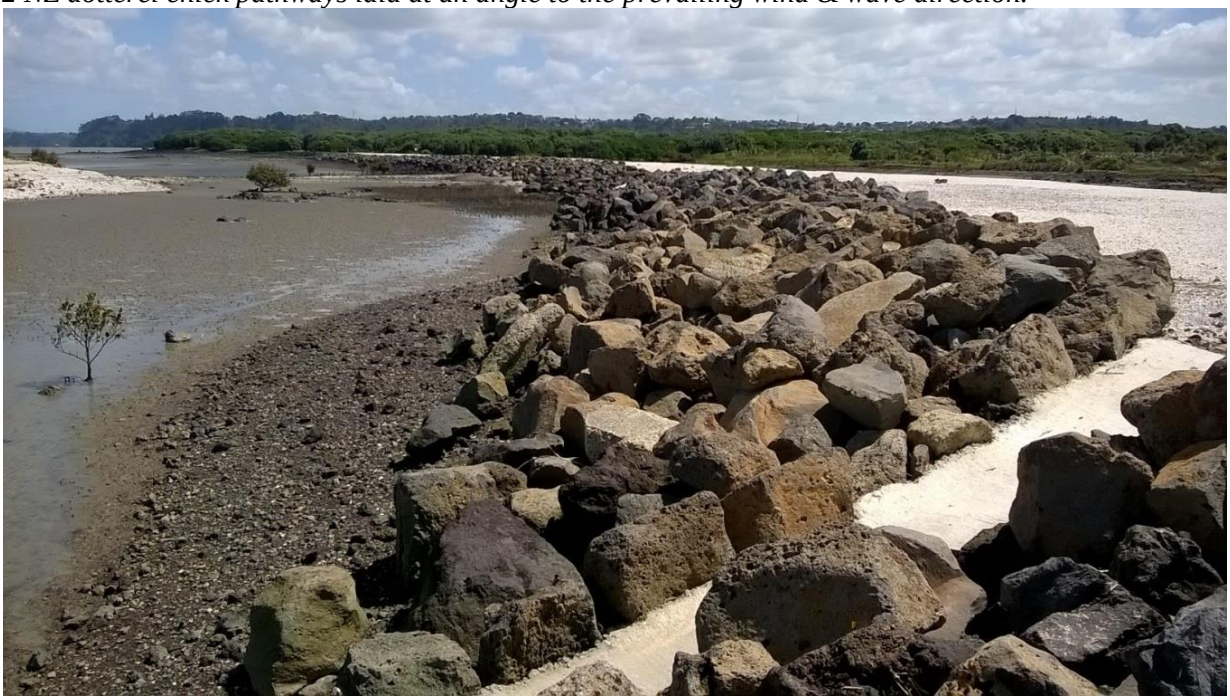
Watercare uses a coordinated multilayer approach to predator control, working closely with Ambury Regional Park rangers using DOC200 traps, bait lines, fumigation and shooting. The main predators to control are mice, rats, hedgehogs, mustelids and cats (through live trapping techniques to ensure that only wild cats are terminated). Rabbits are also extensively controlled in order to make the area less attractive to mustelids and cats. The current bait lines use Brodifacoum with periodic pulses of Diphacinone. Watercare funds the traps and baits while the rangers from Ambury Regional Park manage a dedicated group of volunteers who maintain the trap and bait lines. These bait and trap lines are shown in Figures 7 below. Additionally, Watercare maintains bait lines closer to the plant itself.

Figure 5 Bait and trap lines administered by the Ambury Park rangers and serviced by their wonderful team of volunteers. The traps and bait are paid for by Watercare.

2.5.3 EROSION CONTROL

The effects of wind, wave and rain on the artificial bird roosts causes erosion over time. The roosts are professionally surveyed every year to measure this erosion. Where erosion rates are too fast or the total surface area is not large enough then remedial action is required. The most recent remedial work was carried out in the winter of 2016 on the 'long island' and 'small shell' roosts. Approximately 400 m^3 of gravel were imported to build up the roosts and a further 300 m^3 of shell material was imported to provide a top layer that the waders enjoy (not many species will roost on sharp gravel stones). In addition, large boulders were imported from the Puketutu Island landfill and used to build a rip rap wall to armour the sea ward side of 'long island' roost. On advice from John Dowding (the world's foremost expert on NZ dotterels) concrete pathways through the riprap were built to reduce the risk of the chicks becoming tapped in the rocks as they head to the mudflats to feed. These were placed every 20 metres at a perpendicular angle to the main harbour fetch to prevent sea water surging up these paths to the roosts. See Photograph 2 below for a picture of these pathways and the newly reconstructed roosts.

Photograph 2 'Long Island' bird roost with the newly installed riprap wall and in the foreground one of the 12 NZ dotterel chick pathways laid at an angle to the prevailing wind & wave direction.



2.5.4 PUBLIC INVOLVEMENT

The birds that use these roosts are a national treasure. As caretakers, we have involved local community groups in the conservation effort so that they can share in the responsibility and take ownership of this conservation effort. Successful ecological conservation often relies on the support of local communities because they have the power to drive conservation work or to destroy years of it through deliberate or negligent actions (Ainsworth et al., 2016). In order to raise the perceived value of these roosts Watercare involved local schools and church groups in appropriate conservation activities. As an example, in 2014 students from the local Waterlea Primary School camouflaged some plywood shelters that were built as refuges for New Zealand dotterel chicks. The chicks use these to hide from aerial predators such as gulls and hawks as well as giving them shade during hot summer days. Another example involved a local church group in 2015 that reinstated several tons of shell material that had washed off 'Little Shell' island in order to reverse a decade of wave erosion. Other projects involved poster competitions from multiple local primary schools and of course there is the involvement of the very passionate local volunteer team who manage the trap and bait lines. These projects were all a great success and involving the local communities helps to ensure the sustainability of our conservation work.

Photograph 3 Students from Waterlea Primary School and their decorated New Zealand dotterel chick shelters for the bird roosts.

2.6 THE FUTURE

Watercare takes pride in the work we have done to look after the roosts and advocate of behalf of the wading birds. However, our responsibility extends beyond the bird roosts to the total health of the Manukau Harbour. For this reason, Watercare commissioned the National Institute of Water and Atmospheric Research (NIWA) to create a hydrodynamic model of the Manukau Harbour. The purpose of this model is to predict the movement of water and nutrients in order to understand the effect on the harbours health of not only the release from the plant but also the urban runoff from roads, developments and waterways. This model is one of a number of steps Watercare is taking to ensure our operations are fully sustainable. These birds have been coming to New Zealand for millions of years. If the impacts from society are not understood, managed and fully sustainable, then we cannot expect them to continue to come and feed on the mudflats in the future. A healthy harbour and an abundance of wading birds is a legacy that Watercare would like to continue to contribute to.

Photograph 4 Pied stilts, eastern bar-tailed godwits, knots, and many others feeding on the mudflats opposite the MWWTP.

3 CONCLUSIONS

The Manukau Harbour is the single most important harbour for migratory wading bird species in New Zealand. The artificial roosts managed by Watercare are some of the most important roosts in the harbour. The species that rely on these roosts include eastern bar-tailed godwits, pied stilts, red knots, South Island pied oystercatchers, wrybills, variable oystercatchers, wrybills, and many others. A quarter of the national wading bird population can be found in the Manukau Harbour at any given time and more than half will pass through the harbour at some stage in their life. This harbour is incredibly important to these bird species as well as being incredibly important to the wellbeing of the planet.

We have used this harbour for hundreds of years, for trade, transport, gathering food, and recreation. We have also used this harbour as a place to dump society's wastes without any form of treatment. Now, we have a world class treatment facility, one of the largest in the world, which treats water to a very high standard. The plant and it's surrounds enable the protection of a significant urban landscape for the exclusive use of migratory wading birds. This partnership happened by accident 60 years ago but is now very much part of the corporate responsibility landscape of Watercare. We continue to set new goals toward becoming a fully sustainable organisation. We continue to look to the future to ensure that our operations will safeguard and protect not only the people of Auckland but also the natural environment.

ACKNOWLEDGEMENTS

A special acknowledgement to the hundreds of Birds NZ volunteers who, rain or shine, undertake the winter and summer census counts. Also a very special acknowledgement to all of the wonderful volunteers who help maintain the environment for the birds who live on the harbor. Thank you.

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