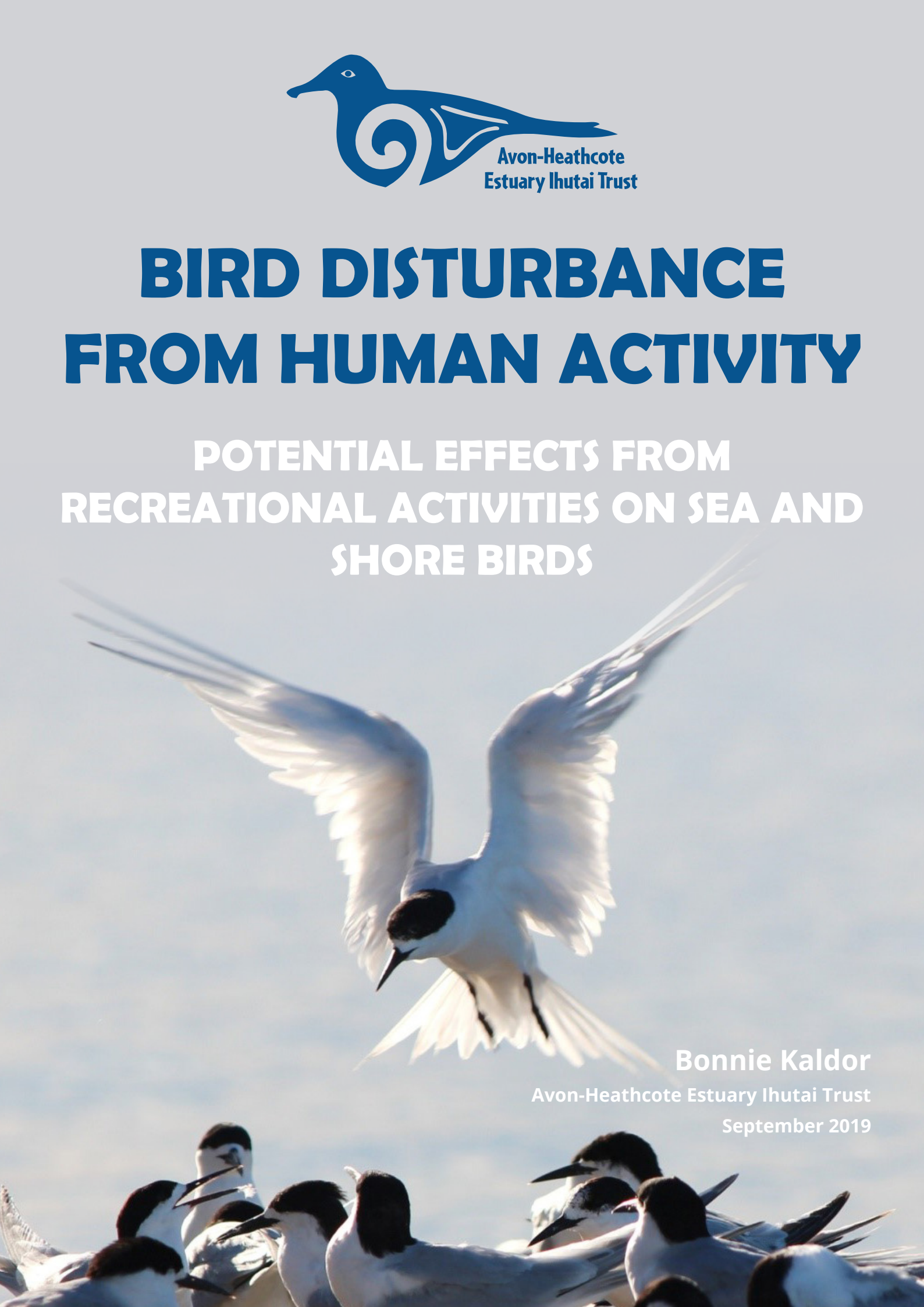
Avon-Heathcote Estuary Ihutai Trust

BIRD DISTURBANCE FROM HUMAN ACTIVITY

POTENTIAL EFFECTS FROM RECREATIONAL ACTIVITIES ON SEA AND SHORE BIRDS



Bonnie Kaldor
Avon-Heathcote Estuary Ihutai Trust
September 2019

Cover photo - White-fronted terns (*Sterna striata*) at Beachville Road by Paul Corliss

EXECUTIVE SUMMARY

1. The Estuary Trust has become concerned in recent years about increased pressure for recreational access to estuary margins. Although we generally encourage equitable access, we are concerned about the effects of wholesale access.

2. The author of this report, Bonnie Kaldor (BSc) was commissioned by the Trust to;

    - Identify and summarise relevant research showing effects/non effects of human behaviours such as walking, jogging and cycling on birds.

    - Identify relevant examples of wetland parks, reserves or wildlife sanctuaries where humans have been excluded from wildlife areas; and summarise the reasons and results of such action.

    - Examine relevant New Zealand wildlife refuge legislation and regulations and see how these relate to disturbance of significant/endangered bird species along the estuary edge (especially the section between Bridge Street bridge and Humphrey's Drive).

3. Bonnie's report confirms anecdotal reports and early studies showing that when birds are approached by people, vehicles or dogs they tend to fly away. Repeated disturbance can result in changed behaviour and may cause birds to permanently leave an area.

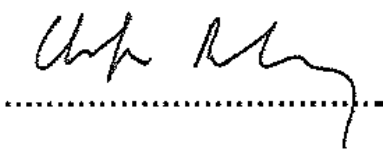
4. The response of birds to disturbances is species-specific, with some flying much farther away than others. The behaviour is often modified when they land again, with increased time for vigilance there is less time for feeding activity and this can result in reduced condition. Some species can adapt to the presence of humans and others remain naturally cautious.

5. The larger the disturbance then the greater effect on bird species. The formation of reserves or sanctuaries which restrict human access can protect birds from disturbances.

6. The Trust is aware of the constant pressure to open up new recreational facilities such as walkways and cycleways around the estuary. However, Bonnie's report has shown us that birdlife can suffer. If there was increased access to the western estuary edge (Bridge Street to Humphreys Drive) then the Trust would be concerned about the effects on Bar-tailed Godwits, South Island Pied Oystercatcher, Variable Oystercatcher, Spur-winged Plover, Banded Dotterel and Pied Stilt.

7. As a result of this report to the Trust we have decided to resist moves to open up the estuary edge where there could be negative effects on wildlife. There is already a legislated Wildlife Reserve along the western edge of the estuary; this should continue to be treated as a sanctuary for birds.

8. We thank Bonnie for producing such a valuable document and we also acknowledge the assistance given her by Trust Board members Professor Islay Marsden and Bill Simpson, and the Trust's Manager, Tanya Jenkins.



Dr Kit Doudney - Chairperson, Avon-Heathcote Estuary Ihutai Trust

September 2019

BACKGROUND

(Extracts from the 2013 Ihutai Management Plan, produced by the Avon-Heathcote Estuary Ihutai Trust).

The Avon-Heathcote Estuary/Ihutai (the estuary) and its tributaries, the Avon/Ōtakaro and Heathcote/Ōpāwaho Rivers are iconic cultural, recreational and ecological features of Christchurch and wider Canterbury. Even though the estuary and its associated catchment have undergone dramatic change and degradation over the years, particularly in relation to indigenous flora and fauna estuary margins and water quality, the estuary still remains an important place for the residents of Christchurch. For Ngāi Tahu this change has a direct and significant impact on their customary relationship with Ihutai resulting in Ihutai being of little, if any, value as a mahinga kai (customary food source).

Protecting and enhancing key features and investigating and eliminating sources of contaminants will be important challenges for the future management of the estuary. Ongoing monitoring, including cultural assessments, will be vital in understanding the success or otherwise of any such actions. A strategic and coordinated management approach across all levels of government, Ngāi Tahu, industry and the community remains our best prospect for a future clean and healthy estuary.

The vision of the Trust for the estuary is:

COMMUNITIES WORKING TOGETHER FOR

Clean Water;

Open Space;

Safe Recreation; and

Healthy Ecosystems.

Toitū te taonga ā iwi

Toitū te taonga ā Tāne

Toitū te taonga ā Tangaroa

Toitū te iwi

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WALKING AND JOGGING

Estuary and coastal environments support a wide range of recreational activities such as cycling, walking, jogging and water sports. However, these environments also support many residential and migratory birds which can be easily disturbed by these recreational activities. The distance from the recreational user and the bird, and the intensity of activity may result in different costs. Early research In Avon-Heathcote Estuary/Ihutai by Haase (1995) confirmed that the behaviour of individuals of both Eastern-Bar Tailed Godwit *(Limosa lapponica)* and South island Pied Oystercatchers *(Haemotopus fincheri)*, were affected by a disturbance within 30m of birds. That study, which was undertaken on the mudflats in South Brighton, found that the response differed between the two species. In all cases, following the disturbance, the proportion of time spent in vigilant behaviours increased and the time foraging decreased. It was shown that humans had a more disruptive effect than dogs and a kayak had a minimal effect. Interestingly the effects of disturbances on pied oystercatchers varied seasonally with the greatest reduction in foraging time occurring in November and over summer the flight distances from the disturbances were higher.

Cost of disturbances

Short-term displacement

In a study located on the boundaries of New York City in Jamaica Bay, Burger (1981) investigated flushing behaviour in non-breeding water birds in response to human disturbance. This behaviour occurs when birds leave their position and flee, and is usually a response to a threat or disturbance. Fleeing incurs energy costs which may limit the time and energy birds can use for various activities such as feeding, resting, or occupying nests. The Jamaica Bay refuge had many recreational activities such as fishing, walking, swimming, and includes numerous freshwater ponds. Observations were made on the number of people within 17 sites within the refuge, and how birds responded to disturbances. People were recorded 17% of the time and birds were present 42% of the time. When people were not recorded at the sample sites, birds were present 72% of the time. Therefore, when people were not present, the abundance of birds increased. Different species showed various types of flushing behaviour. Herring Gulls *(Larus argentatus)* and Common Terns *(Sterna hirundo)* occasionally flushed away then returned to the same spot. Brants *(Branta bernicla)*, ducks *(Anas rubripes)*, gulls and terns flew to a nearby location when disturbed. Some shorebirds, herons and egrets, flew a considerable distance to a remote marshland when disturbed. Birds near ponds flushed 60% of the time when there were workers nearby, and all the time when joggers went past on the paths. These workers and joggers displayed more unpredictable and rapid movements.

Glover et al. (2011) studied the flight initiation distance (FID) of abundant shorebird species in various restricted and unrestricted sites within Victoria, Australia. The FID is the distance in which behavioural responses are initiated to disturbances or threats. Different stimuli (walkers, joggers and a walker with leashed dog) were used in disturbance experiments where 28 species of shorebirds were recorded during daylight between the hours of 0800 to 2130. This study included three bird species which occur in the Avon-Heathcote Estuary/Ihutai: The Bar-tailed Godwit *(Limosa lapponica)* with an FID of 59.5 ± 5.3m, the Banded Dotterel *(Charadrius bicinctus)* with a mean of 32.1 ± 2.8m and the Spur-winged Plover *(Vanellus miles)* with an FID of 62.6 ± 5.8 m. The study found that the general wetland buffer zone used in Victoria (50m) did not eliminate disturbance to shorebirds as a large proportion of birds were provoked to flee when the distance from a potential disturbance was greater than 50m.

For four species of bird, including the Spur-winged Plover, Glover et al. (2011) found the FID was significantly less in unrestricted areas than it was in restricted areas. It was suggested that familiarization with people at the beach, and their predictable movements may have led to this population tolerating disturbances which were further away. However, not all species may become familiarized with human movements in areas which receive constant disturbances.

In a review by Weston et al. (2012) the authors consider the FID of 250 species and conclude that body mass explains most of the variation amongst species but individual species may vary according to diet, sociality and also the form or shape of the wings. They recommend that more work is needed to consider other factors which may be important including age, sex and site attributes including the distance from cover and the presence of fences or canals.

Long-term displacement

Human disturbance can cause long-term displacement for birds in areas which receive high amounts of disruption. Habitats which are unfavourable for breeding, resting, foraging, and nesting could also discourage birds to occupy that space. Pfister et al. (1992) studied the displacement of shorebirds following human disturbance at Plymouth Beach, Massachusetts. The beach had two different resting spots for birds; the back beach (marshy habitat) and the front beach. The back beach supported a high abundance of the Black-bellied Plover *(Pluvialis squatarola),* Semipalmated Plover *(Charadrius semipalmatus),* and the Ruddy Turnstone *(Arenaria interpres).* In contrast, the front-side of the beach supported a high abundance of the Semipalmated Sandpiper *(Calidris pusilla),* Sanderling *(Caladris alba),* Red Knot *(Calidris canutus),* and the Short-billed Dowitcher *(Limnodromus Griseus).* The back beach received little recreational activity, while the front beach supported numerous recreational activities. Bird and vehicle counts were recorded at the site from 1972 to 1989. While it was thought that the more severe and constant disturbances would be from pedestrians and dog-walkers, vehicle counts were considered a practical option to determine days which received higher amounts of disturbances in each area throughout the study period.

When there was high potential disturbance (vehicle count >100) Pfister et al. (1992) found that only 11% of the birds were on the front beach. However, during low disturbance (<20 vehicles) over 50% of the birds were located on the front beach. This decrease in abundance on the front-beach during days of high disturbance was thought to be due to birds from the front beach moving to the back beach or leaving the site completely. Also, the numbers of Red Knot and the Short-billed Dowitchers, which both occupied the front-beach, significantly declined over time. When these species were disturbed, it was found that they commonly left the site completely. It was therefore suggested that many Red Knots and Short-billed Dowitchers had been displaced from the study site, perhaps due to the increasing intensity of human disturbance.

Decreased feeding rates

Goss-Custard and Verboven (1993) investigated the effects of human disturbance on the feeding rates of Eurasian Oystercatchers *(Haematopus ostralegus)* in the Exe Estuary, England. This estuary which has a mussel bed in Cockwood, was easily accessible and provided space for many recreational activities such as walking and bird watching. It supported other shorebirds such as the Black-tailed Godwit *(Limosa limosa),* Bar-tailed Godwit *(Limosa lapponica)* and Ringed Plover *(Charadrius hiaticula).* When the number of people increased on the bed, most of the Eurasian Oystercatchers were temporarily displaced to another area. When they were displaced to a location with a high density of birds there was limited space to forage. This occurred when only three people were present. The average Eurasian Oystercatcher decreased its feeding rate by 20-25% while more vulnerable individuals decreased their feeding rates by 30-55%.

Yasué (2005) examined the effect of human disturbance on feeding rates in Semipalmated Plovers *(Charadrius semipalmatus)* and Least Sandpipers *(Calidris minutilla)* in an experimental study located in Pachena Beach, Canada. During 24 sampling days, the number of prey that were captured by focal individuals in one minute was recorded, together with the human densities on those days. To control for some indirect factors which might influence foraging behaviour, the flock size and prey densities were also determined. It was found that Semipalmated Plovers spent less time feeding when human densities were high. However, Least Sandpipers appeared

to have feeding rates associated with the flock size and prey density rather than exclusively human density.

Human activities in coastal areas can also decrease the amount of food available for wildlife. This is an indirect effect of human activities on shorebirds. In an experimental study, Schlacher et al. (2016) applied various trampling intensities to 5m2 experimental plots within Venus Bay Peninsula, Victoria, Australia. This area supports >100 species of birds, including breeding populations of the threatened Hooded Plover *(Thinornis rubricollis).* They applied a maximum trampling effect 1,400 steps per plot and found that some shorebird food items such as sand hoppers (amphipods) decreased by 50%. Also, in areas with high amounts of trampling, species richness of shorebird food items decreased to an average of 22 species, from an average of 28 species in undisturbed plots.

Unattended nests

Lord et al. (2001) investigated the Northern New Zealand Dotterel *(Charadrius bicinctus)* nesting behaviour in nine coastal beaches along the east coast of the North Island, New Zealand in relation to human disturbances. Nests were discovered by monitoring dotterel parents and then each nest was exposed to three different approaches (walker, runner, and a walker with a leashed dog). All of the approaches influenced flushing behaviour in the birds. Running or walking caused one parent to leave the nest for an average time of 204 seconds, and a walker with a leashed dog caused one parent to leave the nest for an average of 288 seconds. They found that the distance birds flushed and the time that birds spent off the nest in response to human disturbance was positively correlated. This study also found that in coastal beaches which had a high human disturbance pressure, dotterels displayed shorter flush distances in response to walkers. This indicated that at busier locations, dotterels may habituate to human movement.

Energy and time costs

Lilleyman et al. (2016) in Australia investigated how anthropogenic disturbance may lead to reduced energy reserves in four species of roosting shorebirds; Lesser Sand Plovers *(Charadrius mongolus),* Greater Sand Plovers *(Charadrius leschenaultii),* Red Knots *(Calidris canutus),* and Great Knots *(Calidris tenuirostris).* The effects of disturbances on these species were recorded for 84 hrs between September and December 2011 at Lee Point Beach, Northern Territory. Of the 108 disturbances towards these specific species, 77 created a flight response in a bird. Walkers were the main cause of disturbance to the birds, with 54 occurrences recorded, 16 disturbances were walkers with dogs (1 leashed, 15 un-leashed), and 38 were from predators. Flight-induced disturbances occurred on average 0.86 times per hour over the study period. The non-flight disturbances influenced birds to increase vigilant behaviour, interrupt resting behaviour, or cause them to walk away from the disturbance. These occurred on average 0.1 times per hour over the study period. No response towards disturbances occurred at an average rate of 0.26 times per hour over the study period.

These figures were added to an energy cost model which predicted the total energy cost of alarm flights for plovers and knots. The model predicted that 0.5% of the daily energy expenditure for Knots was used to fly away from disturbances. The model also predicted that Sand Plovers used on average 0.8% of their daily energy expenditure for alarm flights in each day. If the maximum disturbances recorded per day during the study (10) were added to this model it would predict on average, between 7.5 to 7.8% of their daily expenditure would be used for alarm flights. It was suggested that this may not be sustainable for migratory shorebirds, and it might influence reductions in fat reserves or disrupt resting times. It was also found that the average flight initiation distance which triggered a response in a bird was 53.6m. It was suggested that buffers between birds and recreational areas should be at least 100m to prevent negative implications.

In another study, Collop et al. (2016) also used energy models to calculate the costs of disturbances in birds from the Wash, England, which is a major estuarine system in the United Kingdom. This study was conducted over three years during the mid-December to March winter period with a total of thirty-eight observation days. The study species were Eurasian Oystercatcher *(Haematopus ostralegus),* Bar-tailed Godwit *(Limosa lapponica),* Grey Plover *(Pluvialis squatarola),* Knot *(Calidris canutus),* Ringed Plover *(Charadrius hiaticula),* Sanderling *(Calidris alba)* and Dunlin *(Calidris alpine).* While one pedestrian walked towards the birds, other observers recorded the behaviour of the disturbed birds. Firstly, flight initiation distances were calculated for each study species. This was the distance from the pedestrian and bird which resulted in the bird flying away. The total time lost from disturbances was also calculated by recording the time taken for a disturbed bird to resume feeding after becoming alerted.

Distances and time loss varied between species, for example, the Bar-tailed Godwit had a mean flight initiation distance of 84.4 ± 4.0m and a mean time loss of 47.0 ± 2.4s , the oystercatcher had a mean flight initiation distance of 97.3 ± 3.0m and a mean time loss of 59.8 ± 2.0s, the Grey Plover had a mean flight initiation distance of 132.3 ± 6.8m and a mean time loss of 58.2 ± 3.4s. The energy used in each alarmed flight was calculated, as was the frequency of disturbances which would reduce available feeding time. For a 10% reduction of available feeding time in one day, the Bar-tailed Godwits would need 122-184 disturbances/day, the oystercatcher would need a smaller amount of 96-144 disturbances/day, while the Grey Plover would need 99 -148 disturbances/day. In the study area it was concluded that the usual number of visitors would be insufficient to result to result in significant disruption to the birds. The authors conclude, however, that this may be possible with a higher visitor numbers. The authors calculated that to have a one percent reduction in available feeding time per day for Bar-tailed Godwits there would only need to be twelve to eighteen disturbances.

How findings relate to Avon-Heathcote Estuary/Ihutai

Recreational activities such as walking, jogging, and cycling in coastal environments have a large potential to directly disturb birds. When displacement occurs, energy and time is lost, and nests can be left unattended. This can increase energy demands, and perhaps, reduce the time available for feeding, resting, and nesting behaviours. In areas such as the Avon-Heathcote Estuary/Ihutai which support many species of birds during their migratory journeys, frequent disturbances from recreational activities may influence a change in stop-over location to somewhere less energetically costly. Increasing human access to areas which are less populated also has the potential for invasive plant species to enter a new environment. Running shoes, and bicycle tyres are common items which can provide dispersal for plants. Invasive or pest plants can alter the current habitat, which may influence food supplies for birds.

One way to minimise the effects of disturbances on birds is to establish buffer zones, areas which separate two or more types of habitat and are commonly used to reduce disturbance from recreational trails or areas on wildlife. While data are limited for all the birds which occupy the Avon-Heathcote Estuary/Ihutai, it is clear that many factors such as location, species, and the type of disturbance influences various flight initiation distances. If there are no buffer zones, or the size is not sufficient to prevent disturbances, then frequent disturbances can result in birds moving permanently away.

DOGS

Dogs can have rapid and unpredictable movements that easily frighten wildlife and they are commonly perceived as a threat to birds. Some studies have shown that dogs may be more of a threat to birds than any other recreational activity.

In a study located at West Kirby Beach, in the Dee Estuary, England, Kirby et al. (1993) found that walkers and dogs were the key causes of disturbances inflicted on birds. Roost sites within the Dee Estuary supported various types of migratory and resident wader birds. The abundance of Knots *(Calidris canutus)*, Dunlins *(Calidris alpina)* and Bar-tailed Godwits *(Limosa lapponica)* had significantly decreased in the area and it was suggested that they had moved to other roost locations in nearby estuaries where there was less human disturbance. In this study, voluntary wardens patrolled the area on about 339 days, from 1986 to 1991. Between 1986 and 1987 the total number of potential disturbances was 3,505, while between 1990 and 1991 the total was 9,257. Activities such as walking, windsurfing, horse riding, cycling, and the abundance of dogs all increased throughout the years. In this study the number of disturbances to birds from various recreational activities was also recorded. Relatively small proportions, 176 disturbances related to dogs were recorded. Other activities such as walking, resulted in 116 disturbances, and windsurfing resulted in 39 disturbances. When dogs were involved in the disturbances, 19% resulted in either a bird leaving the study area to another site within the estuary, or moving completely out of the estuary. Most of the disturbances with dogs (61%) resulted in a bird temporarily leaving the space it was occupying but returning within five minutes. Knots, Dunlins, Bar-tailed Godwits, and the Grey Plover *(Pluvialis squatarola)* commonly left the estuary completely after being disturbed. In contrast, other species such as the Curlew *(Numenius)* and Redshank *(Tringa totanus)* only had three occurrences of leaving the site after a disturbance. The Bar-tailed Godwit left the site to an alternative roost within the estuary 11% of the time after a disturbance and left the entire estuary 12% of the time after a disturbance. Knots showed a similar trend by leaving the site to an alternative roost in the estuary 14% of the time after a disturbance occurred and leaving the entire estuary 20% of the time after a disturbance. As disturbances involving dogs resulted in a high number of birds leaving the site, it is suggested that particularly the Bar-tailed Godwits and knots are quite vulnerable to disturbances from dogs.

Compliance with dog leashing rules is a key issue in many recreational areas. In an experimental study, Dowling and Weston (1999) reported many issues with people breaking dog-related laws in Mornington Peninsula National Park (Victoria, Australia). The area was a heavily used recreational spot for dog walking, with laws restricting dogs without leads in the area. Monitoring the area from 1991 to 1998 revealed that only 12% of dogs were controlled by people with leads throughout these years. This study also examined the effects of human recreation on the threatened Hooded Dotterel *(Thinornis rubricollis)* in this area. Out of 170 nests which had been located, 53 nests were destroyed by human trampling. Out of 49 clutches, monitored in areas where dogs were permitted, there were no successful clutches. However, in areas where dog management rules were implemented, a greater proportion of successful clutches were recorded. While it was suggested that dogs could directly trample or eat eggs from nests it was also suggested there may have been other external factors which could have influenced the success of the clutches.

Burger et al. (2007) studied how recreational activities affect birds in Delaware Bay, New Jersey. This area supports many migratory birds and there is a large human disturbance pressure. Every day between May 19, 2002, to June 6, 2002, observations were conducted at different sections of the bay. Three observers recorded disturbances, environmental factors and behaviour of six focal species; Herring Gull *(Larus argentatus),* Laughing Gull *(Leucophaeus atricilla),* Red Knot *(Calidris canutus),* Turnstone *(Arenaria),* Sanderling *(Calidris alba),* and the Semipalmated Sandpiper (*Calidris pusilla).* Following the disturbances from recreational activities, the average time for gulls to return to the pre-disturbance abundance was five minutes. However, when the disturbance was a dog, there was a greater response time. Ten minutes after the Turnstones

had been disturbed by a dog, only 25% of individuals had returned. Red Knots, Sanderlings, and Semipalmated Sandpipers did not return to the same space within ten minutes after being disturbed by a dog.

Dog chasing roosting South Island Pied Oystercatchers in 2015, Southshore Spit Reserve.
Photo by Brian Betts

In another study, Weston and Elgar (2007) identified dogs as a major problem at ocean beaches in Victoria, Australia. They studied the effects of people on nesting Hooded Dotterels *(Thinornis rubricollis)* in areas where dogs were permitted and not permitted in coastal environments. The space used for recreational activity commonly overlapped with nesting locations of birds. Between 1995 and 1998, 1821 encounters of potential disturbances near (within 100 metres) Hooded Dotterel nests were recorded on 49 observation days. Potential disturbances included recreational activities such as walking, jogging, and walkers accompanied with a dog. The highest number of encounters (49.5% of the total) was for a walker without a dog, followed by a walker with a dog (16.1%). Joggers accompanied with a dog were recorded in 1.4% of total encounters, and dogs which were not accompanied with any people (wandered away from owners) were recorded occasionally (0.9%). When birds were occupying the nest when a disturbance occurred (1,494 times), they were commonly influenced to leave the nest when the disturbance included a dog. Some 44% of the total disturbances with a jogger accompanied with a dog resulted in the birds fleeing for an average time of 1.5 mins. The total number of disturbances from a walker accompanied with an unleashed dog influenced the bird to flee 38.4% of the time. These encounters resulted in birds leaving the nest for an average time of 3.9 minutes. When dogs were on leashes, or walkers did not have a dog, the proportion of encounters which resulted in birds fleeing was much lower. It was suggested that the behaviour of dogs when they were unleashed provided a greater threat to birds, compared to the threat from walkers alone.

How findings relate to Avon-Heathcote Estuary/Ihutai

Recreational users are commonly accompanied with dogs in the Avon-Heathcote Estuary/ Ihutai. While there are rules to prevent unleashed or uncontrolled dogs in certain areas, compliance with these rules is often lacking. Dogs have been shown to threaten and disturb birds which are occupying spaces in coastal areas. Therefore, any construction of recreational paths close to the estuary edge may impose extra disturbance on birds. Disturbances in crucial areas where there are roosts or nests may result in negative consequences for the bird. Time and energy are used to flee, but also eggs within the nest can be left unattended. Some species which are found in the Avon-Heathcote Estuary/ Ihutai, such as the Bar-tailed Godwits, may be quite susceptible to potential disturbances from dogs and may leave, as occurred in the Dee Estuary, England. If access to the estuary edge and mudflats is increased then the number of dogs may increase providing more disturbances to foraging birds.

RECREATIONAL TRAILS

Peak District National Park, England

Some experimental studies show little effect from human disturbance on recreational trails near bird colonies. One study in the Peak District National Park, Northern England, Finney et al. (2005) studied Golden Plovers *(Pluvialis apricaria),* which occupy areas close to the Pennine Way. The path was resurfaced in 1994 and before the resurfacing, 30% of humans who used the footpath strayed from it, creating unpredictable disturbances to Golden Plovers. At this time the Golden Plovers avoided areas up to 200m from the path. After the path restoration, however, Golden Plovers avoided areas on average up to 50m from the path. This was assumed to be due to the reduced amounts of humans straying from the path (4% of users). Although this study showed that human disturbance had less effect when people did not stray from paths, Golden Plovers were still less likely to occupy areas within 50m of the path on weekends (which had significantly more recreational users) than weekdays. Therefore, higher numbers of recreational users could explain why Golden Plovers restrict themselves from areas with closer proximity to the path.

Another study at two locations in the Peak District National Park (Snake Summit and Saddleworth Moors), Pearce-Higgins et al. (2007) found that nests from Golden Plovers were located between 29 and 1,074m from the resurfaced path. It was concluded that they did not avoid the highly disturbed areas by the footpath. It was also found that Dunlin *(Calidris alpine)* and Golden Plovers were occupying spaces closer to the path after resurfacing work than before it.

How findings relate to Avon-Heathcote Estuary/Ihutai

The above study indicates that recreational users on the footpath have only a small effect on the nesting locations or spaces occupied by Golden Plovers and Dunlins. However, it is likely that the chances of direct harassment or intentional interference from humans or predators (such as dogs) increase if occupied nests are within close proximity to paths. Compliance with rules on recreational paths such as restricting unleashed dogs and banning litter are key issues when establishing paths near wildlife habitat. If compliance is not met, birds that occupy locations close to paths could experience severe threats or harm.

Cheetham wetlands, Victoria, Australia

The Cheetham Wetlands located on the Western shoreline of Port Philip Bay, Victoria comprises of 574 hectares of public restricted wetlands with a boundary fence established round the perimeter. The wetlands support various species of birds such as the Sharp-tailed Sandpiper *(Calidris acuminate)* and Curlew Sandpiper *(C. ferruginea),* Black-tailed Godwit *(Limosa limosa),* Marsh Sandpiper *(Tringa stagnatilis),* Common Greenshank *(T. nebularia),* and the Banded Stilt *(Cladorhynchus leucocephalus).* Around the wetlands, residential areas are expanding and encroaching towards the wetlands (refer to Figure 1).

A small buffer between the wetlands and the residential areas has been established with a bicycle track running within the buffer on the northern end. Numerous studies had indicated that people were intruding inside the wetland area without authorized access. In one study, Antos et al. (2007) surveyed the area four times a month on Sunday. They found that there were eight well used entry points along corroded sections of the fence line around the wetlands. Over half of the intrusions (50.5%) occurred on the northern section boundary. This area was close to residential areas and the established bicycle path. It was suggested that the established bicycle path within the buffer was one factor that had facilitated recreational users to leave the track and enter the wetlands. Dog walking occurred on average 8.5 ± 4.5 times per observation

day. All of the dogs on these instances were unleashed. One motorised bike rider was seen and this activity was completely restricted on the bicycle path and in the wetlands. On average, at least one intrusion occurred in 13.6% of the wetlands per observation day. It was found that 250m inland from the fence line, the number of intrusions rapidly declined. It was therefore suggested that buffer distances need to be greater than 250m to prevent intrusions.

Weston et al. (2009) also found intrusions within the Cheetham Wetlands. In their study, sand pads were placed on two different public restricted paths within the wetlands, and at informal well-used access points along the fence line. The sand pads were 2m wide, 1 m long, 10cm deep and were large enough to cover access points and tracks. Over 13 weeks, sand pad checks were conducted on average, once a week. Over the study period they found 192 tracks on the sand pads, distinguished by the hardness left on the pads. Previous control experiments were conducted to calculate different tracks left on the pads. All of the sand pads recorded intruders, with human intruders recorded on 12 of the observation days. Visual observations of the sand pads showed few people or cyclists avoiding the pads. Although there could be some limitations regarding weather interference on the pads, this study did produce reputable evidence of numerous people entering the public restricted wetlands.

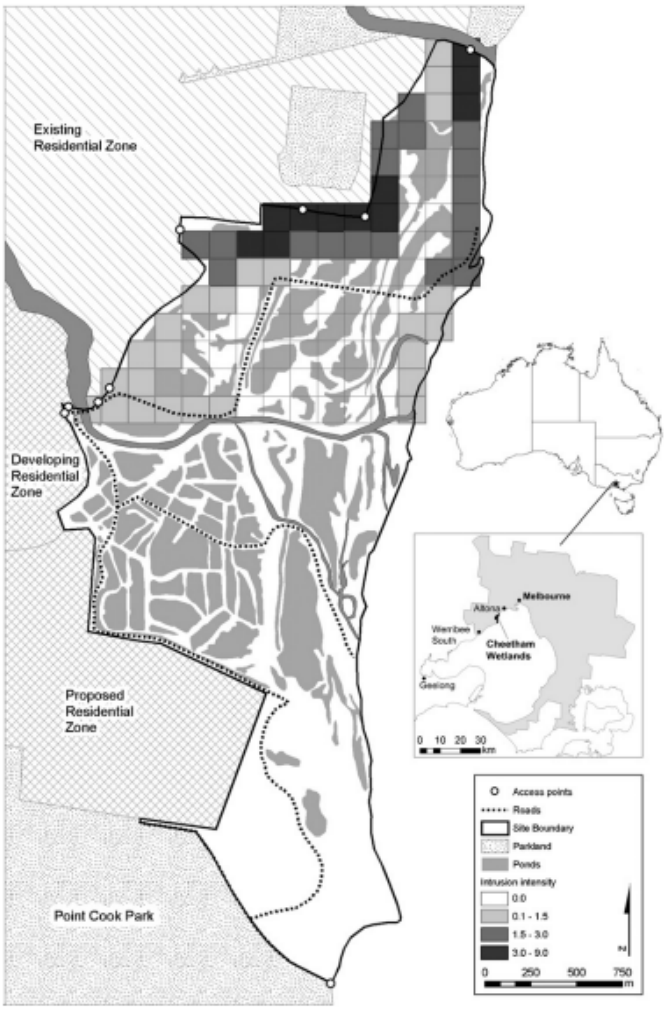

Fig. 1. Cheetham Wetlands site map showing observed intrusion intensity (total intrusions per observation day). The location of the site (inset) in Greater Metropolitan Melbourne (shaded) is also shown. Ponds are shaded grey, unofficial access points are shown by circles and dotted lines show the internal track network used by management vehicles. Residential zones are also indicated.

Figure 1. Cheetham Wetlands area in Victoria, Australia. Sourced from Antos et al. (2007).

How findings relate to Avon-Heathcote Estuary/Ihutai

In Cheetham Wetlands, a bicycle path which was built around the protected wetlands and the expansion of nearby residential areas may have contributed to the number of intruders entering the restricted wetlands. Protected areas may be used by nearby residents with aggressive dogs, or by motorcyclists who choose not to use other suitable areas, perhaps, due to convenience. The Te Huingi Manu Wildlife Refuge is one restricted area in the Avon-Heathcote Estuary/Ihutai. While there could be an existing small proportion of intruders, increasing accessibility near the refuge, or constructing recreational areas nearby, may increase the number of people accessing restricted areas within the refuge.

Sandfly Creek Environmental Reserve, Queensland, Australia

In their study, Milton and Harding (2011) measured the effects from the establishment of a pedestrian and cycle path in Sandfly Creek Environmental Reserve, Queensland on bird numbers. The path encroached on two roost sites in the reserve (refer to figure 2). The authors did 135 spring tide surveys (95 surveys before the establishment and 45 surveys after the establishment in 2007) and found that the mean number of species on the roosts reduced by 34%. Post establishment of the track they estimated that there were only 36 different water bird species present. Before the establishment of the path, the roosts supported >1000 birds on numerous occasions throughout the non-breeding season. Over three years after the establishment of the path only on four occasions did the roosts support 1000 birds. The Lesser Sand Plover *(Charadrius mongolus),* Eastern Curlew *(Numenius madagascariensis),* and the Red-capped Plover *(Charadrius ruficapillus)* all significantly decreased in abundance after the construction of the path. Some rare species which were recorded prior to the construction such as the Black Swan *(Cygnus atratus),* Banded Dotterel *(Charadrius bicinctus),* Red Knot *(Calidris canutus),* and the Black-Tailed Godwit *(Limosa limosa)* were not recorded in any survey since.

Due to human disturbance in this area, an alternative route was created to maximise the distance from recreational users and the roosts. However, compliance was an issue as the decision to use this route was voluntary. Only 34% of the average 38 recreational users who entered the reserve used the alternative path. Of those users who complied 42% were walkers.

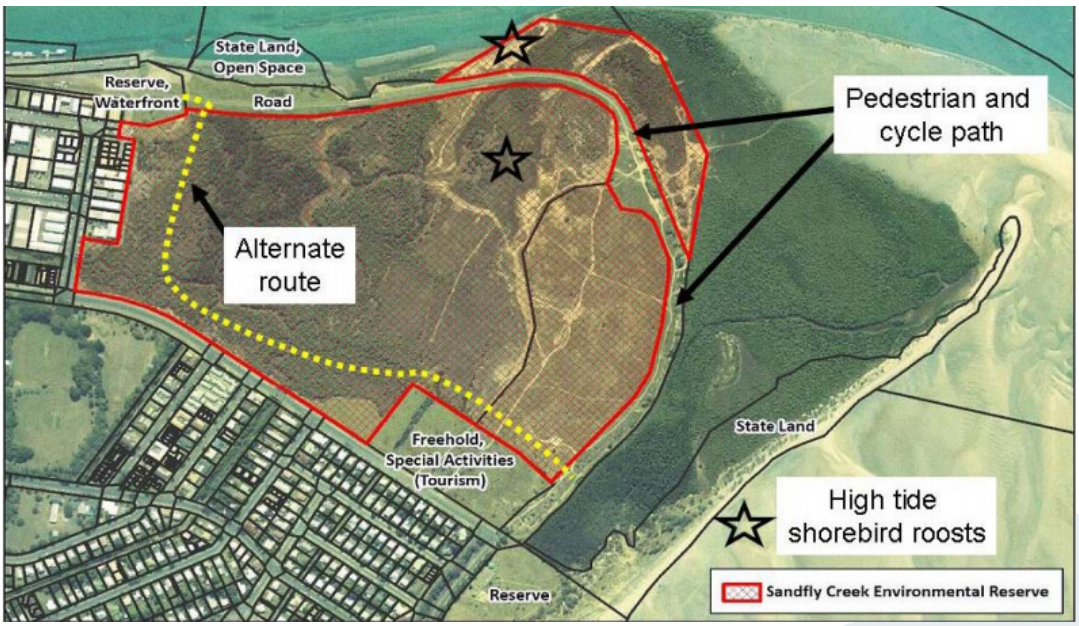

Figure 2. Pedestrian and cycle path established in Sandfly Creek Environmental reserve 2007, including an alternative recreational user route which was promoted to be in use during the non-breeding season in 2010 for migratory shorebirds. (Figure from Milton and Harding (2011).

How findings relate to Avon-Heathcote Estuary/Ihutai

After the establishment of the cycleway/walkway at Sandfly Creek (Queensland), there was clear evidence that species richness and abundance of birds significantly declined. The path trailed near roost sites for birds, which is why it was suggested that recreational users were one factor which had influenced the sudden decline. This example shows how constructing paths near shorebird roosting sites in the Avon-Heathcote Estuary/ Ihutai could follow similar trends. Some species such as the Banded Dotterel *(Charadrius bicinctus),* and the Black Swan *(Cygnus atratus)* have been recorded in the Avon-Heathcote Estuary/Ihutai. Species that have low tolerance to disturbance may leave the estuary with increased recreational use.

Santoña, Victoria and Joyel Marshes Natural Park, Spain

Navedo and Herrera (2012) simulated the potential effects from a proposed small coastal footpath and platform which borders intertidal mudflats in Santoña, Northern Spain. During high tide, the area is a suitable roosting and resting site for water birds. To simulate recreational disturbance a pedestrian walked along the border of the mudflats within 2m of the proposed footpath during the 2004-2005 winter season. While walking, the number of flushing birds was recorded by another observer. A total of 156 disturbance events were recorded, resulting in 4,018 individuals being flushed away from the area. During mid-tide the Grey Plover *(Pluvialis squatarola)* population which uses the area reduced by 22.5% and the Eastern Curlew *(Numenius madagascariensis)* population was reduced by 51.2%. At high tide the Eastern Curlew population was reduced by 83.9% . During low tide, however, there was little effect from the pedestrian on water birds. It was suggested that the proposed coastal footpath may disrupt the water species of birds which occupy the area and may influence some to completely leave the site. The study involved only one pedestrian and it was suggested that many pedestrians could have more serious impacts on the species, particularly during high tide.

How findings relate to Avon-Heathcote Estuary/Ihutai

Recreational disturbance was experimentally simulated for a proposed new recreational path in Santoña, Spain. The effects of a walker in the proposed area showed clear potential negative impacts on water birds. Similar techniques could be used to evaluate any new proposed recreational paths within the Avon-Heathcote Estuary/Ihutai.

Los Lances Beach Natural Park, Spain

Martín et al. (2015) suggested that the construction of cycling and walking tracks have the potential to increase the number of people visiting coastal environments. In 2008 a walking and cycling track was built in Tarifa, Spain that provided public access to parts of the beach and natural park in the Los Lances Beach Natural Park. It was found that this track could have increased the number of summer recreational users in this area by two to five times. During summer, the number of beach visitors ranged from 21 to more than 500 people per day. Maximum counts of people usually occurred during holidays or weekends in summer. This area is important for migratory birds as it provides habitat for birds to stop-over at during their migratory paths. A clear negative trend was found for some of the migratory bird numbers including the Sanderling *(Calidris alba),* Kentish Plover *(Charadrius alexandrines),* and Ringed Plover *(Charadrius hiaticula)* during summer. It was suggested that this trend was due to the increased number of recreational users.

How findings relate to Avon-Heathcote Estuary/Ihutai

The Avon-Heathcote Estuary/Ihutai has an existing large human disturbance pressure on wildlife from the various recreational activities which occur in the area. The above study shows how allowing greater accessibility to the coastal environments heavily increased the number of recreational users in the area, which also increased this disturbance pressure. Similar human disturbance effects on wildlife could become more severe with improved access and connectivity within the Avon-Heathcote Estuary/Ihutai.

Ahuriri Estuary, Napier, New Zealand

The Draft Ahuriri Estuary and Coastal Edge Masterplan 2017 proposed by the Napier City Council included extending a walkway and cycleway path along the edge of the Main Outfall Channel in the Ahuriri Estuary. The Ahuriri Estuary supports many New Zealand resident water birds, and threatened species such as the Pied Stilt *(Himantopus leucocephalus),* Black Shag *(Phalacrocorax carbo),* New Zealand Shoveler *(Anas rhynchotis),* Australasian Bittern *(Botaurus poiciloptilus),* The South Island Pied Oystercatcher *(Haematopus finschi)* and the Spur-winged Plover *(Vanellus miles).* The estuary is also a stop-over spot for migratory birds such as the Bar-tailed Godwit *(Limosa lapponica),* and the Lesser Knot *(Calidris canutus).* These species are commonly found in estuary environments around New Zealand such as the Avon Heathcote Estuary/Ihutai. While experimental studies from human disturbance in this area is lacking, summaries and opinions from key stakeholders were recorded in the Ahuriri Estuary and Coastal Edge Masterplan 2017 (Napier City Council 2017). A common consensus was not in favour for this plan, with groups such as the Ahuriri Estuary Protection Society and the Royal Forest and Bird Protection Society (Napier Branch) concerned about the disruption to birds, and the potential for dogs to create further disturbance. The Bittern was commonly mentioned in the document, with key stakeholders mentioning that an extended pathway could easily frighten and distress this threatened species. The Royal Spoonbill *(Platalea regia)* is also known to inhabit this area and could be easily disturbed. The proposed extension of this pathway was removed from the final masterplan.

UNMANNED AIRCRAFT SYSTEMS

Flushing behaviour is a common response displayed by birds to the noise or visual cue from unmanned aircraft devices. In a study conducted in three wetland locations (Ruby Lake National Park Refuge, Kern National Wildlife Refuge and Tomales Bay, all in USA), Dulava et al. (2015) recorded a total of 38 images of flushing behaviour in water birds out of 538 taken by two different unmanned aircraft devices. It was found that the majority of the flushing behaviour images were taken by the gas-powered device (T- Hawk) when it was flown at low altitudes (below 30m), where there was an emitted noise of approximately 80-90 decibels. The species affected at Tomales Bay mainly included the Western/Clark's Grebes *(Aechmophorus occidentalis/clarkii)*, Double-crested Cormorants *(Phalacrocorax auritus),* and Western Gulls *(Larusoccidentalis).*

In another study, which focussed on the disturbance from drones on birds in France, Vas et al. (2015) found that the birds showed the greatest reaction when the drone was vertically positioned at 90 degrees while approaching the birds. When the drone was flown vertically, in 17 out of 18 approaches, flushing behaviour occurred in Flamingos *(Phoenicopteridae),* eight out of nine approaches resulted in flushing behaviour in Mallards *(Anas platyrhynchos),* and five out of nine approaches to Common Greenshanks *(Tringa nebularia).* However, when the drone was not positioned vertically while flying there was little significant reaction from the birds.

Bevan et al. (2018) conducted an experimental study in the Northern Territory which focused on the effect of drones flying in different altitudes over Crested Terns *(Thalasseus bergii).* The drone was launched one kilometre away from the nesting location of the birds and the speed was reduced to 3-5 m/s when flown over the locations at varying altitudes with each trial. When the drone was flown below 60m it resulted in flushing behaviour and increased vigilance behaviour (rapid head movements and raising wings). The time that individuals of Straw-necked Ibis *(Threskiornis spinicollis),* Australian White Ibis *(T. moluccus)* and Glossy Ibis *(Plegadis falcinellus)* breeding colonies took to return to nests after being disturbed by drones has been studied by Lyons et al. (2018) in Eastern Australia. When the drone hovered above the colonies at 20m it took an average of 30 to 60s for the birds to return to their nest. While hovering at 10m the return time was averaged at 5 minutes.

The time for Arctic cliff-nesting seabirds; Glaucous Gull *(Larus hyperboreus),* Iceland Gull *(Larus glaucoides),* Common Murre *(Uria aalge)* and Thick-billed Murre *(Uria lomvia)* to return to nests after being disturbed by drones has also been studied in Coats Island and Digges Island in Canada. Brisson-Curadeau et al. (2017) recorded an average of 8.5% of birds flushing when the drone flew 15 or 30m away from the breeding plot and stayed hovering until a photo had been taken in all trials. While most of the birds in each trial took an average of five minutes to return, it took a maximum of ten minutes for all the birds that could be accounted for to return.

How findings relate to Avon-Heathcote Estuary/Ihutai

Unmanned devices may be used for numerous reasons within the Avon-Heathcote Estuary/ Ihutai such as spectating wildlife or taking photography. While most research does not show extensive amounts of disruptive consequences from flying drones near birds, it is evident that they have the potential to influence flushing behaviour in birds with improper use. It is likely that recreational users of unmanned devices will not be aware of the specific consequences or effects which their devices can have on birds. Certain angles and directions that unmanned devices fly in, or the amount of noise emitted have disruptive effects on birds. It is expected that recreational users will not take this into consideration with their use of these devices. Increasing accessibility around the estuary may promote more recreational users or researchers to use unmanned devices within the estuary which could increase disturbance of birds.

WATER SPORTS

Water-sports in The Avon-Heathcote Estuary/Ihutai include kayaking, windsurfing, jet skiing and sailing. Early studies by Haase (1995) found that the behaviour of South Island Pied Oystercatchers *(Haemotopus finschi)* and Bar-Tailed Godwits *(Limosa lapponica)* on the mudflats was affected less by an approaching kayak than either a single dog or a person, either running or walking. It was concluded that non-motorised boats would not alter the time budget for these species.

Van Rijn et al. (2006) observed the responses of birds during a kite-surfing event for three hours in the Netherlands. The flight initiation distances of flocks in the area ranged between 500 and 1000m. When the kite surfers approached a high tide roosting site occupied by waders and ducks at 200m, nearly 10,000 birds flew away. When Dunlins *(Calidris alpina)* and Grey Plovers *(Pluvialis squatarola)* were disturbed it took 30-45min for 30% of them to return to the area. Red Knots *(Calidris canutus)* and Black-tailed Godwits *(Limosa limosa)* tended to not return to the area entirely after being disturbed

In an experimental study, Milton et al. (2011) recorded the amount of human disturbance on roosting shorebirds and seabirds for a lunar month in Northern Moreton Bay, Queensland. The most common species recorded in this area were the Bar-tailed Godwit *(Limosa lapponica)* and the Red-necked Stint *(Calidris ruficollis).* Over this study period 73 disturbances were recorded from various recreational activities. Twenty-eight occurrences were caused by jet skis and this resulted in the birds either flying away or in circles. Boats and canoes that were recorded in the area affected 20 out of 80 birds and these either left the area by walking or flying away.

A literature review on kite-surfing was published in Krüger (2016). One study he examined was Beauchamp (2009), which was conducted in Ruakaka Estuary, Northland, New Zealand. This area is a wildlife refuge which supports birds such as the South Island Pied Oystercatcher *(Haematopus finschi),* the Variable Oystercatcher *(Haematopus unicolor),* the Bar-tailed Godwit *(Limosa lapponica),* and the Red Knot *(Calidris canutus).* In this study there were five days of observation with a total of 54 recordings of disturbances. Kite-surfing occurred on two of the days during the study period and a total of eleven disturbances on birds were recorded from kite-surfing. On one occasion during the study, 40 out of 54 Variable Oystercatchers flushed away when a group of kite-surfers entered the water. These birds were all displaced approximately 500m away.

Kayakers and black swans *(Cygnus atratus)* in the estuary in 2016.

Photo taken near Scott Park by Brian Betts

How findings relate to Avon-Heathcote Estuary/Ihutai

The Avon-Heathcote Estuary/Ihutai currently supports many water recreational activities such as windsurfing, paddle boarding, and jet skiing. As more water sports become popular, the number of people participating in these sports within the Estuary is likely to increase. Disturbance from water recreational activities within the Avon-Heathcote Estuary/Ihutai is likely to be occurring currently. Therefore, any future plans which may increase disturbance on estuary birds should be avoided.

OFF-ROAD VEHICLES

Off-road vehicles are another recreational activity which can cause disturbance to coastal habitat and influence the numbers of macroinvertebrates and plants. While these factors can impact shorebirds, off-road vehicles can also directly affect them through disturbing them and influencing displacement. In a study conducted at Fraser Island and North Stradbroke Island, Queensland, Schlacher et al. (2013) found that birds disturbed by off-road vehicles commonly respond by flying away. In this study, Crested Terns *(Thalasseus bergii)* and Australian Pied Oystercatchers *(Haematopus longirostris)* were examined. There were 144 observations of birds reacting to vehicles in the study during sampling days over a three-month period. Some 38% of these disturbances resulted in birds flying away from a nearby vehicle, while in 31% of the observations, birds responded by running and walking away. It was suggested that Oyster Catchers were less sensitive to vehicle exposure than Crested Terns, which were more sensitive, one of the factors being their webbed feet. This may force them to fly away as it is suggested that they are less able to move rapidly on foot.

How findings relate to Avon-Heathcote Estuary/Ihutai

While large off-road vehicles are not permitted for recreational activity in the estuary, off-road vehicles can have a large disturbance on birds by disrupting them, destroying nests, or shaping the habitat. This information reinforces the importance of the current rules regarding motorised vehicles, but also suggests there could be issues with other types of vehicles which are commonly seen in coastal environments such as quad-bikes or motorised bikes.

DELIBERATE DISTURBANCE

Chasing birds

Farmers in North Norway campaigned against Pink Footed Geese *(Anser bruchyrhynchus)* on their fields in Vesteralen for consuming grass. Madsen (1995) examined breeding success and spring fattening in Pink Footed Geese in farms where farmers regularly scared geese away, and on undisturbed farms. When monitoring the geese, it was apparent that approximately two thirds stayed in the same location regardless of disturbance events. Successful breeding occurred in 46% of the geese monitored in undisturbed sites, whereas only 17% were successful on disturbed sites. Before nesting periods, geese tended to deposit fat and protein within abdominal areas. When examining the abdominal profiles of geese on disturbed sites it was evident that it remained similar throughout the study. However, on undisturbed sites the abdominal profile in geese increased at a more rapid rate. There was no apparent difference indicated in the field or bird conditions in each site other than the disturbance by farmers. Therefore, it was suggested that intentional disturbance of the Pink Footed Geese resulted in fewer geese not fattening over the spring.

How findings relate to Avon-Heathcote Estuary/Ihutai

Unfortunately in the Avon-Heathcote Estuary/Ihutai members of the public have been reported chasing birds or throwing sticks at them. Regular encounters between the public and birds also occur on the rivers with ducks and geese.

EXAMPLES OF EXCLUSION AREAS

Manukau Harbour

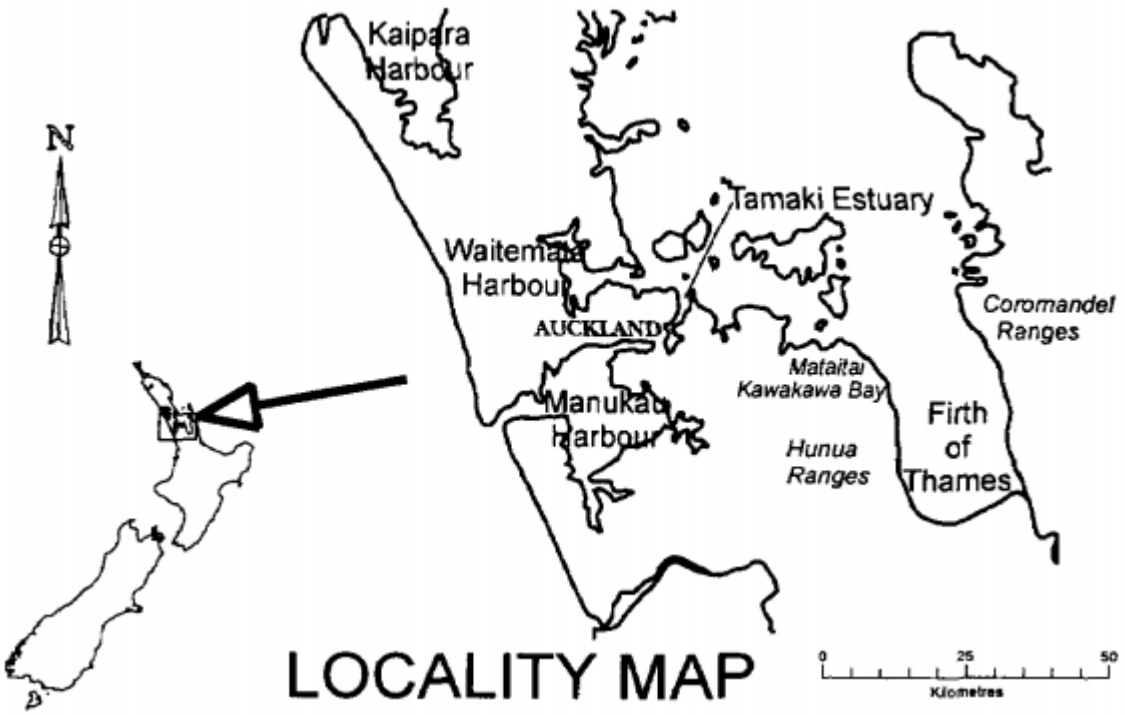

Figure 4. Location of Manukau Harbour in New Zealand. Obtained from Veitch and Habraken (1999).

The Manukau Harbour is situated south-west of Auckland city and includes various artificial roosting sites and large areas of productive sand and mudflats. The area supports high bird diversity and has facilitated the population growth of a few endemic species. However, the area is threatened by the expansion of industrial and recreational developments. Around the harbour there are many industrial buildings, farming areas, housing complexes, but also areas of natural coastline and forest. Over the years the harbour has changed dramatically, and walking trails have been established in many sections to promote recreational activity. However, many sections of the harbour remain coastal protected areas and 12 of the 23 areas have been established to support bird life (Kelly, 2009). Whatipu is one coastal protected area in the harbour. It consists of large sand areas and mobile dunes that help establish roost sites for various birds such as the White-Fronted Tern *(Sterna striata).* Ambury is another protected area, which is also labelled as an area of significant conservation value (ASCV). This section is a modified shoreline which comprises of large intertidal banks that support feeding. This area also supports over 1000 New Zealand wading and various migratory birds. The winter roosting site in Ambury is crucial for many bird species, particularly the South Island Pied Oystercatcher *(Haematopus finschi).* Other coastal protected areas which are also areas of significant conservation value include Ihumātao and Puhinui. Both areas have artificial roosting sites established and intertidal banks that support feeding of many birds. Black Swans *(Cygnus atratus)* and ducks *(Anas platyrhynchos)* are commonly found around Ihumātao. In Puhinui there are large areas of undisturbed salt marsh and sheltered nesting sites which support various birds such as the Wrybill *(Anarhynchus frontalis).*

Bird counts from 1960 to 1990 were examined in Veitch and Habraken (1999). It was found that the harbour supported around 31 wader bird species in 1960. Since then some species such as the South Island Pied Oystercatcher and the Lesser Knot *(Calidris canutus)* were increasing. The Lesser Knot had decreased in other places such as the Firth of Thames. The abundance of Bar-tailed Godwits *(Limosa lapponica)* had stabilised in the area. It was evident that the harbour has

been a crucial area supporting a high species richness for a long period of time.

In another report, Garton et al. (2018) reported how Manukau Harbour had been altered over the years to help support wildlife. The Mangere wastewater treatment plant used to comprise of 515 hectares of oxidation ponds which were restricted to human access. As there was little disturbance, birds used the pond walls as a protected roosting habitat, supported a large amount of the Manukau Harbour bird population. As the Mangere wastewater treatment plant played a large role in supporting wildlife, effective strategies had to be implemented to continue accommodating for wildlife after the ponds were removed in 2003. Garton et al. (2018) described a few of these strategies. After the removal of the ponds, large sections of coastline were restored, and seven artificial beaches were created. Roost management was a high priority within the area. Weed control was implemented on roosting sites to ensure that there was good visibility for birds. Predator control has also been implemented to remove unwanted threats to birds such as mice, rats and cats. Another strategy that was implemented was erosion control. Large boulders were transported to sections of the harbour and rock pathways were established to mitigate erosion from wind, waves and rain. The public have also had a large involvement within areas of the harbour. Volunteers regularly help to manage traps and school children have created shelters for birds.

The restoration of the Mangere Wastewater Treatment plant, and the coastal protected areas have all contributed to maintaining habitat that supports many migratory, and New Zealand resident birds. Bird counts within the Manukau Harbour were also reported in Southey (2009). Of these, 84% of the total New Zealand Wrybill population were typically found in Manukau Harbour and the Firth of Thames. Since 2000, the Manukau Harbour has supporting a larger percentage of them. The Spur-Winged Plover *(Vanellus miles)* also occurs within the harbour and in the 1995 and 2003 winter surveys the average number of Plovers was 187. The Curlew Sandpiper *(Calidris ferruginea)* abundance has also increased in Manukau Harbour. The harbour is one of very few places which support the species in New Zealand with the average of nine birds counted in the summer surveys between 1994 and 2003. The numbers of Pied Stilt *(Himantopus leucocephalus)* have increased throughout the years and in the winter, 1983 to 1994 surveys the average number of birds recorded was 3,348. In the later 1994 to 2003 winter surveys the average number of birds recorded was 3,981. It was also calculated, in Kelly (2009), that the entire bird population within Manukau Harbour is increasing by 1,065 birds annually.

How findings relate to Avon-Heathcote Estuary/Ihutai

The Manukau Harbour is a clear example of an area which supports a high bird diversity in an urban area. While many sections of the harbour are used for recreational activities, and new infrastructure is constantly built around the area, many sections remain under coastal protection. Numerous areas are also classified as those of significant conservation value which limits human access, and have rules to protect coastal wildlife. Coastal protected areas are crucial for wildlife as they help support various threatened and declining species of birds. Therefore, where refuges and coastal protected areas are established in places such as the Avon- Heathcote Estuary/Ihutai, it is critical that they remain protected and efficiently managed. The Avon-Heathcote Estuary/Ihutai has large areas devoted for recreational activity, likewise the Manukau Harbour. However, positive trends in bird abundances are still evident in Manukau Harbour, perhaps due to the many coastal protected areas. Therefore, it is important not to encroach on current protected areas as this may affect the amount of birds which the Avon-Heathcote Estuary/Ihutai will support.

Bream Bay

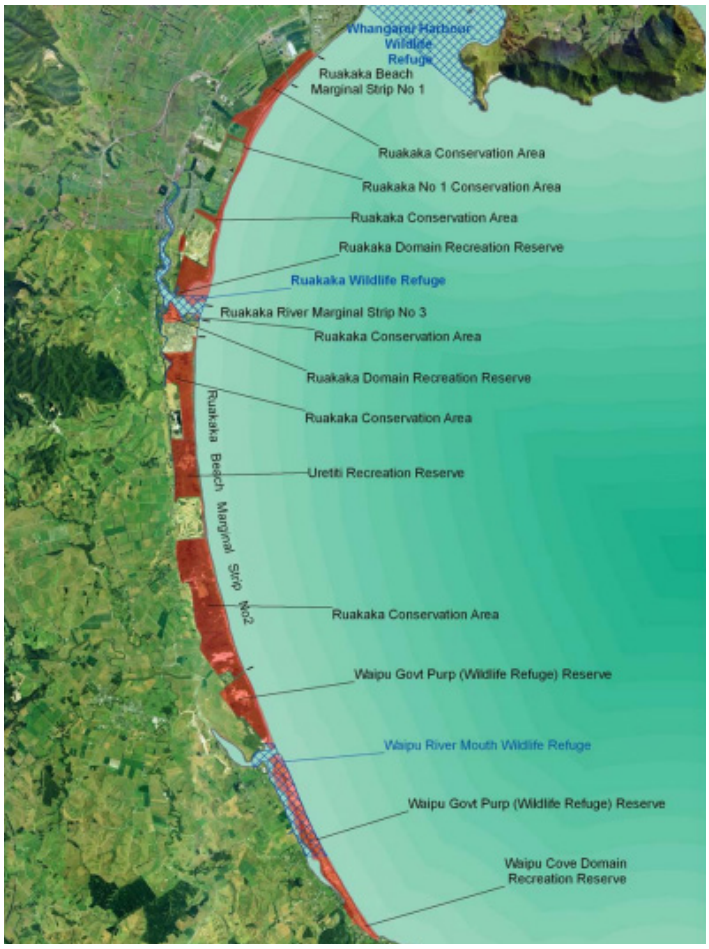

Figure 5. Map of Bream Bay, New Zealand, Indicating Conservation and wild refuge areas. Sourced from The Department of Conservation (2006).

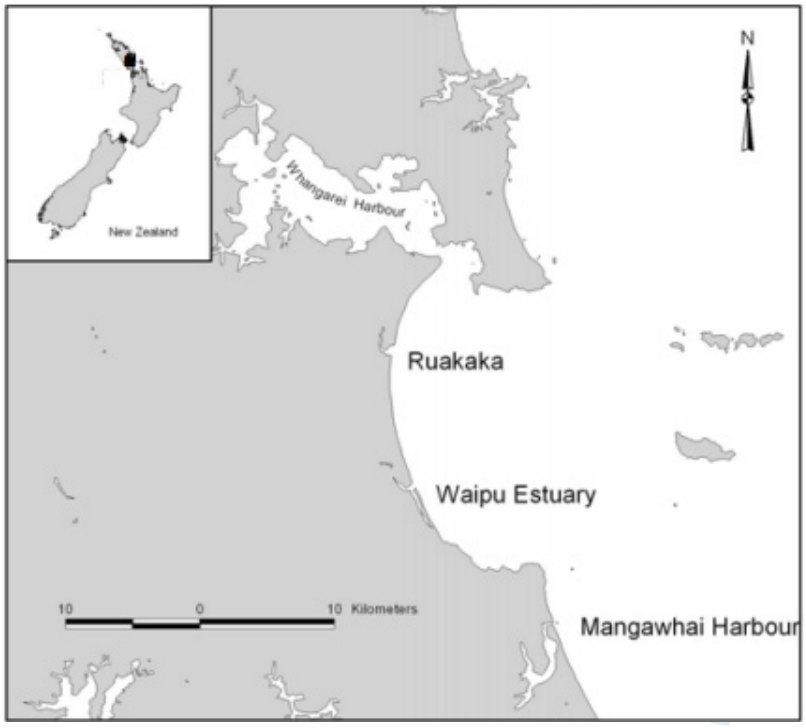

Figure 6. Locations of Mangawhai, Waipu, and Ruakaka in New Zealand. Sourced from Hansen (2005).

Three important wildlife refuge breeding sites for birds are situated along the East coast of Northland, New Zealand. These refuge areas are within Mangawhai, Waipu, and Ruakaka. Details and efficiency of strategies implemented within these refuges were included in Hansen (2005). Mangawhai Wildlife Refuge comprised a large sandy area and vegetated dunes that supported breeding activity. Waipu Wildlife Refuge had a 200m wide sand spit which provided a small breeding area. Ruakaka Wildlife Refuge is a small breeding area, consisting of small dunes and a sandspit. All areas had a low number of human visitors, Ruakaka typically supporting the most, particularly during holiday seasons.

In each of these areas, strategies have been implemented to help support wildlife and facilitate bird population growth. Mangawhai and Waipu have extensive predator control programmes and all sites have different degrees of fencing strategies implemented. All the sites supported the New Zealand Dotterel *(Charadrius obscurus)* and the Variable Oystercatcher *(Haematopus unicolor).* Over five years, 0.5 to 0.54 New Zealand Dotterels were raised per nest in Mangawhai and Waipu. In contrast, over five years in Ruakaka, on average 0.74 young New Zealand Dotterels were raised per nest. The number of Variable Oystercatcher which were raised per nest was similar across all sites, averaging between 0.4 and 0.54. While these figures seem relatively small, it was found that these sites have productivity rates for these two species between four to five times higher than unprotected sites examined in this study (Karikari, and Puwheke Beach). Predator control was beneficial in this study because fewer nests were destroyed by pests. However, fencing strategies did not seem to improve fledging success between areas which were fenced and not fenced. It was suggested that because Mangawhai and Waipu had very little human disturbance, fencing did not result in any significant difference.

Another bird species which was found in the reserve areas (Hansen, 2005) was the New Zealand Fairy Tern *(Sterna nereis davisae).* This bird inhabits only three main areas in New Zealand, Papakanui Spit, Mangawhai and Waipu. Nest protection strategies were implemented in 1983-1984 (Parrish and Pulham,1995) and bird surveys between 1991 and 1994 allowed data from bird surveys before and after the protection strategies began to be analysed. Over the study period there were approximately a total of 39 to 41 chicks fledged from protected areas in these three sites. The majority of these were recorded in Mangawhai. Breeding pairs increased in Mangawhai over the years, with only one or two recorded during the 1980's, while four to five were recorded from 1991 to 1994.

An additional report by Pierce (2000) investigated how a proposed subdivision near Waipu could have major impacts on shorebirds in the area. Waipu Wildlife Refuge is an important breeding location for various birds, with effective strategies implemented to promote breeding and fledging success. Birds in the area had an average hatching success of 40-60% and the author indicated that the Bream Bay area was crucial in supporting the New Zealand Fairy Tern. On the south side of Ruakaka, where disturbance had heavily increased over the years, the number of birds had dramatically declined, and the New Zealand Fairy Tern has not been recorded since 1985. It was suggested that this was due to the increased recreational activities in the area. It was also suggested that the protected Wildlife Refuge in Waipu was crucial in supporting birds which get displaced from nearby areas that are subject to increased levels of human disturbance. It was suggested that the new proposed subdivision near Waipu should be reconsidered due to the necessity of Waipu remaining as an area with little human disturbance. This would ensure that it continues to support wildlife.

Bridson (2000) conducted recreational surveys within Mangawhai, Waipu, and Ruakaka between 1998 and 1999. In each of the areas, the sandspits and estuary environments were relatively unmodified, however, recreational activities such as fishing, surfing, and walking had increased. Common bird species which occupied these areas were the New Zealand Dotterels, Variable Oystercatchers, White-fronted Terns *(Sterna striata),* Caspian Terns *(Hydroprogne caspia),* and New Zealand Fairy Terns. In each of these refuges, fenced off areas were established to limit human disturbance on nests. These surveys were conducted to reveal public opinion and awareness of the refuges and wildlife. Some 67% of visitors in Waipu Wildlife Refuge mentioned that they

saw signs which displayed messages about wildlife. The majority of the people (57) who did not notice the signs were first-time visitors. Similar trends were recorded in each of the other sites. Also, in Waipu, 36% of first-time visitors were unaware that they were within a wildlife refuge. These responses indicate that signs in refuges may be a little bit ineffective, especially to first-time visitors. During these surveys people were recorded occupying spaces right next to fenced areas, clearly disturbing wildlife in nests. There was also an instance of a person walking into a fenced-off area, chasing and throwing objects at birds. Surveys also revealed that only 27% of people in Waipu said that they would not be able to detect if they were disturbing a shorebird. Therefore, it was suggested that some of the main issues within these Wildlife Refuges were - deliberate visitor disturbance, visitors lacking knowledge regarding wildlife refuges, and visitors being unaware of their disturbance effects on birds.

How findings relate to Avon-Heathcote Estuary/Ihutai

The research from these studies show that reserve areas can be useful in protecting the nesting sites and breeding areas of shore birds and this can increase the fledging success. Some studies, however, suggest that even if signs are used to inform the public about wildlife refuges there was not very good public awareness of how people can affect the wildlife. This suggests that in order for wildlife refuges to achieve their goals there needs to be prominent signage and education especially for first time visitors.

WALKING/CYCLING TRACKS AND NEW ZEALAND ACTS

The Te Huingi Manu Wildlife Refuge which includes pastureland and the Bromley waste-water treatment ponds is a noted wildlife refuge (defined in the Wildlife Act 1953). The refuge supports various wetland birds such as the New Zealand Scaup *(Aythya novaeseelandiae),* Australasian Shoveler *(Anas rhynchotis),* Grey Teal *(Anas gracilis),* Paradise Shelduck *(Tadorna variegata),* Canada Goose *(Branta canadensis)* and Black Swan *(Cygnus atratus)* to moult or winter at the ponds (Crossland 2003). Under the Wildlife Act 1953 it is deemed to be unlawful for any person to disturb or worry any wildlife in the refuge, and to influence wildlife to leave the refuge from any action or purpose. It also states that no person should have in their possession a dog or a cat in the refuge. By extending the accessibility for recreational users to enter the refuge it could pose risk to not comply with the Act. Strict monitoring of the track would be necessary to prevent recreational users being accompanied by dogs, or any intentional interference with wildlife.

The Resource Management Act 1991 promotes that natural and physical resources are managed in a way to ensure sustainability and protection. Natural and physical resources are defined in the act to include any animals or plants. While this act focuses on how these resources should be able to provide social, economic and cultural wellbeing, it also highlights how any adverse effects which the environment might receive from any activity need to be avoided, mitigated or remedied. Therefore, management must ensure under this act that an extension of the walking and cycling track must sustainably avoid any adverse effects on the natural and physical resources, and if any are encountered, mitigation techniques must be put into place.

REFERENCES

Antos, M. J., G. C. Ehmke, C. L. Tzaros, and M. A. Weston. 2007. Unauthorised human use of an urban coastal wetland sanctuary: current and future patterns. Landscape and Urban Planning 80:173-183.

Beauchamp, A. 2009. Distribution, disturbance and birds movement during a spring tide and kite surfing period at Ruakaka Estuary–10-15 March 2009. Northland Conservancy, Department of Conservation.

Bevan, E., S. Whiting, T. Tucker, M. Guinea, A. Raith, and R. Douglas. 2018. Measuring behavioral responses of sea turtles, saltwater crocodiles, and crested terns to drone disturbance to define ethical operating thresholds. Plos One 13:e0194460.

Bridson, L. 2000. Minimising visitor impacts on threatened shorebirds and their habitats. Conservation advisory science notes no. 301. Wellington, Department of Conservation.

Brisson-Curadeau, É., D. Bird, C. Burke, D. A. Fifield, P. Pace, R. B. Sherley, and K. H. Elliott. 2017. Seabird species vary in behavioural response to drone census. Scientific reports 7:17884-17889.

Burger, J. 1981. The effect of human activity on birds at a coastal bay. Biological Conservation 21:231-241.

Burger, J., S. A. Carlucci, C. W. Jeitner, and L. Niles. 2007. Habitat choice, disturbance, and management of foraging shorebirds and gulls at a migratory stopover. Journal of Coastal research:1159-1166.

Collop, C., R. A. Stillman, A. Garbutt, M. G. Yates, E. Rispin, and T. Yates. 2016. Variability in the area, energy and time costs of wintering waders responding to disturbance. Ibis 158:711-725.

Crossland, A. 2003. A national biodiversity hot-spot from the treatment of urban wastewater-the Bromley Oxidation Ponds and Te Huingi Manu Wildlife Refuge, Christchurch. Greening the City: Bringing Biodiversity Back into the Urban Environment. Pages 21-24 in Proceedings of Royal New Zealand Institute of Horticulture Conference.

Department of Conservation. 2006. Bream Bay Strategic Plan, Whangarei, New Zealand

Dowling, B., and M. A. Weston. 1999. Managing a breeding population of the Hooded Plover Thinornis rubricollis in a high-use recreational environment. Bird Conservation International 9:255-270.

Dulava, S., W. T. Bean, and O. M. W. Richmond. 2015. Environmental Reviews and Case Studies: Applications of Unmanned Aircraft Systems (UAS) for Waterbird Surveys. Environmental Practice 17:201-210.

Finney, S. K., J. W. Pearce-Higgins, and D. W. Yalden. 2005. The effect of recreational disturbance on an upland breeding bird, the golden plover Pluvialis apricaria. Biological Conservation 121:53-63.

Garton, C., D. Lawrie, B. Turner, and L. Templeton. 2018. 60 Years of MIigratory Bird Management on the Manukau. Watercare Services Ltd.

Glover, H. K., M. A. Weston, G. S. Maguire, K. K. Miller, and B. A. Christie. 2011. Towards ecologically meaningful and socially acceptable buffers: Response distances of shorebirds in Victoria, Australia, to human disturbance. Landscape and Urban Planning 103:326-334.

Goss-Custard, J., and N. Verboven. 1993. Disturbance and feeding shorebirds on the Exe estuary. Wader Study Group Bulletin 68:59-66.

Haase, L.A. 1995. The effects of disturbance on estuarine birds. Masters Thesis in Zoology, University of Canterbury.

Hansen, K. 2005. Protection of Shorebirds at Three Northland Breeding Sites: Mangawhai, Waipu, and Ruakaka. Department of Conservation.

Kelly, S. 2009. Environmental condition and values of Manukau Harbour. Prepared by Coast and Catchment Ltd. for Auckland Regional Council. Auckland Regional Council Technical Report 112.

Kirby, J., C. Clee, and V. Seager. 1993. Impact and extent of recreational disturbance to wader roosts on the Dee estuary: some preliminary results. Wader Study Group Bulletin 68:53-58.

Krüger, T. 2016. On the effects of kitesurfing on waterbirds - a review. Naturschutz Informationsdienst Niedersachsen. 36:3-64.

Lilleyman, A. 2017. Report on impacts from disturbances to migratory birds in Darwin. EcOz Environmental consultants. 35pp.

Lilleyman, A., D. C. Franklin, J. K. Szabo, and M. J. Lawes. 2016. Behavioural responses of migratory shorebirds to disturbance at a high-tide roost. Emu - Austral Ornithology 116:111-118.

Lord, A., J. R. Waas, J. Innes, and M. J. Whittingham. 2001. Effects of human approaches to nests of northern New Zealand dotterels. Biological Conservation 98:233-240.

Lyons, M., K. Brandis, C. Callaghan, J. McCann, C. Mills, S. Ryall, and R. Kingsford. 2018. Bird interactions with drones, from individuals to large colonies. Australian Field Ornithology 35:51-56.

Madsen, J. 1995. Impacts of disturbance on migratory waterfowl. Ibis 137:S67-S74.

Martín, B., S. Delgado, A. Cruz, S. Tirado, and M. Ferrer. 2015. Effects of human presence on the long-term trends of migrant and resident shorebirds: evidence of local population declines. Animal Conservation 18:73-81.

Milton, D. A., D. Beck, V. Campbell, and S. B. Harding. 2011. Monitoring disturbance of shorebirds and seabirds at Buckley's hole sandspit in northern Moreton Bay. Sunbird: Journal of the Queensland Ornithological Society 41:13-33.

Milton, D. A., and S. B. Harding. 2011. Death by a thousand cuts–the incremental loss of coastal high tide roosts for Shorebirds in Australia: Sandfly Creek Environmental Reserve, Central Queensland. Stilt 60:22-33.

Napier City Council. 2017. Record of Community Engagement: Draft Ahuriri Estuary and Coastal Edge Masterplan Full Report Napier City Council, New Zealand.

Navedo, J. G., and A. G. Herrera. 2012. Effects of recreational disturbance on tidal wetlands: supporting the importance of undisturbed roosting sites for waterbird conservation. Journal of Coastal Conservation 16:373-381.

Parrish, G. R., and G. A. Pulham. 1995. Population size, productivity and post breeding movements of the New Zealand Fairy Tern. Tane 35:175-181.

Pearce-Higgins, J. W., S. K. Finney, D. W. Yalden, and R. H. W. Langston. 2007. Testing the effects of recreational disturbance on two upland breeding waders. Ibis 149:45-55.

Pfister, C., B. A. Harrington, and M. Lavine. 1992. The impact of human disturbance on shorebirds at a migration staging area. Biological Conservation 60:115-126.

Pierce, R. J. 2000. Implications of a subdivision proposal near an important shorebird breeding site. Department of Conservation.

Schlacher, T. A., L. K. Carracher, N. Porch, R. M. Connolly, A. D. Olds, B. L. Gilby, K. B. Ekanayake, B. Maslo, and M. A. Weston. 2016. The early shorebird will catch fewer invertebrates on trampled sandy beaches. Plos One 11:e0161905.

Schlacher, T. A., M. A. Weston, D. Lynn, and R. M. Connolly. 2013. Setback distances as a conservation tool in wildlife-human interactions: testing their efficacy for birds affected by vehicles on open-coast sandy beaches. Plos One 8:e71200.

Southey, I. 2009. Numbers of waders in New Zealand 1994-2003. Science & Technical Pub.,

Department of Conservation.

Van Rijn, S., K. Krijgsveld, and R. Strucker. 2006. Gedrag van vogels tijdens een kitesurfevenement op de Grevelingen. Rapport 06-251. Bureau Waardenburg, Culemborg.

Vas, E., A. Lescroël, O. Duriez, G. Boguszewski, and D. Grémillet. 2015. Approaching birds with drones: first experiments and ethical guidelines. Biology letters 11:20140754-20140754.

Veitch, C., and A. Habraken. 1999. Waders of the Manukau Harbour and Firth of Thames. Notornis 46:45-70.

Weston, M. A., M. J. Antos, and C. L. Tzaros. 2009. Sand pads: A promising technique to quantify human visitation into nature conservation areas. Landscape and Urban Planning 89:98-104.

Weston, M. A., and M. A. Elgar. 2007. Responses of incubating hooded plovers (Thinornis rubricollis) to disturbance. Journal of Coastal research:569-576.

Weston, M.A. Mcleod, E.M., Blumstein, D.T. Guay, P.J. A review of flight-initiation distances and their application to manging disturbance to Australian birds. Emu 112: 269-286.

Yasué, M. 2005. The effects of human presence, flock size and prey density on shorebird foraging rates. Journal of Ethology 23:199-204.

APPENDIX - BIRDS OF THE AVON HEATHCOTE ESTUARY/IHUTAI

SPECIES[1]	STATUS[2]	COMMENT
CORMORANT/SHAG		
Black shag/Cormorant	At Risk. Naturally Uncommon	Native
Pied Shag/Cormorant	At Risk. Recovering	Native
Little Shag/Cormorant	Not Threatened	Native
Little Black Shag/Cormorant	At Risk. Naturally Uncommon	Native
CRAKE		
Marsh Crake	At Risk. Declining	Native
GULL/TERN		
Red-billed Gull	At Risk. Declining	Native
Black-billed Gull	Threatened. Nationally Critical	Native
Black-backed/Kelp Gull	Not Threatened	Native
Caspian Tern	Threatened. Nationally Vulnerable	Native
White-fronted Tern	At Risk. Declining	Native
Black-fronted Tern	Threatened. Nationally Endangered	Native
White-winged Black Tern	Not Threatened	Migrant
HERON/SPOONBILL		
White-faced Heron	Not Threatened	Native
White Heron	Threatened. Nationally Critical	Native
Royal Spoonbill	At Risk. Naturally Uncommon	Native
Australasian Bittern	Threatened. Nationally Critical	Native
OTHER		
White-flippered Penguin	At Risk. Declining	Native
Kingfisher	Not Threatened	Native
RAIL		
Pukeko	Not Threatened	Native
Australasian Coot	At Risk. Naturally Uncommon	Native
Spotless Crake	At Risk. Declining	Native
Marsh crake	At Risk. Declining	Native
WADER		
Bar-tailed Godwit	At Risk. Declining	Migrant
South Island Pied Oystercarcher	At Risk. Declining	Native
Variable Oystercatcher	At Risk. Recovering	Native
Spur-winged Plover	Not Threatened	Native
Banded Dotterel	Threatened. Nationally Vulnerable	Native
Lesser Knot	Threatened. Nationally Vulnerable	Migrant
Pied Stilt	Not Threatened	Native
Wrybill	Threatened. Nationally Vulnerable	Native
WATERFOWL		
New Zealand/Australasian Shoveler	Not Threatened	Native
Paradise Shelduck	Not Threatened	Native
Grey Teal	Not Threatened	Native
New Zealand Scaup	Not Threatened	Native
Black Swan	Not Threatened	Native
Grey Duck	Threatened. Nationally critical	Native
Canada Goose	Introduced and naturalised	

[1]Andrew Crossland , Christchurch City Council - "Best Bird-watching" chapter of "Exploring an Estuary", 2nd edition, pub 2016 by The Avon-Heathcote Estuary Ihutai Trust.

[2]Department of Conservation, "Conservation status of New Zealand birds, 2016" (New Zealand Threat Classification Series 19).