

# Marine biodiversity stocktake of the Waikato region 2015

## Volume 2: Appendices

Prepared by:  
Sietse Bouma

For:  
Waikato Regional Council  
Private Bag 3038  
Waikato Mail Centre  
HAMILTON 3240

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Document #: 3752508752508

Peer reviewed by:  
Hilke Giles

Date November 2016

Approved for release by:  
Dominique Noiton

Date December 2016

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The report and references are published in Waikato Regional Council Technical Report 2015/48 Volume 1.



## Appendix 1. Intertidal habitats in Coromandel harbours and estuaries (Needham et al. 2013, 2014)

In 2013, Waikato Regional Council commissioned the National Institute of Water and Atmospheric Research (NIWA) to map intertidal habitats that provide ecosystem goods and services. The study included 14 different harbours and estuaries around the Coromandel Peninsula: Manaia and Te Kouma Harbours, Coromandel Harbour, Colville Bay, Port Charles, Waikawau estuary, Kennedy Bay, Whangapoua Harbour, Whitianga Harbour and Purangi estuary, Tairua Harbour, Whangamata Harbour and Otahu estuary, and Wharekawa Harbour (Needham et al. 2013, 2014).

Three different habitats were defined by the characteristics/dominance of the flora: seagrass, mangroves and pneumatophores (the aerial roots of mangroves). Twelve habitats were defined by characteristics/dominance of the fauna: cockles, pipi, cockles and pipi, wedge shell, oysters, crustacean burrows, crabs and cockles, tubeworms and cockles, snails (*Amphibola*), 'low density deposit feeders' (used as the baseline), 'mounds and pits' (similarly dominated by deposit feeders, but featuring a distinct surface topography) and 'low fauna' (where macro-fauna were extremely sparse) (Needham et al. 2014). Qualifying information for these habitat types (extracted from Needham et al. 2014) is shown in Table 18.

**Table 18. Intertidal habitats in Coromandel harbours and estuaries (Needham et al. 2014).**

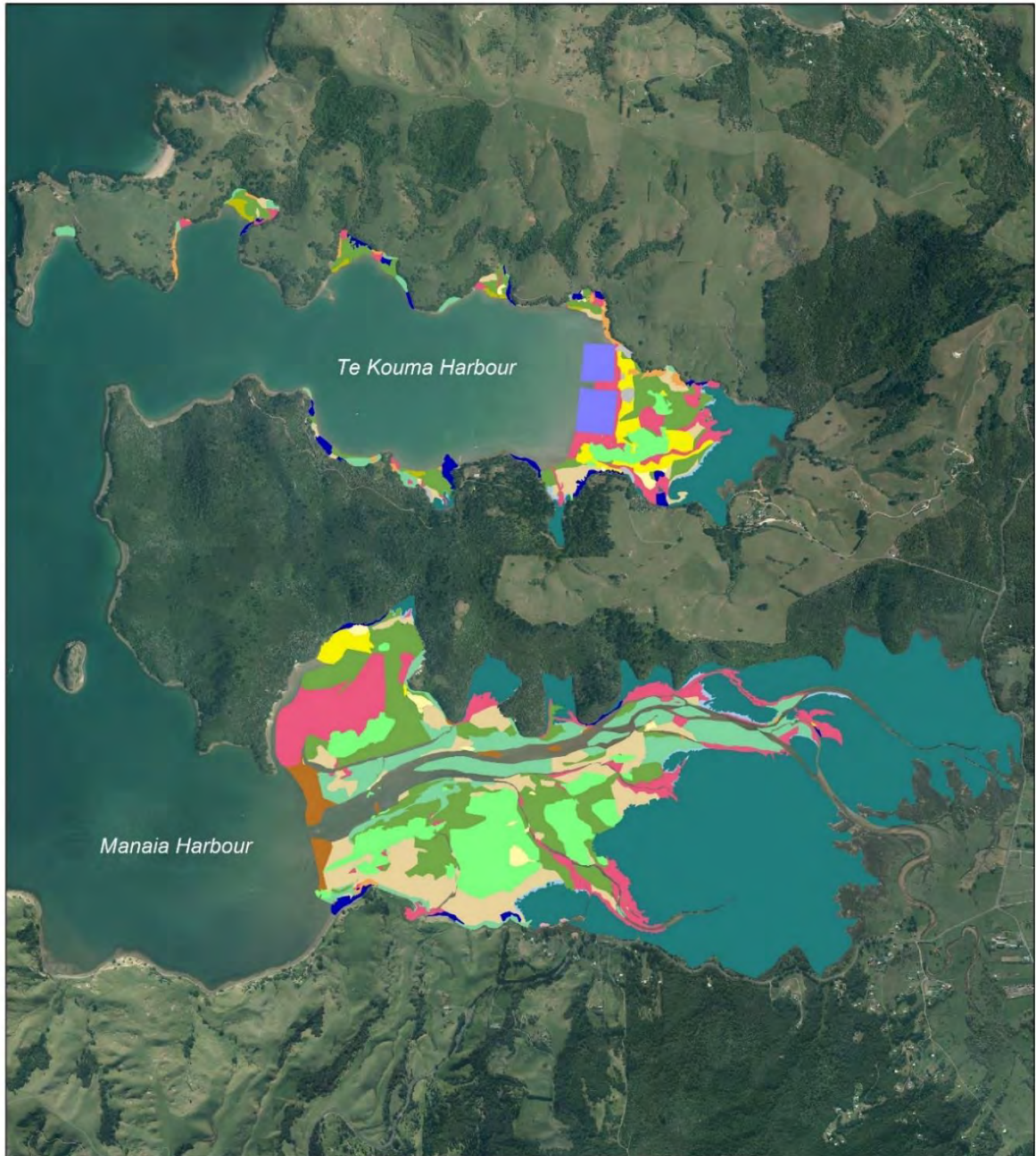
Habitat	Qualifying information
Seagrass	To be considered a 'seagrass' habitat, <i>Zostera</i> had to be of sufficient density and extent (minimum of 10 m <sup>2</sup> ) to form a distinct bed rather than a collection of sparse single leaves. Islands of 'bare' sediment within larger seagrass patches were not demarcated unless greater than 10 m <sup>2</sup> and accessible.
Mangroves	Areas of adult <i>Avicennia marina</i> plants greater than 10 m <sup>2</sup> in spatial extent. This definition excluded areas of seedlings and pneumatophores.
Pneumatophores	Juvenile mangrove structures, extending >5 m from mangrove areas.
High density cockles	Sediment containing 10 or more cockles (≥ 10) sized 20 mm or greater in shell length (≥ 20 mm) from a 15 x 15 cm area and/or more than 3 cockles or ≥ 40 mm shell length. Cockles ≥ 40 mm were not found in any estuaries or harbours other than Manaia Harbour.
High density pipis	Sediment containing 10 or more pipis sized 40 mm or greater in shell length from a 15 x 15 cm area.
High density cockles and pipis	Cockles and pipi found together in sufficiently high density to both qualify for their respective habitat categories (i.e., ≥ 10 cockles sized ≥ 20 mm shell length were present per 15 x 15 cm area, as were ≥ 10 pipi individuals sized ≥ 40 mm shell length). This habitat was exclusive to Otahu Estuary.
High density <i>Macomona</i>	Sediment containing more than 4 <i>Macomona</i> sized 30 mm or greater in shell length per 15 x 15 cm area.
High density oysters	Habitats with an oyster cover greater than 80% of a 0.25 m <sup>2</sup> quadrat when repeated several times over areas greater than 10 m in one dimension.
High density crustacean burrows	Habitats containing 10 conspicuous crabs and/or shrimp burrows or more of 20 mm or greater aperture in a 0.25 m <sup>2</sup> quadrat
High density crab and cockles	Habitats where crabs (crustacean burrows) and cockles were found together in sufficiently high density to both qualify for their respective high density habitat categories.
Low density deposit feeders	A prevalent habitat type dominated by a low to medium density deposit feeding community in muddy sand or sandy mud was assumed to be the 'baseline' and referred to as a 'low density (LD) deposit feeder' habitat. The presence of large burrows is rare or infrequent (> 1 burrow

	of > 2 mm diameter per 0.25 m <sup>2</sup> in n ≥ 3 quadrats) although in some instances high densities of juvenile crabs were also incorporated into this category.
Mounds and pits	Habitats dominated by a predominantly deposit-feeding community (often <i>Macomona</i> , polychaetes and cockles) at densities below their respective individual high density habitat thresholds. 'Mounds and pits' habitat differed from 'low density deposit feeder' habitat by having noticeable topographic features in the sediment through increased bioturbation. These pits and mounds were not dense on a quadrat by quadrat basis (ranging from < 1 to ~4 per 0.25 m <sup>2</sup> quadrat), however when looking across the flats, considerable disturbance and sediment undulations were notable (and differed from that of ray feeding pits).
Low fauna	Areas that were highly physically dominated, for instance, upper estuaries where coarse sediments dominated or areas with large expanses of wave rippled sand. These environments were typically sparsely populated by benthic organisms; the habitat was characterised by a general lack of any visible fauna in a 15 x 15 cm area.
High density <i>Amphibola</i>	Sites where 10 individuals or more per 0.25 m <sup>2</sup> were present in 3 or more random quadrats with a spatial extent of 10 m or greater in any direction.
High density crab and tubeworms	Areas where tubeworms occupied > 60% of the area within sampled quadrats and crabs (crustacean burrows) were present in densities of ≥ 10 burrows per 0.25 m <sup>2</sup> . Tube worm mats were only recorded in Te Kouma Harbour

Maps for these intertidal habitats in the different harbours and estuaries were reproduced by Waikato Regional Council (Needham et al. 2013; Waikato Regional Council GIS-layer "Hauraki Gulf Marine Spatial Plan Locations") and are presented below. The maps can be requested from Waikato Regional Council via the Waikato Regional Council Data Catalogue ([www.waikatoregion.govt.nz/Services/data-catalogue](http://www.waikatoregion.govt.nz/Services/data-catalogue)).

For further available datasets related to benthic communities in these Coromandel harbours and estuaries (e.g. abundances, species lists) or benthic communities in harbours and river mouths on the west coast of the Waikato region please refer to chapter 2 of this report.

# Manaia and Te Kouma Harbours



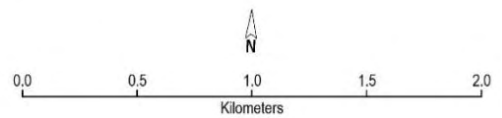
## Intertidal Habitats - Manaia and Te Kouma Harbours

Survey Year 2013

Legend

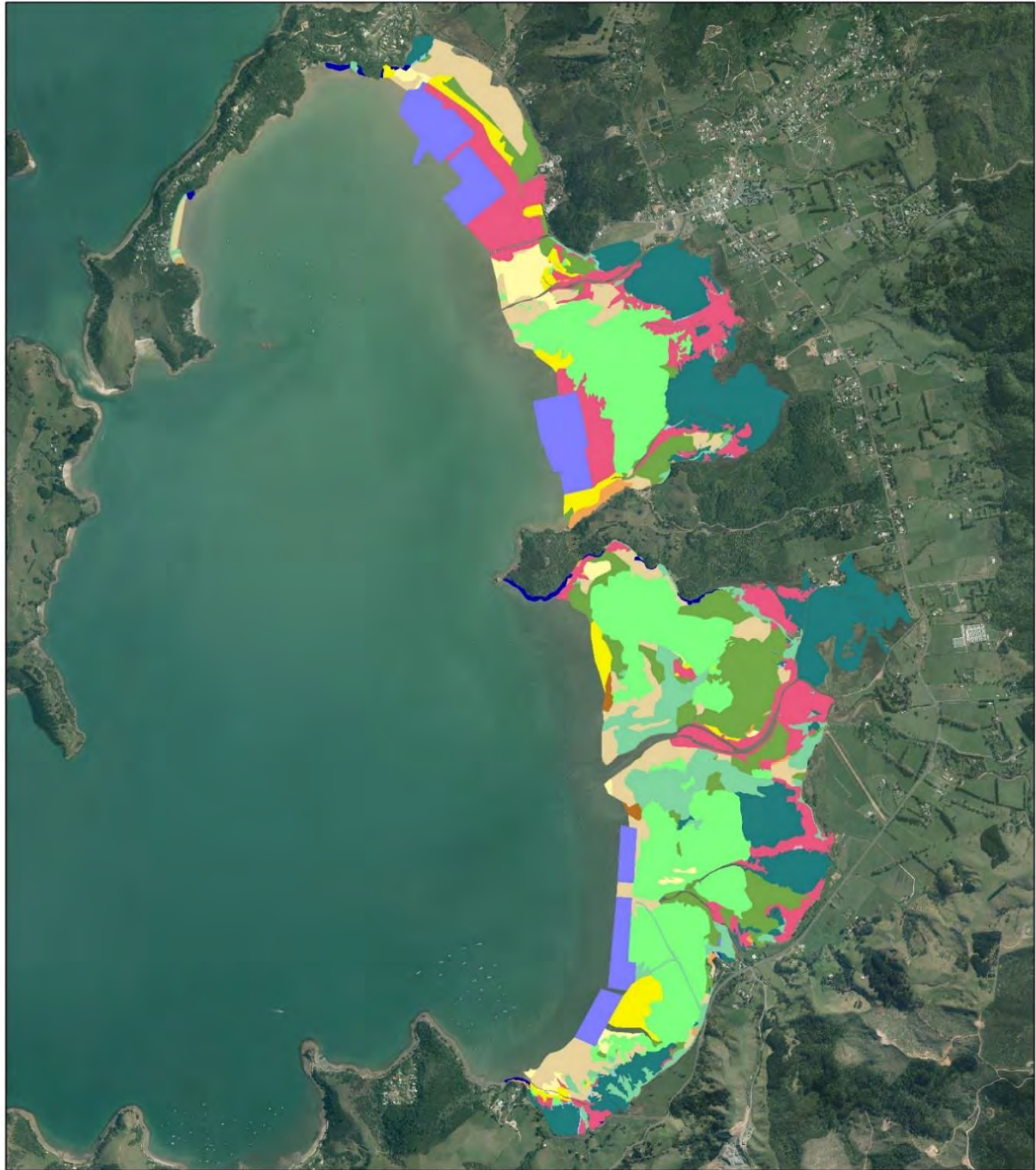
Intertidal Habitats	LD Deposit Feeders
Dead oyster reef	Low Fauna
HD Amphibola	Mangroves
HD Burrows	Mounds and Pits
HD Cockles	Oyster farm
HD Crab & Cockles	Pneumatophores
HD Crab & Tubeworms	Rocky Reef
HD Oysters	Seagrass
HD Pipi	

Source: WRC GIS layer "Hauraki Gulf Marine Spatial Plan Locations"



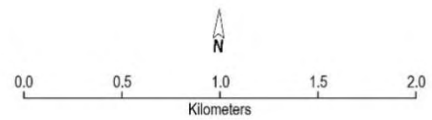
Aerial Imagery WRAPS 2012

# Coromandel Harbour



## Intertidal Habitats - Coromandel Harbour

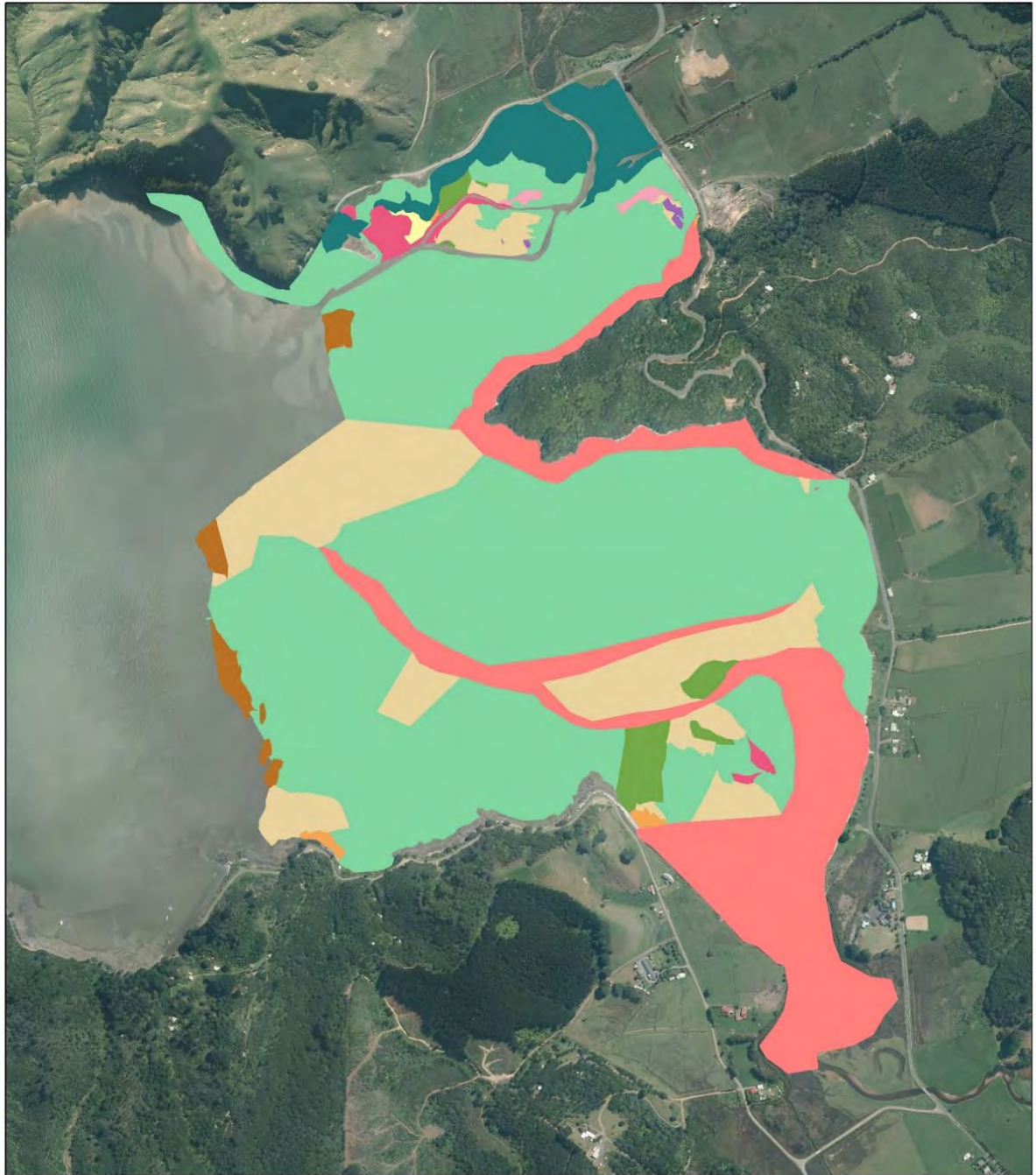
Survey Year 2013



Aerial Imagery WRAPS 2012

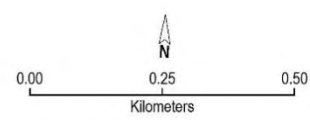
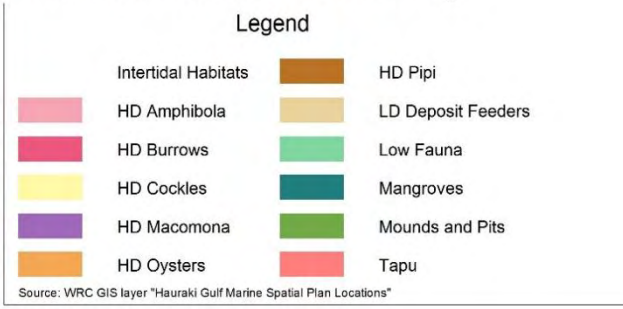


Colville Bay



**Intertidal Habitats - Colville Bay**

Survey Year 2013



Aerial Imagery WRAPS 2012











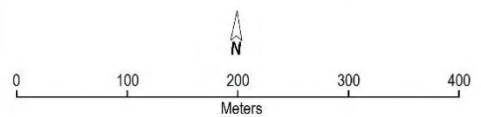
**Intertidal Habitats - Port Charles**

Survey Year 2013

Legend

	Intertidal Habitats		Low Fauna
	HD Burrows		Mangroves
	HD Cockles		Mounds and Pits
	HD Oysters		Pneumatophores
	LD Deposit Feeders		

Source: WRC GIS layer "Hauraki Gulf Marine Spatial Plan Locations"



Aerial Imagery WRAPS 2012

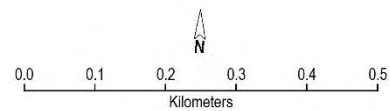
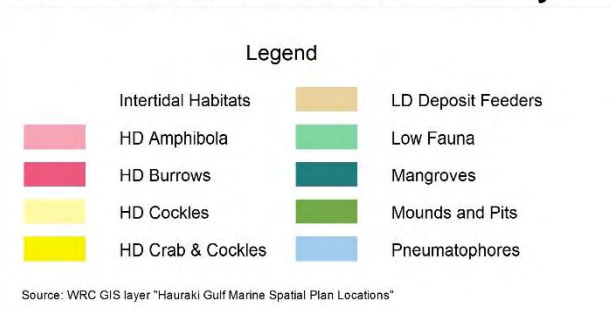


# Waikawau estuary



## Intertidal Habitats - Waikawau Estuary

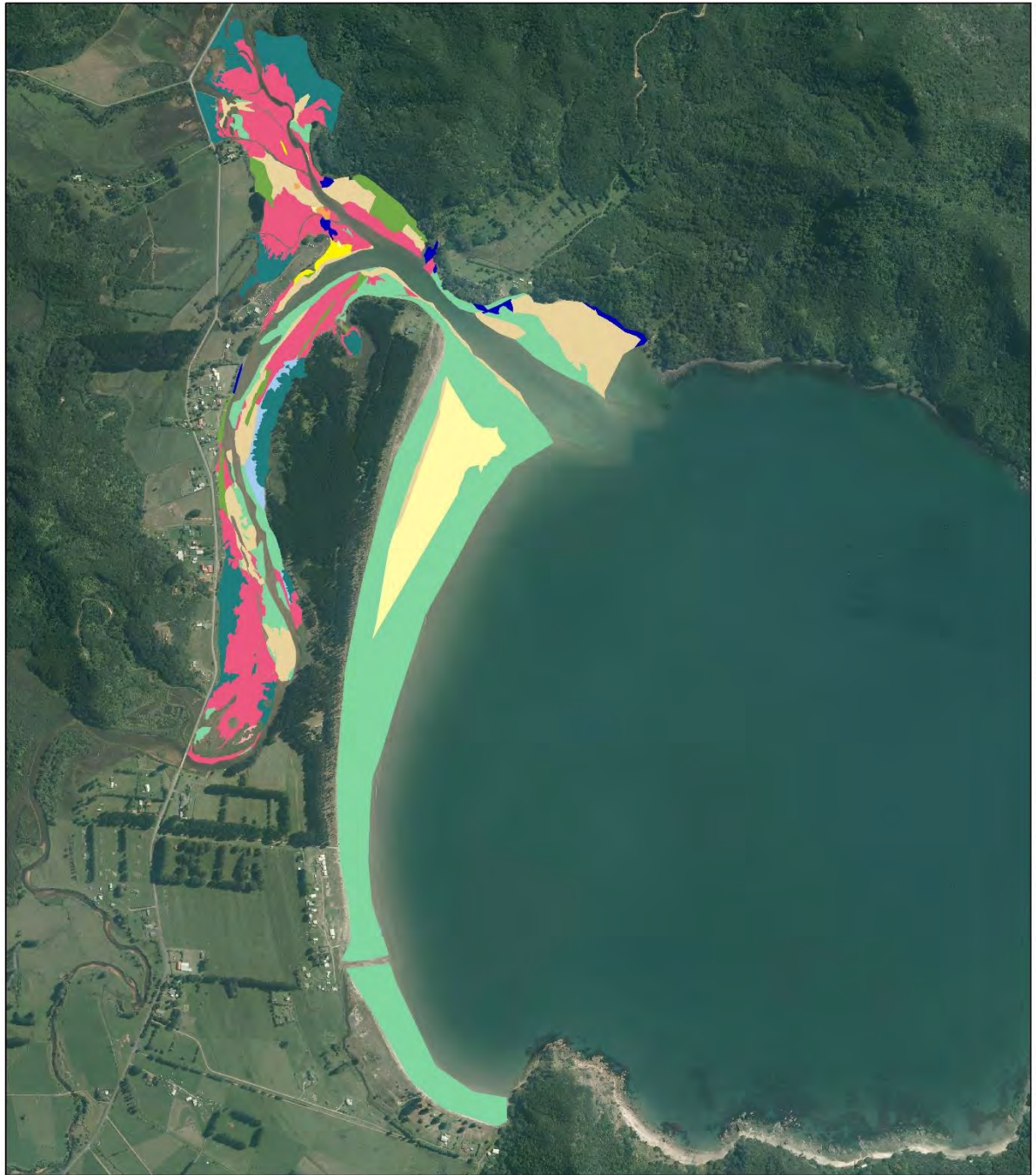
Survey Year 2013



Aerial Imagery WRAPS 2012

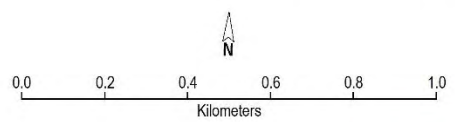


# Kennedy Bay



## Intertidal Habitats - Kennedy Bay

Survey Year 2013

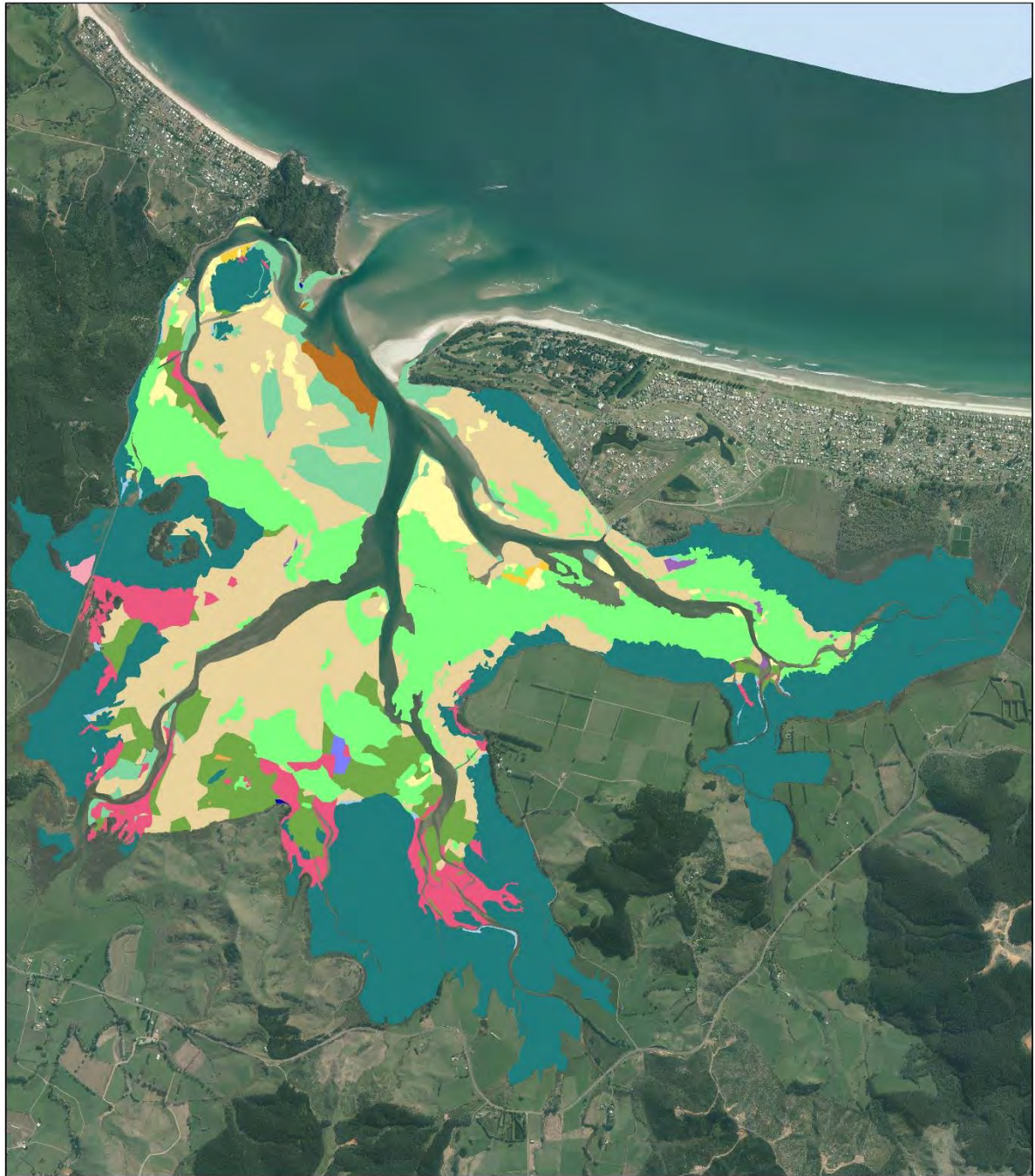


Aerial Imagery WRAPS 2012



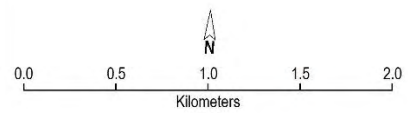


# Whangapoua Harbour



## Intertidal Habitats - Whangapoua Harbour

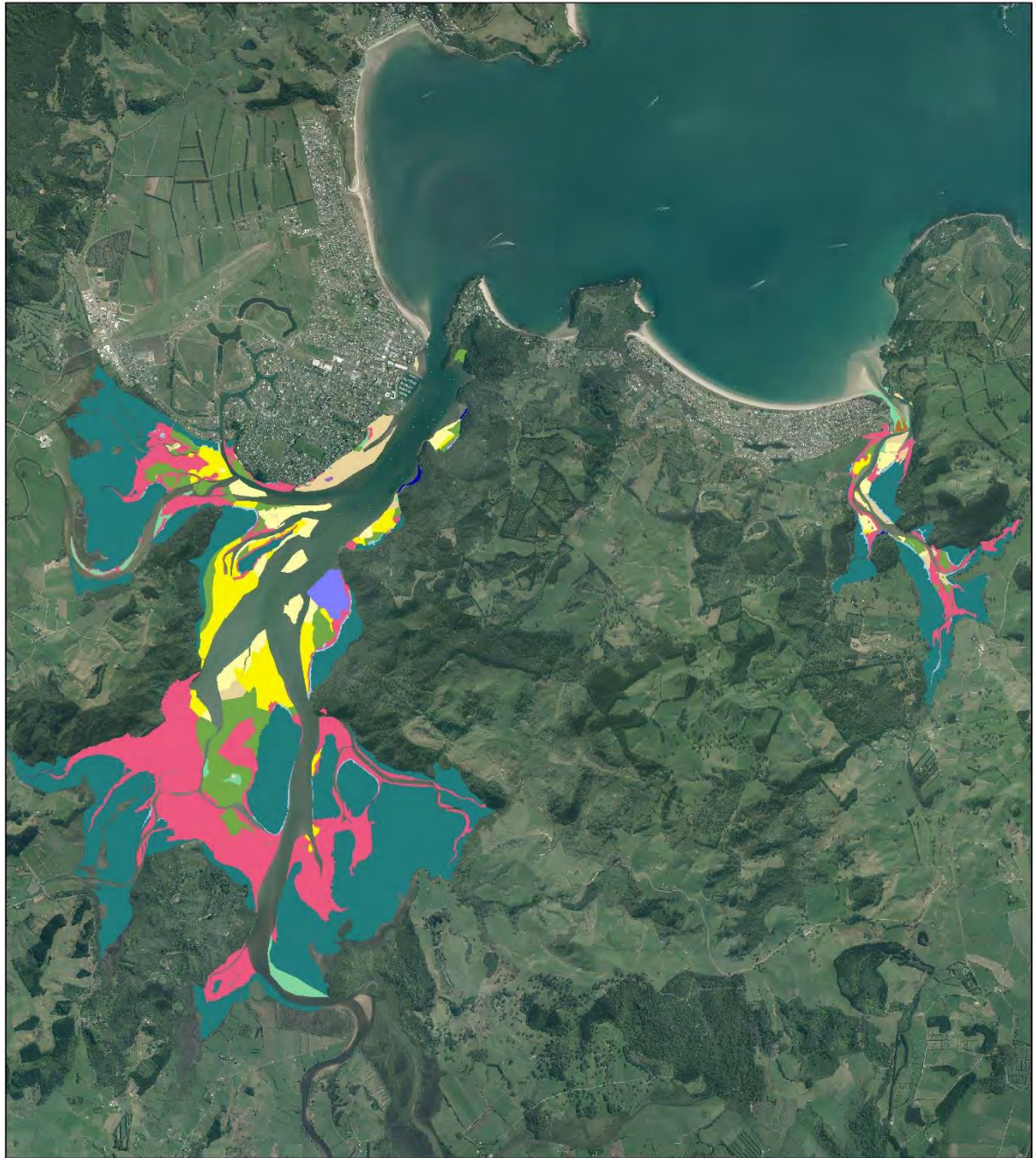
Survey Year 2013



Aerial Imagery WRAPS 2012

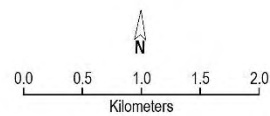
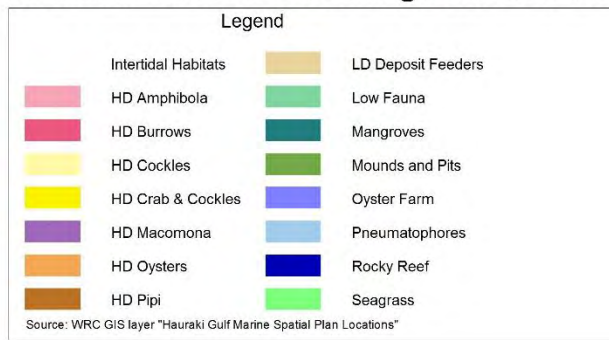


# Whitianga Harbour and Purangi estuary



## Intertidal Habitats - Whitianga Harbour and Purangi Estuary

Survey Year 2013



Aerial Imagery WRAPS 2012

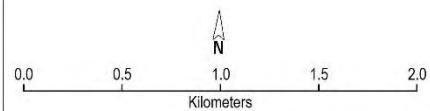


# Tairua Harbour



## Intertidal Habitats - Tairua Harbour

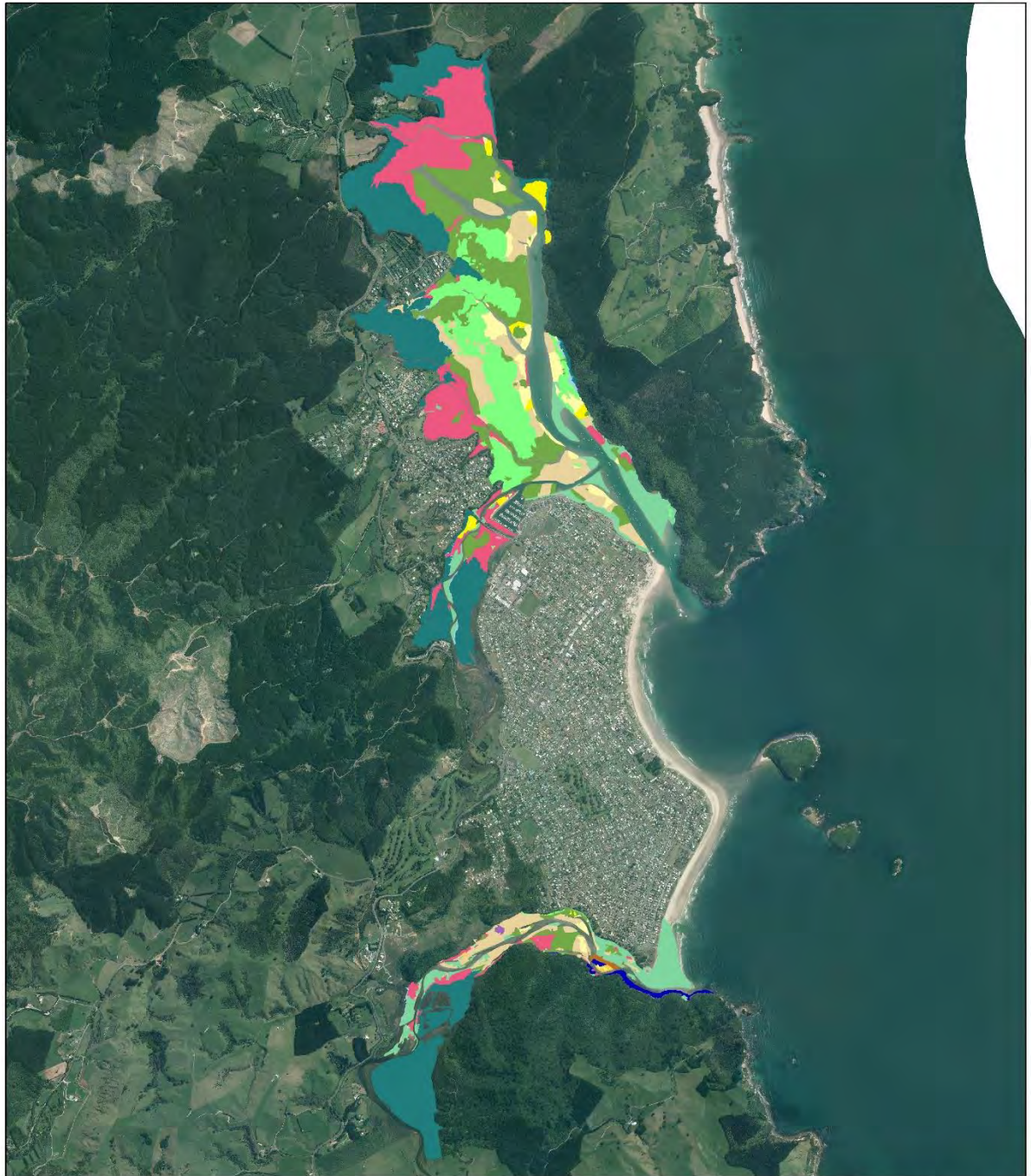
Survey Year 2013



Aerial Imagery WRAPS 2012

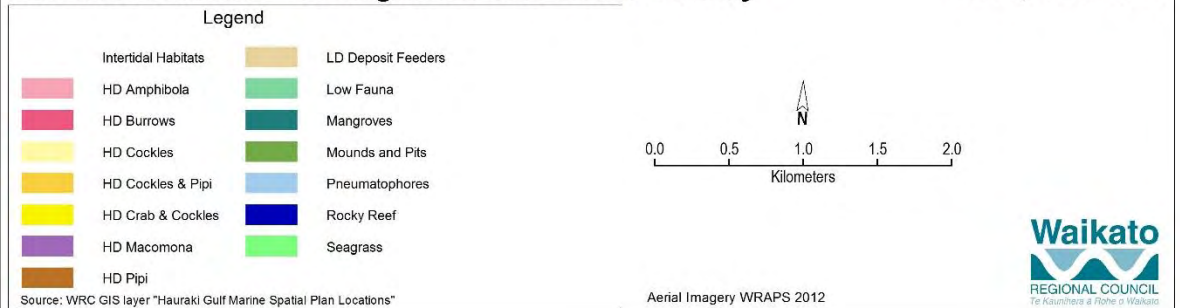


# Whangamata Harbour and Otahu estuary

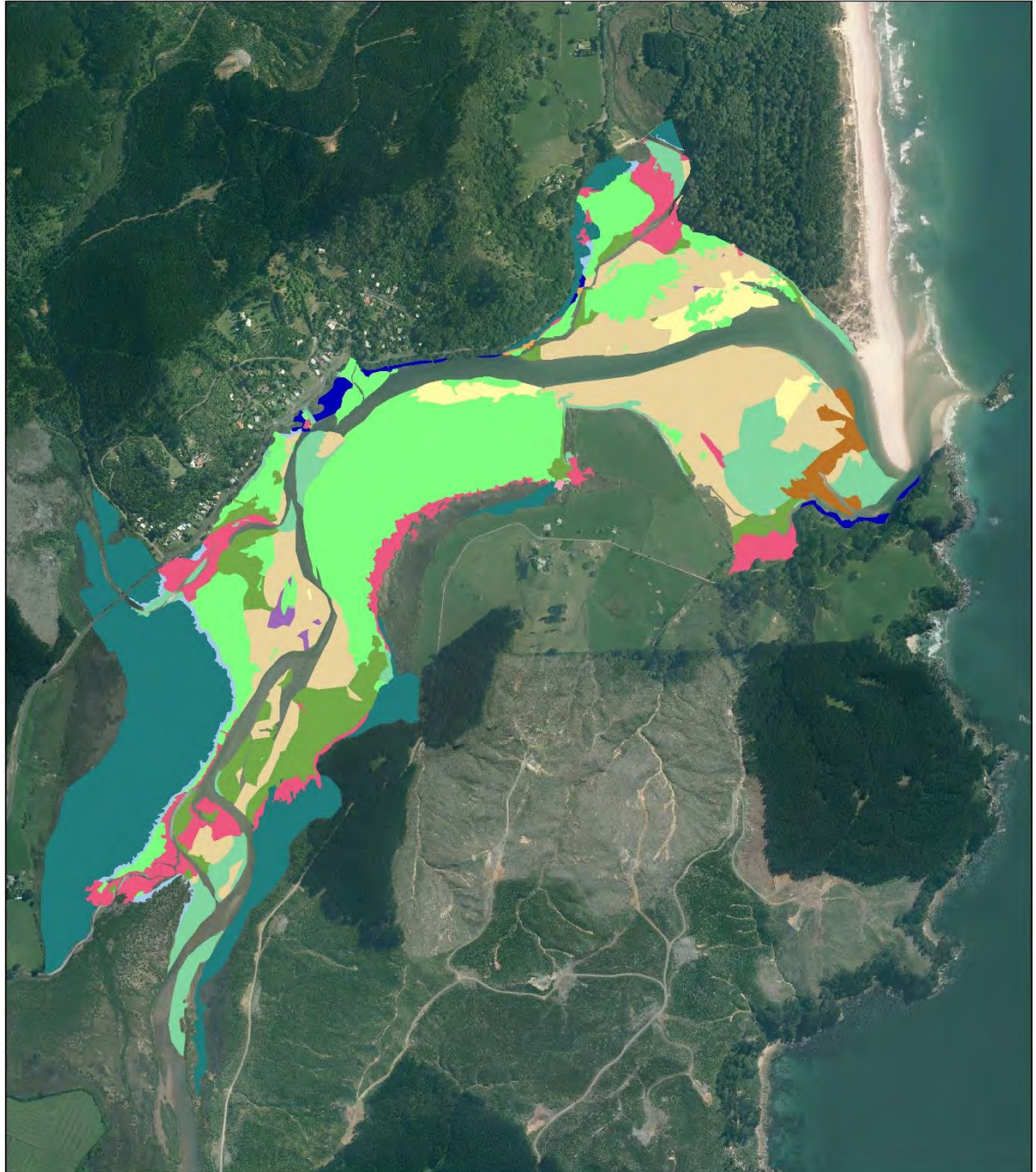


## Intertidal Habitats - Whangamata and Otahu Estuary

Survey Year 2013



# Wharekawa Harbour



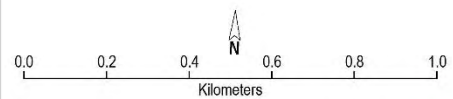
## Intertidal Habitats - Wharekawa Harbour

Survey Year 2013

### Legend

Intertidal Habitats	
	HD Amphibola
	HD Burrows
	HD Cockles
	HD Macomona
	HD Oysters
	HD Pipi
	LD Deposit Feeders
	Low Fauna
	Mangroves
	Mounds and Pits
	Pneumatophores
	Rocky Reef
	Seagrass

Source: WRC GIS layer "Hauraki Gulf Marine Spatial Plan Locations"



Aerial Imagery WRAPS 2012



## Appendix 2. Estuarine vegetation in the Waikato region's harbours and estuaries (Natural Solutions)

Estuarine vegetation surveys have been carried out in most of the Waikato region's harbours and estuaries since 1997, and some have been surveyed multiple times to determine changes in community types over time. Vegetation types within the Coastal Marine Area (CMA) were mapped and included the spatial cover of mangroves, seagrass beds, sea meadows, saltmarsh and estuarine weed communities (e.g. spartina and saltwater paspalum).

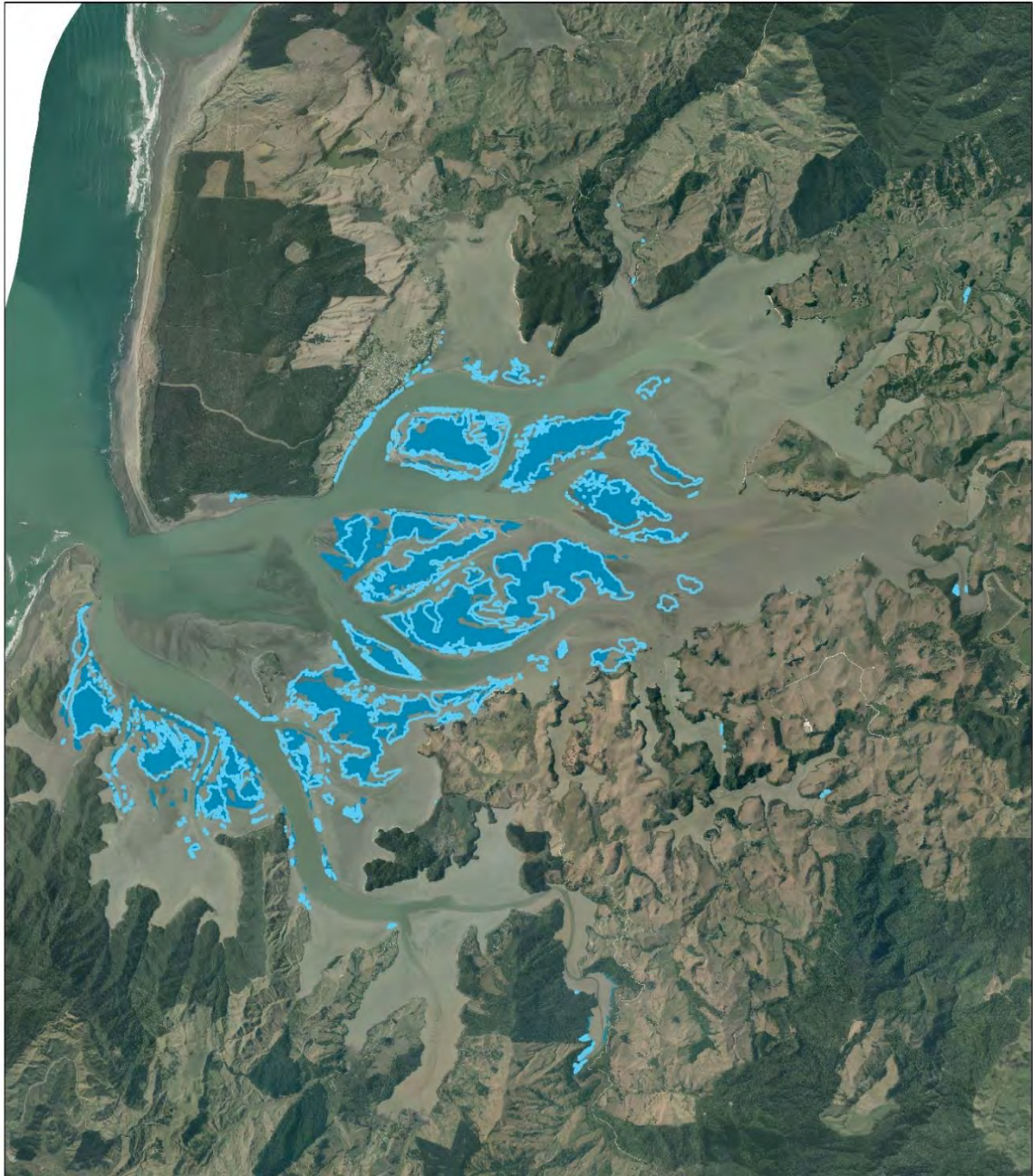
In total 59 different community types were distinguished during all the different surveys. To produce overview maps for this report different community types were grouped together to show the presence/absence of mangroves, seagrass beds, saltmarsh and estuarine weeds mixed with - or without any other vegetation types. The maps were produced by Waikato Regional Council (Waikato Regional Council GIS-layer "Estuarine Vegetation and Harbours") and are presented below. The maps can be requested from Waikato Regional Council via the Waikato Regional Council Data Catalogue ([www.waikatoregion.govt.nz/Services/data-catalogue](http://www.waikatoregion.govt.nz/Services/data-catalogue)).

In 2014 Waikato Regional Council commissioned Natural Solutions to review the estuarine vegetation monitoring programme. The results of this review are published in Graeme & Beard (2015) and are briefly summarised in paragraph 3.2 of this report. This review stated that direct comparison between different surveys is difficult, because mapping techniques evolved from delineating community boundaries on hard copy aerial maps out in the field to mapping community boundaries on to digital aerials while in the field, with the ability to zoom in and out to help clarify features. This statement may be taken into account when interpreting the maps shown below.

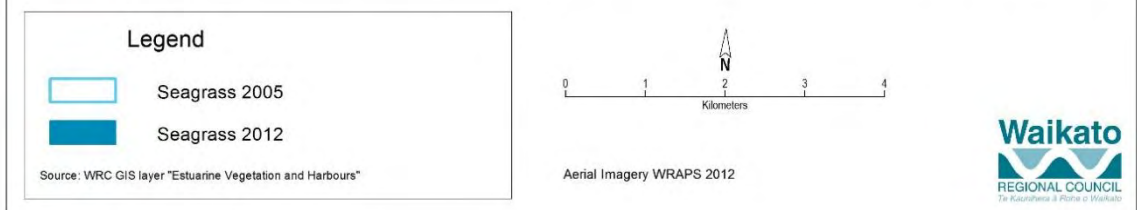
For further available information related to estuarine vegetation in harbours and estuaries in the Waikato region please refer to chapter 3 of this report.

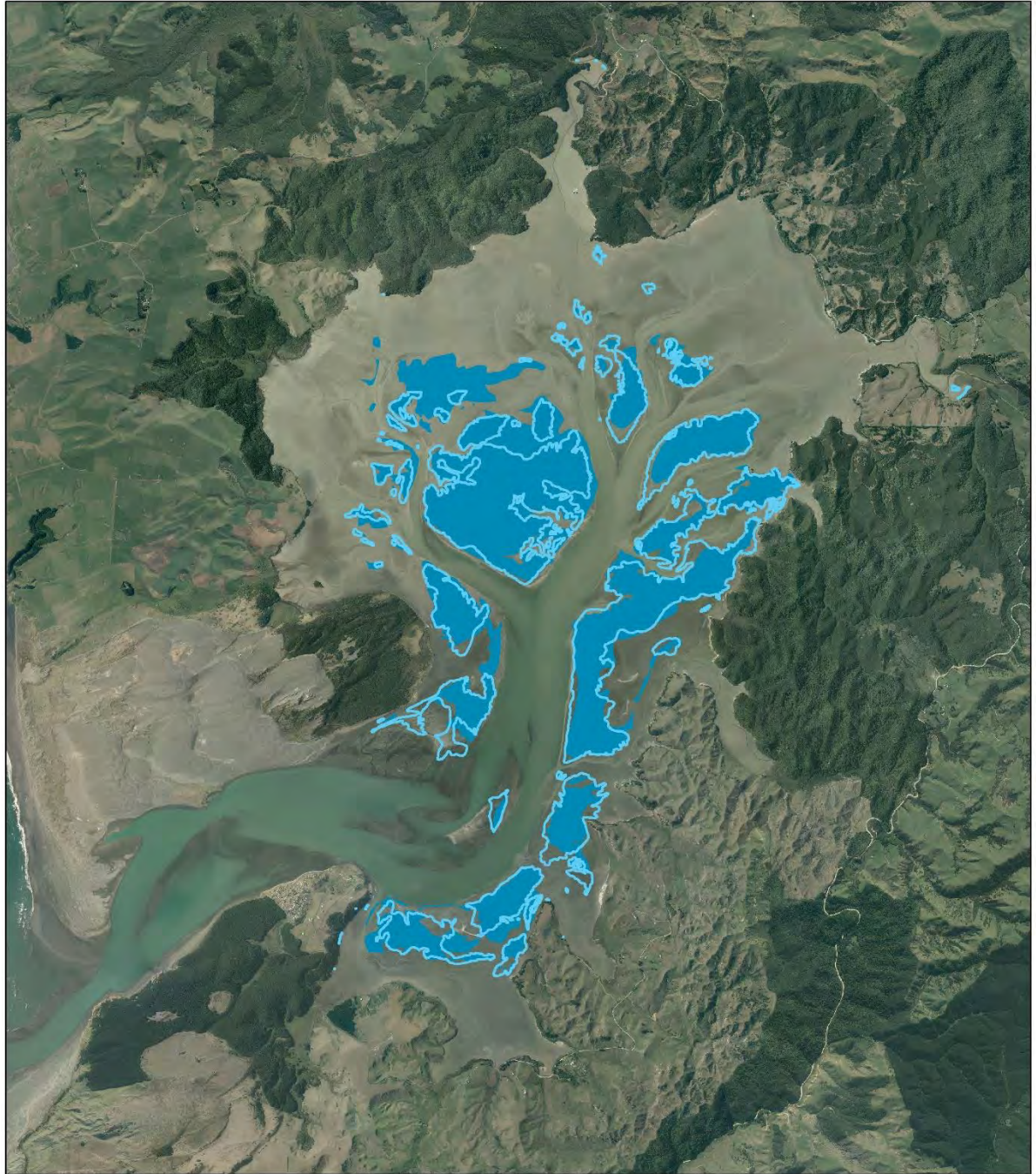
# Seagrass

## Kawhia Harbour



**Estuarine Vegetation - Seagrass - Kawhia Harbour** Year surveyed 2005 and 2012







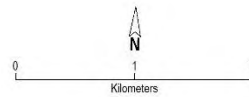
**Estuarine Vegetation - Seagrass - Aotea Harbour**

Year surveyed 2005 and 2012

Legend

-  Seagrass 2005
-  Seagrass 2012

Source: WRC GIS layer "Estuarine Vegetation and Harbours"



Aerial Imagery WRAPS 2012





# Raglan Harbour



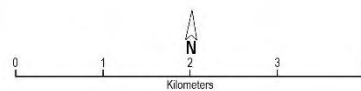
## Estuarine Vegetation - Seagrass - Raglan Harbour

Year surveyed 2005 and 2012

**Legend**

- Seagrass 2005
- Seagrass 2012

Source: WRC GIS layer "Estuarine Vegetation and Harbours"



Aerial Imagery WRAPS 2012





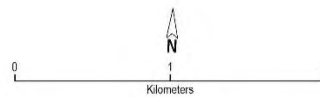
**Estuarine Vegetation - Seagrass - Port Waikato**

Year surveyed 2005 and 2012

**Legend**

	Seagrass 2005
	Seagrass 2012

Source: WRC GIS layer "Estuarine Vegetation and Harbours"



Aerial Imagery WRAPS 2012



## Firth of Thames

The estuarine vegetation survey carried out in 2006 noted a 'lack of seagrass' in the inner Firth of Thames.

Graeme M. report June 2006/40. Estuarine vegetation survey Inner Firth of Thames. Waikato Regional Council Technical Report 2006/40 available at <http://www.waikatoregion.govt.nz/PageFiles/5096/tr06-40.pdf> (part a) and <http://www.waikatoregion.govt.nz/PageFiles/5096/tr06-40b.pdf> (part b)

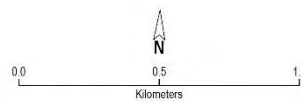


**Estuarine Vegetation - Seagrass - Manaia Harbour**

Year surveyed 1998 and 2008

Legend

-  Seagrass 1998
-  Seagrass 2008



Source: WRC GIS layer "Estuarine Vegetation and Harbours"

Aerial Imagery WRAPS 2012





# Te Kouma Harbour

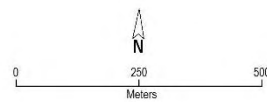


**Estuarine Vegetation - Seagrass - Te Kouma Harbour** Year surveyed 1998 and 2009

**Legend**

-  Seagrass 1998
-  Seagrass 2009

Source: WRC GIS layer "Estuarine Vegetation and Harbours"



Aerial Imagery WRAPS 2012



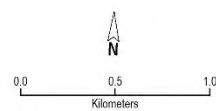


**Estuarine Vegetation - Seagrass - Coromandel Harbour** Year surveyed 1998 and 2009

Legend

	Seagrass 1998
	Seagrass 2009

Source: WRC GIS layer "Estuarine Vegetation and Harbours"



Aerial Imagery WRAPS 2012



# Colville Bay



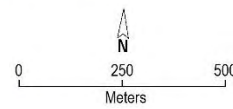
## Estuarine Vegetation - Seagrass - Colville Bay

Year surveyed 2012

Legend

 Seagrass/mixed vegetation 2012

Source: WRC GIS layer "Estuarine Vegetation and Harbours"



Aerial Imagery WRAPS 2012



## Waikawau estuary

In 2008 there was only one small seagrass bed in Waikawau estuary.

Graeme M. 2013/39. Estuarine vegetation survey: Waikawau Estuary. Waikato Regional Council Technical Report 2013/39 available at <http://www.waikatoregion.govt.nz/PageFiles/27668/TR201339.pdf>



# Kennedy Bay



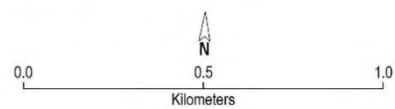
## Estuarine Vegetation - Seagrass - Kennedy Bay

Year surveyed 2012

**Legend**

-  Seagrass/mixed vegetation 2012
-  Seagrass 2012

Source: WRC GIS layer "Estuarine Vegetation and Harbours"



Aerial Imagery WRAPS 2012



# Whangapoua Harbour



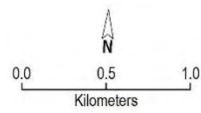
## Estuarine Vegetation - Seagrass - Whangapoua Harbour

Year surveyed 2010

### Legend

-  Seagrass/mixed vegetation 2010
-  Seagrass 2010

Source: WRC GIS layer "Estuarine Vegetation and Harbours"



Aerial Imagery WRAPS 2012



# Otama estuary



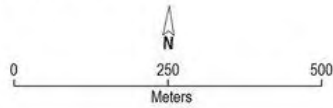
## Estuarine Vegetation - Seagrass - Otama Beach

Year surveyed 2010

### Legend

 Seagrass 2010

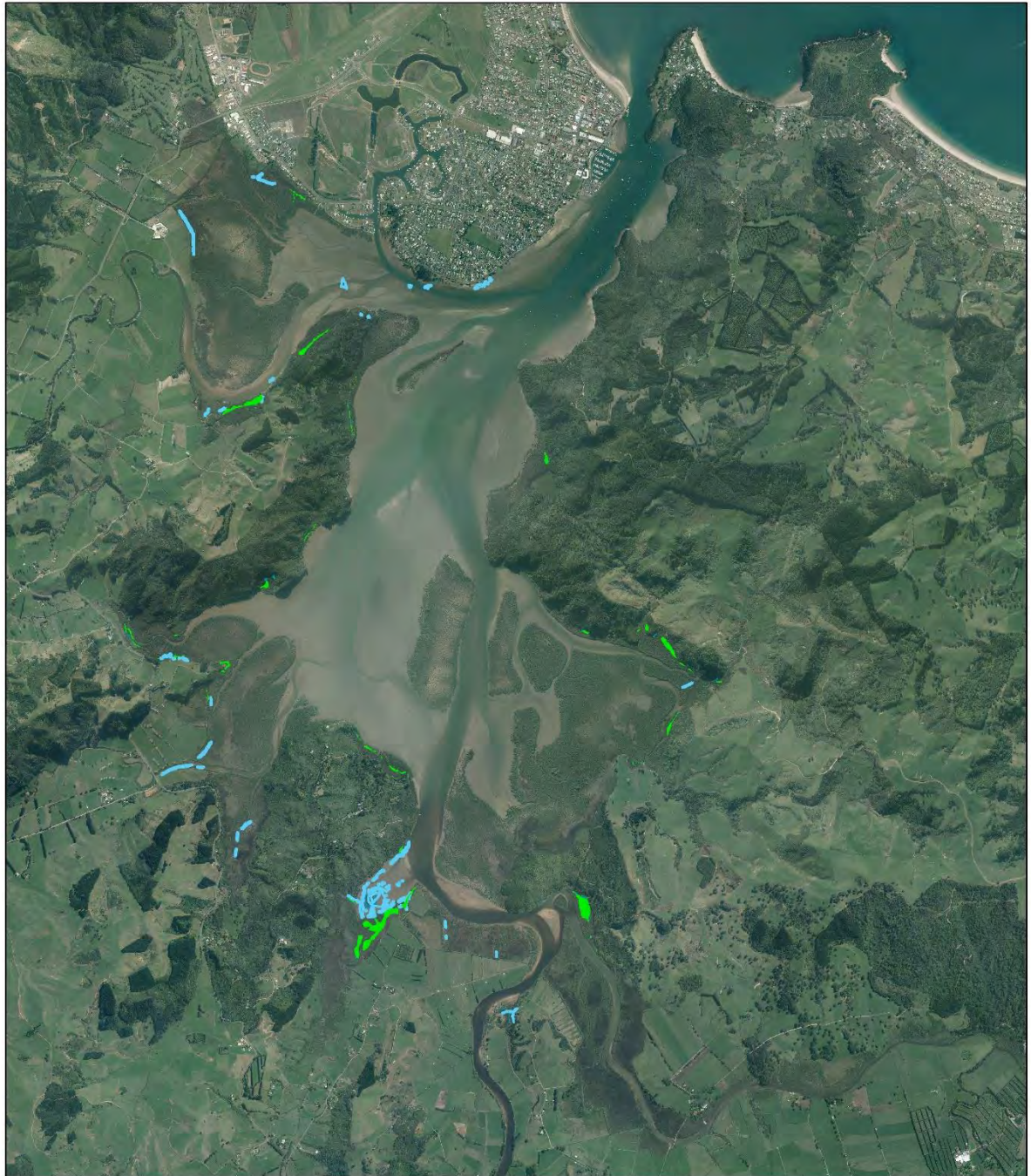
Source: WRC GIS layer "Estuarine Vegetation and Harbours"



Source: Aerial Imagery WRAPS 2012






# Whitianga Harbour



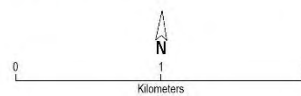
## Estuarine Vegetation - Seagrass - Whitianga Harbour

Year surveyed 1999 and 2009

Legend

-  Seagrass/mixed vegetation 2009
-  Seagrass 1999
-  Seagrass 2009

Source: WRC GIS layer "Estuarine Vegetation and Harbours"



Aerial Imagery WRAPS 2012



## Purangi estuary

In 2012 a few patches of seagrass were found under the tall mature mangrove canopy.

Graeme M. 2014/28. Estuarine vegetation survey - Purangi Estuary (November 2012). Waikato Regional Council Technical Report 2014/28 available at <http://www.waikatoregion.govt.nz/PageFiles/29323/TR201428.pdf>

Tairua Harbour



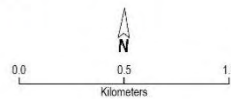
**Estuarine Vegetation - Seagrass - Tairua Harbour**

Year surveyed 1998 and 2008

Legend

- Seagrass/mixed vegetation 2008
- Seagrass 1998
- Seagrass 2008

Source: WRC GIS layer "Estuarine Vegetation and Harbours"






Aerial Imagery WRAPS 2012



# Whangamata Harbour




**Estuarine Vegetation - Seagrass - Whangamata Harbour** Year surveyed 1997 and 2007

Legend	
	Seagrass/mixed vegetation 2007
	Seagrass 1997
	Seagrass 2007

Source: WRC GIS layer "Estuarine Vegetation and Harbours"

N  
0.0      0.5      1.0  
Kilometers

Aerial Imagery WRAPS 2012



Otahu estuary



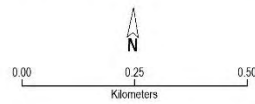
**Estuarine Vegetation - Seagrass - Otahu Estuary**

Year surveyed 1997 and 2007

**Legend**

- Seagrass/mixed vegetation 2007
- Seagrass 1997
- Seagrass 2007

Source: WRC GIS layer "Estuarine Vegetation and Harbours"



Aerial Imagery WRAPS 2012





# Wharekawa Harbour

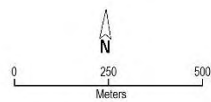


## Estuarine Vegetation - Seagrass - Wharekawa Harbour Year surveyed 1997 and 2008

Legend

- Seagrass/mixed vegetation 2008
- Seagrass 1997
- Seagrass 2008

Source: WRC GIS layer "Estuarine Vegetation and Harbours"



Aerial Imagery WRAPS 2012



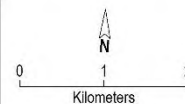
# Mangroves

## Kawhia Harbour



### Estuarine Vegetation - Mangroves - Kawhia Harbour

Year surveyed 2005 and 2012



Aerial Imagery WRAPS 2012

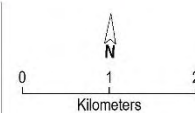


# Aotea Harbour



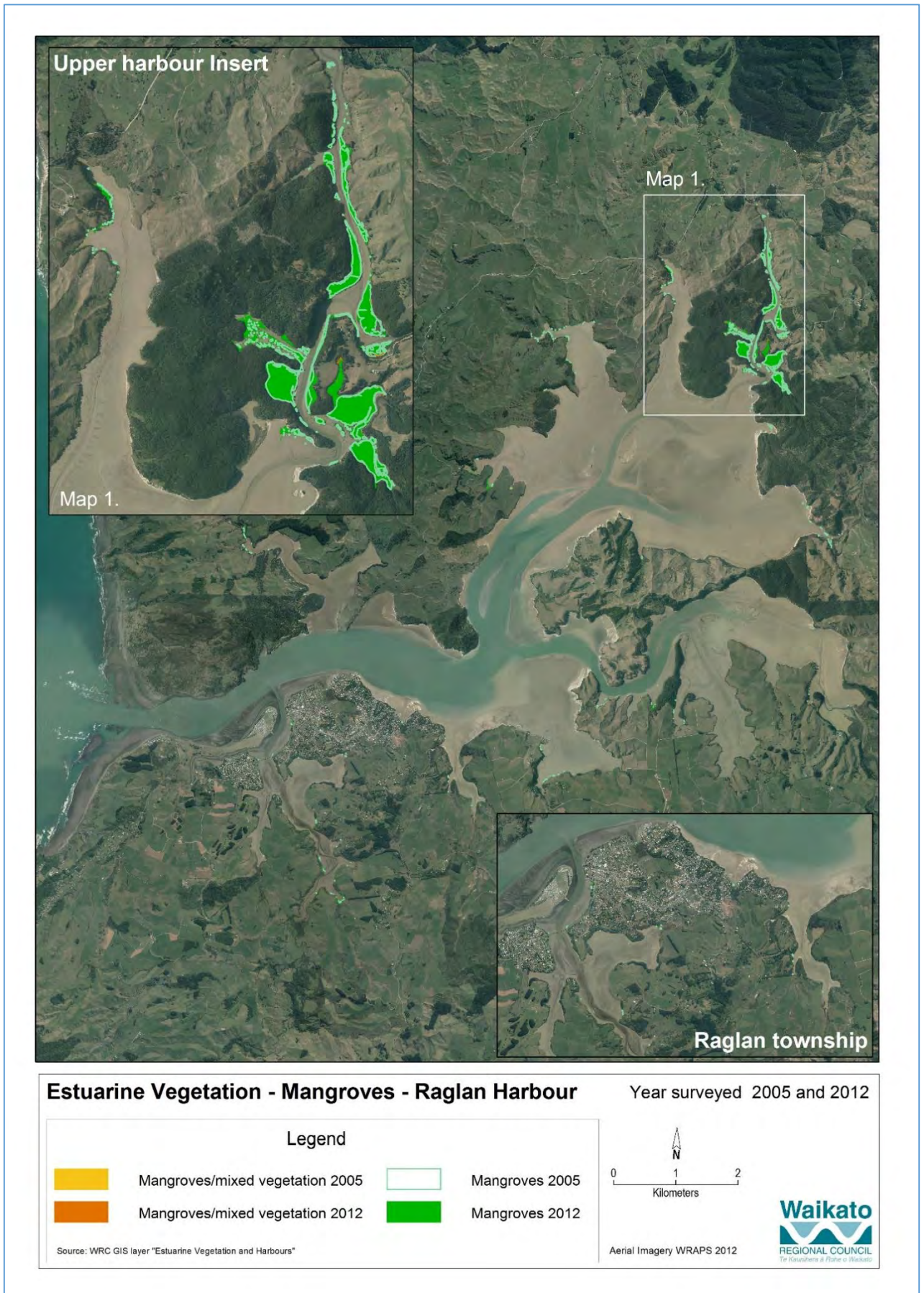
## Estuarine Vegetation - Mangroves - Aotea Harbour

Year surveyed 2005 and 2012



Aerial Imagery WRAPS 2012



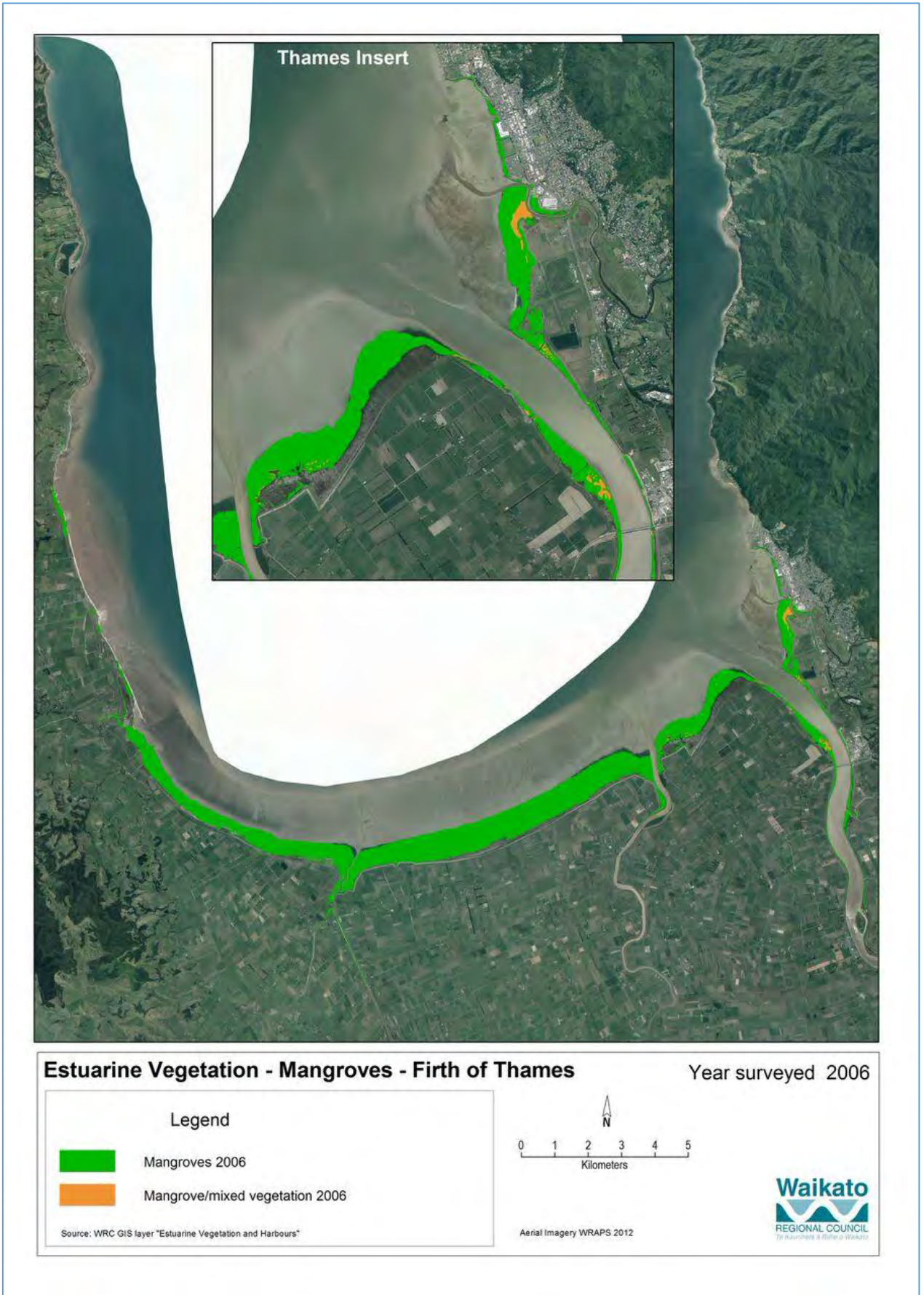


## Port Waikato

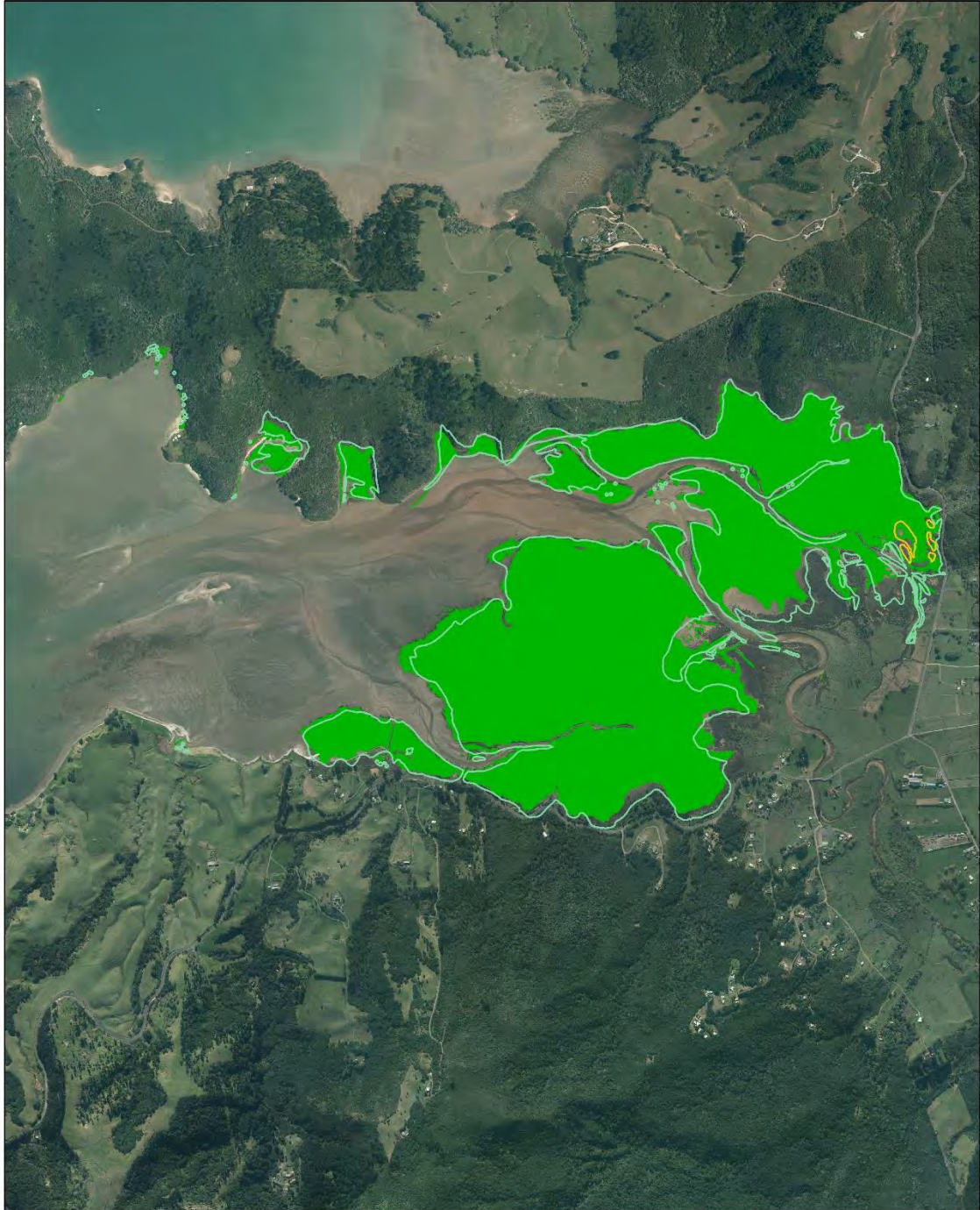
In 2011 one mangrove was found at Port Waikato.

Graeme M. 2014/25. Estuarine vegetation survey - Port Waikato (December 2011). Waikato Regional Council Technical Report 2014/25 available at <http://www.waikatoregion.govt.nz/PageFiles/29325/TR201425.pdf>

# Firth of Thames



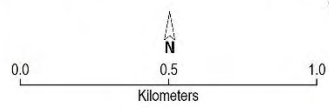
# Manaia Harbour



## Estuarine Vegetation - Mangroves - Manaia Harbour

Year surveyed 1998 and 2008

Legend	
	Mangroves/mixed vegetation 1998
	Mangroves/mixed vegetation 2009
	Mangroves 1998
	Mangroves 2008

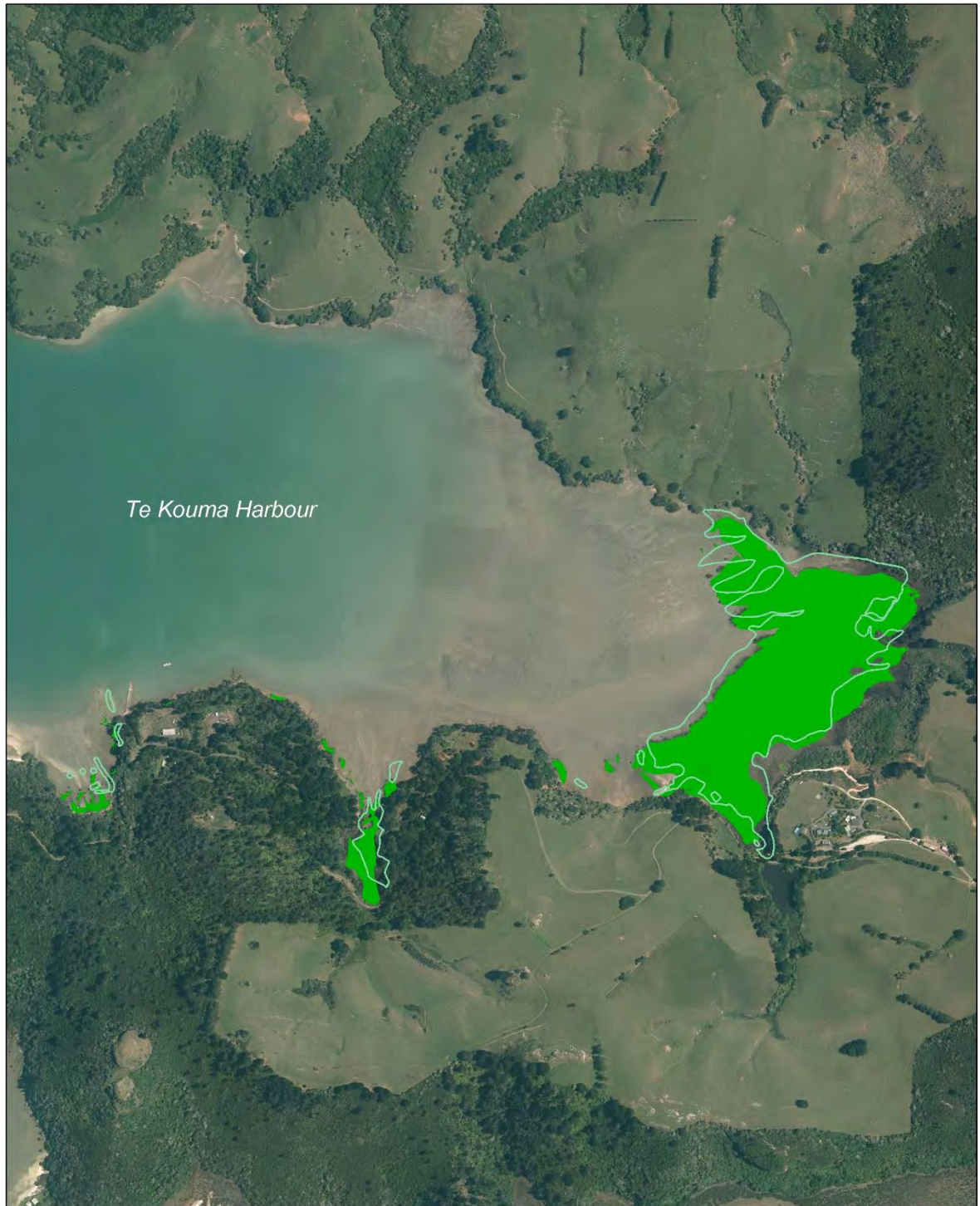


Source: WRC GIS layer "Estuarine Vegetation and Harbours"

Aerial Imagery WRAPS 2012



# Te Kouma Harbour



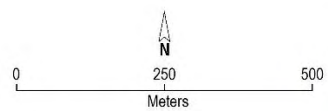
## Estuarine Vegetation - Mangroves - Te Kouma Harbour

Year surveyed 1998 and 2009

### Legend

-  Mangroves 1998
-  Mangroves 2009

Source: WRC GIS layer "Estuarine Vegetation and Harbours"

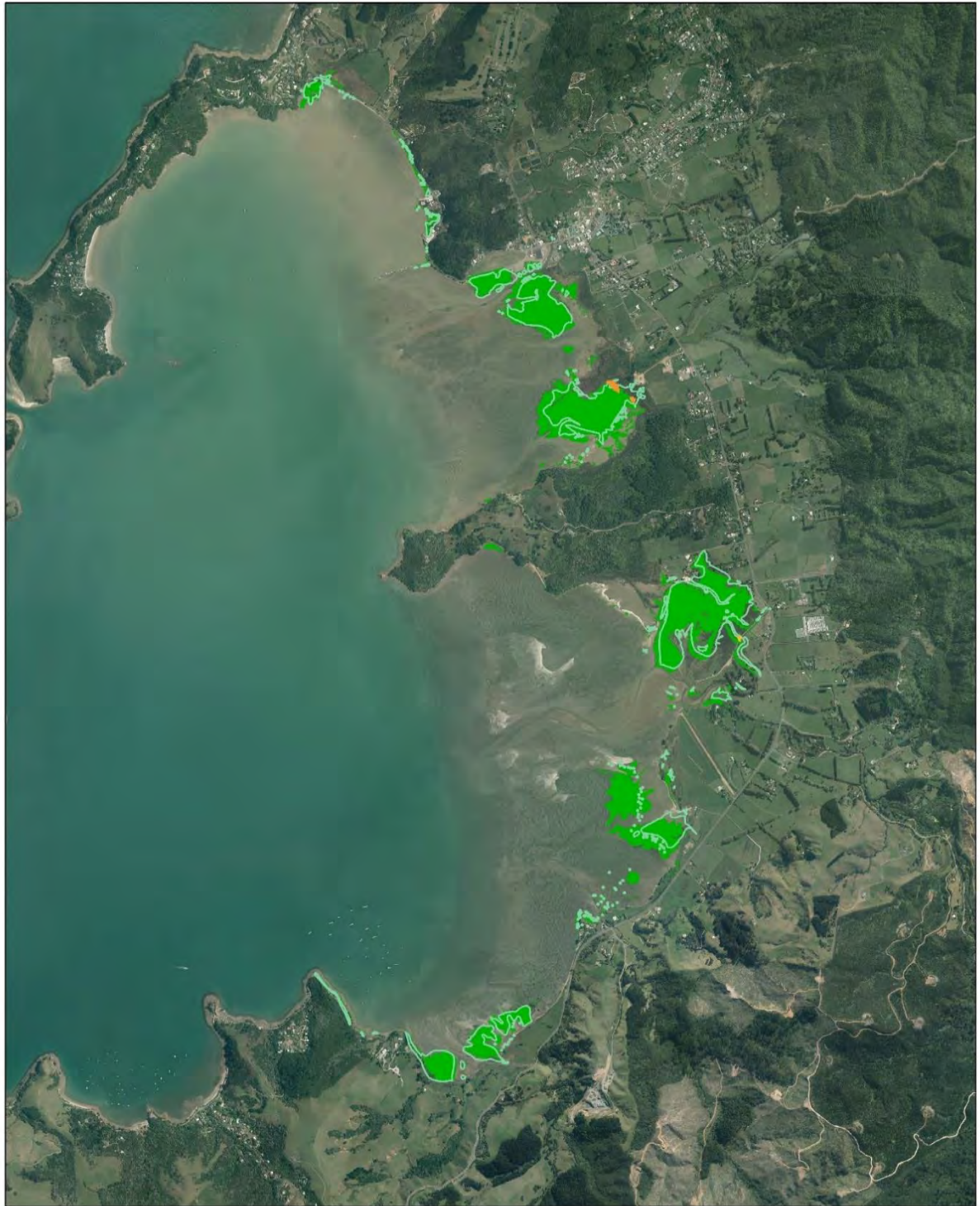


Aerial Imagery WRAPS 2012





# Coromandel Harbour



**Estuarine Vegetation - Mangroves - Coromandel Harbour** Year surveyed 1998 and 2009

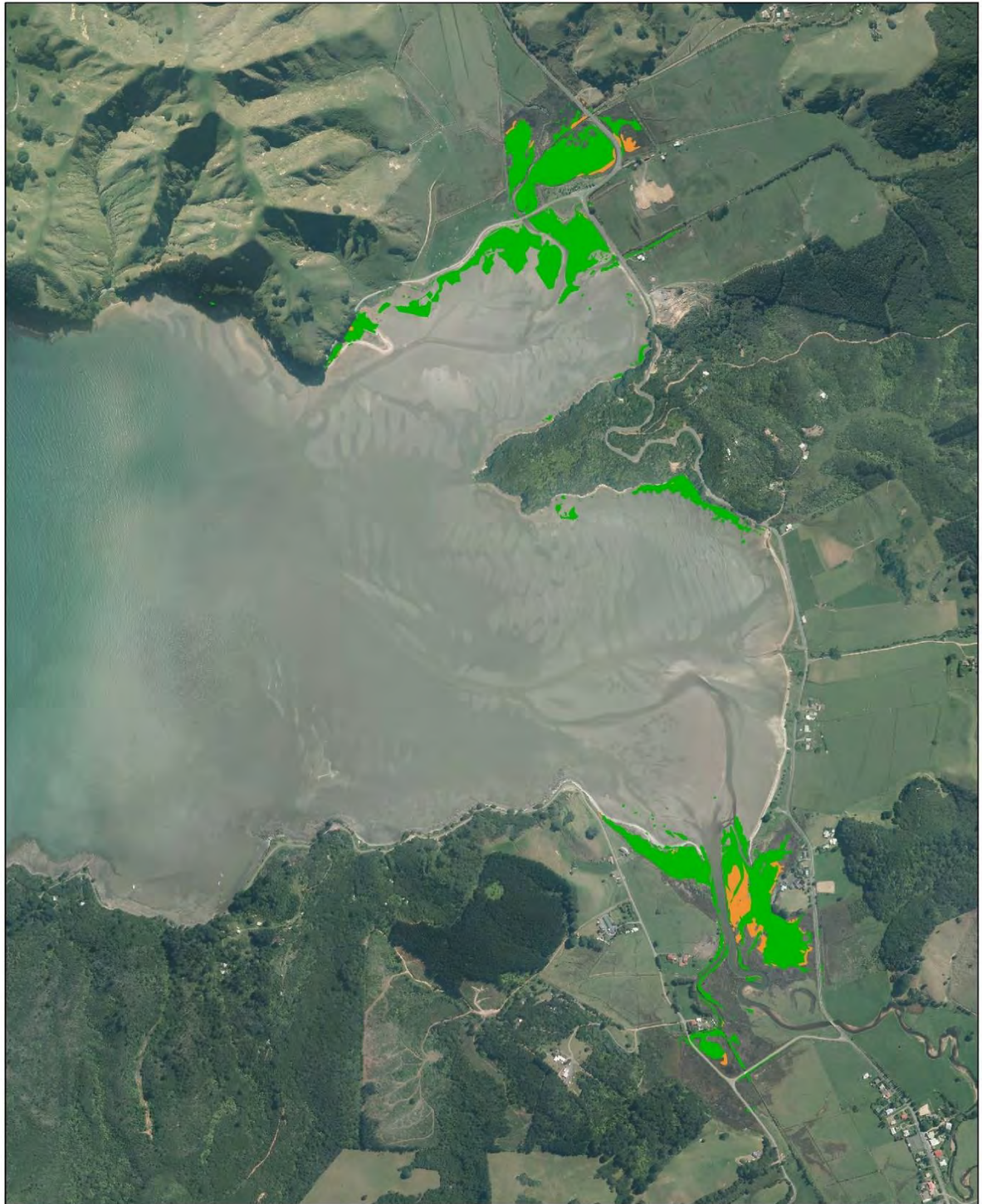
Legend

 Mangroves/mixed vegetation 1998	 Mangroves 1998
 Mangroves/mixed vegetation 2009	 Mangroves 2009

Source: WRC GIS layer "Estuarine Vegetation and Harbours"

  
0,0    0,5    1,0  
Kilometers

  
Aerial Imagery WRAPS 2012



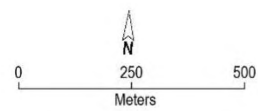
**Estuarine Vegetation - Mangroves - Colville Bay**

Year surveyed 2012

Legend

-  Mangroves/mixed vegetation 2012
-  Mangroves 2012

Source: WRC GIS layer "Estuarine Vegetation and Harbours"



Aerial Imagery WRAPS 2012



# Waikawau estuary



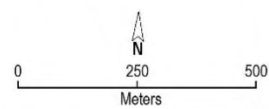
## Estuarine Vegetation - Mangroves - Waikawau Estuary

Year surveyed 2008

### Legend

-  Mangroves/mixed vegetation 2008
-  Mangroves 2008

Source: WRC GIS layer "Estuarine Vegetation and Harbours"



Aerial Imagery WRAPS 2012



# Kennedy Bay



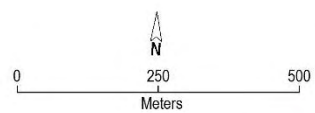
## Estuarine Vegetation - Mangroves - Kennedy Bay

Year surveyed 2012

### Legend

-  Mangroves/mixed vegetation 2012
-  Mangroves 2012

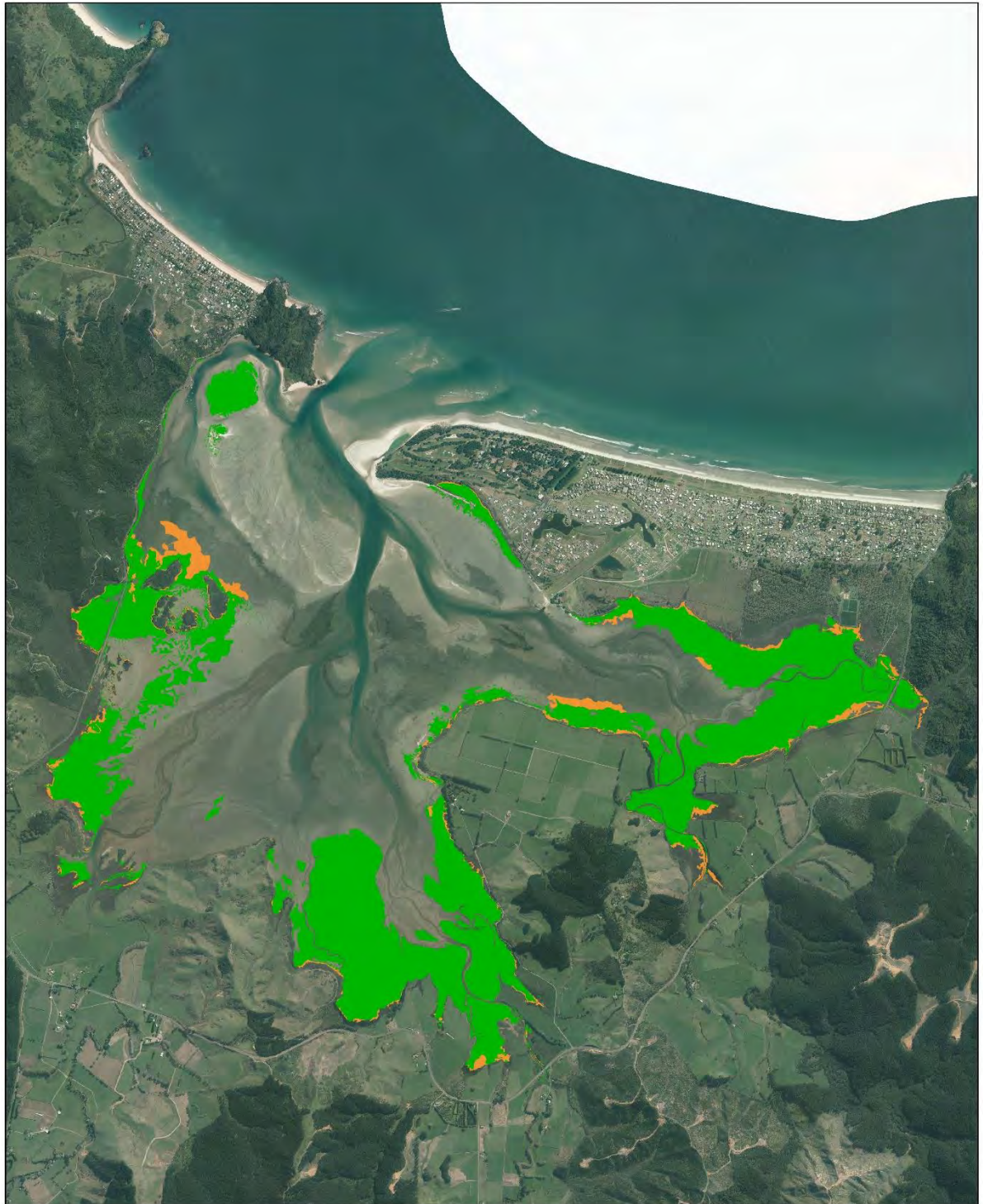
Source: WRC GIS layer "Estuarine Vegetation and Harbours"



Aerial Imagery WRAPS 2012




# Whangapoua Harbour



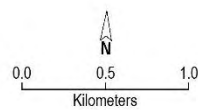
## Estuarine Vegetation - Mangroves - Whangapoua Harbour

Year surveyed 2010

### Legend

-  Mangroves/mixed vegetation 2010
-  Mangroves 2010

Source: WRC GIS layer "Estuarine Vegetation and Harbours"



Aerial Imagery WRAPS 2012



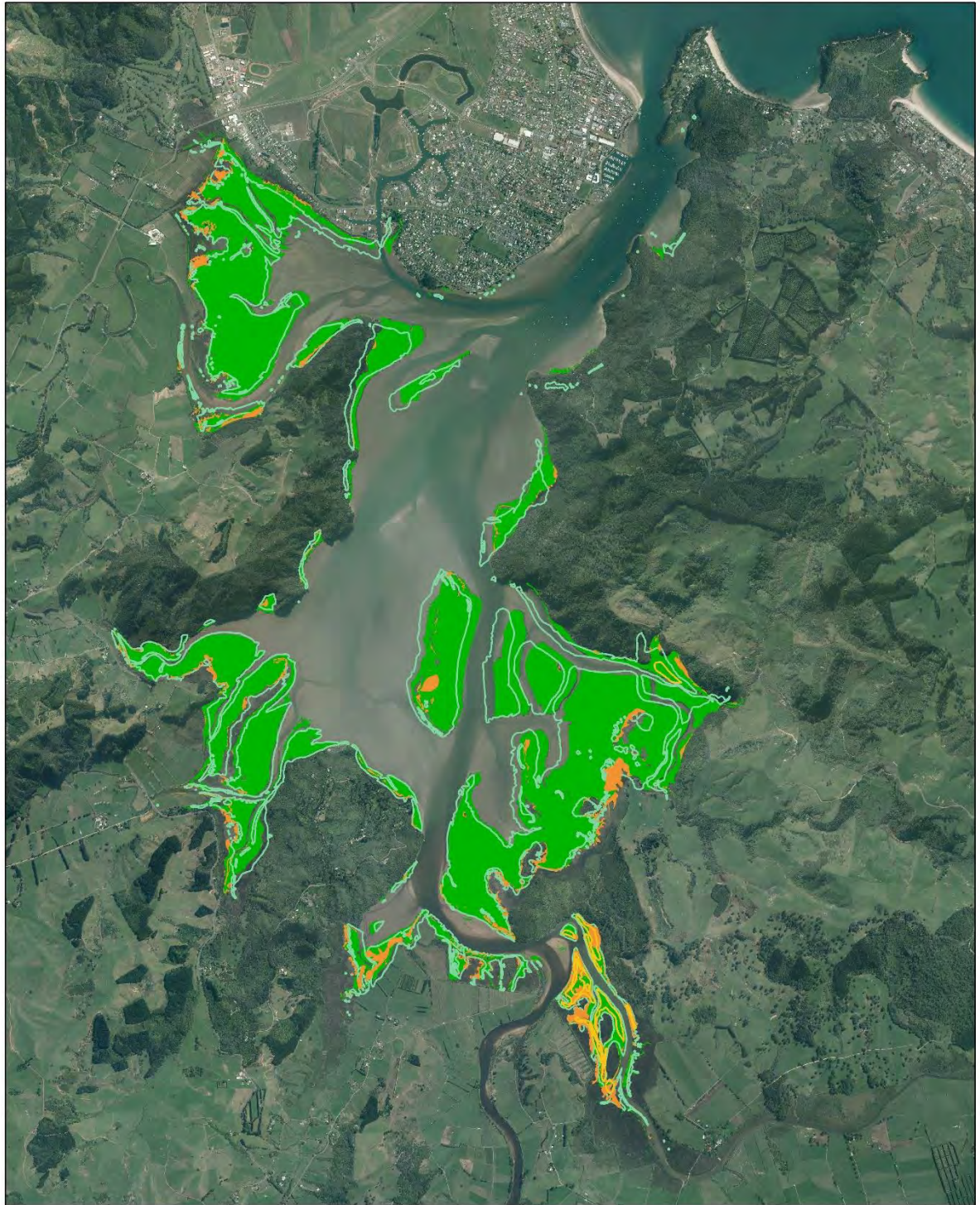
## Otama estuary

In 2010 only one juvenile mangrove was noted in the entire estuary.

Graeme M. 2010/29. Estuarine Vegetation Survey - Otama Estuary. Waikato Regional Council Technical Report 2010/29 available at

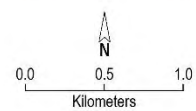
<http://www.waikatoregion.govt.nz/PageFiles/27613/TR201029.pdf>

# Whitianga Harbour



## Estuarine Vegetation - Mangroves - Whitianga Harbour

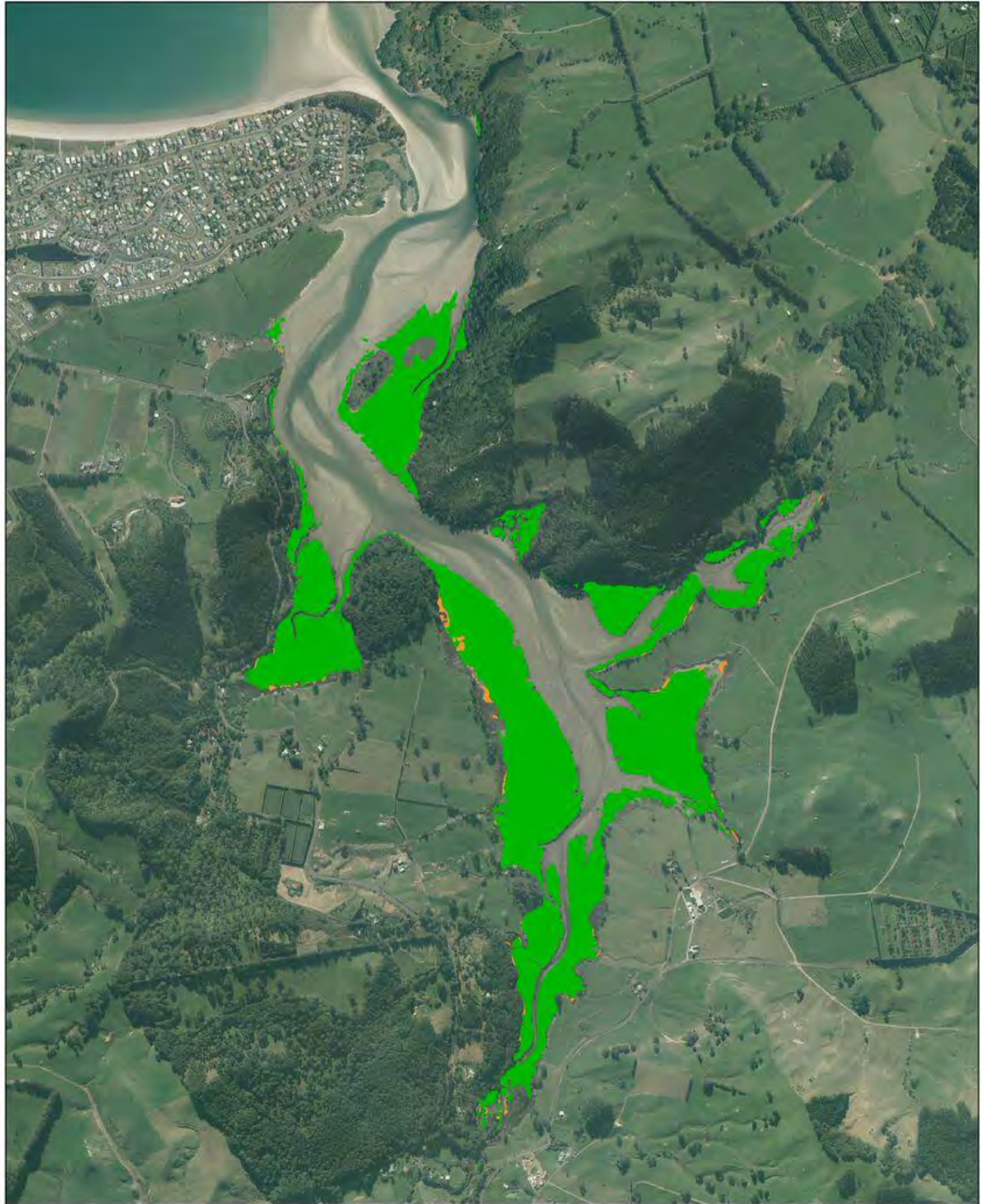
Year surveyed 1999 and 2009



Aerial Imagery WRAPS 2012



# Purangi estuary



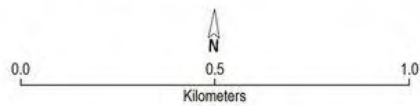
## Estuarine Vegetation - Mangroves - Purangi Estuary

Year surveyed 2012

Legend

-  Mangroves/mixed vegetation 2012
-  Mangroves 2012

Source: WRC GIS layer "Estuarine Vegetation and Harbours"



Aerial Imagery WRAPS 2012









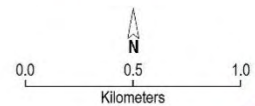


**Estuarine Vegetation - Mangroves - Tairua Harbour**

Year surveyed 1998 and 2008

Legend

- |   |                                 |   |                |
|---|---------------------------------|---|----------------|
|  | Mangroves/mixed vegetation 1998 |  | Mangroves 1998 |
|  | Mangroves/mixed vegetation 2008 |  | Mangroves 2008 |



Source: WRC GIS layer "Estuarine Vegetation and Harbours"

Aerial Imagery WRAPS 2012



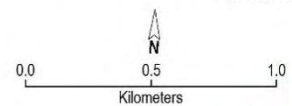
# Whangamata Harbour



## Estuarine Vegetation - Mangroves - Whangamata Harbour

Year surveyed 1997 and 2007

Legend			
	Mangroves/mixed vegetation 1997		Mangroves 1997
	Mangroves/mixed vegetation 2007		Mangroves 2007



Source: WRC GIS layer "Estuarine Vegetation and Harbours"

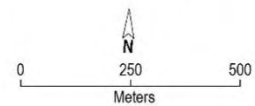
Aerial Imagery WRAPS 2012





### Estuarine Vegetation - Mangroves - Otahu Estuary

Year surveyed 1997 and 2007



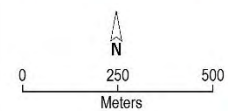
Aerial Imagery WRAPS 2012





**Estuarine Vegetation - Mangroves - Wharekawa Harbour**

Year surveyed 1997 and 2008

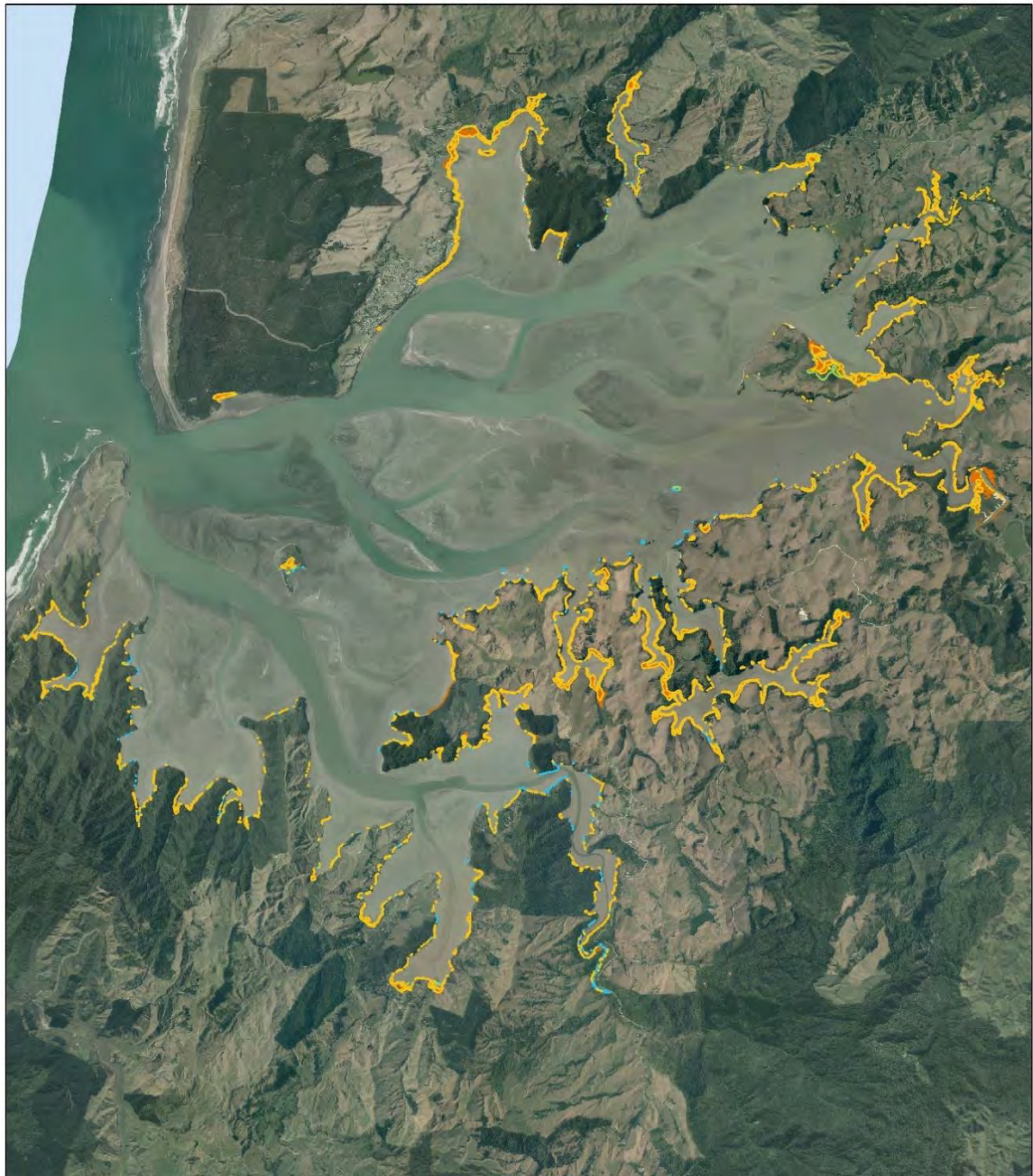


Aerial Imagery WRAPS 2012



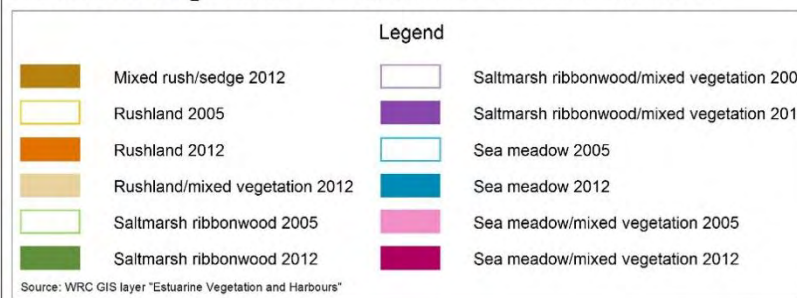
# Saltmarsh

## Kawhia Harbour

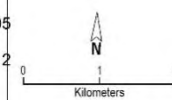


### Estuarine Vegetation - Saltmarsh - Kawhia Harbour

Year surveyed 2005 and 2012

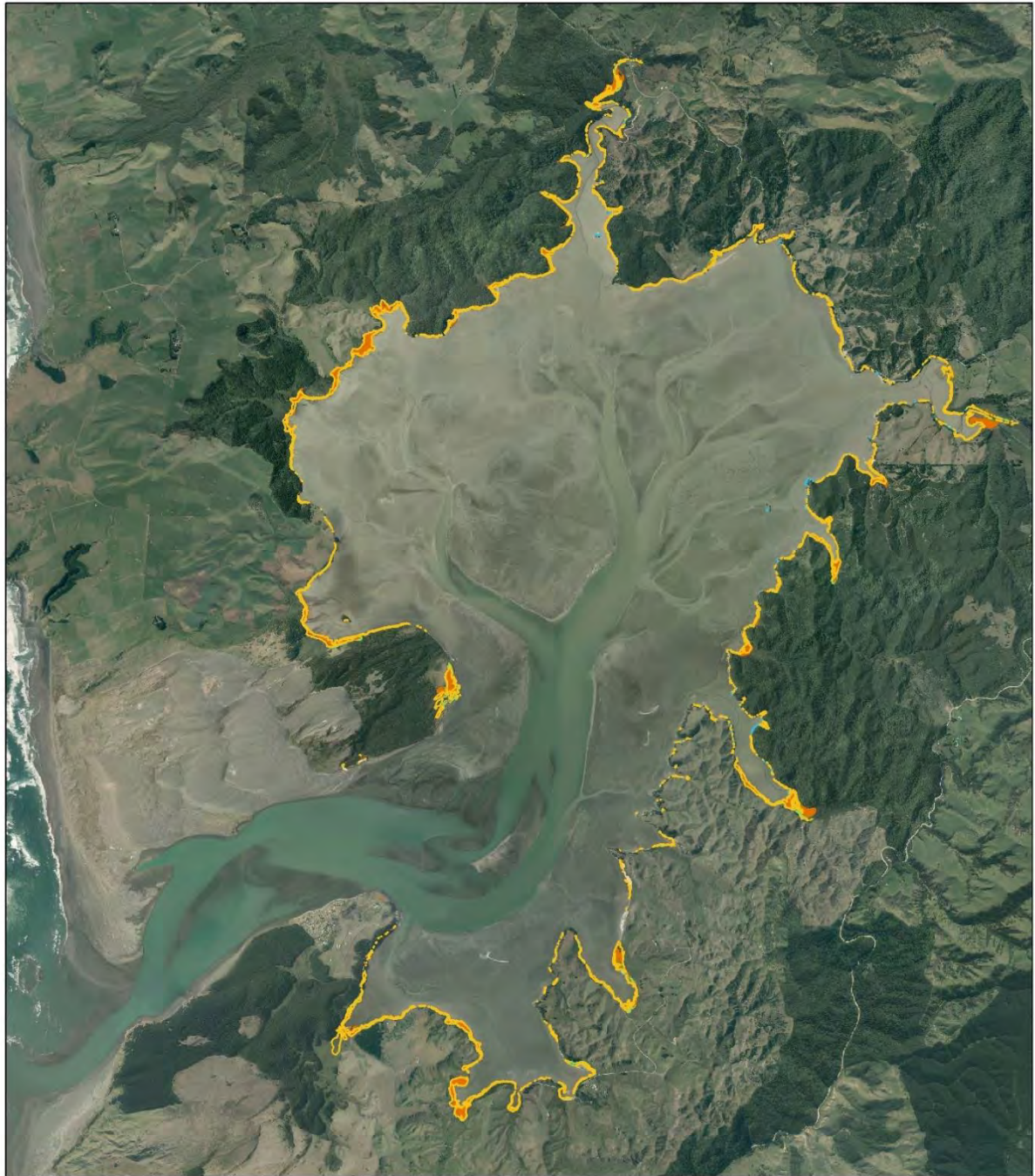


Source: WRC GIS layer "Estuarine Vegetation and Harbours"










Aerial Imagery WRAPS 2012



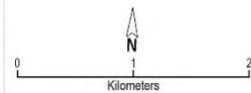


**Estuarine Vegetation - Saltmarsh - Aotea Harbour**

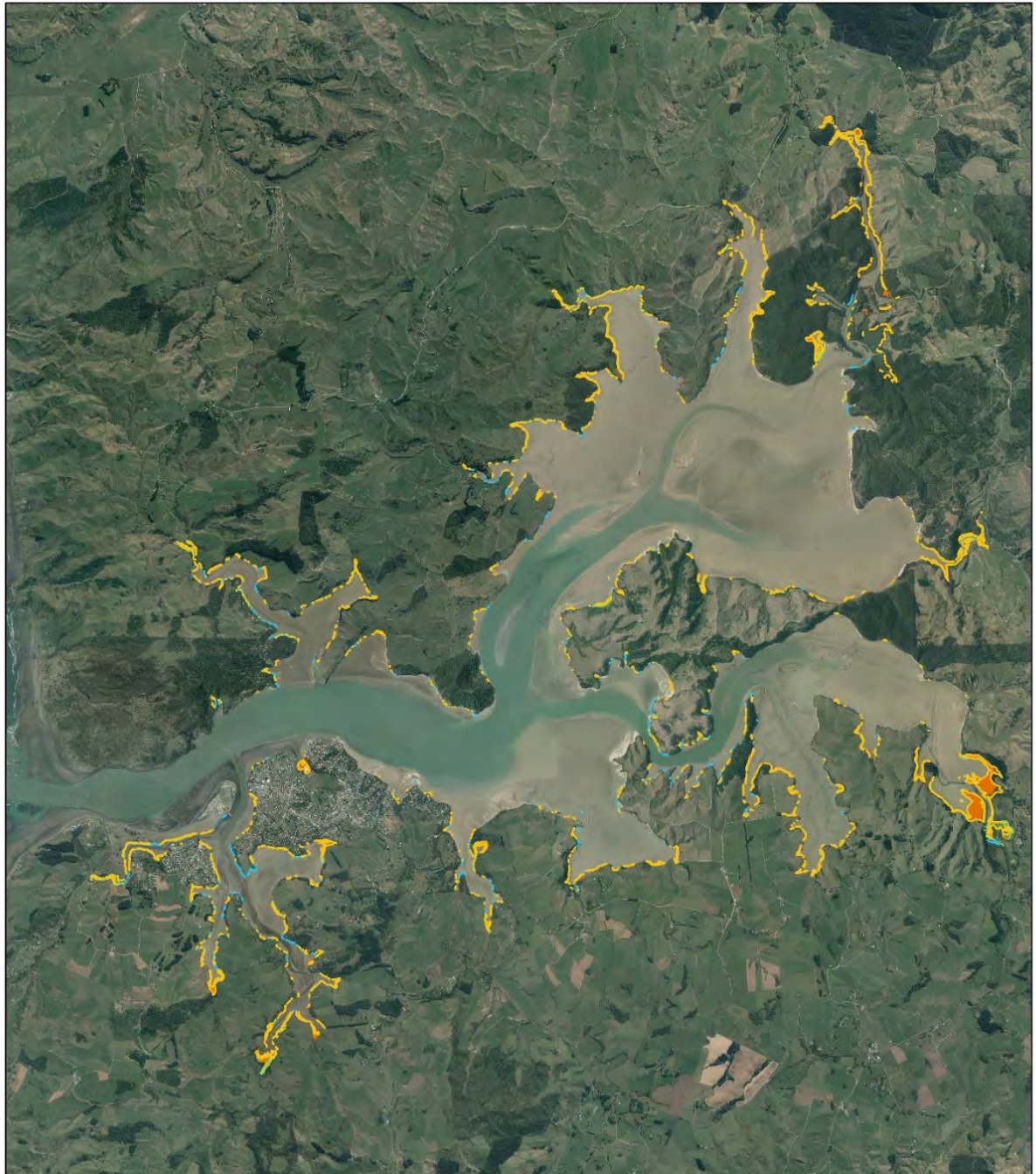
Year surveyed 2005 and 2012

Legend	
	Mixed rush/sedge 2012
	Rushland 2005
	Rushland 2012
	Rushland/mixed vegetation 2012
	Saltmarsh ribbonwood 2005
	Saltmarsh ribbonwood 2012
	Saltmarsh ribbonwood/mixed vegetation 2005
	Saltmarsh ribbonwood/mixed vegetation 2012
	Sea meadow 2005
	Sea meadow 2012
	Sea meadow/mixed vegetation 2005
	Sea meadow/mixed vegetation 2012

Source: WRC GIS layer "Estuarine Vegetation and Harbours"











Aerial Imagery WRAPS 2012

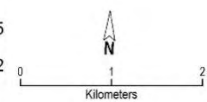


**Estuarine Vegetation - Saltmarsh - Raglan Harbour**

Year surveyed 2005 and 2012

Legend	
	Mixed rush/sedge 2012
	Rushland 2005
	Rushland 2012
	Rushland/mixed vegetation 2012
	Saltmarsh ribbonwood 2005
	Saltmarsh ribbonwood 2012
	Saltmarsh ribbonwood/mixed vegetation 2005
	Saltmarsh ribbonwood/mixed vegetation 2012
	Sea meadow 2005
	Sea meadow 2012
	Sea meadow/mixed vegetation 2005
	Sea meadow/mixed vegetation 2012

Source: WRC GIS layer "Estuarine Vegetation and Harbours"



Aerial Imagery WRAPS 2012

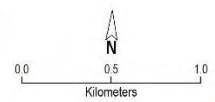


**Estuarine Vegetation - Saltmarsh - Port Waikato**

Year surveyed 2005 and 2012

Legend	
	Mixed rush/sedge 2012
	Rushland 2005
	Rushland 2012
	Rushland/mixed vegetation 2012
	Saltmarsh ribbonwood 2005
	Saltmarsh ribbonwood 2012
	Saltmarsh ribbonwood/mixed vegetation 2005
	Saltmarsh ribbonwood/mixed vegetation 2012
	Sea meadow 2005
	Sea meadow 2012
	Sea meadow/mixed vegetation 2005
	Sea meadow/mixed vegetation 2012

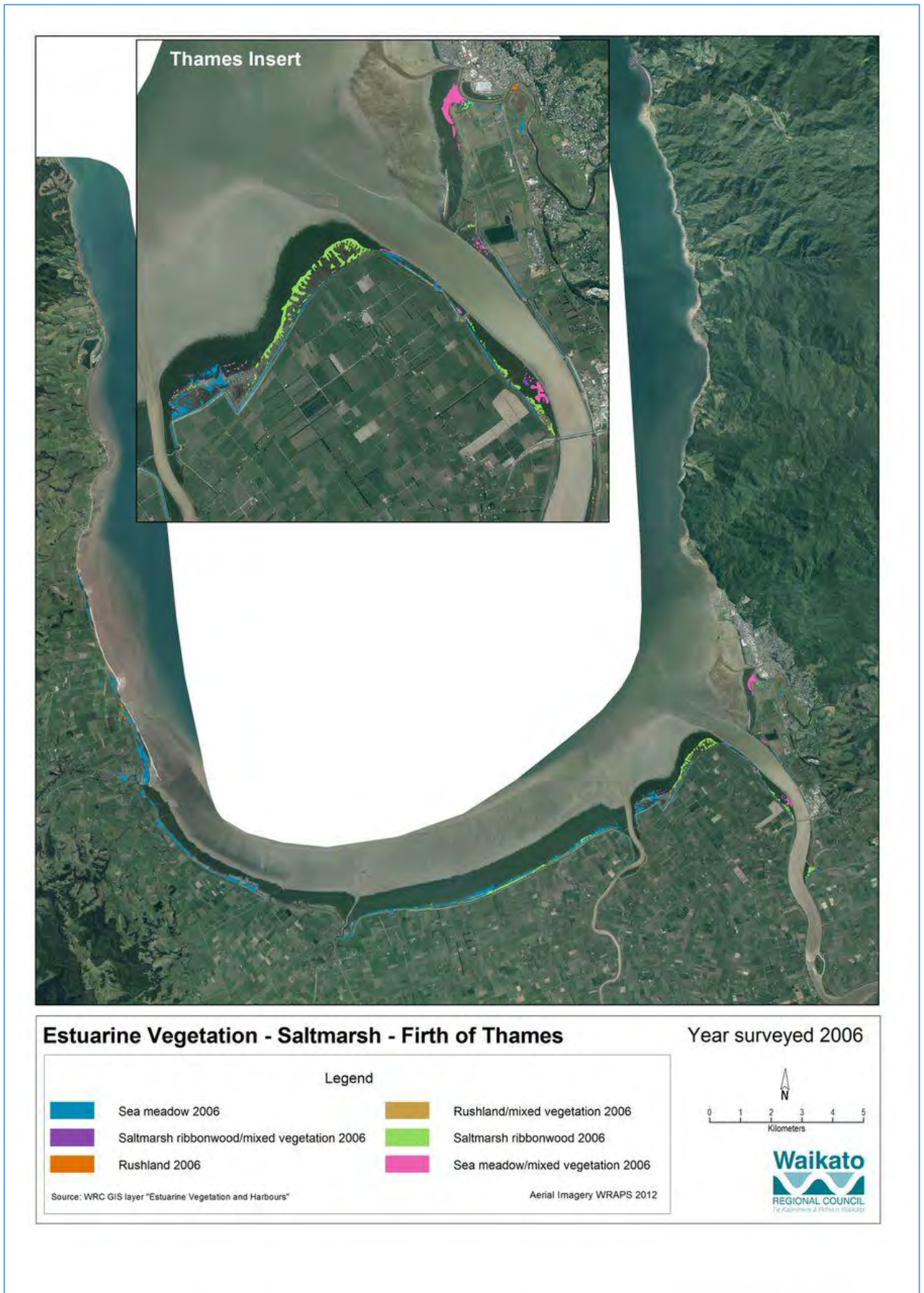
Source: WRC GIS layer "Estuarine Vegetation and Harbours"



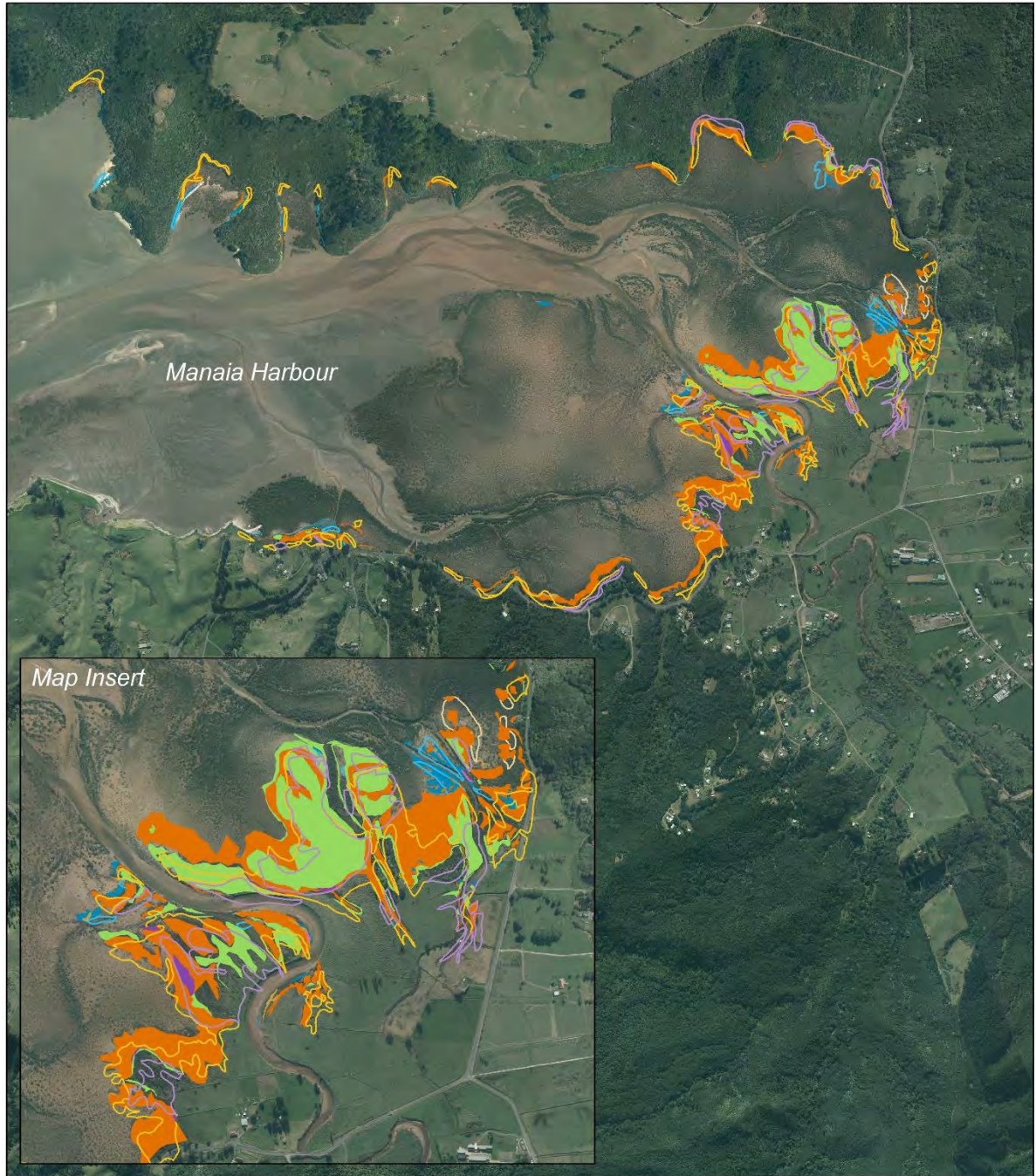
Aerial Imagery WRAPS 2012



# Firth of Thames



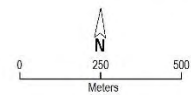
# Manaia Harbour



## Estuarine Vegetation - Saltmarsh - Manaia Harbour

Year surveyed 1998 and 2008

Legend	
	Saltmarsh ribbonwood/mixed vegetation 1998
	Saltmarsh ribbonwood/mixed vegetation 2008
	Rushland 1998
	Rushland 2008
	Rushland/mixed vegetation 1998
	Rushland/mixed vegetation 2008
	Saltmarsh ribbonwood 2008
	Sea meadow 1998
	Sea meadow 2008
	Sea meadow/mixed vegetation 2008



Source: WRC GIS layer "Estuarine Vegetation and Harbours"

Aerial Imagery WRAPS 2012

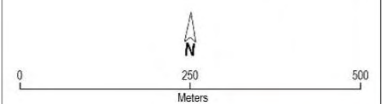
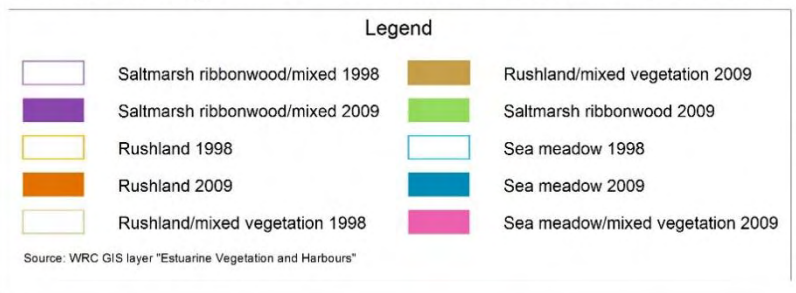


# Te Kouma Harbour



## Estuarine Vegetation - Saltmarsh - Te Kouma Harbour

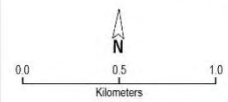
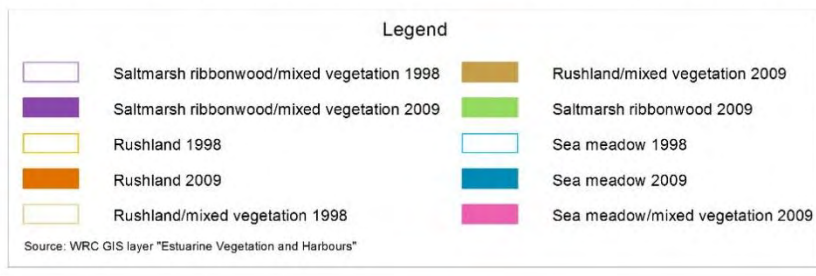
Year surveyed 1998 and 2009

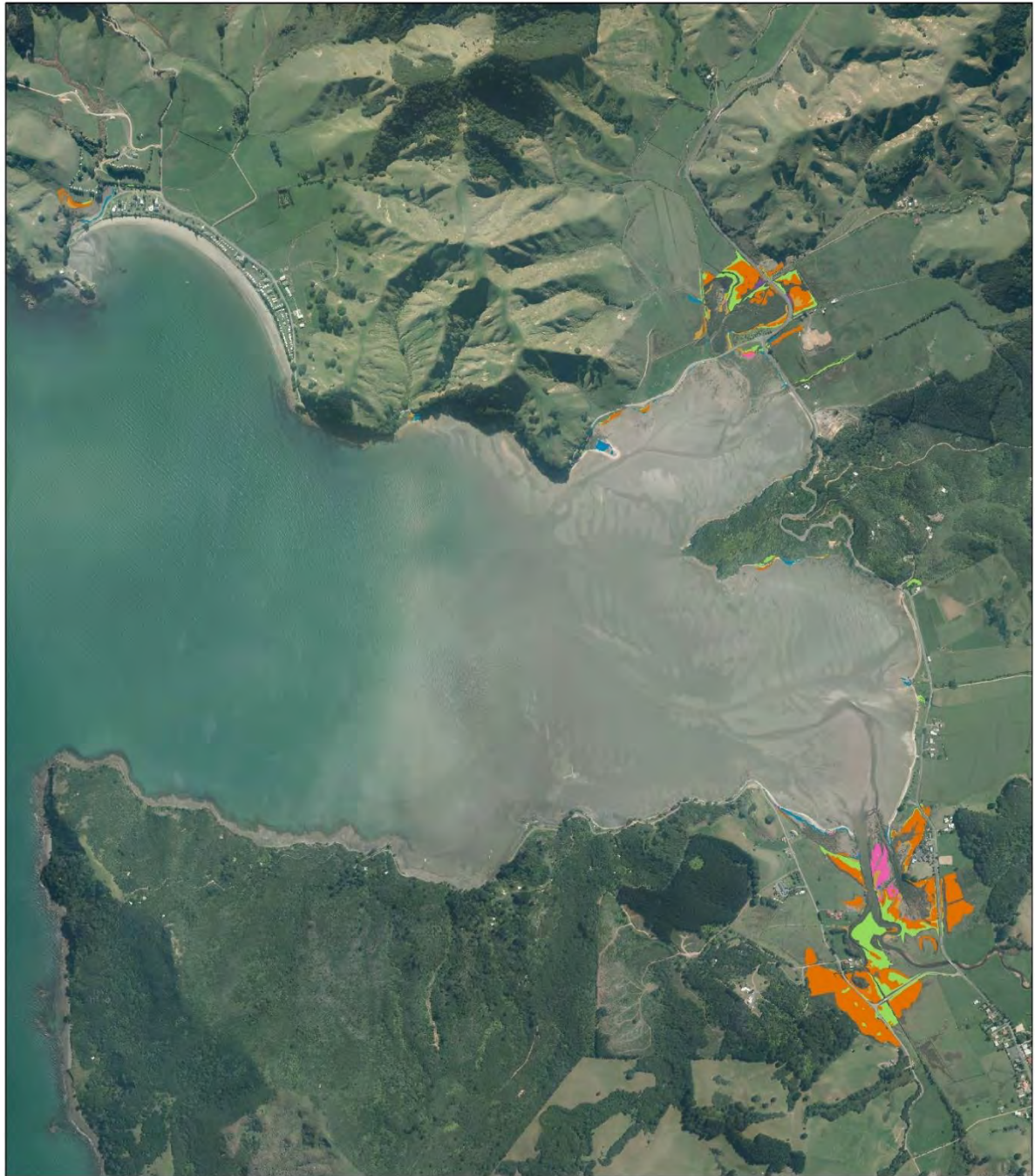




**Estuarine Vegetation - Saltmarsh - Coromandel Harbour**

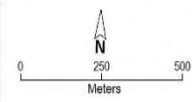
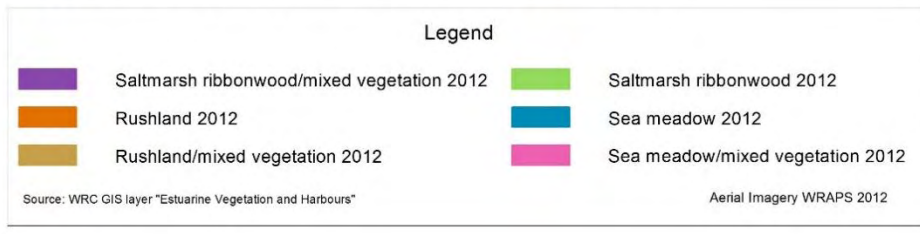
Year surveyed 1998 and 2009





**Estuarine Vegetation - Saltmarsh - Colville Bay**

Year surveyed 2012



Waikawau estuary



**Estuarine Vegetation - Saltmarsh - Waikawau Bay**







Year surveyed 2008



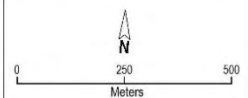


**Estuarine Vegetation - Saltmarsh - Kennedy Bay**

Year surveyed 2012

Legend			
	Saltmarsh ribbonwood/mixed vegetation 2012		Saltmarsh ribbonwood 2012
	Rushland 2012		Sea meadow 2012
	Rushland/mixed vegetation 2012		Sea meadow/mixed vegetation 2012

Source: WRC GIS layer "Estuarine Vegetation and Harbours" Aerial Imagery WRAPS 2012

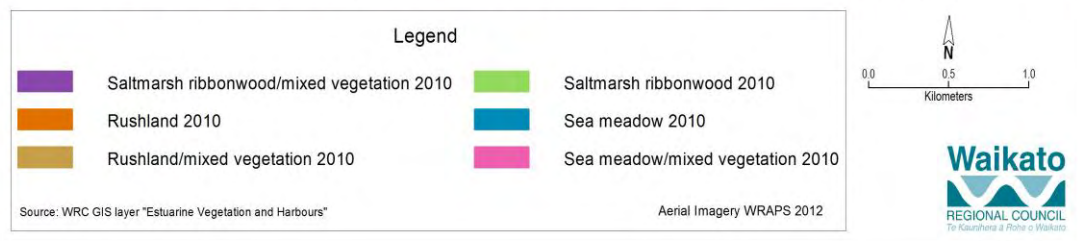


# Whangapoua Harbour



## Estuarine Vegetation - Saltmarsh - Whangapoua Harbour

Year surveyed 2010



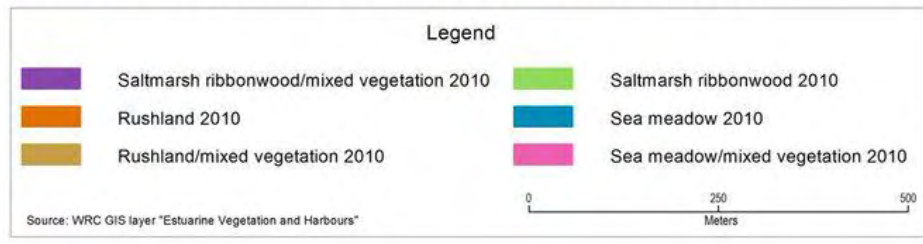


# Otama estuary

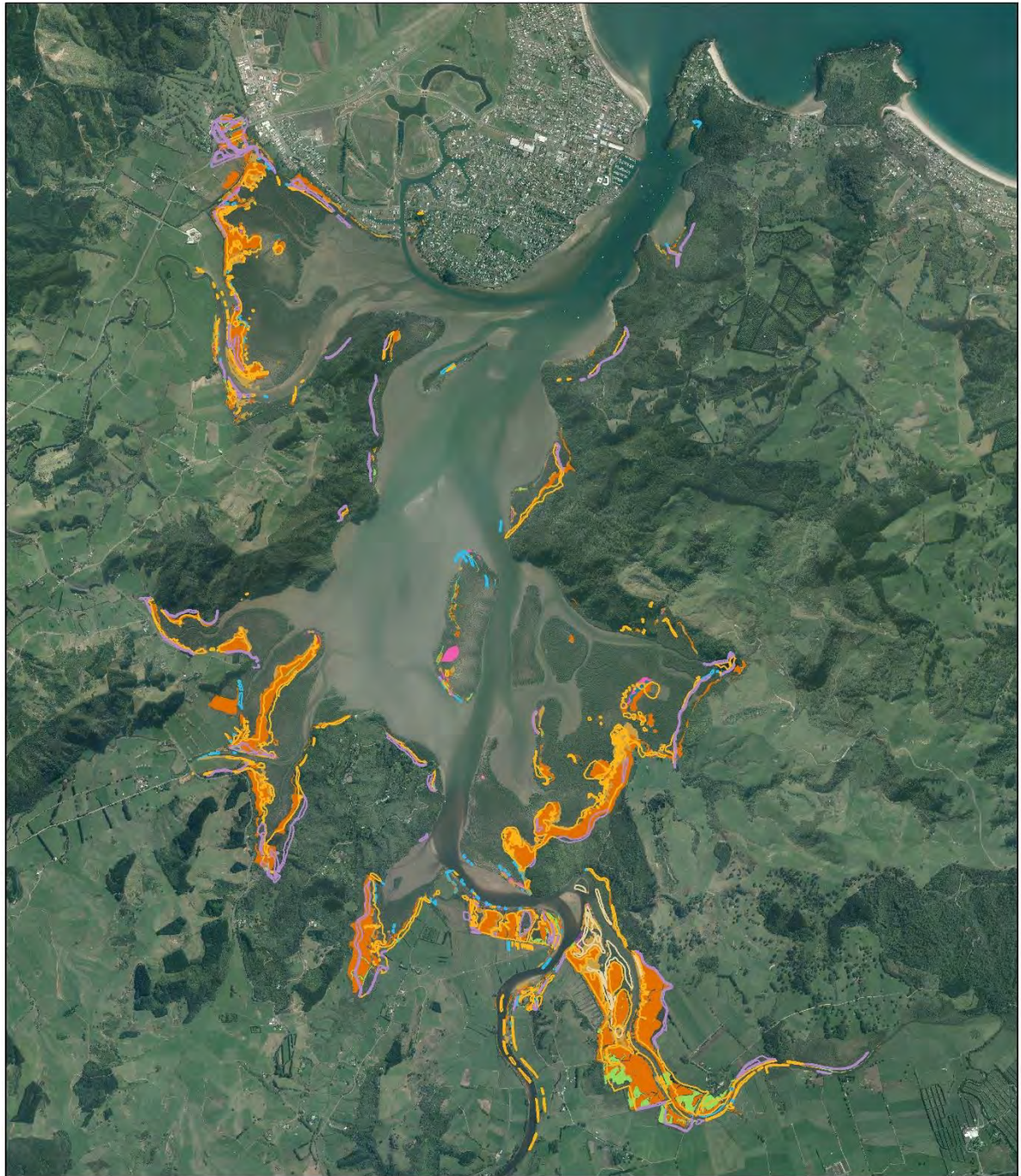


## Estuarine Vegetation - Saltmarsh - Otama Beach

Year surveyed 2010













# Whitianga Harbour



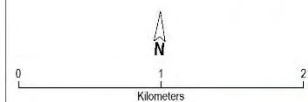
## Estuarine Vegetation - Saltmarsh - Whitianga Harbour

Year surveyed 1999 and 2009

### Legend

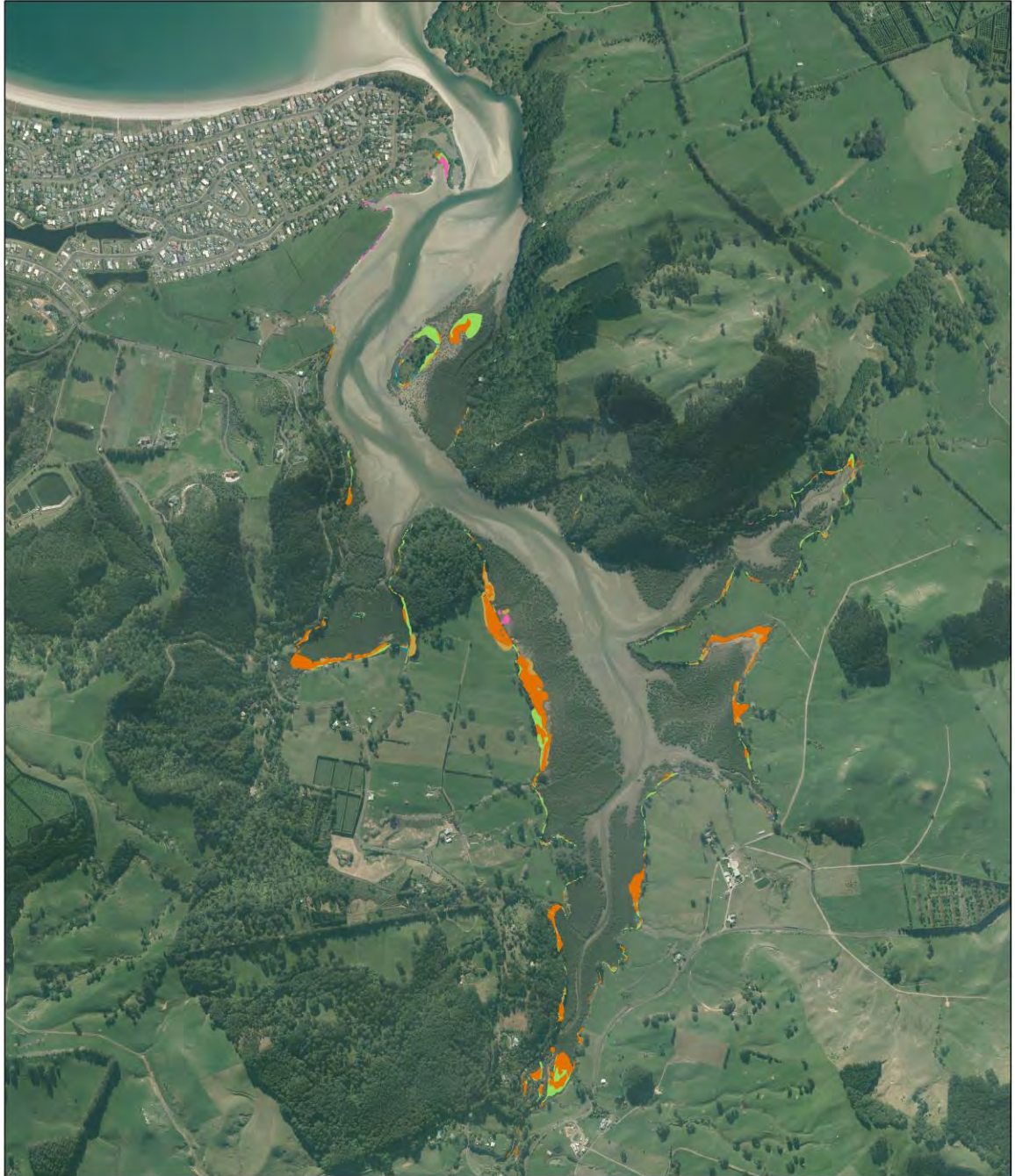
	Saltmarsh ribbonwood/mixed vegetation 1999		Rushland/mixed vegetation 2009
	Saltmarsh ribbonwood/mixed vegetation 2009		Saltmarsh ribbonwood 2009
	Rushland 1999		Sea meadow 1999
	Rushland 2009		Sea meadow 2009
	Rushland/mixed vegetation 1999		Sea meadow/mixed vegetation 2009

Source: WRC GIS layer "Estuarine Vegetation and Harbours"



Aerial Imagery WRAPS 2012

# Purangi estuary



## Estuarine Vegetation - Saltmarsh - Purangi Estuary

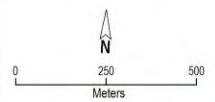
Year surveyed 2012

### Legend

- |  |  |
|--|--|
|  Saltmarsh ribbonwood/mixed vegetation 2012 |  Saltmarsh ribbonwood 2012        |
|  Rushland 2012                              |  Sea meadow 2012                  |
|  Rushland/mixed vegetation 2012             |  Sea meadow/mixed vegetation 2012 |

Source: WRC GIS layer "Estuarine Vegetation and Harbours"

Aerial Imagery WRAPS 2012















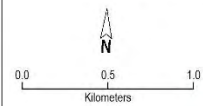
**Estuarine Vegetation - Saltmarsh - Tairua Harbour**

Year surveyed 1998 and 2008

Legend

	Saltmarsh ribbonwood/mixed vegetation 1998		Rushland/mixed vegetation 2008
	Saltmarsh ribbonwood/mixed vegetation 2008		Saltmarsh ribbonwood 2008
	Rushland 1998		Sea meadow 1998
	Rushland 2008		Sea meadow 2008
	Rushland/mixed vegetation 1998		Sea meadow/mixed vegetation 2008

Source: WRC GIS layer "Estuarine Vegetation and Harbours"



Aerial Imagery WRAPS 2012











# Whangamata Harbour



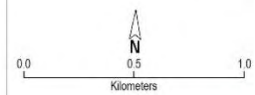
## Estuarine Vegetation - Saltmarsh - Whangamata Harbour

Year surveyed 1997 and 2007

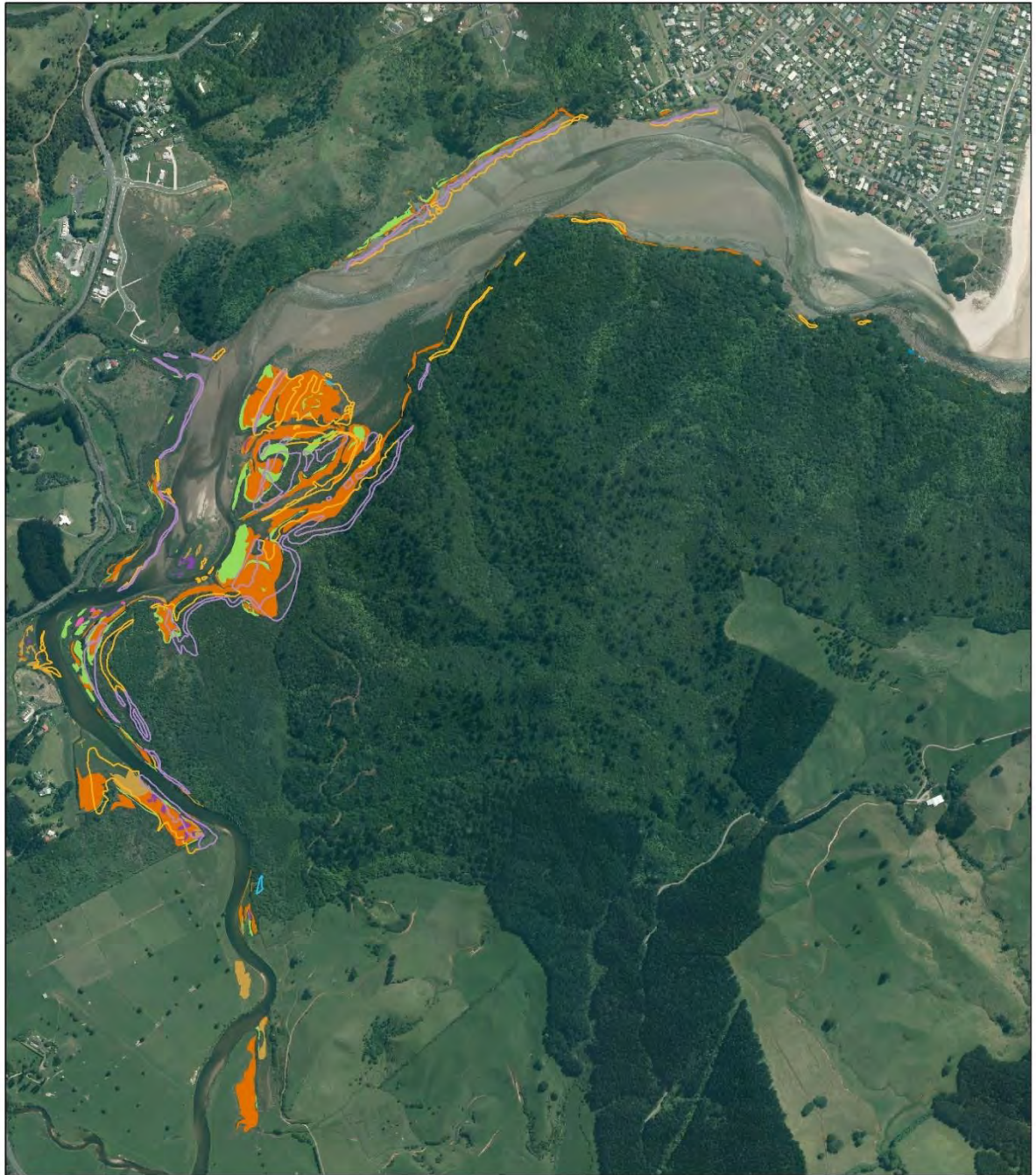
### Legend

	Saltmarsh ribbonwood/mixed vegetation 1997		Rushland/mixed vegetation 2007
	Saltmarsh ribbonwood/mixed vegetation 2007		Saltmarsh ribbonwood 2007
	Rushland 1997		Sea meadow 1997
	Rushland 2007		Sea meadow 2007
	Rushland/mixed vegetation 1997		Sea meadow/mixed vegetation 2007

Source: WRC GIS layer "Estuarine Vegetation and Harbours"













Aerial Imagery WRAPS 2012



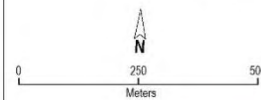
**Estuarine Vegetation - Saltmarsh - Otahu Estuary**

Year surveyed 1997 and 2007

Legend

- |   |  |   |                                  |
|---|--|---|----------------------------------|
|  | Saltmarsh ribbonwood/mixed vegetation 1997 |  | Rushland/mixed vegetation 2007   |
|  | Saltmarsh ribbonwood/mixed vegetation 2007 |  | Saltmarsh ribbonwood 2007        |
|  | Rushland 1997                              |  | Sea meadow 1997                  |
|  | Rushland 2007                              |  | Sea meadow 2007                  |
|  | Rushland/mixed vegetation 1997             |  | Sea meadow/mixed vegetation 2007 |

Source: WRC GIS layer "Estuarine Vegetation and Harbours"













Aerial Imagery WRAPS 2012



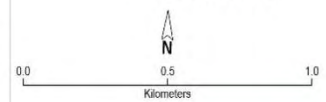
**Estuarine Vegetation - Saltmarsh - Wharekawa Harbour**

Year surveyed 1997 and 2008

Legend

	Saltmarsh ribbonwood/mixed vegetation 1997		Rushland/mixed vegetation 2008
	Saltmarsh ribbonwood/mixed vegetation 2008		Saltmarsh ribbonwood 2008
	Rushland 1997		Sea meadow 1997
	Rushland 2008		Sea meadow 2008
	Rushland/mixed vegetation 1997		Sea meadow/mixed vegetation 2008

Source: WRC GIS layer "Estuarine Vegetation and Harbours"



Aerial Imagery WRAPS 2012

# Estuarine weeds

## Kawhia Harbour

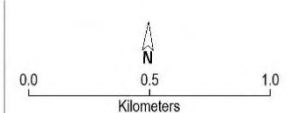


### Estuarine Vegetation - Weeds - Kawhia Harbour

Year surveyed 2005 and 2012



Source: WRC GIS layer "Estuarine Vegetation and Harbours"



Aerial Imagery WRAPS 2012



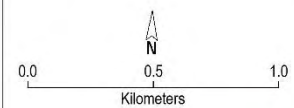
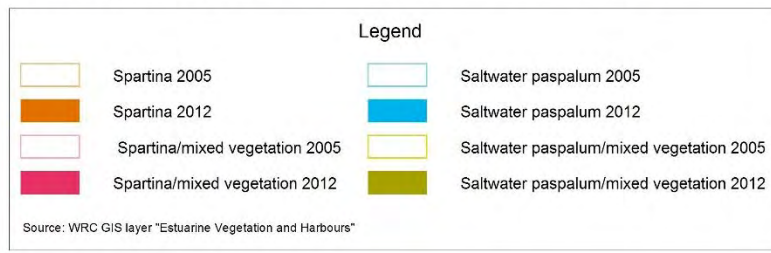


# Aotea Harbour



## Estuarine Vegetation - Weeds - Aotea Harbour

Year surveyed 2005 and 2012



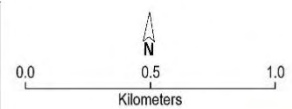
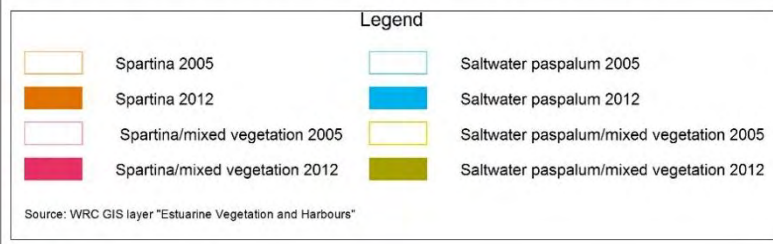
Aerial Imagery WRAPS 2012





**Estuarine Vegetation - Weeds - Raglan Harbour**

Year surveyed 2005 and 2012



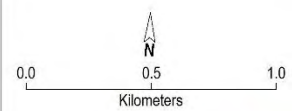
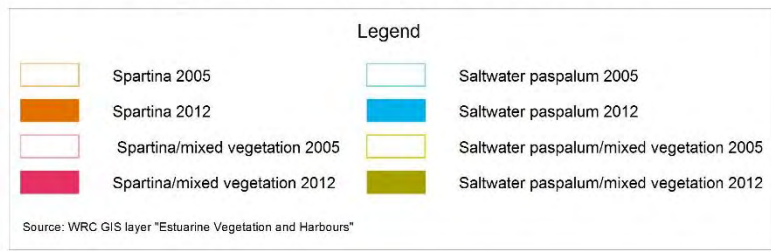
Aerial Imagery WRAPS 2012





**Estuarine Vegetation - Weeds - Port Waikato**

Year surveyed 2005 and 2012



Aerial Imagery WRAPS 2012



# Firth of Thames

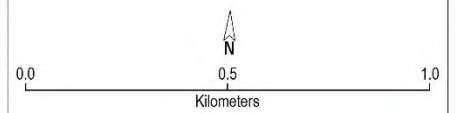
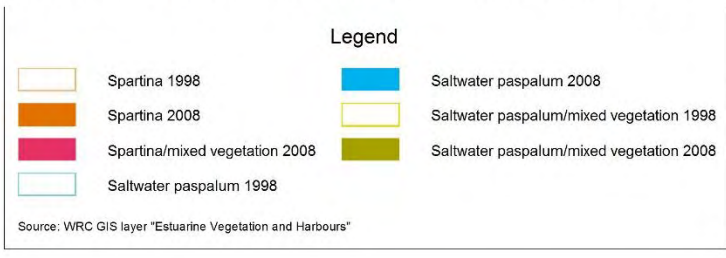


# Manaia Harbour



## Estuarine Vegetation - Weeds - Manaia Harbour

Year surveyed 1998 and 2008



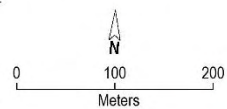
Aerial Imagery WRAPS 2012





**Estuarine Vegetation - Weeds - Te Kouma Harbour**

Year surveyed 1998 and 2009

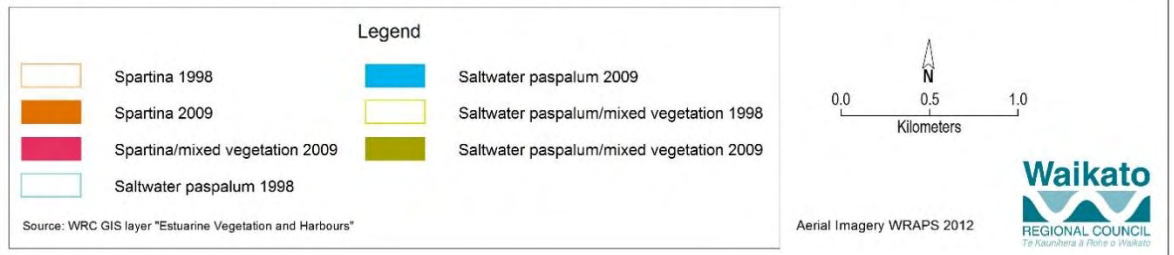


Aerial Imagery WRAPS 2012

# Coromandel Harbour



**Estuarine Vegetation - Weeds - Coromandel Harbour** Year surveyed 1998 and 2009







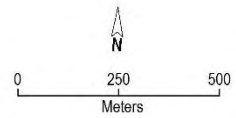
**Estuarine Vegetation - Weeds - Colville Bay**

Year surveyed 2012

Legend

-  Saltwater paspalum 2012
-  Saltwater paspalum/mixed vegetation 2012

Source: WRC GIS layer "Estuarine Vegetation and Harbours"



Aerial Imagery WRAPS 2012





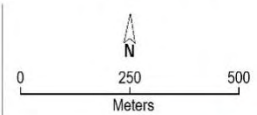
# Waikawau estuary



## Estuarine Vegetation - Weeds - Waikawau Bay

Year surveyed 2008

Legend			
	Spartina 2008		Saltwater paspalum 2008
	Spartina/mixed vegetation 2008		Saltwater paspalum/mixed vegetation 2008



Source: WRC GIS layer "Estuarine Vegetation and Harbours"

Aerial Imagery WRAPS 2012



# Kennedy Bay



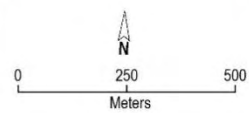
## Estuarine Vegetation - Weeds - Kennedy Bay

Year surveyed 2012

**Legend**

-  Saltwater paspalum 2012
-  Saltwater paspalum/mixed vegetation 2012

Source: WRC GIS layer "Estuarine Vegetation and Harbours"



Aerial Imagery WRAPS 2012

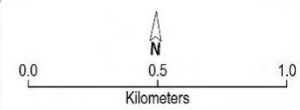
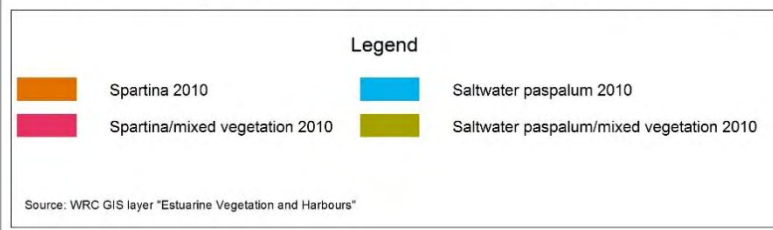


# Whangapoua Harbour



## Estuarine Vegetation - Weeds - Whangapoua Harbour

Year surveyed 2010



Aerial Imagery WRAPS 2012





# Otama estuary



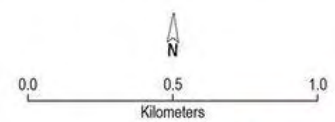
## Estuarine Vegetation - Weeds - Otama Beach

Year surveyed 2010

### Legend

-  Saltwater paspalum 2010
-  Saltwater paspalum/mixed vegetation 2010

Source: WRC GIS layer "Estuarine Vegetation and Harbours"



Aerial Imagery WRAPS 2012

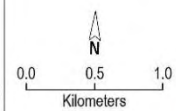
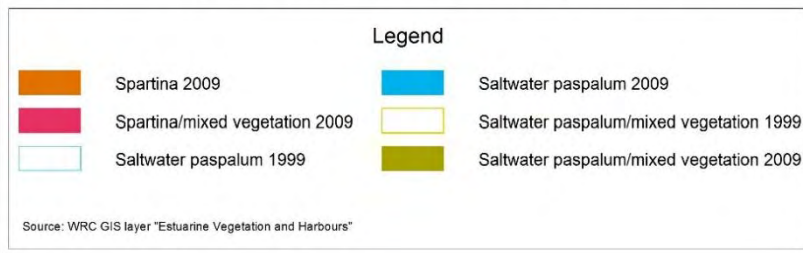


# Whitianga Harbour



## Estuarine Vegetation - Weeds - Whitianga Harbour

Year surveyed 1999 and 2009



Aerial Imagery WRAPS 2012



# Purangi estuary



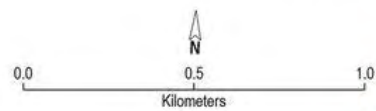
## Estuarine Vegetation - Weeds - Purangi Estuary

Year surveyed 2012

### Legend

-  Saltwater paspalum 2012
-  Saltwater paspalum/mixed vegetation 2012

Source: WRC GIS layer "Estuarine Vegetation and Harbours"



Aerial Imagery WRAPS 2012









# Tairua Harbour

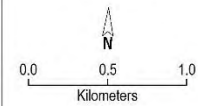


## Estuarine Vegetation - Weeds - Tairua Harbour

Year surveyed 1998 and 2008

Legend			
	Spartina 1998		Saltwater paspalum 2008
	Spartina 2008		Saltwater paspalum/mixed vegetation 1998
	Saltwater paspalum 1998		Saltwater paspalum/mixed vegetation 2008

Source: WRC GIS layer "Estuarine Vegetation and Harbours"

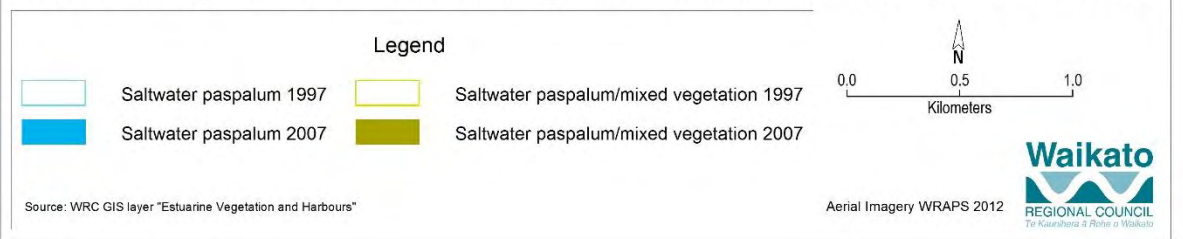


Aerial imagery WRAPS 2012





**Estuarine Vegetation - Weeds - Whangamata Harbour** Year surveyed 1997 and 2007



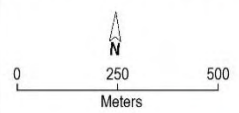


# Otahu estuary



## Estuarine Vegetation - Weeds - Otahu Estuary





Year surveyed 1997 and 2007



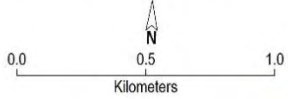
# Wharekawa Harbour




**Estuarine Vegetation - Weeds - Wharekawa Harbour** Year surveyed 1997 and 2008

Legend			
	Saltwater paspalum 1997		Saltwater paspalum/mixed vegetation 1997
	Saltwater paspalum 2008		Saltwater paspalum/mixed vegetation 2008

Source: WRC GIS layer "Estuarine Vegetation and Harbours"



0.0      0.5      1.0  
Kilometers



**Waikato**  
REGIONAL COUNCIL  
Te Kaitiaki o Te Wharekawa

Aerial Imagery WRAPS 2012

## Appendix 3. Areas of importance for shorebirds on the east coast of the Waikato region (Dowding 2013)

Dowding (2013) identified sites of importance to coastal and estuarine birds on the east coast of the Waikato region. Based on criteria on significance provided in the Ramsar Convention and Proposed Waikato Regional Policy Statement, Dowding assigned sites to one of the following four broad priorities:

- Priority 1: The site regularly holds 1% of the global population of one or more species or subspecies that were classified as Threatened under the New Zealand Threat Classification System List for 2012 (Robertson et al. 2013).
- Priority 2: The site regularly holds one or more Threatened or At Risk species or subspecies, or values are insufficiently known but type of habitat, older data, or other factors suggest that this is probable.
- Priority 3: The values of the site for coastal birds are not presently considered high; Threatened or At Risk shorebird or wetland bird taxa are not currently known to be present.
- Priority 4: Where shorebird/wetland bird values of a site are unknown, it is classified as Priority 4 (Insufficient Data).

Areas identified as priority 1 were:

1. Firth of Thames (Kaiaua to Waihou River)
2. Firth of Thames (Waihou River to Tararu)
3. Coromandel Harbour
4. Colville Bay
5. Waikawau Bay (including Little Bay)
6. Whangapoua Harbour (including Whangapoua Beach and Matarangi Spit)
7. Kuaotuna Peninsula (including Otama Beach and Opito Bay)
8. Tairua Harbour (including Tairua Ocean Beach, Pauanui Beach and Spit, and Pauanui Waterways)
9. Opoutere Sandspit and Wharekawa Harbour
10. Whangamata Harbour.

Areas identified as priority 2 were:

1. Coast north of Thames (Te Puru to Matariki Bay)
2. Manaia Harbour
3. Koputauaki Bay to Tukituki Bay
4. Waiaro Bay
5. Port Jackson to Fletcher Bay
6. Stony Bay
7. Port Charles
8. Kennedy Bay
9. Gray's beach-Kuaotuna beach
10. Matapaua Bay to Whauwhao beach
11. Mercury Island Group and Cuvier Island
12. Wharekaho
13. Whitianga Harbour

14. Cook's beach, Purangi estuary, Cathedral Cove and Hahei beach
15. Hot Water Beach
16. Slipper Island
17. Ohui
18. Onemana
19. Tokakahakaha (beach south of Onemana)
20. Otahu estuary
21. Whiritoa beach
22. Mataora Bay

On overview map of all priority 1 and 2 areas is shown below (created from [www.seasketch.org](http://www.seasketch.org); Sea Change Project). More detailed maps of the priority 1 and 2 areas were produced by Waikato Regional Council (Waikato Regional Council GIS-layer "Hauraki Gulf Marine Spatial Plan Locations") and are also presented below. These maps can be requested via the Waikato Regional Council Data Catalogue ([www.waikatoregion.govt.nz/Services/data-catalogue](http://www.waikatoregion.govt.nz/Services/data-catalogue)).

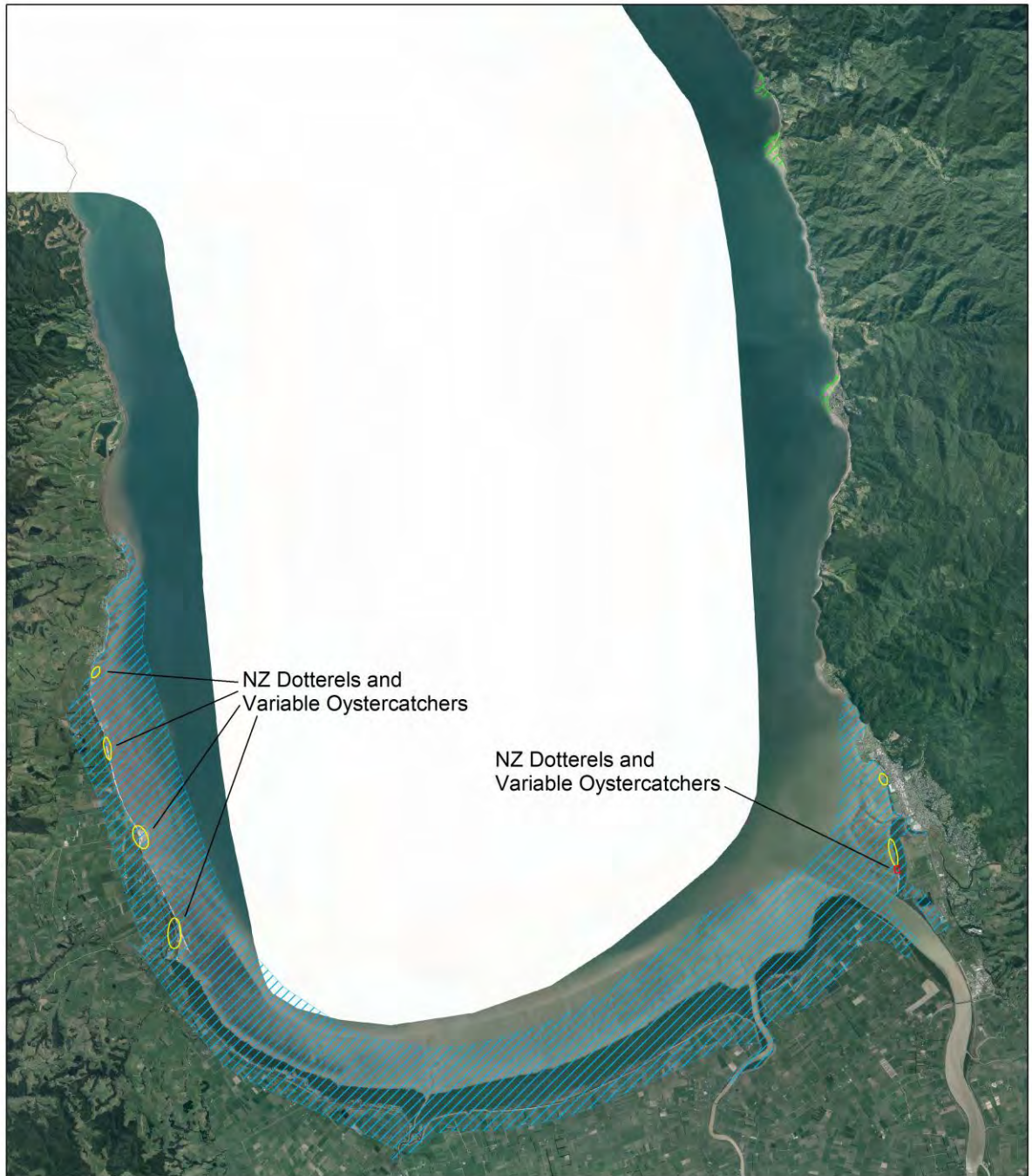
For Tairua Harbour and Whangamata Harbour additional information was provided by Bioresarches. This extra information was added to these maps.

For further available information related to shorebirds in the Waikato region either on the west coast or around the Coromandel Peninsula please refer to chapter 5.2.2 of this report.

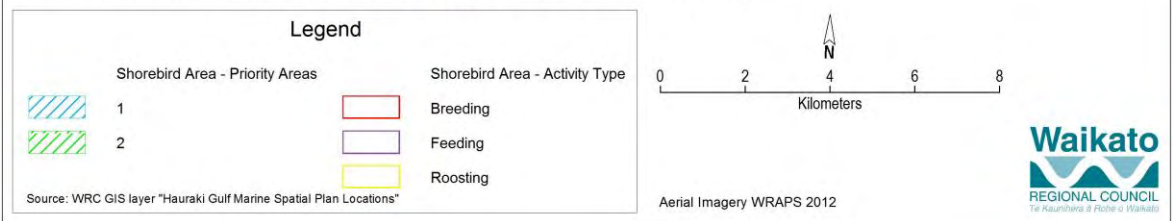
Overview map (priority 1 and 2 areas)

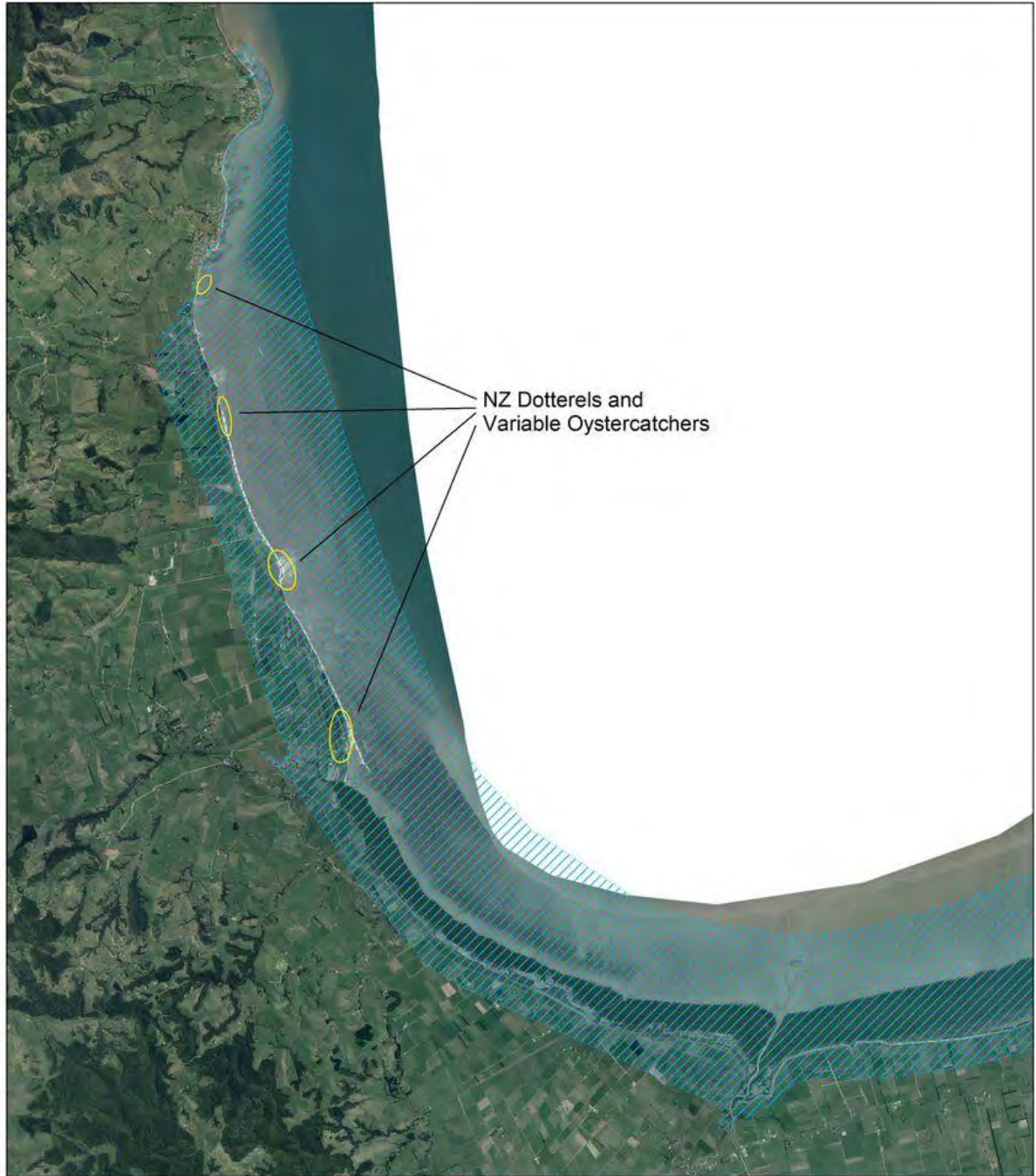


Source: [www.seasketch.org](http://www.seasketch.org)

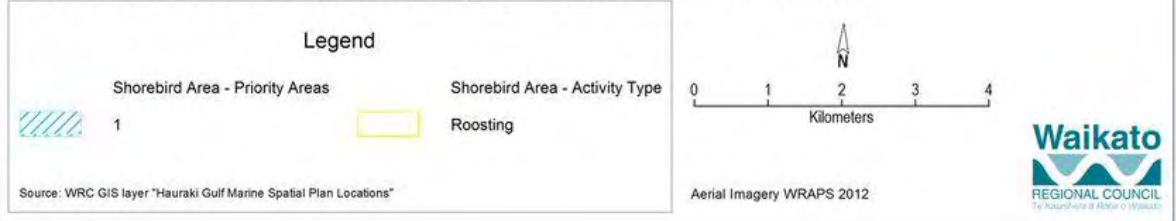


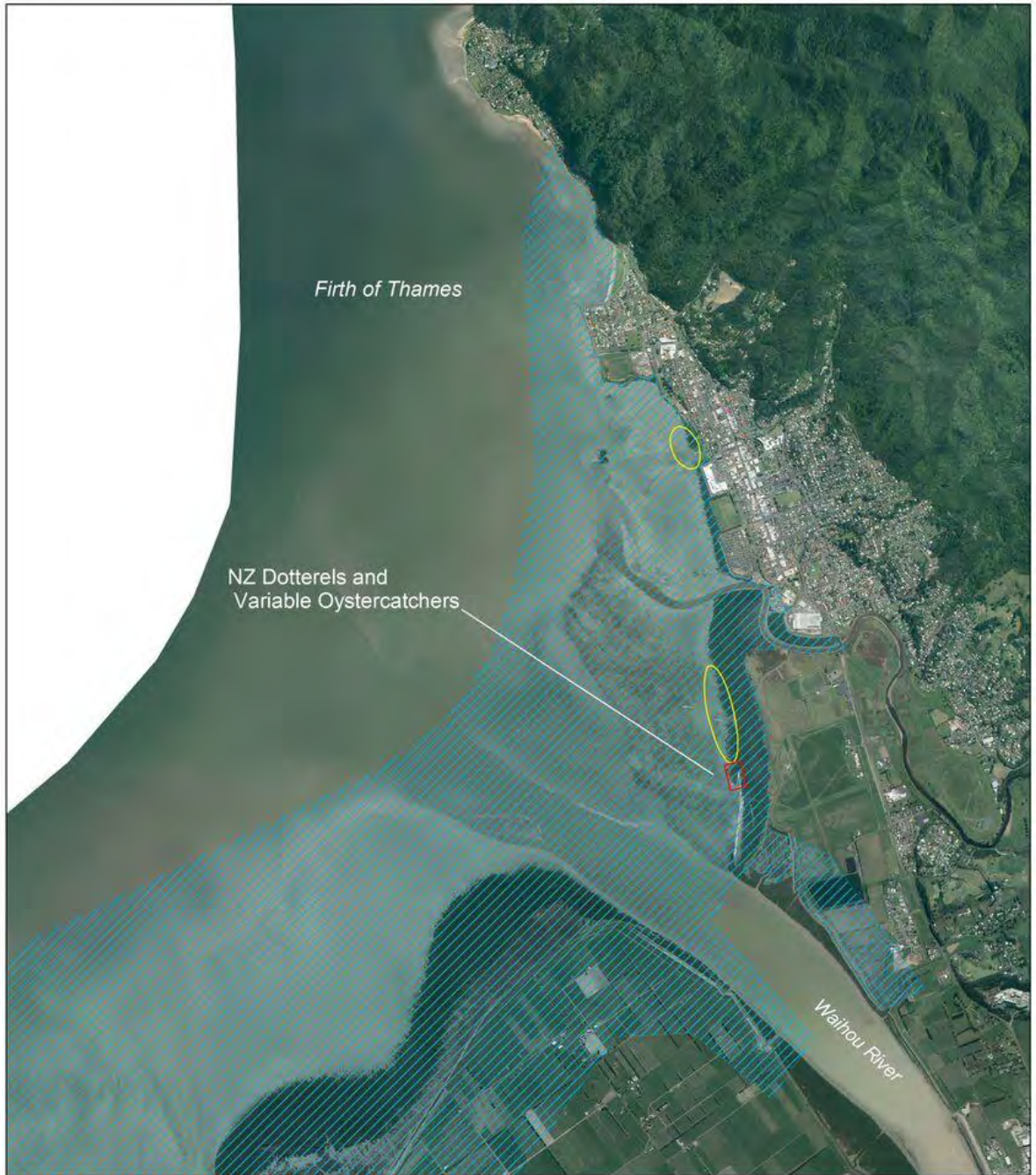
**Shorebird Areas and Activity Types - Firth of Thames**



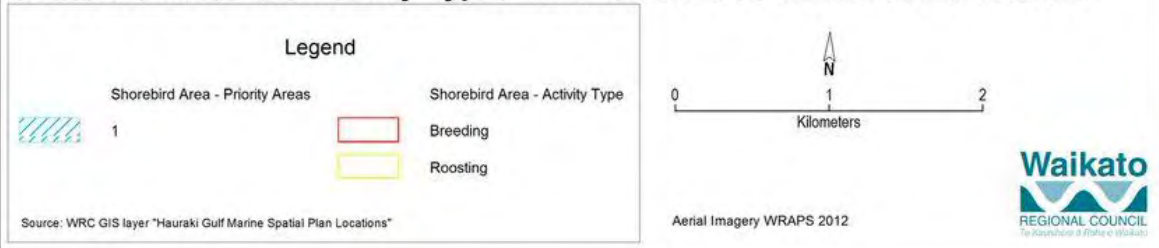


### Shorebird Areas and Activity Types - Kaiaua Firth of Thames



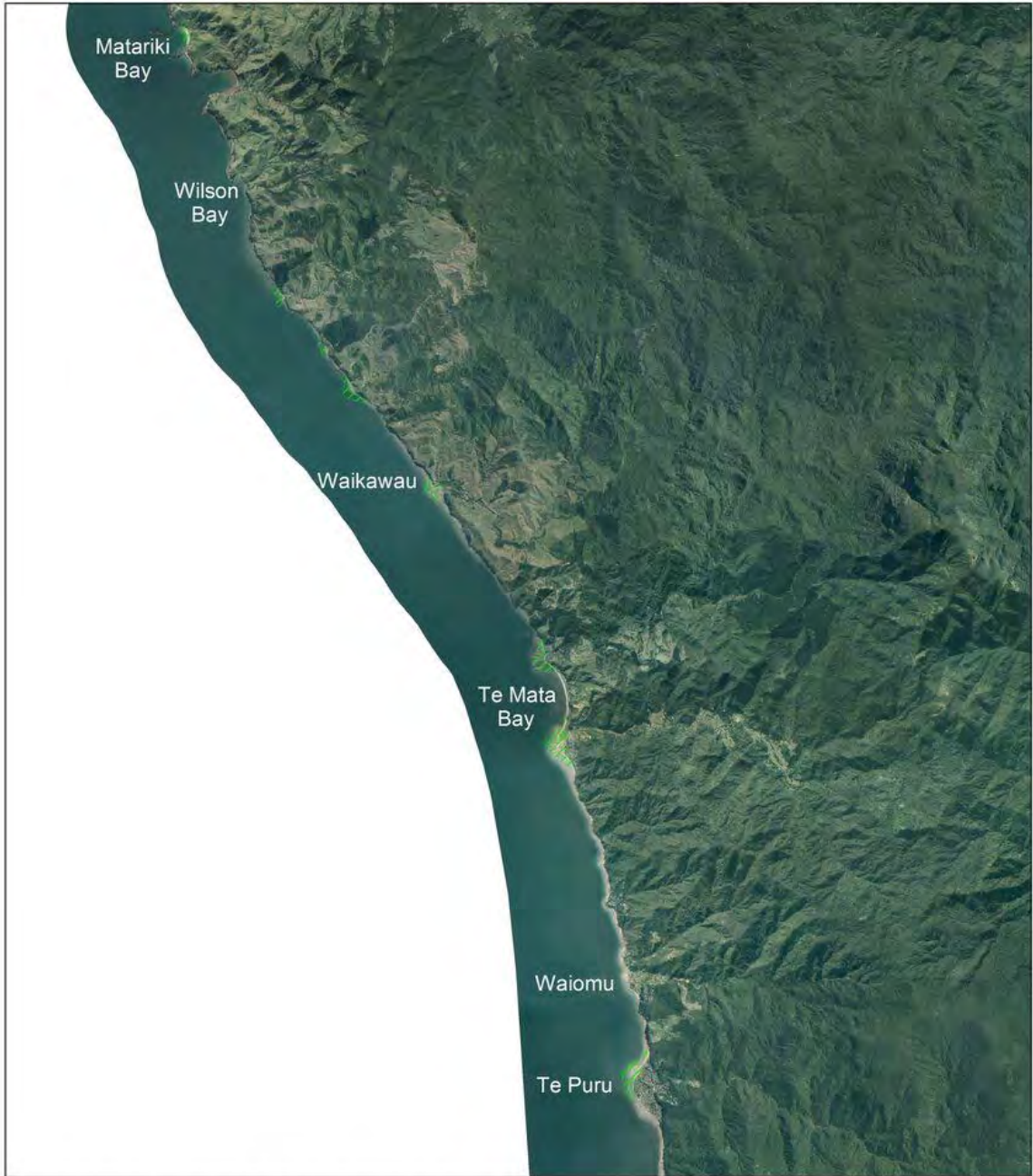


**Shorebird Areas and Activity Types - Waihou River to Tarau Firth of Thames**





# Coast north of Thames (Te Puru to Matariki Bay)



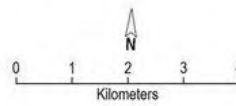
## Shorebird Areas - Te Puru to Matariki Bay

**Legend**

Shorebird Area - Priority Areas

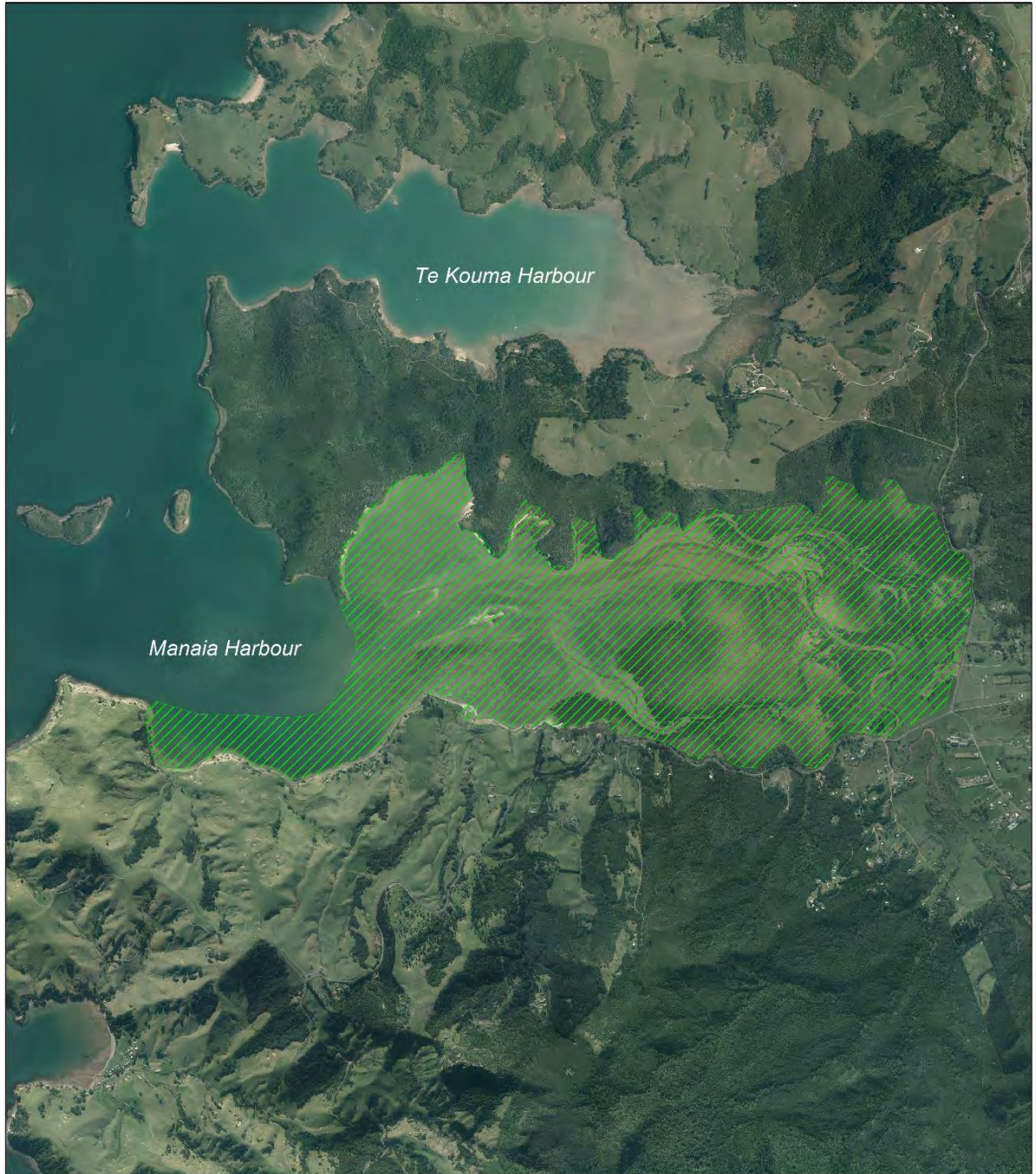
 2

Source: WRC GIS layer "Hauraki Gulf Marine Spatial Plan Locations"



Aerial Imagery WRAPS 2012





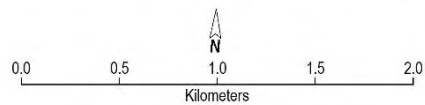
### Shorebird Areas and Activity Types - Manaia and Te Kouma Harbours

Legend

Shorebird Areas - Priority Areas

 2

Source: WRC GIS layer "Hauraki Gulf Marine Spatial Plan Locations"

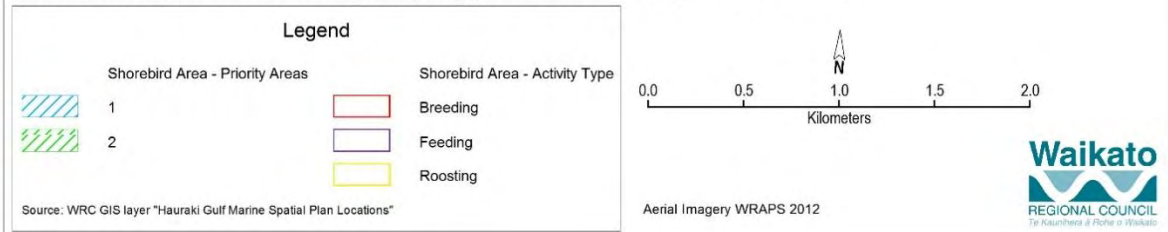


Aerial Imagery WRAPS 2012





**Shorebird Areas and Activity Types - Coromandel Harbour**



# Koputauaki Bay to Tukituki Bay



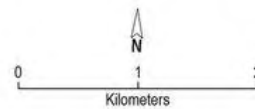
## Shorebird Areas - Koputauaki Bay to Tukituki Bay

**Legend**

Shorebird Area - Priority Areas

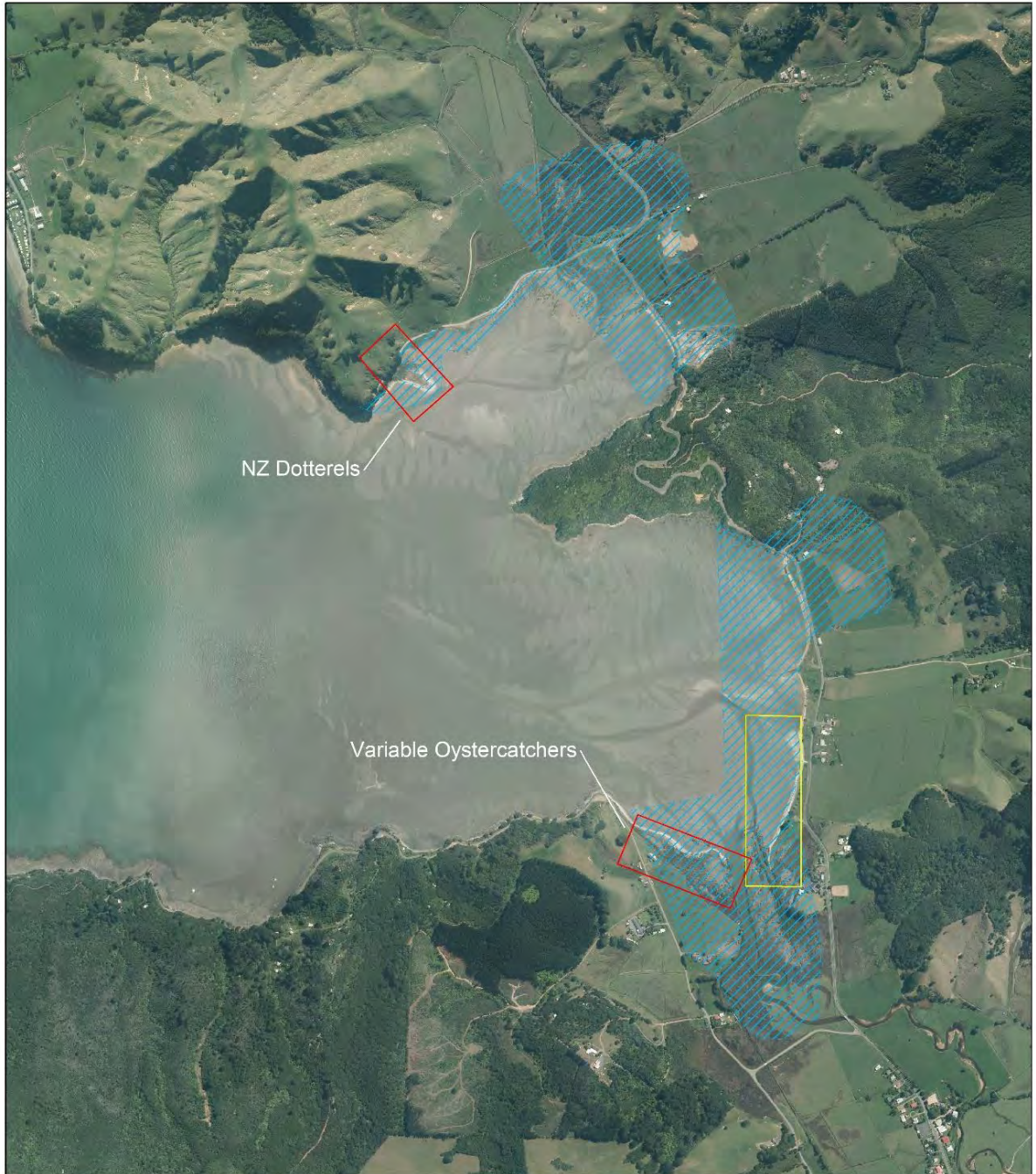
 2

Source: WRC GIS layer "Hauraki Gulf Marine Spatial Plan Locations"



Aerial Imagery WRAPS 2012

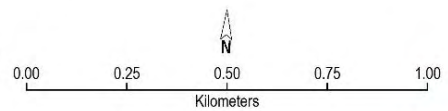




### Shorebird Areas and Activity Types - Colville Bay

Legend

Shorebird Area - Priority Areas		Shorebird Area - Activity Type	
	1		Breeding
	2		Feeding
			Roosting



Source: WRC GIS layer "Hauraki Gulf Marine Spatial Plan Locations"

Aerial Imagery WRAPS 2012



# Waiaro Bay



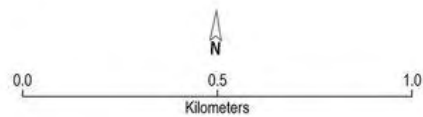
## Shorebird Areas - Waiaro Bay

**Legend**

Shorebird Area - Priority Areas

 2

Source: WRC GIS layer "Hauraki Gulf Marine Spatial Plan Locations"



Aerial Imagery WRAPS 2012



# Port Jackson to Fletcher Bay



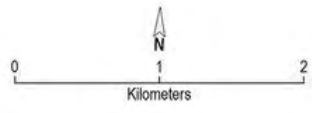
## Shorebird Areas - Port Jackson and Fletcher Bay

**Legend**

Shorebird Area - Priority Areas

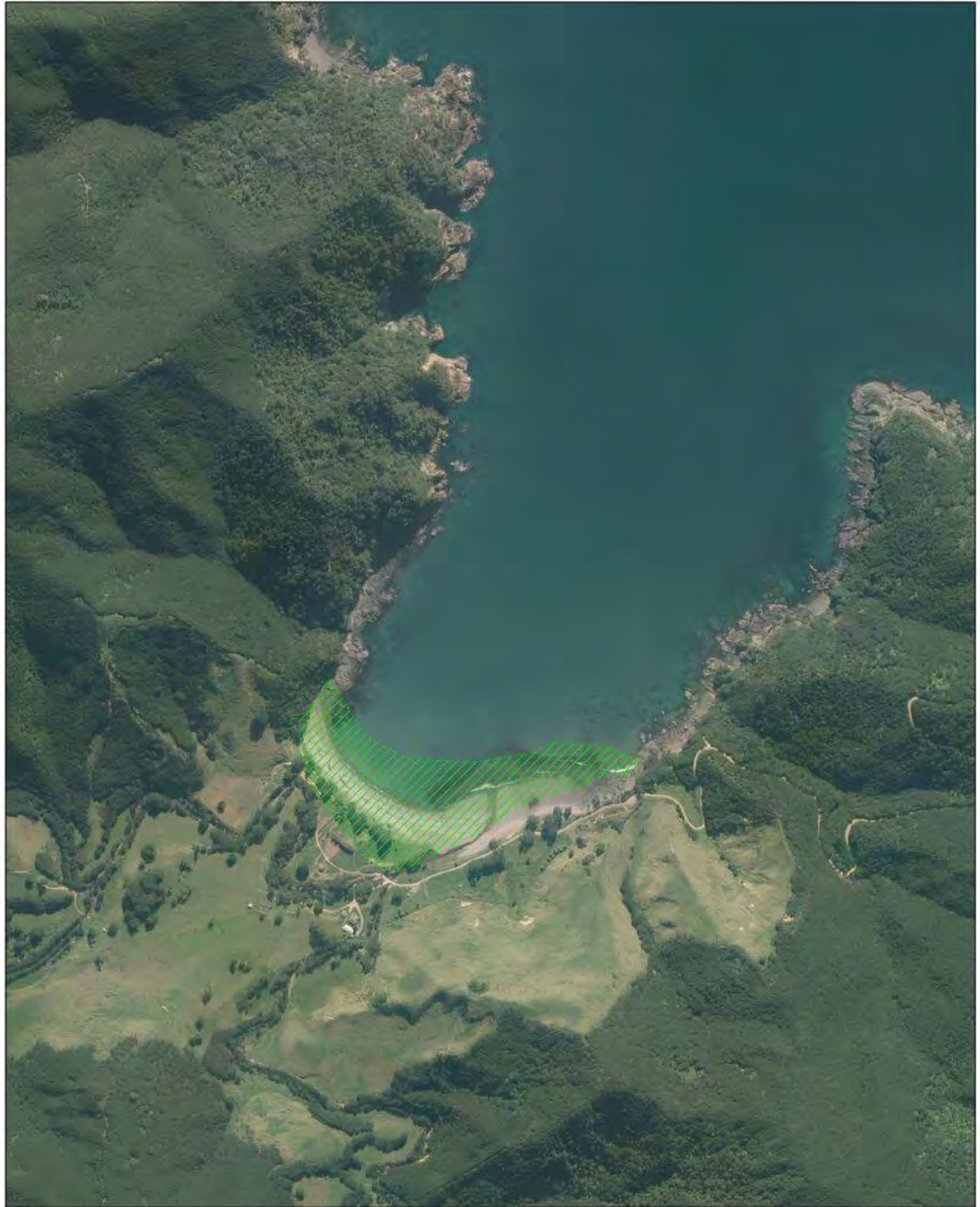
 2

Source: WRC GIS layer "Hauraki Gulf Marine Spatial Plan Locations"



Aerial Imagery WRAPS 2012


# Stony Bay



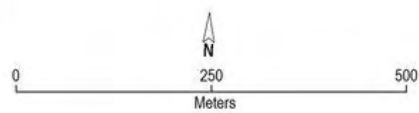
## Shorebird Areas - Stony Bay

Legend

Shorebird Area - Priority Areas

 2

Source: WRC GIS layer "Hauraki Gulf Marine Spatial Plan Locations"



Aerial Imagery WRAPS 2012







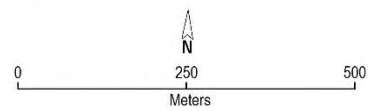
### Shorebird Areas and Activity Types - Port Charles

Legend

Shorebird Areas - Priority Areas

 2

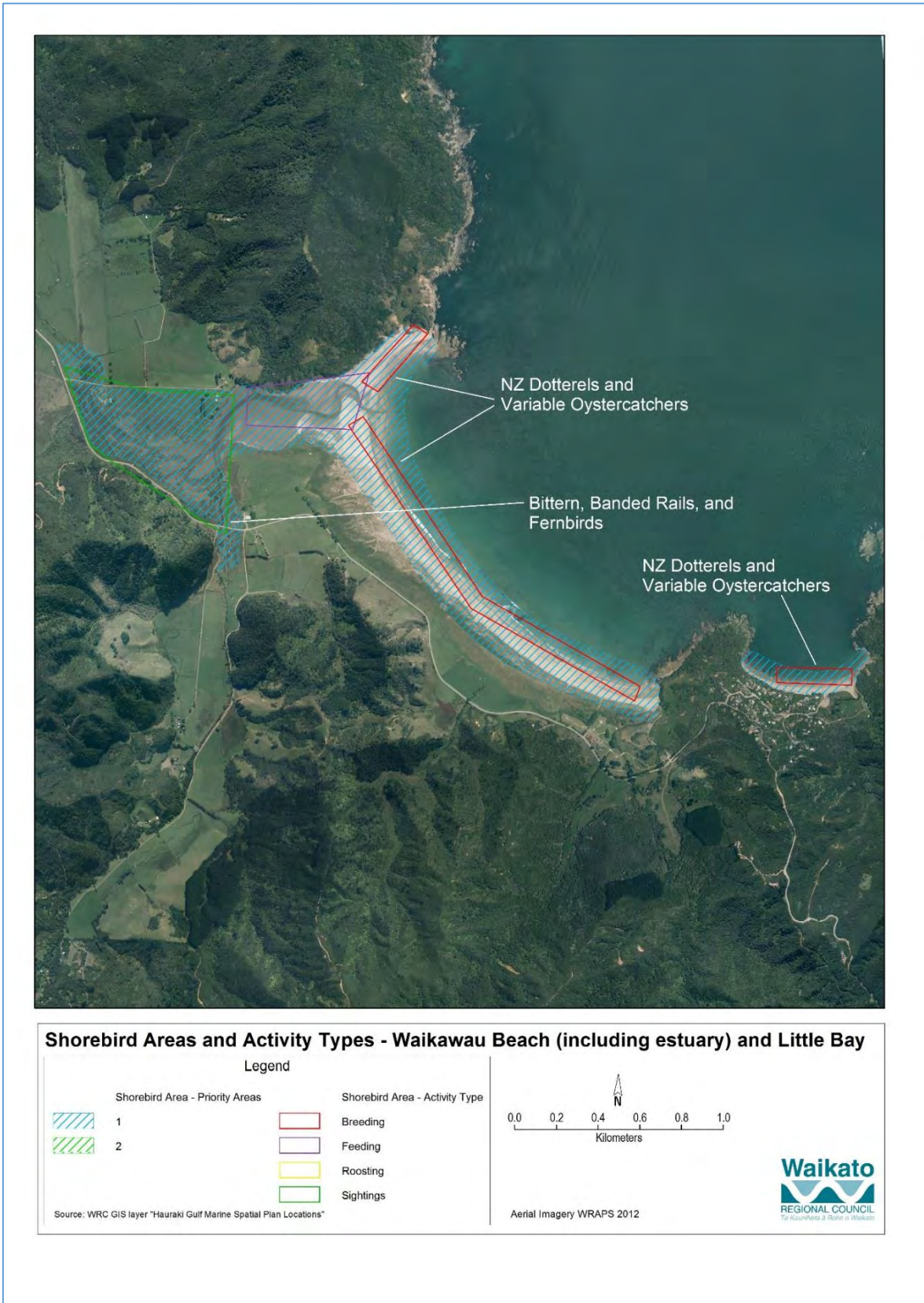
Source: WRC GIS layer "Hauraki Gulf Marine Spatial Plan Locations"



Aerial Imagery WRAPS 2012



# Waikawau Bay and Little Bay

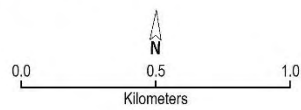


# Kennedy Bay



## Shorebird Areas and Activity Types - Kennedy Bay

- Legend
- Shorebird Areas - Priority Areas
  -  2

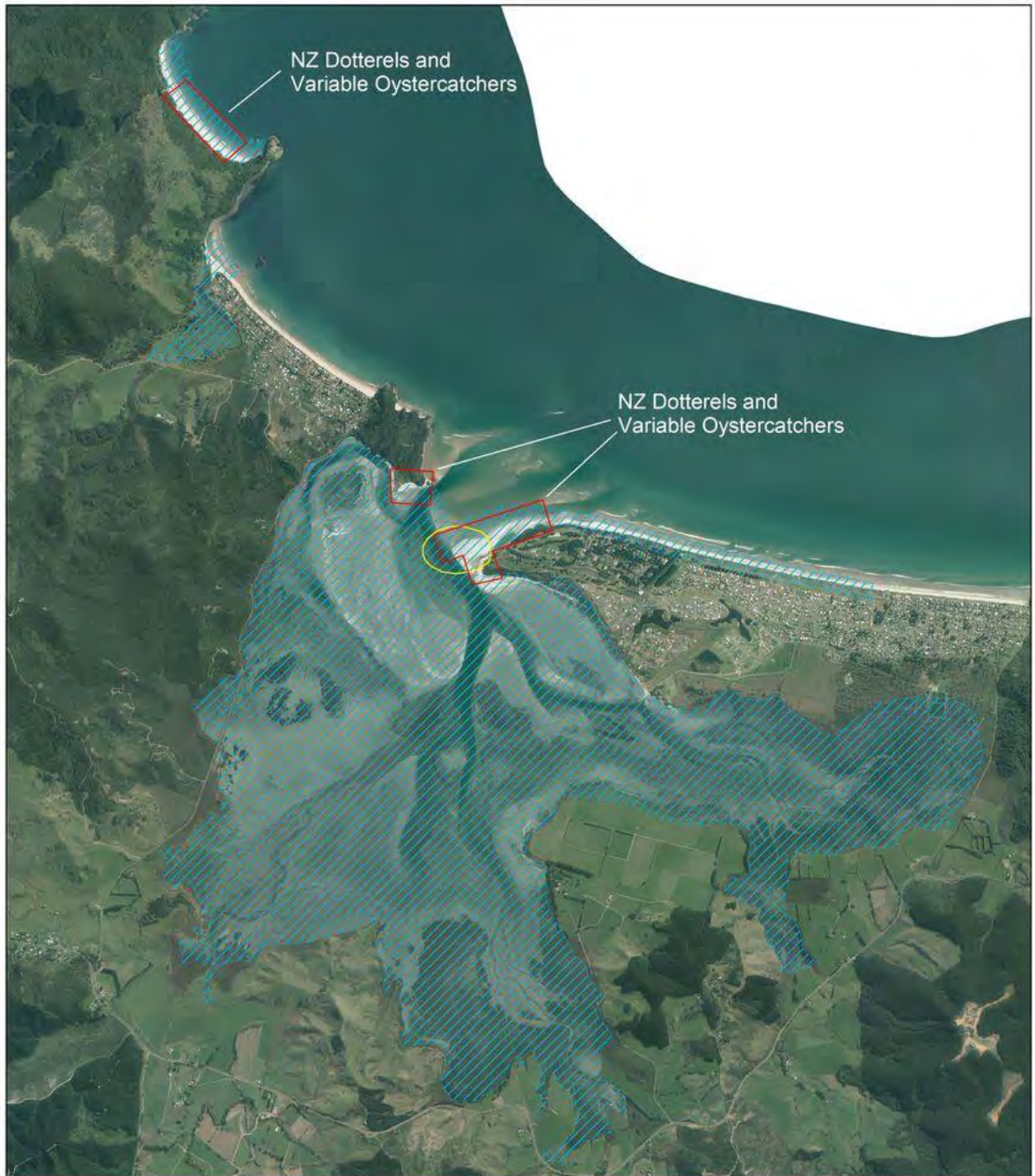


Source: WRC GIS layer "Hauraki Gulf Marine Spatial Plan Locations"

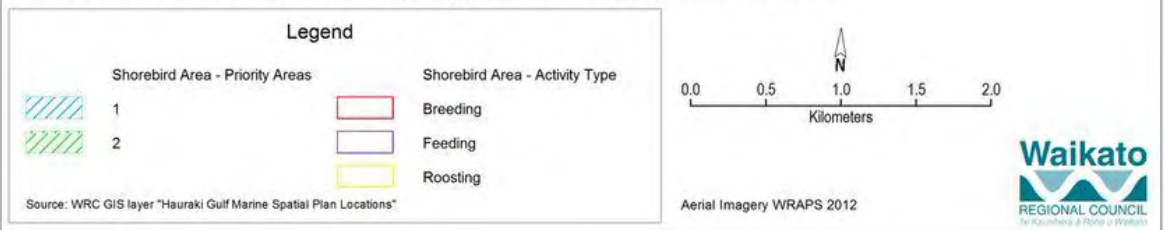
Aerial Imagery WRAPS 2012



Whangapoua Harbour (including Whangapoua Beach and Matarangi Spit)



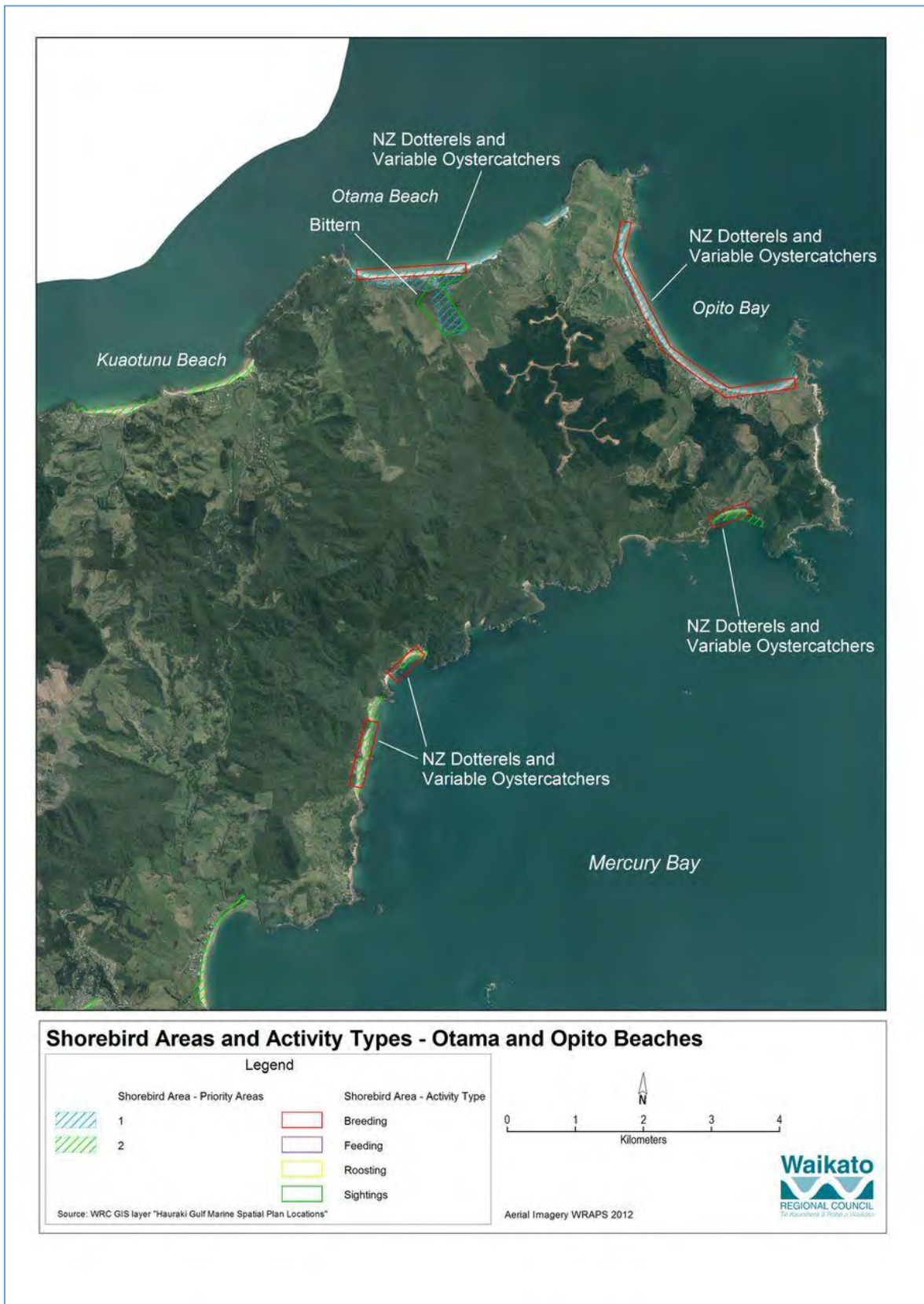
**Shorebird Areas and Activity Types - Whangapoua Harbour**



# Rings Beach to Kuaotuna Beach



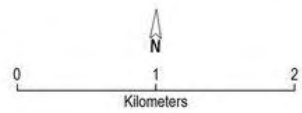
Kuaotuna Peninsula (including Otama Beach and Opito Bay)



# Matapaua Bay to Whauwhau Beach



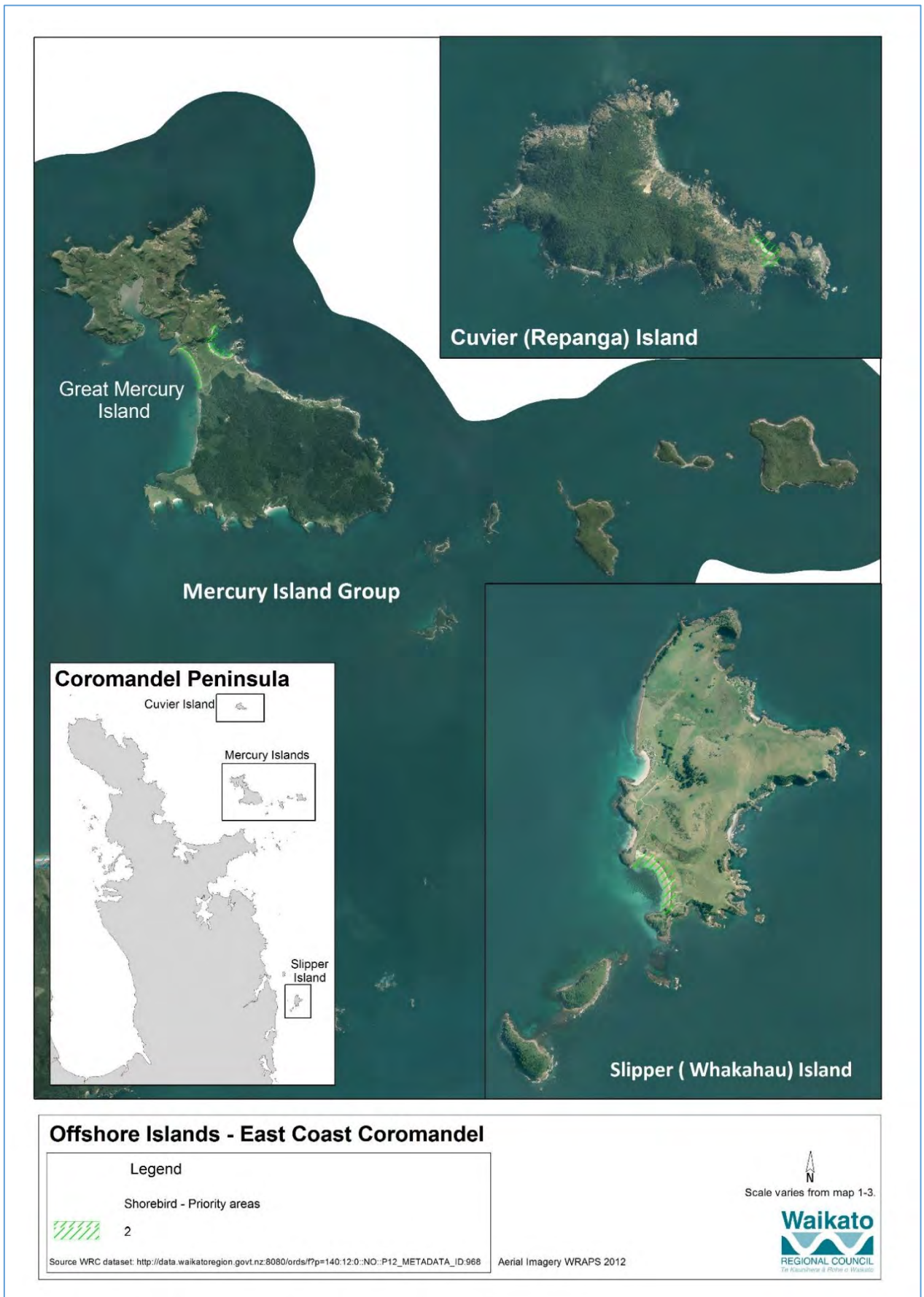
## Shorebird Areas and Activity Types - Matapaua Bay to Whauwhau Beach



Aerial Imagery WRAPS 2012



# Mercury Island Group, Cuvier Island and Slipper Island

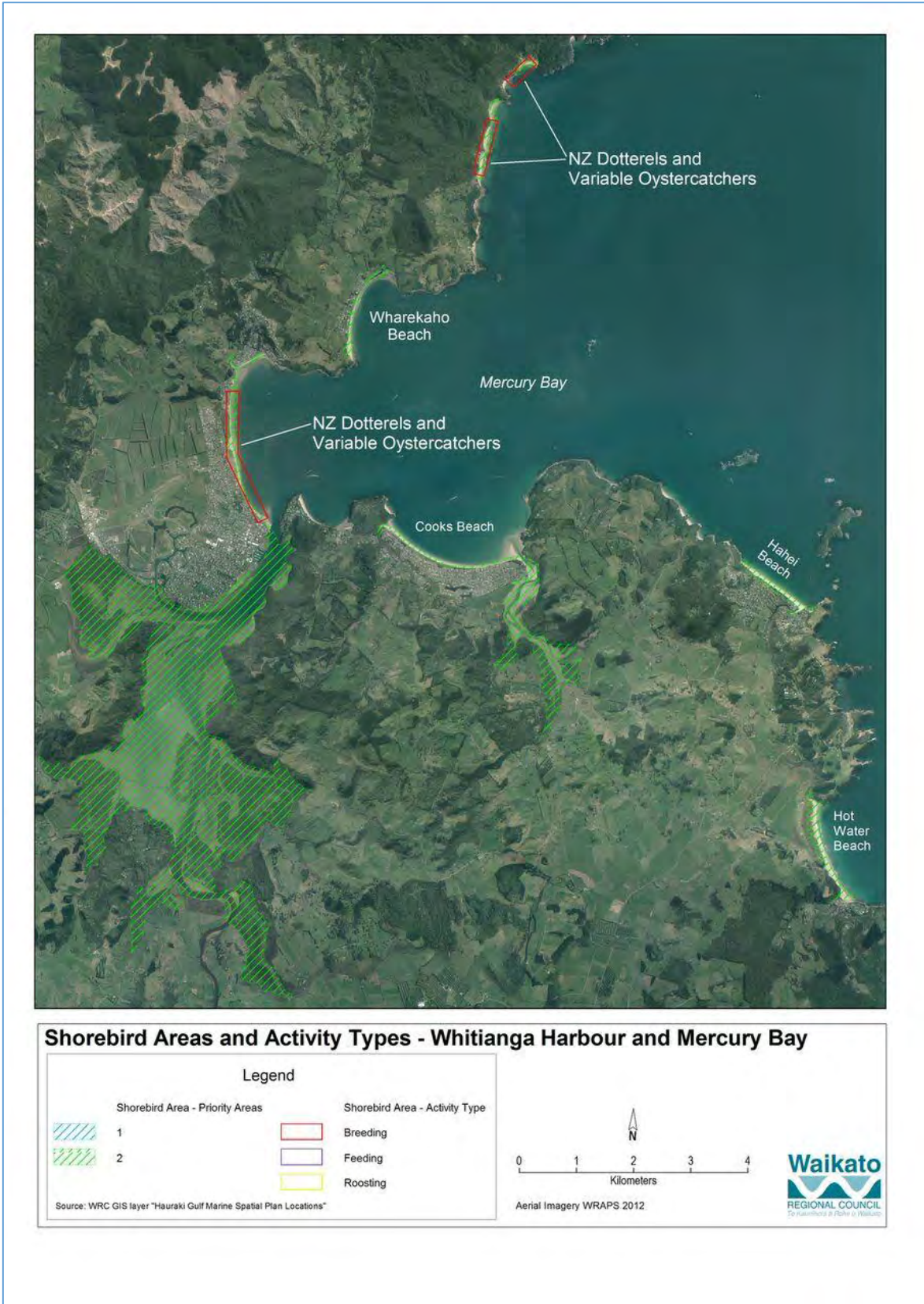




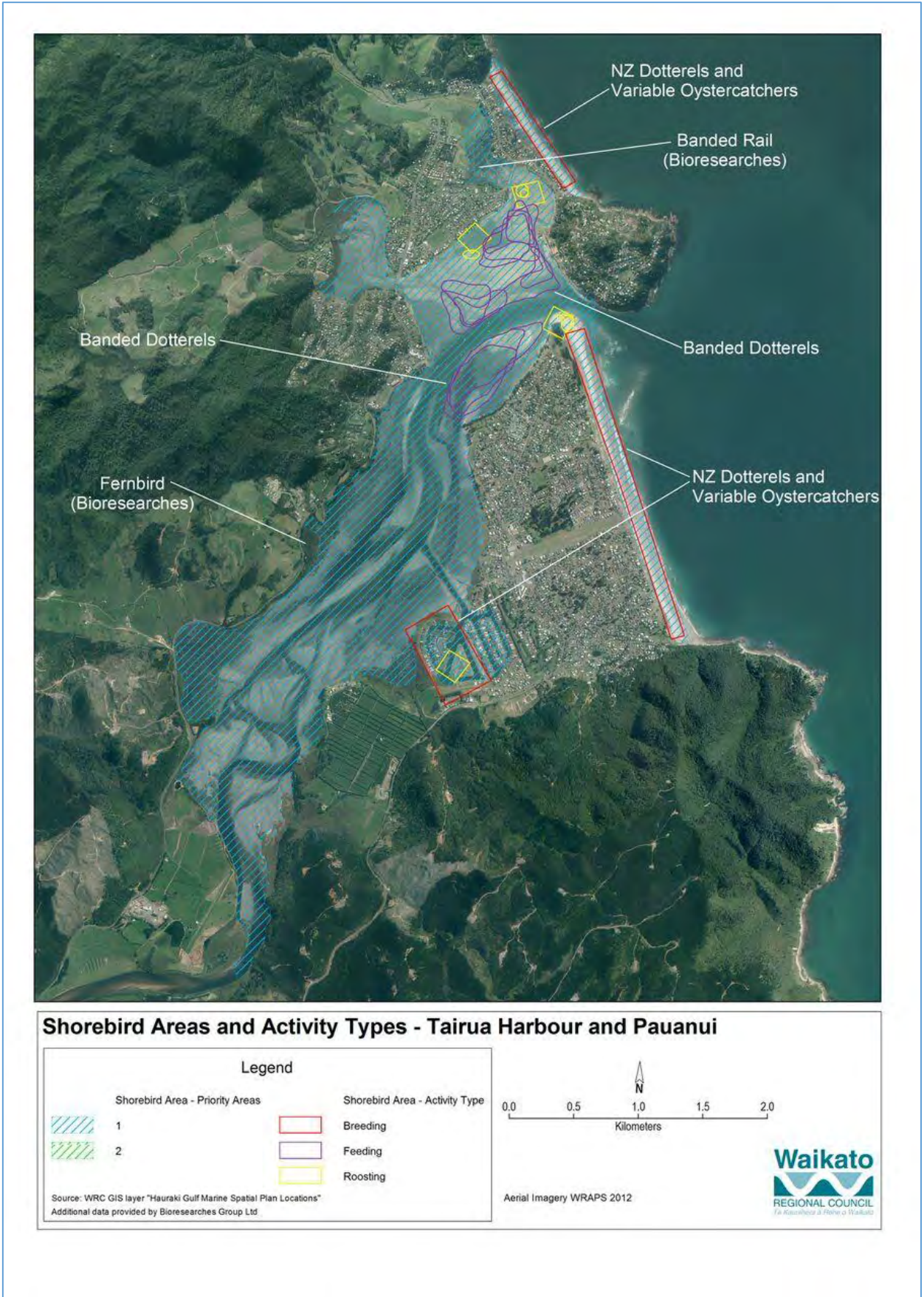
# Wharekaho Beach



Whitianga Harbour, Cooks Beach, Purangi estuary, Cathedral Cove, Hahei Beach and Hot Water Beach



Tairua Harbour (including Tairua Ocean Beach, Pauanui Beach and Spit and Pauanui Waterways)

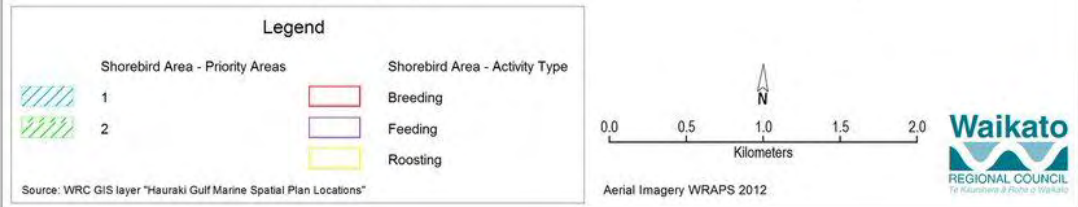


# Ohui, Opoutere Beach and Wharekawa Harbour



NZ Dotterels and Variable Oystercatchers

## Shorebird Areas and Activity Types - Wharekawa Harbour and Opoutere Beach



# Onemana Beach



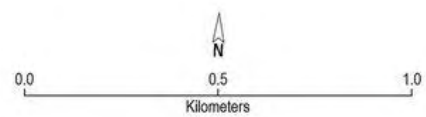
## Shorebird Areas - Onemana Beach

**Legend**

Shorebird Area - Priority Areas

 2

Source: WRC GIS layer "Hauraki Gulf Marine Spatial Plan Locations"



Aerial Imagery WRAPS 2012



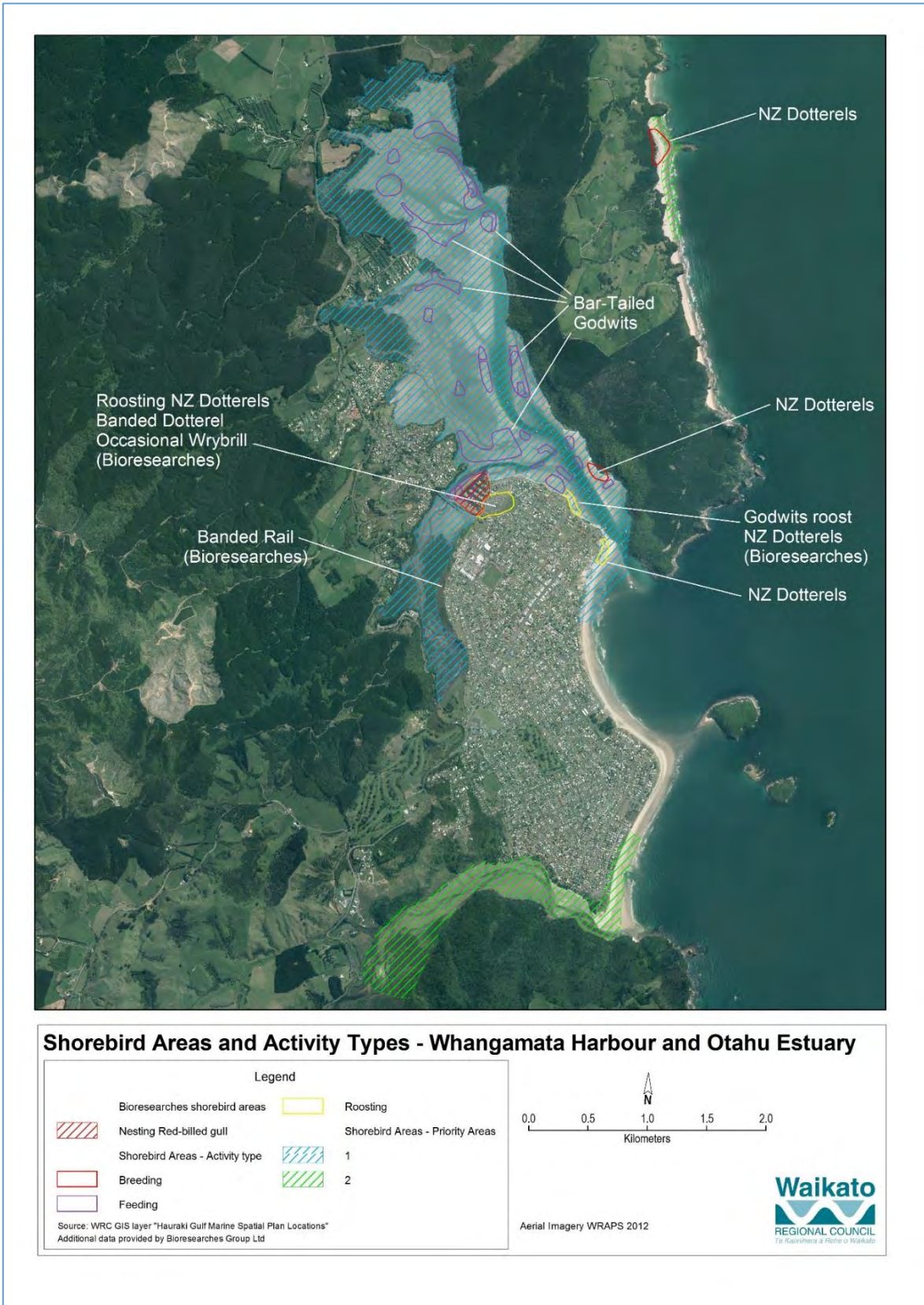
# Tokakahakaha Beach



## Shorebird Areas and Activity Types - Tokakahakaha Beach



# Whangamata Harbour and Otahu estuary



# Whiritoa Beach and Mataora Bay

