

# He Mihi....





# A typology of New Zealand coastal hydrosystems for management purposes

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**(Prepared for 2016 National Wetland Restoration Symposium)**

# Outline

- Why classify coastal hydrosystems?
- What are coastal hydrosystems?
- What classification approach for management?





## Key message

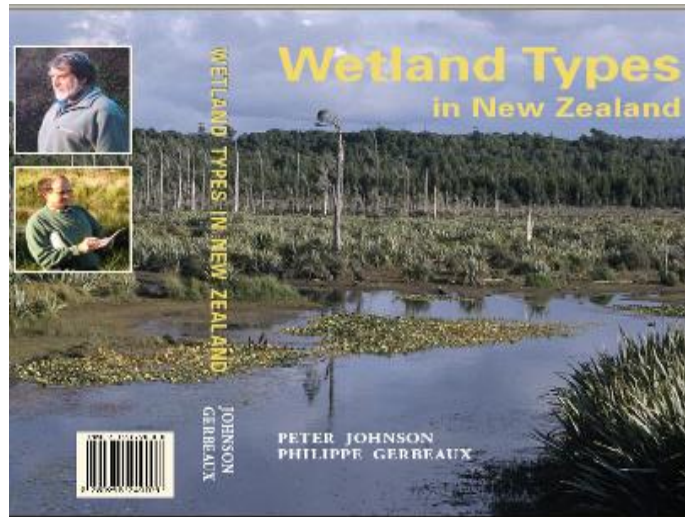
*“To generate clear understanding and coherent management of coastal hydrosystems we need a good classification and consistent terminology. Otherwise there is confusion amongst scientists, managers and planners reflected in inconsistent or technically incorrect use of words in scientific, planning and legislative documents.”*



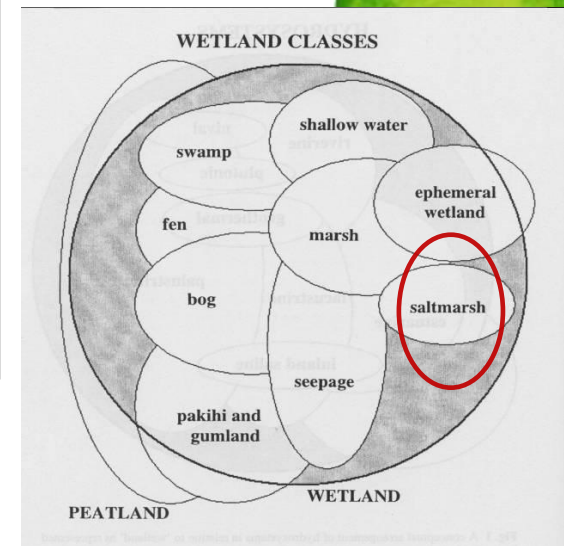
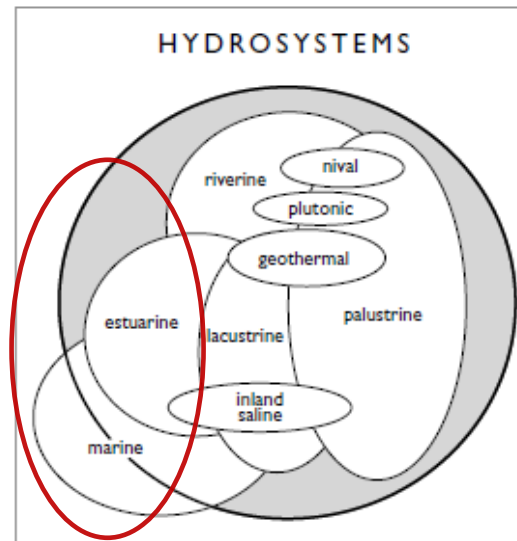
# Part 1: **Why classify coastal hydrosystems?**



# New Zealand has a large diversity of inland and coastal wetland types

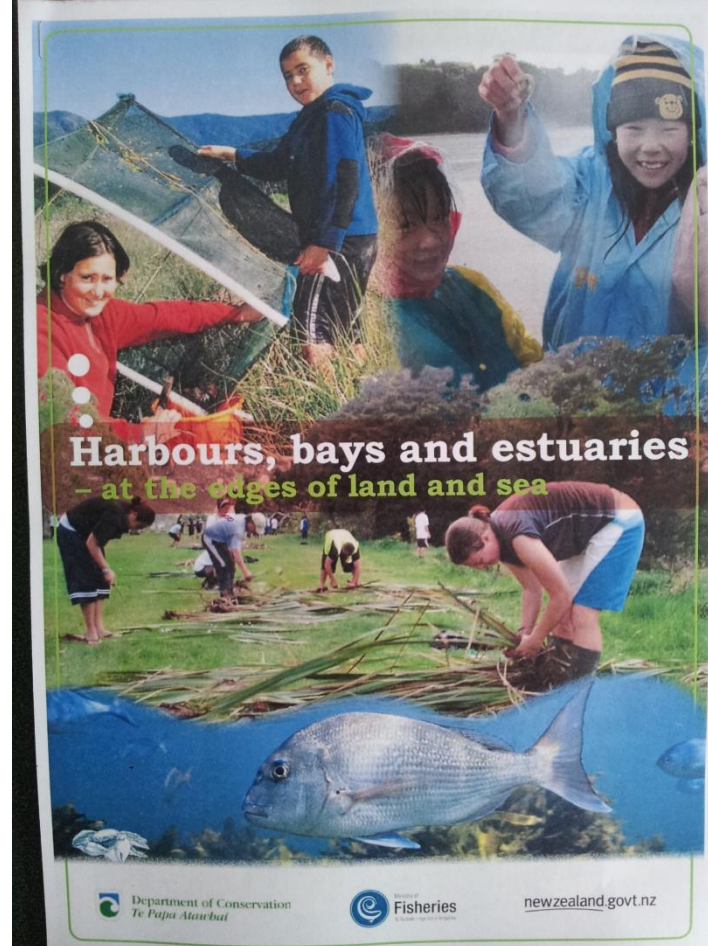
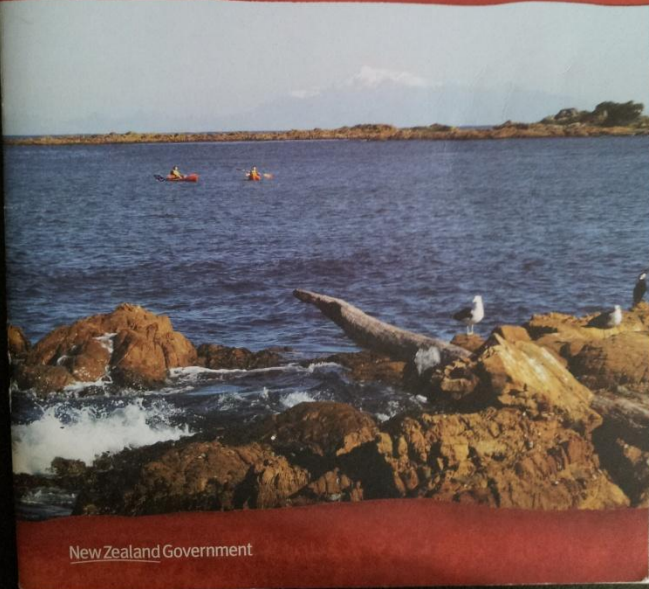


(After Johnson and Gerbeaux 2003)



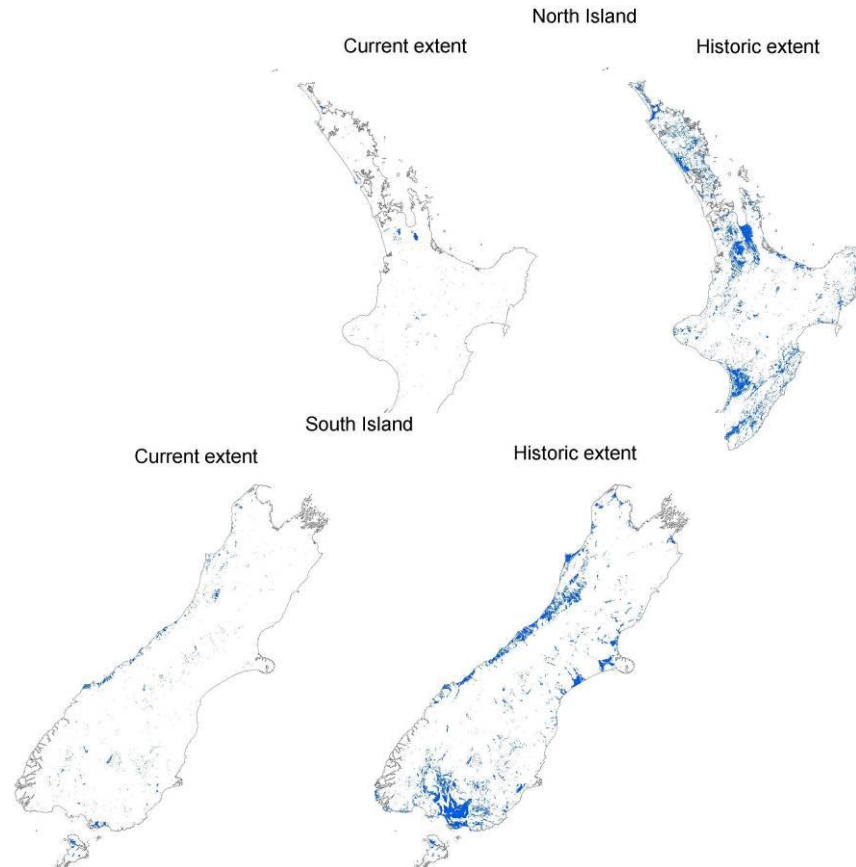
**“Wetland” includes permanently or intermittently wet areas, shallow water and land water margins that support a natural ecosystem of plants and animals that are adapted to wet conditions”**

# New Zealand Coastal Policy Statement 2010



**Policy 1 (2):** “coastal envt” includes: (a) cma, (b) islands within cma, ( c) areas where coastal processes .../... are significant **including coastal lakes, lagoons, tidal estuaries, saltmarshes, coastal wetlands**...(d) areas at risk from coastal hazards...(also the intertidal zone (h) )

# WONI/FENZ wetlands (2005-2010) did not identify estuarine wetlands





# ESTUARIES

Estuaries are where fresh water from rivers mixes with salt water. They are formed where the underlying or adjacent topography constrains the mixed water throughout the tidal cycle. They are formed behind barriers such as sand spits and coastal embayments, at river mouths, in drowned river valleys with gently sloping substrates, and even in fjords. Their inland limit is where salinity reaches a dilution of 5% of the marine concentration. Sheltered, northern estuaries can support mangroves (*Avicennia marina*).

## Occupied and modified

Snow banks  
String mires  
Tarns

## KEY CONTACT



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## Threats

Aggressive invasive weeds have changed the character of estuaries, e.g. *Spartina* spp., saltwater paspalum (*Paspalum vaginatum*), *Juncus acutus*, *J. gerardii* and *Carex divisa*. Invasive fauna also forms a threat, e.g. the introduced portunid crab (*Charybdis japonica*). Estuarine margins in agricultural settings are grazed, trampled, and there are potential problems of nutrient enrichment from fertiliser and stock. Estuarine systems under greatest threat from urban development are near centres of population. Introduced animals pose a high threat in unfenced estuarine margins accessible by domestic and feral animals. These systems are fragile and prone to trampling/browsing damage. There is little threat from on-site erosion, but upper-catchment erosion and sedimentation exacerbate mangrove spread and hence change of ecosystem structure and function. Drainage is mainly a threat on margins that are less influenced by tidal regimes. Aquaculture is an increasing threat in some localities.

## Notable flora and fauna

Threatened and rare plants include the nationally critical grey bush (*Atriplex cinerea*), coastal peppergrass (*Lepidium banksii*), and saltgrass (*Puccinellia rariflorens*); the nationally vulnerable *Machaerina complanata*, the declining *Leptinella tenella*, sea sedge (*Carex litorosa*), tufted hair-grass (*Deschampsia cespitosa*), and the naturally uncommon Kirk's crassula (*Crassula kirkii*), creeping fuchsia (*Fuchsia procumbens*), *Leptinella dispersa* subsp. *dispersa*, *Leptinella plumosa*, native musk (*Mimulus repens*), Chatham Islands salt grass (*Puccinellia chathamica*), and *Puccinellia walkerii* subsp. *walkerii*. Relicts include the orache (*Atriplex australasica*), colonisers include the narrow-leaved Willsonia (*Wilsonia backhousei*), and the data deficient wind grass (*Lachnagrostis tenuis*).

Estuaries support many bird species, but while only a few are threatened, estuaries as a whole are vital for bird conservation. Some birds nest on the estuary margins, such as the 'sparse' banded rail (*Rallus phillipensis*). Others nest mainly, or exclusively, outside of estuaries elsewhere in New Zealand, such as on riverbeds, and visit estuaries only during the winter, e.g. 'nationally vulnerable' wrybill (*Anarhynchus frontalis*) and the 'critical' white heron (*Egretta alba subsp. modesta*).

Most of the migratory winter visitors are from the Northern Hemisphere and although New Zealand estuaries are critical to their survival, such as the bartailed godwit (*Limosa lapponica*), none are ranked as endangered.



## The Estuary Environment Classification (2007)

The EEC uses an estuary definition of: "A partially enclosed coastal body of water that is either permanently or periodically open to the sea in which the aquatic ecosystem is affected by the physical and chemical characteristics of both runoff from the land and inflow from the sea"

Coastal Explorer

The EEC is based on controlling factors such as climate, ocean and river conditions, and catchment characteristics that cause differences in the physical classification for an individual estuary.



A - coastal lakes

B - tidal river mouths

C - tidal river lagoons

D - coastal embayments

E - tidal lagoons or barrier enclosed lagoons

F - barrier enclosed lagoons or drowned valleys

G - fjords or sounds

H - drowned valleys, rias or fjords

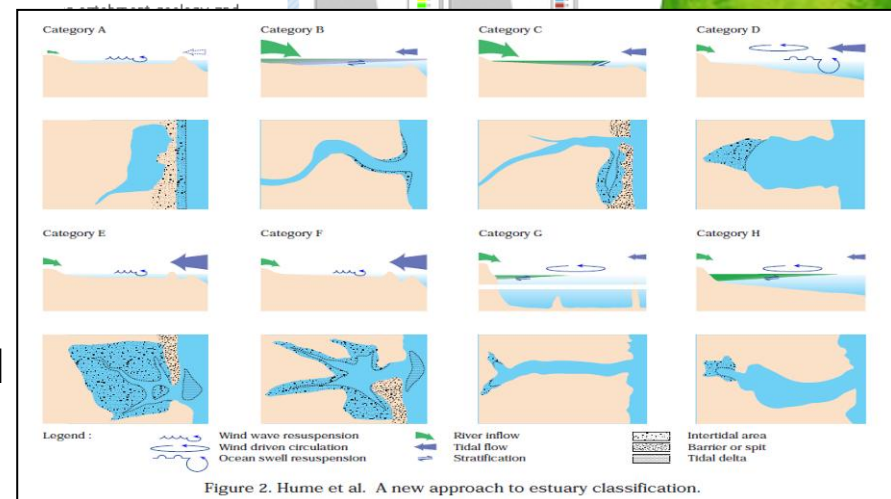


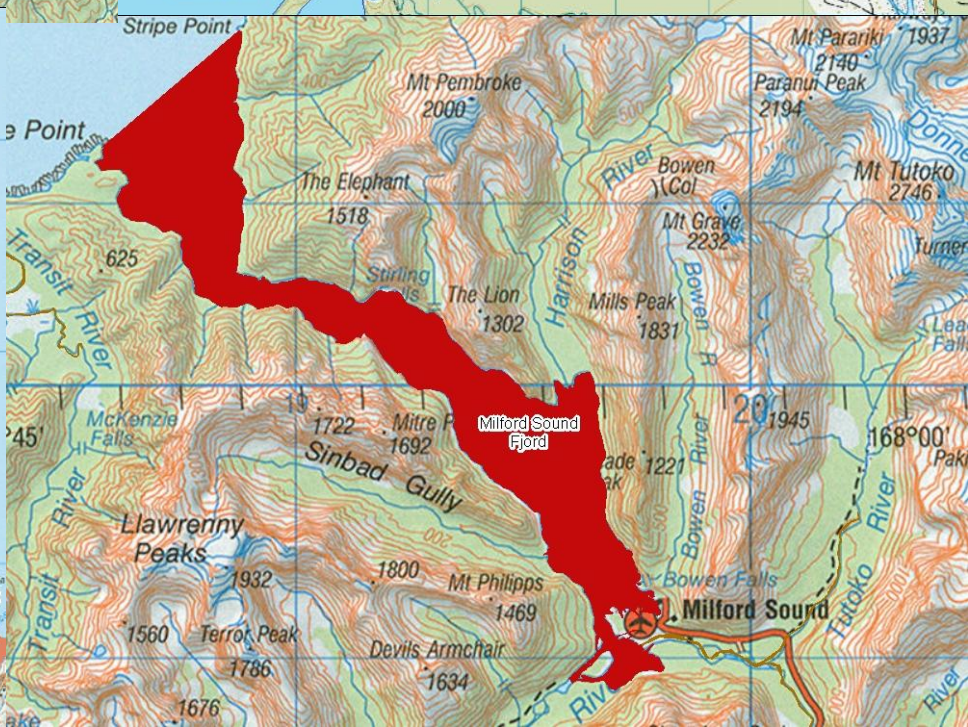
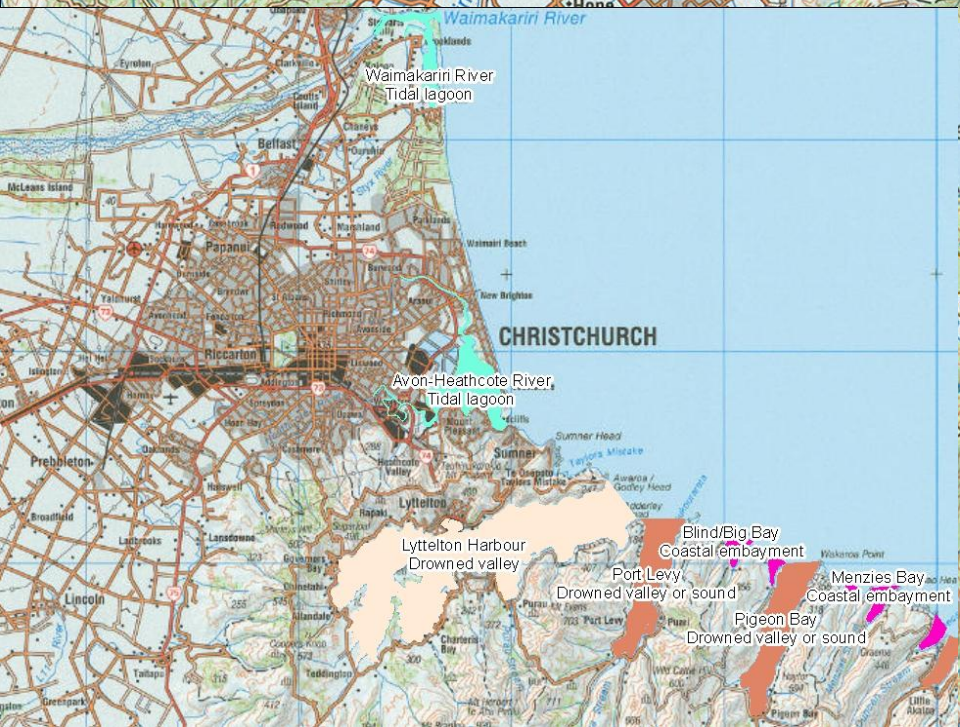
Figure 2. Hume et al. A new approach to estuary classification.

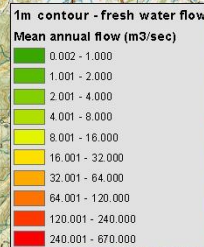
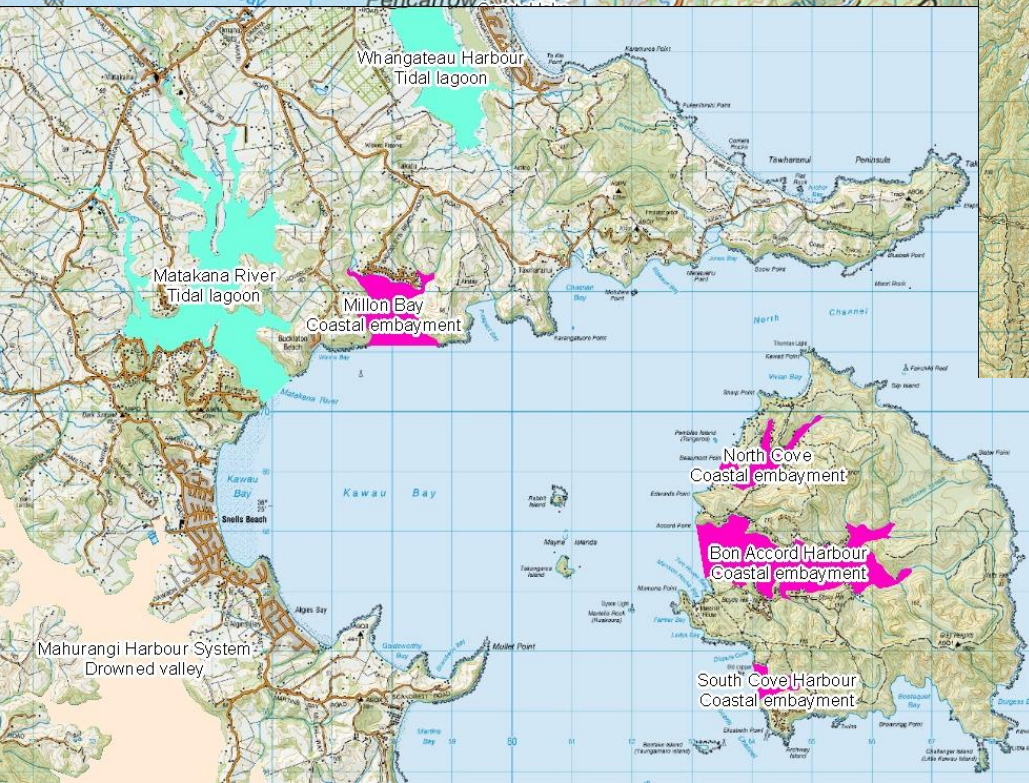
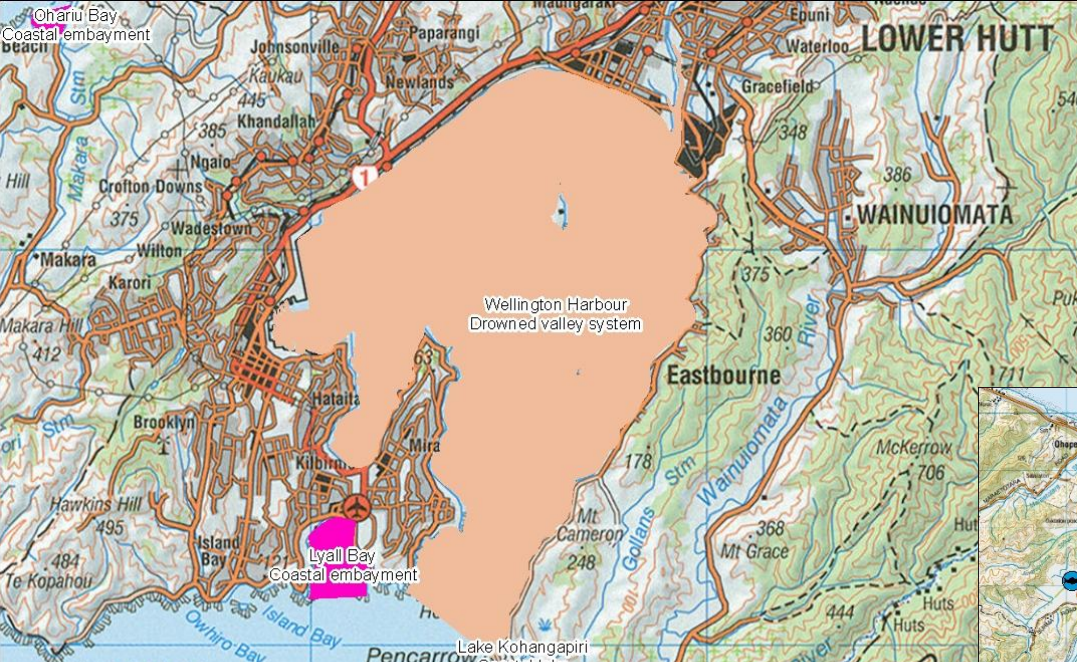
You can click the links above to find out about each estuary type.

GIS and the classification database of estuary properties have been used to map where the different classes of estuaries occur around the New Zealand coast. The 8 classes are denoted by different coloured icons in the Coastal Explorer views.



Department of  
Conservation  
Te Papa Atawhai





# Why? - from a policy and management perspective

- “Dealing with the **hyphen** in the *Freshwater – Ocean interface*”
- NZ coastal hydrosystems are an integral part of the “*ki uta ki tai – mountains to the sea*” management concept





# Coastal hydrosystems illnesses...

- Decline of seagrasses

...and threats

- Mangrove spread
- Sedimentation
- Turbid water
- Contaminants
- Invasive species
- Hydrological changes
- Climate change (SL rise, T, pH)



Drawing: Waikato Regional Council



# In summary: a number of challenges!

- Huge variety of water body type, >400 systems in Hume et al (2007); some in trouble
- Recognising hydrosystems and delimiting their boundaries can be tricky
- Terminology confusing - Terms applied to wetlands and estuaries have been applied and defined in sometimes conflicting ways in the scientific and common language. Creates confusion among managers and planners and in planning documents and unworkable environmental legislation.



# What is the objective of the project?

We aim to produce a wide-ranging terminology and typology of New Zealand *coastal hydrosystems*, complementary of “Wetland types in New Zealand” that can assist with those management challenges



## Part 2: **What are coastal hydrosystems?**






***Hydrosystem:** an ecosystem  
differentiated by broad landform  
and hydrological settings, and by  
water salinity, water chemistry and  
temperature*

*(Johnson and Gerbeaux 2004)*

***Coastal Hydrosystem:** a  
coastal freshwater, brackish  
and/or marine ecosystem  
differentiated by geomorphic,  
hydrological and ecological  
features*

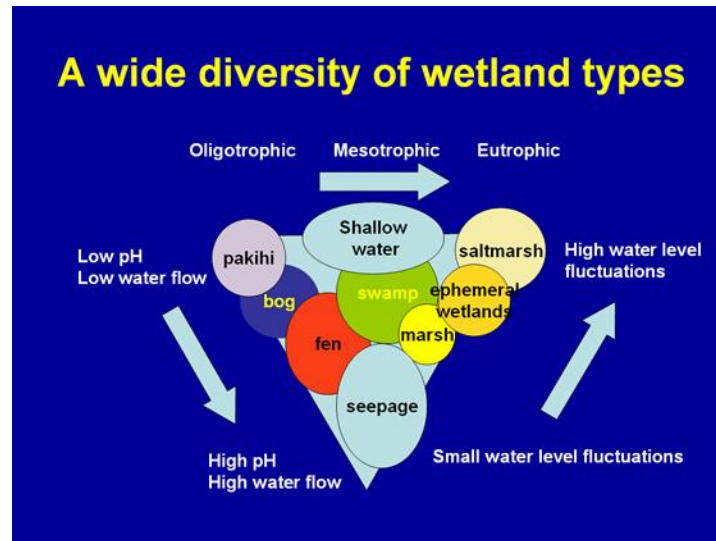
Gradients		Dominant Hydrosystem	Current terminology in use
<i>Shallow</i>  <i>Deep</i>	<i>Freshwater</i>	Lacustrine	Coastal wetland
			Coastal lake
			Waituna lagoon
		Riverine	Coastal stream
			Hillside/Perched stream
			River mouth
			Hapua
			Delta
	Marine	Estuarine	Tidal river
			Tidal lagoon
			Tidal creek
		Marine	Drowned valley
			Sound (Ria)
			Fiord
			Coastal Embayment





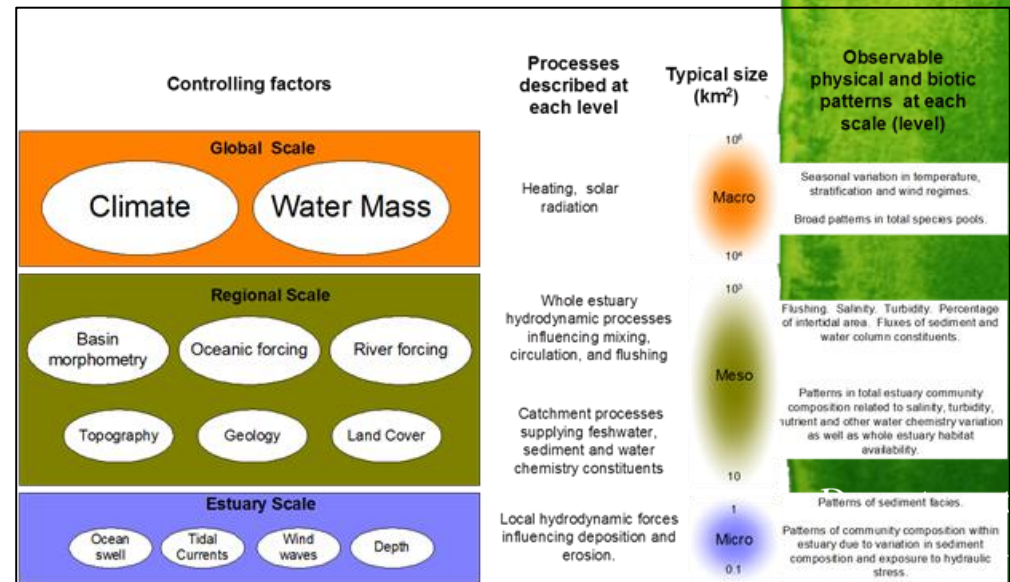
# Methodologies to build on

Wetland



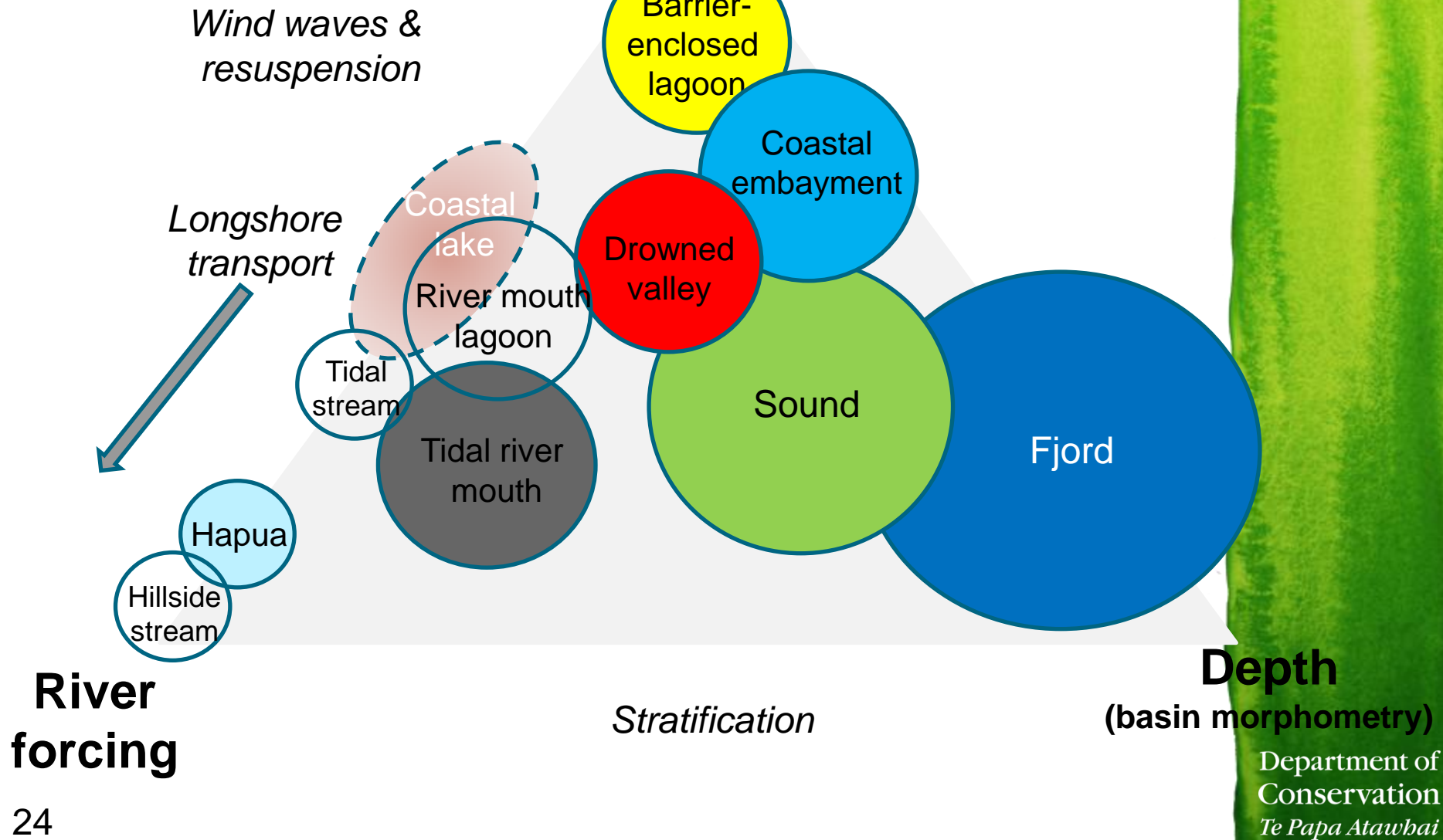
- Not linked
- Both semi-hierarchical
- Both based on controlling factors that capture the functional aspects of those systems

Estuary



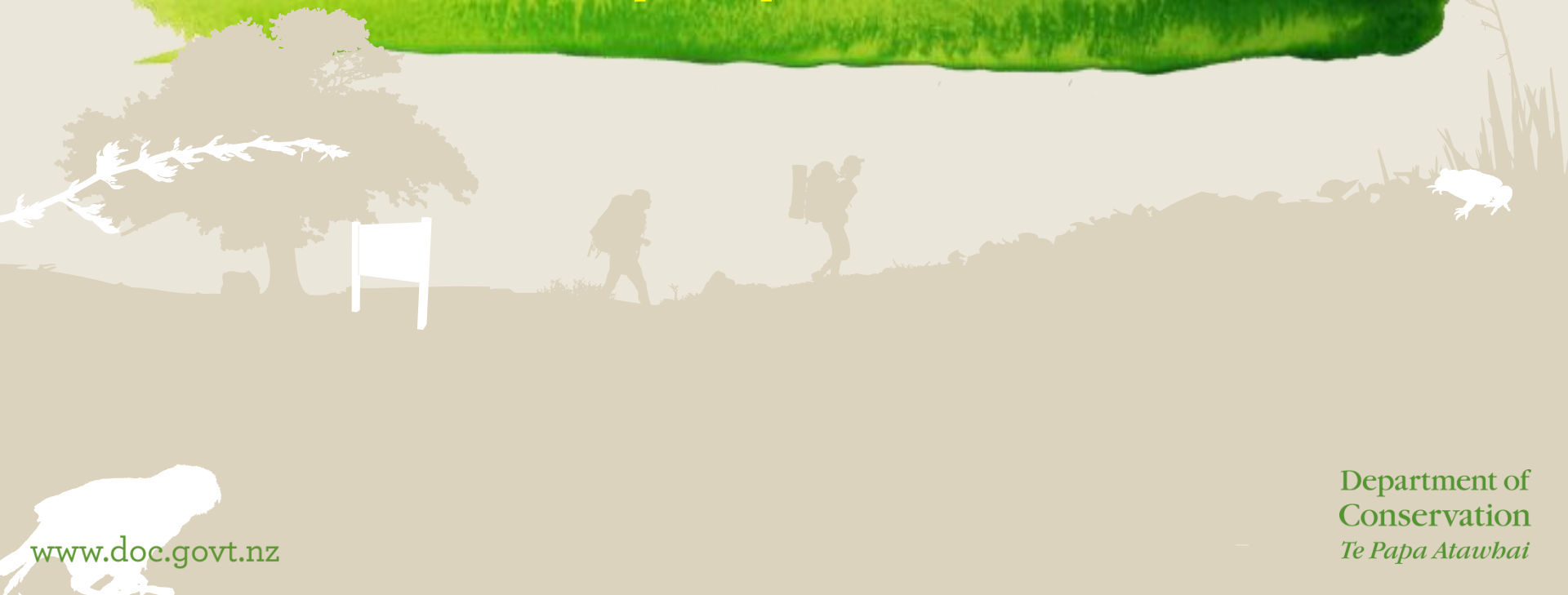


# Tidal forcing





# Part 3: What classification approach for management purpose?





Managing for what values?

Source NIWA

Department of Conservation  
Te Papa Atawhai

## Unhealthy Ecosystem

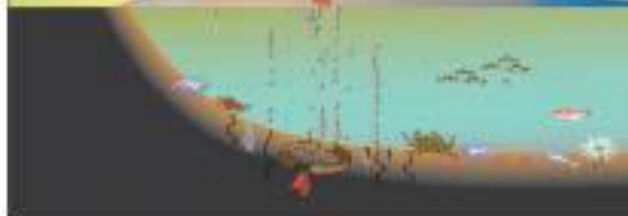


Source Thrush et al 2013)

## Healthy Ecosystem



## Restricted range of Ecosystem Services



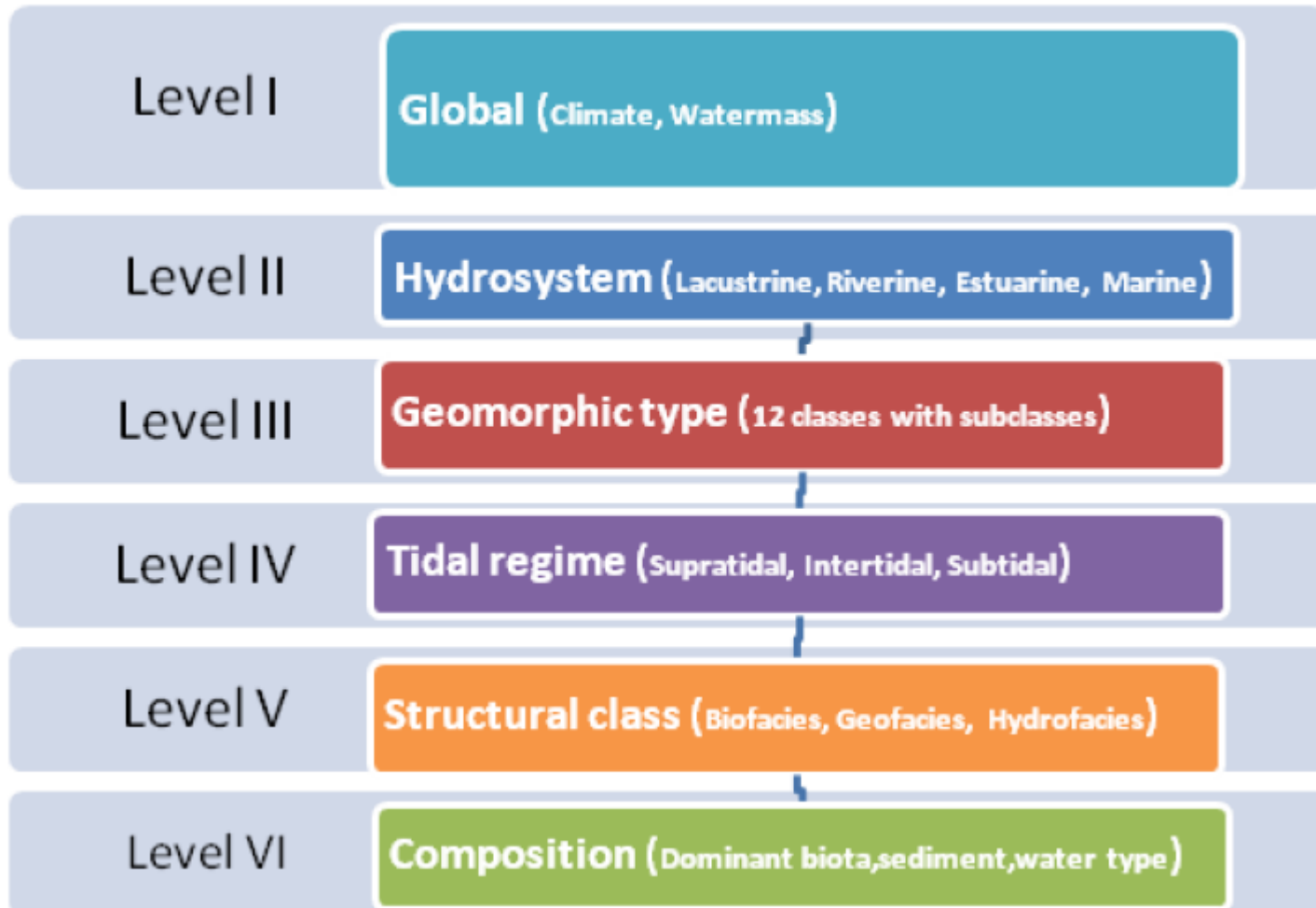
## Greater provision of Ecosystem Services



1. Increased muddy sediments and turbidity
2. Effluent with pathogens and toxic substances
3. Seaweed blooms
4. Lack of oxygen in the sediments
5. Greenhouse gas release
6. Clean beaches
7. Better food resources
8. Retention of sediments
9. Coastal protection
10. Linked foodwebs and large predators
11. Balanced gas exchange
12. Balanced nutrient exchange



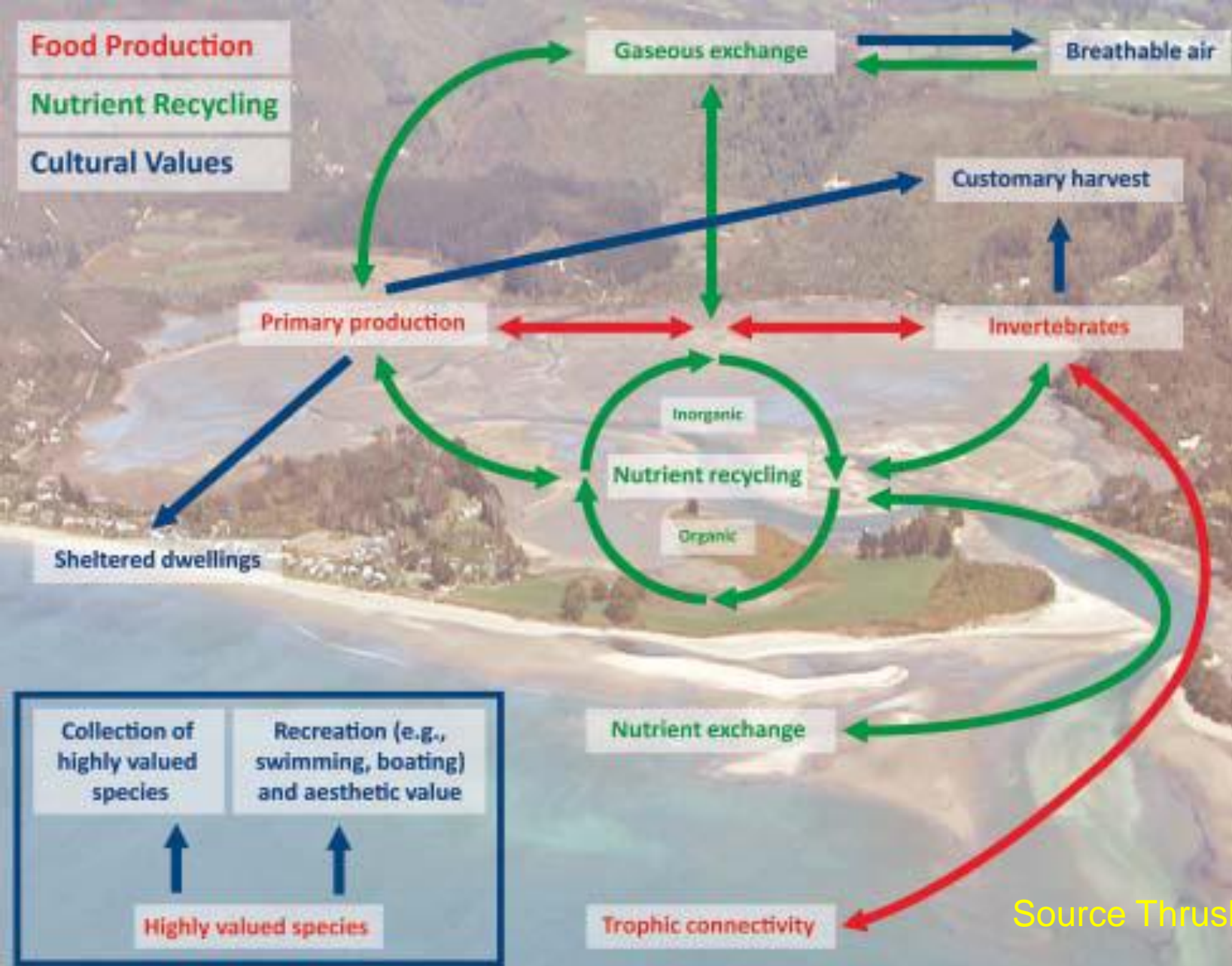
# A semi-hierarchical approach (draft only)



# Coastal hydrosystem classes (geomorphic types)



Dominant hydrosystem (Level II)	Ref#	Geomorphic type (Level III)
Lacustrine	1	Damp sand plain lake
Lacustrine	2	Barrier- or barrier beach-enclosed freshwater lagoon (Waituna) Subtype A: coastal plain depressions Subtype B: valley basins
Riverine	3	Beach stream mouth (Hillside stream) 3 subtypes
Riverine	4	Barrier beach -enclosed wave-dominated river or stream mouth lagoon (Hapua) 4 subtypes
Riverine	5	River mouth 2 subtypes
Riverine/ Estuarine	6	Tidal river mouth 4 subtypes
Estuarine	7	Tidal lagoon 3 subtypes
Estuarine	8	Shallow drowned river valley (Tidal creek)
Estuarine/ Marine	9	Medium depth drowned river valley
Marine/ Estuarine	10	Deep drowned river valley (Ria)
Marine/ Estuarine	11	Drowned glacial valley (Fiord)
Marine	12	Semi-enclosed embayment



Source Thrush et al 2013)

30 What sustains those values? E.g. tidal lagoon



# Bio- facies associated with coastal hydrosystems (when management requires zooming in)

Biofacies (structural class)

Forest	Treeland	Scrub	Shrubland	Flaxland	Tussockland	Fernland	Reedland	Rushland	Sedgeland	Grassland	Cushionfield	Turf	Herbfield	Algalfield	Shellbank	Shelfish field	Wormfield

Key to matrix fill	y=yes						
	n=no						
	s=sometimes						
Key to facies location	intertidal/ subtidal						
	supratidal/ intertidal						
	both						

# Issues and opportunities influencing management



<b>Issue or opportunity</b> (refer to main matrix in section 5 for full list))	<b>Degree of importance</b> (red = major; orange = moderate; green = minor)	<b>Feasibility of intervention</b> (red=difficult; orange = maybe; green = simple)
1. Eutrophication		

Number	Issues and opportunities influencing management responses	Damp sand plain lake	Barrier or barrier beach enclosed	Streammouth or beach stream mouth	Barrier beach enclosed wave dominated	River mouth	Tidal river mouth	Tidal lagoon	Shallow drowned river valley (Tidal)	Drowned medium depth river valley	Drowned deep valley	Fjord	Embayment
1a	Eutrophication – catchment	X	X	X	X	X	X	X	X	X			
1b	Eutrophication - birds				X		X	X					
2a	Species management – threatened	X	X		X	X	X	X	X	X			
2b	Species management – macrophytes		X										
2c	Species management - whitebait			X			X	X					
3	Invasive species (e.g. Undaria, spartina, seasquirt)	X	X							X		X	
4	Hydrology – drainage, groundwater	X	X		X		X						
5	Connectivity – metahabitats	X											
6a	Artificial openings – sea connections		X	X	X				X				
6b	Artificial openings – salinity regime		X										
6c	Artificial openings – flooding		X	X	X		X						
7a	Climate change – sealevel rise	X	X		X	X	X	X	X	X	X	X	X
7b	Climate change – catchment hydrology	X	X			X	X						
7c	Climate change – wave action		X										
7d	Climate change – acidification												
8a	Margins impact – grazing, landuse, pests	X	X			X	X						
8b	Catchment impact – landuse changes, sedimentation						X		X	X	X		
9	Water extraction/diversion	X	X		X	X			X			X	
10	Erosion		X		X	X	X	X			X		
11	Barrier breaching		X										
12	Fish passage		X		X								
13	Sediment mining		X			X							
14	Cultural sites of significance		X			X			X	X	X		
15	Knowledge gaps	X	X	X			X						
16	Urbanisation – baches, contaminants, coverage					X	X	X	X	X?			X

# Example of use in planning



**IN THE MATTER OF:** the Resource  
Management Act 1991  
AND

**IN THE MATTER OF:** a submission on the  
Proposed Canterbury Land and Water Regional Plan  
Variation 3

EVIDENCE OF DR PHILIPPE GERBEAUX  
FOR DIRECTOR-GENERAL OF CONSERVATION  
Dated 25 September 2015

Director General of Conservation  
Private Bag 4715,  
Christchurch 8140  
Tel: (03) 371 3700  
Counsel: Susan Newell

## CONCLUSIONS

- Wainono is a coastal barrier-beach enclosed lagoon (Waituna type) which through its shallowness, brackishness and salinity and water level regimes functions differently from deeper and freshwater lakes.

## WHAT TYPE OF HYDROSYSTEM IS WAINONO LAGOON

- I am proposing first to review the terminology used to describe Wainono lagoon.
- Classifications and typologies enable the use and sharing of common terms and are therefore very important to be understood and used in policy, research and management issues (Gerbeaux et al in press).
- Wainono Lagoon has been described as a Waituna type lagoon (Kirk and Lauder 2000), which can be further defined as a barrier- or 'barrier beach-enclosed freshwater-dominated lagoon' (Hume et al *in prep*), more usually closed from the sea than opened to it. For those lagoons more usually opened than closed, an appropriate term is 'tidal lagoon' (Hume et al *in prep*).
- A key feature of such coastal barrier- or barrier beach-enclosed system relates to their lacustrine hydrosystem characteristics which may allow some to call them coastal shallow lakes (e.g. Schallenberg and Saulnier-Talbot 2014).
- Coastal hydrosystems, as I have highlighted above, are not necessarily functioning like inland shallow lake hydrosystems and even if Wainono is one example of coastal hydrosystems dominated by lacustrine types of processes, its brackishness, shallowness and particular regime of water level and salinity fluctuations combine to produce characteristics tending to indicate a different type of functioning than that of a normal lake.** A reference in the proposed model to the new 'CLUES' estuary tool developed by NIWA (Plew et al 2015) may be desirable



## Key message

*“To generate clear understanding and coherent management of coastal hydrosystems we need a good classification and consistent terminology. Otherwise there is confusion amongst scientists, managers and planners reflected in inconsistent or technically incorrect use of words in scientific, planning and legislative documents.”*



# Acknowledgements:

**Terry Hume, Don Neale, Deirdre Hart, Helen Kettles and MfE for supporting our project**





If interested by this project please  
email me:

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Feel free to pass on to me  
(urgently!) any burning question  
that relate to your management  
needs