Manaaki Whenua
Landcare Research

Wetlands: recent research and current initiatives

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Outline

- A Background
- B Wetland programme research
- C New tools
- D Implications for policy




A Background

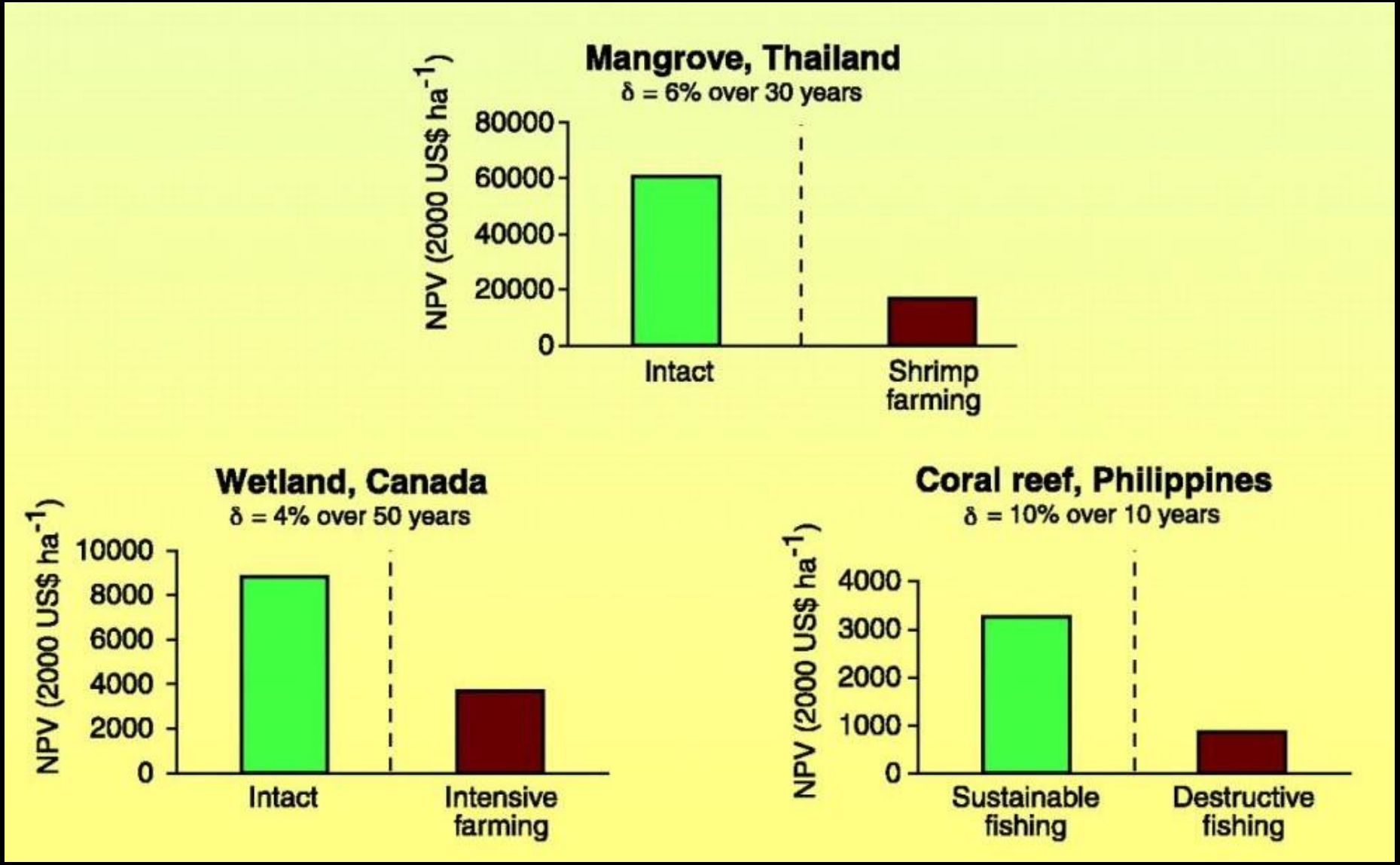
Wetland definition: Permanently or intermittently wet areas, shallow water, and land water margins that support a natural ecosystem of plants and animals that are adapted to wet conditions (RMA 1991)

Kepler Mire Te Anau

Importance of wetlands

- Provide large environmental, economic, social & cultural benefits
  - Regulate water quality/ quantity, global nutrient/ C budgets, provide food
- Wetlands one of the most valuable ecosystems in world
  - NZ wetland ecosystem services estimated at \$34 184 ha^{-1} yr^{-1} (Cole & Patterson 1997)
- NZ wetlands have been severely reduced since European settlement – 90% loss (Ausseil et al. 2008)
- NZ wetlands continue to degrade
  - drainage, nutrients, weeds, pests

$ Value of retaining vs converting natural habitats

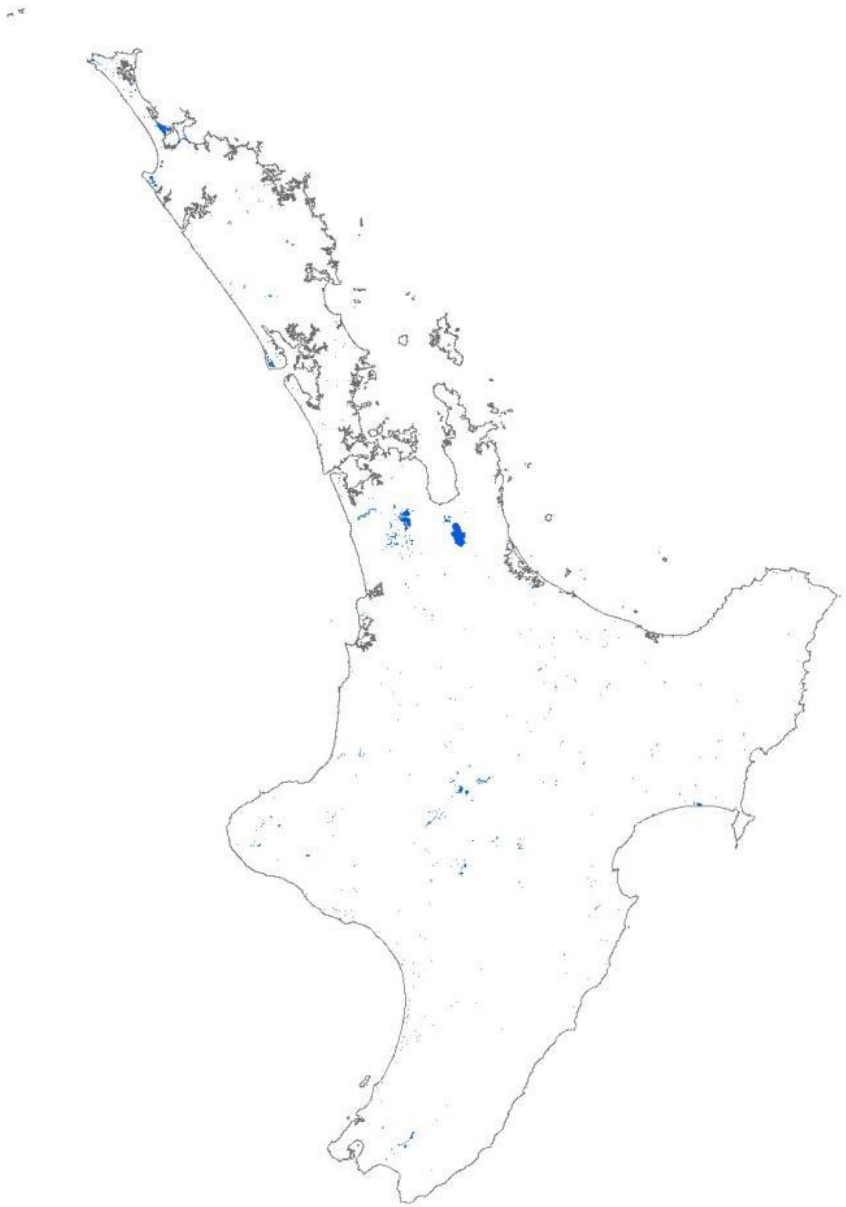


NPV = net present value

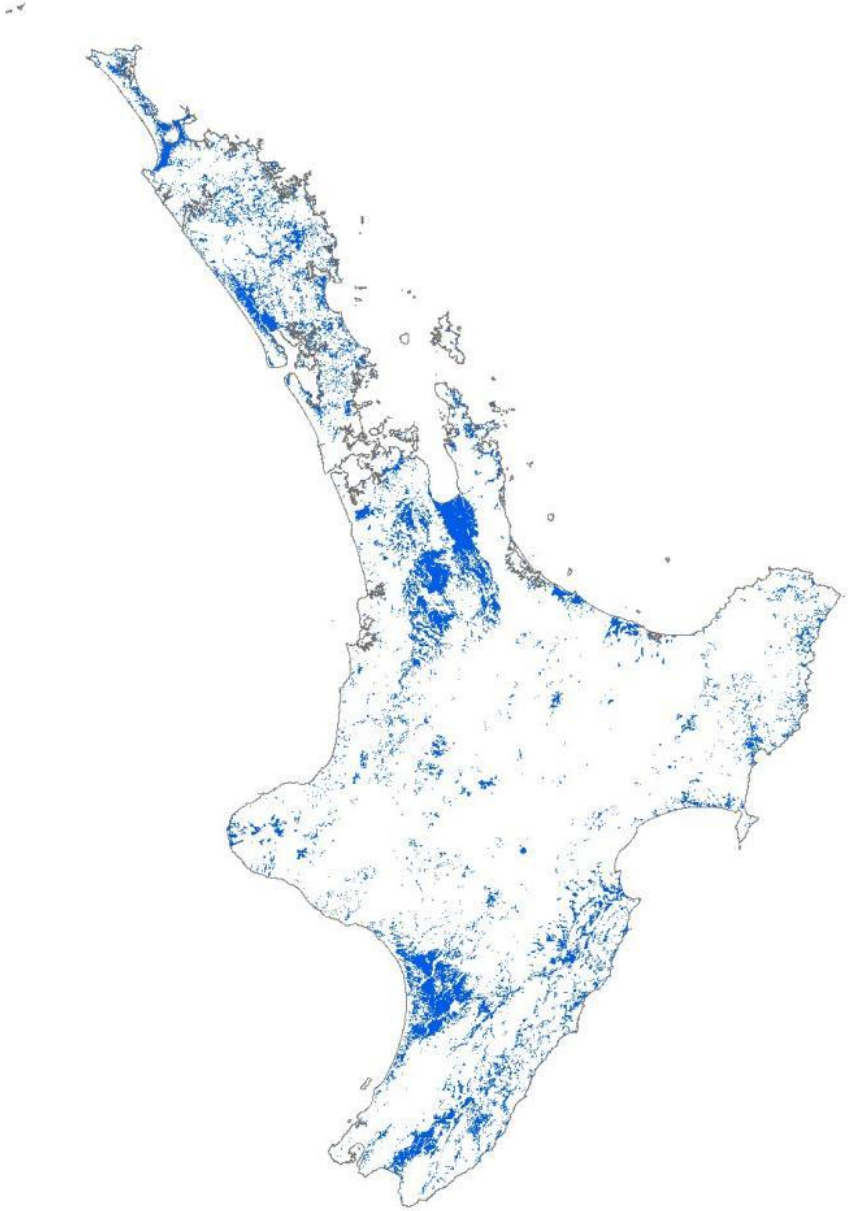
'Economic reasons for conserving wild nature' Balmford et al. 2002 Science 297: 950-953

North Island

Current extent



Historic extent

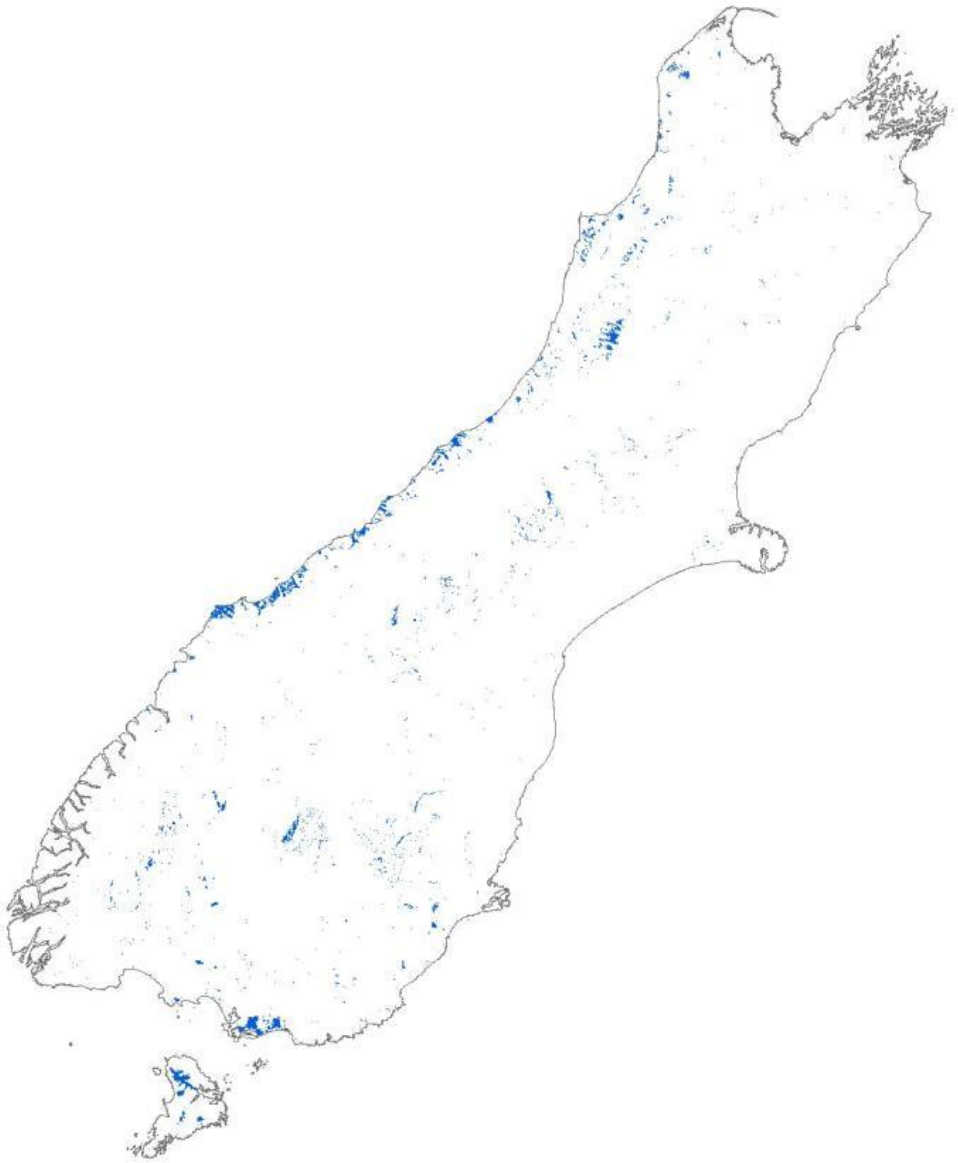


North Island = 4.9% remaining

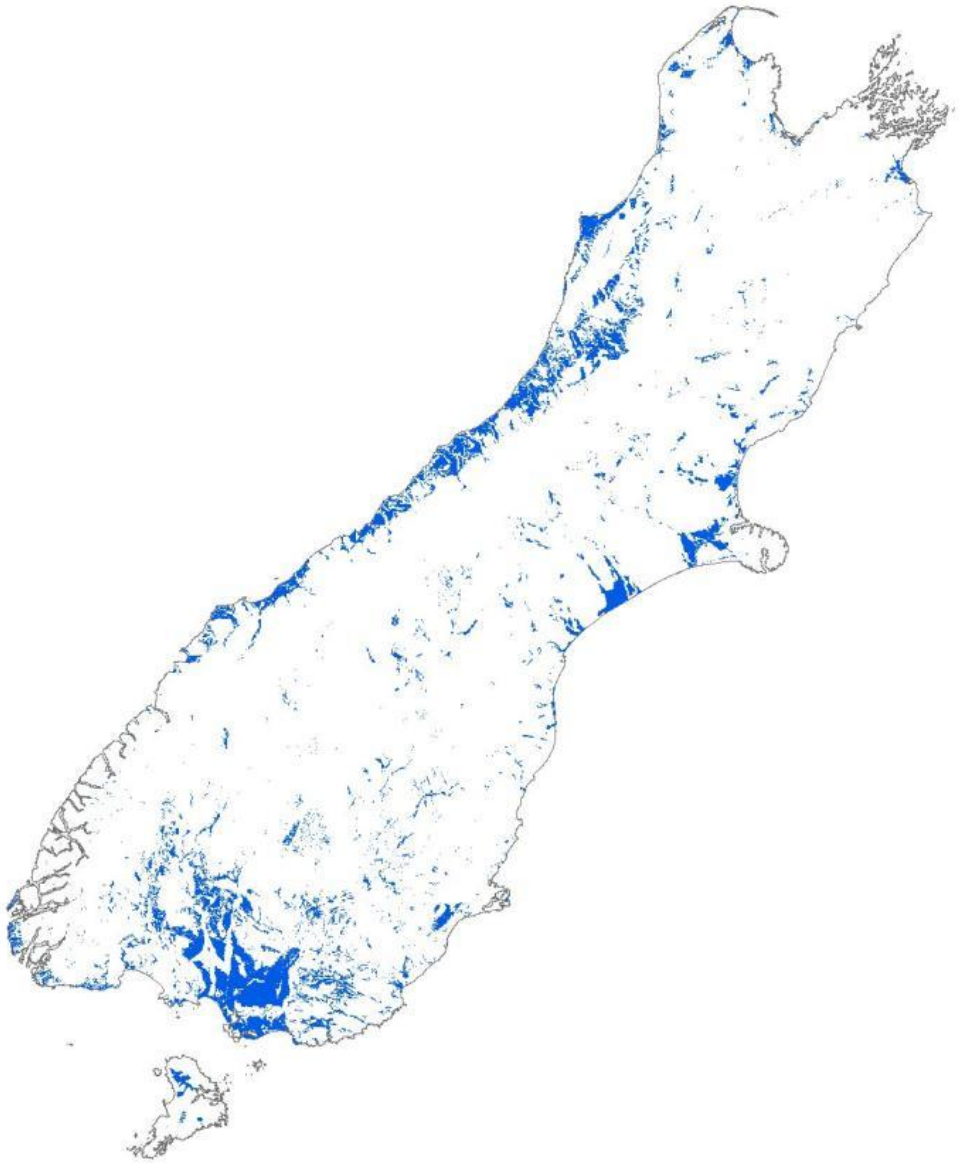
Ausseil et al. 2008

South Island

Current extent



Historic extent



South Island = 16.3% remaining

New Zealand = 10% remaining

Ausseil et al. 2008

Threatened ecosystems

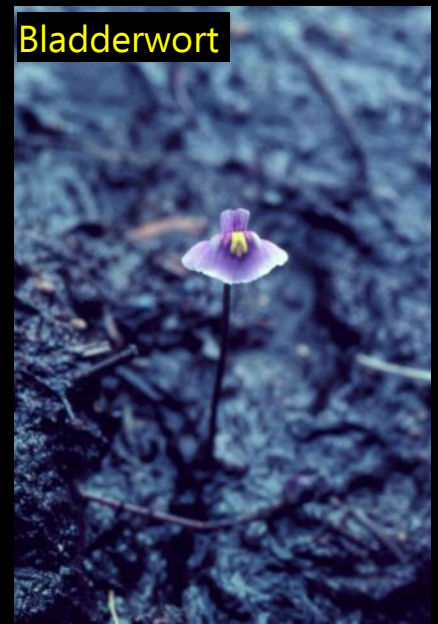
- Wetlands contain disproportionate no. of NZ's threatened species
- Wetlands cover <1% of NZs land area yet contain
  - 12% of all threatened invertebrates
  - 16% of nationally critical bird species (Hitchmough et al. 2007)
  - 23% vascular plants class'd threatened/uncommon (de Lange et al. 2009)

'Fred the thread'

Mudfish

Australasian Bittern

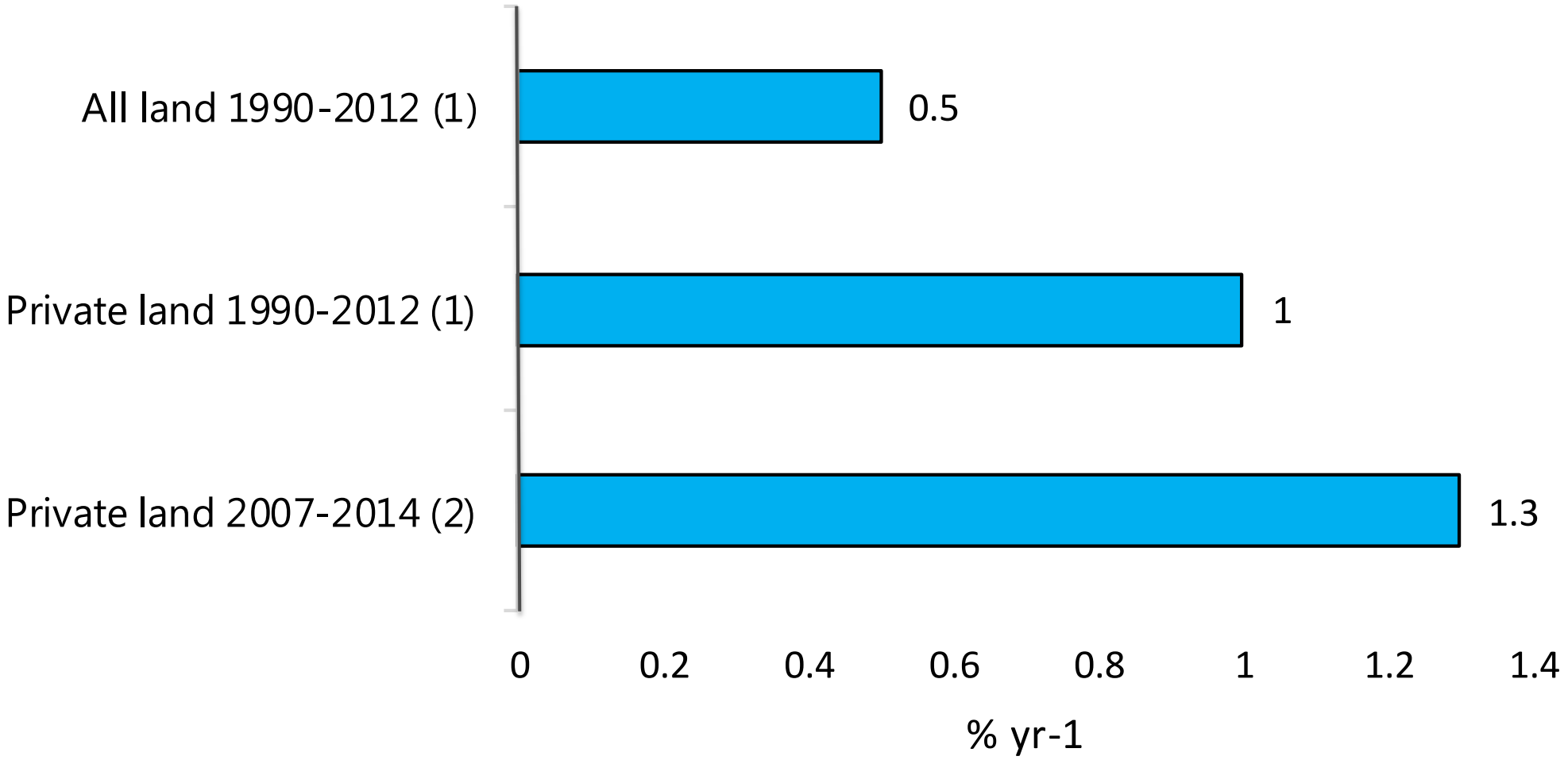
Bladderwort



Policy to protect wetlands

- Resource Management Act (RMA 1991 Sections 6a, 6c)
  - protection & management of wetlands as matters of national importance
- Government National Priorities for protecting indigenous biodiversity on private land 2007 (MfE, DOC)
- NPS-Freshwater Management 2014
  - Key requirement: protect the significant values of wetlands
- NPS-Indigenous Biodiversity under development
  - Aiming to strengthen protection of wetland biodiversity

Southland: rate of wetland loss post-RMA



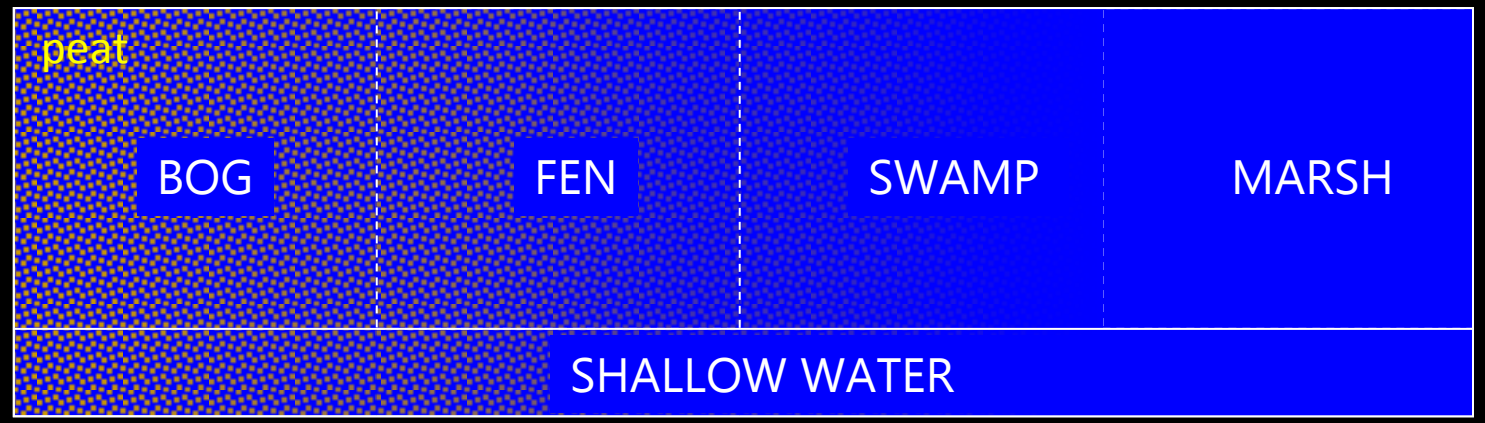
(1) Robertson et al. 2019; (2) Ewans 2016

B Wetland Research Programme

- Wetland function & restoration (MWLR, NIWA, UOW, DOC, Waikato Tainui)
- The key to restoration is understanding wetland function
- Wetland types are classified according to water supply and nutrients (Johnson & Gerbeaux 2004)




Classification of freshwater wetlands



Water source	Rainfall	→	Groundwater	→	Surface water
Water fluctuation	Low	→	Medium	→	High
Nutrients	Low	→	Medium	→	High
pH	Low/acidic	→	Medium	→	Neutral/high

Wetland types

Bog

Swamp

Bog

Fen

Marsh

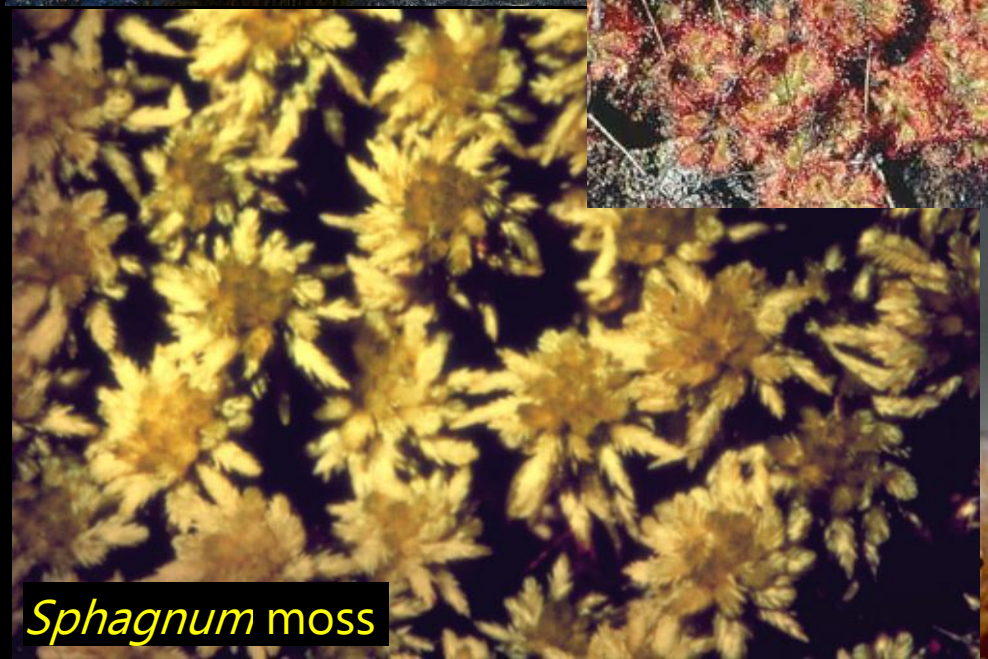
Bog species

Cane rush *Sporadanthus*

Bladderwort *Utricularia*

Sundew *Drosera*

Wire rush *Empodisma*



Sphagnum moss

Empodisma cluster roots

Fen species


Tī kouka Cordyline
Harakeke *Phormium*


Tangle fern *Gleichenia*


Sedge *Machaerina*

Swamp species


Raupo *Typha*


Kuta *Eleocharis*


Carex


Carex

Recent Wetland Programme Products

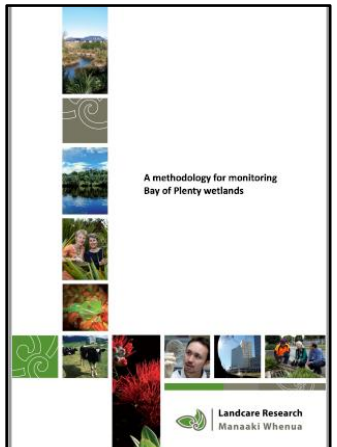
Research papers, chapters, reports

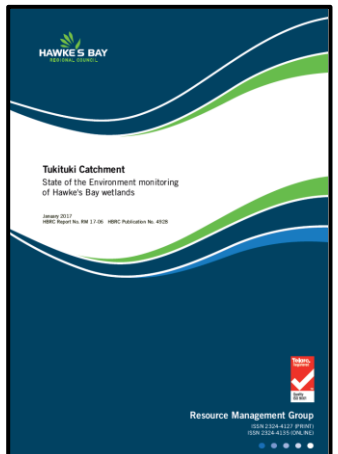
- Function: litter decomposition, nutrient limitation, C dynamics, resilience to drainage
- Restoration: willow control, native vegetation, invertebrates, cut-over bog, hydrology

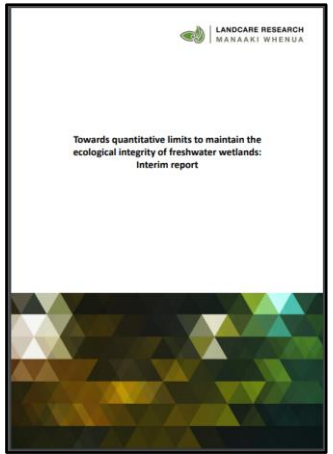
Handbooks/tools

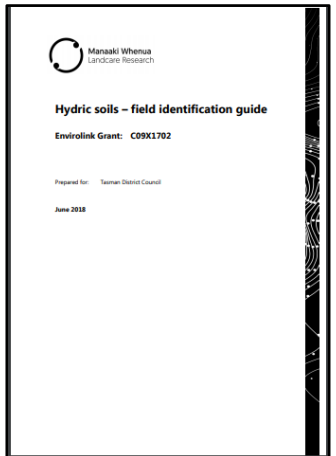
- Wetland restoration handbook: 2010, reprinted 2012 (Peters & Clarkson 2012)
- Te Reo o te Repo (The voice of the wetland) cultural handbook 2017 (Taura et al. 2017)
- Wetland monitoring tool: WCI (Wetland Condition Index) 2004 (Clarkson et al. 2004)
- Revised condition monitoring handbook 2014 (Clarkson et al. 2014, Clarkson & Bartlam 2017)
- Management/policy: interim limits to maintain ecological integrity 2015 (Clarkson et al. 2015)
- Delineation tools: Vegetation (Clarkson 2014), Hydric soils (Fraser et al 2018), Protocols (Clarkson 2018)

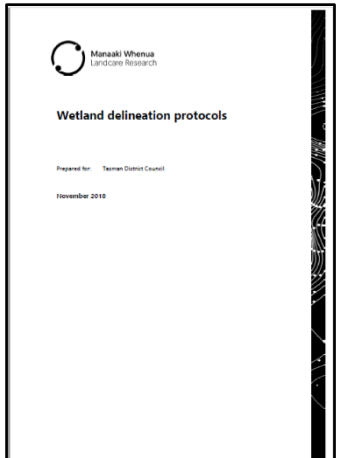
MWLR Website: Google: 'Restoring wetland ecosystem function'

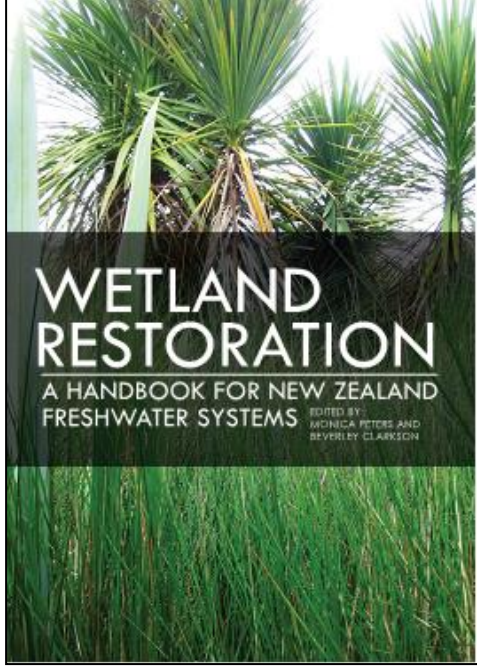


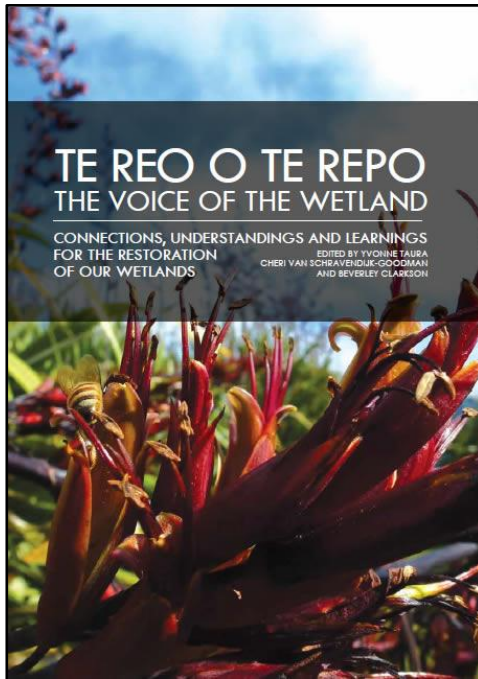








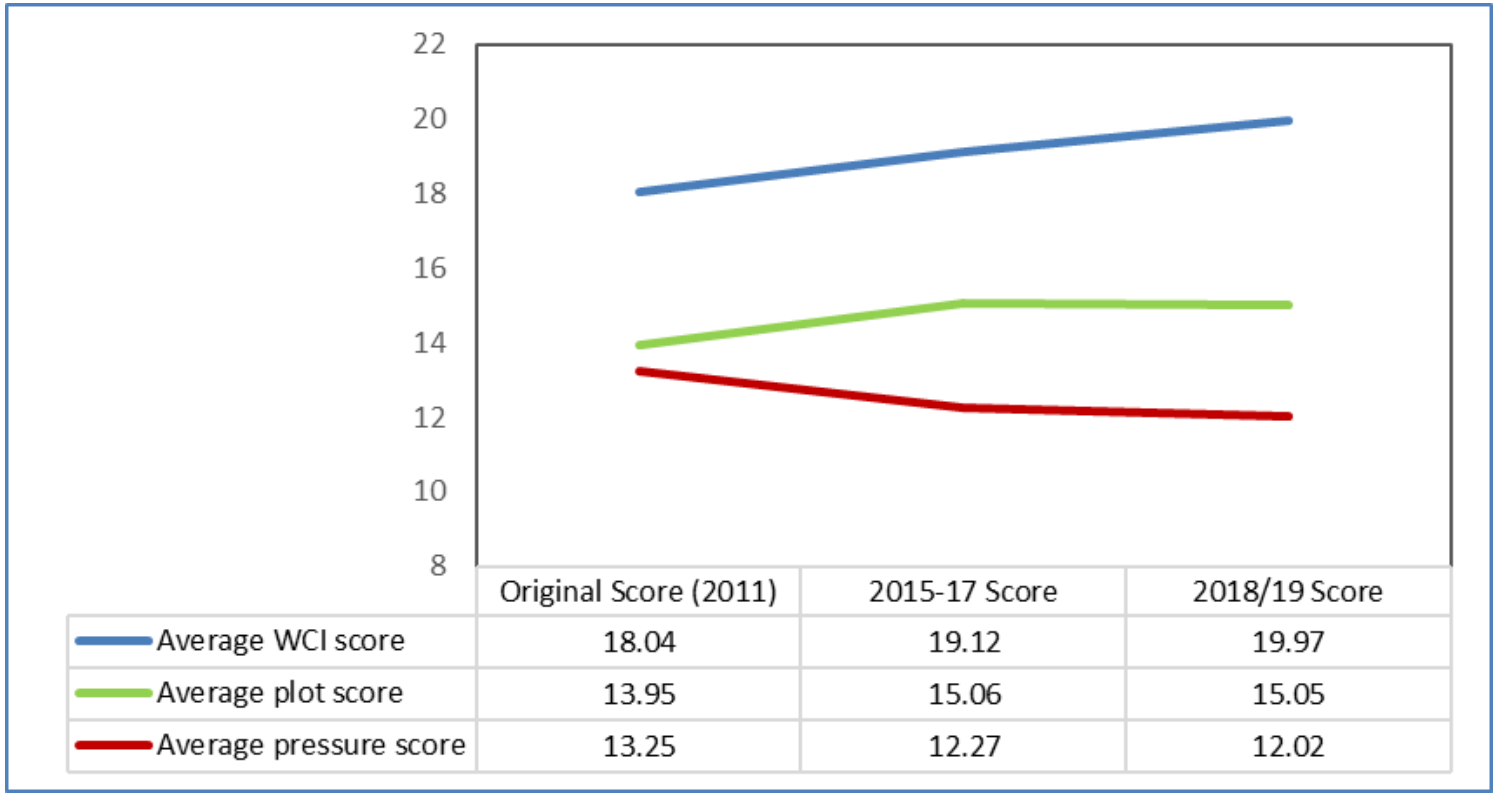




Wetland condition monitoring NRC 2011-2018

Improvements due to:

Initial fencing (env funding)
Improved plant cover
Improved native vs exotic veg
Improved awareness
Some animal pest control



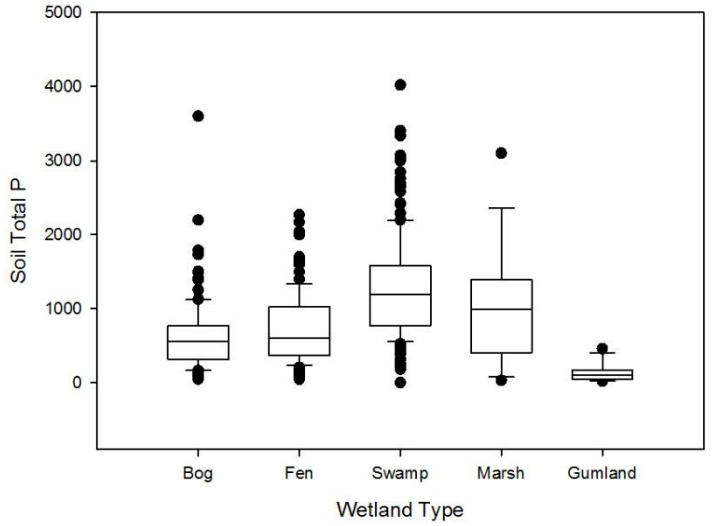
	Original Score (2011)	2015-17 Score	2018/19 Score
Average WCI score	18.04	19.12	19.97
Average plot score	13.95	15.06	15.05
Average pressure score	13.25	12.27	12.02

n = 28 wetlands

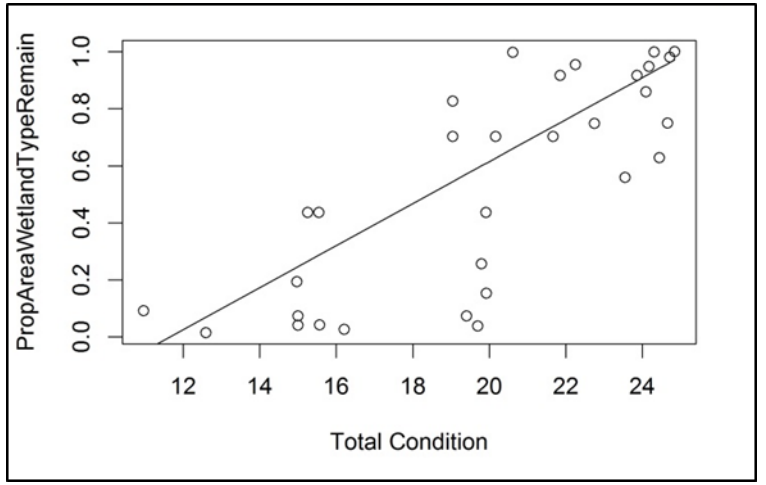
Lisa Forester, Northland Regional Council

Limits to maintain Ecological Integrity

- Preliminary development of attributes for NOF under NPS-FM
- Soil TP, wetland % remaining correlated with Ecological Integrity
- Most practical option=no net loss & management/restoration



Box plots of soil Total P (%) in wetland types



Bogs: % area remaining & wetland condition

Clarkson, Overton, Ausseil, Robertson 2015

C New Tools - Wetland Delineation

How to tell our wetlands from our drylands

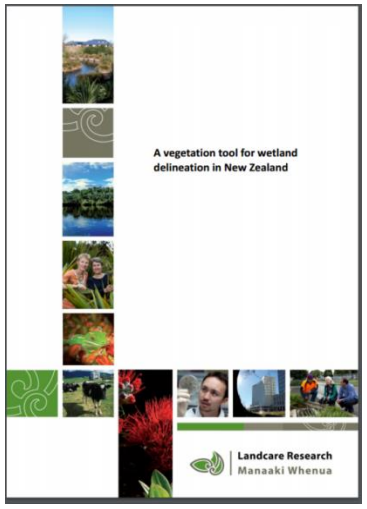
- **ISSUE:** RMA wetland definition difficult to apply on-the-ground
- Need tool(s) to determine whether a site is a wetland or not

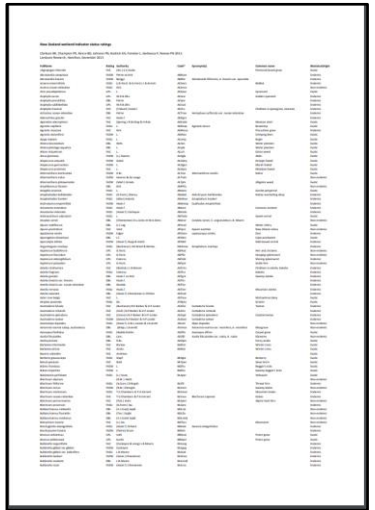
RMA Wetland Definition: Permanently or intermittently wet areas, shallow water, and land water margins that support a natural ecosystem of plants and animals that are adapted to wet conditions.

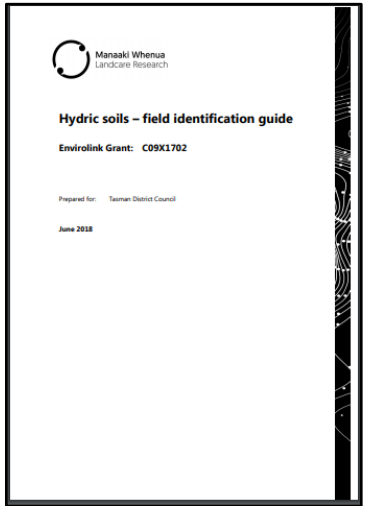
NZ Wetland Delineation: Adapt USA system

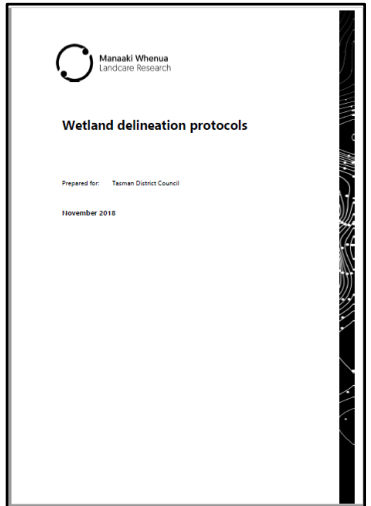
- USA: 3 criteria – vegetation, soils, hydrology (US Army Corps of Engineers 1987 & updates)
  - All 3 required for site to be a wetland
- NZ Vegetation Tool. Based on plant species fidelity to wetland. Completed 2014
- NZ Soil Tool. Hydric soils or reducing conditions present. Completed 2018.
- NZ Hydrology Tool: yet to do…..
- Overall protocols: Completed 2018 (minus full hydrology tool)

US Wetland Training Institute Course San Diego 2012



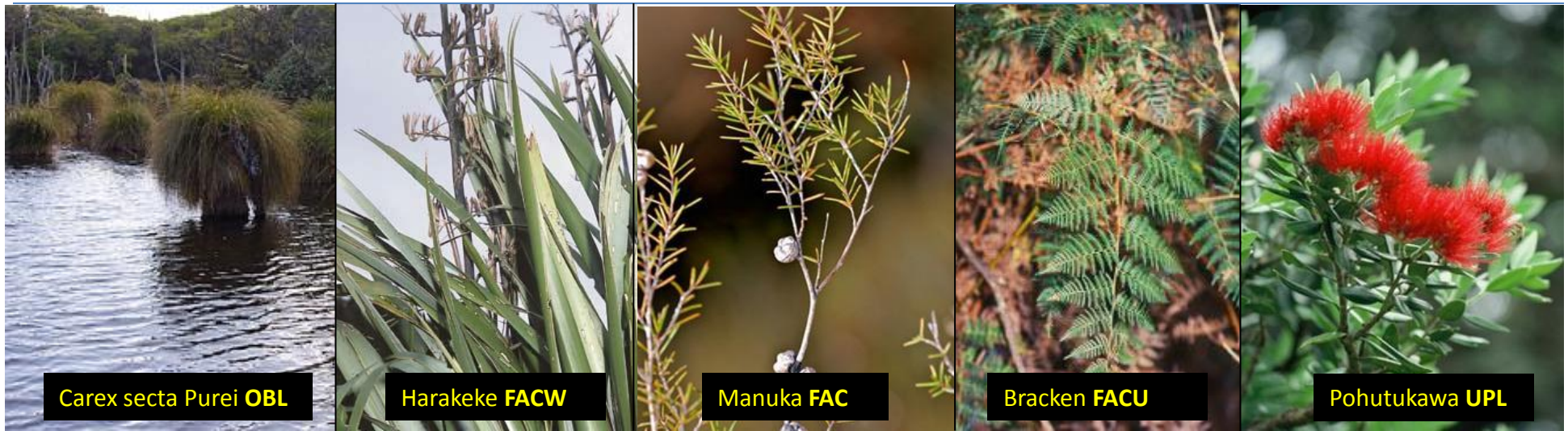






1. Vegetation Tool: Wetland Habitat Classes

- OBL: Obligate wetland. Rarely in uplands (drylands). Estimated probability >99% in wetlands
- FACW: Facultative Wetland. Usually in wetlands, occ. in uplands (67-99%)
- FAC: Facultative. Commonly occurs in wetlands and uplands (34-66%)
- FACU: Facultative Upland. Occasionally in wetlands but usually in uplands (1-33% in wetlands)
- UPL: Obligate Upland. Rarely in wetlands, almost always in uplands (<1%)



New Zealand wetland indicator status ratings

Clarkson BR, Champion PD, Rance BD, Johnson PN, Bodmin KA, Forester L, Gerbeaux P, Reeves PN 2013. Landcare Research, Hamilton, December 2013

FullName	Rating	Authority	Code*	Synonym(s)	Common name	BiostatusOrigin
×Agropogon littoralis	FAC	(Sm.) C.E.Hubb.			Perennial beard grass	Exotic
Abrotanella caespitosa	FACW	Petrie ex Kirk	ABRcae			Endemic
Abrotanella linearis	FACW	Berggr.	ABRlin	Abrotanella filiformis, A. linearis var. apiculata		Endemic
Acaena anserinifolia	FACU	(J.R.Forst. & G.Forst.) J.B.Armstr.	ACAans		Bidibid	Endemic
Acaena novae-zelandiae	FACU	Kirk	ACAnov			Non-endemic
Acer pseudoplatanus	UPL	L.	ACEpse		Sycamore	Exotic
Aciphylla aurea	UPL	W.R.B.Oliv.	ACIaur		Golden spaniard	Endemic
Aciphylla pinnatifida	OBL	Petrie	ACIpin			Endemic
Aciphylla subflabellata	UPL	W.R.B.Oliv.	ACIsub			Endemic
Aciphylla traversii	FAC	(F.Muell.) Hook.f.	ACItrv		Chatham Is speargrass, taramea	Endemic
Actinotus novae-zelandiae	OBL	Petrie	ACTnov	Hemiphues suffocata var. novae-zelandiae		Endemic
Adenochilus gracilis	FAC	Hook.f.	ADEgra			Endemic
Ageratina adenophora	FAC	(Spreng.) R.M.King & H.Rob.	AGEade		Mexican devil	Exotic
Agrostis capillaris	FACU	L.	AGRcap	Agrostis tenuis	Browntop	Exotic
Agrostis muscosa	FAC	Kirk	AGRmus		Pincushion grass	Endemic
Agrostis stolonifera	FACW	L.	AGRsto		Creeping bent	Exotic
Ajuga reptans	FACU	L.	AJUrep		Bugle	Exotic
Alisma lanceolatum	OBL	With.	ALIlan		Water plantain	Exotic
Alisma plantago-aquatica	OBL	L.	ALIpla		Water plantain	Exotic
Allium triquetrum	FAC	L.	ALLtri		Onion weed	Exotic
Alnus glutinosa	FACW	(L.) Gaertn.	ALNglu		Alder	Exotic
Alopecurus aequalis	FACW	Sobol.	ALOaeq		Orange foxtail	Exotic
Alopecurus geniculatus	FACW	L.	ALOgen		Marsh foxtail	Exotic
Alopecurus pratensis	FAC	L.	ALOpra		Meadow foxtail	Exotic
Alternanthera denticulata	FACW	R.Br.	ALTses	Alternanthera sessilis	Nahui	Exotic

http://www.landcareresearch.co.nz/__data/assets/pdf_file/0014/64400/wetland_rating_species_December_2013.pdf

Currently 1066 native and exotic species with wetland indicator status rating

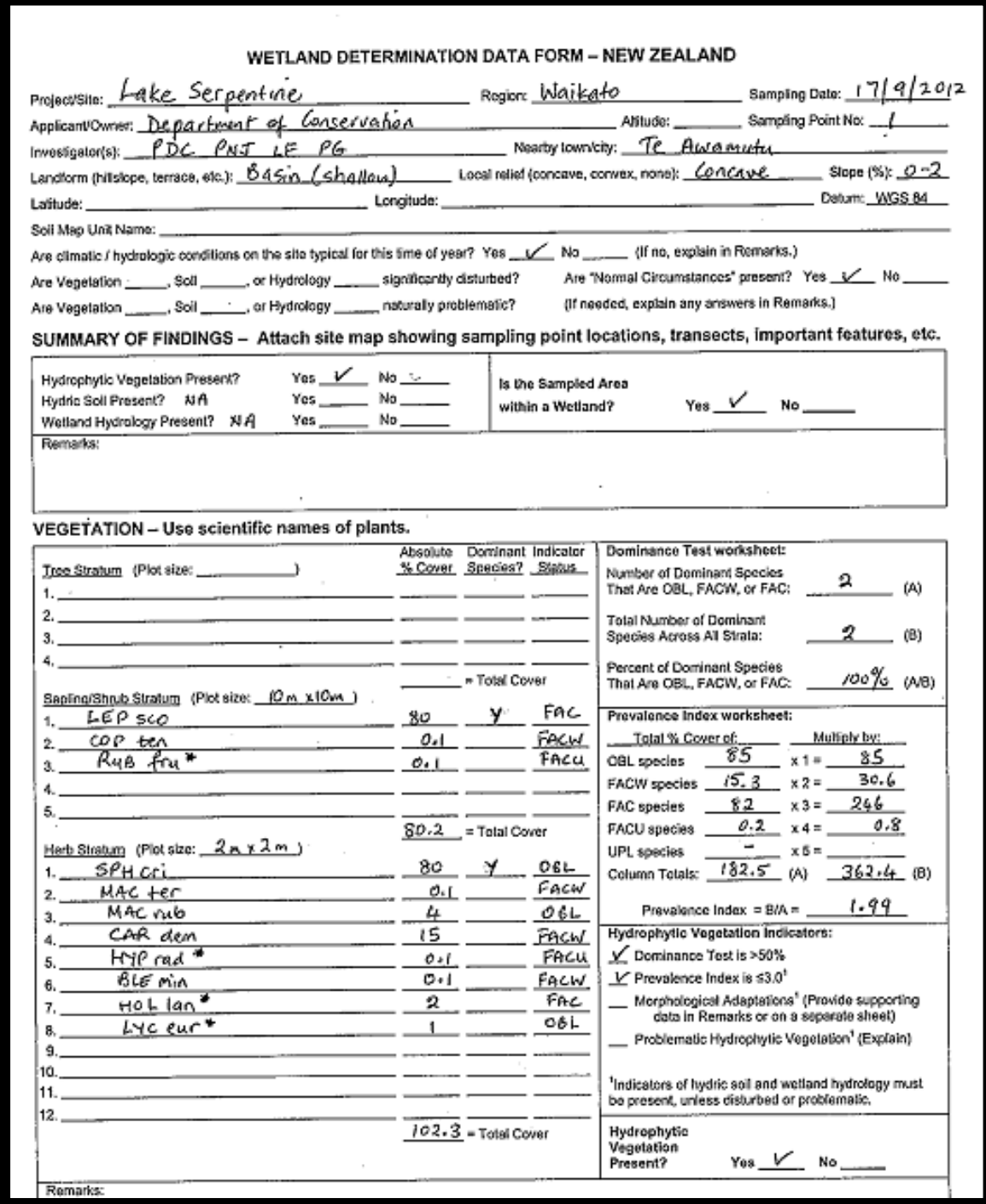
Rotopiko/Lake Serpentine wetland vegetation

Dominance Test >50% of dominant species are OBL, FACW or FAC
Prevalence Index < or = 3

Wetland threshold (both DT and PI required if using only Vegetation Tool)

Plot	Dominance Test %	Wetland vegetation?	Prevalence Index	Wetland vegetation?
1	100	Yes	1.99	Yes
2	100	Yes	2.44	Yes
3	75	Yes	2.70	Yes
4	50	No	3.61	No
5	50	No	3.52	No

Vegetation Wetland Determination Data Form Plot 1 Lake Serpentine



WETLAND DETERMINATION DATA FORM – NEW ZEALAND

Project/Site: Lake Serpentine Region: Waikato Sampling Date: 17/9/2012
Applicant/Owner: Department of Conservation Altitude: _____ Sampling Point No: 1
Investigator(s): PDC PNJ LE PG Nearby town/city: Te Awamutu
Landform (hillslope, terrace, etc.): Basin (shallow) Local relief (concave, convex, none): Concave Slope (%): 0-2
Latitude: _____ Longitude: _____ Datum: WGS 84
Soil Map Unit Name: _____
Are climatic / hydrologic conditions on the site typical for this time of year? Yes ✓ No _____ (If no, explain in Remarks.)
Are Vegetation _____, Soil _____, or Hydrology _____ significantly disturbed? Are "Normal Circumstances" present? Yes ✓ No _____
Are Vegetation _____, Soil _____, or Hydrology _____ naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present? Yes ✓ No _____
Hydric Soil Present? NA Yes _____ No _____
Wetland Hydrology Present? NA Yes _____ No _____
Is the Sampled Area within a Wetland? Yes ✓ No _____
Remarks:

VEGETATION – Use scientific names of plants.

Tree Stratum (Plot size: _____)	Absolute % Cover	Dominant Species?	Indicator Status
1.			
2.			
3.			
4.			
	= Total Cover		
Sapling/Shrub Stratum (Plot size: 10m x10m)			
1. LEP sco	80	Y	FAC
2. COP ten	0.1		FACW
3. RUB fru *	0.1		FACU
4.			
5.			
	80.2 = Total Cover		
Herb Stratum (Plot size: 2m x 2m)			
1. SPH cri	80	Y	OBL
2. MAC ter	0.1		FACW
3. MAC rub	4		OBL
4. CAR den	15		FACW
5. HYP rad *	0.1		FACU
6. BLE min	0.1		FACW
7. HOL lan *	2		FAC
8. LYC eur *	1		OBL
9.			
10.			
11.			
12.			
	102.3 = Total Cover		

Dominance Test worksheet:
Number of Dominant Species That Are OBL, FACW, or FAC: 2 (A)
Total Number of Dominant Species Across All Strata: 2 (B)
Percent of Dominant Species That Are OBL, FACW, or FAC: 100% (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:	
OBL species	85	x 1 =	85
FACW species	15.3	x 2 =	30.6
FAC species	82	x 3 =	246
FACU species	0.2	x 4 =	0.8
UPL species	–	x 5 =	
Column Totals:	182.5 (A)		362.4 (B)

Prevalence Index = B/A = 1.99

Hydrophytic Vegetation Indicators:
✓ Dominance Test is >50%
✓ Prevalence Index is ≤3.0[1]
___ Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)
___ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? Yes ✓ No _____
Remarks:

NZ data form adapted from US Army Corps of Engineers

Wetland vegetation determination

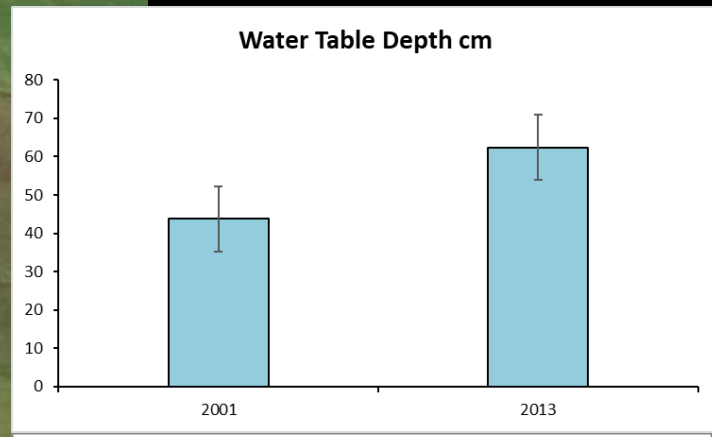
- Rapid Test: visual assessment – not expanded in NZ Vegetation Tool 2014; included in Protocols 2018.
- Dominance Test (DT): plot % cover data – dominant species
- Prevalence Index (PI): plot % cover data – all species
- Standard vegetation tool on its own useful for 80–90% of wetlands

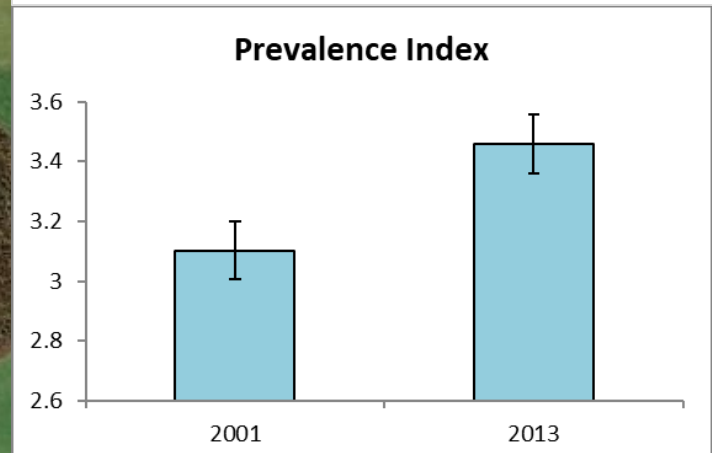
- Problematic situations
  - where DT and PI don't agree, vegetation cover sparse or absent, dominated by FAC species, or modified ie not 'normal circumstances'
  - In these cases use soils and hydrology, & historical information

Lake Maratoto peatland: use of Prevalence Index

Water table & vegetation changes 2001-2013

P5: E1802198 N5804439
P4: E1802277 N5804415
P3: E1802354 N5804386
P2: E1802428 N5804356
P1: E1802497 N5804314





Fire 1993

2. A Hydric Soil Tool for Wetland Delineation

Hydric soil - definition

Soils that have formed under conditions of saturation, flooding or ponding that has caused anaerobic (low oxygen) conditions in at least the upper 30 cm of the soil (based on Federal Register, 1994)

Pedologists: Scott Fraser, Peter Singleton

Understanding soil-landscape relationships

Munsell Soil Color Book

Determination is for top 30 cm of soil


Low
Chroma
Colours
High
Chroma
Colours
25 . 11 . 2013

Soil Wetland Determination Form: S9, Waikoha Station, Waikato Fraser et al. 2018

NZ soil form adapted from US Army Corps of Engineers

WETLAND DETERMINATION FORM – NEW ZEALAND: SOIL

Site: Waikoha Station | Region: Waikato (Te Pahu) | Sampling Point/ID: S9
Owner/address: Waikoha Rd | Land management: Extensive - dry stock | Date: 30/5/17 | Slope (°): 1-2
Landform: Steep hillcountry | Local relief: Very gentle slope | NZTM (E): 1784294
Soil drainage (circle) W MW I (P) VP | Land cover: Herbaceous freshwater vegetn | NZTM (N): 5806087
Investigator: SF | Hydrologic features: Seep at head of gully | Altitude (m): 231

Are climatic/hydrologic conditions on the site typical for this time of year? Yes ✓ No ___ Is the site drained? Yes ✓ No ___
Is the soil disturbed or problematic? ___ Are 'normal circumstances' present Yes ✓ No ___ If needed, explain in Remarks

Profile description: (Describe to the depth needed to document the indicator or confirm absence of indicators, 30 cm default)

Depth (cm)	Matrix Colour (moist)	Mottles Colour (moist)	Mottles %[1]	Mottles Size[2]	Mottles Location[3]	Material[4]	Comments
0-13	10 YR 4/2	7.5 YR 5/8	15	<1 mm	Root	Mineral	
13-25	10YR 5/1	7.5 YR 5/8	5	<1 mm	Pore, Rod flow	Mineral	
25-30	10 YR 6/2	7.5 YR 6/2	20	10-20 mm	Pore	Mineral	Water seepage
-45							
							Typic Orthic Gley GOT

[1]Use % area charts; [2]Use size classes; [3]Ped face, pore, within ped, along roots, within matrix; [4]Organic (peaty), humic, mineral soil

Hydric soil indicators:

Organic layers
___ Organic soil material (general)
___ Peaty topsoil
___ Peaty subsoil

___ Fibric
___ Mesic
___ Humic

Concretions
___ Iron concretions
___ Manganese concretions
___ Nodular

Consistence
✓ Plastic
✓ Sticky
___ Fluid

Colours Profile form either:
✓ Gley OR
___ Mottled

Horizon
✓ Reductimorphic
✓ Redox mottled
___ Redox segregations
___ Perch-gley features

Cause of wetness

Location
___ Depression
___ Flat
___ Valley
___ Gully
___ Slope

Water table
-40 Depth to water (cm)
___ High groundwater
___ Perched water table
___ Seepage
___ Tidal

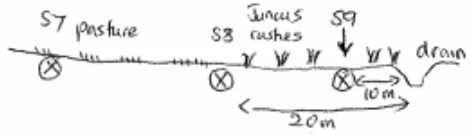
___ Lithic contact

Pans
___ Pan (general)
___ Humus-pan
___ Ironstone-pan
___ Densipan
___ Duripan
___ Fragipan
___ Orstein-pan
___ Depth to pan (cm)

Layers
✓ Slow/ restricted permeability
___ Argillic layer
___ Depth to restrictive layer (cm)

Surface features
✓ Pugged some
___ Ponding

Sketch of site/soil:



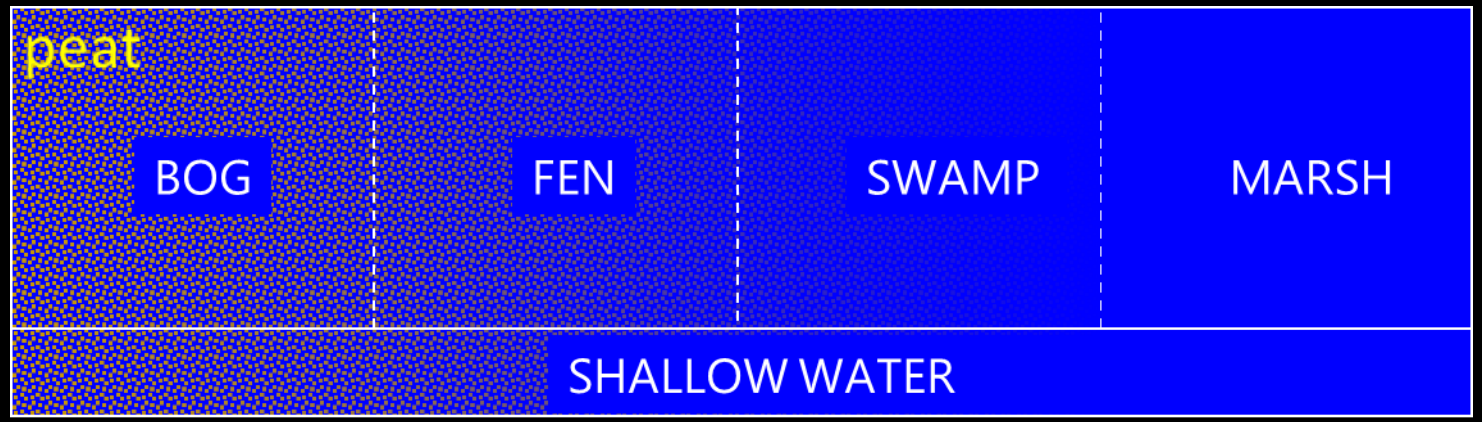
Remarks: Wet at surface; low permeability soils. Water table still rising in hole. Mudstone country. Two other sample points (S7, S8) upland of S9. Both are non-hydric.

Photo numbers: ___

Hydric soil present? ✓ Yes ___ No ___ Uncertain | NZSC Subgroup (if known) GOT

General soil clues for identifying wetland types

Wetland type



Soil Colour

Black/dark → Grey → Grey matrix with rust mottles

Soil Tool Overview

- Most NZ soils are easy – 80:20 rule
- Understand soil-landscape relationships and processes
- Colour is fundamental
- Some soils may require a pedologist

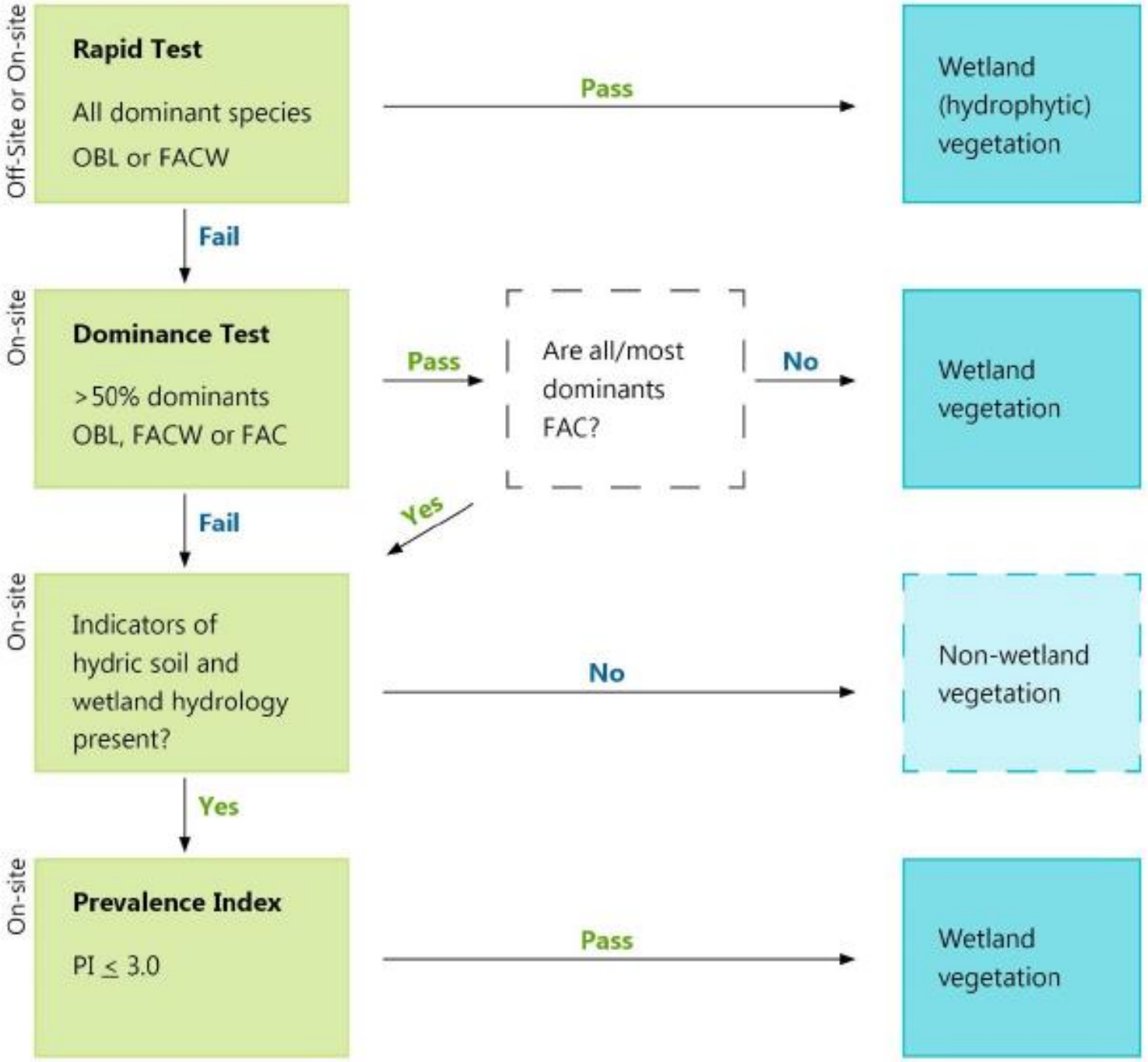
Peat Shrinkage

- https://www.youtube.com/watch?v=Z0y1SCzJ3Q8&sns=em

- This video from the Netherlands provides good information about how peat shrinkage occurs and the consequences.

3. Pulling it together: Wetland Delineation Protocol 2018

1 'Normal circumstances' present
2 Stratify site into landscape units
3 Map main vegetation types
4 'Select' representative plots



Clarkson 2018

Pragmatic approach to delineation

- Ecologists with expert knowledge will map and delineate wetlands based on vegetation (Rapid Test) and where boundaries are clear, e.g. vegetation types, topographic boundary changes, flat vs slope
- Standard national approach useful in resolving disputes and where boundaries are problematic/unclear
- Hydrology tool would complete wetland delineation set (as in USA)
- Not covered by tool: significance, biodiversity values (exotic/native species treated equally)




D Implications/ recommendations for policy

- National accurate maps of wetlands/types to minimum area
- Lower area thresholds for regions with greater loss
- Map exotic as well as native-dominated wetlands
  - NPS-FM significant values of wetlands
  - NPS-IB probably focussed on indigenous communities
- Restoration potential based on historical/ recently modified wetlands important for depleted areas
  - Restored/certain mitigation wetlands on farms also contribute to wetland resource
- Simple indicators of wetland condition needed, e.g. fencing
- $ recognition to landowners for protection, e.g. rewards for nutrient attenuation, C storage, biodiversity

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