



Manaaki Whenua
Landcare Research

Wetlands: recent research and current initiatives

Bev Clarkson

Manaaki Whenua – Landcare Research, Hamilton



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)



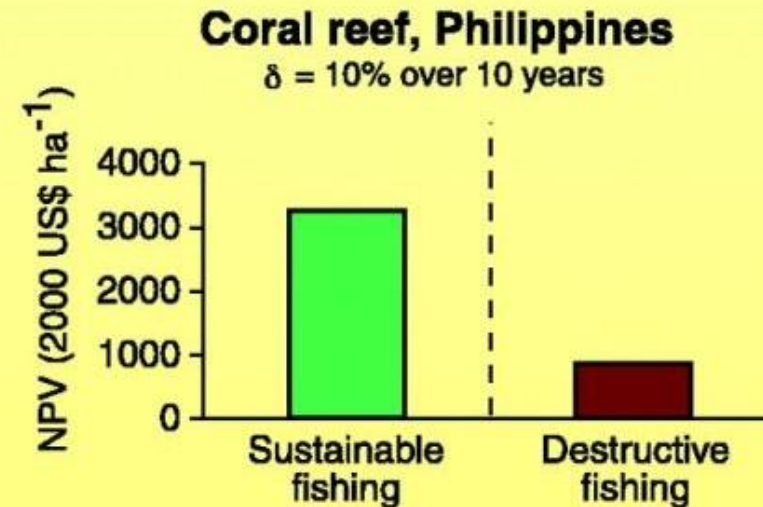
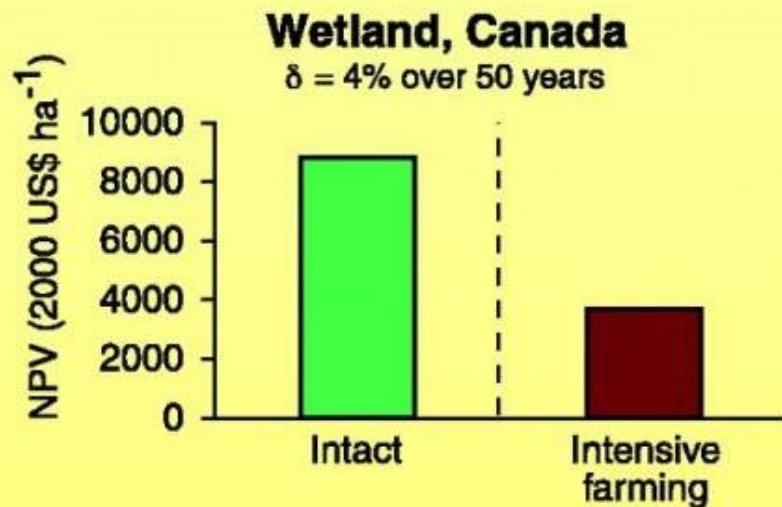
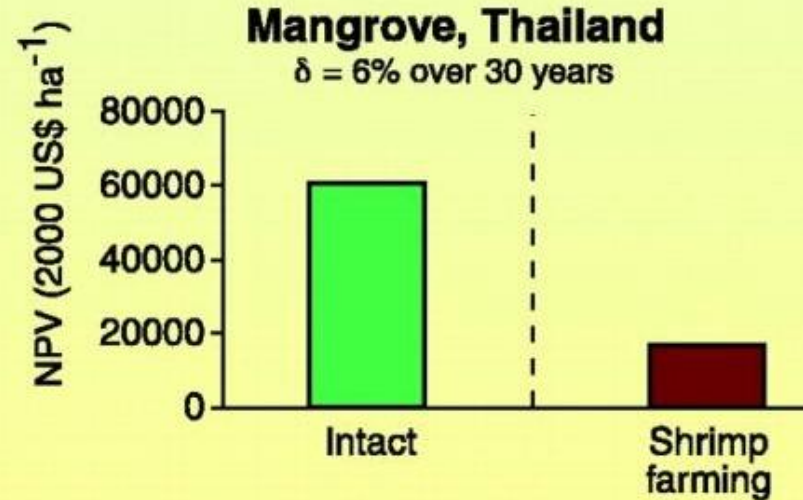
Kepler Mire Te Anau



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



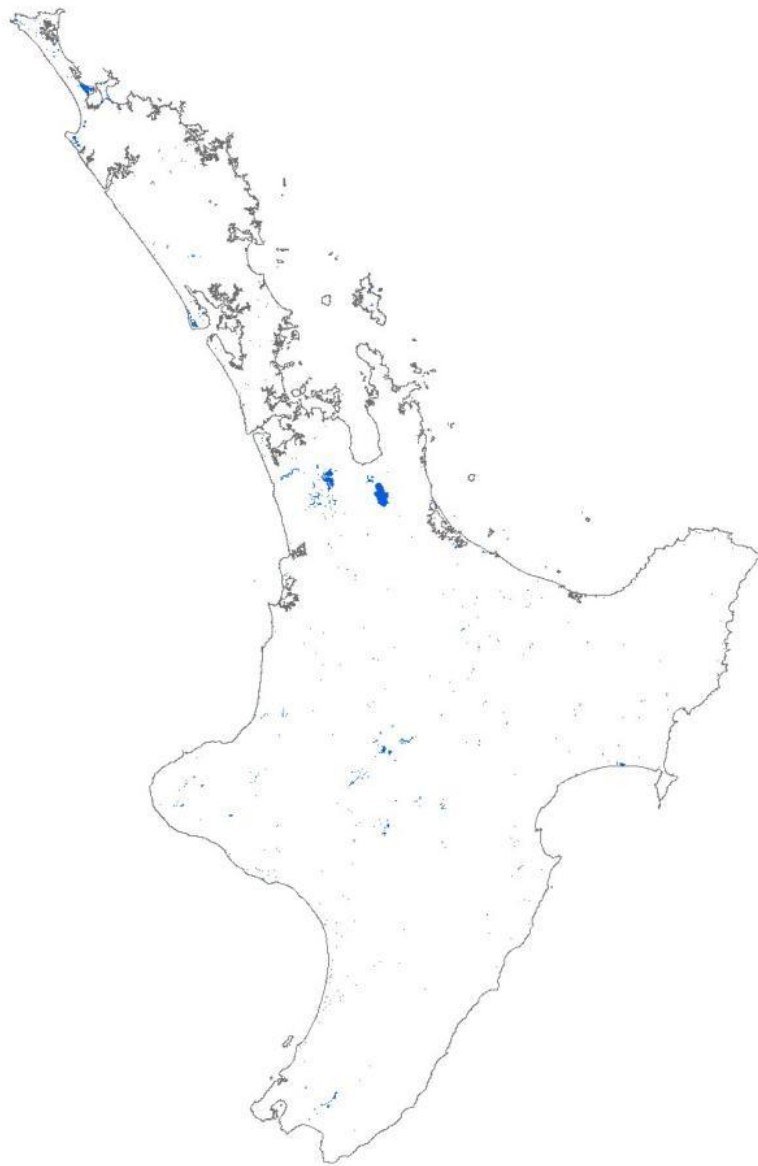
NPV = net present value

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

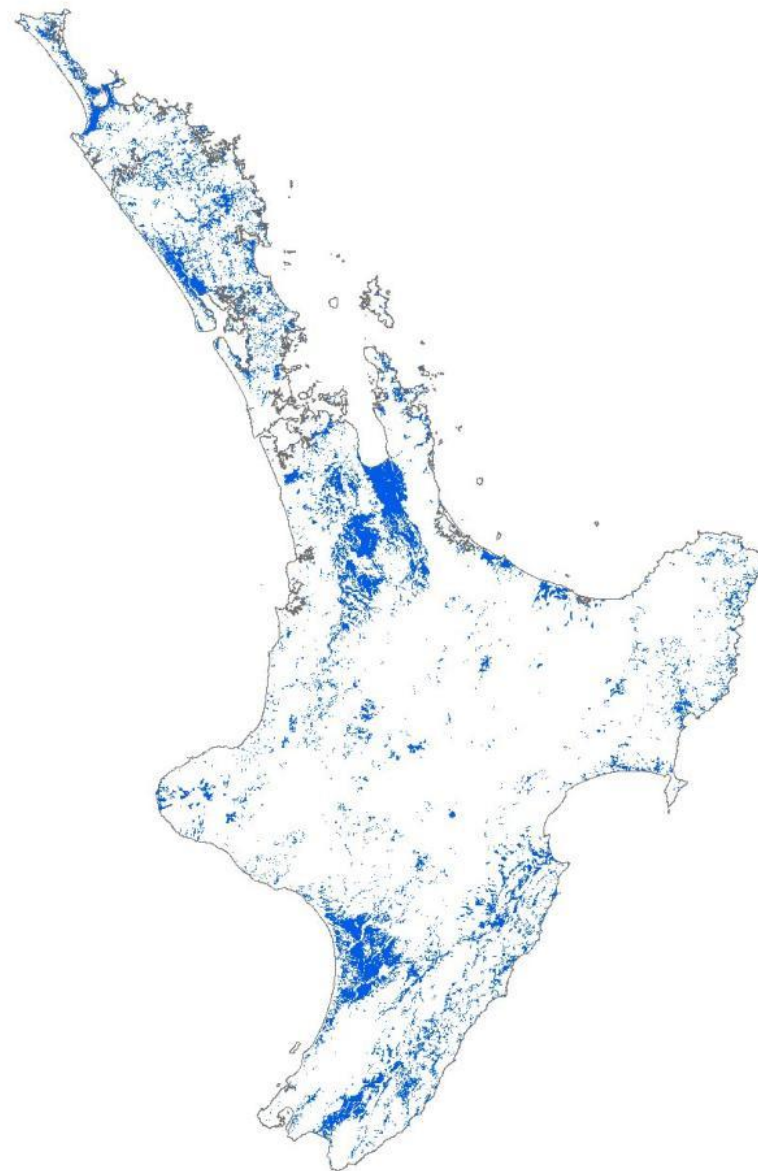
North Island



Current extent



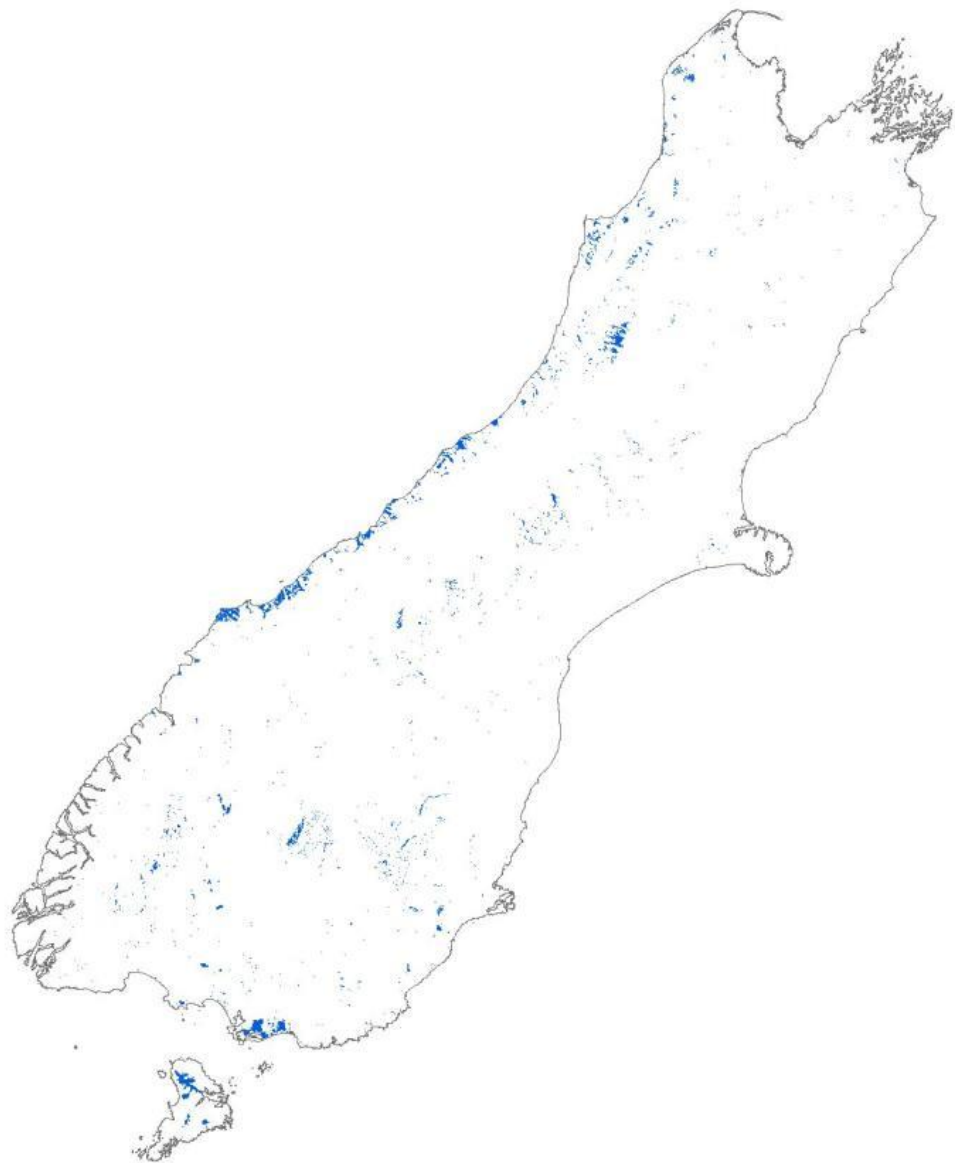
Historic extent



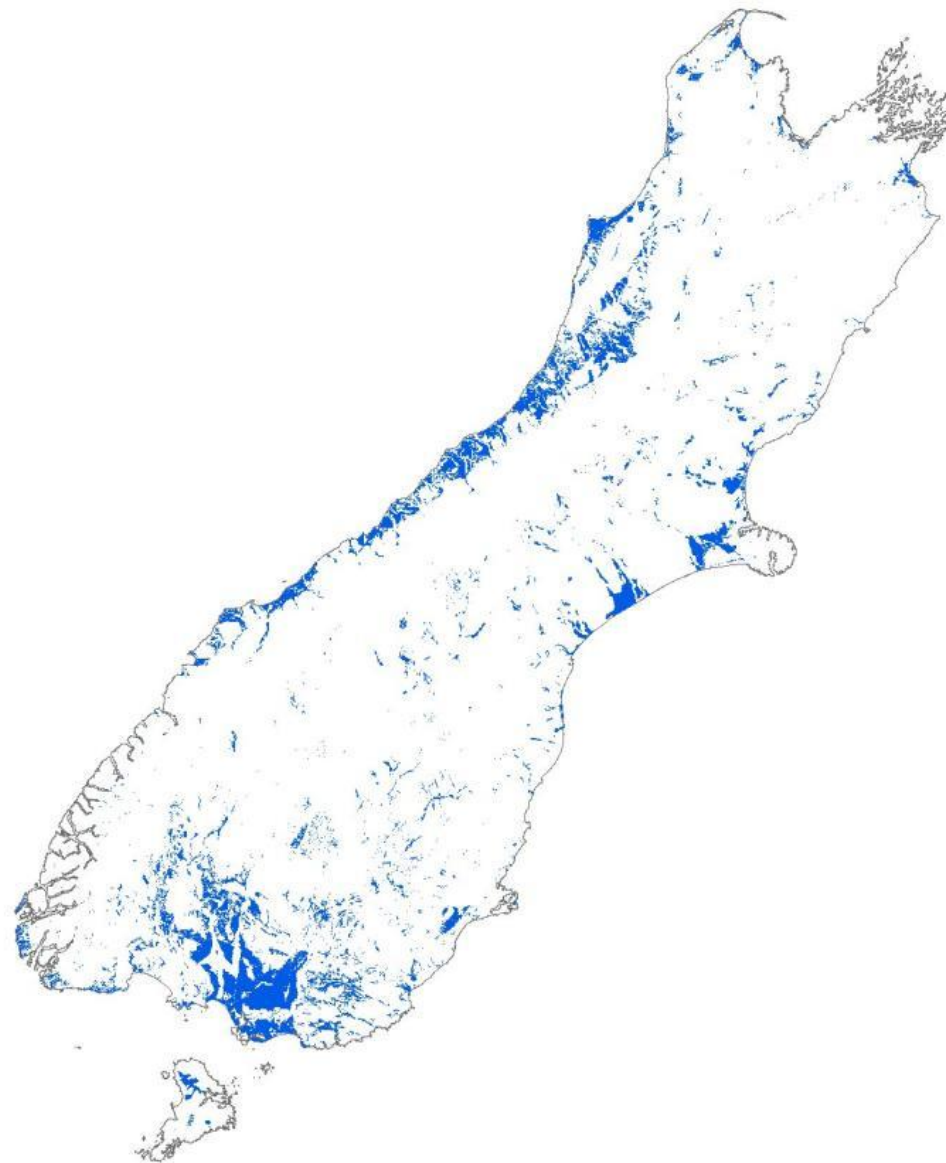
North Island =
4.9% remaining

South Island

Current extent



Historic extent



South Island
= 16.3%
remaining

New Zealand
= 10%
remaining

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

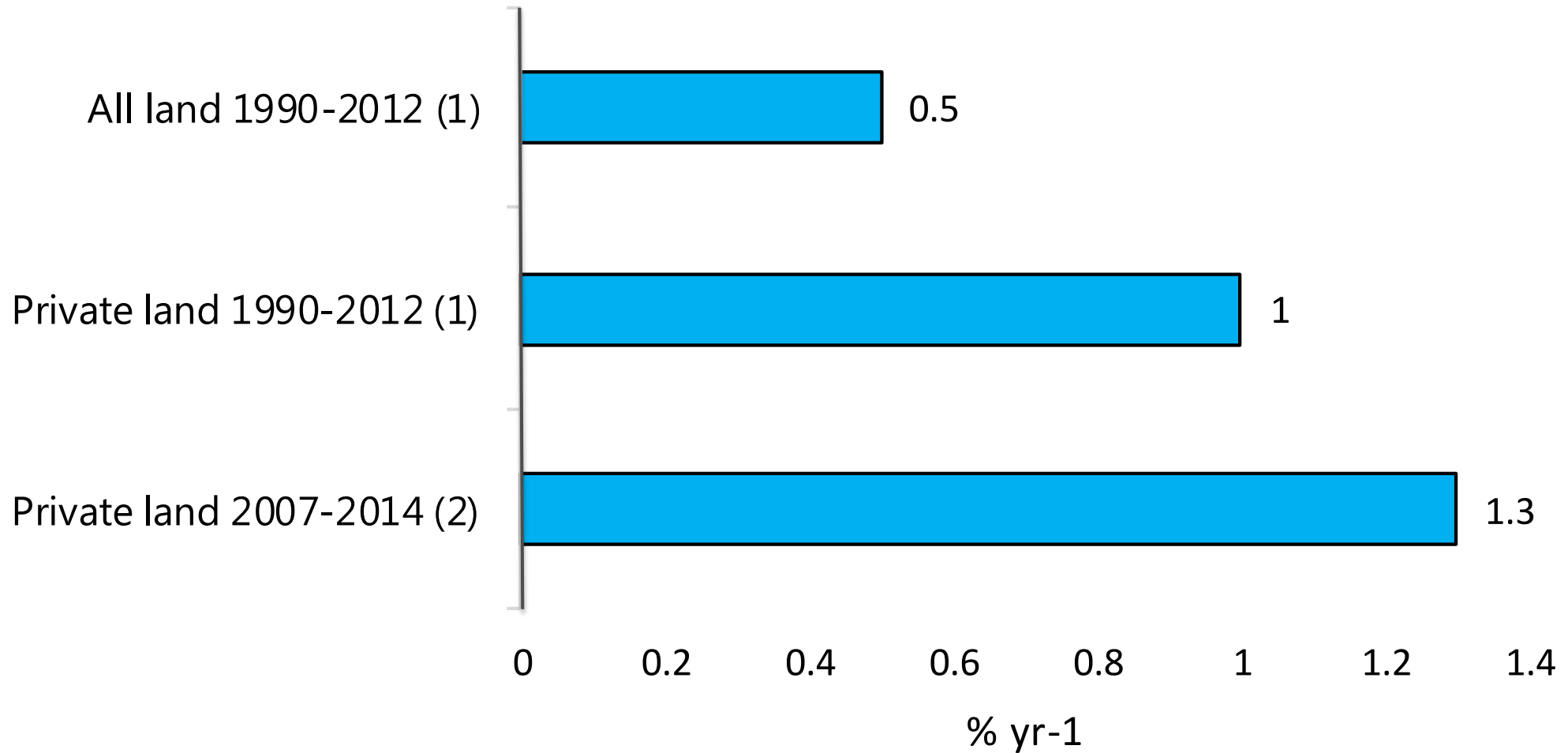




Policy to protect wetlands

- 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

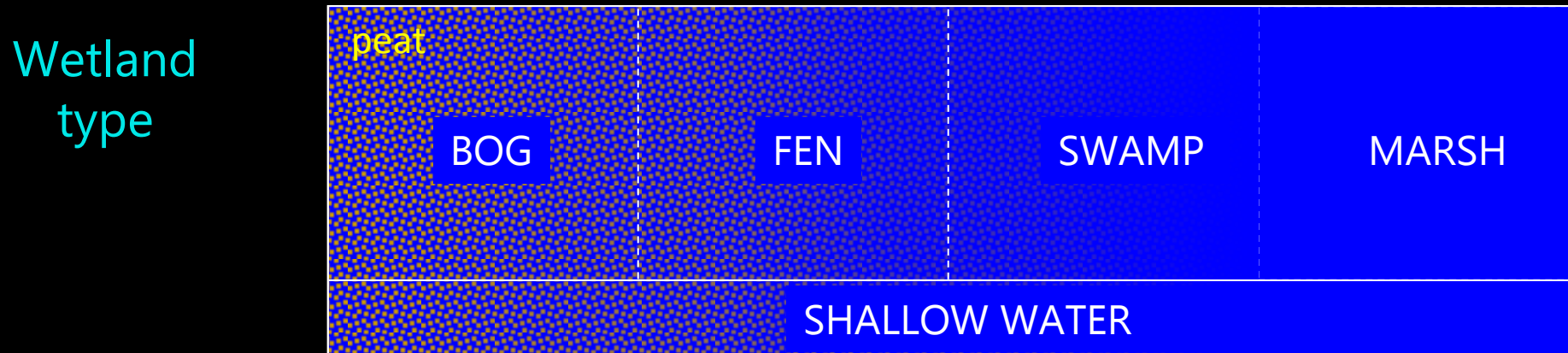


B Wetland Research Programme

- 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

Bog



Swamp



Bog

Fen



Wetland types

Marsh





Bog species



Cane rush *Sporadanthus*



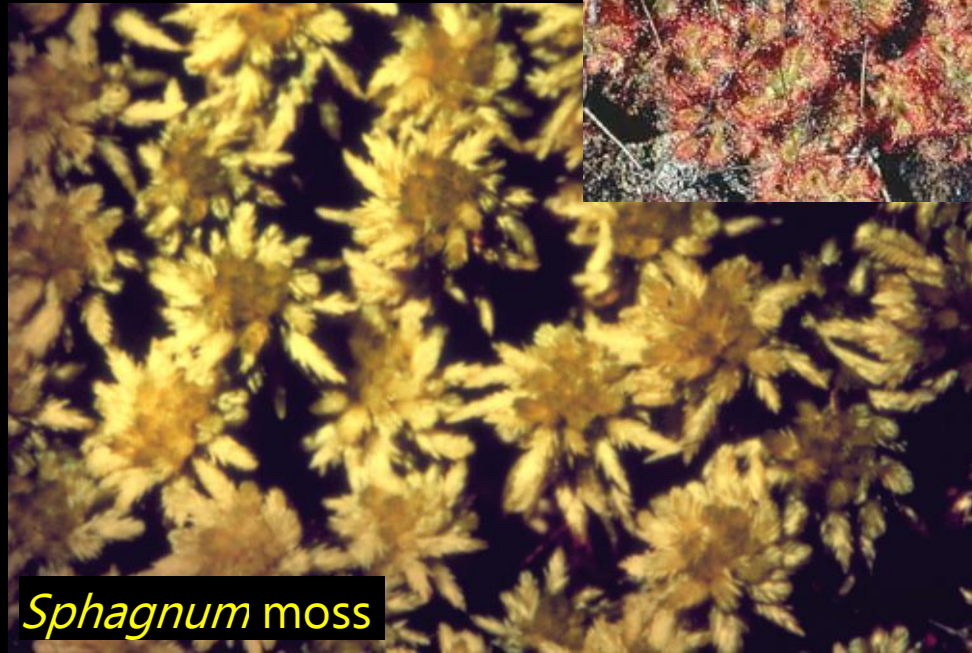
Bladderwort *Utricularia*



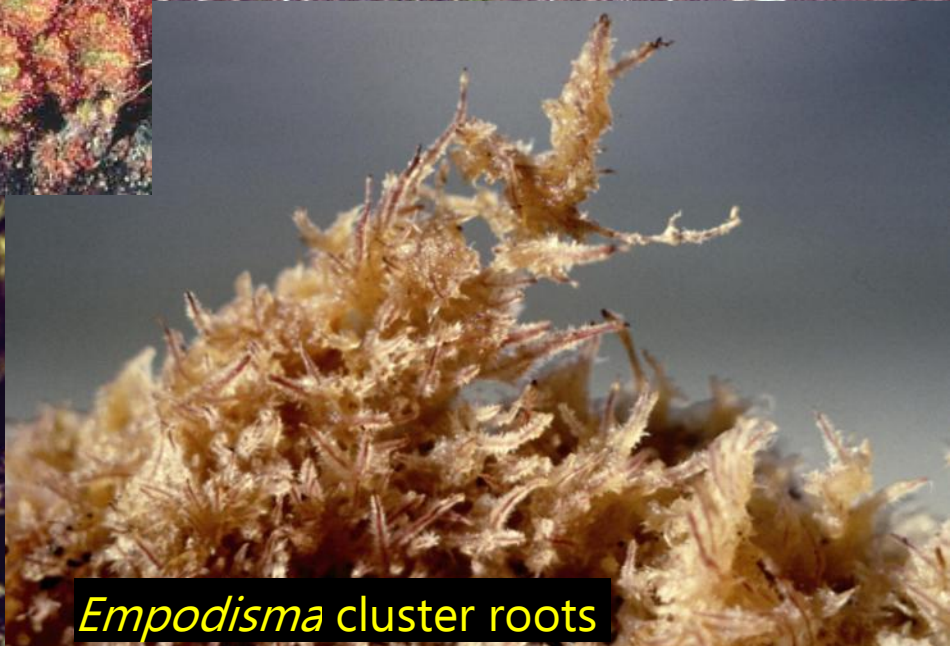
Wire rush *Empodisma*



Sundew *Drosera*



Sphagnum moss



Empodisma cluster roots

Fen species



Ti kouka *Cordyline*

Harakeke *Phormium*



Tangle fern *Gleichenia*



Sedge *Machaerina*



Swamp species



Raupo Typha



Kuta Eleocharis



Carex



Carex

Recent Wetland Programme Products

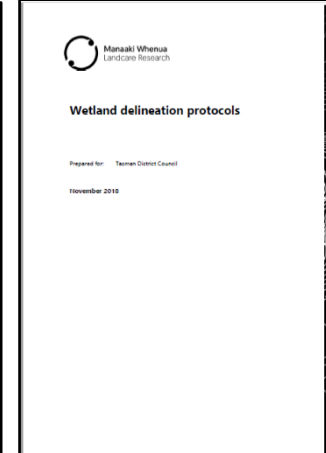
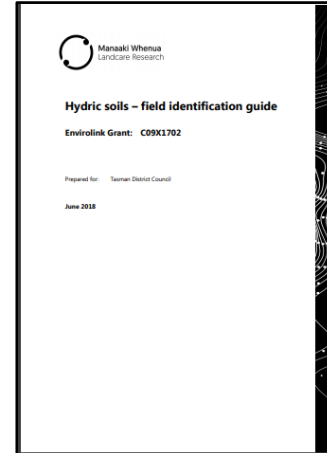
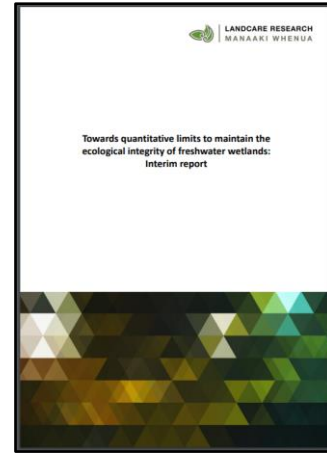
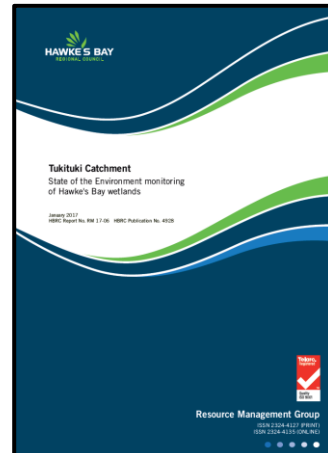
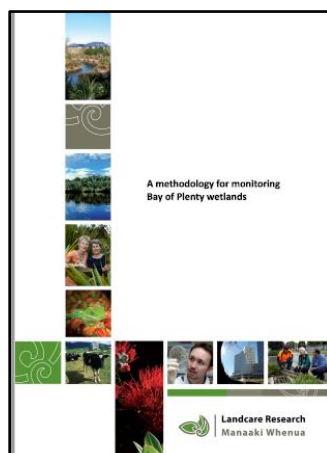
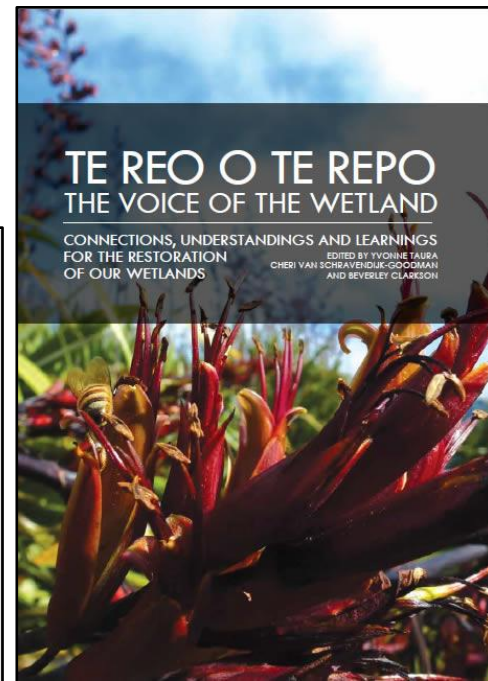
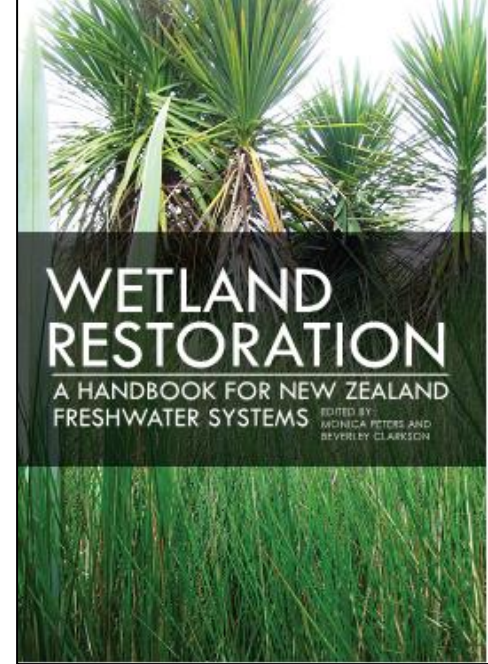
Research papers, chapters, reports

- 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:

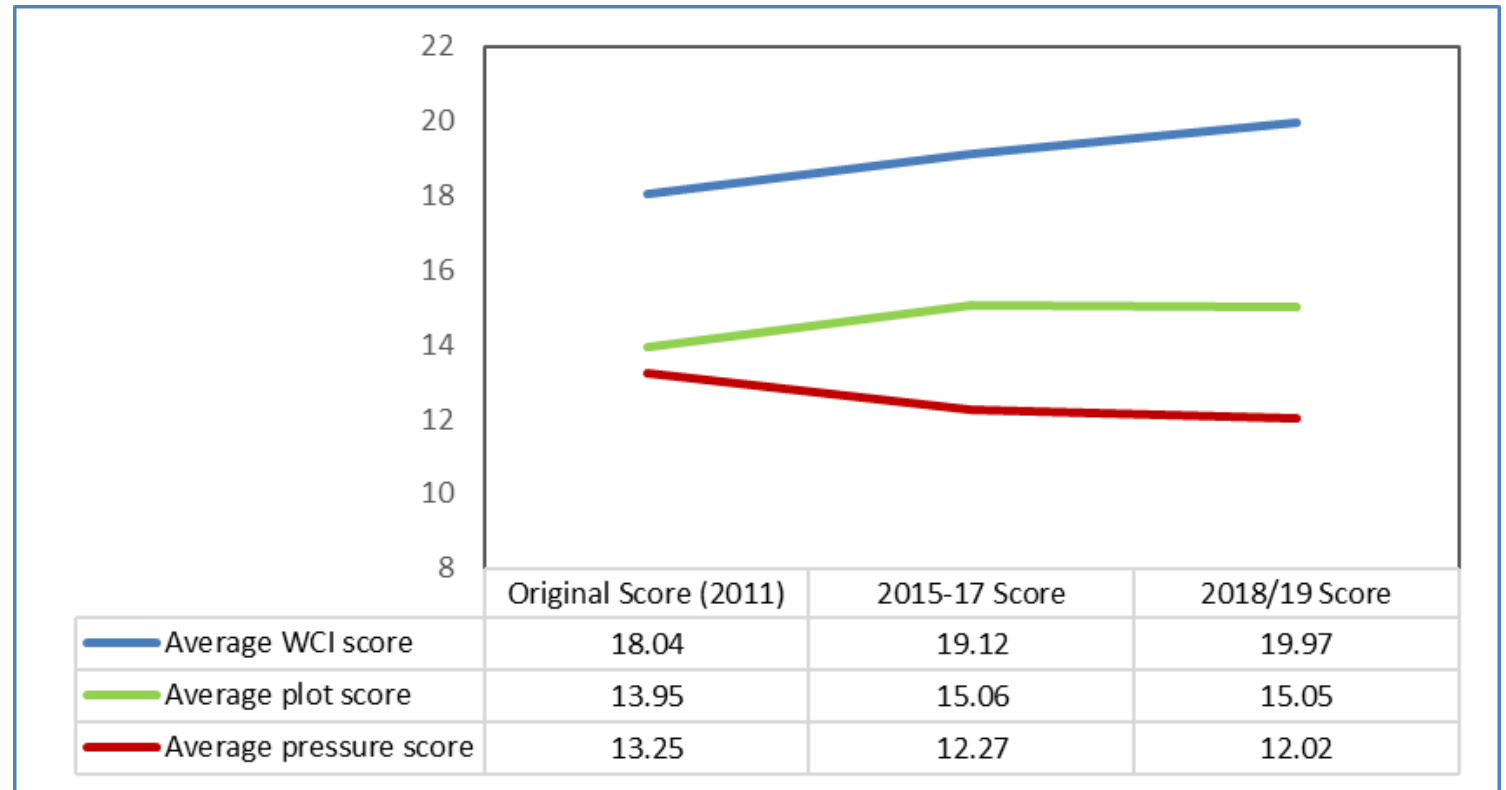
Initial fencing (env funding)

Improved plant cover

Improved native vs exotic veg

Improved awareness

Some animal pest control



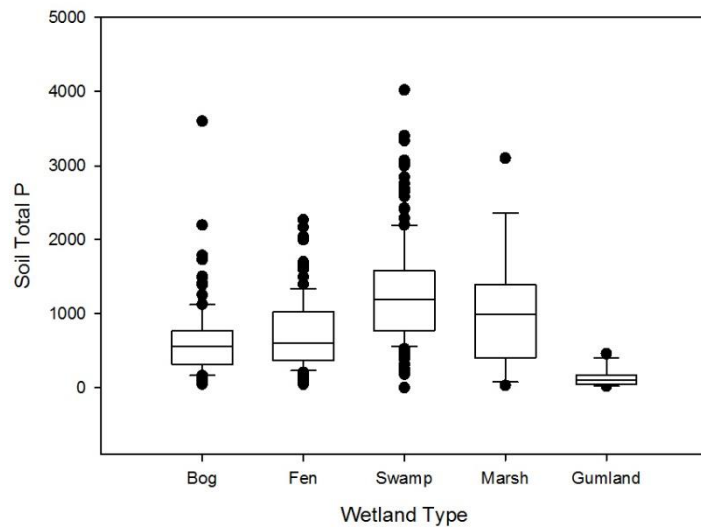
$n = 28$ wetlands

Lisa Forester, Northland Regional Council

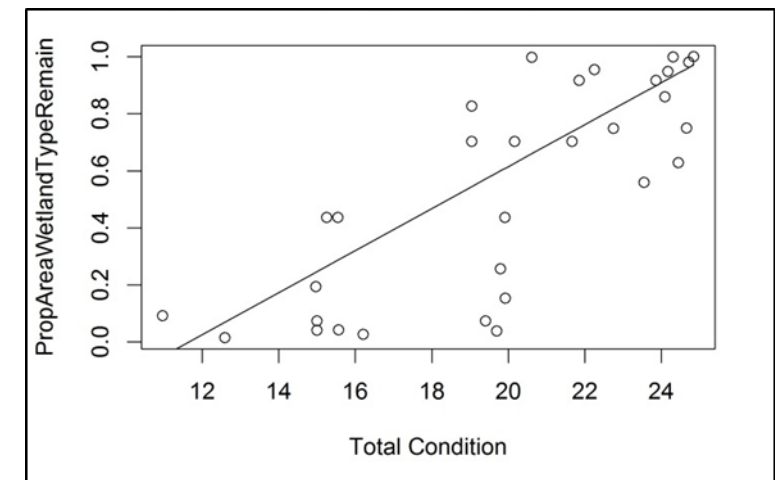


Limits to maintain Ecological Integrity

- 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

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.

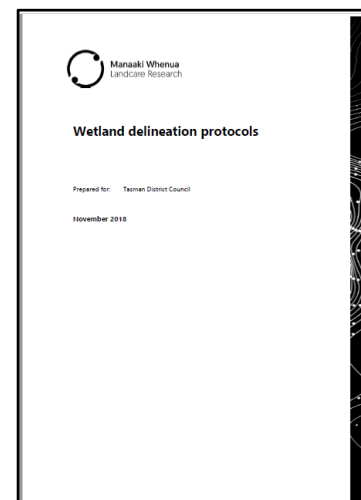
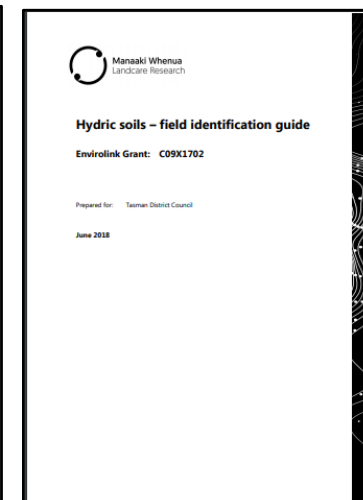
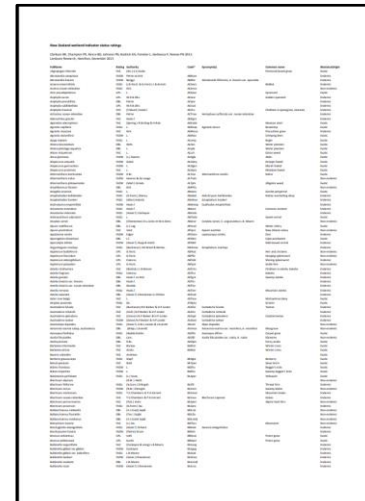


NZ Wetland Delineation: Adapt USA system

- 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)

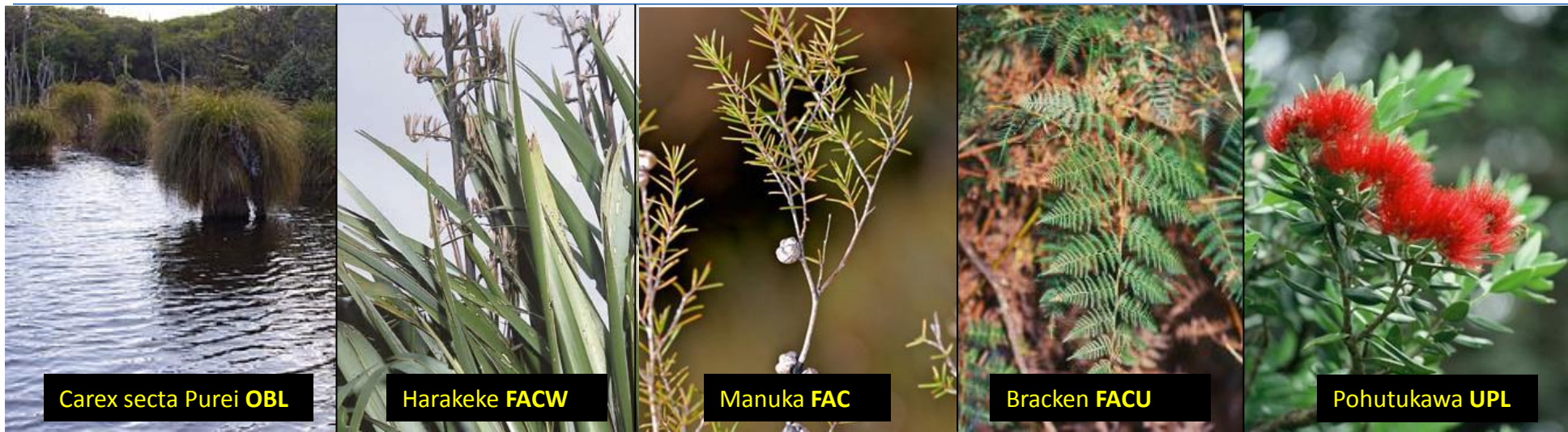


US Wetland
Training Institute
Course San Diego
2012



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
xAgropogon 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.	ACIsab			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 mucosa	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.	ALllan		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 <input checked="" type="checkbox"/> No <input type="checkbox"/>	Hydric Soil Present? <u>N/A</u> Yes _____ No _____	Wetland Hydrology Present? <u>N/A</u> Yes _____ No _____	Is the Sampled Area within a Wetland? Yes <input checked="" type="checkbox"/> No _____
Remarks:			

VEGETATION – Use scientific names of plants.

Tree Stratum (Plot size: _____)	Absolute % Cover	Dominant Species?	Indicator Status	Dominance Test worksheet:	
1. _____	_____	_____	_____	Number of Dominant Species That Are OBL, FACW, or FAC: <u>2</u> (A)	
2. _____	_____	_____	_____	Total Number of Dominant Species Across All Strata: <u>2</u> (B)	
3. _____	_____	_____	_____	Percent of Dominant Species That Are OBL, FACW, or FAC: <u>100%</u> (AB)	
4. _____	_____	_____	_____	Prevalence Index worksheet:	
= Total Cover				Total % Cover of:	Multiply by:
Sapling/Shrub Stratum (Plot size: <u>10m x 10m</u>)				OBL species <u>85</u> x 1 = <u>85</u>	
1. <u>LEP sco</u>	<u>80</u>	<u>Y</u>	<u>FAC</u>	FACW species <u>15.3</u> x 2 = <u>30.6</u>	
2. <u>COP ten</u>	<u>0.1</u>	_____	<u>FACW</u>	FAC species <u>8.2</u> x 3 = <u>24.6</u>	
3. <u>RUB fru*</u>	<u>0.1</u>	_____	<u>FACU</u>	FACU species <u>0.2</u> x 4 = <u>0.8</u>	
4. _____	_____	_____	_____	UPL species _____ x 5 = _____	
5. _____	_____	_____	_____	Column Totals: <u>182.5</u> (A) <u>362.4</u> (B)	
= Total Cover				Prevalence Index = B/A = <u>1.99</u>	
Herb Stratum (Plot size: <u>2m x 2m</u>)				Hydrophytic Vegetation Indicators:	
1. <u>SPH cri</u>	<u>80</u>	<u>Y</u>	<u>OBL</u>	<input checked="" type="checkbox"/> Dominance Test is >50%	
2. <u>MAC ter</u>	<u>0.1</u>	_____	<u>FACW</u>	<input checked="" type="checkbox"/> Prevalence Index is ≤3.0 ¹	
3. <u>MAC rub</u>	<u>4</u>	_____	<u>OBL</u>	____ Morphological Adaptations ¹ (Provide supporting data in Remarks or on a separate sheet)	
4. <u>CAR dem</u>	<u>15</u>	_____	<u>FACW</u>	____ Problematic Hydrophytic Vegetation ¹ (Explain)	
5. <u>HYP rad*</u>	<u>0.1</u>	_____	<u>FACU</u>		
6. <u>BLE min</u>	<u>0.1</u>	_____	<u>FACW</u>		
7. <u>HOL lan*</u>	<u>2</u>	_____	<u>FAC</u>		
8. <u>LYC eur*</u>	<u>1</u>	_____	<u>OBL</u>		
9. _____	_____	_____	_____		
10. _____	_____	_____	_____		
11. _____	_____	_____	_____		
12. _____	_____	_____	_____		
= Total Cover				Hydrophytic Vegetation Present? Yes <input checked="" type="checkbox"/> No _____	
Remarks:					

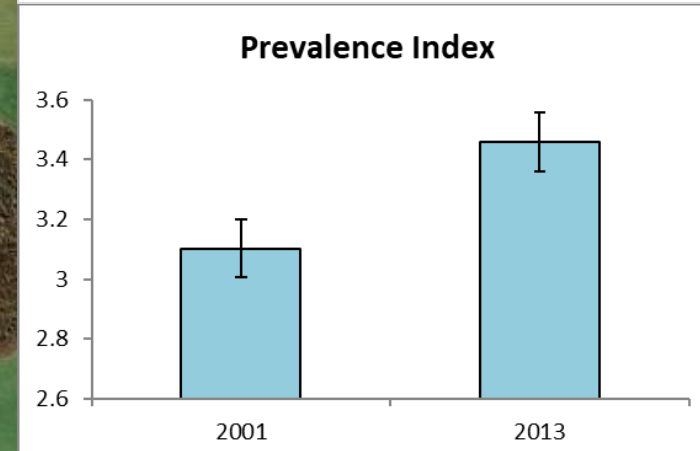
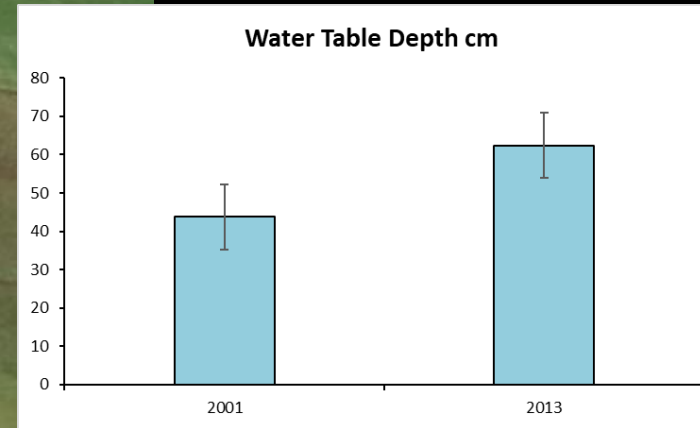
NZ data form adapted from US Army Corps of Engineers

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



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

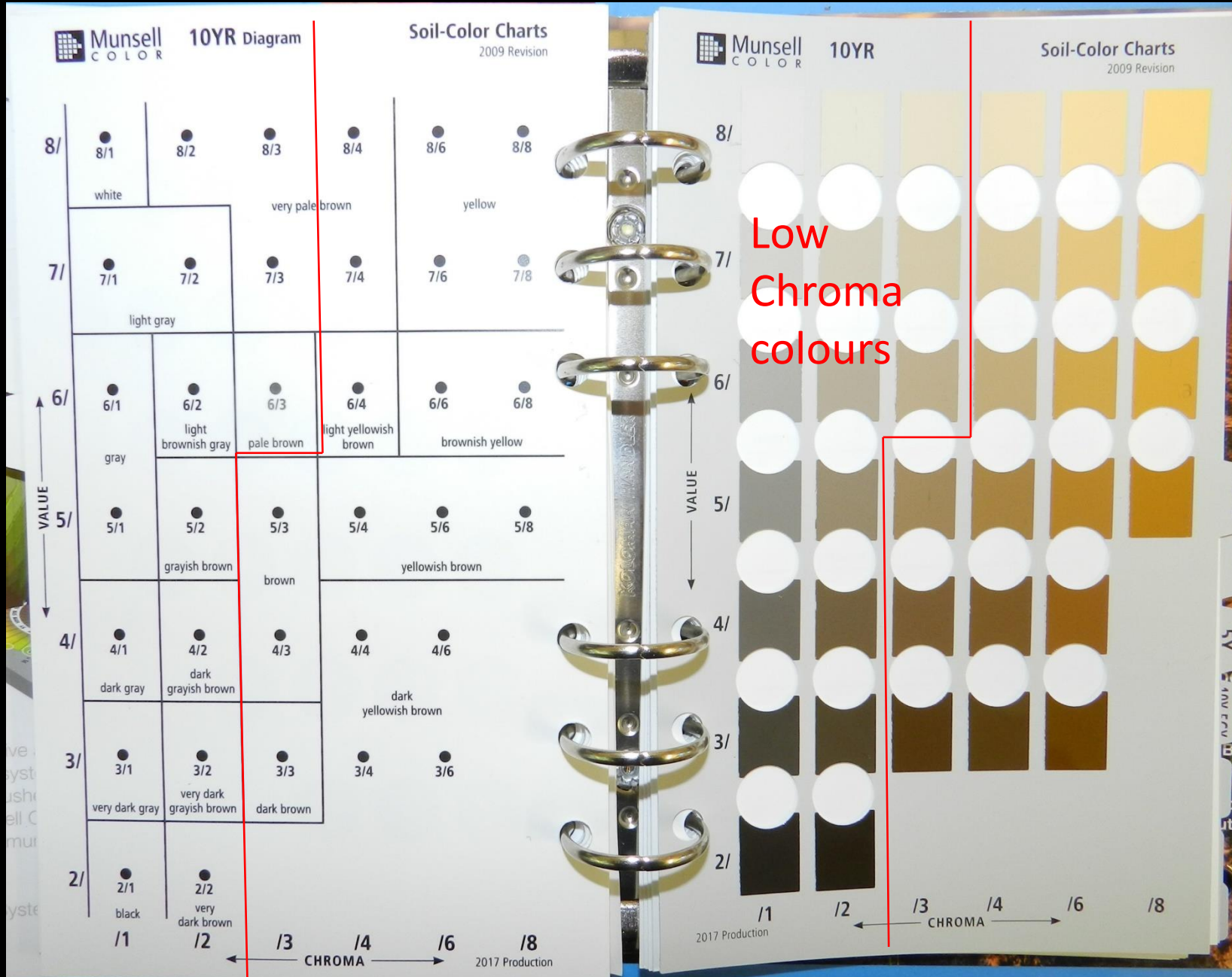
30.05.2017 12:

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

WETLAND DETERMINATION FORM – NEW ZEALAND: SOIL

Site: Waikoha Station Region: Waikato (Te Pahi) 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): 178 4294
 Soil drainage (circle) W MW I (P) VP Land cover: Herbaceous freshwater vegetn NZTM (N): 580 6087
 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		Mottles			Material ⁴	Comments
	Colour (moist)	Colour (moist)	% ¹	Size ²	Location ³		
0-13	10YR 4/2	7.5YR 5/8	15	<1mm	Root	Mineral	
13-25	10YR 5/1	7.5YR 5/8	5	<1mm	Pore, ped face	Mineral	
25-30	10YR 6/2	7.5YR 6/2	20	10-20mm	Pore	Mineral	Water seepage
-45							
							Typic Oxic Gley G0T

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

Hydric soil indicators:

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

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

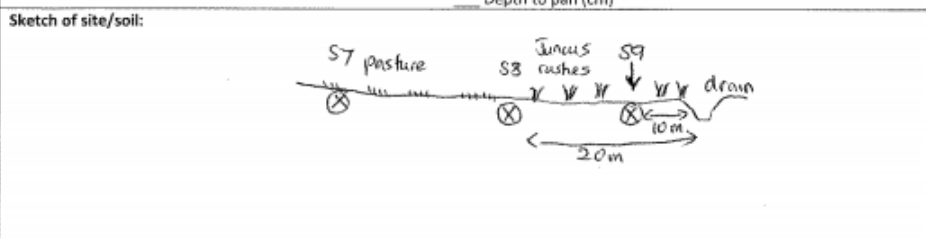
Location
 Depression
 Flat
 Valley
 Gully
 Slope

Water table
 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



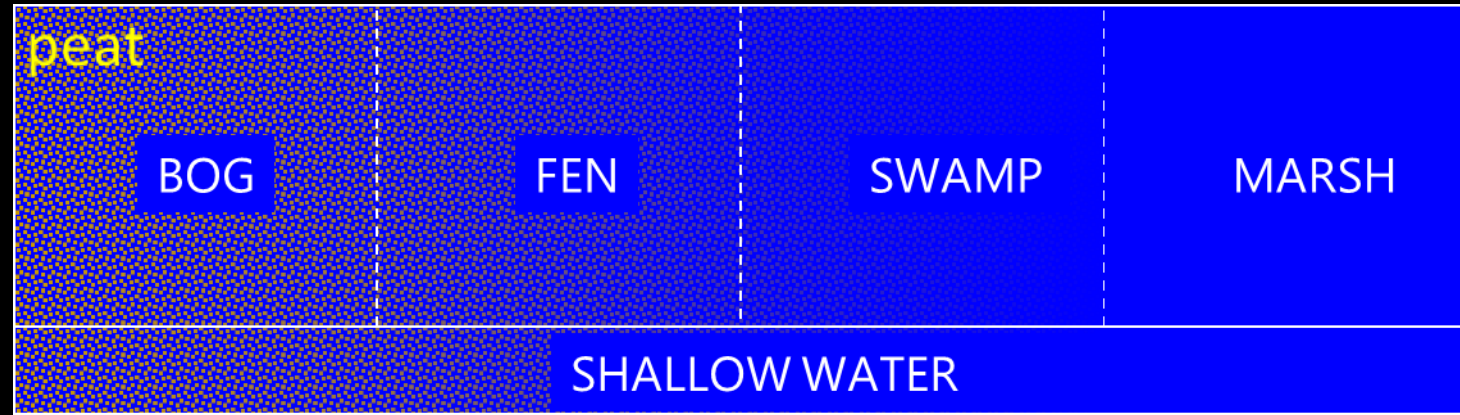
Remarks: wet at surface; low permeability soils, water table still rising in hole, Mudstone country.
Two other sample points (S7, S8) upland of S9. Both are non-hydric.

Photo numbers:
 Hydric soil present? Yes No Uncertain NZSC Subgroup (if known) G0T

NZ soil form adapted
 from US Army Corps
 of Engineers

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



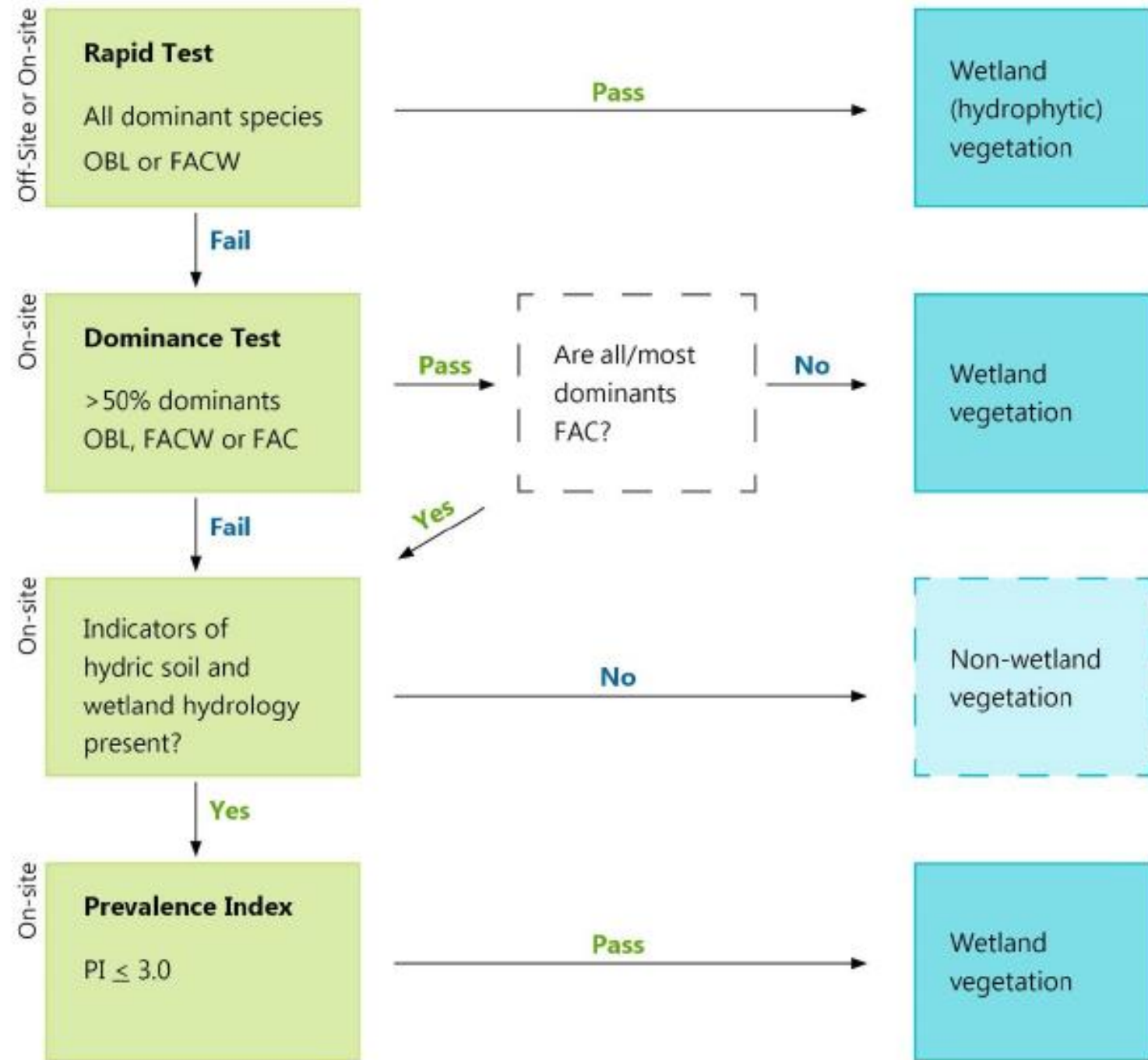
Peat Shrinkage



- <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.

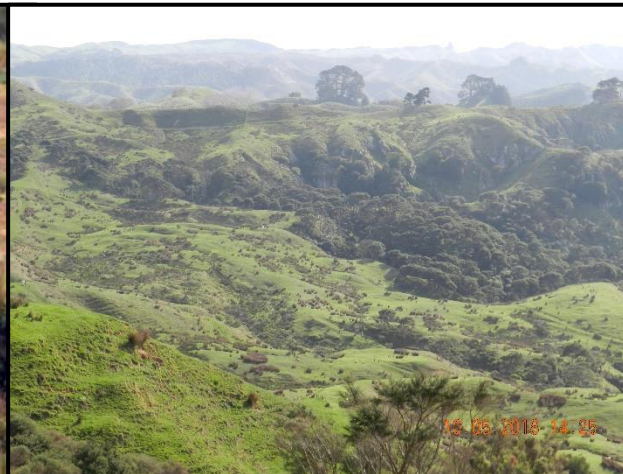
3. Pulling it together: Wetland Delineation Protocol 2018

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



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



Acknowledgements

- Scott Fraser, Scott Bartlam, Anne-Gaelle Ausseil, Jake Overton, Yvonne Taura, MWLR
- Lisa Forester, Katrina Hansen, NRC
- Hugh Robertson, Philippe Gerbeaux, Brian Rance, DOC
- Paul Champion, Kerry Bodmin, NIWA
- Peter Johnson, Paula Reeves
- Peter Singleton, Natural Knowledge Ltd
- Cheri van Schravendijk-Goodman, Swampfrog Environmental Ltd
- Charlie Newling, Jim Teaford, US Wetland Training Institute
- And many others