Freshwater/Lakes Summary

Dr Ngaire Phillips – 25 March 2019

Scope and Topics

Scope

- Values, priorities and water quality targets for shallow lakes (Topics B2, B3, B4, B5)

Topics

- Values, significance and condition of Waikato/Waipā shallow lakes
- Restoration potential of shallow lakes
- Lake FMUs and lake prioritization
- Lake water quality targets
- Other concerns

Key concern: no clear focus on Waikato-Waipā lakes

Values, significance and condition of Waikato/Waipā shallow lakes

- diversity of lakes and associated values (59 included in PC1)

Riverine lakes (15) e.g. Lake Waikare

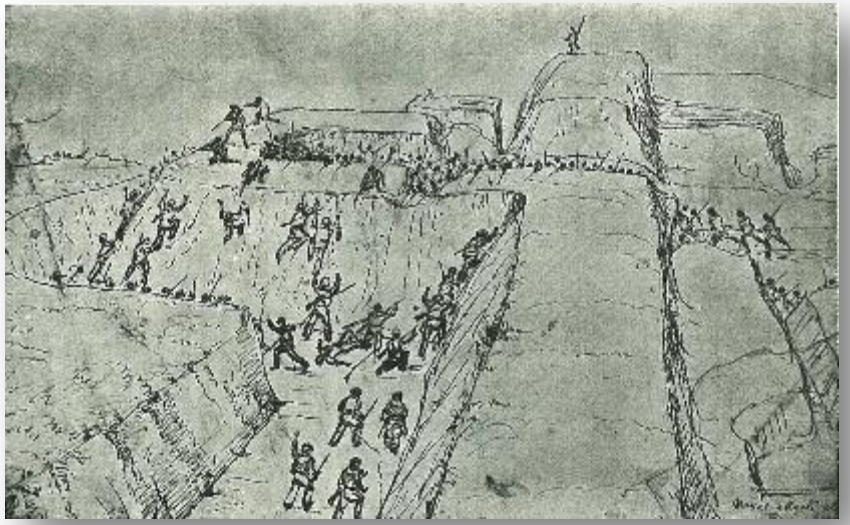
Peat lakes (35) e.g. Lake Rotokauri

Dune lakes (4) e.g. Lake Rotoiti

Volcanic lakes (5) e.g. Lake Ngahewa

Historic values

- Historic values of lakes e.g. Battle of Rangiriri around Lake Kopuera
- Not recognised as intrinsic value in Objective 3.11.1.1



By Charles Heaphy - The New Zealand Wars vol. I, by James Cowan. 1922. P.331, Public Domain, https://commons.wikimedia.org/w/index.php?curid=8283761

Include historic values of lakes under Objective 3.11.1.1 Intrinsic Values - Ancestry and Historic Values.

Peat Lakes

- Waikato/Waipā peat lakes are nationally significant
- Peat lakes are globally rare ecosystems

Lake Serpentine East (Source: R. Eivers)

Shallow Lake Condition

- Lakes impacted by:
  - landuse
  - drainage
  - vegetation clearance
  - sediment and nutrient inputs
  - invasive flora and fauna

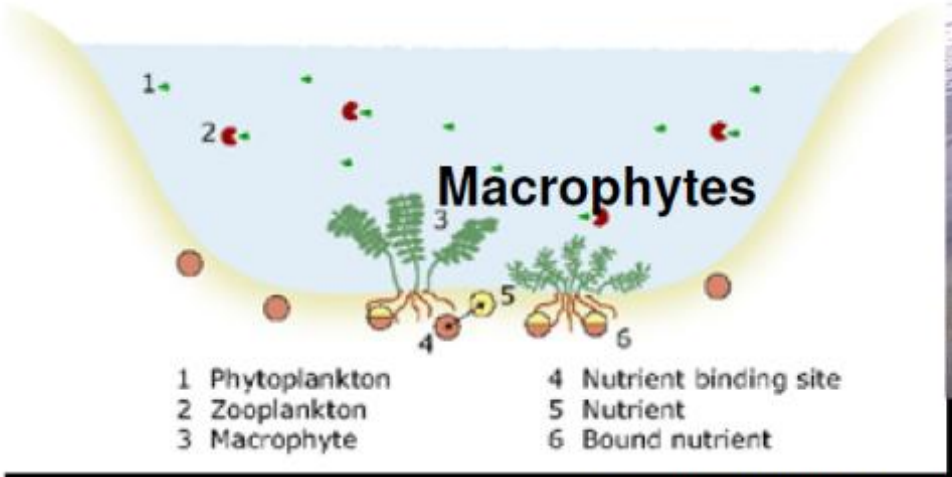
Lake Kainui, May 2011 (Source: R. Eivers)

Ecological Health of Shallow Lakes

- Loss of submerged macrophyte communities
  - Declining water quality
  - Invasive fish species
  - Invasive plant species
- "Flipping" lakes
- 2009 study - 41% of flipped lakes in Waikato region
- 2016 LakeSPI survey indicated only 22% of lakes had submerged vegetation

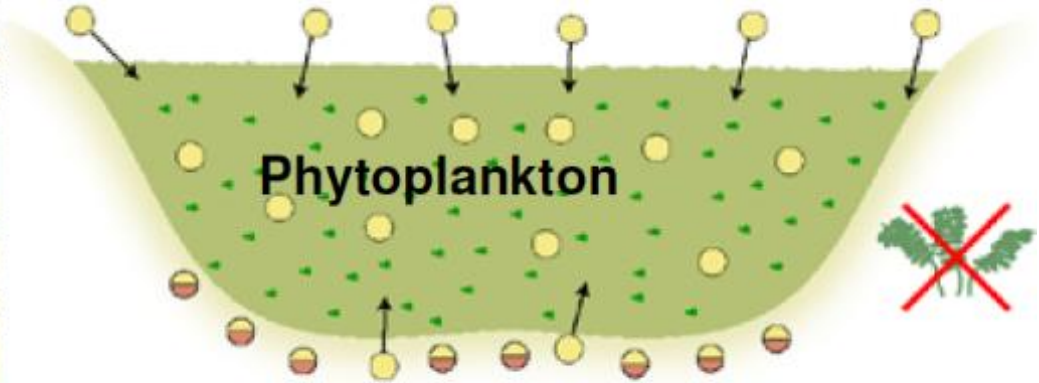
Lagarosiphon (R. Wells, NIWA)

Flipping Lakes – between stable ecological states



Diagrams: Environment Waikato

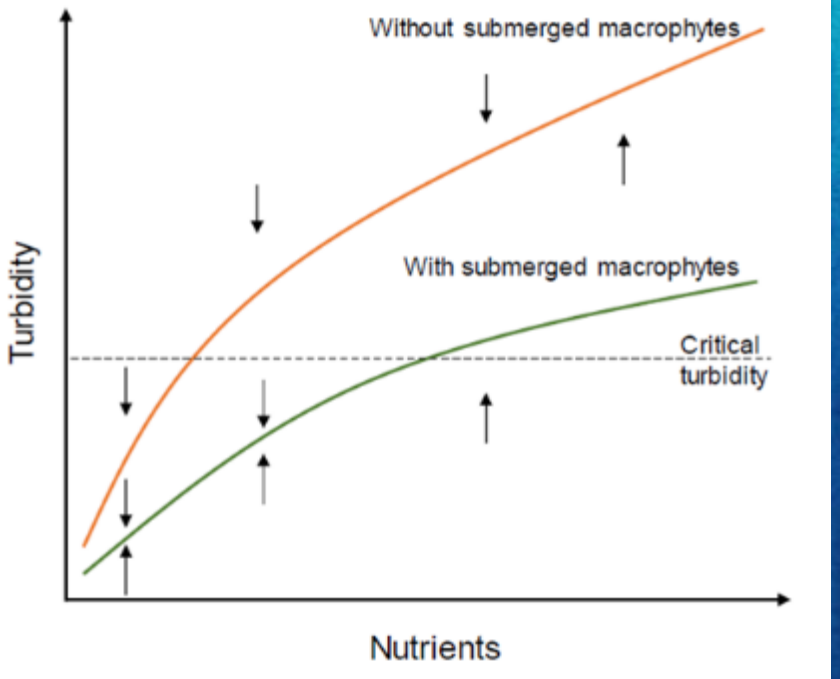
Photo: G. Zwart



Pressures on shallow lakes.
Source: M. Schallenberg, B. Sorrell, D. Hamilton; Waikato Shallow Lakes Restoration Workshop, Dec 2008

Restoration Potential

- Proactive management of water quality vs restoration
- “Flipped lakes” extreme situation - continuum of change along eutrophication gradient
- Modelling suggests restoration complex but possible
- Multi-pronged approach
  - Address internal/external nutrient loads
  - Invasive species management
  - Engineering solutions



Alternative stable states in shallow lakes in temperate latitudes.
Source: Abell 2018 (redrawn from Scheffer et al. 1993)

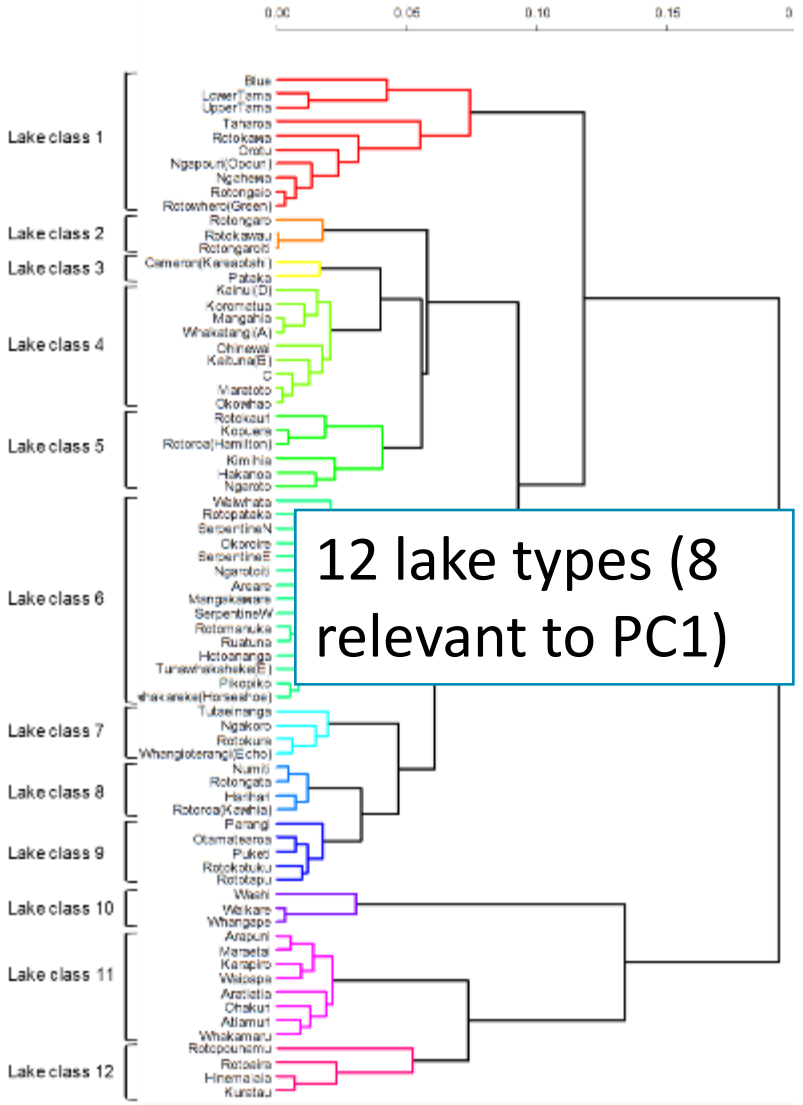
Method for Deriving Lake FMUs

- Simplistic
  - based on a single category variables (geomorphic features reflecting lake formation) influencing lake ecology and functioning
  - doesn't reflect diversity of lake characteristics
- Why is this important?
  - Limits effectiveness of monitoring programmes
  - Doesn't reflect fundamental drivers of lake ecosystem processes

Lake FMUs should be derived from multi-variate analysis

Multi-variate classification approach

- Based on 14 variables known to influence and control lake ecological process and ecosystem functions
- Reflects complexity and variability of Waikato/Waipā lakes
- Variables should align with monitoring purpose



Ozkundakci, D. (2015) An approach for reconciling the lake type classification for the Waikato region. Waikato Regional Council document #3679149

Lake Prioritisation Process

- Inconsistency in way lakes are prioritised
- Doesn’t reflect known values and threats of lakes e.g. dune lakes
- Doesn’t reflect existing initiatives being undertaken
- Unclear how catchments will be managed for lake (as opposed to river) outcomes

Ground truthing location of new fence around Lake Tunawhakaheke/E (Source: Landcare Trust)

Alternative Lake Prioritisation Process

- Significant Natural Lake Areas (Wildlands 2011)
- Scientifically based, multi-criteria ranking system
- Ranks for overall biodiversity outcomes, plus issue-specific outcomes
- More recent data needs to be incorporated
- Focuses on outcomes for lakes

Lake	Overall Biodiversity	Water quality	Vulnerability	Ecological Significance	Ecosystem Condition	Potential Outcomes	Score relative to maximum	Relative Rank
Maratoto	1.00	1.00	0.75	0.80	0.94	0.91	0.90	1
Otamatearoa	0.88	1.00	0.75	0.46	0.90	1.00	0.83	2
Rotopiko	0.90	0.67	1.00	0.65	0.90	0.73	0.81	3
Mangakaware	0.76	0.33	0.75	0.35	0.87	0.88	0.66	4=
Ngahewa	0.76	0.33	0.75	0.37	1.00	0.73	0.66	4=

Long term lake water quality targets

- PC1 long term targets set at NOF National bottom lines or maintain current condition
- D-G submission proposed new targets
  - Applied NOF thresholds to WRC data (2010-2014)
  - Predicted potential changes to NOF bands (expert opinion)
  - Provides targets that reflect current state
- Calculated % change in N, P and Chla to reach targets (restoration potential)

Current and predicted NOF bands (extract)

PC1 FMU	Lake	Lake Water Quality State information (2010-2014) from TLG memo to CSG dated 17/9/2015						DG proposed approach - 80 year target		
		Annual median Chla (mg/m^3)	Annual median Chla (mg/m^3)	Annual Median TN (mg/m^3)	Annual Median TN (mg/m^3)	Annual Median TP (mg/m^3)	Annual Median TP (mg/m^3)	Annual median Chla (mg/m^3)	Annual Median TN (mg/m^3)	Annual Median TP (mg/m^3)
Dune	Otamatearoa	2	A	471	B	10	A	A	A	A
Dune	Puketi	2	A	493	B	14	A	A	A	A
Peat	Rotomanuka	11	C	1073	D	18	B	B	B/C	A
Peat	Rotoroa	8	C	809	D	20	B	B	B	A

% change in attribute concentrations in lake required to achieve long term proposed water quality targets

Current Lake FMU	Lake	Annual median Chla (mg/m^3)	Annual Median TN (mg/m^3)	Annual Median TP (mg/m^3)
Dune	Otamatearoa	0.00	36.31	0.00
Dune	Puketi	0.00	39.15	28.57
Peat	Rotomanuka	54.55	53.40	44.44
Peat	Rotoroa	37.50	38.20	50.00

Short term lake water quality targets

- No short term targets in PC1
- Response time to mitigations in lakes much greater than in rivers
- Incremental changes unlikely to yield significant short-term gains
- Large changes required; delays in implementation will prolong responses (may not meet 80 year target)

Short term target

20% improvement in water quality within the first 10 years of the plan

Proposed short and long term lake water quality targets (PC1 FMU delineation)

PC1 FMUs	Annual median Chla (mg/m^3)				Annual Median TN (mg/m^3)				Annual Median TP (mg/m^3)			
	Short-term target (20% improvement on current value)		Long term year target (80 years)		Short-term target (20% lower than current)		Long term year target (80 years)		Short-term target (20% lower than current)		Long term year target (80 years)	
Dune	2	A	2	A	386	B	300	A	10	A	10	A
Peat	20	D	12	C	1296	D	750	C	63	D	50	C
Riverine	29	D	12	C	1473	D	750	C	92	D	50	C
Volcanic	28	D	12	C	946	D	625	B-C	110	D	50	C

- Short-term target = 20% improvement on current state (medians for each FMU)
- Long term targets as per PC1 Table 3.11-1, except red text, which are targets proposed by Director-General that reflect what is considered achievable based on current state

Proposed short and long term lake water quality targets (alternative FMU delineation)

FMU#	Annual median Chla (mg/m^3)				Annual Median TN (mg/m^3)				Annual Median TP (mg/m^3)			
	Short-term target*		Long term year target (80 years)		Short-term target *		Long term year target (80 years)		Short-term target *		Long term year target (80 years)	
1	33	D	12	C	674	C	500	B	124	D	50	C
4	22	D	12	C	1489	D	750	C	94	D	50	C
5	30	D	12	C	1186	D	750	C	79	D	50	C
6	12	C	5 - 12	B-C	1197	D	500-750	B-C	50	C	50	C
7	24	D	12	C	1218	D	750	C	97	D	50	C
9	2	A	2	A	394	B	300	A	11	B	10	A
10	46	D	12	C	1488	D	800	C	95	D	50	C

- Short-term target = 20% improvement on current state (medians for each FMU)
- Long term targets as per PC1 Table 3.11-1, except red text, which are targets proposed by Director-General that reflect what is considered achievable based on current state

Relevant FMU's from Ozkundakci, D. (2015)

Other concerns

Splitting of lake catchments across river FMUs	→	Consistency with Lake Catchment Plans
Staging and timing for implementation of Lake Catchment Plans	→	Linkage and coordination between lake catchment and sub-catchment planning processes
Integration of existing catchment initiatives	→	Build on existing initiatives
Outstanding waterbodies	→	Use existing reviews