Waikato Objectives Framework – Expert Panel Attributes Workshop

Mike Scarsbrook, 1 October 2014

Summary of Recommendations to Collaborative Stakeholder Group

- Human Health
    a. Apply *E. coli* attribute as per NPS-FM
    b. Apply Planktonic Cyanobacteria attribute, but extend the Freshwater Body Type to include lowland river mainstem reaches
    c. Develop and apply a Water Clarity attribute to lakes and rivers in the Waikato-Waipa catchment
    d. Develop narrative statements relating to physical safety (e.g. clarity, currents and snags) and aesthetics (e.g. colour, odour, bed sediments, aquatic weeds and algae, bank condition and access) that are based on Tikanga and Matauranga Maori
- Ecosystem Health
    a. Apply Phytoplankton attribute as per NPS-FM, but extend the Freshwater Body Type to include the mainstem of the Waikato River and lowland river mainstem reaches
    b. Apply Total N attribute as per NPS-FM, but extend the Freshwater Body Type to include the mainstem of the Waikato River and lowland river mainstem reaches
    c. Apply Total P attribute as per NPS-FM, but extend the Freshwater Body Type to include the mainstem of the Waikato River and lowland river mainstem reaches
    d. Do not apply the Periphyton Attribute as per NPS-FM, because of limited relevance in most streams and rivers in the Waikato-Waipa catchment. Develop a %cover Attribute for surveillance monitoring
    e. Apply Nitrate attribute as per NPS-FM
    f. Apply Ammonia attribute as per NPS-FM
    g. Apply Dissolved Oxygen attribute as per NPS-FM, but extend the Freshwater Body Type to include all rivers rather than just below point sources
    h. Develop and apply a Light Climate attribute to lakes and large rivers in the Waikato-Waipa catchment
    i. Develop and apply a Submerged Macrophyte attribute to rivers in the Waikato-Waipa catchment
    j. Develop a set of Dissolved Nutrient 'norms' that could be applied to rivers that are not covered by TN or TP attributes
    k. Develop and apply a deposited sediment attribute for wadeable rivers
    l. Develop and apply a Temperature attribute to rivers in the Waikato-Waipa catchment
- Mahinga kai
    a. Apply *E. coli* and Cyanobacteria attributes to Mahinga Kai value
    b. Apply Catch-Per-Unit-Effort attribute to rivers in the Waikato-Waipa catchment
    c. Develop Heavy Metals attribute
    d. Develop Biotic Index attribute reflecting food chain intactness (e.g. MCI)

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Attributes Workshop – 30 September 2014

Convenors

- Mike Scarsbrook

- Antoine Coffin
- Vicki Carruthers

Expert Panel

- Bill Vant (WRC)
- Bruno David (WRC)
- Chris Hickey (NIWA)
- Chris Koroheke (AgResearch)
- David Hamilton (University of Waikato)
- Erica Williams (NIWA) - not available on 30th
- Erina Watene-Rawiri (Waikato-Tainui College for Research and Development) - not available on 30th
- John Te Maru (Waikato-Tainui College for Research and Development)
- Kevin Collier (University of Waikato)
- Ngaire Phillips (Streamlined Environmental)

Purpose

To populate a Waikato-centric National Objectives Framework (i.e. WOF) with appropriate attributes and attribute states relating to Human Health ('Swimmability'), Ecosystem Health ('Healthy Biodiversity') and Mahinga Kai ('Fishable'). These attributes will be used to describe current state, assist with definition of change scenarios to aid CSG deliberations and provide a framework for eventual recommendation to the Healthy Rivers committee on limits and targets relating to the four main contaminants of interest (i.e., N, P, sediment and faecal bacteria) within defined Freshwater Management Units in the Waikato-Waipa catchment.

Background

Appendix 2 of the NPS-FM (2014) sets out a number of attributes used to measure the state of the two nationally compulsory values in lakes and rivers. These are set out below:

- Human Health for Recreation is measured against levels of *E. coli* (lakes and rivers) and planktonic cyanobacteria (lakes and lake fed rivers)
- Ecosystem Health in lakes is measured against trophic state indicators (phytoplankton biomass, Total P and Total N concentrations) and levels of Ammoniacal-N (toxicant)
- Ecosystem Health in rivers is measured relative to levels of the periphyton biomass (trophic state), nitrate-N and ammoniacal-N (toxicants) and dissolved oxygen (below point sources only)

Policy CA2 of the NPS-FM (2014) sets out the process for regional councils to follow in developing freshwater objectives. In addition to the nationally compulsory values above, regional councils should consider other national values (e.g. mahinga kai), or other values the council considers appropriate at regional or local scales. Councils are then directed to identify the relevant attributes considered applicable to each value, including the applicability of existing attributes in the NPS-FM.

Workshop process

The Expert Panel Workshop process reviewed three cores values that have been identified in the Focus Statement of the Collaborative Stakeholder Group:

- Human Health ('Swimmable')
- Ecosystem Health ('Healthy Biodiversity')

- Mahinga kai ('Fishable')

For each value, the Expert Panel reviewed existing attributes contained in the NPS-FM (2014) and assessed their applicability to the Waikato-Waipa catchment. Where appropriate the content of these attributes was modified to improve their relevance to Waikato-Waipa lake and river habitats. The Panel also provided advice on other attributes deemed relevant to the measurement of the three values in Freshwater Management Units of the Waikato-Waipa catchment.

Set out below are the full set of attributes identified by the Expert Panel as relevant to the different values in the Waikato-Waipa catchment. These include existing attributes from the NPS-FM, some modified and some unchanged, as well as several additional attributes.

A recommendation to the CSG is provided for each attribute.

Assumptions adopted for workshop process:

- 'Swimmability' is a value applied to all waterways, at all times of the year , and under all flow conditions
- Wetlands and aquifers are out of scope of this workbrief

Human Health ('Swimmability')

'Swimmability' incorporates both human health attributes (e.g. risk of infection and rashes) as well as a range of attributes that determine physical safety (e.g. clarity, currents and snags) and aesthetics (e.g. colour, odour, bed sediments, aquatic weeds and algae, bank condition and access). The former is already covered by the NPS-FM, but the latter requires development of appropriate numeric and narrative attributes.

Attribute – *E. coli* (Existing NPS_FM)

Value	Human health for recreation		
Freshwater Body Type	Lakes and rivers		
Attribute	*E. coli**		
Attribute Unit	*E. coli*/100 mL (number of *E. coli* per hundred millilitres)		
Attribute State	Numeric Attribute State	Sampling Statistic	Narrative Attribute State
A	≤260	Annual median	People are exposed to a very low risk of infection (less than 0.1% risk) from contact with water during activities with occasional immersion and some ingestion of water (such as wading and boating)
		95th percentile	People are exposed to a low risk of infection (up to 1% risk) when undertaking activities likely to involve full immersion.
B	>260 and ≤540	Annual median	People are exposed to a low risk of infection (less than 1% risk) from contact with water during activities with occasional immersion and some ingestion of water (such as wading and boating).
		95th percentile	People are exposed to a moderate risk of infection (less than 5% risk) when undertaking activities likely to involve full immersion. 540 / 100ml is the **minimum acceptable state** for activities likely to involve full immersion.
C	>540 and ≤1000	Annual median	People are exposed to a moderate risk of infection (less than 5% risk) from contact with water during activities with occasional immersion and some ingestion of water (such as wading and boating). People are exposed to a high risk of infection (greater than 5% risk) from contact with water during activities likely to involve immersion.
National Bottom Line	1000	Annual median	
D	>1000	Annual median	People are exposed to a high risk of infection (greater than 5% risk) from contact with water during activities with occasional immersion and some ingestion of water (such as wading and boating).

*Escherichia coli

Recommendation to CSG:

- Apply *E. coli* attribute as above
- WRC to seek guidance from MfE on calculation of 95th percentile

Attribute – Planktonic Cyanobacteria (Existing NPS_FM)

Value	Human health for recreation	
Freshwater Body Type	Lakes and lake fed rivers	
Attribute	Cyanobacteria - Planktonic	
Attribute Unit	Biovolume - mm^3/L (cubic millimetres per litre) OR Cell Count - cells/mL (cells per millilitre)	
Attribute State	**Numeric Attribute State**	**Narrative Attribute State**
	80th percentile*	
A	≤0.5 mm^3/L biovolume equivalent for the combined total of all cyanobacteria OR ≤500 cells/mL of total cyanobacteria	Risk exposure from cyanobacteria is no different to that in natural conditions (from any contact with fresh water).
B	N/A	
C	>0.5 and ≤1.8 mm^3/L biovolume equivalent of potentially toxic cyanobacteria OR >0.5 and ≤10 mm^3/L total biovolume of all cyanobacteria	Low risk of health effects from exposure to cyanobacteria (from any contact with fresh water).
National Bottom Line	**1.8 mm^3/L Biovolume equivalent of potentially toxic cyanobacteria OR 10 mm^3/L total biovolume of all cyanobacteria**	
D	Biovolume equivalent of >1.8 mm^3/L of potentially toxic cyanobacteria OR >10 mm^3/L total biovolume of all cyanobacteria	Potential health risks (eg, respiratory, irritation and allergy symptoms) exist from exposure to cyanobacteria (from any contact with fresh water).

* The 80th percentile must be calculated using a minimum of 12 samples collected over 3 years. 30 samples collected over 3 years is recommended.

Recommendation to CSG:

- Apply Planktonic Cyanobacteria attribute as above, but extend the Freshwater Body Type to include lowland river mainstem reaches, where residence time is increased through hydraulic effects of Waikato River. This includes the lower Waipa River (below Pirongia) and lowland tributaries such as Mangawara River. WRC monitoring data indicates that cyanobacteria do accumulate in some lowland river reaches upstream of the Waikato River confluence and can breach the national bottom line.

Attribute – Water clarity (NEW)

The Expert Panel agreed that water clarity was an important attribute relating to 'Swimmability', although it does not directly affect human health.

Water clarity is likely to influence people's choice of where to swim.

Further development of this attribute is needed to align lake and river breakpoints associated with differing methodology. Monitoring and compliance statistics needed to be defined.

Value	'Swimmability'	
Freshwater Body Type	Lakes & rivers	
Attribute	Water clarity	
Attribute Unit	m (measured using Secchi Disk in lakes and horizontal Black disc in rivers)	
Attribute State	**Numeric Attribute State**	**Narrative Attribute State**
	Annual median	
A	≥4	Water clarity is deemed excellent for swimming (WRISS)
B	≥1.6 and <4	Water clarity is deemed suitable for swimming*
C	≥1.1 and <1.6	Water clarity is deemed marginally suitable for swimming*
Minimum acceptable state	**1.1**	
D	<1.1	Water clarity is deemed unsuitable for swimming

* Smith, D. G. & Davies-Colley, R. J. 1992. Perception of water clarity and colour in terms of suitability for recreational use. Journal of Environmental Management 36: 225-235.

Recommendation to CSG:

- Apply Water Clarity attribute to lakes and rivers in the Waikato-Waipa catchment to represent elements of 'Swimmability' not directly related to Human Health.

Narrative Attributes – 'Swimmability' (NEW)

The following attributes require development of narrative statements relating to suitability for swimming:

- Odour
- Colour
- Bed sediments
- Weeds/algae
- Debris/snags
- Bank condition
- Access
- Habitat (e.g. presence of trees for swings)

Recommendation to CSG:

- Develop narrative statements relating to physical safety (e.g. clarity, currents and snags) and aesthetics (e.g. colour, odour, bed sediments, aquatic weeds and algae, bank condition and access) that are based on Tikanga and Matauranga Maori
- This may fall outside the scope of this workbrief and should be actioned separately by TLG

Ecosystem Health ('Healthy Biodiversity')

Attribute – Phytoplankton (Existing NPS-FM)

Value	Ecosystem health		
Freshwater Body Type	Lakes		
Attribute	Phytoplankton (Trophic state)		
Attribute Unit	mg/m³ (milligrams chlorophyll-a per cubic metre)		
Attribute State	Numeric Attribute State		Narrative Attribute State
	Annual Median	Annual Maximum	
A	≤2	≤10	Lake ecological communities are healthy and resilient, similar to natural reference conditions.
B	>2 and ≤5	>10 and ≤25	Lake ecological communities are slightly impacted by additional algal and plant growth arising from nutrients levels that are elevated above natural reference conditions.
C	>5 and ≤12	>25 and ≤60	Lake ecological communities are moderately impacted by additional algal and plant growth arising from nutrients levels that are elevated well above natural reference conditions.
National Bottom Line	12	60	
D	>12	>60	Lake ecological communities have undergone or are at high risk of a regime shift to a persistent, degraded state, due to impacts of elevated nutrients leading to excessive algal and/or plant growth, as well as from losing oxygen in bottom waters of deep lakes.

Recommendation to CSG:

- Apply Phytoplankton attribute as above, but extend the Freshwater Body Type to include the mainstem of the Waikato River and lowland river mainstem reaches, where residence time is increased through hydraulic effects of Waikato River. This includes the lower Waipa River (below Pirongia) and lowland tributaries such as Mangawara River.

Attribute – Total Nitrogen (Existing NPS-FM)

Contrast these values with WRISS

Value	Ecosystem health		
Freshwater Body Type	Lakes		
Attribute	Total Nitrogen (Trophic state)		
Attribute Unit	mg/m³ (milligrams per cubic metre)		
Attribute State	Numeric Attribute State		Narrative Attribute State
	Annual Median	Annual Median	
	Seasonally Stratified and Brackish*	Polymictic	
A	≤160	≤300	Lake ecological communities are healthy and resilient, similar to natural reference conditions.
B	>160 and ≤350	>300 and ≤500	Lake ecological communities are slightly impacted by additional algal and plant growth arising from nutrients levels that are elevated above natural reference conditions.
C	>350 and ≤750	>500 and ≤800	Lake ecological communities are moderately impacted by additional algal and plant growth arising from nutrients levels that are elevated well above natural reference conditions
National Bottom Line	**750**	**800**	
D	>750	>800	Lake ecological communities have undergone or are at high risk of a regime shift to a persistent, degraded state, due to impacts of elevated nutrients leading to excessive algal and/or plant growth, as well as from losing oxygen in bottom waters of deep lakes.

* Intermittently closing and opening lagoons (ICOLs) are not included in brackish lakes.

Recommendation to CSG:

- Apply TN attribute as above, but extend the Freshwater Body Type to include the mainstem of the Waikato River and lowland river mainstem reaches, where residence time is increased through hydraulic effects of Waikato River. This includes the lower Waipa River (below Pirongia) and lowland tributaries such as Mangawara River.

Attribute – Total Phosphorus (Existing NPS-FM)

Value	Ecosystem health	
Freshwater Body Type	Lakes	
Attribute	Total Phosphorus (Trophic state)	
Attribute Unit	mg/m³ (milligrams per cubic metre)	
Attribute State	Numeric Attribute State	Narrative Attribute State
	Annual Median	
A	≤10	Lake ecological communities are healthy and resilient, similar to natural reference conditions.
B	>10 and ≤20	Lake ecological communities are slightly impacted by additional algal and plant growth arising from nutrients levels that are elevated above natural reference conditions.
C	>20 and ≤50	Lake ecological communities are moderately impacted by additional algal and plant growth arising from nutrients levels that are elevated well above natural reference conditions.
National Bottom Line	50	
D	>50	Lake ecological communities have undergone or are at high risk of a regime shift to a persistent, degraded state, due to impacts of elevated nutrients leading to excessive algal and/or plant growth, as well as from losing oxygen in bottom waters of deep lakes.

Recommendation to CSG:

- Apply TP attribute as above, but extend the Freshwater Body Type to include the mainstem of the Waikato River and lowland river mainstem reaches, where residence time is increased through hydraulic effects of Waikato River. This includes the lower Waipa River (below Pirongia) and lowland tributaries such as Mangawara River.

Attribute – Periphyton (Existing NPS-FM)

The Expert Panel observed that periphyton issues are rare in the Waikato as a result of stream morphology (i.e. a predominance of 'soft-bottomed' streams) and shade conditions.

Value	Ecosystem health		
Freshwater Body Type	Rivers		
Attribute	Periphyton (Trophic state)		
Attribute Unit	mg chl-a/m² (milligrams chlorophyll-a per square metre)		
Attribute State	Numeric Attribute State (Default Class)	Numeric Attribute State (Productive Class[1])	Narrative Attribute State
	Exceeded no more than 8% of samples[2]	Exceeded no more than 17% of samples[2]	
A	≤50	≤50	Rare blooms reflecting negligible nutrient enrichment and/or alteration of the natural flow regime or habitat.
B	>50 and ≤120	>50 and ≤120	Occasional blooms reflecting low nutrient enrichment and/ or alteration of the natural flow regime or habitat.
C	>120 and ≤200	>120 and ≤200	Periodic short-duration nuisance blooms reflecting moderate nutrient enrichment and/or alteration of the natural flow regime or habitat.
National Bottom Line	200	200	
D	>200	>200	Regular and/or extended-duration nuisance blooms reflecting high nutrient enrichment and/or significant alteration of the natural flow regime or habitat.

1. Classes are streams and rivers defined according to types in the River Environment Classification (REC). The Productive periphyton class is defined by the combination of REC "Dry" Climate categories (i.e. Warm-Dry (WD) and Cool-Dry (CD)) and REC Geology categories that have naturally high levels of nutrient enrichment due to their catchment geology (i.e. Soft-Sedimentary (SS), Volcanic Acidic (VA) and Volcanic Basic (VB)). Therefore the productive category is defined by the following REC defined types: WD/SS, WD/VB, WD/VA, CD/SS, CD/VB, CD/VA. The Default class includes all REC types not in the Productive class.

2. Based on a monthly monitoring regime. The minimum record length for grading a site based on periphyton (chl-a) is 3 years.

Recommendation to CSG:

- Do not apply the Periphyton Attribute as above, because of limited relevance in most streams and rivers in the Waikato-Waipa catchment
- It is recommended that an attribute based on %cover (Matheson et al. 2013) be used for surveillance monitoring only

Attribute – Nitrate (Existing NPS-FM)

The Expert Panel observed that nitrate concentrations seldom approach levels where direct, chronic toxicity occurs.

Value	Ecosystem health		
Freshwater Body Type	Rivers		
Attribute	Nitrate (Toxicity)		
Attribute Unit	mg NO_3-N/L (milligrams nitrate-nitrogen per litre)		
Attribute State	Numeric Attribute State		Narrative Attribute State
	Annual Median	Annual 95th Percentile	
A	≤1.0	≤1.5	High conservation value system. Unlikely to be effects even on sensitive species
B	>1.0 and ≤2.4	>1.5 and ≤3.5	Some growth effect on up to 5% of species.
C	>2.4 and ≤6.9	>3.5 and ≤9.8	Growth effects on up to 20% of species (mainly sensitive species such as fish). No acute effects.
National Bottom Line	6.9	9.8	
D	>6.9	>9.8	Impacts on growth of multiple species, and starts approaching acute impact level (ie risk of death) for sensitive species at higher concentrations (>20 mg/L)

Recommendation to CSG:

- Apply Nitrate attribute as per NPS-FM
- This attribute is of limited relevance in most streams and rivers in the Waikato-Waipa catchment, because direct toxic effects of nitrates are unlikely given current concentrations observed in streams and rivers

Attribute –Ammonia (Existing NPS-FM

Value	Ecosystem health		
Freshwater Body Type	Lakes and rivers		
Attribute	Ammonia (Toxicity)		
Attribute Unit	mg NH_4-N/L (milligrams ammoniacal-nitrogen per litre)		
Attribute State	Numeric Attribute State		Narrative Attribute State
	Annual Median*	**Annual Maximum***	
A	≤0.03	≤0.05	99% species protection level: No observed effect on any species tested
B	>0.03 and ≤0.24	>0.05 and ≤0.40	95% species protection level: Starts impacting occasionally on the 5% most sensitive species
C	>0.24 and ≤1.30	>0.40 and ≤2.20	80% species protection level: Starts impacting regularly on the 20% most sensitive species (reduced survival of most sensitive species)
National Bottom Line	**1.30**	**2.20**	
D	>1.30	>2.20	Starts approaching acute impact level (ie risk of death) for sensitive species

* Based on pH 8 and temperature of 20°C.

Compliance with the numeric attribute states should be undertaken after pH adjustment.

Recommendation to CSG:

- Apply Ammonia attribute as per NPS-FM

Attribute – Dissolved Oxygen (Existing NPS-FM)

Value	Ecosystem health		
Freshwater Body Type	Rivers (below point sources)		
Attribute	Dissolved Oxygen		
Attribute Unit	mg/L (milligrams per litre)		
Attribute State	Numeric Attribute State		Narrative Attribute State
	7-day mean minimum[1] (Summer Period: 1 November to 30th April)	1-day minimum[2] (Summer Period: 1 November to 30th April)	
A	≥8.0	≥7.5	No stress caused by low dissolved oxygen on any aquatic organisms that are present at matched reference (near-pristine) sites.
B	≥7.0 and <8.0	≥5.0 and <7.5	Occasional minor stress on sensitive organisms caused by short periods (a few hours each day) of lower dissolved oxygen. Risk of reduced abundance of sensitive fish and macroinvertebrate species.
C	≥5.0 and <7.0	≥4.0 and <5.0	Moderate stress on a number of aquatic organisms caused by dissolved oxygen levels exceeding preference levels for periods of several hours each day. Risk of sensitive fish and macroinvertebrate species being lost.
National Bottom Line	**5.0**	**4.0**	
D	<5.0	<4.0	Significant, persistent stress on a range of aquatic organisms caused by dissolved oxygen exceeding tolerance levels. Likelihood of local extinctions of keystone species and loss of ecological integrity.

1. The mean value of 7 consecutive daily minimum values.

2. The lowest daily minimum across the whole summer period.

Recommendation to CSG:

- Apply Dissolved Oxygen attribute as per NPS-FM, but extend the Freshwater Body Type to include all rivers rather than just below point sources

Attribute – Light Climate (NEW)

The expert panel identified light climate as an important attribute relevant to ecosystem health in Waikato lakes (e.g. peat lakes) and large rivers (e.g. Waikato mainstem).

Value	Ecosystem Health	
Freshwater Body Type	Lakes & large rivers	
Attribute	Visual clarity (Δ from reference state)	
Attribute Unit	m (measured using Secchi Disk in lakes and horizontal Black disc in rivers)	
Attribute State	**Numeric Attribute State**	**Narrative Attribute State**
	Δ in clarity vs Reference	
A	<X%	Light climate is similar to reference state and supports the full range of species expected to be present
B	>X but <Y%	Light climate somewhat modified and likely to support most expected species
C	>Y but <Z%	Light climate significantly modified and likely to support only some expected species
Minimum acceptable state	**Z%**	
D	>Z%	Light climate does not support species expected to be present

Recommendation to CSG:

- Develop and apply a Light Climate attribute to lakes and large rivers in the Waikato-Waipa catchment

Attribute – Submerged Macrophytes (NEW)

The Expert Panel agreed that macrophyte biomass was an important attribute that was relevant to Ecosystem Health in Waikato rivers. There was concern noted about the potential for this attribute to impact on Mahinga kai values (e.g. watercress). Restricting the Attribute to submerged macrophytes will address this concern.

Value	Ecosystem Health	
Freshwater Body Type	Rivers	
Attribute	Submerged Macrophytes	
Attribute Unit	% Channel cross-sectional area	
Attribute State	**Numeric Attribute State**	**Narrative Attribute State**
	Summer maximum???	
A	<X%	
B	>X but <Y%	
C	>Y but <Z%	
Minimum acceptable state	**50%***	
D	>Z%	

*Source: Matheson et al (2013)

Recommendation to CSG:

- Apply Submerged Macrophyte attribute to rivers in the Waikato-Waipa catchment

Attribute – Dissolved Nutrients (NEW)

Development of DIN and DRP 'norms' was considered appropriate for managing nutrient levels in streams and rivers that fall outside the application of TN and TP attributes. This would be done in the same way as in ANZECC (2000). That is, the 80th percentile of monitored data for representative sites in the Waikato-Waipa catchment.

Further work is needed to identify how these 'norms' would fit into a Waikato Objectives Framework. At the very least these 'norms' would be used in surveillance monitoring to support objectives set on river mainstems in relation to TN and TP levels.

Attribute – Deposited sediment (NEW)

Value	Ecosystem Health	
Freshwater Body Type	Wadeable rivers	
Attribute	Deposited Sediment	
Attribute Unit	%cover	
Attribute State	**Numeric Attribute State**	**Narrative Attribute State**
	Summer base flow	
A		Excellent
B		Good
C		Fair
Minimum acceptable state		
D		Poor

Recommendation to CSG:

- Apply Deposited Sediment attribute to wadeable rivers in the Waikato-Waipa catchment

Attribute – Temperature (NEW)

Value	Ecosystem Health	
Freshwater Body Type	Rivers	
Attribute	Water Temperature	
Attribute Unit	Degrees C	
Attribute State	**Numeric Attribute State**	**Narrative Attribute State**
	????	
A		Excellent
B		Good
C		Fair
Minimum acceptable state		
D		Poor

Recommendation to CSG:

- Apply Temperature attribute to rivers in the Waikato-Waipa catchment

Mahinga kai ('Fishable')

The Expert Panel members with specific expertise in Mahinga kai, observed that this value can be broken into two themes:

- Food is safe to eat
- Food stocks are sufficient to be fit for purpose

In relation to the former, the *E. coli* and Cyanobacteria Attributes proposed under Human Health are relevant, as are many of the suggested narrative attributes proposed for 'Swimmability'. An additional Attribute around levels of heavy metals would also be appropriate and relevant to Waikato.

In relation to the latter, the Expert Panel suggested a catch-per-unit-effort (CPUE) attribute be developed, along with an integrated measure of food chain intactness. The Macroinvertebrate Community Index was proposed as an integrator measure relating to the 'health' of the food chain.

Recommendations to CSG:

- Apply *E. coli* and Cyanobacteria attributes to Mahinga Kai value
- Apply Catch-Per-Unit-Effort attribute to rivers in the Waikato-Waipa catchment
- Develop Heavy Metals attribute
- Develop Biotic Index attribute reflecting food chain intactness (e.g. MCI)

Attribute – Catch per Unit Effort (NEW)

Value	Mahinga kai	
Freshwater Body Type	Lakes & Rivers	
Attribute	Catch per Unit Effort	
Attribute Unit	CPUE	
Attribute State	**Numeric Attribute State**	**Narrative Attribute State**
	????	
A		Excellent
B		Good
C		Fair
Minimum acceptable state		
D		Poor

Attribute – Heavy Metals (NEW)

Value	Mahinga kai	
Freshwater Body Type	Lakes & Rivers	
Attribute	Heavy Metals	
Attribute Unit	Concentration in flesh or environment?	
Attribute State	**Numeric Attribute State**	**Narrative Attribute State**
	????	
A		Excellent
B		Good
C		Fair
Minimum acceptable state		
D		Poor

Attribute – Food Chain Health/Intactness (NEW)

Value	Mahinga kai	
Freshwater Body Type	Lakes & Rivers	
Attribute	Food Chain Health = MCI	
Attribute Unit	Dimensionless (hard and soft-bottomed variants used)	
Attribute State	**Numeric Attribute State**	**Narrative Attribute State**
	Summer survey	
A	>120	Excellent
B	100-120	Good
C	80-100	Fair
Minimum acceptable state	80	
D	<80	Poor