What do we currently know?

…about surface water quality… & land use… in the Hurunui catchment

Gathering current knowledge with the Science Stakeholder Group: 8 March 2017, WAIPARA

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Purpose

- Share what we (the whole SSG) know
- Find, & plan to fill, knowledge gaps
- Reach a level of comfort with messages

…to inform ZC & wider community

(public meeting at Waikari Hall, Monday 20 March at 7.30pm)

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Outline topics for today

1. Surface water quality / ecology (60 mins)
2. Current land use & N loads (20 mins)
3. Next steps…

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Surface Water Quality in the Hurunui River Catchment

Kimberley Dynes – Ecology Scientist
Adrian Meredith – Principal Surface Water and Ecology Scientist
Environment Canterbury

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Topics to cover

- Key Messages
- Water quality monitoring programmes
- Aquatic ecosystem health
- Periphyton indicators
  - Total periphyton and cyanobacteria
- Nutrients
  - Nutrient impacts on periphyton
  - Toxicity
- Faecal indicator bacteria
  - *E.coli* for Wadeable and Swimmable
- Additional monitoring

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Key messages

- Cyanobacteria is an issue in the lower reaches of the Hurunui River – Didymo appears to be the dominant algae in the upper reaches
- Nitrate from intensive land use in the Amuri Basin is an important source to the mainstem, with increasing concentrations in some tributary sites and for SH1
- Ecological health occasionally indicates degradation for some sites
- Swimmibility is an issue for the tributary streams and at SH1 much of the time
- Need to manage N, P, microbial contamination and sediment (and flow) to achieve freshwater objectives

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Water Quality in Rivers and Streams

- 3 different monitoring programmes
  - Aquatic Ecosystem Health – assesses the aquatic bugs (macroinvertebrates) living in the water over the summer months
  - Water quality monitoring for physical and chemical water quality
    - Nutrients, bacteria, water clarity, periphyton (algae)
  - Recreational Water Quality

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Aquatic ecosystem health

Monitoring of aquatic macro-invertebrates (bugs >0.5 mm) species as an indicator of overall water quality and stream habitat

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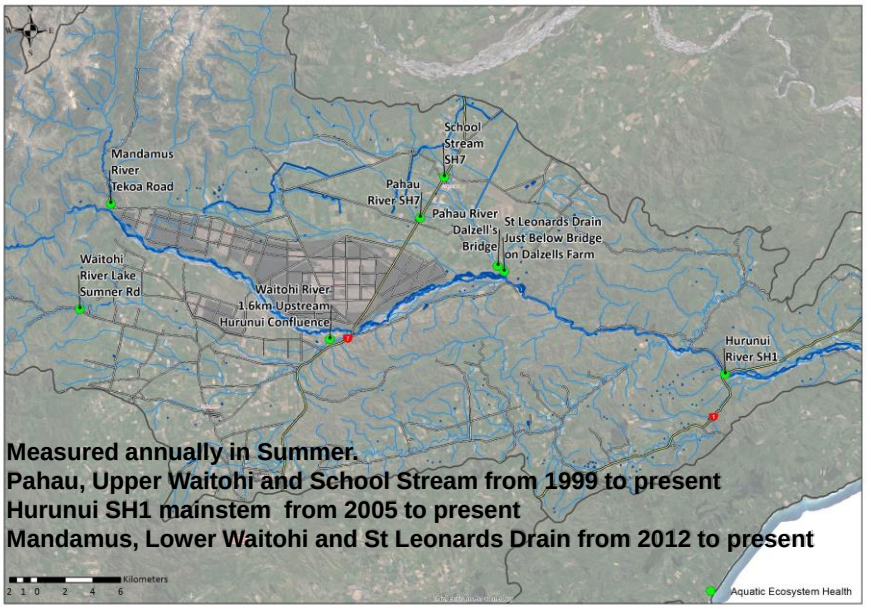
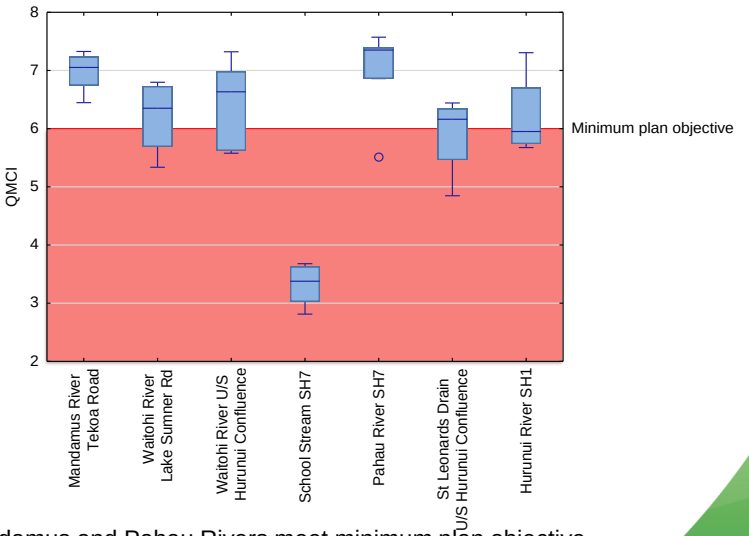
Aquatic ecosystem health





- Mandamus and Pahau Rivers meet minimum plan objective
- Waitohi (2 sites), St Leonards Drain and Hurunui SH1 occasionally do not meet the minimum plan objective
- School Stream at SH7 does not achieve the minimum plan Objective

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Key Messages: Aquatic Ecosystem Health

- 2 sites always meet plan objectives, 4 sites sometimes meet plan objectives,
- School Stream at SH7 does not meet the minimum plan objective
  - Stagnant flow, choked with macrophytes/floating algae,

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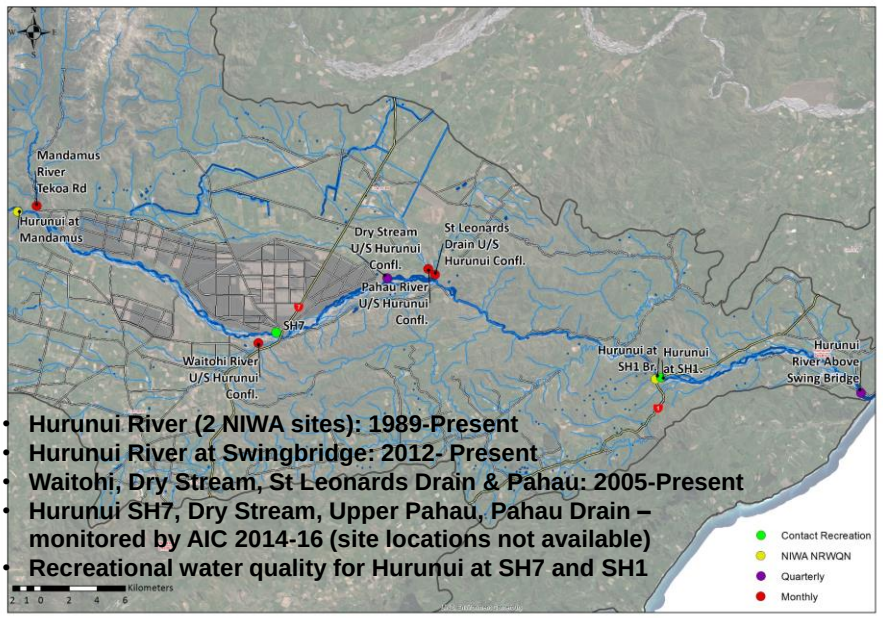
Routine water quality in streams and rivers



- **Hurunui River (2 NIWA sites): 1989-Present**
- **Hurunui River at Swingbridge: 2012- Present**
- **Waitohi, Dry Stream, St Leonards Drain & Pahau: 2005-Present**
- **Hurunui SH7, Dry Stream, Upper Pahau, Pahau Drain – monitored by AIC 2014-16 (site locations not available)**
- **Recreational water quality for Hurunui at SH7 and SH1**

Periphyton Monitoring

- Total Biomass
- Total cover %
- Filamentous algae
- Cyanobacteria mats
- Didymo

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Total Periphyton - biomass

- Measure of total periphyton community for a given area
- NPS-FM National Objectives Framework – Benthic Periphyton – chlorophyll 'a'
  - Only have suitable data at 2 sites: Hurunui SH1 + Pahau River
- Pahau River at Top Pahau Rd generally good
- Hurunui River at SH1 variable and not suitable all years

Benthic Periphyton	No. samples	National Bottom line		C		B		A	
SQ30064	Hurunui River SH1								
3 yr	36	4	11%	5	14%	2	6%	22	61%
2011-12	12	3	25%	2	17%	0	0%	5	42%
2012-13	12	1	8%	1	8%	1	8%	8	67%
2013-14	12	0	0%	2	17%	1	8%	9	75%
SQ00540	Pahau River at Top Pahau Road								
3 yr	36	0	0%	0	0%	1	3%	34	94%
2011-12	12	0	0%	0	0%	0	0%	12	100%
2012-13	12	0	0%	0	0%	1	8%	10	83%
2013-14	12	0	0%	0	0%	0	0%	12	100%

Periphyton Monitoring

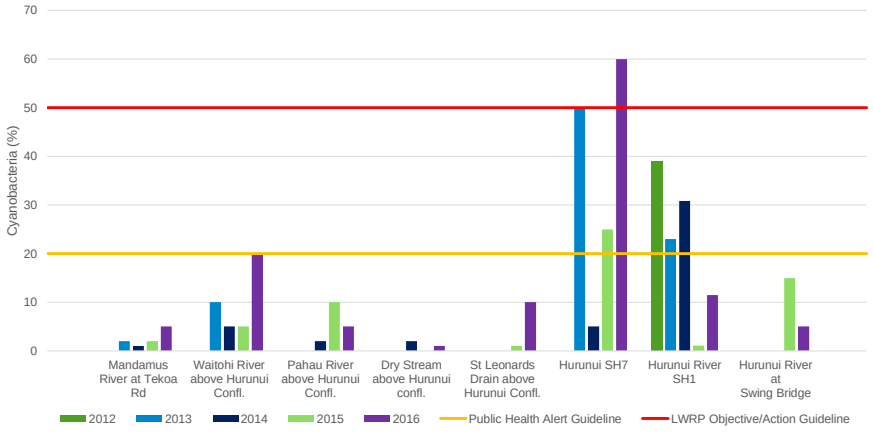
- Total Biomass
- Total cover %
- Filamentous algae
- Cyanobacteria mats
- Didymo

Filamentous Algae periphyton cover

- Green filamentous algae for hill-fed trib and Hurunui mainstem sites monitored in the catchment achieves plan objectives
- Green filamentous algae does not appear to be the dominant algae in the Hurunui River catchment

Cyanobacteria mat cover in rivers

- Most problematic in Hurunui River
- Public Health Warnings often issued at SH7 & SH1 due to moderate-high cover, and detaching mats



Cyanobacteria mats in rivers

- Public health warnings have been issued for the Hurunui River at SH7 and SH1
- Hurunui SH7 cyanobacteria is generally assessed for public health notification upstream of a swimming site – last few years this has been in a side braid
- Cyanobacteria is now the dominant periphyton in the lower Hurunui River
- Flow (freshes/floods) = greatest influence limiting growths, followed by nutrient

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Didymo cover in rivers

- Didymo is the dominant periphyton in the upper catchment (upstream of SH7) (Kilroy 2016)
- Didymo appears to dominate under low nutrient conditions

Nutrients and their impact on water quality

- **Nutrients**
  - At **low** concentrations - Beneficial in encouraging thin growths of algae in rivers (food for aquatic life)
  - At **higher** concentrations – encourage conspicuous nuisance growths of algae (periphyton)
  - At **very high** concentrations some nutrients (Nitrate-N, Ammonium-N) can be toxic
- Different guideline address different effects

Recap of previous presentations - Groundwater

- increasing nitrate trends with intensification across the Amuri Basin
- phosphorus elevated in some shallow GW - may be related to landuse

Recap of previous presentations – Periphyton and Cyanobacteria

- River flow has greatest influence on periphyton growth, followed by nutrients when flow is optimal
- different periphyton appear to have different nutrient requirements
  - cyanobacteria = potentially low P in water
  - didymo = low nutrient requirements
  - long filament = elevated N & P
  - Need to manage both N & P to meet requirements of different periphyton

Recap of previous presentations – Periphyton and Cyanobacteria

- In the Hurunui River:
  - Shift from didymo dominated upstream to cyanobacteria downstream
  - Mirrored by nutrient shift from low N & P conc. upstream (suitable for didymo as low nutrient requirements) to higher N but P limited downstream (suitable for cyanobacteria as may utilise alternative P source e.g sediment)

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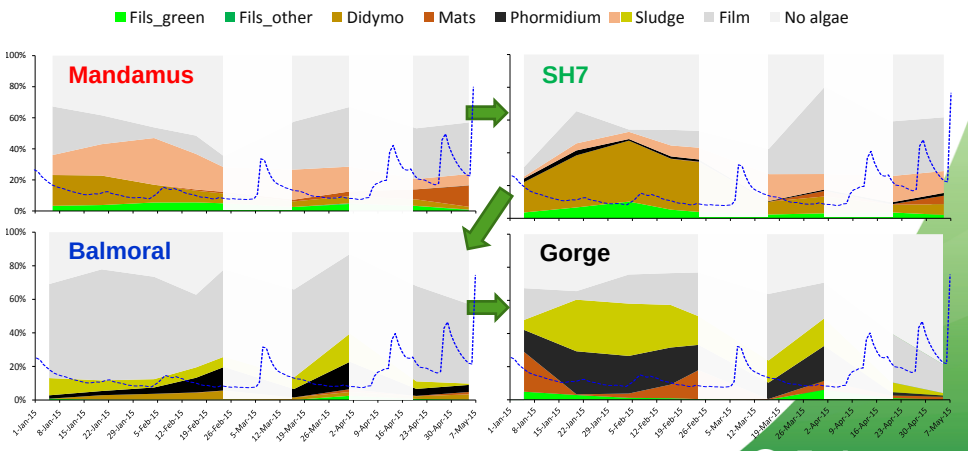
Periphyton cover on the river bed (visual estimates)



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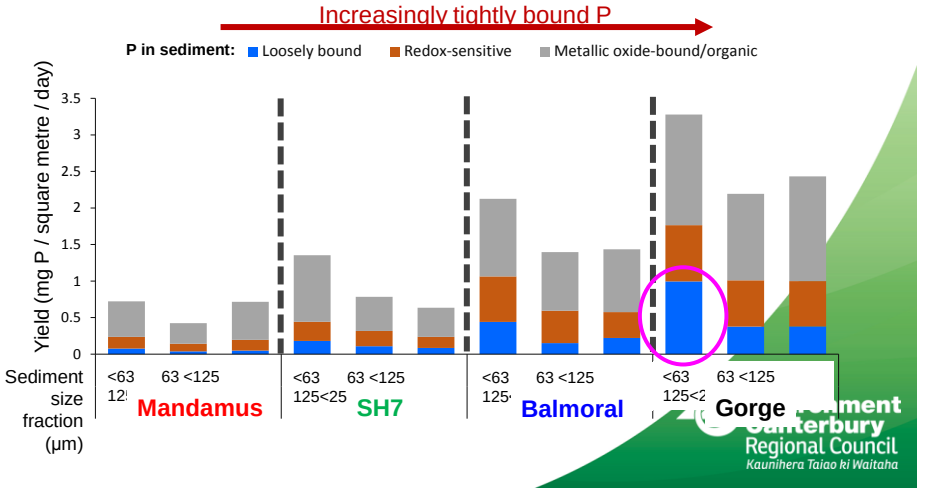
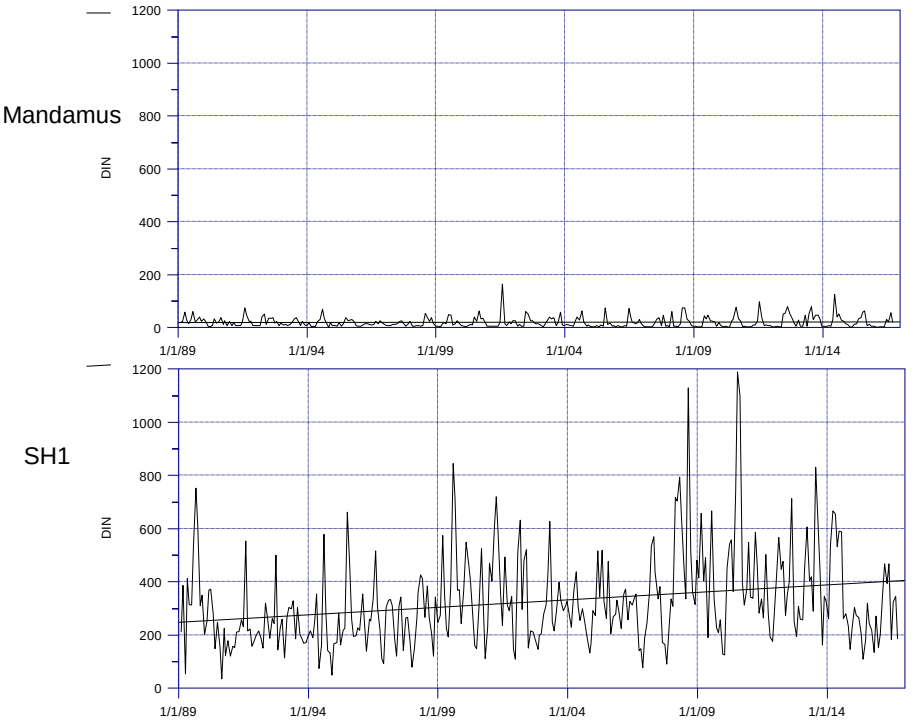
- Increase in fine sediment downstream, with increasing P content in sediment downstream (correlated to greatest cyanobacteria cover)

Sediment trap study: summary results



Nutrient impacts on periphyton – Nitrogen

- Increase in N from upper Hurunui (Mandamus/SH7) to lower (SH1/SB)
  - indicating moderate-high risk of nuisance periphyton blooms in lower river
- Long term trends = decreasing trend at Mandamus, Increasing trend at SH1



Nutrient impacts on periphyton – Nitrogen

- Increase in N from upper Pahau (Downs) to lower Pahau (above Hurunui)
- Nitrogen elevated in tributary streams (Amuri Basin)
  - Greatest in spring-fed tributaries e.g Pahau Drain, St Leonards Drain
- Increasing trends for Waitohi and St Leonards Drain, decreasing for Dry (irrigation race water)

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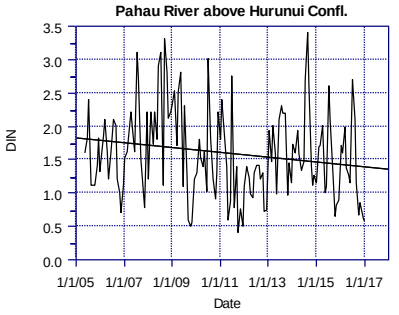

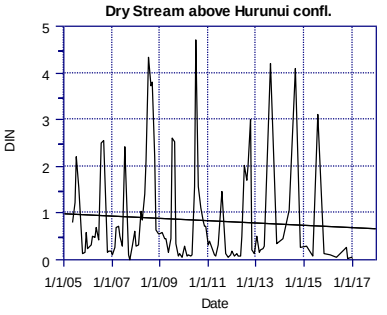

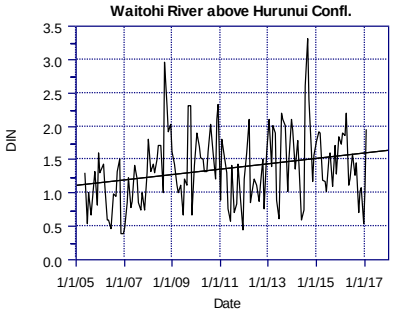

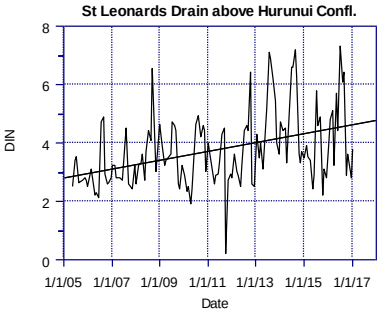

Nutrient impacts on periphyton – Phosphorus

- Tributaries show higher P - moderate increase in risk of nuisance growths
- Decreasing trends for mainstem, Waitohi, Pahau, and Dry Stream
- Mainstem Hurunui shows P-limitation – does not account for sediment P sources i.e for *Phormidium* growth

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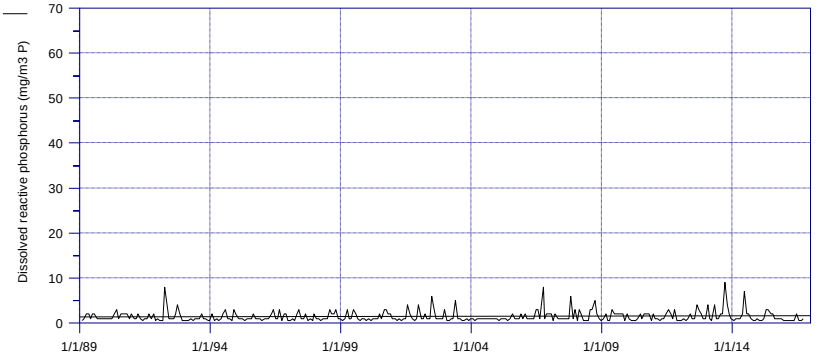
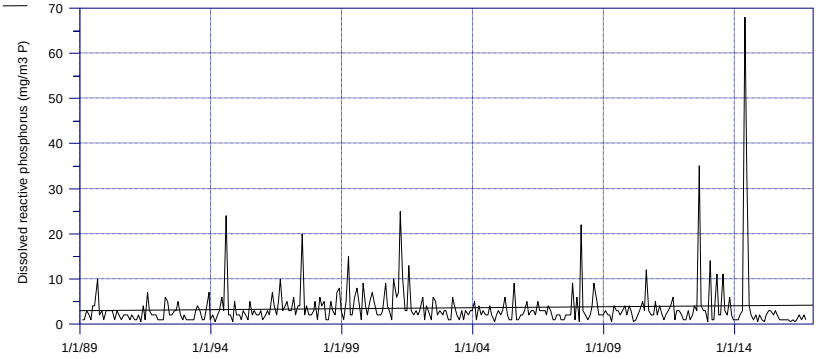
Mandamus



SH1



Nutrient impacts on periphyton – Phosphorus

- Tributaries show higher P - moderate increase in risk of nuisance growths
- Mainstem Hurunui shows P can often be limiting – does not account for sediment P sources i.e for *Phormidium* growth
- Decreasing trends for mainstem, Waitohi, Pahau, and Dry Stream

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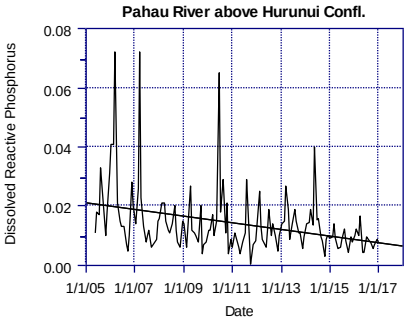

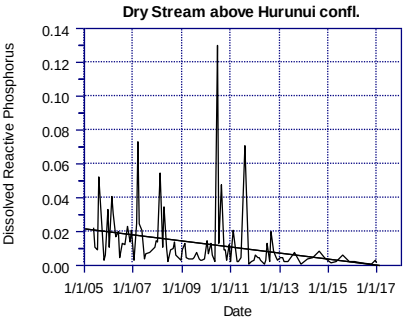

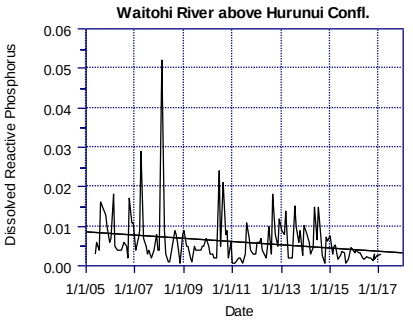

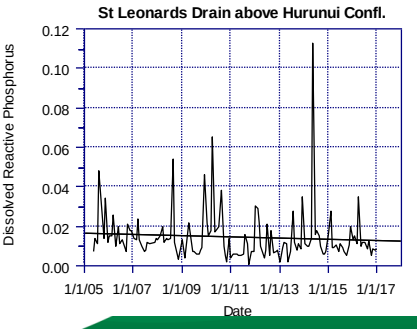

Key Messages: Nutrients and periphyton

- **Hurunui River mainstem:**
  - Upper river dominated by didymo, with N & P co-limitation
  - Lower river dominated by cyanobacteria. Increasing N concentrations, but can be limited by P concentrations
    - Kilroy (2016) indicates increased fine sediment and associated P may be a source supporting cyanobacteria

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Key Messages: Nutrients and periphyton

- **Amuri Basin tributaries**:
  - Elevated nutrient concentrations sufficient for periphyton growth
    - Nitrogen concentrations increasing in some tributaries
  - Tributaries do not appear to be susceptible to nuisance growths
  - Elevated nutrient concentrations important as a source to the mainstem

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Nutrient toxicity – National Criteria

- Ammonia and Nitrate toxicity assessed compared to the NPS-FM National Objectives Framework
- All river sites monitored classed in the A and B bands of the NPS-FM for ammonia – indicates low ammonia toxicity risk

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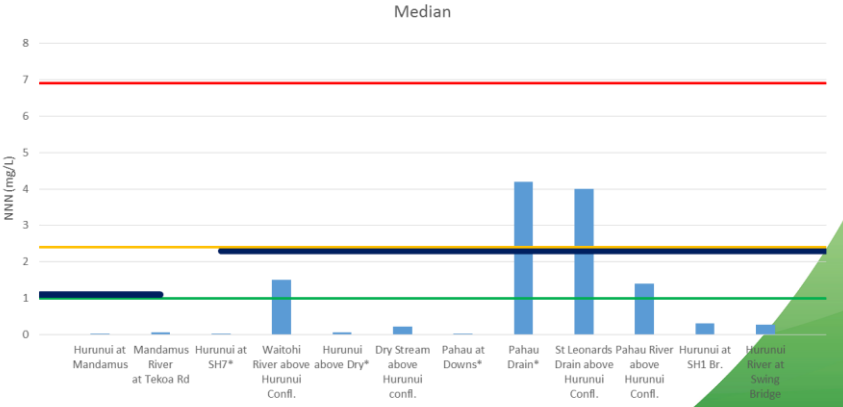
Nitrate toxicity – National Criteria

- Median concentrations indicate some toxic effects on species for spring-fed streams i.e Pahau Drain and St Leonards Drain
- Do not meet the HWRRP objective for these sites



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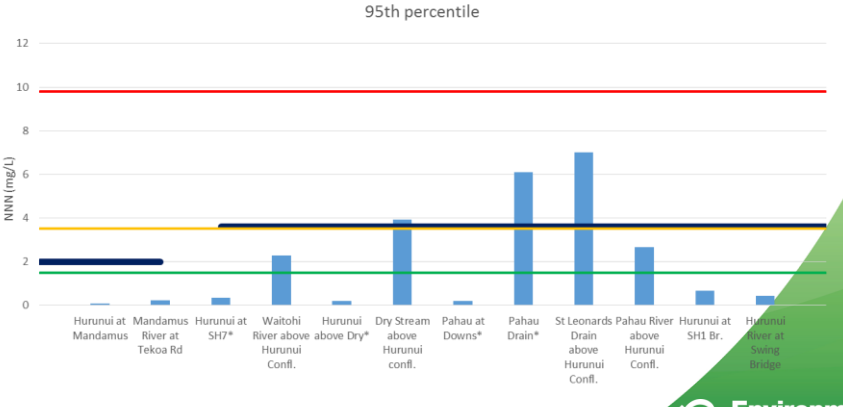
Nitrate toxicity – National Criteria

- 95th percentile concentrations indicate some toxic effects on species for spring-fed streams i.e Pahau Drain and St Leonards Drain, and Dry Stream
- Do not meet the HWRRP objective for these sites



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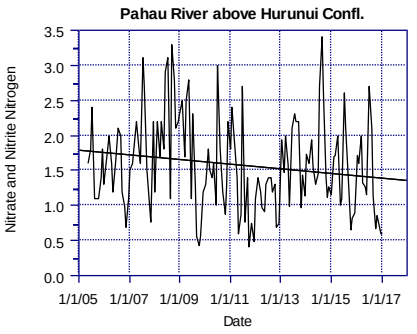
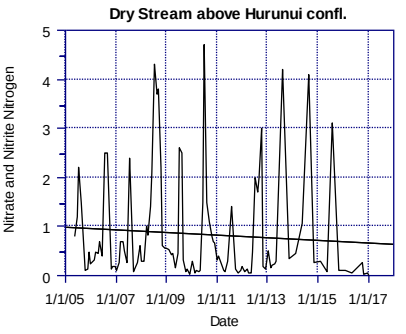
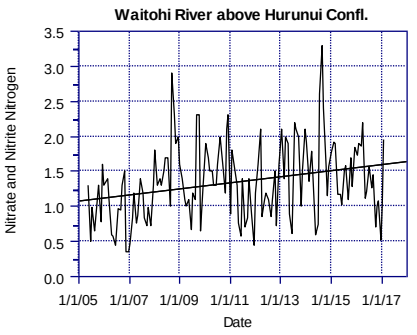
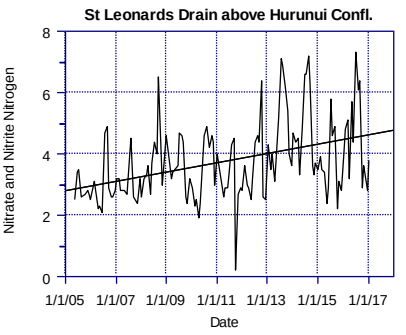
Nitrate toxicity – National Criteria

- Spring-fed streams – Nitrate concentrations may have potential toxicity effects (on 20% of aquatic species (i.e sensitive species)).
- Increasing trends for Waitohi and St Leonards Drain, decreasing trend for Dry Stream (irrigation race water)









Key Messages: Nutrient Toxicity

- Low risk of toxic effects for the mainstem of the Hurunui River
- Hill and spring-fed tributaries indicate potential species loss or growth effects due to elevated nitrate concentrations
- Does not take into consideration the lower nutrient thresholds for nuisance periphyton

Wadeable and Swimmable

- **Wadeable** = People are exposed to a high risk of infection (>5% risk) from contact with water during activities with partial immersion and some ingestion of water
  - Annual median must not exceed 1000 MPN/100mL
- **Swimmable** = moderate risk of infection (< 5% risk) from activities likely to involve full immersion.
  - Annual 95th percentile must not exceed 540 MPN/100mL

From NPS-FM (2014)

Wadeable and Swimmable

- Wadeable: All sites monitored classed in the A and B bands of the NPS-FM for 2011-16 – indicates suitable for wading activities
- Swimmable:
  - 2013-14 5 of 6 sites do not meet minimum requirements for Swimmibility
  - Tributary streams frequently do not meet minimum requirements for swimmability
  - Hurunui River at SH1 did not meet minimum requirements for past 4 years – reflected by a poor suitability for recreation grading

Swimmable	2011-12	2012-13	2013-14	2014-15	2015-16
Hurunui River at Mandamus	A	A	B	A	A
Mandamus River – Tekoa Rd				B	B
Waitohi above Hurunui Confl.		B			
Dry Stream above Hurunui Confl.	Insufficient data for analysis				
Pahau River above Hurunui Confl.	B	B		A	
St Leonards Drain above Pahau					
Hurunui River SH1	B				

Sites coded red do not meet the minimum acceptable state for Swimmibility for that year.

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Key Messages: Wadeable/Swimmable

- All sites meet Wadeable bottom lines
- Amuri Basin tributary streams and Hurunui River at SH1 generally do not meet minimum acceptable state for Swimmibility
- Suitability for recreation monitoring only carried out for Hurunui River at SH7 and SH1 = recent improvement to Fair grading, but have both been previously considered unsuitable for recreation

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Summary - Water quality in rivers and streams

	Mainstem - below Mandamus	Tributary Streams
Aquatic Ecological Health	😐	☹
Cyanobacteria	☹	🙂
Filamentous Algae	😐	🙂
Nitrogen	☹	☹
Phosphorus	🙂	😐
Swimmibility	☹	☹

Summary - Water quality in rivers and streams

- Cyanobacteria is an issue in the lower reaches of the Hurunui River – Didymo appears to be the dominant algae in the upper reaches
- Nitrate from intensive land use in the Amuri Basin is an important source to the mainstem, with increasing concentrations in some tributary sites and for SH1
- Ecological health occasionally indicates degradation for some sites
- Swimmibility is an issue for the tributary streams and at SH1 much of the time

Summary - Water quality in rivers and streams

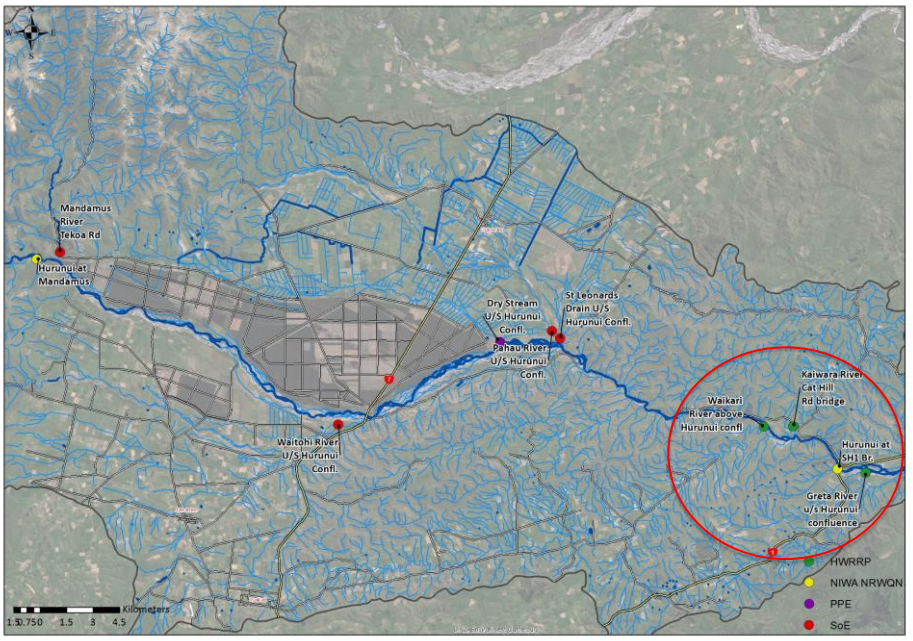
- Need to manage N, P, microbial contamination and sediment (and flow) to achieve freshwater objectives

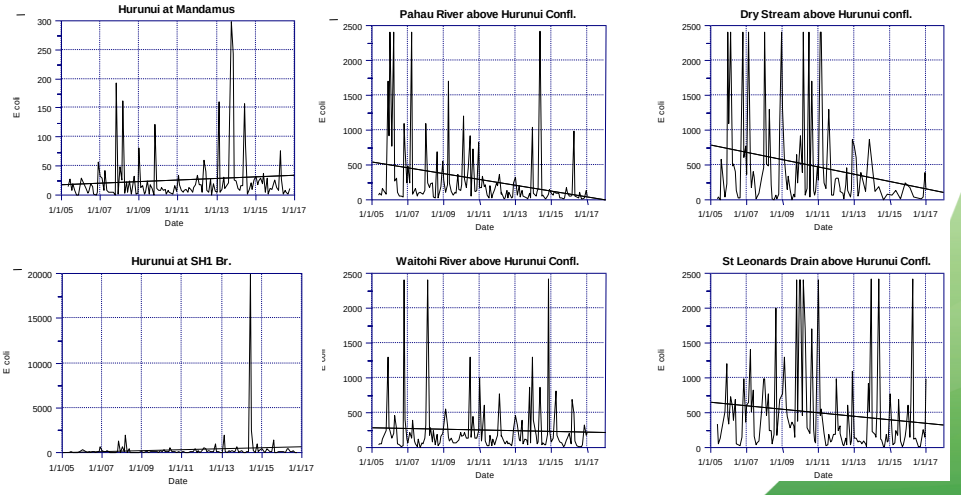
Additional Monitoring Data

Additional monitoring data required or underway:

Plan Monitoring sites – 3 additional tributary sites being monitored for tributary nutrient load determination (plan requirement)

Current Gap Filling and Plan Effectiveness monitoring sites





<insert surface water slides here>

Current land use and estimates of both 'Source' & 'In-river' nutrient loads

Ned Norton – Technical Lead
Ognjen Mojsilovic – Land Resources Scientist

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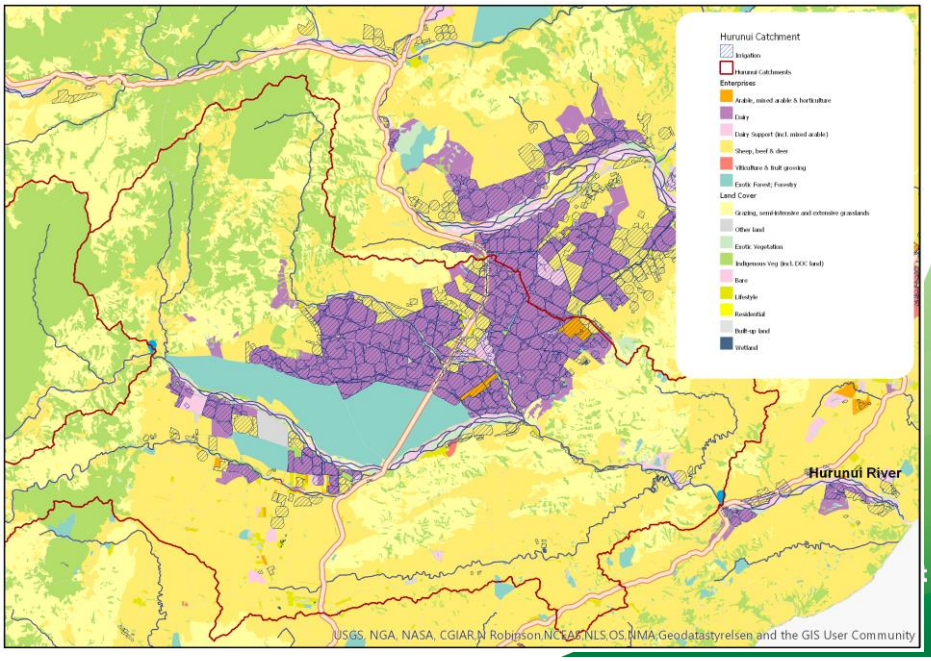
How do we estimate current land use patterns at regional scale?

1. Use following databases in GIS…
   - AgriBase (AsureQuality 2016)
   - Farm Dairy Effluent consents (ECan 2016)
   - Valuation roll (ECan 2016)
   - Land Cover Database (2012)
   - Irrigation (Aqualinc 2015)
   - Select LINZ Topo 50 layers (LINZ 2016)

Draft method to be written up & made available

2. Match agricultural enterprises to base farm classes established by the MGM project
   (Matrix of Good Management)

Draft result: GIS layer 'current' landuse



How do we estimate N loss at regional scale?

1. Use estimated current land use GIS layer
2. Use soil layer (MGM classes)
3. Use climate (rainfall) layer (MGM classes)
4. Use N loss estimates (kg/ha/yr) for different farm classes on different soils & rainfall – from the MGM project
5. Use GIS tool to sum up the loads

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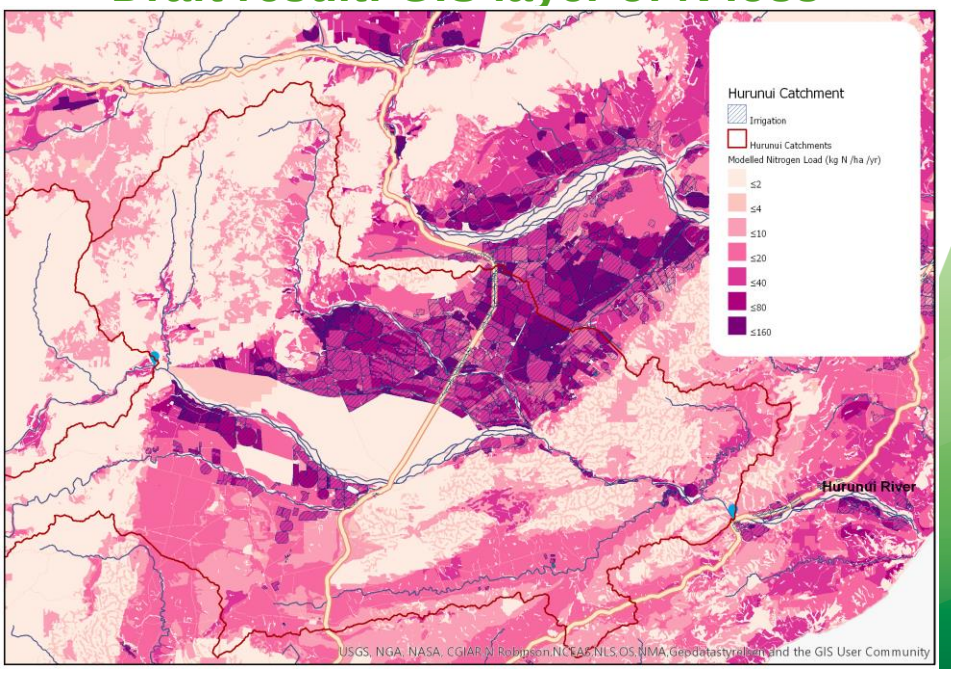
Draft result: GIS layer of N loss



Using these layers to estimate DRAFT 'Source' loads & compare to 'In-river' loads

Catchment	Area (ha)	'Source' loads (Nitrogen tonnes/yr)#	'In-river' loads (Nitrogen tonnes/yr)*	Existing Plan load limit (N tonnes/yr)
Hurunui at Mandamus	105,754	**228**	**55*** (29-104)**	**39**
Hurunui at SH1 (Total)	252,395	**1,886**	**713*** (270-1266)**	**963**

Based on summing loads from draft GIS layers on previous slides
* Based on rolling 6 year average annual load estimate as at 2016
** Large range of annual load estimates for the period 2005 to 2016 – see next slide

Variability with 'In-river' load calculations

	DIN annual load estimates (tonnes/yr)
Hurunui SH1	
2005-06	516
2006-07	472
2007-08	520
2008-09	1266
2009-10	845
2010-11	948
2011-12	475
2012-13	698
2013-14	1451
2014-15	435
2015-16	270
Rolling 6 year average annual load estimate (T/yr)	**713**

Hurunui at u/s Mandamus	
2005-06	29
2006-07	32
2007-08	42
2008-09	62
2009-10	28
2010-11	42
2011-12	43
2012-13	66
2013-14	105
2014-15	43
2015-16	29
Rolling 6 year average annual load estimate (T/yr)	**55**

The differences between 'Source' loads and 'In-River' loads?

1. Methods (modelled vs measured [still estimated])
2. Attenuation – uptake between sources & receiving environment
3. Time lags – between source & in-river
4. Assumptions - current versus past & future practices (eg where are we at compared to 'good management practice defined by MGM project?)

Next steps to improve?

1. Current land use patterns – local ground-truthing & adjustment?
2. Local help with assumptions - current versus past & future practices eg where are we at compared to 'good management practice' (MGM)?
3. Sharing & checking process is underway with AIC, HWP and NT
4. Others?

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Questions?

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