Theme 1: Managing land uses in harmony with freshwater
He Oranga mo nga Uri Tuku Iho trust
Land use and river health

- New Zealand’s biggest environmental issue
- River health = catchment health
- Contaminants
  - nutrients
  - faecal bacteria
  - sediment
- Riparian management – one answer?
- Maori perspectives
River health and fisheries

Roger Young, Cawthron

Aaron Quarterman, Karen Shearer, Joe Hay,
John Hayes, Joanne Clapcott, Kati Doehring, Dean Olsen, Rowan Strickland - Cawthron

Rebecca Eyles - Otago University
Rob Smith, Trevor James - TDC
Lawson Davey, Neil Deans - Fish & Game
Les Basher, Andrew Fenemor - Landcare Research
Kevin Collier – EW/Waikato University
River health

• How do climate, geology and land use influence water quality and river health?

• Water quality
• Stream invertebrate communities
• Functional indicators
Water Quality Sampling Network

- 23 Sites throughout the catchment
- Contrasting land use
- Contrasting geology
- Patterns along the river
- Measured – oxygen, conductivity, pH, nutrients (NO$_3$, DRP), faecal bacteria, pathogens, turbidity, suspended solids, clarity

Stream Invertebrate Sampling

• Common indicator of river health
• 46 Sites throughout the catchment
• Contrasting land use
• Contrasting geology

• Interesting geology/landuse interactions
• Small pastoral streams in poor health
• Headwaters and mainstem healthy
Functional indicators

• A new approach to river health assessment
• Ecosystem processes/functions
• Ecosystem metabolism
• Organic matter

\[ \text{GPP} = 107 \text{ gO}_2/\text{m}^2/\text{day} \]
\[ \text{ER} = 65 \text{ gO}_2/\text{m}^2/\text{day} \]

\[ \text{CO}_2 + \text{H}_2\text{O} \xrightarrow{\text{light}} \text{CH}_2\text{O} + \text{O}_2 \]

Young et al. 2008: JNABS 39: 803-825;
Clapcott et al. in press: Freshwater Biology
Implications

- Strong role of land use and geology on water quality and river health
- SOE reporting
  - Action – bridges, riparian management
- New monitoring tools
  - Being used in NZ and overseas
Fisheries

• Why did the Motueka trout population crash in the mid 1990’s?
What is affecting fish numbers?

- Floods
- Droughts
- Warm temperatures
- Food supply
- Water clarity
- Sediment
- Pine trees
- Disease
- Water Augmentation
- Angling pressure
- Shags
- Lack of stocking
- Didymo
Numbers of trout (/km)

Duration of floods >FRE3 during RELEVANT Oct/Nov (hours)

Large >40 cm
$R^2 = 0.24$
$P = 0.04$

Medium 20-40 cm
$R^2 = 0.35$
$P = 0.01$

Small <20 cm
$R^2 = 0.10$
$P = 0.19$
Management implications

• Demonstrates value of long records
• Floods have over-riding effects on trout population

• What will climate change do to flood frequency?
Faecal contamination

Recent findings from the Mot. ICM prgme

E. coli – Indicator of faecal pollution

Rob Davies-Colley
NIWA, Hamilton
Two questions -

1. Why measure *E. coli*?
   Because we can’t test routinely for all the faecal pathogens that **might** be present (but mostly aren’t…)

2. Does it matter if faecal pollution is from livestock rather than humans?
   **YES!** Livestock carry human diseases. Not viruses (usually), but often **protozoans** (e.g., *Cryptosporidium*) and **bacteria** (e.g., *Campylobacter*)
Motueka River

Woodmans Bend (near Mot R mouth)

NN2 Woodstock

NN1 Gorge

Young et al. (2005)
WQ of Mot R
(incl. E. coli)
at 23 sites, 2000-1
Faecal Pollution
(Mot. River at Woodmans)

McKergow & D-C (2010)
Hydrol proc. 24
98% of faecal pollution from the Mot Catchment is transported in stormflows (McKergow & D-C 2009)
Motueka River

Young et al (2005)
WQ of Mot R
(incl. E. coli)
at 23 sites, 2000-1
Cow crossings in the Sherry

- Studied in October 2001
- Davies-Colley et al. (2004) *NZJMFR 38*

*High pollutant concentrations - correlated with cow count*
Direct deposition – to unfenced streams

- *E. coli* up to 30,000 cfu/100 mL
- ~0.5% of faecal deposits go into the stream (9 expts)

D-C & Nagels (2008)
IWA conference on Diffuse Pollution, Thailand
How can faecal pollution be reduced?
– to be suitable for CR...
review article by Collins et al. 2007 in NZJAR V50

• Eliminate livestock contact with water
  Fencing, bridging,...

• Isolate waters from grazed land
  Riparian buffers – later talk...

• Protect wetlands
  Fencing (again)

• Range of other actions
  e.g., care with ‘unfavourable’ soils;
  management of irrigation, grazing
Faecal pollution mitigations (BMPs)
(Collins et al. 2006 report to MAF – see www.MAF.govt.nz)
Sediment

- Sediment yield and sediment sources
- Fine sediment characterisation
- Gravel

Contributors
Murray Hicks, Rob Merrilees (NIWA)
Ian Fuller (Massey University)
Chris Phillips, Mike Marden, Alex Watson, John Payne (LCR)
Roger Young (Cawthron Institute)
Neil Deans, Lawson Davey (Fish&Game)
Rob Smith, Eric Verstappen (Tasman District Council)
Tony Hewitt (Envirolink)
Fine sediment

• How does fine sediment affect freshwater and marine ecosystems?

• What are the major influences (climate, geology, land use) on fine sediment generation and delivery to Tasman Bay?

• Can we, or do we need to, manage sediment better?
Sediment yield

• estimates of SSY for major terrains within catchment and yield to Tasman Bay

• sediment yields increased after March 2005 flood
  ➢ Motueka gorge >10x
  ➢ Woodmans Bend 3-4x

• large events have spatially extensive and temporally persistent effect on sediment yield

• sediment yield increases from forest harvesting of similar magnitude but affect smaller area and recover more quickly
Sediment load to Tasman Bay is highly variable. Relatively low over the last 10 years.

**Motueka at Woodstock**

- 1969-2006 average: 281,000 t/yr
- 2001-2006 average: 150,000 t/yr
Fine sediment abundance

- data on spatial and temporal patterns of fine sediment abundance in Motueka
- most sites have low abundance and stable values
- fine sediment has probably had limited influence on trout numbers in main stem
Small increases at some sites after floods or forest harvesting
Recovery within 2-3 yrs

Motueka at Gorge

Storm March 2005

Wangapeka

Forest harvesting
2007-08
Gravel

High demand, low supply

How do we best manage gravel resources in the river?

- analysed long- and short-term bed level changes
- cross sections provide adequate information on bed level trends but not gravel volume changes (underestimate)

DEM difference 2004-2005

Volume change (m³)
DEM -11,346
Cross sections -3500

High demand, low supply

How do we best manage gravel resources in the river?

- analysed long- and short-term bed level changes
- cross sections provide adequate information on bed level trends but not gravel volume changes (underestimate)
Gravel management

- river bed in the upper Motueka is degrading at a slow rate
  - but beds are degrading even where gravel isn’t extracted, and coasts are eroding → sediment supply issue (as well as gravel extraction issue)

- needs a cautious, adaptive management approach to gravel management with better information on gravel transport rates and proportion that can be sustainably harvested
Riparian management in ICM: where the rubber meets the road?

Chris Phillips, Michael Marden,
Nick Ledgard, Lisa Langer
Rob Davies-Colley, Roger Young, Barbara Stuart, Andrew Burton
Riparian management

1. Questions

- Is riparian vegetation the “silver bullet” for improving water quality?
- How do farmers restore native riparian vegetation, what plants are best?

“where in the catchment should I start and what should I do first”

2. Major areas of investigation

- Riparian survey
- Native plant trials
- Restoration opportunities
- Rehabilitation trials

3. Results and applications

- Native plant root research
- Native plant establishment
Is riparian vegetation the silver bullet for WQ?

- Depends on what you are trying to manage for
- Depends on the “contaminant” – N, P, SS, bugs
- Slope determines functional success
- Type of vegetation makes a difference
- No “one-size fits all”
- Success depends on on-going management

Answer: No and Yes – context and site specific
Native plants & soil reinforcement
Native plants & soil reinforcement

3 year olds

Toe toe

Flax - cookianum

Carex secta

Kahikatea & Puriri

4m

1m
Native plants & soil reinforcement

Total structural root length

3-5 year old

Year 3
Year 4
Year 5

“Big trees”
“Colonisers”
Non-woody
Native plant roots - summary

• Depth: cabbage tree, ribbonwood
• Spread: lemonwood, ribbonwood
• Biomass: cabbage tree, tutu
• Height: lacebark, ribbonwood, cab. tree
• Root strength: lacebark, kanuka, kohuhu
• Non-woody better than woody early on
• Best natives almost as good as exotics - maybe
Establishing natives in riparian areas of Sherry river, with particular emphasis on weed control

Final output: Guidelines for ‘best bet’
Major weed control treatments:

* No control
* Chemical
* Mulches
  ~ Weed mat
  ~ Carpet

Bavin’s trial, Sherry River
Key trial results

### Survival

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Survival (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>c</td>
</tr>
<tr>
<td>Chemical</td>
<td>ab</td>
</tr>
<tr>
<td>Carpet</td>
<td>bc</td>
</tr>
<tr>
<td>Weed Mat</td>
<td>bc</td>
</tr>
</tbody>
</table>

### Height

- Control: 24 cm
- Chemical: 30 cm
- Carpet: 26 cm
- Weed Mat: 28 cm

### Surface area by species

- ARiser: 0.3 m²
- COProb: 0.9 m²
- CORaus: 1.2 m²
- KUNeri: 0.1 m²
- PITten: 0.2 m²
- PLAreg: 0.4 m²
- PODtot: 0.6 m²

### Cost

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Material</th>
<th>Sub-total Pegs Sub-total</th>
<th>Sub-total Installation (@$30/hr)</th>
<th>Sub-total Maintenance (@$30/hr)</th>
<th>Sub-total</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Chemical</td>
<td>25.20</td>
<td>0.18</td>
<td>0.5</td>
<td>3.5</td>
<td>1.50</td>
<td>1.89</td>
</tr>
<tr>
<td>Weedmat</td>
<td>63.20</td>
<td>0.90</td>
<td>4</td>
<td>0.86</td>
<td>0.15</td>
<td>2.02</td>
</tr>
<tr>
<td>Carpet</td>
<td>0</td>
<td>0</td>
<td>0.20</td>
<td>1.71</td>
<td>0.3</td>
<td>2.04</td>
</tr>
</tbody>
</table>

- Chemical: $1.89/m²
- Weed Mat: $2.02/m²
- Carpet: $2.04/m²
Native plant establishment along riparian margins of the Sherry River, Motueka catchment
‘Best bet’ guidelines

Nick Ledgard and David Henley
Scion, Christchurch
October, 2009

• Better to establish small areas well
• Success = plants are alive after 2 years
• Weed control **Essential** for first 2 years
• Main plant spec. is RCD & size of root mass
• Permanent fence for domestic animals
• Best site conditions: Good cover of rank grass, which can be readily herbicide killed

Plant establishment is more than just planting
Summary

• Riparian management can make a difference
• Need to prioritise – where and what
• Need a plan, know what you are managing for
• There will be delays between action and success
• Fencing can make a big difference
• Planting is not the end
• Right plant, right place, right job
Cultural River Health

ICM AGM Nelson
April 2010

Garth Harmsworth
(Te Arawa, Ngāti Tūwharetoa, Ngāti Raukawa, Tuhourangi)
Landcare Research, Private Bag 11-052, Palmerston North
HarmsworthG@LandcareResearch.co.nz

Dean Walker
Projects Manager
for Tiakina Te Taiao Ltd
dean@tiakina.co.nz
Cultural River Health

How can we reconcile Māori and Pākeha values for improved water quality?
A Māori world view

• A natural order to the universe, overarching principle of balance
• Whakapapa (central thread)
• (W)Holistic – Inter-relationship of all living things to each other (interconnection between all parts)
• Kete o te wānanga – The three baskets of knowledge by Tāne (kete aronui, kete tuauri, kete tuatea)
• Tikanga (custom, protocols, values)
• Mātauranga Māori, Māori values, Māori issues
• Traditional concepts and values integral (e.g., whakapapa, mauri, taonga tuku iho, kaitiakitanga, whānaungatanga, manaakitanga, rangatiratanga, mana whenua, mana moana, wairua, tapu, etc.)
• Maori wellbeing linked to the health of the environment
Cultural monitoring in Motueka (2005 – 2010)

Cultural monitoring/reporting can:
• Provide an indigenous knowledge/perspective on the environment;
• Articulate cultural values & aspirations;
• Identify trends/change from a Maori perspective;
• Be collated/aggregated to report on the iwi/hapū state of the environment (from a cultural perspective);
• Help contribute to responsibilities under kaitiakitanga, whakapapa, tino rangatiratanga, etc;
• Give responsibilities and importance of tangata whenua engaged in Resource Management (RMA 1991);
• Build iwi /hapū/whānau capacity in Resource Management;
• Feed into other SOE reporting (i.e. local, regional, national)
In future environmental monitoring programmes could be classed into three main types that are complementary:

<table>
<thead>
<tr>
<th>Māori knowledge based</th>
<th>Community – scientific based</th>
<th>Scientific based</th>
</tr>
</thead>
</table>
| **Māori indicators** – In depth Māori understanding and knowledge of particular environments. Understanding of Māori values, goals, and aspirations required. Examples:  
  - Taonga lists;  
  - Key sensitive taonga indicators;  
  - Te Mauri/ wairua;  
  - Knowledge on uses and preparation of taonga;  
  - Land-uses, point discharges, modification, impacting on cultural values and uses.  
  - Key pest species | **Community based indicators** – requiring low levels of technical input and skill but scientifically robust and part-value based. Cost effective, relatively simple and short duration. Examples:  
  - Hydrology;  
  - Soils/Nutrients;  
  - Intactness of wetland;  
  - Connectivity/Buffering or Fragmentation;  
  - Introduced plants;  
  - Animal damage;  
  - Modifications to catchment hydrology;  
  - Water quality within catchment;  
  - Other landuse threats;  
  - Key undesirable species;  
  - % catchment in introduced vegetation;  
  - Animal access. | **Scientific indicators** – requiring higher levels of technical input and skill, robust sampling strategies, analysis and interpretation. May be time consuming. Examples:  
  - Chemistry, water quality, nutrients;  
  - Hydrology;  
  - Water table modeling;  
  - Botanical mapping, classification of plants;  
  - pH;  
  - Bacterial counts;  
  - Giardia;  
  - Cryptosporidum;  
  - GIS applications;  
  - Satellite imagery;  
  - Studies of fish, macro-invertebrates, macrophytes. |
Location: Motueka catchment across to Nelson
Cultural River Health

- Provides a Māori perspective of rivers/streams – Māori aspirations and goals
- Use of mātauranga Māori (knowledge) and Māori values (relationship or connection to place)
- Identifies issues and change from Māori viewpoint
- Links Māori wellbeing and river/stream health
- Use of indicators and assessment
- Reporting
- Planning and policy
- Actions (e.g., restoration projects, mahinga kai, capacity building, GIS)
Cultural indicator assessment
Motueka and Riwaka catchments
Ngā Atua domains framework

**Ranginui**
The sky father, immeasurable universe

**Tawhirimatea** Atua of the wind & air

**Tumatauenga** Atua of war & tangata (people)

**Haumiatiketike** Atua of wild foods including fern roots

**Nga Atua Kaitiaki**
The spiritual guardians

**Rongomatane** Atua of peace & cultivated foods

**Tangaroa** Atua of nga moana (seas), awa (rivers) & roto (lakes)

**Papatuanuku**
Earth mother, planet earth

Figure 1: Atua (departmental gods) domain framework Source: Tiakina te Taiao.
Methods

• Training, field assessment (geo coordinates, place), reporting, and GIS entry and analyses;
• Assessment forms (iwi indicators), score sheets–ratings.
• Inventory: Site status, mahinga kai, total CHI score, Score 1-5: 1 – poor; 5 – excellent
Indicators (examples)

Tangaroa
- Water Clarity
- Water Flow
- Water Quality
- Shape and form of river, riverbank condition, sediment
- Insects
- Fish

Tāne Mahuta
- Riparian vegetation
- Catchment vegetation
- Bird life (species)
- Ngahere/Taonga
- Pests

Haumia tiketike
- Mahinga kai
- Rongoa

Tūmatauenga
- Human activity, Use of river
- Access
- Cultural sites

Tāwhirimātea
- Smell

Mauri / Wairua
- Feeling, taste, wellbeing
Links between science and cultural indicators
Cultural Stream Health Measure

E. coli (cfu/100 mL)

SQMCI

Clarity (m)

% Native Vegetation

$r = 0.846$

$p = 0.0001$

$r = 0.519$

$p = 0.058$

$r = 0.526$

$p = 0.053$

$r = -0.48$

$p = 0.13$
Results

• Links between science and cultural indicators;
• Some good correlations, some poor;
• Strong correlation between cultural health and increasing % of catchment area natural/indigenous cover;
• Science /cultural monitoring together gives a rich, full picture of river health (and the environment)
• Cultural indicators impose stricter environmental standards
• We can use complementary monitoring and reporting