Toward a Framework for Water Allocation Review for Horizons Regional Council: Workshop Summary

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TOWARD A FRAMEWORK FOR WATER ALLOCATION REVIEW FOR HORIZONS REGIONAL COUNCIL: WORKSHOP SUMMARY

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1. INTRODUCTION

Horizons Regional Council's (Horizons) 'One Plan' water allocation framework has been in place for several years. The One Plan specifies freshwater management objectives for water management zones (WMZ and sub-zones), and stipulates numerical water allocation limits and minimum flows intended to achieve these. The next step is to assess whether those numerical minimum flow and water allocation limits are achieving the purposes for which they were designed. With this in mind, Horizons sought advice from Cawthron Institute (Cawthron) on a framework for water allocation review, and on monitoring requirements to support it.

Specifically, Horizons asked for advice on factors that needed to be considered in developing a monitoring and assessment framework within which the following questions can be answered:

- Are the core allocation limits and minimum flows that are set in the One Plan (as part of the water allocation framework), achieving the instream management objectives, and protecting the identified values of the region's waterways?
- What do we need to measure and how would we assess the effectiveness of the limits?
- What are the key indicators related to specific instream values?
- What would trigger a review of a minimum flow or core allocation limit either up or down?
- How would we separate any apparent effects from those caused by water quality issues as opposed to effects directly attributable to allocation?

A workshop session, involving Cawthron and Horizons staff[1], to discuss development of a framework to answer these questions, was held in Palmerston North on 20 May 2015. This report summarises the discussion at, and outcomes of, that workshop.

[1] Attendees from Horizons: Raelene Mercer, Logan Brown, Maree Clark, Tom Bowen, Amy Shears, Abby Matthews, Jon Roygard, Harold Barnett, Toni Shell, James Lambie, Mike Patterson. From Cawthron Insitute: Roger Young, John Hayes, Joe Hay.

2. WORKSHOP SUMMARY

Discussion progressed around the six topics outlined below.

2.1. Management objectives defining monitoring requirements

Surface water management values and associated management objectives are presented in Table 6.2 of the *Water* chapter of the One Plan (and Schedule AB).

Prior to the workshop, Horizons supplied Cawthron with a MS Excel summary table, providing information on the following for each water management zone (WMZ) and sub-zone.

- The surface water management values identified.
- The basis for existing minimum flow derivation in each zone.
- The existing monitoring being undertaken and how the monitoring locations aligned with WMZs.
- Guidelines and standards applied to the water quality and biomonitoring data.

We used data from the summary table to develop a PowerPoint presentation (Appendix 1) to guide and stimulate discussion at the workshop. Key points arising from these slides and the discussion around them included:

1. Measurability of management objectives
    - Since the One Plan was initially proposed, the National Policy Statement for Freshwater Management (NPSFM) has introduced a requirement for councils to include measureable freshwater objectives and enforceable water resource use limits (for water quality and water quantity) in regional plans.
    - For flowing water, water quantity limits must comprise at least a minimum flow (the flow below which no further water is to be taken) and an allocation rate (the maximum rate of abstraction).
    - The One Plan provides clear resource use limits in the form of numeric minimum flows and allocation limits for each WMZ and sub-zone.
    - However, the instream management objectives (as specified in Table 6.2 of the *Water* chapter of the Plan) are not sufficiently measureable to allow monitoring to unambiguously identify whether they are being met. This is likely to have prompted the question “What would trigger a review of a minimum flow or core allocation limit either up or down?”
2. Alignment of monitoring with management objectives

- The questions "What do we need to measure and how would we assess the effectiveness of the limits?" and "What are the key indicators related to specific instream values?" relate to the need to ensure that monitoring data align with identified values and management objectives.
- Currently, fishery data appear to be lacking and flow data are not collected for all WMZ.

Key points and more detail on specific components discussed, including flow, fishery, and water quality data are provided in the following sub-sections.

2.1.1. Flow data

- Flow data is critical for identifying whether changes to flow, through water allocation, have caused environmental effects.

With respect to flow data, it was suggested that flow need not necessarily be monitored for all WMZs. We understand Horizons is working towards developing flow relationships with gauged sites for those WMZ that currently do not have flow records. While this seems a sensible approach, another possibility to consider is whether a representative sub-set of sites could be strategically selected to focus monitoring effort (*e.g.* based on river size and flow variability categories, perhaps using an ELOHA[2] framework [Poff *et al.* 2009]).

2.1.2. Fishery data

- Most sub-zones (74 of 124) have some level of trout fishery value identified in Table 6.2. However, Horizons do not monitor trout fisheries. This point is also relevant for other fish-related values (*e.g.* inanga spawning, whitebait migration, trout spawning), although we understand there is some native fish monitoring undertaken from time to time.
- To ensure water management objectives are being met, environmental state indicators would need to include indices or metrics relevant for assessing fish biodiversity and productivity, such as: fish abundance/biomass, growth, and fisheries usage.
- However, high natural variability in fish populations makes it difficult to identify human impacts (*i.e.* find a signal in the noise). Consequently, it will be difficult and expensive to collect appropriate data with sufficient statistical power to detect differences between pre- and post-One Plan flow regimes. In addition, 'pre-Plan' data may be lacking, since most of the discrete water quality/state of the environment monitoring data sets started from 2007 onward (~105 sites).

[2] ELOHA = Ecological Limits of Hydrological Alteration

With respect to increasing the measurability of management objectives, a key suggestion was that additional columns could be added to Table 6.2, specifying attributes to be monitored to represent each value/management objective, and levels of change in these attributes that would stimulate a review of existing water management actions/policy (these types of guidelines already exist for water quality monitoring). This would provide measurability for the existing management objectives and identify attributes that need to be monitored to ensure that the management objectives are being met. For example, the management objective listed in Table 6.2 of the One Plan for zones with trout fishery values currently state "*The water body and its bed sustain healthy rainbow or brown trout fisheries*". Attributes associated with this management objective might include trout abundance and growth rates, and angler usage. A clause could be included stipulating that if trout abundance or angler use change by *x* or *y*%, respectively, a review of whether or what management actions may be responsible for that change will be instigated.

There was some discussion of the concept of using a hypothesis-based approach for selecting attributes for monitoring. That is, by hypothesising the potential impact of management actions on a value of interest the attributes that would need to be monitored to assess the hypothesis should become more obvious. For example, if a reduction in flow through water allocation is hypothesised to reduce feeding opportunity for drift-feeding trout (see Section 2.2) and thereby reduce trout growth rates, monitoring that allows assessment of the presence or extent of food limitation of trout growth would be required[3]. Perceived advantages of this approach were that the rationale for monitoring would be logical and transparent, and it would also provide a check on whether the attributes identified for monitoring are likely to answer the questions.

It was recognised that there are both ecological and sociological components to managing and monitoring for fishery values (*e.g.* fish abundance and growth, *versus*, angler use/perceptions). Given the natural variability of fishery data, it is likely that very large (long) datasets would be required to detect anything other than a catastrophic decline (or phenomenal improvement) in fish populations. Consequently, collecting appropriate data is likely to require a collaborative monitoring effort involving Horizons, Fish & Game New Zealand (and possibly also iwi, and Department of Conservation [DOC]), with Horizons co-ordinating the programme. We understand that Horizons have already approached Fish & Game New Zealand with regard to sharing monitoring data, but effectively answering the questions posed above is likely to require a co-ordinated effort with strategically aligned goals between organisations.

The following list summarises data, indices and metrics that are available or potentially able to be adapted, for monitoring and interpreting trout fishery attributes:

[3] For example, monitoring of water temperature and invertebrate drift could be used to inform bioenergetics modelling to explore the extent of food limitation for trout.

- National Angler Survey database. This provides estimates of angling usage (no. angling days) for most rivers and lakes supporting trout (and salmon) fisheries throughout New Zealand. It allows assessment of spatial and temporal patterns of angling usage. National surveys are conducted approximately 5-yearly; they will provide pre- and post-One Plan data. The Horizon's National Angler Survey data could be supplemented with regional angling perception data by including perception questions. This would make it possible to tease out the reasons for changes in angling usage (*e.g.* separating the influence of real changes in trout abundance or growth from the influence of perceptions of deteriorating fishery arising from water quality changes (dirty water) or word of mouth.
- Fish surveys, using standard electric-fishing and drift-dive techniques and dual frequency identification sonar (DIDSON). The latter has potential for monitoring trout abundance in turbid rivers, although at lower precision than drift diving can deliver in clear-water rivers (see Hayes *et al.* 2015). As discussed above, such fish surveys would probably require a collaborative strategic monitoring effort with other organisations (*e.g.* Fish & Game New Zealand, DOC). Despite all of the science, a cost-effective method to assess whether a river is at carrying capacity for fish (salmonids and native fish) remains elusive. This is a critical question because if a river is at carrying capacity, every drop of water (and associated habitat and production) counts. Whereas, if other factors are controlling populations below carrying capacity (*e.g.* frequent floods), then there should be scope for abstraction without incurring adverse effects on fish populations. The same concept applies to aquatic invertebrates.

- Bioenergetics modelling: These models include:
  - comparatively simple models that can explore the extent of food limitation versus temperature on growth over the life of a fish.
  - state-of-the-art process-based models relating incremental changes in flow to invertebrate drift dynamics and drift-feeding trout energetics (predicting trout growth and abundance) and potentially even an index of carrying capacity. The invertebrate drift model component is being developed to run off shear stress, so drift data at one flow could be modelled across a range of flow regimes.
- Trout prey indices (TPIs), along similar lines to the macroinvertebrate community index (MCI), are currently undergoing testing pending adequate funding. This index allows benthic invertebrate monitoring data to be interpreted with respect to the relative value of the community for trout food. The TPIs still require further validation to set the class boundaries/break points and peer-reviewed documentation.

2.1.3. Water quality data—dissolved oxygen, pH and temperature

Conceptually, large reductions in flow may exacerbate the daily peaks and troughs in dissolved oxygen (DO) and pH that are caused by the biological activity of aquatic plants, animals and microbes (photosynthesis and respiration). Reductions in flow also reduce thermal inertia of a waterbody, again potentially resulting in higher maximum temperatures and lower minimum temperatures than at higher flows.

Modules predicting likely changes in DO and temperature with flow are included in the System for Environmental Flow Analysis (SEFA) and based on earlier models or iterations in WAIORA and RHYHABSIM (Jowett *et al.* 2014). There have been several attempts to validate the predicted changes in minimum DO concentration with flow (*e.g.* Doehring & Young 2012; Allen & Young 2012; Young & Hay 2011; Young & Doehring 2010) with partial success. Unfortunately, observed flows rarely dropped to low enough levels in these studies to determine if the predicted dramatic reduction in DO at extremely low flows would be observed. A more recent study by Wilding (2014) found a close match between model predictions and observations across a wide range of flows in several lowland streams in the Hawke's Bay region. Low gradient and deep streams with limited potential for exchange of oxygen through the water surface are probably most susceptible to the effects of change in flow on DO. Oxygen exchange through the river surface will tend to keep DO levels within suitable ranges for aquatic life in more turbulent and shallow systems. A national collation of continuous DO data is currently underway and should help define river types where low DO concentrations are likely, and where maintenance of appropriate minimum DO levels may be the critical factor driving flow allocations.

Predicted changes in temperature with flow are relatively minor until flows drop to very low levels. Generally, flow has a minor influence on temperature compared to other factors such as shading and level of groundwater inputs.

2.2. Changes in Instream Flow Incremental Methodology modelling and interpretation since One Plan

Advances in modelling and changes in the conservation status of several New Zealand native fish species (particularly torrentfish, *Cheimarrichthys fosteri*) have the potential to influence any review of water allocation and minimum flows within the One Plan.

Most of the minimum flows stipulated in the One Plan were derived from predictions of hydraulic-habitat modelling, which is one of the tools commonly employed within the Instream Flow Incremental Methodology (IFIM) framework. Within this framework models are often used to predict the effects of incremental changes in flow. State-of-the-art process-based modelling of invertebrate drift dynamics and trout net rate of energy intake (and related predictions of flow related trout abundance) can be applied within the IFIM framework. Most minimum flows in the One Plan were derived either directly from hydraulic-habitat modelling, based on habitat retention for a given species (usually 90% retention of brown trout habitat at the mean annual low flow [MALF]), or through a generalised regional relationship between the MALF and minimum flows derived by the former method (essentially a regional method)[4].

Trout habitat was used to derive minimum flows in the One Plan because trout are recognised as being among the most flow-demanding fish in New Zealand rivers and they support valued recreational fisheries (Hay 2009). When interpreting hydraulic-habitat modelling predictions to guide minimum flow recommendations we used the concept of identifying critical instream values, generally the species with the highest flow requirements. Candidates for critical value status might include flow-sensitive rare or endangered species, or species with high fishery value. The assumption is made that by providing sufficient flow to sustain this critical value, there should also be sufficient flow for other values with lower flow requirements. For instance, habitat for most native fish species is maximised at low flows in larger rivers, whereas trout habitat is maximised at higher flows so they require higher minimum flows. Minimum flows set for trout will still provide habitat for less flow-demanding native fish along slow river margins, or in riffles or pools. Their relatively high flow demands (particularly for drift feeding) and fishery value makes trout an obvious candidate for critical instream value status. Note that native fish such as torrentfish, kōaro (*Galaxias brevipinnis*) and bluegill bullies (*Gobiomorphus hubbsi*) are exceptions to the above rule; they have high water velocity, and therefore high flow, requirements—sometimes higher than adult trout. A case could be made for basing minimum flows (and water allocation rules) on these high flow-demanding native fish species if their conservation and/or fishery value warrants it.

Since the One Plan hearings the conservation status of several species of native fish has altered. Of particular relevance to selection of critical instream values, the threat classification of torrentfish and kōaro have both increased from 'not threatened' to 'at risk, declining' (Goodman *et al.* 2014). This promotes these species for consideration as potential critical value species, particularly in locations where trout fishery values do not apply or are not especially high. It also potentially elevates the status of torrentfish for consideration in the selection of 'Sites of Significance—Aquatic'; locations identified as having particular aquatic values and associated management objectives in the One Plan process. Part of the criteria for identifying these sites of

[4] The method involved using a specific proportion of mean annual low flow (MALF) to set minimum flows in streams where sufficient hydrological data existed, based on statistical relationships between MALFs and minimum flows derived from hydraulic-habitat analyses already undertaken on rivers in the Horizons region (Hurndell *et al.* 2007). The proportion of MALF applied varied depending on the size of the river or stream, as indicated by the magnitude of the MALF (95%, 85% or 80% of MALF for small, medium and large streams, respectively). This adaptation takes into account that predicted habitat tends to decline more rapidly with flow reductions below the MALF in small streams than in large rivers.

significance was the threat classification of species recorded from the sites (McArthur *et al.* 2007). The elevation of threat classification for torrentfish and kōaro puts them into the same ranking as giant kōkopu (*Galaxias argenteus*) and dwarf galaxias (*G. divergens*), species which were both included in the definition of 'sites of significance—aquatic' (McArthur *et al.* 2007). Kōaro were already included in the definition of sites of significance—aquatic in recognition of the rarity of this species in the Horizon's region.

Note also that benthic invertebrates also have high-flow requirements, usually higher than trout; often their habitat is maximised at flows approaching the median flow. The degree to which benthic invertebrates influence a minimum flow, or more usually a water allocation limit, depends on how much weight these have in influencing a regional council's definition of life supporting capacity.

As an aside, the derivation of minimum flows using the generalised regional method mentioned above (using the relationship between the MALF and minimum flows determined through trout habitat retention from habitat modelling) raised a question about the appropriateness of tacitly using trout as a critical value in all rivers where this method was applied. Developing an alternative regional relationship using a more applicable critical value for situations where the trout fishery value does not apply could be a more defensible approach.

A more fundamental change in the way hydraulic-habitat modelling is interpreted is likely to come from advances in process-based modelling applied within the IFIM flow regime assessment framework (Hayes *et al.* in review). Over the last 15 years Cawthron has been involved in the development of a suite of models that predict how changes in flow affect invertebrate drift and energetics of drift-feeding trout. Recent advances in the application of this modelling approach, suggests that drift-feeding fish may be more sensitive to flow reductions around the MALF than was previously recognised. Both water velocity and drift concentration (the number of invertebrates per unit volume of water) decline with flow reduction and the two factors combine to reduce rate of invertebrates passing through the cross-sectional foraging area of a drift-feeding fish. While habitat availability for adult trout in larger rivers is often predicted to peak at flows in the low to median flow range, net rate of energy intake for drift-feeding trout is predicted to continue to increase across this flow range. The net rate of energy intake is a fitness metric that translates to growth and abundance potential. These findings suggest that allocation of water in the mid-to-low flow range (in the order of about 0.5 × median to MALF) has the potential to adversely affect feeding opportunity, growth, and ultimately, carrying capacity of drift-feeding trout. These findings are based on a mechanistic understanding of ecosystem processes, as such inferences ought to apply to drift-feeding native fish (*e.g.* smelt, inanga, dwarf galaxias, kōaro) as well, depending on river size (*i.e.* because these fish are smaller than adult trout adverse effects of flow allocation will most likely occur in small rivers).

Both conservation status revision and advances in modelling are likely to influence the outcomes of future water allocation review, highlighting a need for policy to adapt to changes in scientific understanding.

2.3. Capturing institutional knowledge

Discussion at the workshop revealed extensive intuitional knowledge around the derivation and interpretation of policy within the One Plan. A suggestion was made that a guidance document, collating this knowledge would be useful for staff undertaking review of water allocation etc. Ideas for content included:

- explanations of how existing policy and management objectives were intended to be interpreted. This point may become less relevant if a greater degree of specificity/measurability is applied to existing management objectives.
- links to original technical reports on which policy was based.

This type of document or database would also be prudent for succession planning, ensuring future staff have an historical perspective of the Plan.

2.4. Isolating the impacts of water allocation policy

The question, “How would we separate any apparent effects from those caused by water quality issues as opposed to effects directly attributable to allocation?” was recognised as a challenging question. It is an extremely difficult task to determine if water allocation policy is effectively meeting the objectives (and protecting the values) set in the One Plan, when other factors like water quality, land management, discharge management and climate change are also potentially having an effect on these objectives or values. It may be impossible to determine if policy is effective at a large scale across the region.

Focusing on a few representative sites might make this challenge more tractable. But even then large science funding, and long term data sets (10–30 years) would be required to answer these questions at the selected sites. For this reason we suggest that a coordinated national monitoring programme, with collaboration between regional councils, central government, and research organisations (and perhaps also Fish & Game New Zealand and others) may be the best approach. We understand that Horizons would be keen to support this type of strategic research if it is proposed or led by research organisations. Stable national research vision, policy and funding would be critical for such a venture. The research could be designed around an ELOHA methodology. For example, rivers classified by hydrological variability and hypotheses-driven research conducted within the classes with replication; geology and land-use classes affecting water quality could also be accounted for in study site selection.

The hypothesis driven approach to monitoring may help with exploring the possible mechanisms for any changes picked up in monitoring data. For a given adverse change in monitoring data, alternative hypotheses could be generated for the likely cause and these could be explored through additional monitoring, data analysis and modelling in an attempt to identify what management actions could possibly rectify the problem.

2.5. Discussion of existing values and management objectives

The points below were raised during discussion of the existing values and management objectives listed in Table 6.2 of the One Plan:

- Natural State (NS). Attributes in this value category are not expected to change noticeably over time and therefore monitoring all parameters at these sites gives a baseline to compare with other sites (*i.e.* control). Some zones are influenced by very small abstractions (*e.g.* water take for ski field), but presumed to have negligible effects.
- There is currently no weighting associated with the various values. Minimum flows have been set using the critical value concept, based on the value perceived to have the highest flow demands. Usually this has been the trout fishery (TF) value, but where no TF value identified, then native fish or whio (blue duck, *Hymenolaimus malacorhynchos*) habitat values take precedence for protection of Sites of Significance Aquatic (SOS-A).
- Sites of Significance Aquatic SOS-A. As discussed in Section 2.2 the change in the conservation status of some native fish (especially torrentfish) may require a reassessment of the indicator species included within this value category (requires a plan change).
- Whitebait Migration (WM). Resource consent conditions associated with this value category are generally related to physical attributes such as fish barriers and screening of intakes; not so much related to the function of minimum flow setting and water allocation.
- Life-Supporting Capacity (LSC). This value is fairly universally applied to WMZ, but is not generally used in assessing water allocation implementation, with the focus instead being on TF and SOS-A. A question was raised about the definition of life supporting capacity (we understand that there is currently no legal definition or case law to define LSC). It seems intuitive that ‘capacity’ is more than ‘capability’ (*i.e.* merely the presence of life) and more to do with a quantum (*i.e.* diversity and abundance). Ultimately, this may be

defined/incorporated within the National Objectives Framework via the compulsory national ecosystem health value.

- Trout Spawning (TS). Habitat (*i.e.* appropriate substrate being wetted and remaining wetted throughout the incubation period) and passage (so that fish are able to access the habitat) are pertinent to allocation assessment. Water quality and avoiding excessive sedimentation are also relevant. With respect to monitoring, electric-fishing surveys of fry abundance may be more effective and efficient than redd or spawner counts.
- Capacity to Assimilate Pollution (CAP). The location of allocation is likely to influence capacity to assimilate pollution at base flows. For example, if water is abstracted from sources with high nutrient loads this may reduce the nutrient concentration downstream, if cleaner water sources remain to dilute inputs. Conversely, if water is abstracted from relatively clean sources this may reduce potential dilution downstream. Ground water discharge to base flow and associated nutrient concentration also needs to be considered; allocation of cleaner surface water may have a disproportionate effect on CAP.

2.6. Toward a framework for water allocation review

During the workshop a series of questions were proposed that could be worked through during the review of water allocation policy for a given water management zone. With some additional development these questions could be adapted to form the basis of a flowchart for water allocation policy review. We have edited and/or added to the questions used in the workshop to produce the series of questions presented below:

1. What critical value was used to set the minimum flow? Is this still appropriate?
2. Have stakeholders expressed an interest in reviewing allocation policy in this WMZ (*e.g.* desire for additional allocation, or desire for more stringent environmental protection)?
3. Do monitoring data show any problems?
4. Which water management objectives or identified values are being compromised? If there are multiple issues, attempt to prioritise.
5. Could changing water allocation/minimum flow influence the identified issue(s)? Hypothesise likely effects of allocation change and perform data analysis and modelling (if possible) to test these hypotheses.
6. Will the changes required to address this/these issue(s) impact on other management objectives or identified values? If so, may need to prioritise or make a trade off.

We also trialled applying this series of questions to a case study WMZ at the workshop (see below). Note: the case study below is for illustrative purposes only, and was based on information at hand during the workshop. It not intended to represent a thorough review of the water allocation policy for the case study WMZ.

Manawatu at Weber Rd example:

1. What critical value was used to set the minimum flow? Is this still appropriate?
   - Adult brown trout feeding habitat
   - Yes, regionally significant trout fishery

2. Have stakeholders expressed an interest in reviewing allocation policy in this WMZ (e.g. desire for additional allocation, or desire for more stringent environmental protection)?
   - Yes, desire for either increased allocation or lower minimum flows

3. Do monitoring data show any problems?
   - Yes, water temperature and periphyton guidelines frequently breached

4. Which water management objectives/identified values are being compromised? If there are multiple issues, attempt to prioritise.
   - Life supporting capacity
   - Capacity to assimilate pollution
   - High temperatures and nuisance periphyton may also have adverse effects on trout fishery value

5. Could changing water allocation/minimum flow influence the identified issue/s? Hypothesise likely impacts of allocation change and perform data analysis or modelling (if possible) to test these hypotheses.
   - Main drivers of periphyton proliferation likely to be accrual time (time between flushing flow events) and nutrient enrichment. Neither of these is likely to be altered much by changes to water allocation or minimum flows, but any reduction in minimum flow is likely to exacerbate the problem to some extent (*i.e.* less flow may reduce dilution of nutrients, as well as increasing temperature guideline breaches, leading to more rapid periphyton growth).
   - Altering water allocation volume could alter nutrient inputs (thereby influencing periphyton accrual rates), depending on the source. If water is abstracted from sources/tributaries with high nutrient loads this may reduce the nutrient concentration downstream, if cleaner water sources remain to dilute inputs. Conversely, if water is abstracted from relatively clean sources, this may reduce potential dilution downstream.

6. Will the changes required to address this/these issue(s) impact on other management objectives or identified values? If so, may need to prioritise or make a trade-off.
    - This question was not discussed during the workshop and the answer would depend on what changes to allocation policy were proposed. Our experience with new process-based modelling on drift and drift-feeding trout net rate of energy intake suggests that any reduction in minimum flow or increase in water allocation is likely to have an adverse impact on trout feeding opportunity. This influences growth and/or carrying capacity and fishery value (see Section 2.2).

3. CONCLUSIONS AND RECOMMENDATIONS

These are the key conclusions and recommendations arising from the workshop.

- Identify measureable management objectives for each value specified in the One Plan, including attributes to be monitored and degree of change that will trigger review of management.
- The identification of attributes to be monitored can be informed by hypothesising the probable effects of water allocation, and considering what attributes would need to be monitored to test these hypotheses. Discussion of aspects of the hydrological regime likely to be affected by allocation and varying degrees of hydrological alteration in Hayes (2009) and Beca (2008) would provide a good starting point for thinking about this. It is worth noting that there may be obvious direct effects on physical habitat and on water quality (*e.g.* flow effects on temperature and dissolved oxygen), but indirect effects may also arise (*e.g.* altered flushing flows affecting periphyton accrual—affecting dissolved oxygen).
- A similar hypothesis-based approach would also help assess the potential impacts of changing water allocation policy during a water management zone review process.
- Existing monitoring data is likely to be useful for assessing the fulfilment of water management objectives, where flow-related water quality is the critical management issue. By contrast, existing monitoring data is unlikely to be useful for testing the effectiveness of policy in the One Plan for maintaining habitat and food quantity to fish. A collaborative approach to monitoring with other organisations, with a strategic alignment of goals, is probably the best approach to gathering appropriate fish and fishery data.
- There is real value in the long-term datasets that can be developed through Regional Council monitoring programmes. However, some questions are likely to be better addressed through national strategic research programmes.

Targeted strategic research aimed at assessing the sensitivity of river ecosystems (perhaps classified by hydrological variability) to flow changes through water allocation, as well as understanding the degree to which carrying capacity is achieved, offers the potential to identify the scope for increasing allocation, or decreasing minimum flows. Thus there is a tangible economic incentive for such research. In the interim, a mitigating feature of the allocation rules in the One Plan is that they largely allow for only minor to moderate hydrological alteration, through run of the river abstraction. Consequently, ecological effects are likely to be relatively minor.

- Advances in modelling and changes in the conservation status of several New Zealand native fish species highlight a need for adaptable policy. Changes in scientific understanding may influence any future review of water allocation and minimum flows within the One Plan.
- Developing a guidance document to capture institutional knowledge around the derivation and interpretation of policy within the One Plan would assist staff with water allocation review and help ensure this knowledge remains accessible in the future.
- Expanding and adapting the series of questions discussed in section 2.6 into a flowchart, or process diagram, would be a logical next step in developing a framework for water allocation policy review. This is likely to require an iterative process of working through case studies to identify additional considerations and decision points that were not discussed in the workshop.

4. ACKNOWLEDGEMENTS

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5. REFERENCES

Allen C, Young RG 2012. Effects of flow abstraction on habitat availability and water quality in the Motupipi River. Prepared for AP & KM Reilly Ltd. Cawthron Report No. 2233. 13 p. plus appendices.

Beca 2008. Draft Guidelines for the Selection of Methods to Determine Ecological Flows and Water Levels. Report prepared by Beca Infrastructure Ltd for MfE. Ministry for the Environment, Wellington, New Zealand.

Doehring KAM, Young RG 2012. Relationship between flow and dissolved oxygen in the Meadow Burn—Summer 2012. Prepared for Environment Southland. Cawthron Report No. 2246. 14 p.

Goodman JM, Dunn NR, Ravenscroft PJ, Allibone RM, Boubee JAT, David BO, Griffith M, Ling N, Hitchmough RA, Rolfe JR 2014. Conservation Status of New Zealand Freshwater Fish, 2013. New Zealand Threat Classification Series 7. Department of Conservation, Wellington. 12 p.

Hay J 2009. Section 42a report presented on behalf of Horizons (Manawatu-Wanganui) Regional Council before the hearing on submissions concerning the Proposed One Plan, on instream application of habitat modelling to the water allocation framework (included supplementary evidence on methods to assess maintenance of flow variability).

Hayes JW 2009. Section 42A Report evidence presented to the Hearings Panel presiding over Manawatu-Wanganui Regional Council's (Horizon's) One Plan: environmental flows, water quality conditions and flow allocation.

Hayes JW, Hay J, Maxwell I, Quarterman A 2015. Estimating Trout Abundance with Cataraft-Mounted Dual-Frequency Identification Sonar: a Comparison with Drift Diving. North American Journal of Fisheries Management, 35: 528-536.

Hayes JW, Goodwin E, Shearer K, Hay J, Kelly L in review. Can WUA Predict the Flow Requirements of Drift-Feeding Salmonids? Comparison with a Net Rate of Energy Intake Model Incorporating Drift-Flow Processes. Transactions of the American Fisheries Society.

Jowett I, Payne T, Milhous R 2014. System for Environmental Flow Analysis (SEFA)—software manual—version 1.2.1. 221 p.

McArthur K, Clark M, McGehan J 2007. Sites of significance for aquatic biodiversity in the Manawatu-Wanganui Region: Technical report to support policy development. Horizons Regional Council Report No. 2007/EXT/794. ISBN: 1-877413-82-8. 96p.

Poff NL, and 18 other authors. 2009. The ecological limits of hydrologic alteration (ELOHA): a new framework for developing regional environmental flow standards. Freshwater Biology 55:147-170

Wilding T 2014. Karamu catchment —Instream flows for oxygen. HBRC Report No. RM 13/25-4559. Hawke's Bay Regional Council.

Young RG, Doehring KAM 2010. Relationship between low flow and dissolved oxygen in selected rivers and streams in the Wairarapa: Preliminary findings from 2009/10 summer monitoring. Prepared for Greater Wellington Regional Council. Cawthron Report No. 1865. 28 p.

Young RG, Hay J 2011. Relationship between flow and dissolved oxygen in the Meadow Burn. Prepared for Environment Southland. Cawthron Report No. 1950. 13 p.

6. APPENDIX

Appendix 1. Water allocation policy effectiveness monitoring workshop presentation.

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