STAFF REPORT

TO: Resource Management Policy Committee

FROM: Joseph Thomas – Resource Scientist Water/Special Pojects

REFERENCE: W323

SUBJECT: Water Resources Investigations in the Upper Motueka Catchment – Technical Report

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1. BACKGROUND

One of the primary goals of the Integrated Catchment Management (ICM) research project is to improve understanding of the water resources in the Motueka Catchment and assist water resources management. An important part of this understanding relates to the in-stream values that are supported within the catchment and how these values may be affected by changes in flow. Several studies related to this topic have been conducted in the Upper Motueka Catchment over the last 6 years as part of the ICM project and are summarised in this report. These studies relate to:

- Water quality and river health throughout the Motueka Catchment
- Flow-habitat modelling
- Fish movement and implications for habitat requirements
- Assessing the importance of groundwater/surface water interactions

2. WATER QUALITY AND RIVER HEALTH

Water quality has been assessed by TDC and Cawthron at 16 sites on a monthly or quarterly basis throughout the catchment since 2000. Two sites (Gorge and Woodstock) are also part of the National River Water Quality Network and sampled monthly by NIWA since 1989. Stream invertebrate communities have also been sampled at many sites throughout the catchment by TDC, Cawthron and others as an indicator of the health of the river system. The results from these studies have been reviewed in TDC's report on the 'State of Surface Water Quality in Tasman District' in June 2005 (Young, James & Hay 2005).

In terms of the Upper Motueka Catchment, water quality was generally good at most sites. However, problems with high concentrations of faecal indicator bacteria and nutrients were evident at sites that drained subcatchments dominated by pastoral land use (Kikiwa, Motupiko; Figure 1). Water temperatures exceeded guideline values during the summer at several sites, particularly where there was little riparian vegetation and shading (Kikiwa, Tadmor; Figure 2A). The health of the river ecosystem, as indicated by stream invertebrate community composition, ranged from satisfactory to very good in the Upper Motueka (Figure 2B).

These results indicate that water quality and instream values are generally good in the Upper Motueka. However, there are concerns with some areas where pastoral land use and lack of riparian vegetation appear to be having an effect on water quality. This needs to be considered further if increases in water storage and allocation allow more intensive agriculture.

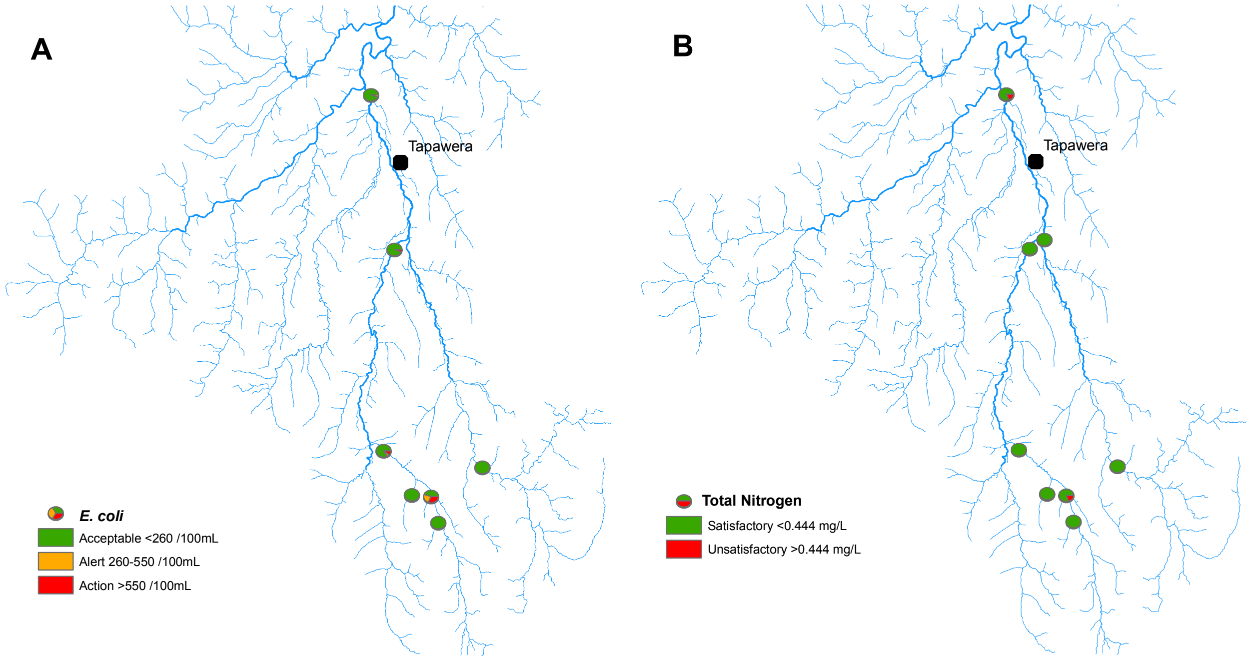

Figure 1 Proportion of measurements of faecal indicator bacteria (A) and total nitrogen (B) that met or exceeded guidelines.

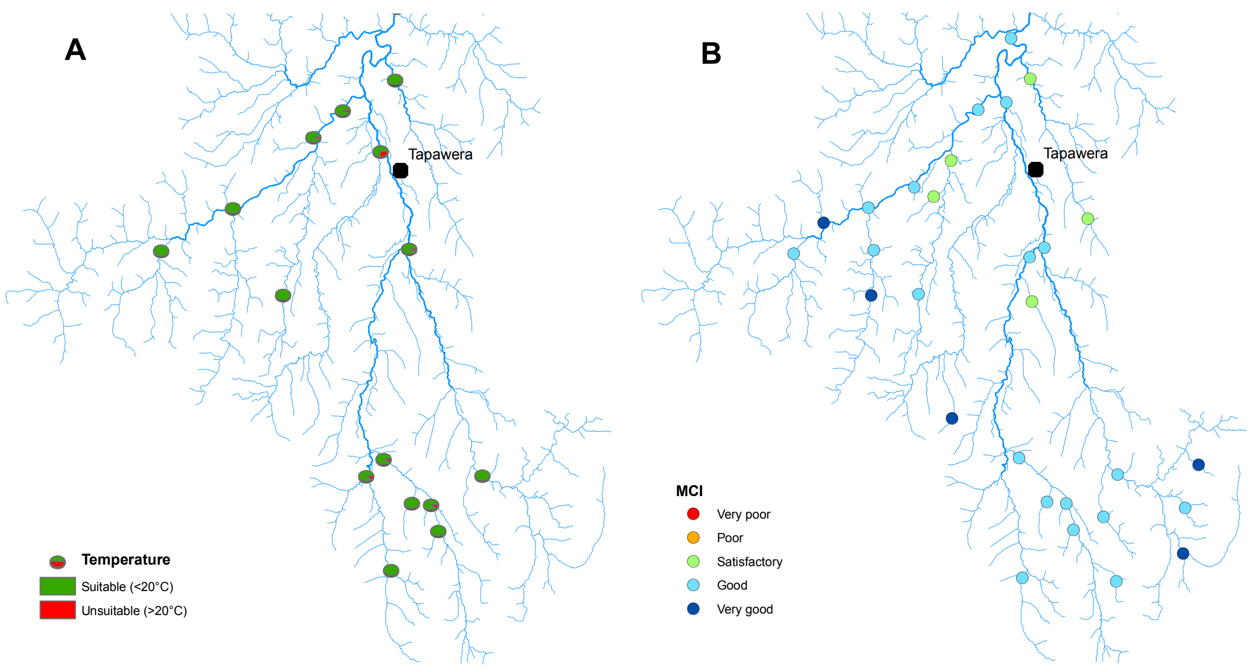

Figure 2 (A) Proportion of the summer period when temperature measurements exceeded criteria for ecosystem health. (B) Average macroinvertebrate community index (MCI) scores.

The long-term water quality dataset from the Gorge and Woodstock (sampled monthly since 1989) enables an assessment of trends over time. Most water quality parameters showed no trends. However, there was a significant increase in nitrate-nitrogen concentration at Woodstock from 1989 to 2005 (Figure 3). Fortunately, this rate of increase is relatively low (2.6% per year), and concentrations are typically below guideline limits for protection of ecosystem health (444 mg/m^3). Nevertheless, this trend in water quality should be considered in future resource management decisions in the Upper Motueka catchment.

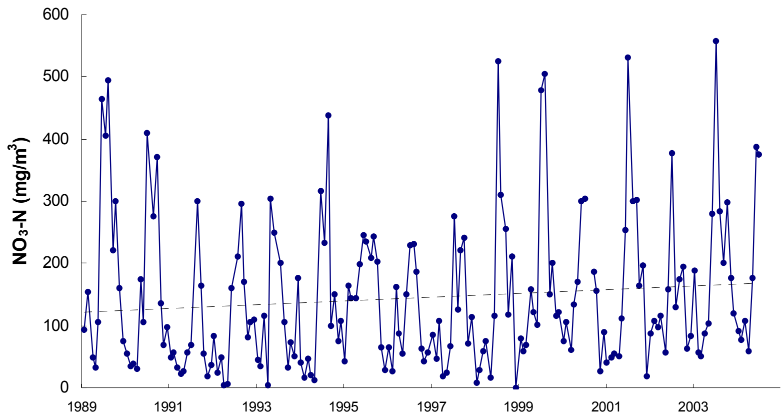

Figure 3 Increase in nitrate-nitrogen concentration at the Woodstock sampling site from 1989 to 2005.

3. FLOW-HABITAT MODELLING

A key question with water resources management is “How much water can be abstracted from a river without affecting the ecological, cultural, aesthetic and recreational values associated with that river system?” This is not a simple question, but there are a variety of methods that can be used to help guide decisions.

- Historic flow methods are the easiest to apply and use information from the existing flow regime to set minimum flows (*e.g.* 1-in-5 year low flow).
- Hydraulic methods require some field surveys and predict how depth, velocity and river width will change with flow. Flow management decisions can then be based on an acceptable degree of change in these parameters compared to the natural flows (*e.g.* < 10% reduction in river width).
- Habitat methods are the most sophisticated and relate changes in depths and velocities with the habitat requirements of particular species. However, these methods require intensive field surveys and still attract controversy regarding the interpretation of the model outputs. Using habitat methods, flow management decisions can be based on an acceptable change in the availability of suitable habitat for particular species (*e.g.* retain 90% of adult trout habitat available at the natural mean annual low flow). A special feature of habitat methods is that they can help to predict how an altered flow regime may actually improve habitat availability compared with the natural situation. However, this is only applicable in large swift rivers where reductions in velocity will benefit most species, including the ones with high flow demands.

Habitat methods were used in the negotiations involved with the Motueka Water Conservation Order to describe how habitat availability changes with flow in the middle and lower reaches of the Motueka River. However, until recently there has been no similar information to guide water resources management in the Upper Motueka Catchment. A 2-dimensional habitat survey was conducted on a 400 m long section of the Motueka River upstream of Tapawera. Flow measurements indicate that there are substantial losses of surface water to the aquifer in this reach of the river and therefore this section was considered to represent the reach that experiences the most pronounced effects of low flows.

Habitat availability for flow demanding species like adult trout, longfin eels and torrentfish was predicted to decline quite rapidly in this reach below about 4 m^3/s (Figure 4). In contrast, habitat availability for species that prefer shallow, slow water (*e.g.* dwarf galaxias and upland bullies) was predicted to increase as flows reduce (Figure 4).

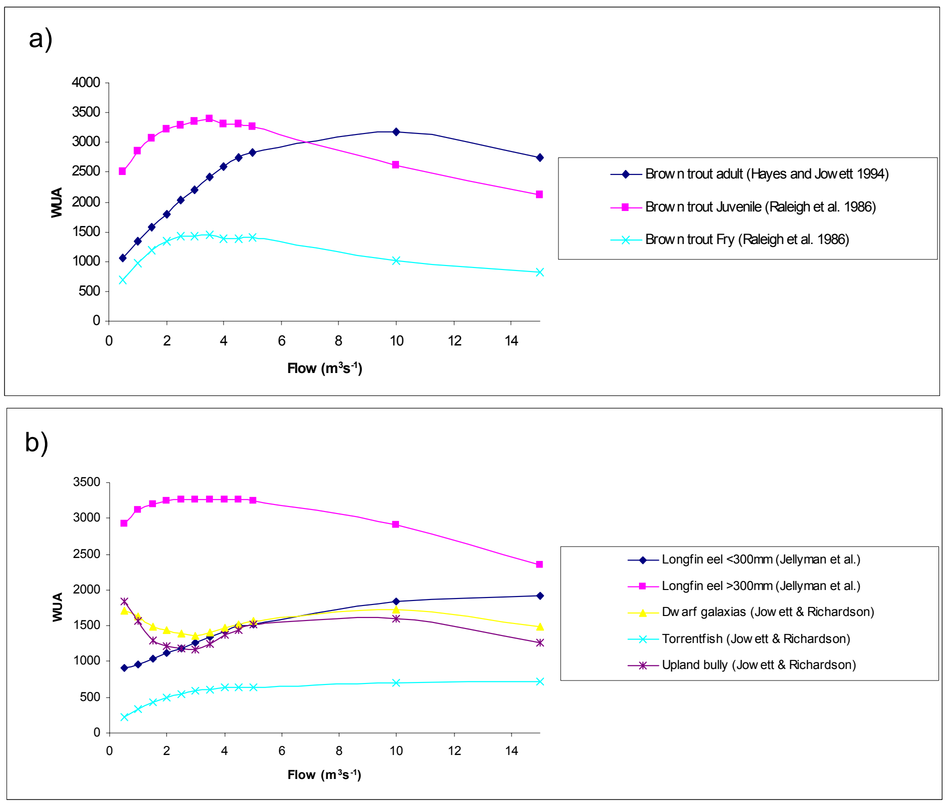

Figure 4 Predicted changes in habitat availability (WUA) for (a) different life stages of brown trout and (b) native fish species in the Tapawera reach of the Motueka River.

When setting minimum flows for instream values, the assumption is made that habitat availability at the minimum flow is a limiting factor. Choices also need to be made regarding which species or values are chosen as the critical ones to guide flow management. Candidates for critical value status include flow sensitive species, rare species, or species with high fishery value. In this case, habitat availability for adult brown trout is an appropriate critical value, since trout are sensitive to flows and the Motueka supports a highly valued trout fishery.

The final decision on an appropriate flow regime relates to what level of habitat availability should be maintained. The level of habitat retention is somewhat arbitrary since current scientific knowledge is not sufficient to identify levels below which impacts will occur. In reality, this choice is about risk management. The greater the value of the resource, the less risk is acceptable (*i.e.* highly valued instream resources warrant a higher level of protection than low values instream resources). A level of 90% habitat retention compared to natural flows is suggested for this reach given the high value of the Motueka fishery. This corresponds to a minimum flow of 1.2 m^3/s, compared with an estimated natural mean annual low flow of 1.55 m^3/s. If a 80% habitat retention level was chosen, the corresponding minimum flow would be 0.9 m^3/s, but there would be a greater risk of observing reductions in fish abundance.

4. FISH MOVEMENT AND IMPLICATIONS FOR HABITAT REQUIREMENTS

The results presented above regarding changes in habitat availability with flow are only relevant for parts of the river system. Fish and some invertebrates have the ability to move throughout a river catchment and seek refuge elsewhere if conditions at their present location are unsuitable. For example, some anglers consider that several tributaries of the Motueka (such as the Motupiko and Rainy) provide good fishing during October-December when flows are moderate, but poor fishing later in the season when flows are typically at their lowest. One explanation for this is that adult trout may move downstream and spend the height of summer in the lower Motueka where flows and water temperatures provide more favourable habitat. Therefore, it may not be appropriate to try and protect adult trout habitat in these tributaries during low flow periods if they typically find refuge elsewhere in the catchment.

To investigate this issue we radiotagged 49 adult trout in the Rainy and Motupiko rivers in September/October 2004 (Figure 5). There was a small amount of initial downstream movement by some fish prior to Christmas, but most of the trout that we were able to regularly relocate remained within the Motupiko River throughout the summer. Flows were relatively high throughout the summer of 2004/05, and these trout appeared to be content remaining in the larger deeper pools in the Motupiko. Only 3 fish were relocated in the Motueka River downstream of the confluence with the Motupiko.

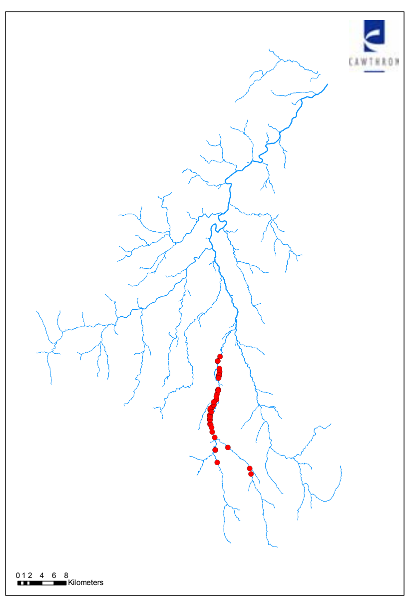

Figure 5 Initial release locations for the 49 radiotagged trout released in Sept/Oct 2004.

Unfortunately, we lost contact with almost half of the trout we had tagged, despite searching most of the catchment by plane on several occasions. It's not clear if the radiotransmitters failed, the trout were caught and removed from the river, or if the fish migrated beyond our search area. Transmitter failure seems most likely explanation. Interestingly, the 'Good Friday' 2005 flood had a big impact on the 22 trout that we knew were still alive and well in the Motupiko River. Almost 40% of them were definitely killed during the flood with radio signals coming from beneath gravel bars and debris jams, while a further 18% were not relocated after the flood and may have also perished.

The results from this study were not conclusive in terms of fish movements, although it does indicate that some adult trout can persist in the Motupiko over summer and probably depend on deep pools for habitat.

Further research related to this topic is underway in conjunction with a Masters student from Otago University (Ricky Olley). He is using the chemical composition of trout otoliths (or earbones) to try and determine patterns of fish movement. Otoliths continue to grow throughout the life of a fish and so record how old they are (Figure 6) and potentially where they've been. The initial results from this work look promising. Juvenile fish from the same tributaries have similar levels of strontium in their otoliths, but there are substantial differences among juveniles collected from different tributaries suggesting that it will be possible to define chemical signatures specific to different parts of the catchment. Results from some adult trout otoliths show large variations in chemical composition from the centre to the edge of the otolith suggesting pronounced migration over the life of these fish. Further analyses will hopefully enable a match between the chemical composition and likely location of fish during different stages in their lives.

Figure 6 A photo of a cross-section through an otolith from a 10 year old trout showing the annual growth rings.

5. GROUNDWATER-SURFACE WATER INTERACTIONS

As outlined in the separate report on the groundwater modelling, there appears to be some significant interactions between surface water and groundwater in the reach of the Motueka River between Kohatu and the confluence with the Wangapeka River. Measurements of river flow through this reach indicate increases in flow in some sections (*i.e.* gaining sections), and decreases in flow in other sections (*i.e.* losing sections). Cold upwelling groundwater could provide important refuges for fish and other stream life during low flow periods in summer when water temperatures are known to exceed guidelines for ecosystem health. To investigate this further we deployed temperature loggers in 2 sections that are considered to be gaining water and 3 sections considered to be losing water to determine if there are any broad-scale differences in the temperature regimes of these contrasting sections. We also deployed loggers in a groundwater well (Hyatts) and at the source of a springfed stream (Hinetai Hops) to measure groundwater temperatures for comparison.

The temperature regimes of the gaining and losing sections were very similar, indicating little broad-scale impact of groundwater inputs to the river. The only possible effect was slightly lower daily maximum temperatures (<2°C) in one of the gaining reaches near the mouth of the Tadmor River (Figure 7). This difference is unlikely to be ecologically significant.

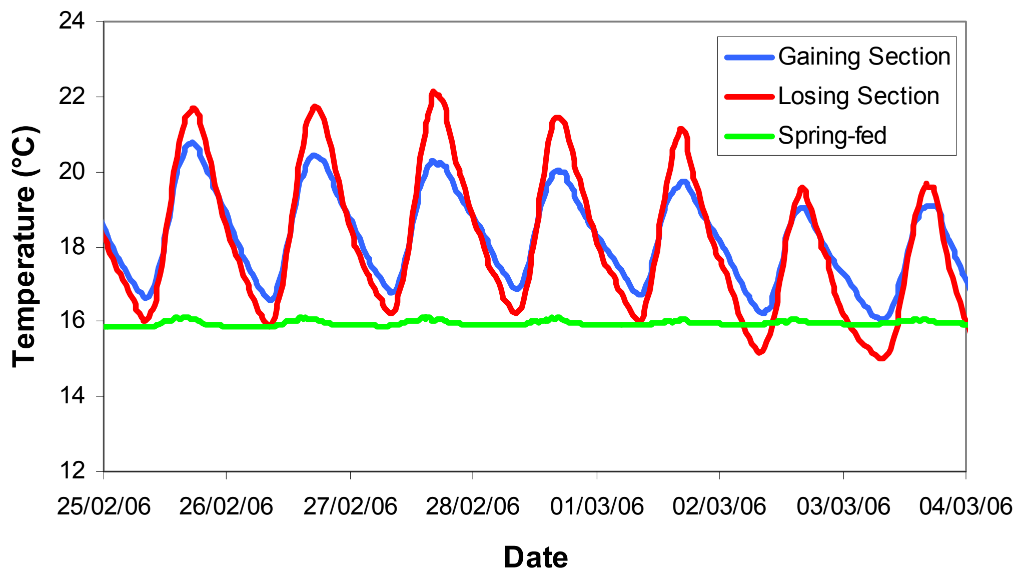

Figure 7 Contrasting temperature regimes between a gaining and losing section in the Motueka River near Tapawera. Temperatures from a spring-fed stream at Hinetai Hops are shown for comparison.

We also conducted some more detailed surveys of the reach looking for specific locations where cold groundwater was up-welling. We initially thought that groundwater may well-up into the bottom of deep pools, perhaps leading to a layer of cold water providing a refuge for fish. However, all the pools throughout the reach were well mixed with no indication of cold water near the bottom. The most substantial thermal variations were found in some remnant side-channels where water temperatures were up to 4°C colder than in the main river (Figure 8). The depth of many of these side channels means that they are unlikely to act as refuges for adult trout. However, they may provide important habitat for other species during warm periods. Large numbers of native fish were seen in some of these side-channels. It is not clear if the cold water entering these side-channels is true groundwater, or recent river water that has simply passed through gravel bars in the river bed.

Figure 8 Side-channel of the Motueka River receiving cold groundwater.

Surface water/Groundwater interactions are not large enough to result in large sections of the river acting as thermal refuges during warm periods. However, there are some side-channels in this reach that are significantly cooler than the main river water and may provide important habitat for some species. Some further work on 'What's living in these side-channels?' and 'Where the water entering these side channels comes from?' is planned for this summer.

6. SUMMARY

The Upper Motueka Catchment supports a wide variety of in-stream values and generally has good water quality. The main issues appear to be associated with intensive pastoral development leading to increased concentrations of faecal indicator bacteria and nutrients. A long-term dataset indicates that dissolved nitrate concentrations at Woodstock have increased slowly over the last 15 years. Water temperatures in some areas regularly exceed guidelines for ecosystem health. In the smaller streams this could be mitigated by promoting riparian plantings to increase shade.

There are a variety of methods that can be used to help guide decisions on flow allocation. A two-dimensional habitat survey was conducted on a section of the Motueka River near Tapawera to predict how habitat will change with flow in this reach. A 90% habitat retention level is suggested for this reach, which corresponds to a minimum flow of 1.2 m^3/s. There would be a greater risk of observing impacts at lower minimum flows.

Fish may migrate throughout the Motueka Catchment in response to changes in flow. Therefore, it may be pointless trying to maintain sufficient flows for some species if they typically find refuge elsewhere in the catchment. A radiotagging study of adult trout movement from the Rainy and Motupiko rivers was somewhat inconclusive regarding migration patterns. However, some adult trout remain in the Motupiko River throughout the summer and rely on deep pools for habitat. Further work using chemical tracing techniques is underway and showing promise.

Upwelling groundwater has the potential to provide cool-water refuges for aquatic life during the height of summer. Broad-scale measurements of the temperature regime in gaining and losing sections of the Motueka River between Kohatu and the Wangapeka confluence indicate that surface water/groundwater interactions are not large enough to result in large sections of the river acting as thermal refuges. However, there are some side-channels in this reach that are significantly cooler than the main river water and may provide important habitat for some species.

7. RECOMMENDATION

- **Council receives this report.**

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