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Instream habitat assessment for the Waikanae River

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Executive Summary

An instream habitat investigation of the Waikanae River was performed to assess the ability of the current minimum flow to safeguard the life-supporting capacity of the river. The study objectives were to: determine how changes in flow affect instream habitat availability, determine how low flow conditions affect instream habitat availability, and assess instream habitat at the current minimum flow in the Regional Freshwater Plan.

The assessment was performed using the Instream Flow Incremental Methodology (IFIM), on two reaches of the river. The IFIM analysis focussed on brown trout, food-producing habitat, and several species of native fish that are found in the Waikanae River (longfin eel, torrentfish, and redfin bully). The results showed that:

- The flow at which optimum habitat availability occurs varies between species, and for most species the optimum habitat occurs at flows significantly greater than the mean annual low flow;

- Low flow conditions in the Waikanae River have the most detrimental impact on adult brown trout, food-producing and torrentfish habitat availability; and

- Compared with other New Zealand rivers, at mean annual low flow the Waikanae River has a high proportion of yearling and fry brown trout and native fish habitat, and a relatively low proportion of adult brown trout and food-producing habitat.

At the current minimum flow, which is about 20% lower than the mean annual low flow, the most habitat is available to eels, bullies, and yearling brown trout. The most habitat loss, compared to habitat available at mean annual low flow, is experienced by adult brown trout and food-producing habitat. The reduction in river depth, width and velocity from conditions at mean annual low flow is relatively minor in both study reaches.

The difficulty in assessing the current minimum flow of 750 L/s is the lack of a definition of acceptable habitat loss or sufficient habitat provision. The 'minimum habitat' guideline was recommended by Jowett (1993) for deriving minimum flows for smaller rivers in the Wellington region. This approach ensures that the minimum flow is set at a level where brown trout and food-producing habitat availability is comparable to other New Zealand rivers.

The results from the two study reaches suggest that a minimum flow of 810 L/s is required for the Waikanae River to meet the minimum habitat guideline. This flow is only 8% higher than the current minimum flow in the Regional Freshwater Plan. The IFIM results indicate that increasing the minimum flow by this magnitude would not result in a large increase in habitat availability.

It is recommended that the current minimum flow of 750 L/s at the Greater Wellington recorder site be retained. A lower minimum flow would result in further loss of food-producing habitat, which is vital for maintaining a healthy instream ecosystem. Increasing the minimum flow is not justified based on the results of this study, specifically because:

- The current minimum flow provides a high proportion of the habitat available for most species at mean annual low flow;

- The current minimum flow provides a high proportion of the river depth, width and velocity that occur at mean annual low flow; and

- The flow required to meet the minimum habitat guideline based on the two study reaches (810 L/s) is only 8% higher than the current minimum flow and would only result in a small increase in habitat availability.

The recommendation to retain the current minimum is based on flow requirements for instream habitat only. A higher threshold may be necessary to provide for other matters in Part II of the Resource Management Act, but these matters are not addressed in this report.

Consideration should be given to developing new guidelines for determining minimum flow requirements in Wellington rivers. Further work will also be done to develop or test other methods to compliment IFIM in assessing instream habitat. In addition, biological and water quality monitoring of the Waikanae River should continue to ensure that the suitability of the minimum flow can be continually assessed.

Contents

1. Introduction

The Greater Wellington Regional Council is responsible for promoting the sustainable management of the Waikanae River. This means managing the river so that people can provide for their social, cultural and economic wellbeing, for example by abstracting water, while the life-supporting capacity of the river is safeguarded.

This report presents the results of an instream flow incremental methodology (IFIM) study on two reaches of the Waikanae River. The study forms part of an ongoing programme to review the minimum flows in the Regional Freshwater Plan for the Wellington Region (Regional Freshwater Plan) (Wellington Regional Council, 1999). The purpose of the study was to assess whether the current minimum flow can safeguard the life-supporting capacity of the river. The specific objectives were to:

- Determine how the amount of aquatic habitat available in the Waikanae River varies with flow;
- Assess the effect of low flow conditions on habitat availability; and
- Assess the habitat availability at the current minimum flow in the Regional Freshwater Plan.

This report does not investigate the flows necessary to provide for the relationship of Maori with the river, or to maintain and enhance amenity values, or any other matters in sections 6, 7 and 8 of the Resource Management Act 1991. These wider matters must be taken into account during the preparation of regional plans and the assessment of resource consent applications.

2. The Waikanae River

The Waikanae River (Figure 1) of the Kapiti Coast is a gravel bed river with a catchment area of about 149 km^2, draining the southwest Tararua range. The river has four main tributaries: Maungakotukutuku Stream, Reikorangi Stream, Rangiora River, and Ngatiawa River. The upper Waikanae catchment is covered in natural vegetation, but large areas of the Ngatiawa and Maungakotukutuku valleys are pasture.

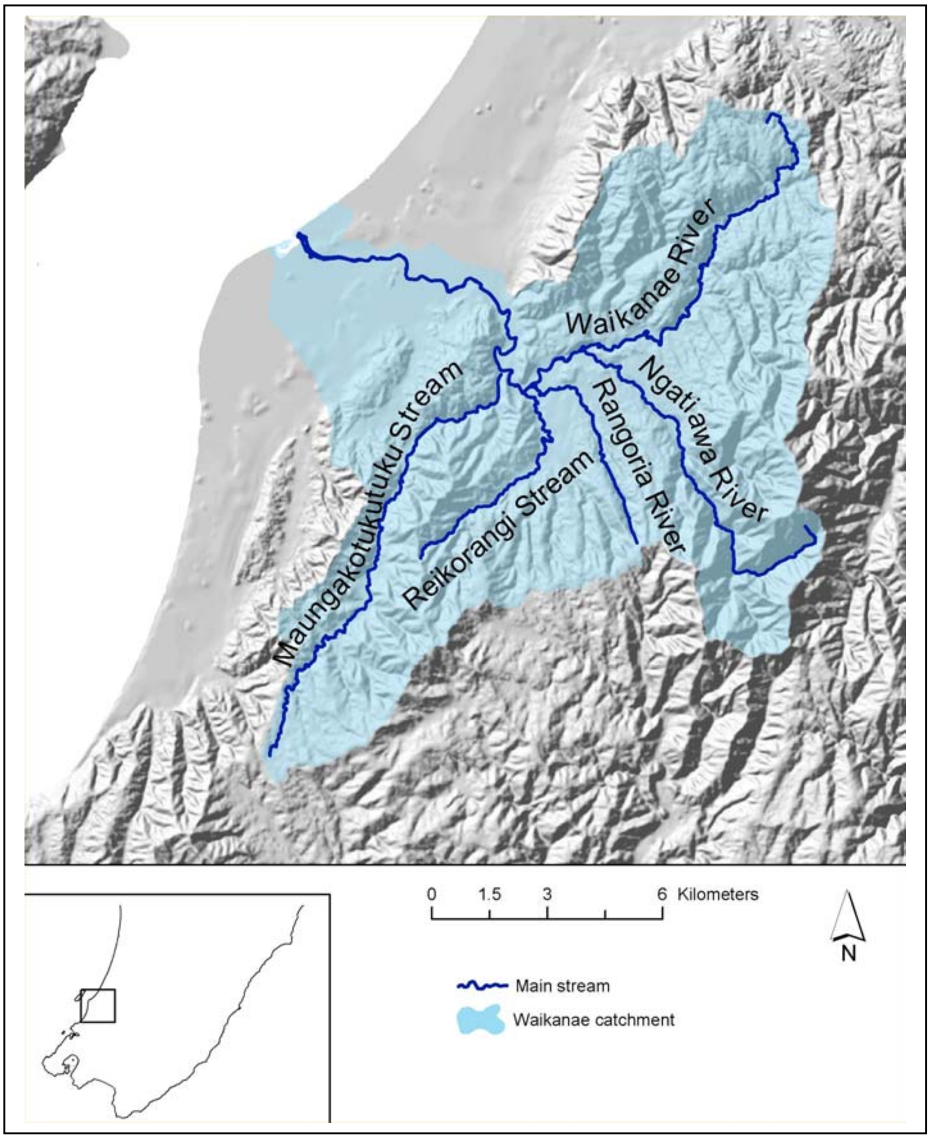

Figure 1: Waikanae River and its tributaries

The Waikanae Water Treatment Plant, operated by Kapiti Coast District Council, is downstream of the confluence with the Maungakotukutuku Stream. This plant may abstract up to 463 L/s of water from the river, with a gradual stepdown during low flow conditions. Downstream of the Water Treatment Plant the Waikanae River flows across the coastal plain, losing a significant amount of flow to groundwater between the State Highway 1 and Jim Cooke Park (Figure 2). Flow is gained from groundwater downstream of Jim Cooke Park.

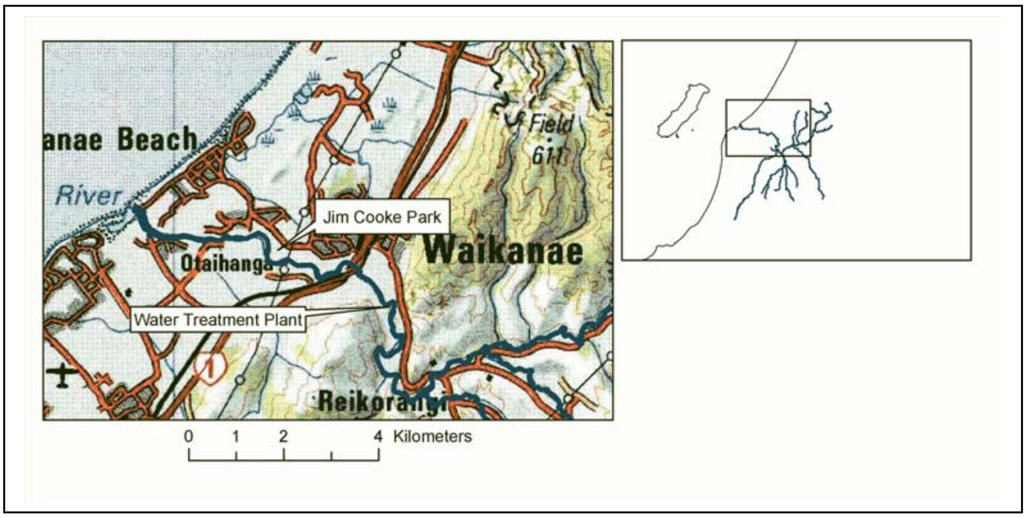

Figure 2: Lower reaches of the Waikanae River

2.1 Study reaches

Two reaches of the river were selected for use in this study. The first reach (Water Treatment Plant reach) starts at the Water Treatment Plant (Figure 2), and continues upstream approximately 225 metres. This reach has high banks on both sides of the river, with predominantly native riparian vegetation (Figure 3).

Figure 3: Looking upstream to the Water Treatment Plant reach

The second study reach is at Jim Cooke Park, downstream of State Highway 1 (Figure 2). The reach has a lower gradient than the Water Treatment Plant reach. There are sports fields on the right bank and willows on the left bank (Figure 4). This reach is approximately 220 metres long.

Figure 4: Jim Cooke Park reach (looking upstream)

The substrate of the two reaches (determined in the IFIM survey) is fairly similar (Figure 5). Both reaches are dominated by gravel and fine gravel. However, the Jim Cooke Park reach has more sand and mud than the Water Treatment Plant reach, and no significant boulder substrate.

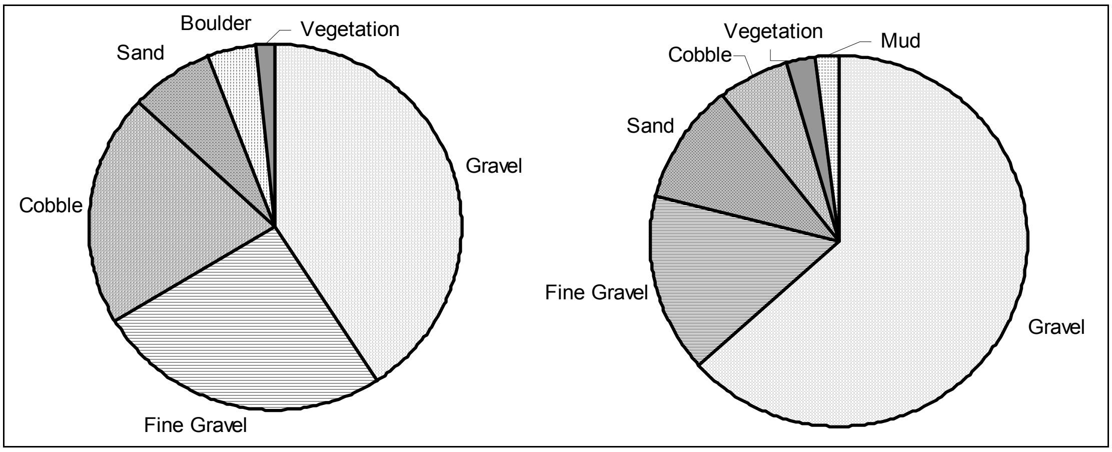

Figure 5: Substrate composition of two reaches of the Waikanae River. Water Treatment Plant reach (left) and Jim Cooke Park reach (right).

2.2 Flow statistics

Greater Wellington operates a flow recorder site in the Water Treatment Plant reach a short distance upstream of the Waikanae Water Treatment Plant. The flow record begins in March 1975. No continuous flow records are available for the Jim Cooke Park reach, but the flow record for the reach can be simulated by making a correlation between gaugings in the reach and the flow at Greater Wellington's recorder site.

Table 1 shows the mean flow, median flow, and the mean annual low flow (MALF) in the two reaches. The flow in the Jim Cooke Park reach is less than that in the Water Treatment Plant reach because of the loss to groundwater that occurs between the two reaches.

Table 1: Flow statistics (L/s) for the Waikanae River, 1975 – 2003

Reach	Mean flow	Median flow	Mean annual low flow
Water Treatment Plant	4600	3020	950
Jim Cooke Park [1,2]	4150	2630	630

2.3 Management of the Waikanae River

The Regional Freshwater Plan sets out the objectives, policies and rules for the management of freshwater in the Wellington region. The Waikanae River is identified in the Plan as a water body with:

- Nationally threatened indigenous fish (koaro and short-jawed kokopu) recorded in the catchment;
- Important trout habitat; and
- Regionally significant amenity and recreation values.

The water quality of the Waikanae River is therefore to be managed for fishery and fish spawning, contact recreation[3] and water supply purposes[4]. The allocation of water from the Waikanae River is guided by Policy 6.2.1 of the Regional Freshwater Plan. This policy directs decision-makers to recognise that certain minimum flows should be retained in low flow conditions. The minimum flow is a guide that provides an indication of flow in the river that will:

- Safe-guard the life-supporting capacity of ecosystems;
- Meet the needs of future generations; and
- Provide for adequate water quality (Wellington Regional Council, 1999).

The minimum flow at the Greater Wellington flow recorder site is given as 750 L/s. This minimum flow was derived using results from an earlier instream habitat study (Hayes, 1993). Although Kapiti Coast District Council is currently consented to take water at flows less than the current minimum flow, the assessment in this report assumes that no abstraction of water will occur below the minimum flow.

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[1] Estimated based on correlation between gaugings at this reach and flow at the Greater Wellington recorder upstream of the Water Treatment Plant
[2] Natural flow in the reach, assuming no abstraction at the Water Treatment Plant
[3] From State Highway 1 to the river mouth, for swimming and angling
[4] Upstream of the Waikanae Water Treatment Plant

3. Instream habitat assessment method

3.1 Background

The combination of a description of habitat preferences with hydraulic modelling of river flow is called hydraulic habitat modelling. Hydraulic habitat models predict water depth and velocity at each point in a section of river at a certain flow, and then use habitat suitability curves to evaluate whether that point provides suitable habitat for the target species (Jowett, 1996). This is often referred to as instream flow incremental methodology (IFIM) because the method quantifies changes in the amount of available habitat that result from changes in river flow. Note that this method assesses habitat suitability based on hydraulic properties only and does not consider factors such as water quality or streamside shading.

The instream area where the physical character meets the criteria specified in the habitat suitability curves is the weighted usable area (WUA). The greater the WUA the more instream habitat is available in the river. In this report WUA is mostly expressed in terms of area (square metres per metre of river length). WUA is expressed as a percentage of the river width (i.e. the percentage of the river that is available for habitat) when comparisons are made with other rivers so that the effect of river size is removed.

The instream habitat assessment method using IFIM was used in this study because this method has been commonly applied to Wellington rivers, following recommendations of Jowett (1993). The method consists of the following steps (adapted from Hudson *et al*., 2003):

1. The hydro-geomorphology of the study area is surveyed and hydraulic models calibrated so that changes in depth and velocity can be simulated at different streamflows.

2. Habitat suitability curves are selected to represent how habitat suitability for a species varies with habitat variables (depth, velocity and substrate).

3. The habitat suitability curves are used within the hydraulic model to simulate how WUA varies with streamflow.

4. WUA-streamflow relationships are interpreted to develop an instream flow recommendation.

A common misconception is that IFIM determines a minimum flow. It is reiterated here that IFIM shows only how instream habitat for the selected species varies with flow. The decision about setting a minimum flow is a separate process that is only aided by the IFIM results.

3.2 Survey method

The IFIM survey was undertaken during mean flow conditions (around 4600 L/s) on 13 June 2003. Two calibration runs, where water level and flow were measured, were completed on 17 and 27 June when flow was lower (4400 and 2100 L/s respectively).

Within the two reaches cross-sections were selected to represent the physical characteristics of each reach. At each cross-section measurements of water depth, velocity and flow were taken, and a visual assessment of the substrate composition was made. Fifteen cross-sections were surveyed in the Water Treatment Plant reach, and fourteen in the Jim Cooke Park reach. The survey procedure is explained in detail by Jowett (1999).

3.3 Habitat suitability curves

The species modelled were those likely to be found in the Waikanae River (as indicated by NIWA's Freshwater Fish Database and Porter, 2003). The particular species selected were:

- Brown trout – adult (Hayes & Jowett, 1994), yearling (Raleigh *et al.*, 1986) and fry (Raleigh *et al.*, 1986);
- Longfin eel;
- Torrentfish; and
- Redfin bully.

Food-producing habitat (Waters, 1976) was also modelled to assess the extent of suitable habitat for a range of aquatic macroinvertebrate species that provide food for larger fish. The habitat suitability curves not referenced above are those developed by NIWA and contained in the RHYHABSIM v2.13 software (Jowett, 1999).

Note that although the Waikanae catchment is acknowledged in the Regional Freshwater Plan as having koaro and short-jawed kokopu recorded in the catchment, these species were not included in the IFIM analysis. This is because these species are only found in the headwaters of the river only.

3.4 Modelling WUA-flow relationships

The hydraulic survey data were entered into the RHYHABSIM hydraulic habitat model, and rating curves for the cross-sections were checked. The program was then used to model how habitat varies with flow.

3.5 Limitations

As previously mentioned the IFIM process is limited to assessing habitat quantity, not quality. The method assumes that the only factors affecting habitat suitability are water depth, width and velocity, and substrate. This is obviously not the case in reality, and reinforces the point that ongoing water quality monitoring is required to assess the suitability of a minimum flow.

4. Instream habitat assessment - results

4.1 Changes in habitat with flow

All habitat types were found to vary significantly with changes in flow in the Waikanae River. Graphs of WUA versus flow are contained in Appendix 1.

The flow for maximum habitat availability varies between species (Table 2). Optimum habitat for adult brown trout, food production, longfin eel and torrentfish occurs at or around the mean flow, i.e. at flows about five times the MALF. Optimum habitat for yearling and fry brown trout occurs between MALF and the median flow, which is lower than the flow for optimum adult brown trout habitat. Redfin bully has its maximum WUA available at flows lower than the MALF. However, for most species the amount of WUA decreases sharply as flow decreases below MALF.

Table 2: Flows (L/s) for optimum habitat in the Waikanae River

Habitat type	Water Treatment Plant reach	Jim Cooke Park reach
Adult brown trout	4700	3800
Yearling brown trout	1700	1300
Brown trout fry	1200	1300
Food-producing	5800	3500
Longfin eel	4800	5000
Torrentfish	4700	7600
Redfin Bully	500	800

The results of this study are consistent with the results of Hayes (1993). However, note that Hayes assessed WUA as a percentage of river width, and the analysis was restricted to adult brown trout and food-producing habitat only.

4.2 Habitat at mean annual low flow

The modelled habitat available at MALF can be used to:

- Assess how low flow conditions in a river affect the amount of habitat available to different species; and
- Compare the habitat availability in a river during low flow conditions to that in other New Zealand rivers.

4.2.1 Effect of low flows on habitat availability

Table 3 shows the WUA at MALF for a range of species found in the Waikanae River. The percentage that this represents of the peak WUA for that species is also shown. For example, at MALF in the Water Treatment Plant reach, the WUA for food-producing habitat is 2.1 m^2/m. The peak WUA for food production in the reach is 4.5 m^2/m (which occurs at a higher flow). Therefore, at MALF 47% of the optimum habitat for food production is available.

Table 3: Habitat provided at MALF in the Waikanae River

Habitat type	Water Treatment Plant reach		Jim Cooke Park reach	
	WUA at MALF (m^2/m)	Percentage of peak WUA	WUA at MALF (m^2/m)	Percentage of peak WUA
Adult brown trout	0.9	22	0.8	43
Yearling brown trout	2.9	99	3.9	89
Brown trout fry	1.9	98	2.8	83
Food-producing	2.1	47	1.3	28
Longfin eel	4.4	66	5.8	89
Torrentfish	1.6	45	1.1	17
Redfin Bully	3.3	72	6.6	99

At MALF in both reaches more habitat is available to longfin eel, redfin bully and yearling brown trout than the other species. For these species and also brown trout fry the amount of habitat provided at MALF is a high proportion of the peak WUA – i.e. these species are more suited to typical low flow conditions in the Waikanae River than the other species. Adult brown trout and torrentfish have the least available habitat at MALF than other species in the study. Low flow conditions have the most detrimental impact on WUA for adult brown trout, torrentfish and food-producing habitat.

4.2.2 Comparison with NZ rivers data

The percentage WUA at MALF for various species was assessed in 73 New Zealand rivers (as found in Jowett, 1996). The results are compared to those for the Waikanae River in Table 4. This shows that, at MALF, the Waikanae River:

- Provides a high proportion of habitat for yearling brown trout, brown trout fry, longfin eel, torrentfish, redfin bully compared other New Zealand rivers; and

- Is in or near the lower quartile of New Zealand rivers for adult brown trout and food-producing habitat.

Table 4: WUA (percentage of river width) at mean annual low flow

Habitat type	73 New Zealand rivers data (from Jowett, 1996)			Waikanae River[5]
	Lower quartile	Median	Upper quartile	
Adult brown trout	7.6	12.5	18.5	8
Yearling brown trout	15.4	21.8	25.9	29
Brown trout fry	8.4	12.3	17.2	25
Food-producing	14.3	22.8	34.4	15
Longfin eel	6.2	10.5	14.7	44
Torrentfish	3.2	6.5	10.4	12
Redfin Bully	10.8	18.1	27.1	46

[5] Average of the two study reaches

5. Instream habitat and minimum flow

5.1 Habitat available at the current minimum flow

Table 5 shows the amount of habitat available in the two reaches when a flow of 750 L/s occurs at the recorder site (the current minimum flow in the Regional Freshwater Plan)[6]. At this flow, the most habitat is available to longfin eel, redfin bully and yearling brown trout, and the least habitat is available to adult brown trout and food-producing. The Water Treatment Plant reach has more food-producing habitat, and less yearling brown trout, longfin eel and redfin bully habitat, than the Jim Cooke Park reach at the current minimum flow.

Table 5: Habitat (WUA m^2/m) in the Waikanae River at the current minimum flow

Habitat type	Water Treatment Plant reach	Jim Cooke Park reach
Adult brown trout	0.7	0.7
Yearling brown trout	2.7	3.5
Brown trout fry	1.8	2.3
Food-producing	1.7	0.8
Longfin eel	4.3	5.5
Torrentfish	1.3	0.9
Redfin Bully	4.3	6.2

The habitat provided at minimum flow is often reported as a proportion of habitat available at MALF. This is so that the degree of reduction in habitat from that available under 'average' annual conditions can be assessed.

Figure 6 shows the habitat at the current minimum flow as a proportion of that which occurs at MALF. In general, at 750 L/s about 80 – 90 % of the habitat provided at MALF is available. The exception is that in the Jim Cooke Park reach 62% of the food-producing habitat at MALF is retained – i.e. food-producing habitat has the greatest degree of habitat loss. The least habitat loss at this minimum flow, compared to that available at MALF, is for brown trout fry, longfin eel, and redfin bully. These were species shown in Section 4.2.1 to be most suited to low flow conditions in the Waikanae River.

[6] The estimated corresponding flow in the Jim Cooke Park reach is 430 – 450 l/s.

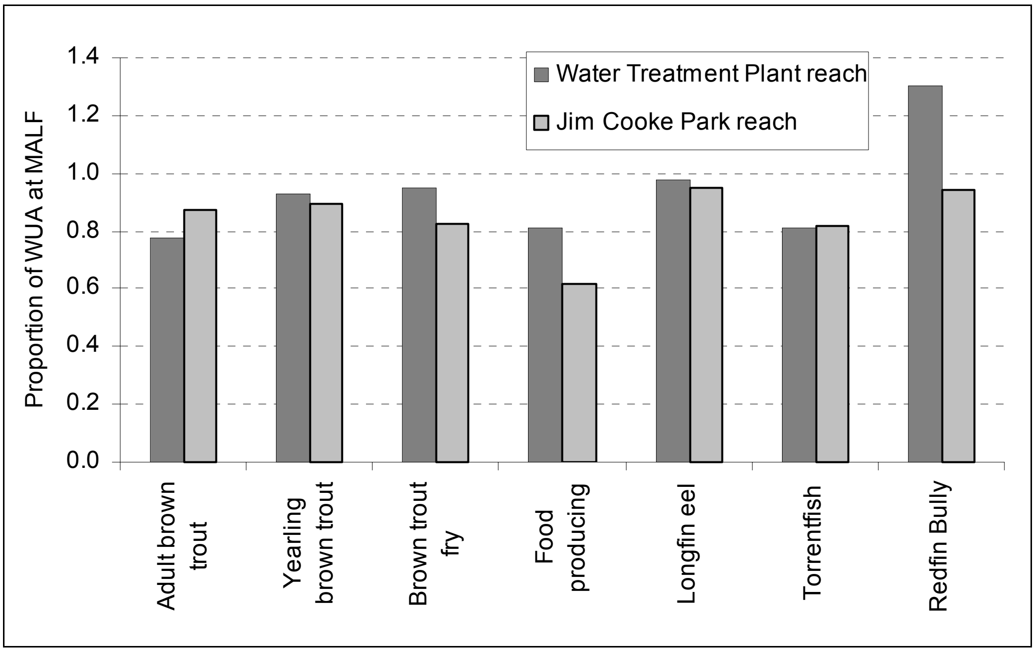

Figure 6: Habitat (WUA) at the current minimum flow as a proportion of that at MALF in the Waikanae River

The reduction in depth, width and velocity at the minimum flow compared to average annual low flow conditions (such as at MALF) can also be considered. Table 6 shows that in both study reaches at the current minimum flow, river depth and width is a high percentage (93 – 95%) of their values at MALF. The velocity is reduced by about 10 to 20% of that which occurs at MALF.

Table 6: Predicted depth, width and velocity of the Waikanae River at the current minimum flow

Hydraulic variable	Water Treatment Plant reach		Jim Cooke Park reach	
	Value at minimum flow	Percentage of value at MALF	Value at minimum flow	Percentage of value at MALF
Mean depth	0.34 m	95	0.33 m	95
Mean width	9.1 m	93	11.9 m	95
Mean velocity	0.32 m/s	91	0.13 m/s	79

5.2 Minimum flow assessment

The aim of this study was to assess the ability of the recommended minimum flow in the Regional Freshwater Plan (750 L/s) to provide habitat for the range of fish that would normally live in the Waikanae River. The difficulty with this is the lack of a definition of 'adequate' habitat availability. Minimum flows adopted in the Regional Freshwater Plan and in supporting technical documents have been derived based on habitat using two guidelines:

1. Using a maximum percentage loss of habitat compared to that at MALF; or
2. Retaining a minimum amount of habitat.

Both these guidelines were developed to apply to adult brown trout and food-producing habitat (Jowett, 1993), but there is no reason why they cannot be applied to native fish. However, because some native fish (such as bullies) can withstand lower flow regimes, the use of trout and food-producing habitat often results in a more conservative (higher) minimum flow.

5.2.1 Maximum habitat loss

Jowett (1993) suggested that the habitat loss should be restricted to one-third of the habitat available at MALF. Concern has been expressed over the use of this "rule of thumb" (Ministry for the Environment, 1997), but there is no widely accepted methodology for selecting an acceptable percentage loss of habitat. Although this method was intended to apply to larger rivers in the Wellington region, calculating the habitat loss is useful for assessing whether 750 L/s is an appropriate threshold for the Waikanae River.

Section 5.1 and Figure 6 showed habitat at the current minimum flow as a proportion of habitat available at MALF. In the Waikanae River (average of the two study reaches) the loss of habitat is 17% for adult brown trout and 28% for food-producing habitat. These are within the guidelines suggested by Jowett (1993), although the loss of food-producing habitat is close to the maximum loss threshold.

Habitat loss for native fish and various life stages of trout should also be considered. The habitat loss at the current minimum flow compared to at MALF is on average 9 to 11% for yearling brown trout and fry. The native fish included in the study also retain a high proportion of the habitat available at MALF (greater than 80%). Thus all native fish studied and trout yearling and fry have less than one-third loss at the current minimum flow, compared to habitat available at MALF.

5.2.2 Minimum habitat retention

For 'smaller' rivers in the Wellington region, Jowett (1993) suggested that the minimum flow be derived based on retaining a minimum amount of habitat. He proposed that this minimum amount of habitat should be equivalent to that exceeded by 85% of national survey rivers at their MALF. This equates to a minimum of 13% WUA for food-producing habitat, and 6.5% WUA for adult brown trout habitat.

Following the minimum habitat guideline, the results of this study give the minimum flows shown in Table 7. The average of the minimum flows for the two reaches is 810 L/s at the Greater Wellington recorder site, which is similar to the results of Hayes (1993). The flows for the Jim Cooke Park reach are estimated using the flow correlation with the Greater Wellington recorder site.

Table 7: Flows (L/s) at the Greater Wellington flow recorder site required to retain a minimum amount of habitat in the Waikanae River

Reach	Food-producing habitat	Adult brown trout habitat	Average
Water Treatment Plant	500	620	560
Jim Cooke Park	1140	970	1050

For the Jim Cooke Park reach to retain a minimum amount of habitat the flow required is greater than in the Water Treatment Plant reach. This is because in the lower reaches of a river the gradient is lower, hence velocity will be less than at the same flow upstream. Velocity is a critical factor for both food-producing and trout habitat. This point should be kept in mind when assessing consent applications to take water at flows below the minimum flow.

This method was also applied to native fish, yearling brown trout and brown trout fry. As shown in Table 4, in general the Waikanae River provides a high percentage WUA for these species relative to other New Zealand rivers. Thus the flows required to meet the minimum habitat guideline for these species were significantly less than 750 L/s.

5.3 Minimum flow recommendations

It is recommended that the current minimum flow of 750 L/s be retained. A lower minimum flow would result in unacceptable habitat loss particularly for food production, which is vital for maintaining a healthy instream ecosystem.

In the absence of a definition of *acceptable habitat loss* or *sufficient habitat availability* for the Waikanae River, 750 L/s at the recorder site is an appropriate minimum flow for the river. This is justified by the findings that at this flow:

- A high proportion of habitat available during average annual low flow conditions is retained;
- River width and depth is only slightly reduced from that at MALF; and
- The proportion of habitat for yearling and fry brown trout, longfin eel, torrentfish and redfin bully is greater than in most New Zealand rivers at MALF[7].

The results of this study indicate that a minimum flow of 810 L/s is required for the river to meet the minimum habitat guideline of Jowett (1993). This is only 8% higher than the current minimum flow. If the minimum flow were to be increased by this amount, the increase in habitat (WUA) that would occur in the Water Treatment Plant reach ranges from -1% for redfin bully to 7% for

[7] Based on the 73 New Zealand Rivers survey results (found in Jowett, 1996)

torrentfish habitat. In the Jim Cooke Park reach the increase in habitat that would result is more difficult to calculate due to the uncertain flow relationship with the Water Treatment Plant reach, but it is likely to be of a similar magnitude. River depth, width and velocity would only increase by 1 to 5%. Thus the benefits from increasing the minimum flow by 8% would be relatively minor.

It should be kept in mind that the minimum habitat guideline is based on ensuring that abstraction ceases at a level at which the proportion of habitat is equivalent to that exceeded by 85% of New Zealand rivers in a national survey. The Waikanae River under natural low flow conditions appears to have a lower proportion of trout and food-producing habitat than other New Zealand rivers anyway, probably due to the low water depths that occur. Thus the appropriateness of the minimum habitat guideline for use in the Waikanae catchment is questionable.

The lower reaches of the Waikanae River probably require a higher flow for habitat retention than the upper reaches. If Greater Wellington wishes to ensure that all reaches of the Waikanae River meet Jowett's minimum habitat guideline (or any alternative guideline) then the minimum flow should be based on the reach that requires the highest flow. However, this decision requires an investigation of additional reaches of the river, fish movement between the reaches, and of the flow losses and gains along the river.

These recommendations are based on assessing the minimum flow requirements for instream habitat only. Decisions about minimum flows for the Waikanae River may take into account other matters in Part II of the Resource Management Act.

6. Conclusions

The results of this study show that during annual low flow conditions in the Waikanae River longfin eel, redfin bully, and yearling brown trout have the most available habitat. The greatest habitat loss at low flows is experienced by adult brown trout, torrentfish, and food-producing habitat, because these species are suited to higher flow conditions. Compared with other New Zealand rivers at MALF, the Waikanae River has a high proportion of habitat for brown trout fry, yearling brown trout, longfin eel, torrentfish and redfin bully.

Instream habitat varies with flow in different ways for different species. Therefore it is not possible to set a minimum flow for the Waikanae River that will optimise habitat for all species. In addition, most species have optimum habitat availability at flows significantly higher than low flow in the Waikanae River.

The results of this study show that the current minimum flow of 750 L/s provides sufficient instream habitat for the aquatic life that would normally live there, based on the amount of habitat that is retained compared to habitat at mean annual low flow. In addition, the current minimum flow is only 8% lower than the flow required to meet the ‘minimum habitat’ guideline recommended by Jowett (1993). Increasing the minimum flow by 8% would result in a relatively minor increase in habitat availability.

From the results of this study, which used two study reaches only, increasing the minimum flow for the Waikanae cannot be justified. However, this recommendation is based on the amount of instream habitat only. Setting higher thresholds to provide for other matters in Part II of the Act may be determined during consultation on the Regional Freshwater Plan or during assessment of consent applications to take water.

7. Further work

Biological and water quality monitoring should be continued in the Waikanae River to assess the suitability of the minimum flow. As new data becomes available it may be necessary to review the minimum flow again in the future.

The IFIM method and its application in New Zealand has received recent criticism (Hudson *et al*., 2003). Further work will be done by Greater Wellington to assess additional methods for determining the flow requirements of instream habitat, for use alongside IFIM.

The only guideline that Greater Wellington has for setting minimum flows for Wellington's smaller rivers is the minimum habitat guideline of Jowett (1993). Consideration should be given to reviewing the appropriateness of this guideline, as it is not related to environmental effects *per se* and is not appropriate for river that naturally have low availability of trout habitat. If new guidelines are developed the minimum flow for the Waikanae River may need to be reassessed.

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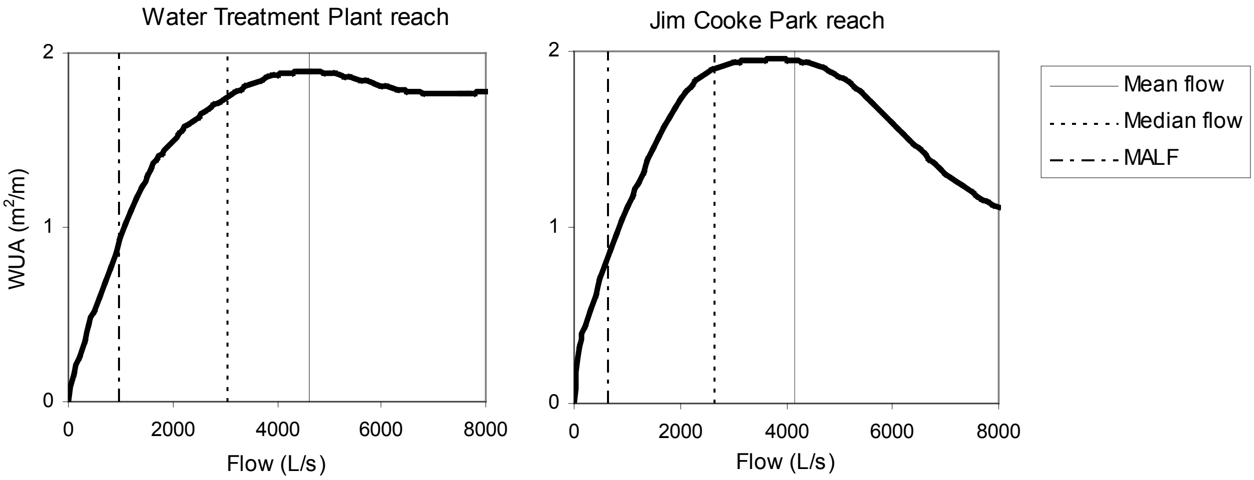
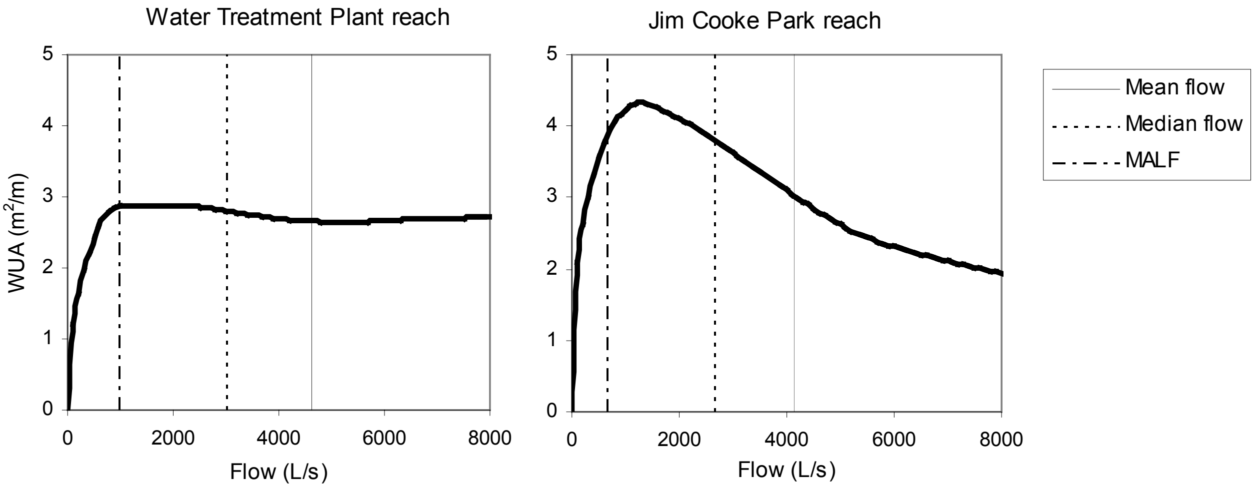
Appendix 1 – WUA-Discharge graphs

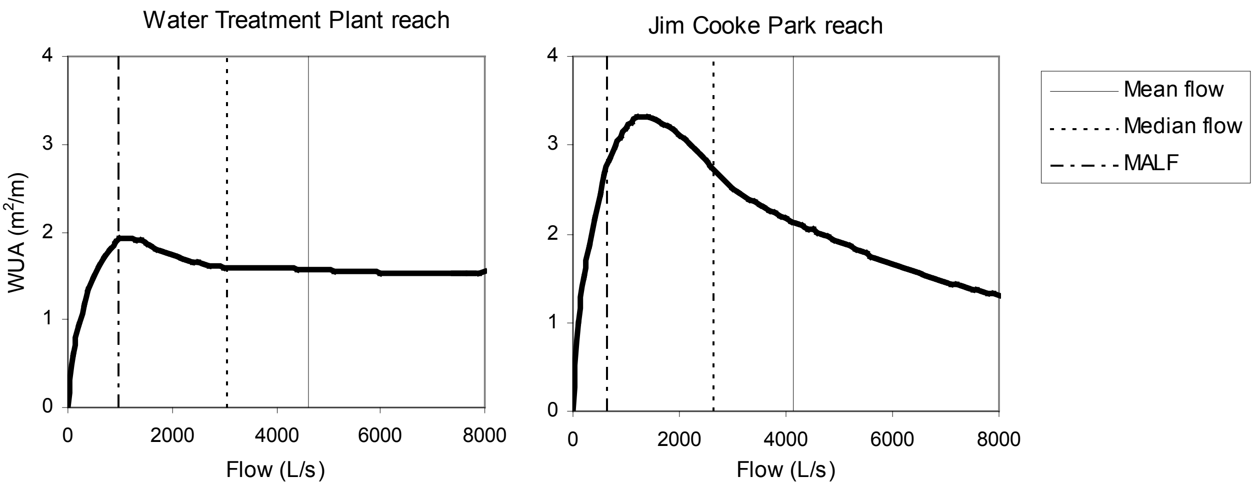
Adult brown trout:



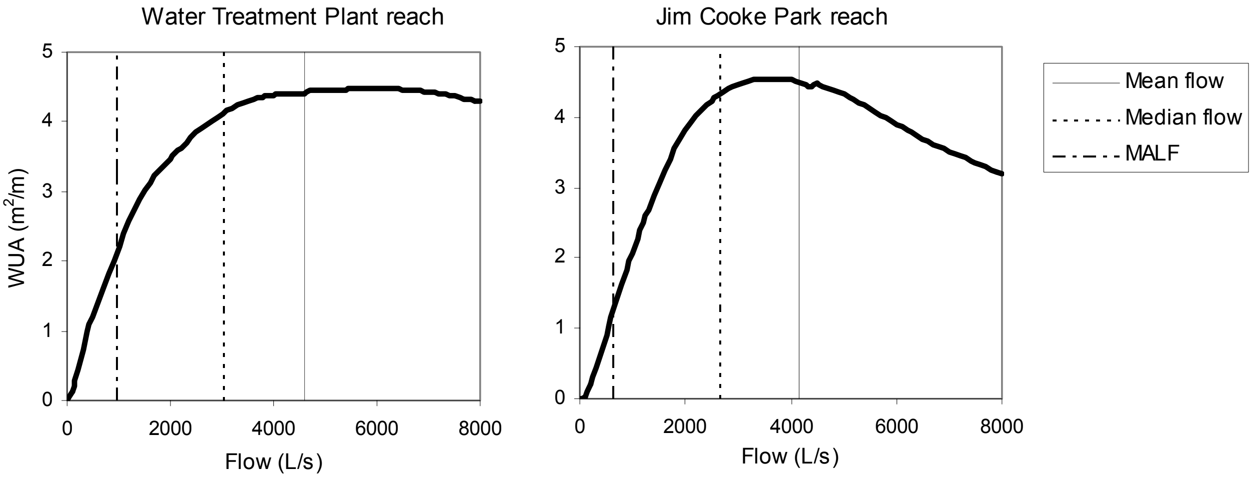
Yearling brown trout:



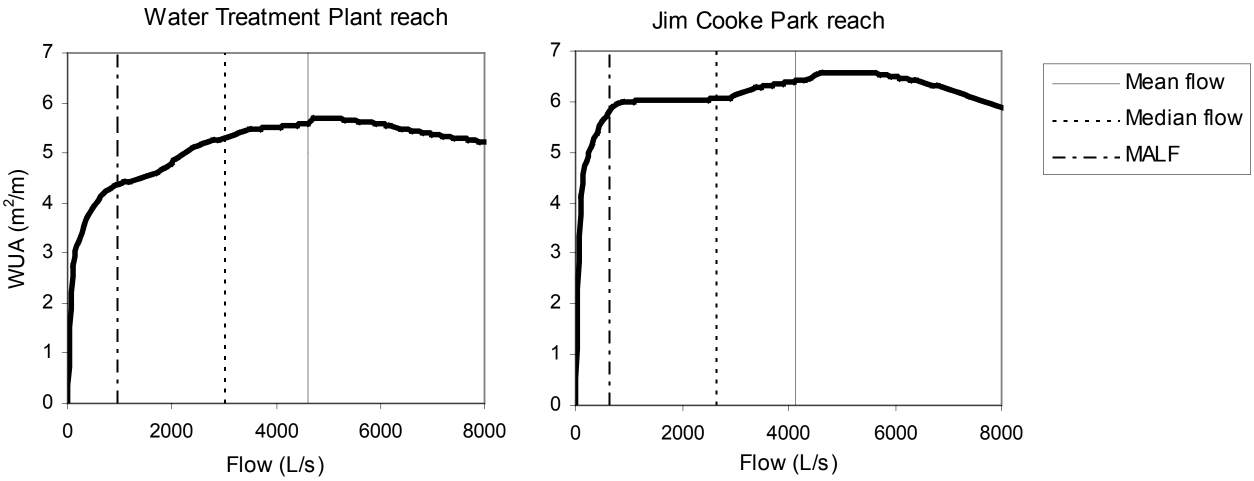
Brown trout fry:



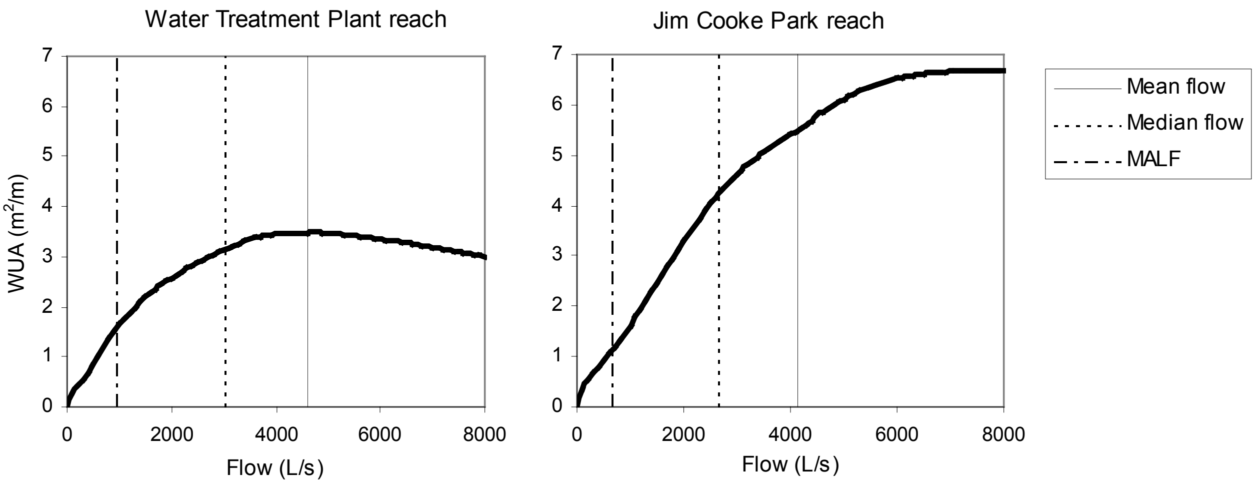
Food-producing habitat:



Longfin eel:



Torrentfish:



Redfin bully: