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REGIONAL COUNCIL

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2009 Tutaekuri River IFIM Discussion Document

Purpose

The primary purpose of this document is to inform on the progress Hawke's Bay Regional Council is making towards adapting Instream Flow Incremental Methodology (IFIM) procedures to Hawke's Bay Rivers and seek stakeholder input prior to finalization of the field survey design. The proposed National Environmental Standards (NES) on Ecological Flows and Water Levels outlines the selection of methods for scientific investigations of minimum flow requirements. For rivers with high instream values, 1D physical habitat modeling (RHYHABSIM) is a recommended analytical method and this document describes the development of the field survey to be used with RHYHABSIM modeling.

Background

Increases in abstraction pressures in the upper Tutaekuri catchment have created the requirement for the implementation of minimum flows and allocation limits for the upper reaches of the river system.

The IFIM process, including physical habitat modeling, has been used across New Zealand and internationally to set minimum flows and allocation limits. This approach incorporates stakeholder input, scientific research, and policy to arrive at management schemes that aim to balance economic viability and environmental sustainability.

A meeting was held between staff from HBRC, Fish and Game, Iwi, and the Department of Conservation to discuss the implementation of the field survey (management objectives, survey location and design, and reach selection). Much discussion centered on the suitability of the modeling package RHYHABSIM. At the conclusion of the meeting agreement was reached to progress with reach selection, habitat mapping and the marking of cross-sections.

2008 Survey

Immediately following the stakeholder meeting, participants from HBRC, Cawthron Institute, Fish and Game NZ, and Department of Conservation chose a total of 29 cross-sections during a field excursion following the stakeholder meeting. These cross-sections included a variety of runs, riffles, and pools in both single-channel and braided sections. During the first run, gaugings, stage height and stage at zero flow (SZF) measurements, and identification of substrate classes for each cross-section were completed. Four successive runs included gaugings at the head of runs and stage height measurements at each cross-section.

The data were entered into RHYHABSIM and checked for formatting and data quality. After completion of field work, data were input into RHYHABSIM and analysed. The model applies ratings to relate stage with flow for each cross-section by means of a best-fit rating curve. The condition of fit is described by the correlation coefficient. In the case of the Tutaekuri data, few ratings were of sufficient quality to continue with modeling, thereby halting progress. Additional field work could not be completed to rectify the ratings problem because a high flow event had rearranged the river bed through much of the reach.

The proper functioning of the RHYHABSIM model depends entirely on the establishment of robust ratings (flow-stage relationships) for each cross-section of the survey. Ratings are affected by both the range of flows surveyed and accurate stage and flow data for each cross-section during each successive gauging run.

Lessons Learned

The selection and adaptation of survey methodology is often an iterative process; identifying deficiencies in procedures and promoting the development of robust science. An internal review of our procedures has shown that the majority of inadequacies of the 2008 survey were related to the planning phase. These are identified as follows:

- There was no identification of a proper minimum flow site with respect to river conditions and existing infrastructure.

- Communication between Environmental Science, Consents, and Policy was not properly facilitated to ensure the river survey was conducted in the most relevant location. This is essential to provide the most useful information from both environmental and consent/compliance perspectives.

- No site visits were conducted to familiarise HBRC staff and stakeholders with the target reaches prior to the survey, and the reach selection was carried out over a matter of hours, rather than a matter of days.

- Gauged flows were not recorded for each cross-section during successive field excursions, but rather at the head of runs where flow appeared to be constant. The nature of the river with respect to gravel size, channel geometry, and stream gradient in the survey location led to significant flow losses and gains from one cross-section to the next. This creates a situation where measured flow at one cross-section cannot be applied to cross-sections further downstream, even those only 50 meters away. This was especially true for cross-sections on small braids.

- The field survey began when the river had already reached the summer low-flow level. Recessions were barely measurable, often within the range of error. This exacerbated the difficulty in obtaining reliable ratings. Even those cross-sections that had measured flow and stage height for each successive gauging run suffered from poor ratings for this reason.

2009 Survey Methodology

The process whereby the 2009 survey has been constructed has focused much effort on pre-survey planning. A thorough review process and established scientific principles have been used to develop a survey designed to maximise robust scientific output, efficiency, and stakeholder buy-in. The design of the 2009 survey has adopted the following rules and considerations:

- Identification of Instream Management Objectives
- Identification of Consent Pressures
- Identification of Existing Infrastructure and River access
- Identification of Minimum Flow Compliance
- Identification of Representative Reaches

Consent Review

The majority of irrigable land in the upper catchment is along the Mangatutu Stream and between the Tutaekuri main stem and the Otakarara Stream. Current consents include two takes from the main stem (25 l/s and 60 l/s), and one consent each on the Mangatutu and Otakarara streams (5 l/s and 25 l/s, respectively). An additional application (70l/s) is soon to be lodged to take from the Otakarara (Figure 1) as well as another application from the Mangatutu (120 l/s). This data allowed an informed decision to be made as to the survey location. Further applications for resource consents are expected to occur until all available allocation has been consented.

Key Field Work Considerations

A river section between the Mangatutu Stream confluence and the Ngaroto climate/gauging site (Figure 1) was identified as a result of pre-survey planning with particular consideration to catchment water takes and hydrological characteristics. A decision was then made to move the survey location downstream for the following reasons:

- Flows from the Mangatutu and Otakarara comprise nearly 1/3 of total streamflow measured at Puketapu. The proposed survey section includes these flow contributions.

- Sustaining rainbow trout habitat has been identified as a key management objective. This section has shown to have increased widths and depths, providing a greater level of trout habitat.

- The predominantly single-channel nature of the river, more stable bed sediments, and increased access are beneficial for the establishment of a minimum flow site.

- The proposed section is predominantly single channel flow, which reduces the complexity of interflow and throughflow within the streambed gravels. This increases the consistency of gauging data within a given reach, which aids in obtaining reliable ratings.

Evaluating habitat below the Otakarara and Mangatutu Streams will take their contribution to total streamflow into account. The management approach for the streams themselves will be accomplished through setting allocation limits, as detailed in the proposed National Environment Standard for Ecological Flows and Water Levels.

Field Survey Design

The objective of instream habitat surveys is to quantify the relationship between available habitat and flow. It is important that the survey location be representative of the river or a critical section of river. A preferred method to cover the range of mesohabitats (runs, riffles, pools) in the survey is through stratified random sampling. This involves identifying the number of strata, or mesohabiat types in the river section, and dividing the river section accordingly. This process is defined as habitat mapping. The strata indentified through the habitat mapping process are then selected by random. The placing of cross sections in the selected strata follows the same process. This allows for a comprehensive survey that is based on observations, but with little or no bias in the selection process.

Habitat mapping was completed by HBRC on 7 November, 2008 for the 11 kilometre section of river from the Mangatutu confluence downstream to Ngaroto Road. For each habitat type (runs, riffles, and pools), the individual length, total habitat length, proportion by type, and proportion of total stream length have been recorded. Data collected has been used to formulate a survey design which is both scientifically robust and practical from a resourcing perspective.

Table 1 Stream statistics by habitat type and recommended number of survey cross-sections based on a total survey of 20 cross-sections. Runs, riffles, and pools comprise the respective order of habitat dominance.

RUN				Survey Cross-sections	
Total Count	Total Length	% Count	% Length	Number based on % Count	Number based on % Length
87	7770	0.47	0.61	9	12
RIFFLE					
Total Count	Total Length	% Count	% Length	Number based on % Count	Number based on % Length
72	4467	0.39	0.35	8	7
POOL					
Total Count	Total Length	% Count	% Length	Number based on % Count	Number based on % Length
27	423	0.15	0.03	3	1

Table 1 shows the proportion of the total number and stream length of each habitat in the study section. Runs make up approximately half of the number of habitat types and account for over 60% of the stream length. Riffles comprise slightly less than 40% in both length and number. Pools make up 15% of the total number and only 3% of the total stream length.

A survey of 20 total cross-sections formed the basis of figures highlighted in Table 1. This is deemed appropriate based on evidence found in Jowet, et al. 2008. Several references were given of surveys where 18-20 cross-sections were able to produce robust WUA functions for streams with diverse habitat (pp. 58, 59).

The number of cross-sections is based on both the proportion of habitat counts (% Count) and the proportion of stream length (% Length). The higher result was used to determine the final number of cross-sections. This allows for both habitat quantity (example: long runs) and quality (example: short pools) to be accounted for in the survey design by using the number of cross-sections based on the higher proportion (count or length). Thus, the final survey recommendation was 12 runs, 8 riffles, and 3 pools, for a total of 23 cross-sections.

Initial field observations and subsequent review of GPS data indicated that the first third of the survey section (downstream of the Mangatutu confluence) exhibits a spatial distribution of habitat types representative of the total survey section. From a resourcing perspective it was also advantageous to focus on a shorter survey reach. The total number of each habitat type within this shorter section was noted. Random numbers were used to select individual habitats according to the predetermined numbers from Table 1.

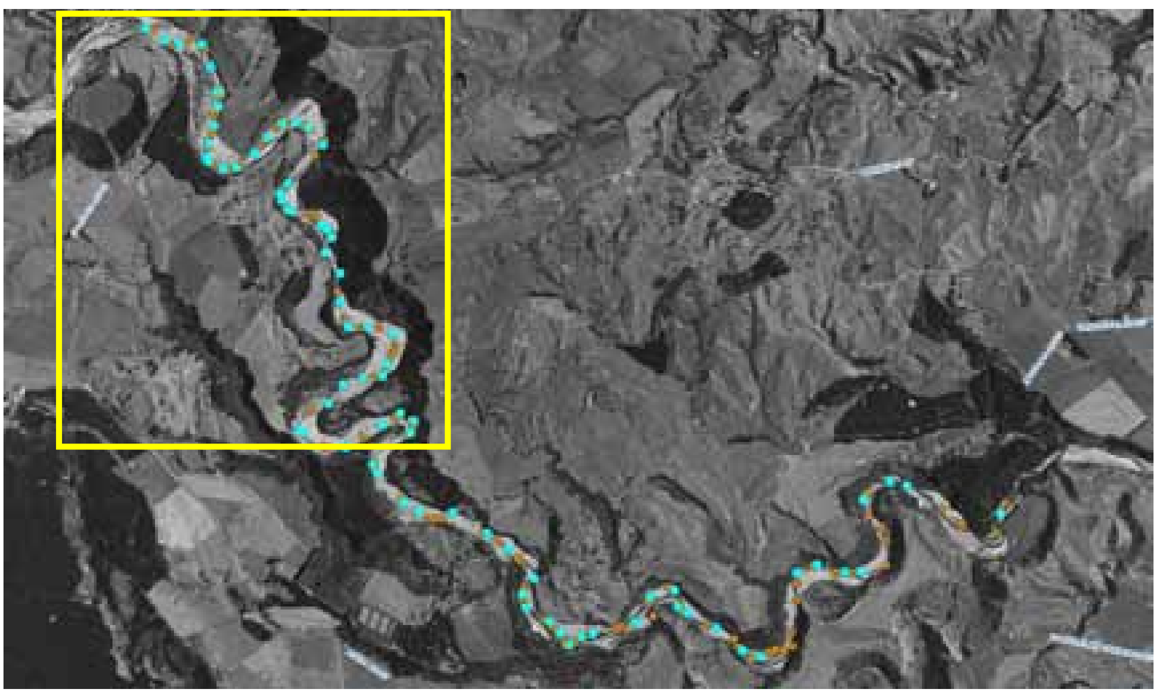

Figure 1: Tutaekuri River from Mangatutu confluence to Ngaroto Road. Blue dots indicate location of runs. Yellow border indicates proposed survey reach.

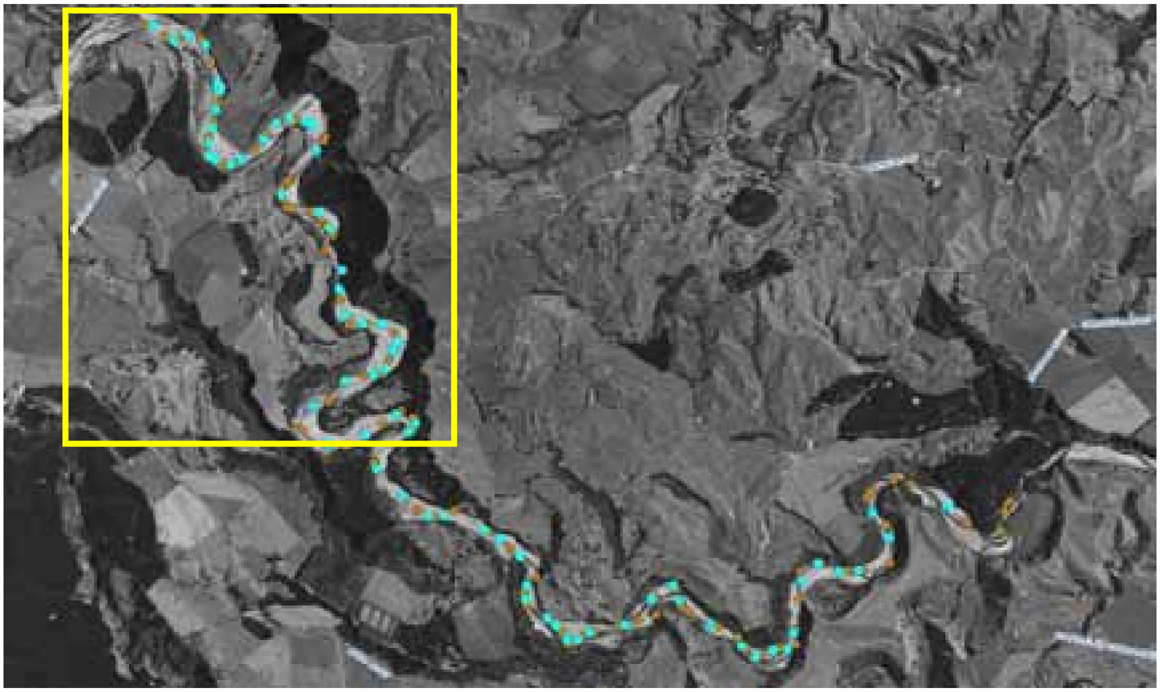

Figure 2: Tutaekuri River from Mangatutu confluence to Ngaroto Road. Blue dots indicate location of riffles. Yellow border indicates proposed survey reach.

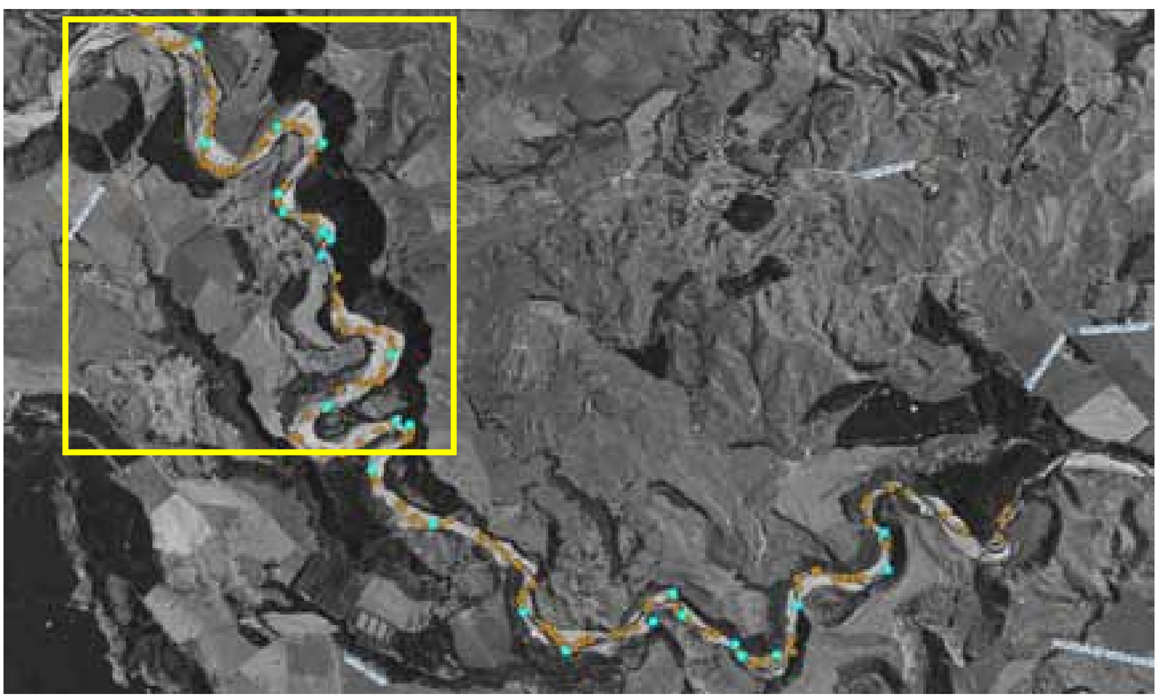

Figure 3: Tutaekuri River from Mangatutu confluence to Ngaroto Road. Blue dots indicate location of pools. Yellow border indicates proposed survey reach.

All run and riffle habitat segments were grouped into 20 meter length classes and their distributions plotted (Figures 4 and 5). Pools were omitted from this exercise as their lengths were consistent throughout the surveyed section (10-20 meters). The lengths of the randomly selected cross-sections were then compared to the original length distributions. The resulting comparison shows that the selected cross-sections cover the range and proportion of size classes found throughout the entire section (Figures 4 and 5). The orange series shows the numbers of cross-sections of each length class selected in the shortened survey reach. The number and distribution of the selected cross-sections reflects the number and distribution of the river section from the Mangatutu confluence to Ngaroto Road. This indicates that the selected cross-sections are representative of the total section of river.

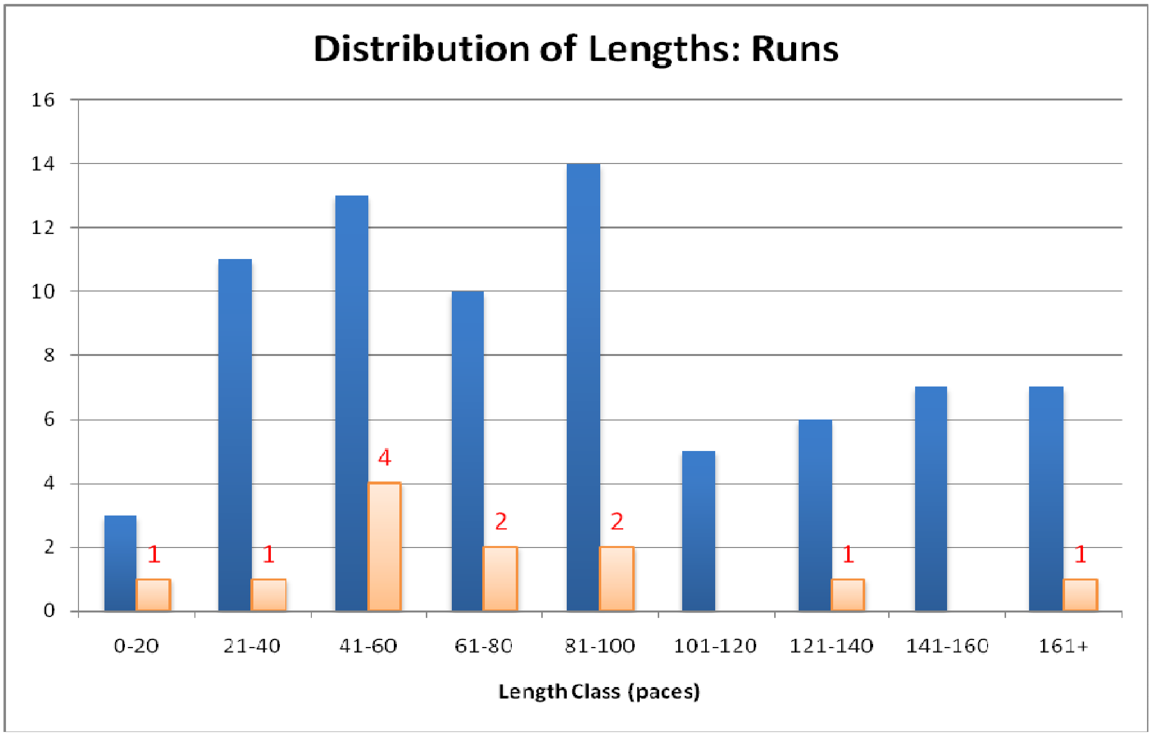

Figure 4: The distribution of run habitat lengths (blue) and number of surveyed riffles (orange) in the river section from the Mangatutu Confluence to Ngaroto Road.

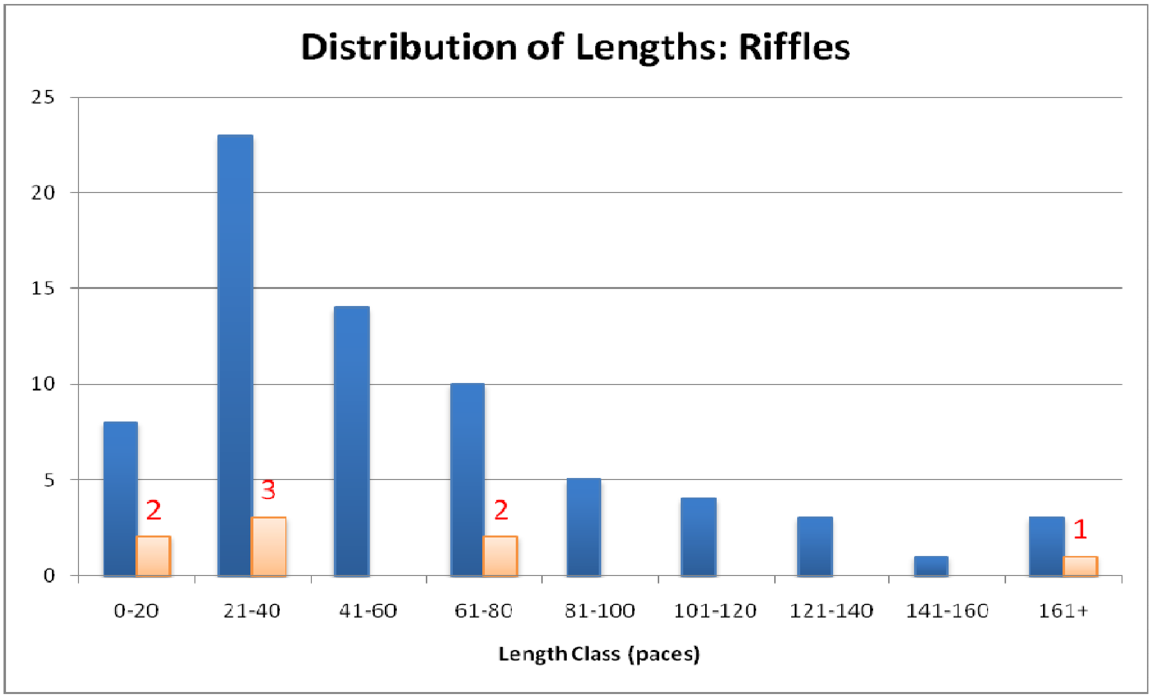

Figure 5: The distribution of riffle habitat lengths (blue) and number of surveyed riffles (orange) in the river section from the Mangatutu Confluence to Ngaroto Road.

Conclusions

The design of the 2009 field survey follows the practices established in the Instream Flow Incremental Methodology. Hawke's Bay Regional Council are confident that the 2009 survey design in scientifically robust, incorporates stakeholder interests, and is practical to implement. It is concluded that:

- The hydraulic and morphological characteristics of the Tutaekuri in the proposed survey reach are conducive to robust model outputs;
- The proposed survey reach is representative of the greater river section;
- Rainbow trout have been identified as a key management objective and the proposed survey location and design maximises the ability of the model to define the habitat-flow relationship of rainbow trout;
- The proposed survey design incorporates the range and distribution of habitat types and the selected number of cross-sections is consistent with modelling requirements and habitat parameters;
- The length of the survey reach and number of selected cross-sections will allow field teams to complete the survey efficiently.

Future Steps

The NES on Ecological Flows and Water Levels recommends that two evaluation methods be used to formulate minimum flow requirements. The application of a second method will be required to be compliant with the NES. Hawke's Bay Regional Council are currently considering additional methods.

The field survey on the Tutaekuri will be followed by RHYHABSIM modelling and interpretation of the results. The interpretations will be used to formulate a minimum flow recommendation for the upper Tutaekuri River. This work is scheduled for peer review by appropriately qualified professionals upon completion.

At the completion of field studies and data analysis, a minimum flow recommendation will be presented to stakeholders. Upon agreement, the new minimum flow will be submitted under a plan change process for inclusion in the HBRC Regional Resource Management Plan.

References

Jowet, I.G., Hayes, J.W., Duncan, M.J., 2008. A guide to instream habitat survey methods and analysis. NIWA Science and Technology Series No. 54