Report on the Usage of SHMAK (Stream Health Monitoring and Assessment Kit) for environmental education purposes

Project Name: Stream Health Monitoring and Assessment Kit

Department: Information

Focus Area: Environmental Education Programmes

Product/Process: Modifications to the assessment kit for environmental education usage.

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1 Introduction

This is an evaluation of SHMAK for environmental education and assessment of 'stream health monitoring' purposes.

1.1. Purpose

This report reviews proposed modifications of the SHMAK, (Stream Health Monitoring and Assessment Kit) which was originally designed by NIWA (National Institute of Water and Atmosphere). In combination with existing stream assessment techniques already provided to school pupils by Taranaki Regional Council, Environmental Education staff. SHMAK provides a more intensive monitoring experience that offers valuable skills to secondary school students in order to understand the procedures that are involved in stream health monitoring. The participation of secondary school students (particularly those already in year 12 and 13), will provide more consistent, long-term results that will add to the data gathered about the health of Taranaki's regional streams and rivers.

1.2. Background

The opportunity was taken to perform a set of SHMAK assessments using the standard kit and also after the addition of the Taranaki Regional Council 'Bugbox' and some other modifications. The additions were made to increase the kit's usability in the Taranaki region and create environmental awareness amongst the younger generation of our society. Seven sites were monitored during January 2006 to test the original SHMAK techniques in comparison to the additional techniques introduced by the author in consultation with TRC staff.

The aquatic invertebrate component has been a major focus in the development of additions to SHMAK. These organisms are valuable indicators for stream health monitoring. Collecting samples of aquatic invertebrates and extending the level of monitoring detail (by carrying out laboratory observations) may provide more reliable results that add to the effectiveness of the original SHMAK method.

2. Methods

2.1. Stream Habitat

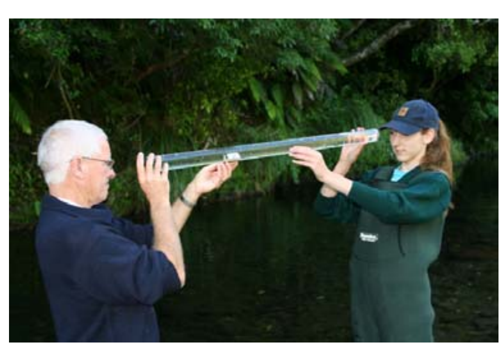
This component of the monitoring system requires the user to produce a habitat score that is used in combination with a biological score and transferred into a 'habitat versus invertebrate' graph to give the overall health condition of a stream. In order to generate a habitat score certain measurements need to be carried out during the field work (Figures 1 and 2). These measurements are listed below:

- water velocity
- water pH
- water temperature
- water conductivity
- water clarity
- composition of the stream bed
- presence and extent of loose, silty deposits on the stream bed
- stream-bank vegetation at the site.

The original version of SHMAK contained two levels of stream health monitoring. The differences between these levels were in the biological sampling methods. Level 1 involved basic observations for presence of macroinvertebrates, while level 2 required counting of the numbers of macroinvertebrates in each sample collected. TRC staff have suggested the introduction of a third level to the SHMAK system to increase the accuracy of biological information. Coincident with the additional level 3 provided for the biological sampling approach, water samples were taken back to the chemistry laboratory for further analysis of pH and conductivity using the calibrated equipment available in the TRC laboratory. In order to prevent changes to the water pH and conductivity from the time the samples were collected from the field, to the time they were measured in the laboratory; extra care was given to the transportation of the samples. As a result of respiration and photosynthesis pH tends to decrease during the night and increase during the day. It is therefore important to note the time of day when surveys are performed. pH values show greater variation during the summer season during which the seven streams were monitored.

Figure 1 Measuring stream velocity

Figure 2 Measuring water clarity



2.2. Stream Habitat Results for Water pH and Conductivity

The survey results from the seven sites are presented in Table 1.

Table 1 Stream water pH and conductivity results, SHMAK monitoring programme January 2006.

					LEVEL 1 and 2	LEVEL 3	LEVEL 1 and 2	LEVEL 3
Date	**Time of day (NZST)**	**Stream/ River**	**Site**	**Site location (GPS)**	**pH measured in the field (SHMAK)**	**pH measured in the laboratory**	**Conductivity measured in the field, (SHMAK) [µSiemens/cm – at 20°C]**	**Conductivity measured in the laboratory, [µSiemens/cm – at 20°C]**
16-01-06	11.30	Te Henui Stream	Baker Rd.	E2603811 N6230377	6.5	7.7	80	86
17-01-06	11.30	Waingongoro River	Eltham Rd.	E2620739 N6196591	7.0	7.6	100	131
17-01-06	13.30	Waingongoro River	Ohawe Beach	E2612577 N6179360	7.0	7.2	160	191
17-01-06	9.30	Waingongoro River	Opunake Rd.	E2615789 N6204278	6.5	8.2	70	100
18-01-06	11.00	Mangaoraka Stream	Corbett Rd.	E2612639 N6238061	7.0	8.1	180	181
18-01-06	9.00	Te Henui Stream	East End	E2604421 N6238659	6.5	7.7	100	100
27-01-06	10.00	Waiokura Steam	Manaia Golf Course	E2607747 N6183760	6.5	7.6	220	228

The additional laboratory measurements have indicated that by using 'Merck Neutralit' pH strips supplied in SHMAK (Figure 4), the results were significantly (lower then laboratory results).The conductivity instrument used in SHMAK (EUTECH Cybernetics TDScan 3) is an acceptable field meter to use (Figure 3) providing that the instrument calibration is checked on a regular basis. The results in Table 1 suggest that the meter was not properly calibrated until the monitoring of 18-01-06 and on average, the reading provided by the probe was about 30 µSiemens/cm lower than the correct –(lab) value. For this type of situation, level 3 stream monitoring becomes more useful.

With water pH and conductivity being corrected in most cases after level 3 monitoring, there is a chance that the habitat score will require adjustment. In this case if all levels of assessment are being carried out, the habitat score in level 1 and 2 will most likely be different to the score in level 3.

Figure 3 Measuring water conductivity with the 'EUTECH Cybernetics TDScan 3' conductivity instrument.

Figure 4 Measuring water pH with 'Merck Neutralit' pH strips.

2.3 Overall Stream Habitat Scores

This table presents the habitat scores produced from the seven sites monitored using the different stream health monitoring levels in SHMAK.

Table 2 SHMAK and level 3 habitat scores.

Date	Stream/River	Site	SHMAK (level 1 & 2)	Level 3
16-01-06	Te Henui Stream	Baker Rd.	87	82
17-01-06	Waingongoro River	Eltham Rd.	75	70
17-01-06	Waingongoro River	Ohawe Beach	69	69
17-01-06	Waingongoro River	Opunake Rd.	88	83
18-01-06	Mangaoraka Stream	Corbett Rd.	66	61
18-01-06	Te Henui Stream	East End	80	75
27-01-06	Waiokura Stream	Manaia Golf Course	50	45

All but one case show that the overall habitat score altered after level 3 water pH measurements that were done in the TRC chemistry laboratory. Stream pH measurements performed in the field were lower than the measurements from calibrated equipment in the laboratory. Using the scaling system available in the SHMAK manual this has reduced the pH score of six of the seven sites assessed, (from water pH score of 10 to 5). As a result, this has reduced the overall habitat score by 5.

Although the water conductivity probe produced reading errors such as the ones on the 17-01-06, this did not change the water conductivity habitat score. The water conductivity scale used in SHMAK, progresses in 50 µSiemens/cm altering the score by 5. Because the largest water conductivity difference recorded was only 30 µSiemens/cm, this did not alter the overall water conductivity score.

3. Biological Sampling

In addition to habitat assessment (section 2.1), SHMAK requires biological (macroinvertebrate and periphyton) surveys. The standard macroinvertebrate sampling techniques used by the original SHMAK Kit have been maintained in level 1 procedures. These techniques include collecting rock samples from the site in an ice cream container (Figure 6) and noting any invertebrates present. However, in the more advanced monitoring programme (levels 2 and 3), I have introduced some of the TRC environmental education methodology (Figure 5). This involved the addition of a Bugbox and the use of a fine mesh collection net (0.5mm) to provide more representative samples for use with the standard kit methods.

The macroinvertebrate samples collected at seven different sites around the Taranaki region were retained for later sorting and identification under a stereomicroscope in the Taranaki Regional Council biology laboratory. It is acknowledged that this may not always suit secondary school students as they may need to do their laboratory assessment on the same day as the samples were collected.

TRC use a scoring system for macroinvertebrate taxa according to their sensitivity to organic pollution in New Zealand stony streams. Highly 'sensitive' taxa were assigned the highest scores of 9 or 10, while the most 'tolerant' taxa scored 1. The three levels used to evaluate SHMAK provided differing biological score calculations. Levels 1 and 2 use SHMAK calculation methods, while level 3 uses the MCI scores developed by TRC.

At the time of the samplings, standard kit techniques and the adaptations were tested simultaneously. It was decided that these adaptations would be divided according to possible time constraints. A Council staff member, (K Archer - Education Officer) and the author collected stream macroinvertebrates from various sites as part of the level 2 monitoring using a method of scrubbing the underside of stones and rocks and the placement of aquatic invertebrates in appropriate compartments in the Bugbox. Identified macroinvertebrates present were counted and recorded on a data form.

In addition the level 2 samples were collected and taken back to the laboratory in order to perform level 3 sorting and identification. Level 3 monitoring requires a level of greater detail in the invertebrate identification aspect of the monitoring programme. The individual Bugbox samples were also taken back to the TRC freshwater laboratory along with a level 2 sample where they were sorted by the author under a stereomicroscope and identifications checked and confirmed by C Fowles (TRC Scientific Officer).

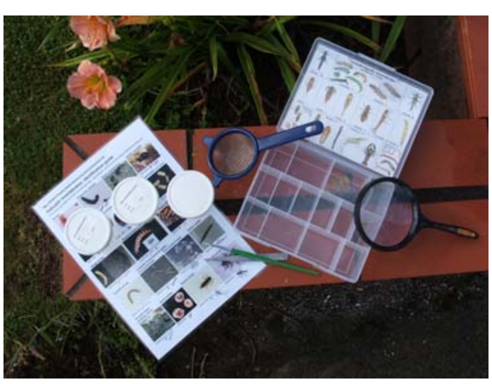


Figure 5 Equipment used in level 2 biological sampling including the Bugbox.

Figure 6 SHMAK biological sampling technique – level 1

3.1. Biological Sampling Results

3.2.1 Macroinvertebrates

The environmental monitoring exercises were performed at seven sites in the Taranaki region. The results of these surveys are presented in the Table 3 below.

Table 3 Aquatic macroinvertebrate results, SHMAK monitoring programme, January 2006.

				LEVEL 1		LEVEL 2	Level 3		
Date	**Stream/ River**	**Site**	**Site location (GPS)**	**SHMAK (basic)**	**SHMAK (basic + counts)**	**TRC Bugbox (counts)**	**TRC Bugbox (+ lab sort/ID/SHMAK scores)**	**TRC Bugbox (+ lab sort/ID/TRC sensitivity score)**	**TRC biodata base**
16-01-06	Te Henui Stream	Baker Rd.	E2603811 N6230377	6.1 [3]	8.8 [3]	7.8 [4]	5.7 [15]	5.1[15]	4.7
17-01-06	Waingongoro River	Eltham Rd.	E2620739 N6196591	8.2 [5]	8.3 [3]	7.0 [6]	5.8 [10]	5.2 [10]	4.7-5.7
17-01-06	Waingongoro River	Ohawe Beach	E2612577 N6179360	5.5 [3]	6.1 [3]	6.7 [6]	5.6 [11]	4.6 [11]	3.5-4.5
17-01-06	Waingongoro River	Opunake Rd.	E2615789 N6204278	7.4 [4]	6.7 [4]	8.6 [7]	6.9 [16]	6.4 [16]	6.0-6.7
18-01-06	Mangaoraka Stream	Corbett Rd.	E2612639 N6238061	4.4 [4]	4.0 [5]	4.7 [8]	4.8 [14]	4.3 [14]	3.8-4.5
18-01-06	Te Henui Stream	East End	E2604421 N6238659	6.5 [2]	4.6 [2]	5.5 [7]	4.2 [11]	3.9 [11]	3.9
27-01-06	Waiokura Steam	Manaia Golf Course	E2607747 N6183760	7.2 [2]	7.2 [2]	7.8 [6]	5.4 [15]	4.9 [15]	4.1-4.9

KEY	
[ ]	No. of invertebrate taxa

Biological sampling modifications made to level 2 have helped to increase the number of invertebrate taxa identified. Referring to one of the sites monitored (Te Henui, Baker Rd), it is evident that invertebrate taxa number identified has been increased from 3 to 15. The largest improvement was in the Waiokura Stream where invertebrate taxa identified increased from (2 to 15) after level 3 biological processing. The Bugbox has improved sorting and counting macroinvertebrates in the field. The addition of level 3 (laboratory sort/ID) increased the number of invertebrate taxa found (Figure 7). This was particularly apparent when smaller species (usually less 'sensitive' taxa) were present. Their size often prevented accurate identification in the field and some were not observed at all. Level 3 provided more accurate interpretation of the actual health condition of these streams and rivers. The level 3 sampling method using TRC sensitivity scores generally provided data in the ranges of historical scores gathered by more intensive sampling and stored in the TRC biodatabase.

Figure 7 Level 3 aquatic invertebrates sorting and identification.

3.2.2 Periphyton

SHMAK biological sampling also requires the examination of rock samples to identify any periphyton present. In level 1, this exercise involves only identification of types of periphyton (Figure 8), while level 2 requires the user not only to identify the type of periphyton present on a sample of a rock, but also to estimate the percentage of coverage. SHMAK has introduced this method to the kit so that the periphyton score can be used in case the invertebrate score indicates that the stream is anything less than moderate.

Figure 8 Periphyton identification guide

4. Stream Health Assessment

Table 4 Comparison of overall stream health using different monitoring levels and scoring system.

Date	Stream/River	Site	Stream/River category	Level 1 (SHMAK basic + counts) overall stream health	Level 2 (TRC Bugbox) overall stream health	Level 3 (using SHMAK scores)	Level 3 (using TRC 'sensitivity ' scores)
16-01-06	Te Henui Stream	Baker Rd.	Stony	Excellent	Good-Very Good	Moderate	Moderate
17-01-06	Waingongoro River	Eltham Rd.	Stony	Excellent	Good-Very Good	Moderate	Moderate
17-01-06	Waingongoro River	Ohawe Beach	Stony	Moderate	Moderate	Moderate	Poor
17-01-06	Waingongoro River	Opunake Rd.	Stony	Good-Very Good	Excellent	Moderate	Moderate
18-01-06	Mangaoraka Stream	Corbett Rd.	Stony	Poor	Poor	Poor	Poor
18-01-06	Te Henui Stream	East End	Stony	Poor	Moderate	Poor	Poor
27-01-06	Waiokura Stream	Manaia Golf Course	Stony/Sandy	Very Good	Very Good	Good	Moderate

The graphs that are used in this kit (see Figure 9) were designed specifically for the SHMAK aquatic invertebrates' sensitivity scores. When the TRC aquatic invertebrates' sensitivity scores were applied to the graph provided by SHMAK, it was apparent that the graph wasn't designed for the individual taxa sensitivity scores used by TRC biologists. It has been decided that level 3 will continue to be practised in the laboratory but only using the sensitivity scores provided by SHMAK. If in the future different users wish to apply their own sensitivity scores with SHMAK, they will need to adjust the graphs' assessments of stream health categories.

Figure 9 Stony/Sandy stream graph – level 3 data.

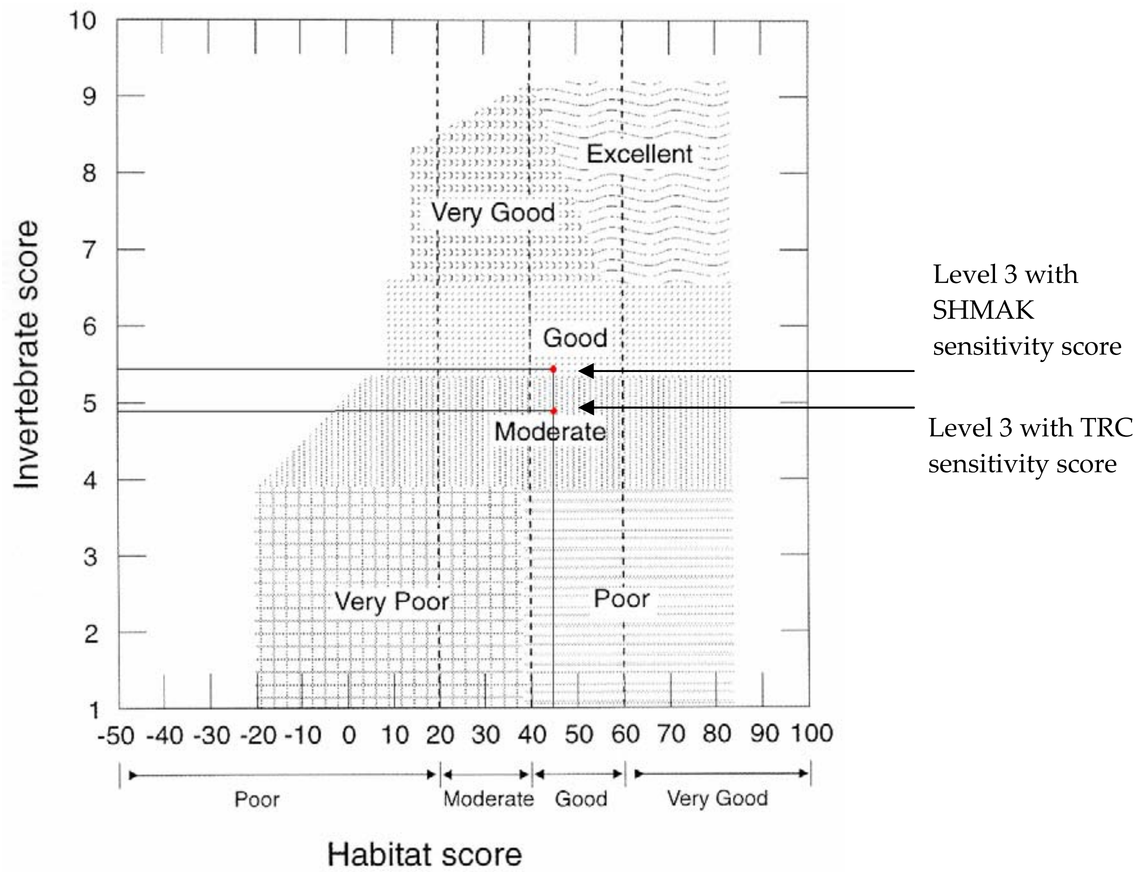


Figure 9 illustrates a 'habitat versus invertebrate' graph provided in the manual. This particular graph is for stony/sandy streams and uses the SHMAK invertebrate sensitivity scores. Habitat and invertebrate scores from the Waiokura Stream are shown on this graph using TRC and SHMAK sensitivity scores. The results show that although the same samples were tested and the same invertebrates were identified in level 3, the SHMAK sensitivity scores totalled 5.4 while TRC sensitivity scores totalled 4.6, (0.8 of a unit less). This has made a difference to the assessment to the overall stream health. The SHMAK scoring system in this instance has classified the stream as 'Good' while TRC sensitivity scores classified the stream as 'Moderate'. In this case if different users use their own sensitivity scores, new graphs will need to be established for each stream category to match the sensitivity scores being applied.

5. Discussion

The New Zealand Stream Monitoring and Assessment Kit has been field tested for its adaptability and usefulness as a stream health monitoring device for use by secondary school pupils. Integration of the SHMAK Kit and TRC's environmental education Bugbox resulted in an effective stream monitoring programme.

This monitoring kit may now be presented to secondary schools as a teaching resource that contains many valuable skills for various school subjects available through National Certificate of Educational Achievements (NCEA). There are many opportunities for cross-curricula linkages through this SHMAK system. From field trips to laboratory sorting/identification and measurements, as well as data interpretation, many benefits can be gained from this monitoring kit.

The addition of a change in the collection of samples and the use of the Bugbox has been an important aspect in this project. The Bugbox provides introductory methods for sampling, field identification (of principal invertebrate groups) and the concept of sensitivity scores. This system of collecting and identifying aquatic invertebrates has been used by primary school pupils in the Taranaki region for over 10 years. As a result many secondary school pupils would already be familiar with this process. Retaining the Bugbox field samples for further laboratory processing (sorting and identification) is a worthwhile exercise providing a more comprehensive taxa list and improving the accuracy of the sensitivity score (for educational or other purposes). The stream monitoring exercise performed in January 2006 at seven different locations around the Taranaki region has shown that the Bugbox samples processed in the laboratory (and subsequently checked by the TRC biologist) improved the taxa number found at these sites and refined the stream health categories assigned to each site.

The level 3 laboratory assessment will make it possible for students to improve biological and non-biological examinations in a laboratory environment where the equipment is more accurate and expertise is available from the Education Officer.

It should be noted that the seven sites utilised in this exercise do not fully represent the variability in macroinvertebrate communities formed across the region. While some TRC sensitive scores produced in level 3 were within the ranges found in the TRC biodatabase, they reflect the results of single reference monitoring surveys.

The graph that is used at the end of the data collecting and calculations is specific to SHMAK methodology. The information required the use of this graph includes the habitat and biological scores. The periphyton score can be used if the graph produced indicates that the health condition of the monitored stream is anything less then moderate. This periphyton score will give the user a little more information about the state of the stream and maybe even improve the score for its final health assessment.

6. Recommendations

It is important not to look at the three levels in SHMAK as completely different activities as they all contribute to the final outcome. Level 1 stream health monitoring has been kept in the original form and follows all the steps proposed by NIWA using the standard SHMAK.

Some changes to SHMAK methodology were applied in the use of the kit at levels 2 and 3. While the field work procedures were being tested, on several occasions different elements were introduced or adjusted. The following list provides the aspects that were found to be important in order to facilitate its usage:

Level 2 – Biological Surveys

- The use of a large, shallow identification tray to replace the ice cream containers used in level 1.
- The use of the TRC Environmental Education Bugbox for identification purposes as additional to the method in level 1 of SHMAK.
- Instead of using a record form provided in the original SHMAK manual, use of the 'TRC Invertebrate Identification Sheet' with visual diagrams for recording, but retaining the SHMAK sensitivity scores.
- The use of a finer diameter net (0.5mm) and a 'scrubbing brush' technique to replace the 'hand washing' method as detailed in SHMAK.
- The addition of a paint brush to assist in transferring macroinvertebrates from a tray sample into the Bugbox.

Level 3 – Biological Surveys

- The inclusion of the laboratory based work; sorting /identification, which would enable a greater range of invertebrates to be included for assessment purposes.
- Large invertebrates in any level 2 samples which can be properly identified at the stream edge (e.g. freshwater crayfish dobsonfly etc) may be placed back in the stream, but must be recorded for inclusion in the level 3 score.

Level 3 – Stream Habitat

- Retaining the water pH and conductivity samples for further measurements at the laboratory.
- SHMAK 'health' assessments should include laboratory processing of 'Bugbox' samples i.e. not be limited to simple field techniques.

Stream bank analysis

- Appropriate site location, recording is essential for exact location of a site. A photograph for later reference is a basic requirement.
- Before this activity is used as part of the assessment, students need to be given tuition and practise in the correct identification of the different categories of vegetation found on the stream banks. Without this, the accuracy of the results would be jeopardised.

Preparation for SHMAK field surveys.

Teachers or supervisors will need to undergo training in the use of SHMAK before introducing the stream health monitoring programme to their pupils and particularly prior to field usage. It is recommended that the revised kit be used by senior students (year 12 and 13) under either the close supervision of a teacher who is conversant with the monitoring programme or the TRC Education Officer, or both, depending on the size of the group. Extension to level 3 usage may be considered at the discretion of the teacher/Education Officer.

This study has indicated that the additional survey levels have been successful in improving the performance of SHMAK. It is recommended that students and teachers consider proceeding with level 3 stream health monitoring whenever possible as field trials have shown that more accurate results have been found proceeding to this level.

7. References

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