Tactics for stretching a waterbug based monitoring program across a continent

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Key Points

- The National Waterbug Blitz will provide a snapshot of the health of waterways nationally
- It uses three tiers of activity, each subsequent level more complicated than the previous, but all compatible, allowing people to contribute to increasingly complex datasets as their experience increases

Abstract

The principle aim of the National Waterbug Blitz (https://waterbugblitz.org.au) is to bring together existing citizen-based water monitoring (e.g. Waterwatch) programs from around Australia and provide them a shared set of aquatic macroinvertebrate (waterbug) identification and waterway assessment resources. Coupled with an annual monitoring event conducted over 2 consecutive years, this is intended to provide a snapshot of the health of waterways nationally. This task is complicated by (a) different states identifying their waterbugs to different taxonomic levels, and (b) different groups of people having different amounts of time that they are prepared to spend volunteering for the program. This paper introduces techniques that have the potential to turn these impediments into data of appropriate quality for assessing waterways, while engaging and educating users.

The National Waterbug Blitz uses three tiers of activity (methods) to collect waterbug data, each subsequent level more complicated than the previous:

1. The mayfly muster will simply identify the presence of Ephemeroptera across the landscape, mapping in detail the boundary around urban areas where water quality is too poor for them to persist.

2. Order-level waterbug assessments, which will be used in several states to generate assessments of waterway health.

3. The Agreed Level Taxonomy (ALT), which is currently used by the Waterwatch program to and will be used for the National Waterbug Blitz to generate assessments of waterway health and teaches users to identify a wide range of different waterbugs. ALT also provides additional information on biodiversity as well as waterway health at a site.

A variety of quality control procedures, implemented and managed through an associated App, will allow novice data to be co-analysed alongside data collected by more experienced waterbug monitoring volunteers, in order to make waterway assessments.

Keywords

Waterbugs, Volunteers, Biomonitoring, Citizen Science, Ecological Health, ALT

Introduction

Biological assessment of fresh water ecosystems has been a long standing subcomponent of citizen science-based water monitoring for the better part of 20 years (Waterwatch Victoria 2018). Fresh water macroinvertebrates (Waterbugs) include all invertebrates in fresh water that can be readily seen with the unaided eye. They are a diverse group, dominated by insects, but with some crustaceans, molluscs and worms. They are effective indicators of the health of fresh water ecosystems because some are known to be intolerant of poor water quality while others can survive in all but the most acutely toxic waters. These tendencies have been formalised for Australian waters through SIGNAL (Stream Invertebrate Grade Number – Average Level) scores (Chessman 2003). Each taxon is scored between 0 (tolerant of poor water quality) and 10 (extremely sensitive to poor water quality). Once averaged across the taxa occurring at a site, SIGNAL scores provide a simple assessment that can be used to rate a site's health. These scores feature in many of the Waterwatch assessments implemented around Australia currently (for example Melbourne Water (2016), Miles et al. (2016), North Central Waterwatch (2016),Upper Murrumbidgee Waterwatch (2017) and Waterwatch Victoria (2018)).

Despite sharing SIGNAL assessments as a method for assessing fresh water ecosystems, there are a number of important differences in the data collected by the different Waterwatch groups across Australia. Mostly they differ in the taxonomic level to which waterbugs are identified (Table 1). This can reflect the availability of scientific experts to help with training, or the levels of effort that volunteers can afford to contribute. Lower taxonomic levels (such as Agreed Level Taxonomy, ALT) require more training and also more time for a site assessment.

Table 1 Current volunteer based monitoring programs from around Australia, with notes on the taxonomic levels used.

Current programs	Taxonomic level used
Upper Murrumbidgee Waterwatch (ACT)	Order level(e.g. the difference between mayflies and stoneflies)
Waterwatch Victoria	ALT (as low as possible with a hand lens, sometimes genus, sometimes order) Order if preferred by volunteers
Melbourne Water Waterwatch	ALT
Streamwatch (NSW)	ALT for stoneflies, mayflies and caddisflies, order for all other taxa
NSW Waterwatch	Order level
North Central Waterwatch (Vic)	ALT
Waterbug Bioblitz in the SA Murray-Darling Basin	as low as practical (often equivalent to ALT)
River Detectives (schools program - Vic)	Order level

Taxonomic levels used for identification

Agreed Level Taxonomy

The method of waterbug identification at the heart of the National Waterbug Blitz, and The Waterbug App (The Waterbug Company Pty Ltd (2016)) uses keys that were tested on Waterwatch volunteers to determine what waterbug characters could be reliably seen by people with limited training and a hand lens (15x magnification). The resulting taxonomic levels (agreed levels) are a mixture from Phylum (Nematomorpha for example) to species (*Physa acuta* - the introduced snail). These staggered taxonomic levels are not uncommon in professional ecological data sets and fit well with the concept of taxonomic sufficiency (Ellis (1985)).

All ALT level data can be readily converted to order level data and can also contribute to *The Mayfly Muster*.

Waterbugs at order level and the River Detectives Program

Order level identifications are often the simplest to complete in the field as they occur at a taxonomic level that matches well with the differences people see when they initially sit down with a tray of bugs and try to identify them. Most people will recognise a water beetle (order Coleoptera, Figure 1, left) or a mayfly nymph (order Ephemeroptera, Figure 1, right) and will readily distinguish them from one another. Waterwatch has traditionally had strong links with schools, and the order level identification presents a task that fits well within science curricula or STEM (science, technology, engineering and mathematics) activities. Younger groups learn about biodiversity and taxonomy, and older groups learn using the lists of animals to perform SIGNAL-style environmental site assessments. The River Detectives Program (North Central CMA 2017) maintains these educational links by being incorporated into The Waterbug App.

All order level data can contribute to *The Mayfly Muster*.

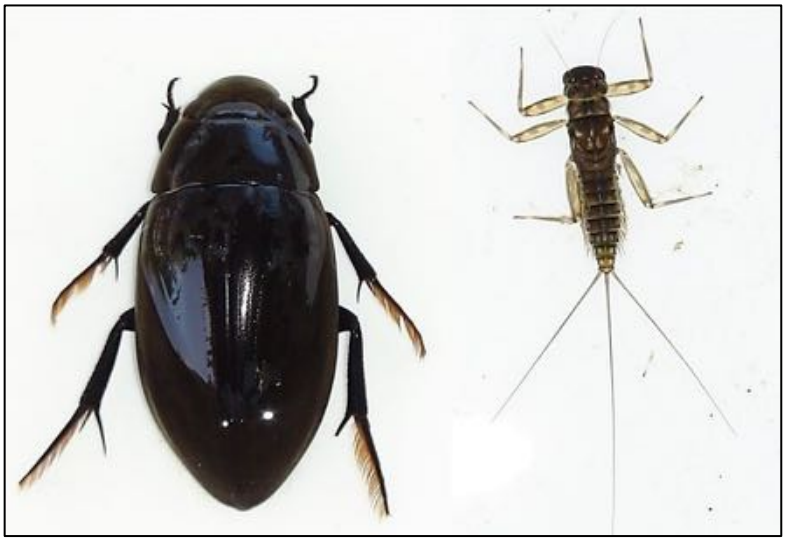

Figure 1 Two waterbugs readily recognised at order level. A water beetle (order Coleoptera), left and a mayfly nymph (order Ephemeroptera), right.

The Mayfly Muster

Mayflies are iconic animals that are as familiar to recreational fly fishers as they are to Waterwatch volunteers. This popularity makes them an ideal subject for rapid surveys in fresh water habitats. As a group of animals they are extremely sensitive to pollution (Hynes 1960), to the extent that their distribution neatly maps the edges of anthropogenic impact (see Figure 2).

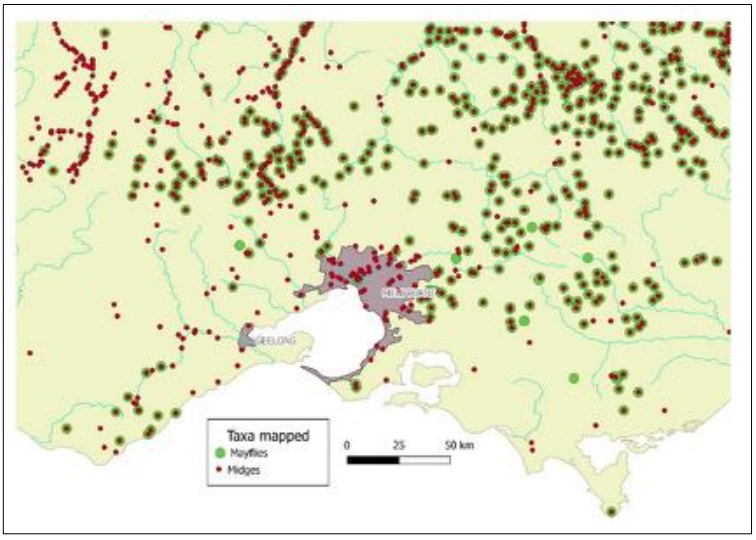

Figure 2 Data from the Atlas of Living Australia showing sites where Mayflies (family: Leptophlebiidae) and Midges (family: Chironomidae) occur around Melbourne, Victoria. Mayflies are sensitive to poor water quality while Midges are not. The Midge distribution has been included as a surrogate demonstrating sites where people have looked at waterbugs but not found mayflies.

Taxonomy, experience, learning and effort

Citizen science programs are often forced to choose between running intensive programs that require extensive training of volunteers, or programs that can be executed by people with minimal or no training and can therefore enlist larger numbers of volunteers (Nerbonne and Nelson 2008). The National Waterbug Blitz will attempt to circumvent this problem by offering volunteers both options. Each citizen scientist will decide on the method they will follow based on their current levels of experience with waterbug identification, or on how much effort they are able to offer on the day they participate. Volunteers can start with the simpler methods during the first National event in spring 2018 when it is anticipated that a variety of training resources will be available, and change to complete more in-depth assessments in subsequent years. This acknowledges that even in areas where the data is being collected at order level, some of the volunteers will be interested in learning more.

The Waterbug App (Figure 3, The Waterbug Company Pty Ltd (2016)) and the ALT keys (Gooderham et al. (2017)) use easily recognisable characters including colour and movement to simplify the identification process. They are also intentionally designed with steps within the keying process where people can opt out, but still complete an identification that will helpfully contribute to a site assessment. For example, on the way to identifying a head-banger caddis (genus *Notalina*), there will be a point where the user has successfully identified the animal as:

1. not a mayfly (useful for The Mayfly Muster)
2. a caddisfly (order level ID- Trichoptera)

3. a cased caddisfly (River Detectives distinguish the cased from the non-cased)
4. a leptocerid caddisfly (family Leptoceridae)
5. a head-banger caddis (genus *Notalina*)

With the exception of the uppermost level (1 above), each of these nested identifications is usable for generating a site assessment using a SIGNAL score.

Figure 3 The Waterbug App provides several different ways of identifying waterbugs for those participating in The National Waterbug Blitz.

In order for the National Waterbug Blitz to be relevant for existing citizen science programs it needs to be able to provide them with identification resources that are compatible with their current methods. In the Australian Capital Territory (ACT), waterbugs are identified to order level, and contribute to biennial reporting (Upper Murrumbidgee Waterwatch (2017)). The Waterbug App will maintain this taxonomic level for their data, but give volunteers the option to go further if they are interested. The order level identifications (described below) are relatively swift to complete in the field, and this allows the volunteers to visit a large number of sites (229 in the 2016-17 surveys). The order level has also been assessed as accurate and fit for purpose by an independent scientific review (Harrison et al. 2013).

In the North Central region of Victoria, the Native Fish Recovery Plan is using Waterwatch volunteers and ALT level assessments to monitor habitat rehabilitation in several rivers (North Central Waterwatch 2016). These groups have required extensive training, and are providing data that is at a taxonomic level matched to their specific monitoring project and checked as relevant through a pilot study.

One of the more challenging parts of The Mayfly Muster will be getting people to record absences.

Data quality

The value of waterbug data collected by volunteers has been scrutinized extensively and found to be acceptable when training and quality control measures are in place (Firehock and West 1995, Fore et al. 2001, Engel and Voshell 2002, Harrison et al. 2013, Reid et al. 2016, Storey et al. 2016). Training and accreditation already exists for ALT identifications, and is embodied in a “belt” system similar to those used in martial arts(Gooderham 2014). Volunteers who achieve green belt can submit data to the National Waterbug Blitz without peer-review. Blue belts can grade other volunteers and assign green belt status.

The Waterbug App provides a further level of quality assurance / quality control (QA/QC) in that photographs of each of the waterbugs identified must be submitted along with each sample for identification verification. This will help confirm identifications for unaccredited users (so their data can still be used), and allow accredited users to continue being assessed remotely through their identifications and the associated images stored in each sample.

Conclusions

The National Waterbug Blitz (https://waterbugblitz.org.au) intends to generate nationwide data sets that describe and infer waterway health from the presence (or absence) of taxa of waterbugs. By using existing networks of experienced volunteers we can maintain existing monitoring activity throughout Australia, improving their data by providing an app that streamlines data collection and also introduces several QA/QC components to strengthen data confidence. By adopting a flexible approach to waterbug identification, data can be submitted through the App at a number of different taxonomic levels, some serviceable with no training (the Mayfly Muster), some with limited training (the Order Level and River Detective components), and others through relatively intense training and accreditation as part of the ALT program. The resulting dataset is hierarchical, provides detailed assessments for those who require them (for example, in areas assessing management actions such as in-stream habitat rehabilitation), and less detailed, but more geographically broad summaries of ecological health that can be used to target areas for further study or report on temporal and spatial trends in waterway health.

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https://biocache.ala.org.au/occurrences/search?andq=lsid%3Aurn%3Alsid%3Abiodiversity.org.au%3Aafd.taxon%3Aed04029e-d352-4c7a-b7d6-b23c583edde8 *accessed on Thu April 26 09:46:11 AEST 2018.*

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