Detecting cease to flow events in streams using time lapse photography

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Key Points

- Detecting cease-to-flow events in small streams is difficult using traditional stream gauging methods
- Time lapse photography was effective for detecting cease-to-flow events
- The use of cameras reduced time required in the field (reduced costs and improved safety).
- Photographic series provide a useful communication tool for explaining stream flow impacts.

Keywords

streamflow, hydrographic methods, cease-to-flow, time-lapse photography

Introduction

Under the Victorian Water Act 1989, Melbourne Water are responsible for managing the taking of surface water from rivers, creeks and dams in various catchments. This water is used for a variety of agricultural, industrial, commercial and domestic purposes. As managers of these Water Supply Protection Areas (WSPA), Melbourne Water seeks to balance water supply and water demand whilst ensuring healthy waterways.

Stream Flow Management Plans (SFMPs) have been developed for each of Melbourne Water's WSPAs. These SFMPs document the ways in which water will be managed to ensure it is shared fairly between diverters and the environment. Part of the SFMP defines stream flow requirements for ecological values in the streams.

Melbourne Water sought to understand the effectiveness of existing SFMPs to manage the impact of licensed water diversions on environmental flows in tributaries within the Yarra River catchment. The SFMPs for these subcatchments apply a minimum passing flow trigger to stopping diversions. The trigger is based on environmental flow recommendations, and is measured at gauging stations located at key downstream nodes in the subcatchment.

The overall aim of the environmental flow recommendations is the maintenance of connectivity and inundation of instream habitat along the waterways (Sinclair Knight Merz, 2005; Sharpe & Woodman, 2013). The environmental flow recommendations related to low flows are aimed at preventing cease-to-flow events, and have been calculated based on hydraulic modelling of water depth. Consequently, it is expected that if the environmental flows comply with the recommendations during the low flow period then the channel will remain connected and aquatic habitat will be protected.

However, these gauging stations may not reflect the conditions in lower-order streams. The headwaters and small tributaries with diversion sites are at risk of being "sucked dry" while the flow at gauging station is maintained by flow from the remainder of the stream network.

Melbourne Water implemented a monitoring program to validate whether the critical environmental flow requirements for key ecological values are protected by the current SFMP. The cease-to-flow component of the program is aimed at validating the low flow recommendations, and test if the SFMP cease-to-divert trigger levels are effective maintaining aquatic habitat at various locations across the sub-catchment by preventing the stream from drying out.

Selection of a technique to detect cease-to-flow event

There are a number of possible techniques, both direct and indirect, that can be used to determine a cease-to-flow event. Ideally a technique which can be deployed at multiple sites throughout the catchment to accurately determine cease-to-flow events, and in which the data could be remotely accessed or logged for subsequent analysis may offer advantages of cost efficiency. Detecting cease-to-flow using traditional hydrographic methods (e.g. v-notch weirs, and water level meters) was not considered suitable for these small streams, due to the poor sensitivity of these methods at low flows, and the amount of site disturbance required during installation. Other indirect methods considered for detecting the presence/absence of water relied on water quality sensors becoming exposed to air. However, these methods required placement in the path of lowest flow, which was considered unreliable in irregular and dynamic streambed sediments.

It was recognized that photographic method could record the presence or absence of water across the cross section of dynamic stream bed substrate. Time lapse and movement triggered photography has been used in fauna surveys for a number of years, and this application for the monitoring of flow in waterways provides the same key benefits of reduced requirement for personnel to work in the field. This provides cost benefits, but also improves workplace safety through minimising the time people need to work in or around water. Photographs of streams are also easily analysed and provide a useful communication tool for explaining stream flow impacts.

The method selected used programmable field cameras installed above or beside the channel, programmed to take photos of the stream showing the water levels on a daily basis (Figure 1). The photos provided a record of the changes in wetted areas in the channel, with the intent of identifying if and when the stream dries up. The cameras were aimed at the area of the waterway that was considered most likely to dry up during a low flow period (i.e. shallow riffle areas, or similar hydraulic controls).

Cameras used were Reconyx Hyperfire HC500 or HC600 (2 megapixel 72dpi image), or a UOV UV564HD (2.5 megagpixel, 180dpi). In daylight conditions the cameras took a colour image, whereas in low light conditions, (such as under dense canopy or on overcast weather) the images were monochrome with either a white light or infrared flash (depending on the camera model). Cameras were either mounted on trees or exisiting structures. If a monitoring site was exposed to public access, a lockable security housing was installed to protect the equipment from theft or vandalism – the loss of images and subsequent loss of monitoring data was considered greater potential cost than the loss of the equipment itself.

The cameras were installed in at the start of summer, low flow season. As the equipment had not been used before, the cameras were revisited after approximately 1 week to check they were aimed correctly, confirm images were usable, and to re-aim the camera if required. A 32GB SD card was installed in each camera, and with 12 rechargeable NiMH batteries, the cameras were left deployed to take one photograph per day. The cameras were then re-visited after approximately 6 weeks to download the images and change over batteries. Cameras were retrieved at the end of the low-flow season, once the autumn/winter rainfalls had commenced.

Figure 1. Examples of field based cameras to capture in situ flow levels

Analysis of Results

Photographs collected were reviewed to determine the occurrence and durations of any cease-to-flow event during the monitoring period. As the photographs are date and time stamped, the analyses simply involve viewing each photograph to see if the channel was dry. Some example photographs that demonstrate a small stream in which flow stopped and then returned are presented in Figure 2.

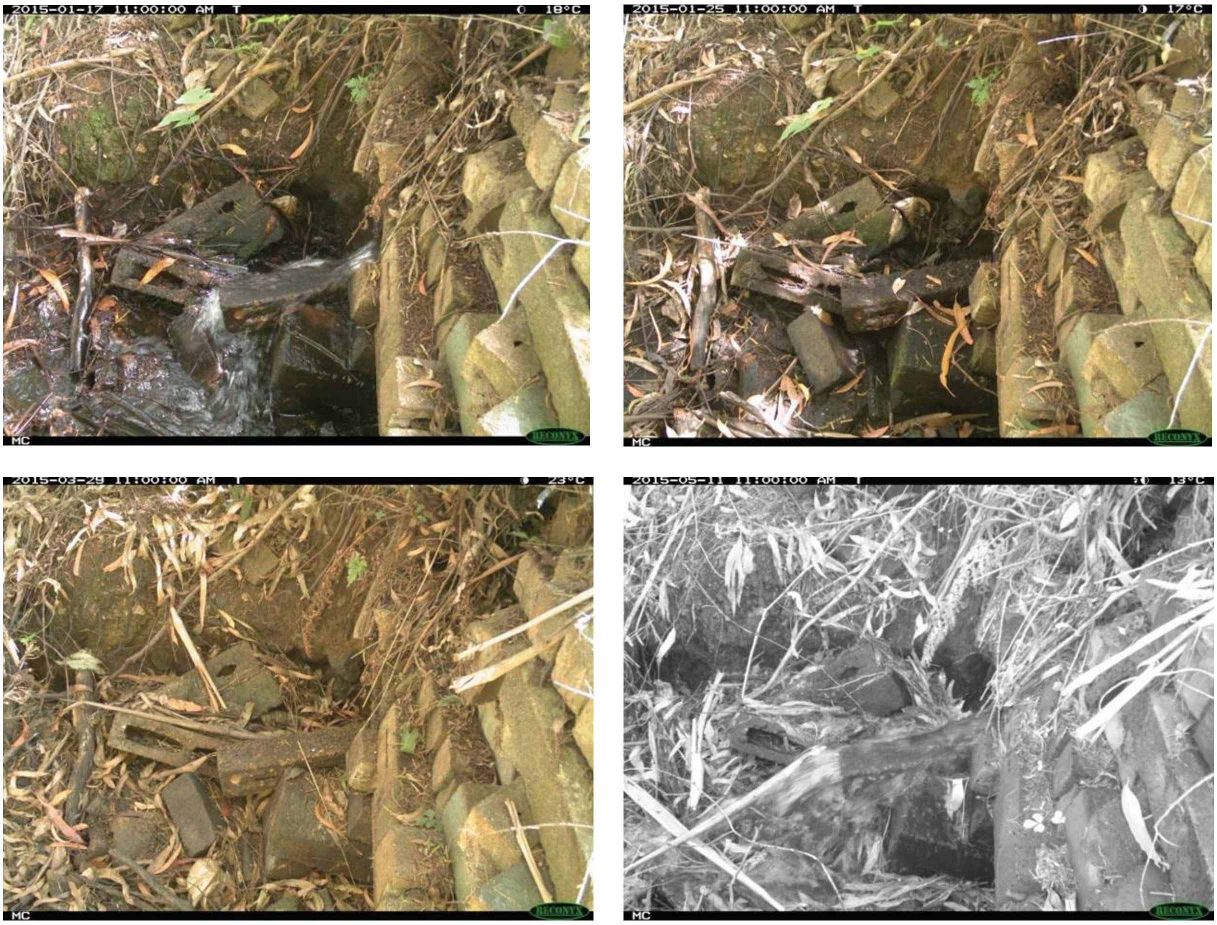

Figure 2. Examples of time-lapse photographs showing flow, cease-to-flow and return of flow at one site.

The purpose of this cease-to-flow monitoring was not only to detect cease-to-flow events, but to determine if the SFMP cease-to-divert trigger levels protect the critical flow component across the sub-catchment. Of the six sites monitored, the cameras clearly recorded cease-to-flow at one site, and demonstrated variable but continual flow at other sites. During this monitoring period, flow at the gauging station persisted, so the lack of flow from this tributary did not trigger diversions to stop. Thus, this monitoring method was able to confirm that the SFMP cease-to-divert trigger values did protect flow at most lower order streams. However, this method for measuring flow provides evidence that protecting flow conditions required for maintaining ecological values in the upper catchment streams may require some smaller scale objectives, particularly for diversion licenses located on unnamed tributaries in forested gullies.

Benefits and Further Applications

Following the application of time-lapse photography for monitoring low flows, the technique has been used to monitor high flows, during a managed environmental flow release from Upper Yarra Reservoir. A study into the inundation of bank vegetation during the flow event used time-lapse cameras to records the degree of overbank inundation and extent of habitat engaged. The ability to collect site condition information at multiple locations during a prolonged period to capture the rise and fall of the flow event was particularly useful. The enhanced safety aspect was particularly significant when monitoring high flow releases that would otherwise be too dangerous to enter.

Time-lapse photography has also been used for a similar project investigating the engagement of river channels bypassed by tunnels (Figure 3). The cameras were deployed at locations that would confirm whether the bypassed river channel received river flows during a high flow event. The photographic series were compared against the relevant river flow hydrograph, which enabled a determination of the flow required to engage the channel. The use of cameras reduced the time required in the field otherwise required to install flow monitoring equipment sufficiently sensitive to detect range of flow conditions cease-to-flow.

Figure 3. Examples of time-lapse photography for channel engagement monitoring.

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