Junee-Florentine (JF) Dye Tracing Extravaganza

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THE Southern Tasmanian Caverneers (STC) are in the midst of a very large and complex dye tracing exercise in the Junee-Florentine (JF) karst region in Tasmania.

I guess you'd say I'm spearheading the effort. Despite being within easy reach of a day trip from Hobart, the area contains one of the largest hydrologically connected cave systems in Australia, and contains almost all of the ten deepest caves in the country. The caving is cold, hard and frequently miserable, but as a result, the potential for new discoveries is excellent.

A good deal of historical dye tracing work has already been completed, establishing key flow paths between many significant caves, however most of these used mechanical (dyed spores and nets) or chemical (dye and charcoal detectors) methods. Some years ago, Petr Smejkal had some success with electronic detectors he'd built, and some years later I took up the torch with the support of TFM Engineering Australia. More than 200 days of Melbourne lockdown turned out to be an excellent opportunity for research and development, and a family of prototype devices was officially released into the wild in the summer of 2019-20.

Historically, a 'more, the merrier' approach to dye releasing was taken; however, in the long and arduous process of gaining a formal research permit from Tasmania Parks and Wildlife, this was obviously not cool. Turning pristine Tasmanian rivers green is to be avoided at all costs. Even pictures of green rivers on social media are best avoided.

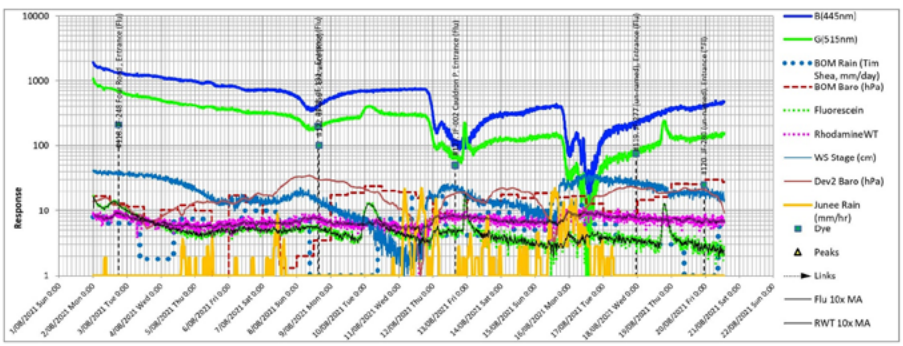
Fortunately, the detectors are extremely sensitive to fluorescent tracing dyes including fluorescein and rhodamine WT, so with some due diligence we can keep resurgences well below visual thresholds. The Tasmanian EPA were also kind enough to provide us with guidelines on dye levels in drinking water and for the environment, and the dyes used are obviously chosen for their lack of environmental impact.

STEPHEN FORDYCE

Pax releases a carefully calculated amount of fluorescein in Sesame

The detectors are, to be honest, pretty awesome, beyond even my optimistic expectations, with a detection threshold in the order of 10 parts per trillion or better. In summer conditions (approx. 1000 L/s), a release of 10 g of fluorescein powder at Growling Swallet is easily detectable at the Junee River resurgence, some 10 km away as the crow flies. A recent dye trace saw 20 g (100 mL solution) of Rhodamine WT detectable in winter flood conditions (approx. 3000 L/s). Historically, kilograms of dye were used for this trace. As a rule, we aim for dye levels to be visually undetectable at Junee (there is a 5 km gap between the last Niggly detector and the Junee resurgence).

As the detectors take a reading every 10 minutes, they provide information on flow time, dilution and peak shape, as well as temperature and water level, opening the door to a whole series of detailed analysis of water flow and cave characteristics. It has been interesting to see how the peaks differ with the different types of inflow — for example, a dye release into a small tributary at the extents of the catchment in summer took ten days to travel to Junee and made a dye peak three days wide. A repeat trace in winter had two days travel time and a six-hour-wide peak. A winter dye release in Owl Pot showed two distinct peaks on reaching Niggly, indicating that multiple flow paths were in play. Of course, the most useful thing about this is that a detector can record many dye peaks across a single deployment. A dye peak may also go past



Example detector results

STEPHEN FORDYCE

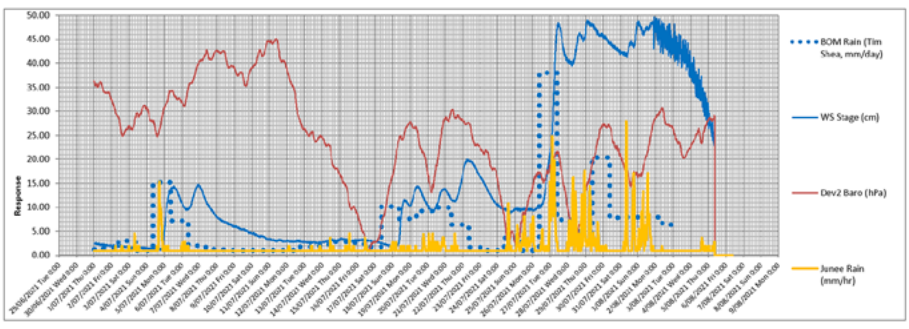
Nice clean devices — but not for long

multiple detectors — as many as eight with the current deployment —allowing detailed study of how it changes with distance and cave characteristics.

Electronic detectors already exist; however, they are prohibitively expensive, such that most dye traces use only a single detector. Those that I have developed are cheaper, so many can be deployed at once, to create a comprehensive net for a series of dye releases. In fact, where previous studies traced only key inflows, we have managed to trace almost every swallet and sink known in the area. The family of devices includes dye detectors, stage loggers, weather stations, and automatic dye releasers. The last are particularly useful for keeping dye releases several days apart to prevent interference. A single day of setup and another of collection can achieve as many dye releases as you have devices for. The weather stations are useful at cave entrances for recording rainfall to correlate with water level data and in caves for normalising water depth readings. We know from flood marks that some areas of Niggly flood to 20+ m and Growling Swallet to 35+ m. As they record atmospheric pressure, draught can be extrapolated and studied (an anemometer version is in the works too).

OXANA REPINA

Reconfiguring a dye dispenser in the field

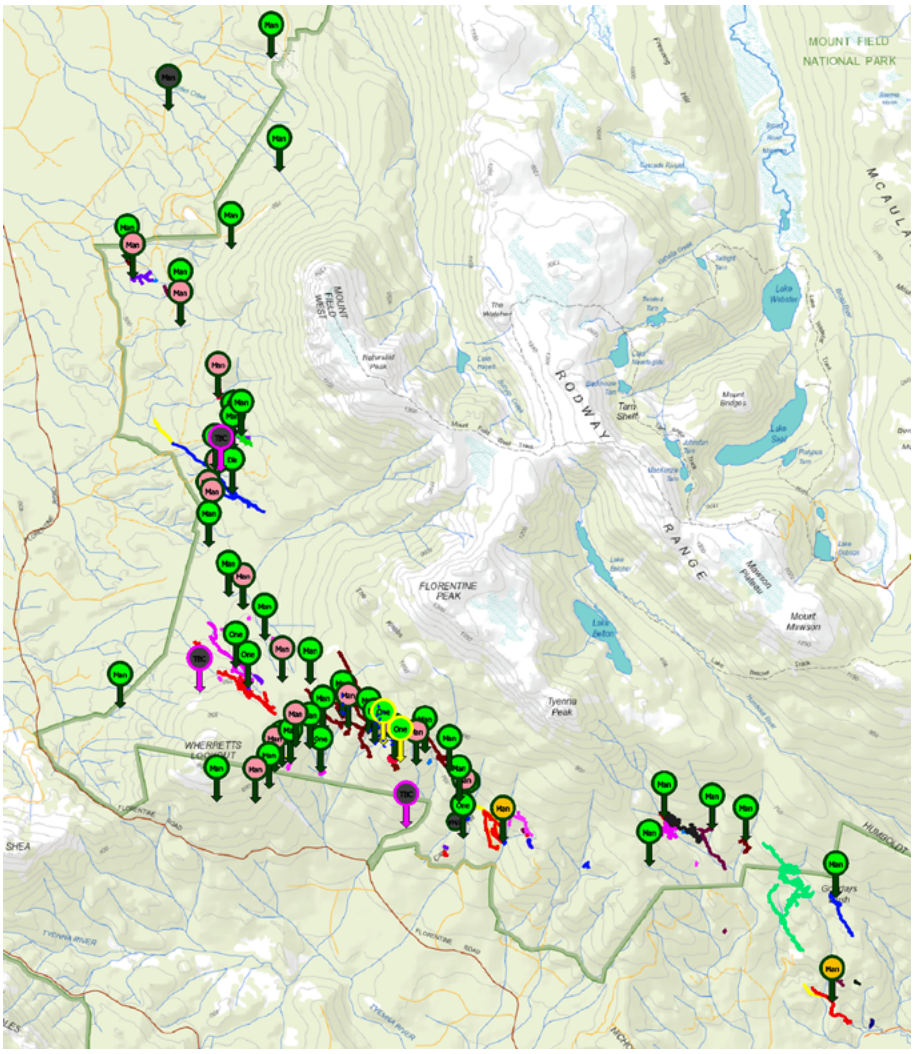


Junee River (at carpark) stage and weather data for 1st July to 9th August

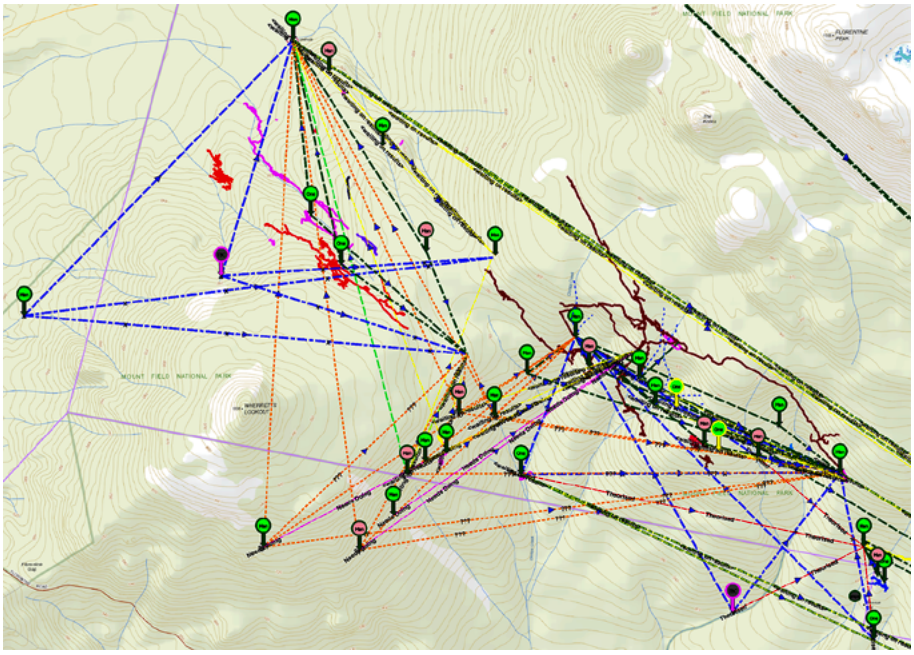
In case you're not impressed yet, I had better rattle off the current population: five detectors and three weather stations in Niggly Cave; two detectors and two stage loggers in Growling Swallet; four detectors and a weather station in Porcupine Pot; two detectors, two weather stations and a phone for results reporting at Junee Cave. Plus a detector in Lawrence River Rising and a few expended dye release devices up near Tachycardia. I haven't misplaced one yet, but it is a serious possibility. Most of these were placed in May 2021, with a few back in January and February 2021 (the longest verified deployment to date is about six months). They were configured to stop high power detection on 1st September 2021, and revert to water level only logging on 1st January 2022. There should then be enough battery power left to continue logging until the end of 2022 in the event of another global pandemic…

In a spectacular club-wide effort, we have done 129 dye releases since December 2020. This is all the more ridiculous when you consider that to avoid interference, generally only one lot of each dye can be released each day. Big thanks to everyone who has put up with my beggings to make a small or large detour or a dedicated trip. Results are updated in the shared QGIS project as I get to it. I hope you will agree it's been worth it. I dare say the dataset will be analysed in various ways for decades to come. Please contact me if you have interest, ideas or a spare research assistant.

A subject for another article is the use of QGIS to display cave data. The learning curve for this is steep, but lockdown weekends were a good opportunity to wean myself off Google Earth and into this much more powerful program, otherwise known as the free and open-source version of ArcGIS. All the JF cave data in the STC archive has been translated and configured to show up in QGIS, which can even be used on our Android phones in the field. LiDAR/topo/satellite background, cave locations using a



Dye releases to 25th August (green outline is completed, magenta - yet to be done, yellow — TBC by device)



Some delicious, automatically generated graphical carnage in QGIS

spreadsheet master, survey overlays, roads, cave routes, points of interest, surface walking breadcrumbs, etc. It is still a work in progress, but at some point soon I will make a sample package ready to share and be populated for other areas, so watch that space or feel free to hassle me.

But I digress… the point of all that was that the increasingly huge dye tracing dataset is also integrated to allow geographic visualisation of the myriad devices, traces and context in the grand scheme of things. Device deployments, dye releases and links between the two are recorded in spreadsheet registers, which generate CSV files for selection and display in QGIS.

The current state of play has all the planned dye releases completed, although extra data points are always useful, and a nervous wait until everything can be retrieved and the data extracted in summer and with open borders. I've been having a bit of a break from full-on detector work to catch up on life this lockdown, so while I've been keeping the ball rolling, things like commercial rollout/sales, another batch and what on earth to actually do with the huge dataset have been on the backburner.

If you have a potential dye tracing project, and/or would be interested in buying some kit, please feel free to let me know. There isn't much in the way of spare devices at the moment, but there should be a few kicking around once the current batch is retrieved.

DAN MKITCHELL

Oxana and Nina prepping Oneshot dye release devices