NZASE resource

Environmental DNA

NZASE Science Communicator Mike Stone explains environmental DNA, including tools schools have used with their students.

Television programmes like *CSI* show us that whenever a person enters a room they leave behind traces of evidence that forensic scientists can find and analyse. A key piece of all this evidence is DNA, left in blood, urine, semen, sweat, and shed skin cells.

Plants and animals also leave behind a trail of DNA wherever they go, called environmental DNA (eDNA). Genetic material from animals is left in saliva, fur, faeces, shed skin, carcasses and even breath in water, soil, ice cores and air. Plants, too, leave traces of DNA in roots, leaves, fruit and pollen.

The public has become more aware of eDNA recently through <u>wastewater testing for Covid-</u><u>19</u> and Dunedin geneticist Professor Neil Gemmell's <u>hunt for the Loch Ness Monster</u>.

Other uses of eDNA

eDNA allows us to monitor organisms without collecting or even seeing them – so it costs little. Species that are invasive, hard to find, or endangered can be detected without stressing them.

A major use of eDNA is to detect and identify species that could influence conservation efforts, such as a rare species that needs protecting, or an invasive pest that needs eradicating.

Scientists can use eDNA to identify which predator killed a protected species. The body is swabbed in wounds, damp patches (potential saliva), and under claws if it fought back. And because DNA is unique to each organism, results can be used to identify not only the species of predator but the particular animal involved. Knowing which species can help tailor control strategies, and knowing which individual can lead to prosecutions.

However, the corpse needs to be fresh as DNA degrades over time, and once scavengers and decomposers start feeding, their DNA will cloud the picture.

eDNA, though, only identifies what is there – the biodiversity – but nothing about numbers, sex ratios, or health, so it works best supplementing traditional studies.

One of Neil Gemmell's PhD students is cleverly

investigating the use of eDNA found in filter-feeding sponges to collect information about the biodiversity of their environment.

Wilderlab and schools

Christoph Zink at Fiordland College is sampling eDNA with his Year 10 students. The school has monitored the health of nearby streams for several years. In 2016 they "wanted to beef up the junior programme and make it more relevant," explains Christoph. With the support of the Kids Restore the Kepler project, they established a stream study course. Students use <u>SHMAK kits</u> to test the stream's chemical and biological health.

More recently they have also joined the Wai Tuwhera o te Taiao / Open Waters Aotearoa program. This project uses the <u>kits and eDNA</u> <u>testing facilities of Wilderlab</u>. The country's only eDNA testing lab has developed tools and processes to make eDNA testing accessible to schools and community groups, as well as by DoC, the Environmental Protection Authority, and the primary sector. The kits are simple and straightforward to use and data can be pro-

NZASE New Zealand Association of Science Educators



Free NZ.

Te Waihora/

Ellesmere.

Earth. (See

Google

page 3.)

Lake



galaxias (Galaxias gollumoides). a length of 18cm, are found only in

Gollum cessed within 24 hours to give a measure of biodiversity and a health rating for an ecosystem.

Using these tools, students compared the health of two streams, one draining bush in which can Fiordland National Park and one in farmland, grow to for assessment. Both the SHMAK kit and eDNA testing gave a measure of the streams' health. "which corresponded nicely", says Christoph.

Students also found a species previously Aotearoa. unknown in this stream. "We knew about the koaro (a fish in the bush stream) and the longfin eels (in the farm stream), but what we didn't know was that Galaxias gollumoides, a very special and at risk native fish, is found so close to Te Anau," said education co-ordinator Alessandra Menegatti.

> Last year in English, students also wrote articles to upload to a webpage and to use for their internal assessment. Posts on Meet the Locals show careful crafting as students discuss Kepler, the Kepler area and some of the species they have found.

Christoph says, "the beauty of this project is that students are not focusing on highly visible takahē or kiwi, but looking at organisms they are hardly aware are there. It gives them a new perspective on their local environment."

Wilderlab and iwi

Emily Bailey works in the Maru Wai Matara project of a local charitable trust, monitoring the health of the streams flowing from Taranaki Maunga to the sea. The focus is on action training, resourcing and mentoring Taranaki hapū and marae to monitor, restore and manage their waterways and mahinga kai sources, with support from tamariki in a local kura.

They use SHMAK kits to collect biological, physical and chemical data, as well as other fauna and flora surveys. The trust also uses Wilderlab eDNA kits to monitor streams on Māoriowned farms, and other community sites.

The eDNA results confirmed the presence of taonga ika species and indicated trout species formerly unknown here, but also showed no

sign of the banded kokopu previously found in the area. There was also evidence that tuna were repopulating a section of the river devastated by a factory chemical spill in the last year. "This opportunity is of great help to our many kaitiaki taiao from hapū and iwi, to help us identify, protect and restore native biodiversity here in Taranaki," Emily said.



Wilderlab & House of Science Kit

Equipment for testing eDNA, Wilderlab.

House of Science (HoS) has a kit called Who's Been There? which explores eDNA. It includes several activities that help primary children grasp a basic understanding of DNA structure and function, and extend that to eDNA traces. Vivienne Hoeta from Te Kura Kaupapa Māori o Ngāti Rangi recently used the kit with year 1-5 students. Hers is a rural school with only 12 students this year.

Vivienne valued many things about this kit. "All the resources are in te reo Māori as well as English, so I don't have to translate it, which saves time. The teacher's guides scaffold the activities - the teacher aide found it very easy to follow the guide step by step with her new entrants."

She liked the way the activities encouraged Te Aho Matua, critical thinking, which is a focus for the school. A Year 5 student made the connection: "So that's why we have to wash our hiking boots!" Others asked "what are Rangi and Papa's DNA?" A kuia came in to talk about te ao Māori and to this question she replied "science will fit with us, not us fit with science."

Vivienne found her students were engaged by the resources and keen to do science. "Māori have always been scientists and this





has ignited a love for the subject – 'are we doing science now?' The activities resulted in lively discussions that took the class off in many directions."

Vivienne appreciated the way HoS made the kits accessi-

Te Puke ble for her school, saying "They matched us up Primary School sampling stream. Photo: Karen

with two other small rural schools in the region, students so we can afford the kits, share the \$400." As part of this unit she organised a number *their local* of field trips that were unfortunately cancelled due to bad weather: with iwi to monitor whio and pekapeka; with DoC to find out about Scott. forest predators; and water sampling to find eDNA in the local stream.

Karen Scott, then teaching at Te Puke Primary School, trialled this kit during its development stage with her Y5 and 6 students. She did all the activities, which culminated in students going out to collect water samples from a local stream.

They used a syringe to push the water through a filter which was then posted to Wilderlab. Scientists analysed the data and posted it on their interactive map for the school to access. This citizen science project told them much about the organisms in their stream.

Processing eDNA samples. Photo: Murray Broom.

DNA iTech

Murray Broom, with a grant from Callaghan Innovation, has developed tools and pro-



cesses to sample eDNA with schools.

In 2020 he worked with teachers and students of Haeata Community Campus to sample the waters of Te Waihora / Lake Ellesmere. This large shallow lake is a major region of mahinga kai, and an important source of mana for Ngāi Tahu, but for many years its health has been in serious decline.

The school has 70 percent Māori and Pasifika students and each day students select what they want to learn about. Thirteen students chose to work with Murray and two teachers, Brittany Coutts and Morgan Bowen, on this project for two weeks. This mixed group included students from Years 11-13 and they each worked to collect and analyse data for an assessed investigation. They met with organisations collaborating to manage the wetland, learning about the different perspectives and histories with the taonga.

On a field trip to Te Waihora, students sampled 13 tributaries to the lake and took them back to the lab. They filtered the water then extracted the DNA, analysing it on the DANiTech instruments, using a smartphone as the analytical interface. They measured levels of E. coli and toxin-secreting cyano-bacteria, showing the impact of intensive farming. Some students used spectrophotometers to find a correlation between high levels of these organisms and water cloudiness. After writing up the results, there was a broad-ranging discussion on the implications of what they found.

Sources

Science news for students: DNA in air, 2022; eDNA explainer, 2018.

Wikipedia, 2022, Environmental DNA. Environmental Protection Authority, 2022, Te Whenua Tomuri Trust trains kaitiaki in eDNA sampling.

Marjorie Cook, 2021, Gollum galaxias hidey-hole revealed near Te Anau, Southland App. DNAiTech, 2020, Curious Minds Project report.

Ngā Kupu

Atua – Deity, supernatural, ancestor Kaitiaki taiao - Caretakers, guardians of the enviroronment Koaro – small, spotted freshwater fish Mahinga kai - Food gathering place Pekapeka – Bat Taonga ika – Treasured fish species Te Aho Matua – Philosophical base for Kura Kaupapa Māori education Tuna – Eel Whio – Blue duck.

From Te Aka Maori Dictionary



