Scholar Report

Name:	Amarni Newman
Faculty:	Biological Sciences
Email address:	Bs22ajn@leeds.ac.uk
Title of Scholarship Project:	The impact of temperature on the consumption rates of invasive Narrow-clawed crayfish and Signal crayfish

If I am honest, when I was given my project title, I had little idea of what to expect. Invasion science? Aquatics? These ecological concepts are far from the cellular and molecular biology I usually study. The idea of not knowing the first thing about ecology left me feeling lost and inadequate. As I sat at my desk ruminating in all the ways I would look a fool to my supervisor and peers, I glanced up at my books, my eyes landing on the marine biology book I use to practise drawing. I had always been very interested in marine biology, but thought it was probably an out of reach goal. And yet, here I sat with the offer to dip my toes into what could be the beginning of a fulfilling career in the field I have loved from afar. Apprehension turned to excitement. New skills, new experiences, new opportunities were unfolding before me, and they were all in the shape of a crayfish.

The Project

Background

Invasive species are a threat to the environment and the surrounding communities (Lodge *et al*, 2012). They are often introduced to native habitats by human intervention, such as using them as a pest control (Madzivanzira *et al*, 2020; Gherardi, 2007). Invasive freshwater crayfish are of particular concern due to their presence worldwide. Freshwater ecosystems are already under pressure from climate change (Kouba *et al*, 2021) and are thus highly vulnerable. Invasive crayfish species compete with native analogues as well as other species, such as birds and fish, for resources, causing a decline in biodiversity. This can affect local communities that rely on freshwater bodies for their income or sources of protein. For example, studies conducted in Kenyan rivers found that the invasive red swamp crayfish (*Procambarus clarkii)* competed with the native crab species, leading to smaller sizes within the native populations (Jackson *et al,* 2016). This led to the invader becoming the primary protein source of the river otter, demonstrating how the invasive crayfish can insert itself into trophic levels.

Concerningly, the invasive crayfish can insert itself into multiple trophic levels due to its omnivorous diet (Madzivanzira *et al*, 2020). A key part of the crayfish diet is foliage, leading to a shredding behaviour (Madzivanzira *et al*, 2020). This

behaviour has two negative impacts; firstly, it speeds up the degradation process and disrupts nutrient cycling. This affects water quality. Secondly, by consuming leaf material, the invaders are competing directly and indirectly with other species.

My project aimed to quantify the rate of leaf consumption of the Narrow-clawed crayfish (*Pontastacus leptodactylus*), which is found in some parts of the UK, and compare with the results of the more well-studied Signal crayfish *(Pacifastacus leniusculus)* to determine a relative impact potential. This research will be used to advise on how to manage current invasive populations in unused reservoirs in Yorkshire to prevent further spread and mitigate a biosecurity hazard if the reservoir is put in use.

In the lab

To begin, my supervisor organised a meeting with the rest of her students. It gave me a chance to learn about the wider context of the research, as well as learn the basics of ecology that I was so worried about not knowing. I was grateful to help master's student, James Hodson, with his own experiments before starting my own. I learned how to manage lab animals, how to set up tanks with water lines, and how to properly clean-up to avoid a biosecurity breech. All this knowledge was invaluable to a student only dealing with unicellular organisms in the lab. After only a few days of working together, we developed a smooth rhythm, picking up slack where the other had gotten distracted with another task. We worked efficiently and happily, listening to music, talking about life, and during the truly monotonous task of sifting through mud to sort macroinvertebrates (insects, to you and me), we watched a film together. I could not have asked for a better introduction to the lab and felt highly encouraged in my teamworking skills. Eventually, James' data collection was finished, and it was time that I started my own experiments by myself.

In practise, consumption rate experiments are easy to set up and run. Before the experiment, individual crayfish were measured and weighed before being placed in experimental tanks for a 24-hour period prior to the experiment to standardise hunger levels. In the meantime, the leaves used in the experiment had to be conditioned in water for 24 hours beforehand. After those 24 hours, a standard mass of leaves was added to the experimental tanks containing a crayfish and left for another 24 hours. Once the experiment time was over, crayfish were removed so that leaves could be collected, and reweighed. Finally, the leaves were dried in an oven for a 24-hour period and weighed once again to obtain a 'dry' mass. It is easy enough to perform these experimental runs, but there were a few issues along the way.

With one full run of the experiment taking 72 hours to complete, it was not easy to plan out two runs within a single week. Therefore, I had to be considerate about timings and multitasking to maximise the data I could collect in a single week by overlapping experimental runs. This was aided by the fact that the tanks were in two temperature-controlled rooms. Therefore, I had an obvious divide in experiments during the week. Another issue was with obtaining an accurate wet leaf mass after the experiment. Before weighing wet leaves, the

excess water must be squeezed out, however there is no way of knowing how much water had been removed. Luckily this was not going to alter my results significantly because the dry leaf mass was used as the most accurate results, since the drying process had a standardised duration and temperature.

Another task I had to complete in the lab was collecting data for a wet-dry regression curve for the mass of leaves. This would allow me to correlate the mass of wet leaves with their mass when dry, which was essential for data analysis. I decided to do this as my first independent task in the lab, but later realised that most of the data was not usable. For some inexplicable reason, I decided that I would not bother setting a suitable upper and lower bound for my masses, and thus ended up with values far higher than was expected. This only became evident when trying to make sense of my data, to discover that I had gained more leaf mass after adding them to the crayfish tanks! As you can imagine, I was much more careful the second time.

The data collection process was quite smooth sailing, just slow – especially when the tanks needed a water change, which was every 3 experiments. But once it was over, it was time for the task I dreaded most; data analysis.

Data analysis

Let it be known that I am no mathematician. The task of analysing data seemed insurmountable, mostly because I was not too sure of where to begin. I had read the experimental paper multiple times, racking my brain over the calculations given and the graphs I needed to produce.

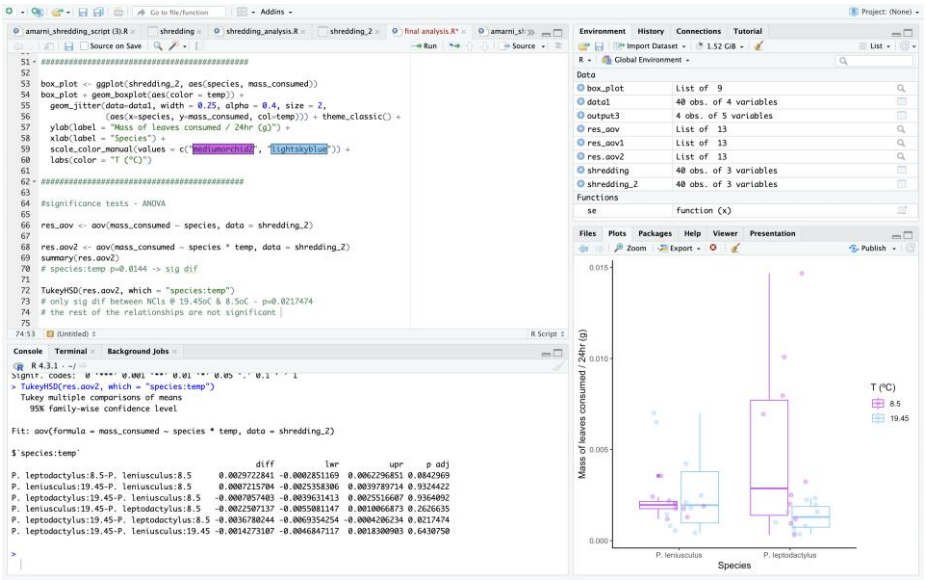
Not only were the graphs a daunting task for me, but the significance testing was also going to truly test me. I remember my Statistics for Biological Sciences lectures, but I had not yet used any of that knowledge in practise. For those unfamiliar with significance tests, they are essentially a handy way of determining whether your data sets are different in any meaningful way – i.e., did variables change the results, or was it chance?

Luckily for me, I would have the guidance of my supervisor for this final stretch of the project. After my final week of data collection, I was almost relieved that I would be trying a new task instead of the same lab tasks I have been doing for 5 weeks. My supervisor kindly showed me a coding programme, called R, which is used for data analysis and visualisation.

After our short meeting, I was largely left to figure out the code by myself. It was daunting at first, but my supervisor had left me with some basic graph outlines to play with, which made the learning process a lot easier. Slowly but

surely, I figured out how to produce the graphs I was looking for, as well as the statistical tests I needed to perform.

This was a highly rewarding part of my project. Not only did I learn a new skill that I was initially afraid of, but I watched a summer's worth of work all come together into a neat graph that has real world impact and can be communicated to the public.



Field Work

One of my favourite experiences working in the aquatic's lab was the field work I completed with other students. It was a two-day affair, with the aim of setting traps for crayfish and collecting macroinvertebrates for a fellow student's research.

The first day, I arrived woefully unprepared. Having just moved house, I had misplaced my jacket. If there is a god, they have a wicked sense of humour, because the rain was torrential. That did not stop be from enjoying the day though. We were in a beautiful part of Yorkshire, jumping in and out of the river, setting traps, and all the while being educated about the world around us by my supervisor. It was a long and wet day, but without being able to change circumstances, I decided it was better to stay positive and enjoy the experience.

The second day was a gorgeous day to collect the traps. We had little luck catching crayfish, but that does not mean the traps were empty. My supervisor, knee deep in the water, gently pulled a small brown trout from the trap and beckoned us over to see. Have you ever had an epiphany before? If you have, you will know they are always in the strangest, smallest moments of your life.

Mine was right now, looking at this small fish and its little pink spots. Was this my calling? Was I meant to be an aquatic scientist? I practically leaped into the water at the chance of holding this fish. I have never wanted to hold a fish more in my life. And I cannot lie, it felt pretty good. In my attempt to be gentle, the little trout slipped out of my hands and disappeared into the murky water, leaving me changed forever.

On this second day, we also visited the Boshaw reservoir where there are reports of the invasive Narrow-clawed crayfish. We had the privilege of meeting a fish scientist, who showed us some tech used to ID and track fish. Essentially small chips are placed in the fish which are read by cables that produce a magnetic field in the water. Later, he would visit our lab where we had the chance to experiment with placing these chips into the crayfish for tracking purposes.

Final thoughts and the future

My research experience has been the single most eye-opening experience in my life so far, giving me skills in lab maintenance, teamworking and experimental practise. I have gained confidence in teamwork and in working through problems on my own. I believe I managed my time effectively, with a few hiccups, which ultimately allowed me to learn and improve. I am thankful for the space and time I have been given to explore my weaknesses and strengths in the lab, as well as deepen my passion for a biological field I thought was not accessible to me.

I know I still have a lot to improve upon, but I now have a clearer idea of what exactly those things are. Although my communication skills have vastly improved, I find I only express what I find essential, whereas I should aim to converse more with my peers and supervisors. Although I am curious, in conversation I tend to be narrow-minded, forgetting to ask questions, and share experiences outside of the work in front of us. I believe this will come with more exposure in work settings. I would also like to improve my data analysis skills as this was the most challenging aspect of my project, considering I had little to no experience with this skill.

As of writing, I have applied to present a poster of my research at the BES Annual Conference 2023 in Belfast, which would be an incredible opportunity to debut my science career, and network with other experts across the country. I am very eager to broaden my interests at this event.

So, what about the future? Well, this experience has left me uncertain about my career goals. I would love to pursue a PhD, but in what field? Do I want to pursue microbiology, as my degree trains me to do, or do I want to push to join the world of aquatic and marine biology? Perhaps I do not have to choose. Marine microbiology is a thing, right? My next move will be exploring year in

industry options for my third year of my degree programme. I am currently very intrigued by experiencing more field work.

No matter the outcome, I know that this summer will be in the forefront of my mind for years to come, having been the beginning of my career in STEM. I am grateful to everyone who made this possible; Lord Laidlaw, the Laidlaw team at the University of Leeds, my lovely supervisor, Dr. Josie South, and my various lab mates throughout the summer. You have all impacted the trajectory of my life, and I thank you all deeply for that.

References

Gherardi, F. (2007) 'Understanding the impact of invasive crayfish', *Biological invaders in inland waters: Profiles, distribution, and threats*, pp. 507–542. doi:10.1007/978-1-4020-6029-8_28.

Jackson, M.C. *et al.* (2016) 'Dietary niche constriction when invaders meet natives: Evidence from freshwater decapods', *Journal of Animal Ecology*, 85(4), pp. 1098–1107. doi:10.1111/1365- 2656.12533.

Kouba, A. *et al.* (2021) 'Identifying economic costs and knowledge gaps of invasive aquatic crustaceans', *Science of The Total Environment*, 813, p. 152325. doi:10.1016/j.scitotenv.2021.152325.

Lodge, D.M. *et al.* (2012) 'Global introductions of crayfishes: Evaluating the impact of species invasions on ecosystem services', *Annual Review of Ecology, Evolution, and Systematics*, 43(1), pp. 449–472. doi:10.1146/annurev-ecolsys-111511-103919.

Madzivanzira, T.C., Weyl, O.L. and South, J. (2020) 'Ecological and potential socioeconomic impacts of two globally-invasive crayfish', *NeoBiota*, 72, pp. 25–43. doi:10.3897/neobiota.72.71868.

Supervisor

For the past two months or so, Amarni has fully integrated herself within the both the lab group, the broader lab groups projects, as well as her own project itself. It has been genuinely a delight having Amarni as part of the group, and I am particularly hopeful that she will stay involved in the research that she has contributed to and the group, past the Laidlaw Scholarship period. Often, undergraduate students are cautious and reserved about asking questions, clarifying issues, and getting their hands dirty in the lab – on the other hand, Amarni seems to have used this to her benefit and gone straight in the deep end and risen to the challenge. Amarni has shown excellent problem-solving skills, teamwork, and practical aptitude in both the lab and field – both being situations often out of people's comfort zones. In field teams particularly, the

days can be physically tiring, uncomfortable and extremely long, Amarni was consistently upbeat and an invaluable member of the team. In the lab, she was essentially left to figure out how she was going to complete her experiments with minimal supervision from myself. I have been very impressed with her ability to take initiative and was very happy to see how her confidence and excitement regarding the project and broader topics has grown considerably. The work produced is of publication quality, and will be published alongside the Masters project work Amarni assisted with and presented at the British Ecological Society. This is a huge achievement, and I'm extremely proud of the work undertaken, especially as this is something that Amarni can truly own as her own achievement. Having recently gone over some basics in data analysis and R programming with Amarni, I suspect that this will be something that she turns her hand to mastering soon in order to explore her own data. I expect to see Amarni progress extremely well in research and team environments, and hope that this has been a fulfilling endeavour and experience in ecological research.

Dr Josie South, 

Signature of Scholar ___  _____ Date:_20__/_09__/_2023___

Signature of Project Leader ____  _____Date: _18___/_09___/_2023___