**The impact of ghost nets on marine wildlife in the UK**

*Dr James Brown & Dr Simon Oliver, University of Chester*

*Dr Richard Walker Global Underwater Explorers (GUE) and Ghost Fishing UK*

Ghost nets are fishing nets that have been abandoned, lost or otherwise discarded in the ocean. The United Nations estimates that 640,000 metric tons of ghost nets are generated by fisheries across the globe each year. These nets linger in the water for a considerable time before they break-up. During this time they continue to trap and kill wildlife that encounter them. Although various studies have assessed the negative effects that ghost nets have on marine organisms, very few investigations have explored the impacts that factors such as net type, mesh size, time at sea, location and depth have on the species that become entangled in them.

This project aims to recover ghost nets from around the UK (in collaboration with Ghost Fishing UK) and determine the catch rates and composition of species caught in the nets to make predictions of the threat that lost fishing gear presents to UK marine wildlife. Findings will inform fishers and fisheries management of the potential impacts of gear loss and the importance of recovering lost nets.

The ideal candidate will have experience with identifying UK marine taxa and be willing and able to join crews aboard fishing and recreational dive vessels for field sampling over the course of the study. There will be an optional opportunity for the candidate to become certified as a SCUBA diver with Global Underwater Explorers (GUE) and use the skill set that they accrue in the certification process to collect *in situ* video data for the project.

The successful candidate will gain essential work experience in marine taxonomy, marine field techniques, and complementary statistical analyses, and will enhance their teamwork and communication skills. Should the candidate choose to become certified as a GUE SCUBA diver, there will also be an opportunity to develop scientific diving, underwater videography and video transect skills.

Additional costs to support this project may be required up to a maximum of £2000 (specific final cost will be confirmed and agreed prior to acceptance on the course).

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**Is the buzz worth it: Investigating acute and chronic physiological effects of caffeine usage in commercial production systems on bumblebees**

*Dr Jordan Ryder, Dr James Brown & Dr Candice Owen, University of Chester*

Pollination is an important ecosystem service, allowing for the reproduction of most wild and commercial flowering plant species. Recent studies have shown that bees will preferentially forage on flowers when exposed to both the odour of and an actual caffeine stimulant, with caffeine-treated bees making more initial visits to odour-associated target flowers (Arnold et al., 2021).

This offers potential for applications within commercial pollination systems to increase yields and thus potentially food security. Many possible target plants, however, do not naturally produce caffeine and research into the uptake mechanism of caffeine into plants remains in its infancy. Furthermore, and more importantly for this study, research into the knock-on effects of caffeine dosages on bee physiology is limited.

This project will delve into the physiological and metabolic responses of bumblebees to caffeine at the individual and micro-colony level, accompanied with pilot investigations into the potential for caffeine expression in commercial plant nectar. It is primarily a laboratory-based project, with possibilities for semi-field experiments. Previous experience in the laboratory is not required but is preferred. A willingness to learn and commitment to the project are both essential requirements. The project will involve extensive work with both bees and pollen.

Additional costs to support this project may be required up to a maximum of £2000 (specific final cost will be confirmed and agreed prior to acceptance on the course).

Starter readings

Arnold , S .E. J., Dudenhöffer, J. H., Fountain, M. T., James, K. L., Hall, D. R., Farman, D. I., Wäckers, F. L., & Stevenson, P. C. (2021). Bumblebees show an induced preference for flowers when primed with caffeinated nectar and a target floral odor. Current Biology, 31, 4127-4131. https://doi.org/10.1016/j.cub.2021.06.068

Mustard, J. A. (2014). The buzz on caffeine in invertebrates: effects on behaviour and molecular mechanisms. Cellular and Molecular Life Sciences, 71(8), 1375-1382. https://doi.org/10.1007/s00018-013-1497-8

Ryder, J. T., Cherrill, A., Thompson, H. M., & Walters, F. A. (2021). Lower pollen nutritional quality delays nest building and egg laying in Bombus terrestris audax micro-colonies leading to reduced biomass gain. Apidologie, 52, 1033–1047. https://doi.org/10.1007/s13592-021-00885-3

Wolf, T. J., Schmid-Hempel, P., Ellington, C. P., & Stevenson, R. D. (1989). Physiological correlates of foraging efforts in honey-bees: oxygen consumption and nectar load. Functional Ecology, 3(4), 417-424. https://doi.org/10.2307/2389615

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**Tackling fish fraud: The use of biomolecules (proteins and DNA) for species identification in the fishing industry**

*Dr Virginia Harvey, University of Chester*

Seafood is the most traded food commodity in the world. Growing demand for wild, poorly managed species threatens biodiversity and favours food fraud, illegal fishing, and the trade of endangered species. Today, it is estimated that one-third of the world’s fish stocks are overfished, and another 60% are fished at their maximum sustainable levels. Increasing demands on the planet’s remaining fish populations, plus monetary incentives, are facilitating ‘fisheries crime’ such as food fraud (species substitution, mislabelling), illegal fishing and trade in endangered species.

Approximately one-quarter of fish samples from all studies on food fraud have been found to be mislabelled. As well as deceiving customers by overcharging and hindering sustainable choices, food fraud in the fishing industry also leads to significant safety risks, with hundreds of cases of illness and deaths related to product mislabelling each year worldwide. Due to illegal fishing and trade of endangered sharks and rays, a quarter of all these species are facing an elevated extinction risk. Combating these crimes is a challenging and complex task that pivots on the development of methods for verifying the authenticity of fish produce.

This project will test methods of protein analysis in identifying and tracing fish products in high-impact areas of fish crime, such as overexploited tuna, wild versus farmed sea bass, and the illegal trade of sharks and rays. This project aims to test the capacity of protein analysis (protein fingerprinting using MALDI-ToF MS) for identifying and tracing fish products from the food industry, and will focus on novel and bespoke case studies that represent prevalent forms of fisheries crime, but which may be at the limit of DNA identification capabilities. DNA analysis will be used supplementary to verify species identifications, and to test the availability of each biomolecule following heat experiments.

The candidate should ideally have some experience of biomolecular extraction and analysis (proteomics, or DNA), or similar transferrable lab skills.

For further details please contact Dr Virginia Harvey on v.harvey@chester.ac.uk

Useful publications/further reading:

 • Dierickx, K., Presslee, S., & Harvey, V. L. (2023). Rapid collagen peptide mass fingerprinting as a tool to authenticate Pleuronectiformes in the food industry. Food Control, 148, 109680.

 • Naaum, A., & Hanner, R. (Eds.). (2016). Seafood authenticity and traceability: A DNA-based pespective. Academic Press.

 • Harvey, V. L., Daugnora, L., & Buckley, M. (2018). Species identification of ancient Lithuanian fish remains using collagen fingerprinting. Journal of Archaeological Science, 98, 102-111.

 • Chiozzi, R. Z., Capriotti, A. L., Cavaliere, C., La Barbera, G., Montone, C. M., Piovesana, S., & Laganà, A. (2018). Label-free shotgun proteomics approach to characterize muscle tissue from farmed and wild European Sea bass (Dicentrarchus labrax). Food Analytical Methods, 11(1), 292-301.

 • Shum, P., Moore, L., Pampoulie, C., Di Muri, C., Vandamme, S., & Mariani, S. (2017). Harnessing mtDNA variation to resolve ambiguity in ‘Redfish’ sold in Europe. PeerJ, 5, e3746.

**Potential for natural saponin compounds as molluscicides**

*Dr Dan Baldock, Dr Jordan Ryder & Dr Candice Owen, University of Chester*

The grey field slug (*Deroceras reticulatum*) is a well-known slug pest that incurs substantial financial costs for farmers and gardeners through lost yields and control attempts (Forbes *et al.*, 2020). Furthermore, the chemical pesticides currently used for the slug might have adverse impacts on other non-target species (Gething et al, 2020), with some organic farmers and enthusiasts moving away from artificial chemical control options. To address these issues, this research aims to develop insight into a potential natural molluscicide based on natural Saponin compounds extracted from easily-accessible plants.

This project will be split into two parts. The first will aim to develop and refine methods for the extraction and quantification of Saponin compounds from a range of potential plant materials in the laboratory. These materials will include weed species and plant materials that are by-products of crop production, allowing for the potential for increased efficiency and sustainability of such systems.

If successful, this will lead to investigations into the efficacy of the extracted natural Saponin compounds on slug mortality by conducting bioassays at different concentrations. Data from this study will allow for calculations of the Lethal Doses (LD50 and LD90) of Saponin compounds for slug control. The outcomes of this research will contribute valuable insights into the potential of natural Saponin-based molluscicides for effective pest control. Additionally, positive results may lead to further trials exploring the practical applications of these products.

**Starter readings**

De Geyter, E., Lambert, E., Geelen, D., and Smagghe, G. (2007). Novel advances with plant Saponins as natural insecticides to control pest insects. *Pest Technology*, 1(2), 96-105.

Forbes, E., Back, M. A., Brooks, A., Petrovskaya, N. B., Petrovskii, S. V., Pope, T. W., & Walters, K. F. (2020). Locomotor behaviour promotes stability of the patchy distribution of slugs in arable fields: tracking the movement of individual *Deroceras reticulatum*. *Pest Management Science*, 76(9), 2944-2952.

Gething, K. J., Pickwell, A., Chadd, R. P., & Wood, P. J. (2020). The effects of metaldehyde on non-target aquatic macroinvertebrates: Integrating field and laboratory-based evidence. Environmental Pollution, 265, 115015.

Griffith, T. C., Paterson, I. D., Owen, C. A., & Coetzee, J. A. (2019). Thermal plasticity and microevolution enhance establishment success and persistence of a water hyacinth biological control agent. *Entomologia Experimentalis et Applicata,* Special Issue: Next Generation Biological Control, 1-10.

Wagner, H., Nickl, H., & Aynehchi, Y. (1984) Molluscicidal Saponins from *Gundelia tournefortii*. *Phytochemistry*, 23(11), 2505-2508.

For further details please contact Dr Dan Baldock on d.baldock@chester.ac.uk

**Social networks in captive Livingstone’s fruit bats *Pteropus livingstonii***

*Dr Christina Stanley and Dr Morgan Edwards, University of Chester*

*Dr Eluned Price and Gale Glendewar, Durrell Wildlife Conservation Trust; Lucy Edwards, Northumberland Zoo*

Since 2017, we have been collecting data on social relationships in the captive population of Livingstone’s fruit bats at Jersey Zoo. As this breeding group has, until recently, formed around 80% of the total worldwide captive population of this Critically Endangered species, understanding how to safeguard their welfare and optimise reproduction has been essential for the future persistence of this species. In 2022, some of these individuals moved with others relocating from Bristol Zoo to form a new captive breeding colony in Northumberland Zoo. Our research has previously demonstrated that social relationships persist over time between individuals, but it is not yet known whether these have persisted with a change in group membership and/or relocation, and how any changes might have impacted reproductive success.

This project will involve collecting behavioural data on both institutions’ breeding groups and interrogating data on reproductive events. Individuals can be identified by natural markings and easily viewed at both locations. The aim of this project is to determine whether social relationships are stable over time and context. By furthering our understanding of the complexity of social relationships in this species, we can influence guidelines for the translocation of individuals between breeding populations and enclosures, ensuring evidence-based decisions can be made that safeguard individual welfare.

The student will need to have experience of carrying out behavioural observations, with either experience in social network analysis or a willingness to learn these methods and carry out analyses in the R environment. They will develop these analytical skills during the project with the help of supervisory team and will also gain useful experience of working in a zoo environment, in addition to skills in project management and collaboration with external partners. The successful student will need to be prepared to spend 6-8 weeks each in both Jersey and Northumberland to learn to identify individual bats and collect behavioural data.

Publications so far resulting from this project:

* [Welch, M. J., Smith, T., Hosie, C., Wormell, D., Price, E., & Stanley, C. R. (2020). Social Experience of Captive Livingstone’s Fruit Bats (*Pteropus livingstonii*). *Animals*, *10*(8), 1321. doi:10.3390/ani10081321](https://www.mdpi.com/2076-2615/10/8/1321/htm)
* [Edwards, M. J., Hosie, C. A., Smith, T. E., Wormell, D., Price, E., & Stanley, C. R. (2021). Principal Component Analysis as a novel method for the assessment of the enclosure use patterns of captive Livingstone’s fruit bats (*Pteropus livingstonii*). *Applied Animal Behaviour Science*, *244*, 105479.](https://www.sciencedirect.com/science/article/pii/S0168159121002665)
* [Edwards, M. J., Stanley, C. R., Hosie, C. A., Richdon, S., Price, E., Wormell, D., & Smith, T. E. (2022). Social roles influence cortisol levels in captive Livingstone's fruit bats (*Pteropus livingstonii*). *Hormones and Behavior*, *144*, 105228.](https://www.sciencedirect.com/science/article/pii/S0018506X22001222)

Whilst some of the student’s accommodation costs should be covered by the project, the student will have to pay some of these costs, in addition to their travel to and from these two locations. This will be around £1,500 in addition to the course fees.

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**Old vs New: Evaluating environmental DNA (eDNA) for entomological surveillance compared to traditional methods**

*Dr Amaka Akpodiete & Dr Bethan Stallwood, University of Chester*

Historically, traditional morphological identification methods such as direct monitoring or identification of collected samples have been employed in entomological surveillance and monitoring (Niang et al., 2021). These methods, which include nets and insect traps, are time-consuming and labour-intensive, requiring entomological expertise. In addition, damage to vital morphological keys during collection and the lack of keys for certain species have necessitated research into non-morphological identification techniques (Chua et al., 2023). In the past decade, DNA-based technologies such as quantitative PCR (qPCR) and high-throughput sequencing (HTS) technologies have been widely used for monitoring insects for different purposes, including monitoring insect bioindicators of environmental health (Brantschen et al., 2022) conservation purposes (Blattner et al., 2021), and recently vector surveillance (Kristan et al., 2023).

Monitoring methods based on DNA sequencing and analysis are rapid, cost-effective, scalable, and can deliver species-level identification. Additionally, they are more reproducible and yield user-independent results. The success of this method depends on efficient sample collection and the availability of DNA reference data. Insect DNA can be sourced from various sample types, such as bulk specimen collections and environmental DNA (eDNA). The use of insect eDNA has the advantage of being non-invasive. There is, therefore, a need to evaluate the characteristics of insect eDNA from various sources (Chua et al., 2023). A comparison of the effectiveness of species richness and composition from traditional specimen sampling sources and emerging insect eDNA sources could result in an integration of these novel protocols into routine monitoring or surveillance programmes. This offers potential for improved vector surveillance, especially in the face of emerging vector-borne diseases such as West Nile Virus and Dengue fever in Europe (Marini et al., 2022). The UK Health and Safety Agency has recently heightened surveillance for these vectors based on traditional sampling methods, and novel monitoring methods are needed to improve the ability to detect micro-populations of these insects (UKHSA, 2023). Conservation efforts to preserve insect biodiversity and safeguard their roles in food chains, pollination, and nutrient cycling will be equipped with a broader toolkit. Additionally, data collected from insect eDNA analysis can provide insight into microbial communities associated with sampled habitats (Goodenough et al., 2017).

This project, therefore, aims to evaluate the viability of eDNA as an entomological surveillance tool for select emerging insect vectors in Europe (*Aedes aegypti* – dengue fever and *Culex pipiens*- West Nile Virus) using experimental bioassays. Secondly, a comparison of the effectiveness of eDNA analysis to measure biodiversity and species richness compared to traditional methods (specimen collection and identification) with a focus on some families of insect bioindicators (Plecoptera, Ephemeroptera, Trichoptera). Thirdly, a comparison of the effectiveness of emerging insect eDNA sampling methods (bathing and vacuuming snails, tree rolling, rainwater collection, spider webs, flower petals, herbarium material) with traditional sampling methods (colour pan trap, nets, malaise trap, pitfall traps, dipping). DNA spatial and temporal characteristics (dispersal, persistence, degradation) from both methods will be compared. Lastly, data retrieved from eDNA sequencing will be further analysed for microbial communities associated with insect eDNA sources, potentially revealing species interactions and ecosystem functions. Candidates can choose from any of the four aims of this project for their MRes dissertation.

Ideally, the candidate should be conversant with entomological sampling techniques and molecular biology techniques such as DNA extraction, PCR, q PCR and DNA sequencing (Oxford Nanopore). However, a lack of experience in these skills is not a limitation for an interested and hardworking candidate, as training will be provided.

Additional costs to support this project may be required up to a maximum of £2300 (the specific final cost will be confirmed and agreed upon prior to acceptance of the course).

For further details, please contact contact Dr Amaka Akpodiete (n.akpodiete@chester.ac.uk)

Starter reading:

Blattner, L., Ebner, J. N., Zopfi, J., & von Fumetti, S. (2021). Targeted non-invasive bioindicator species detection in eDNA water samples to assess and monitor the integrity of vulnerable alpine freshwater environments. *Ecological Indicators*, *129*, 107916.

Brantschen, J., Pellissier, L., Walser, J. C., & Altermatt, F. (2022). Evaluation of primer pairs for eDNA‐based assessment of Ephemeroptera, Plecoptera, and Trichoptera across a biogeographically diverse region. *Environmental DNA*, *4*(6), 1356-1368.

Chua, P. Y., Bourlat, S. J., Ferguson, C., Korlevic, P., Zhao, L., Ekrem, T., Rudolf, Meier., & Lawniczak, M. K. (2023). Future of DNA-based insect monitoring. *Trends in Genetics,* 39(7), 531-544.

Goodenough, A. E., Stallwood, B., Dandy, S., Nicholson, T. E., Stubbs, H., & Coker, D. G. (2017). Like mother like nest: similarity in microbial communities of adult female Pied Flycatchers and their nests. *Journal of Ornithology*, *158*, 233-244.

Kristan, M., Acford-Palmer, H., Campos, M. O., Collins, E. L., Phelan, J., Portwood, N. M., Pelloquin, B., Clarke, S., Lines, J., Clark, T.G., Campino, S., & Messenger, L. A. (2023). Towards environmental detection, quantification, and molecular characterization of *Anopheles stephensi* and *Aedes aegypti* from experimental larval breeding sites. *Scientific Reports*, *13*(1), 2729.

Marini, G., Pugliese, A., Wint, W., Alexander, N. S., Rizzoli, A., & Rosa, R. (2022). Modelling the West Nile virus force of infection in the European human population. *One Health*, *15*, 100462.

Niang, A., Sawadogo, S. P., Millogo, A. A., Akpodiete, N. O., Dabiré, R. K., Tripet, F., & Diabaté, A. (2021). Entomological baseline data collection and power analyses in preparation of a mosquito swarm-killing intervention in south-western Burkina Faso. *Malaria Journal*, *20*(1), 346.

UK Health and Safety Agency (2023). UKHSA Advisory Board: preparedness for infectious disease threats. [UKHSA Advisory Board: preparedness for infectious disease threats - GOV.UK (www.gov.uk)](https://www.gov.uk/government/publications/ukhsa-board-meeting-papers-january-2023/ukhsa-advisory-board-preparedness-for-infectious-disease-threats)