UCD Impact Case Study

You are what you eat (and we can tell!)

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HEALTH ACADEMIC ECONOMIC SCIENTIFIC ENVIRONMENTAL

SUMMARY

What we eat has a profound impact on how our bodies work, and that goes for every living being from bacteria and plants to humans. Dr Andrew Parnell and colleagues have developed research tools and computer software that have changed the way that people work out what a living being is eating, and how that food affects them. These tools allow researchers to estimate diet from chemical measurements of blood and tissue without killing or harming the animal or plant. This opens the way to answering important and far-reaching questions about food science, climate change and even human history.

The mathematical model and software that Dr Parnell and colleagues developed has been used in thousands of research studies to help scientists work out how the diets of living beings affect their makeup.

RESEARCH DESCRIPTION

You are what you eat, but how can we tell what parts of the food go into making you?

To find out, Dr Parnell has developed a set of mathematical tools to analyse the data. The starting point is to measure chemical markers known as stable isotopes, both in the living being, and in its typical food sources. Importantly, in many cases, clues can be picked up from blood or small samples, so the living being is not harmed or killed. The model then uses a statistical approach to estimate how the living being's diet contributes to its makeup and tissues.

Dr Parnell built the mathematical model drawing on ideas, data and inspiration from collaborators in the UK (Professor Stuart Bearhop, Exeter), in the US (Professor Don Phillips, EPA; Professor Brice Semmens, Scripps) and in Ireland (Professor Andrew Jackson, TCD). Dr Parnell has also built a software package to allow people to calculate the answers based on the data they collect.

The approach is based on a type of statistics called a Bayesian model, and scientists can use it to examine snapshots of diets or the longer-term contributions of foodstuffs or nutrients over time.

The software and the papers based on this basic mathematical research have attracted plenty of attention from the scientific community and the key findings continue to disperse across dozens of fields of research as the use of this tool and its associated software becomes ever more widespread.

RESEARCH IMPACT

The mathematical model and software that Dr Parnell and colleagues developed has been used in thousands of research studies to help scientists work out how the diets of living beings affect their makeup.

The original paper that describes the findings was published in the open access journal PLOS One in 2010. Since then it has been downloaded more than 26,000 times and has had more than 1,150 citations, in other academic papers and studies. The software arising from the research has been downloaded more than 22,000 times.

In 2016 alone, more than 250 academic published papers cited or used the tool. They include studies on the management and potential collapse of important microscopic plankton in the Ionian Sea, whether American Black Bears are consuming human crops, the impacts of predator/prey removal and the new EU Common Fishery policy, the effects of land use on living beings in river streams and the link between storm-water run-off and pollution, how the diets of individual Neanderthals differed from others, the metabolic rate of Bottlenose dolphins, the life cycle of Uruguayan Green turtles and the increase of trace heavy metals in seagrass leaves.

"There are literally hundreds more examples of this type of impact, covering ancient humans, environmental changes due to climate change or pollution, and the effects of interventions in ecosystem balance among others," says Dr Parnell. "The central part to all these analyses is that they are using our software to quantify with uncertainty something that could not previously be quantified. The mathematical methods and software have been evidently transformative in a variety of fields."

To date, those who have benefited most directly from the research are other scientific researchers in a multitude of different fields. But in turn their research will have an impact on the living beings, including humans, that are affected by ecosystem and climate change and by changes in the policies put in place to protect the environment. "The impact is so widely felt that I cannot keep up with all the fields where this is being used," says Dr Parnell. "The impact is constant and accelerating and it has had global impact in every continent, especially those sensitive to climate and ecosystem change. Our model has become the standard tool in a variety of fields and will be felt for years to come as we extend and further develop the analysis techniques."

REFERENCES

They key research paper is:

- Parnell, A. C., Inger, R., Bearhop, S., & Jackson, A. L. (2010). Source partitioning using stable isotopes: coping with too much variation. *PloS one*, 5(3), e9672. https://doi.org/10.1371/journal.pone.0009672

Other associated research papers include:

- Jackson, A. L., Inger, R., Parnell, A. C., & Bearhop, S. (2011). Comparing isotopic niche widths among and within communities: SIBER–Stable Isotope Bayesian Ellipses in R. *Journal of Animal Ecology*, 80(3), 595-602. 10.1111/j.1365-2656.2011.01806.x
- Phillips, Donald L., Richard Inger, Stuart Bearhop, Andrew L. Jackson, Jonathan W. Moore, Andrew C. Parnell, Brice X. Semmens, and Eric J. Ward. "Best practices for use of stable isotope mixing models in food-web studies." *Canadian Journal of Zoology* 92, no. 10 (2014): 823-835. 10.1139/cjz-2014-0127
- Parnell, Andrew C., Donald L. Phillips, Stuart Bearhop, Brice X. Semmens, Eric J. Ward, Jonathan W. Moore, Andrew L. Jackson, Jonathan Grey, David J. Kelly, and Richard Inger. "Bayesian stable isotope mixing models." *Environmetrics* 24, no. 6 (2013): 387-399. 10.1002/env.2221