[C] Using isotope-derived metrics of food web architecture to evaluate the success of habitat restorations.

Charlotte Pike – *Wild Trout Trust, The Ribble Rivers Trust, QMUL*

[A] Using Stable Isotope Analysis to identify the life history strategy of brown trout (*Salmo Trutta*) in river systems in the East of England and to establish their contribution to greater sea-trout stocks.

Abbie Nye – *Wild Trout Trust, Environment Agency, Guash Fishing Club, Welland Rivers Trust, ZSL, UCL, River Glaven Conservation Group, Norfolk Rivers Trust, QMUL*

Aims

[C] To analyse samples collected from pre and post-intervention works and compare them to an unimpacted control. It will be evaluated whether the restoration has affected river populations and altered community composition.

[A] To identify the presence, distribution and spawning capacity of sea-trout in the rivers Welland, Glaven, and Stiffkey.

Project Background

[C] Rivers provide a multitude of ecosystem services, i.e. food, transport and irrigation[1]. The structure and functioning of almost all rivers has been heavily impacted by anthropogenic stressors[2]. This includes:

- Dam/Weir construction – Preventing migration
- Flood drainage – Excess nutrient introduction
- Channel straightening – Flow alteration
- Land use intensification – Increases in nutrient pollution
- Addition of non-native species – Disease spread/resource competition

Following a perturbation, a community has the ability to recover to it's original state. Under this notion, restoration projects conducted on rivers aim to rehabilitate the system and allow species to return. This recovery can be explored through food web architecture[2] (Figure 1).

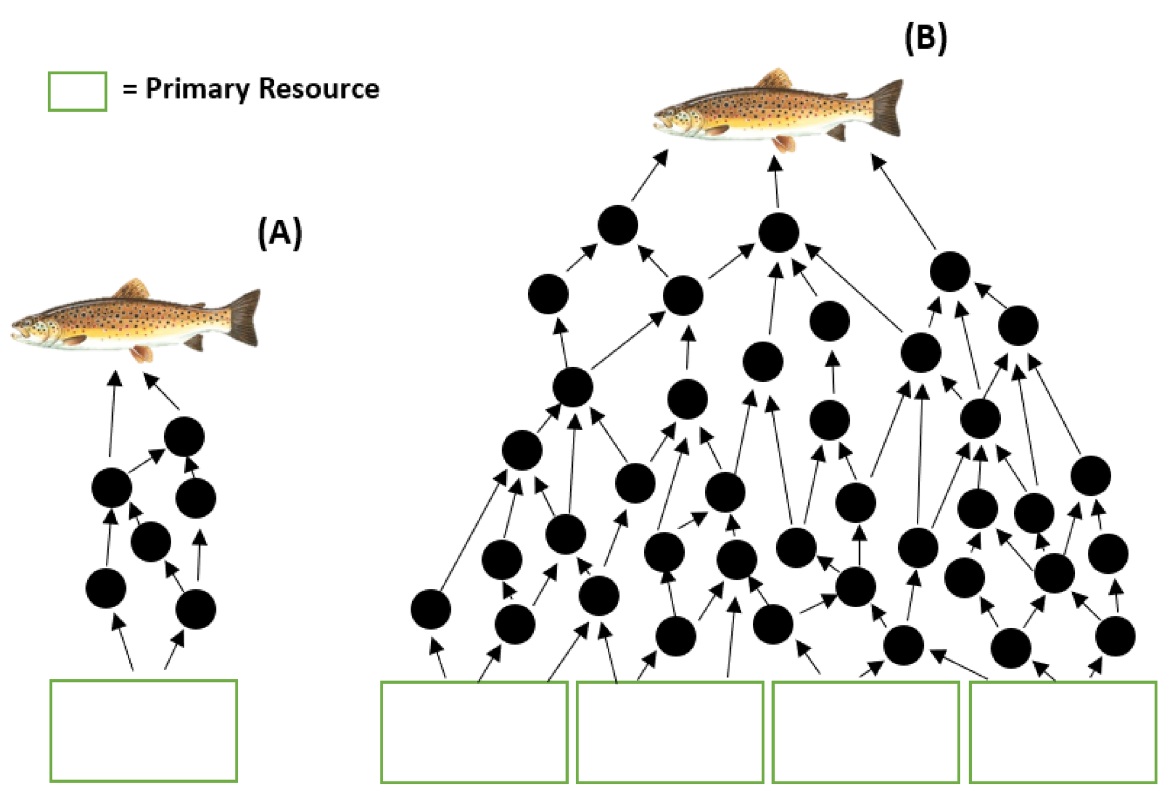


Figure 1 – (a) A basic web expected of a disturbed system. (b) a complex web expected of a restored system.

[A] Brown trout have two main life history strategies, freshwater residential and migratory. The migratory strategy allows individuals to feed in a more productive marine habitat that can increase reproductive fitness[3].

Identifying the presence, distribution and spawning capacity of sea-trout within these river systems will indicate the contribution of these populations to the wider sea-trout stocks. This knowledge will allow development of suitable management plans for these waterways in order to prevent disruption of migration routes and allow these population to flourish.

Figure 2 – comparison of an adult resident (A), and migratory (B) brown trout (WTT, 2018).

Stable Isotope Analysis [C,A]

Stable isotopes (SI) are versions of the same element containing differing numbers of neutrons, causing them to have different molecular weights. When an organism ingests a resource, some components are assimilated within its tissues. The heavier isotope is preferentially retained, and the lighter isotope gets excreted, resulting in the consumer becoming isotopically heavier than its prey[4].

The offset of this enrichment is known as the Trophic Discrimination Factor (TDF). The TDF differs with each element, making them useful to indicate differing trophic pathways (Figure 3). In this way, SI are commonly used to study trophic interactions and assign trophic position, particularly in aquatic environments where it is difficult to establish links through observation[5].

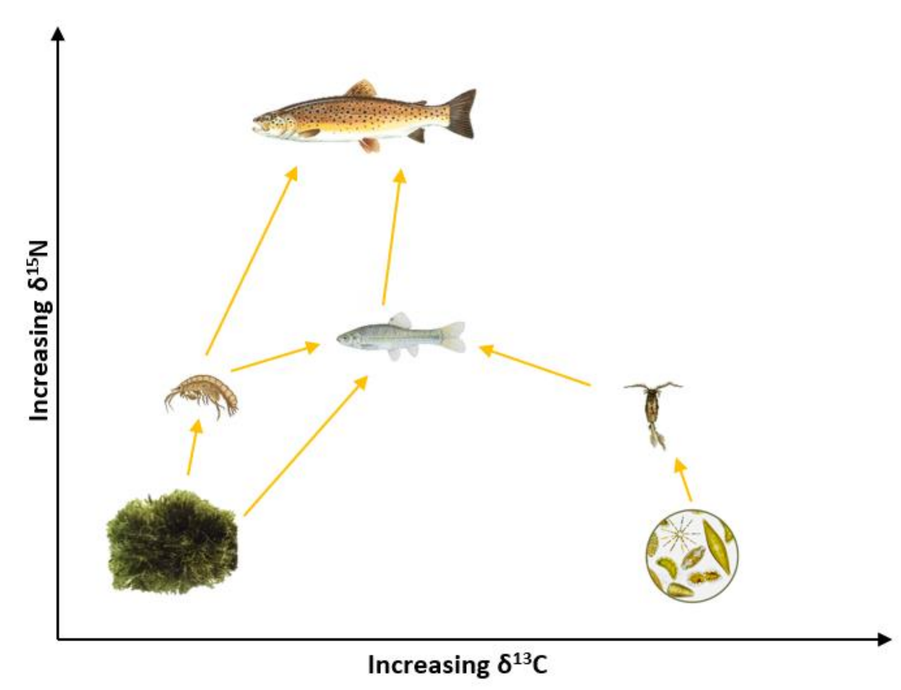
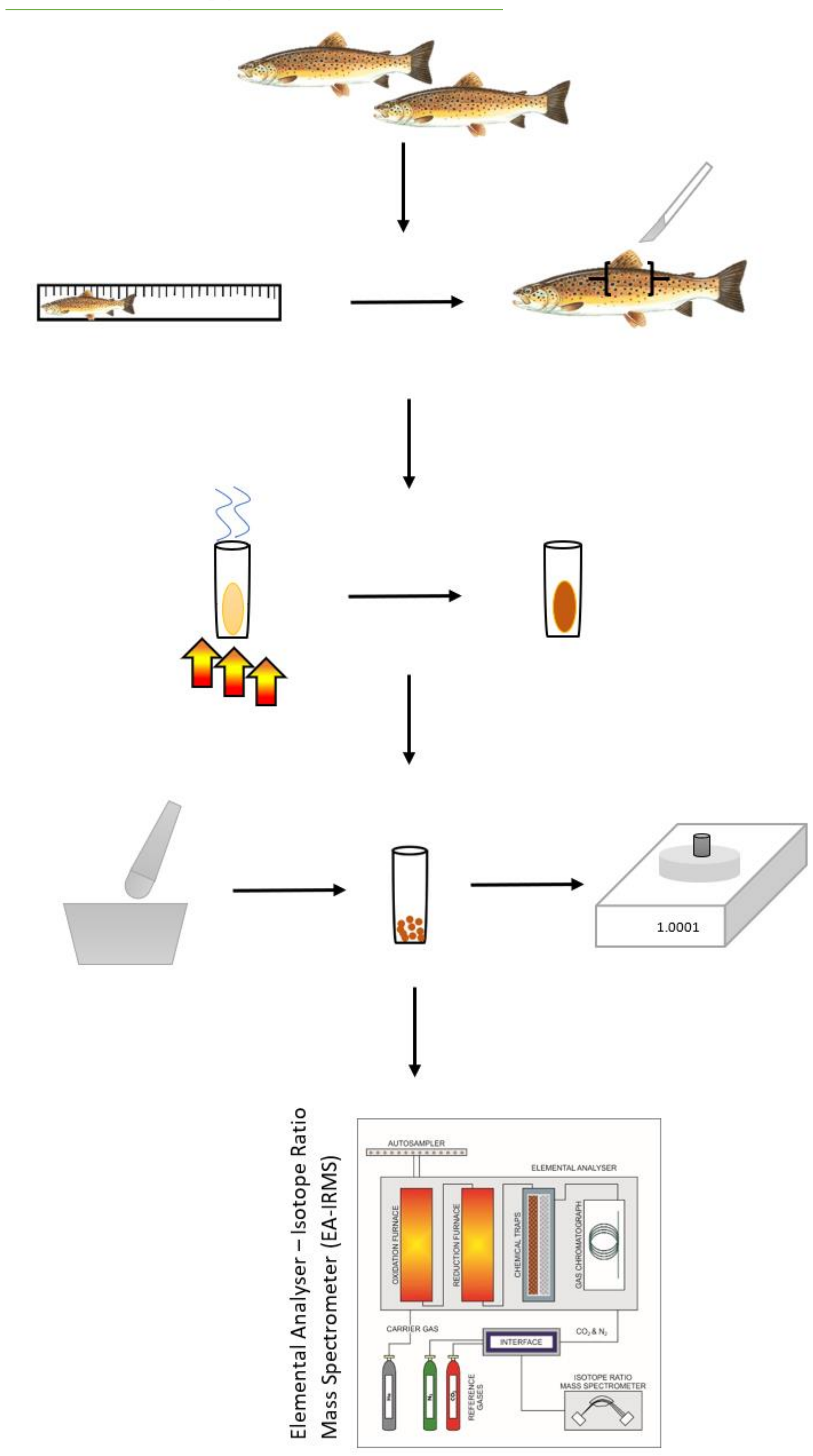


Figure 3 – Increasing isotope ratios of N and C with trophic position and dietary reliance, respectively.

Typically, a combination of carbon and nitrogen ratios are the main elements used in analysis:

- Nitrogen - Stepwise enrichment used to estimate trophic position[4].
- Carbon - Used to determine sources of dietary carbon through reliance on different primary producers, as carbon ratio varies between photosynthetic pathways[4].

Methodology [C,A]



Results so far…

[C]

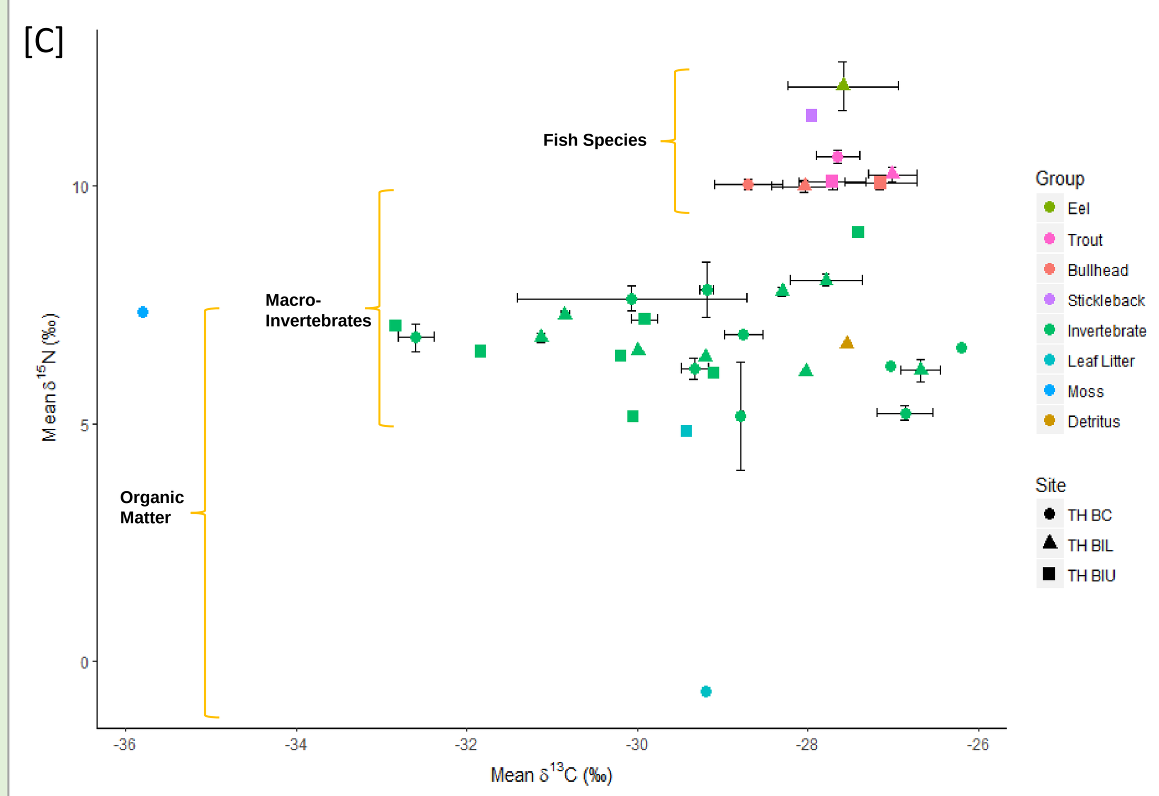


Figure 4 – Scatter plot of $\delta^{15}N$ and $\delta^{13}C$ values (Mean ± SE) for samples collected before restoration intervention at upper (BIU), lower (BIL), and control (BC) sites at Townley Hall.

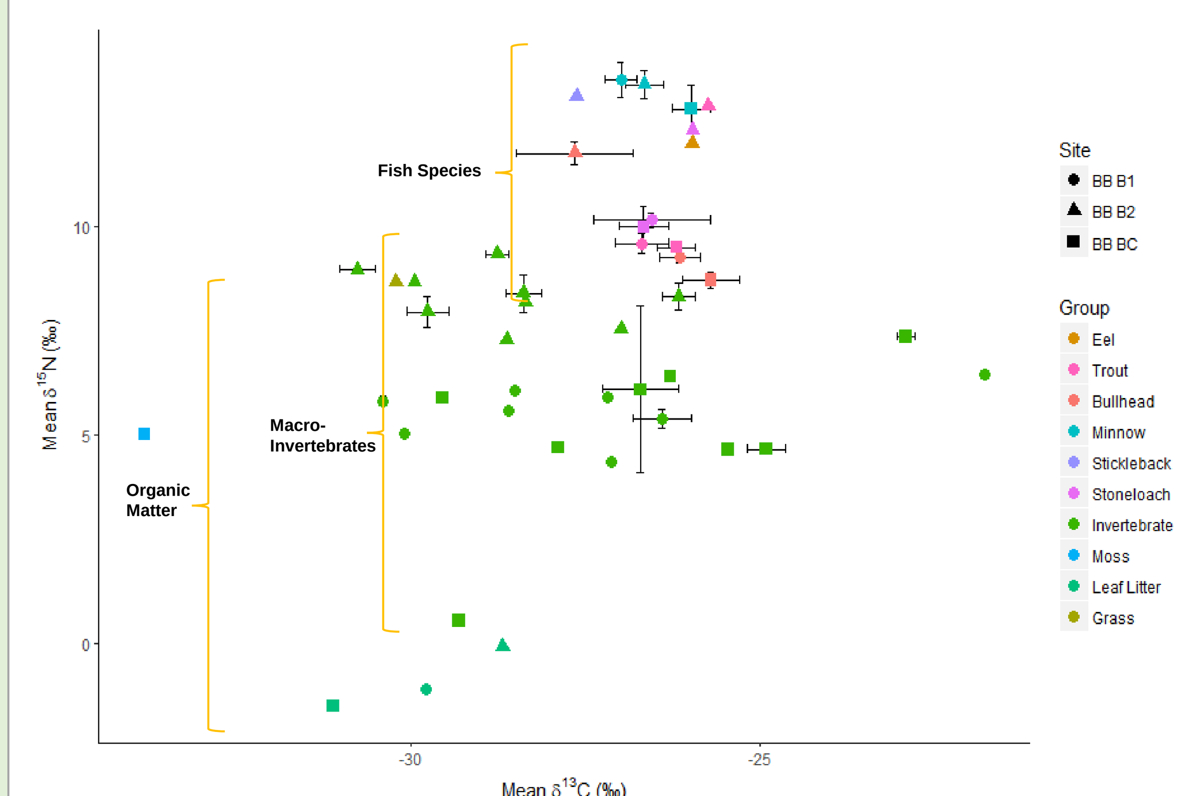


Figure 5 – Scatter plot of $\delta^{15}N$ and $\delta^{13}C$ values (Mean ± SE) for samples collected before restoration intervention at upper (TH B1), lower (TH B2), and control (TH BC) sites at Bashall Brook.

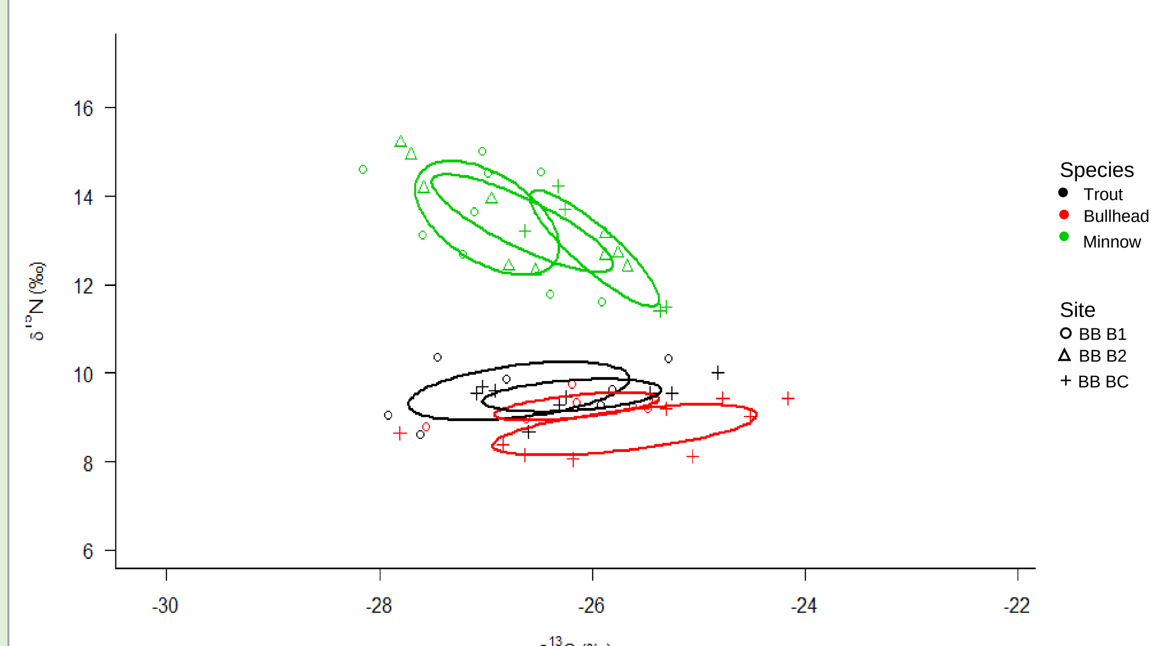


Figure 6 – Isotope bi-plot comparing $\delta^{15}N$ and $\delta^{13}C$ in consumer species containing ≥5 samples collected from upper (BB B1), lower (BB B2), and control (BB BC) sites at Bashall Brook. Ellipses represent core isotopic niche area for each species.

[A]

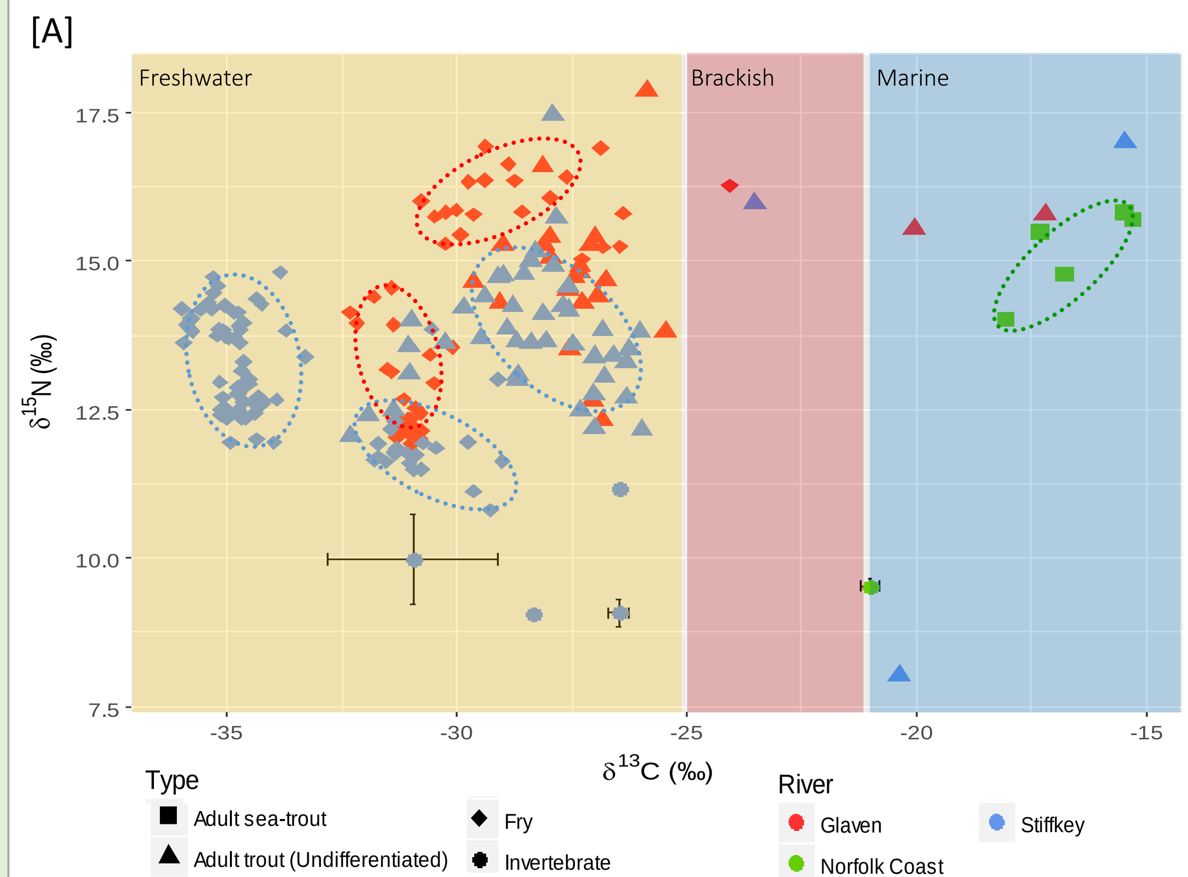


Figure 7 – Combined $\delta^{13}C$ and $\delta^{15}N$ signatures of individual *salmo trutta* fry, undifferentiated adults, and confirmed sea-trout, in relation to macroinvertebrate food sources (Mean ± SE) in various sites within the rivers Glaven and Stiffkey, and the Norfolk coast. Ellipses indicate perceived groups of individuals with similar isotopic signatures.

[1] Sabater, S., & Stevenson, R. J. (2010). Foreword: Global change and river ecosystems— implications for structure, function, and ecosystem services. *Hydrobiologia*, 657, pp. 1-2.
[2] Calizza, E., Costantini, M. L., Rossi, D., Carlino, P., & Rossi, L. (2012). Effects of disturbance on an urban river food web. *Freshwater Biology*, 57, pp. 2613–2628.
[3] Stefansson, S. O., Bjornsson, B. T., Ebbesson, L. O. & McCormick, S. D. (2008). Smoltification. *Fish larval physiology*, pp. 639-681.
[4] Nielsen, J. M., Clare, E. L., Hayden, B., Brett, M. T., & Kratina, P. (2018). Diet tracing in ecology: Method comparison and selection. *Methods Ecol. Evol.*, 9, pp. 278–291.
[5] Grey, J. (2006). The use of stable isotope analysis in freshwater ecology: Current awareness. *Pol. J. Ecol.*, 54(4), pp. 563-584.