X: Variable by species and sample type: see compilation by Smart et al. (2018) and others.

Shell-bound nitrogen is almost entirely amino acid (Paolini et al., 2023).

Phenylalanine is an essential amino acid and is required for trophic position calculations. It is in low abundance in tissue and thus is useful for estimating the the minimum sample required. Phenylalanine makes up approximately 4% of amino acid nitrogen in the foraminifera samples presented here.

$$\frac{X\ nmol\ N}{1\ mg\ shell} \times \frac{1\ nmol\ AA\ N}{1\ nmol\ N} \times \frac{0.04\ nmol\ Phe\ N}{1\ nmol\ AA\ N} = \frac{A\ nmol\ Phe\ N}{1\ mg\ shell}$$

$$\frac{Y\ ng\ N\ on\ column}{1\ GC\ injection} \times \frac{1\ nmol\ N}{14\ ng\ N} \times \frac{1\ nmol\ Phe}{1\ nmol\ N} \times \frac{1\ mg\ shell}{A\ nmol\ Phe\ N} = \frac{B\ mg\ shell}{1\ GC\ injection}$$

Y: Requirements for amount of nitrogen on-column for a gas chromatography injection will vary from instrument to instrument; consult with the operator of the GC-C-IRMS.

This value (B) provides an estimate for shell material *per injection* but must be multiplied for triplicate injections and the final dilution volume. Final dilution volume will determine whether autosampler or manual injection methods are required. Consult with the operator of the GC-C-IRMS for ideal number of injections per sample.