Mixing models

N. Geeraert 9 October 2019 Stable Isotope Ecology Short Course

The importance of mixing models

Fig. 1. Number of citations per year from 1990 to 2012 for papers matching the search terms (a) "stable isotopes" and "mixing model" or (b) "stable isotopes" and "mixing models" from ISI Web of Knowledge. Search conducted June 2013.



Mixing 2 sources



Source 1 Source 2 Sample $f_1=0.1, f_2=0.9$ 0 1 2 3 4 5 6 7 8 9 10 $\delta^{15}N$ Mixing=weighted average

- 1 isotope =>
 2 sources
 - $\begin{cases} \delta_{mix} = f_1 * \delta_1 + f_2 * \delta_2 \\ f_1 + f_2 = 1 \end{cases}$

Mixing 3 sources



• 2 isotopes =>

3 sources

$$\begin{cases} \delta E_{mix} = f_1 * \delta E_1 + f_2 * \delta E_2 + f_3 * \delta E_3 \\ \delta F_{mix} = f_1 * \delta F_1 + f_2 * \delta F_2 + f_3 * \delta F_3 \\ f_1 + f_2 + f_3 = 1 \end{cases}$$

Rules of mixing models



- A No solution is possible if the mixture is outside the convex polygon bounded by all sources.
- B A source must contribute (cannot be0) if the mixture is outside the convex polygon bounded by all other sources.
- C A source need not contribute (may be 0) if it is inside the convex polygon bounded by all other sources.
- D Mixtures near the periphery of the mixing polygon have well constrained solutions.
- E Mixtures near the center have more diffuse solutions.
- F Narrow mixing polygons with small differences between sources have diffuse solutions

(Phillips and Gregg, 2003)

Some real data

Soil C profiles in Kenya



Exercise

- Calculate the fraction of C3 and C4 plants for the different trenches
- Open file: Exercise_mixing.xlsx
- What would you choose as end-members and which isotopic value would you assign to it?

Dealing with uncertainty



(Phillips and Gregg, 2003)

Calculating fractions with confidence intervals

- Somebody did the hard work for you:
- Open: isoerror1_04.xls

 Calculate the confidence interval for the first half and second half of trench 1 (from the first exercise)



Unmixing fractions per site, bars indicate 95% interval, grey zones are outside of 0-1 range



Be more efficient ...

- There exist several R packages to help you with the isotope mixing analysis:
 - simmr (easy)
 - MixSIAR (more advanced)



Simmr output from the assimilation corrected samples



Underdetermined mixing sources

Α





Underdetermined mixing sources



Phillips et al. 2014

Marine Foods (% of diet)