Elemental Ecology
Linear and Concentration Dependent Mixing Model Exercise
Due at Beginning of Class on Thursday October 28th

Problem #1: Linear Stable Isotope Mixing Models

Mixing models are an often used but rarely understood component of many applied studies in both plant and animal isotope ecology.

A) Briefly describe how mixing models work, the type of data required for their use, and most importantly the major assumptions that are implicit in their accurate use and interpretation.

B) Using the hair isotope dataset from Alaskan black and brown bears below, determine the relative proportion of the two general prey sources (salmon and berries) to each populations diet using two 2-source, 1-isotope linear mixing model. Build one model for carbon ($\delta^{13}C$) and another for nitrogen ($\delta^{15}N$). Be sure to write and describe the variables in the equations for both $\delta^{13}C$ and $\delta^{15}N$ based mixing models.

Consumer/Prey	$\delta^{13}C$	$\delta^{15}N$	$\Delta^{13}C$	$\Delta^{15}N$
Brown Bear (sympatric)	-20.3	10.9	–	–
Black Bear (sympatric)	-22.5	4.9	–	–
Black Bear (allopatric)	-20.1	7.6	–	–
Salmon	-20.5	13.2	2.0	2.5
Berries	-26.6	-0.9	3.0	4.0

Problem #2: Concentration-Dependent Stable Isotope Mixing Models

A) Using the same isotopic dataset as in Problem #1, determine the relative proportions of the two general prey sources to each bear's diet with a two-source, 1-isotope concentration-dependent mixing model. Using the data below, build one model for carbon using the $\delta^{13}C$ and [C], and another using the $\delta^{15}N$ and [N] data below. For more details read Phillips and Koch 2002.

$$\delta^{15}N_{BEAR} = (p_X)(`[N]_X)(\delta^{15}N_X + \Delta^{15}N_X) + (p_Y)(`[N]_Y)(\delta^{15}N_Y + \Delta^{15}N_Y)$$

$$`[N]_X = [N]_X / [N]_X + [N]_Y$$
$$`[N]_Y = [N]_Y / [N]_X + [N]_Y$$

$$1 = p_X + p_Y$$

Consumer/Prey	**$\delta^{13}C$**	**$\delta^{15}N$**	**$\delta^{13}C$**	**$\delta^{15}N$**	**[C]**	**[N]**
Brown Bear (sympatric)	-20.3	10.9	–	–	–	–
Black Bear (sympatric)	-22.5	4.9	–	–	–	–
Black Bear (allopatric)	-20.1	7.6	–	–	–	–
Salmon	-20.5	13.2	2.0	2.5	45.0	12.0
Berries	-26.6	-0.9	3.0	4.0	48.0	0.5

B) How did the results change after the elemental concentrations of each prey source were included in the model? What other ecological scenarios might require the consideration of concentration-dependence (think beyond omnivores)?