3rd STABLE ISOTOPE COURSE IN ECOLOGY AND ENVIRONMENTAL SCIENCES
2018

Niche Metrics

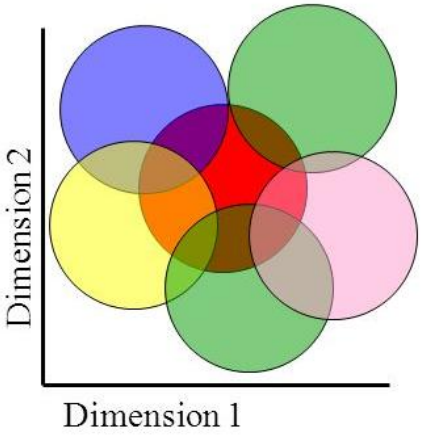
12-16 Noviembre

Joan Giménez
Estación Biológica de Doñana

What is a Species' Niche?

Grinelliang niche:

Grinell (1917) understood the niche as a subdivision of the habitat containing the **environmental conditions** that enable individuals os a species to survive and reproduce, based on **broad-scale variables** (climate). **Scenopoetic axe.**

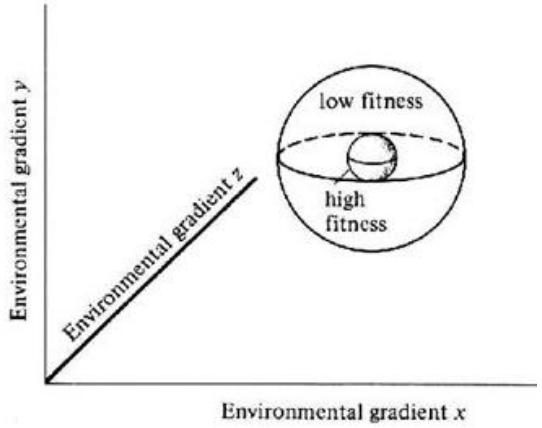


Eltonian niche:

Elton (1927) emphasised the functional role of a species in a community, especially its position in food webs, based on **fine-scale variables** (nutrients) that may be consumed or modified by the species. **Bionomic axe**.

Hutchinson niche:

Hutchinson (1957) defined the species niche as the **n-dimensional volume in the environmental space** where a species can maintain a viable population and persist along time.



A niche for isotopic ecology

Seth D Newsome[1*], Carlos Martinez del Rio[2], Stuart Bearhop[3], and Donald L Phillips[4]

isotopic niche as an area (in δ-space) with isotopic values (δ-values) as coordinates

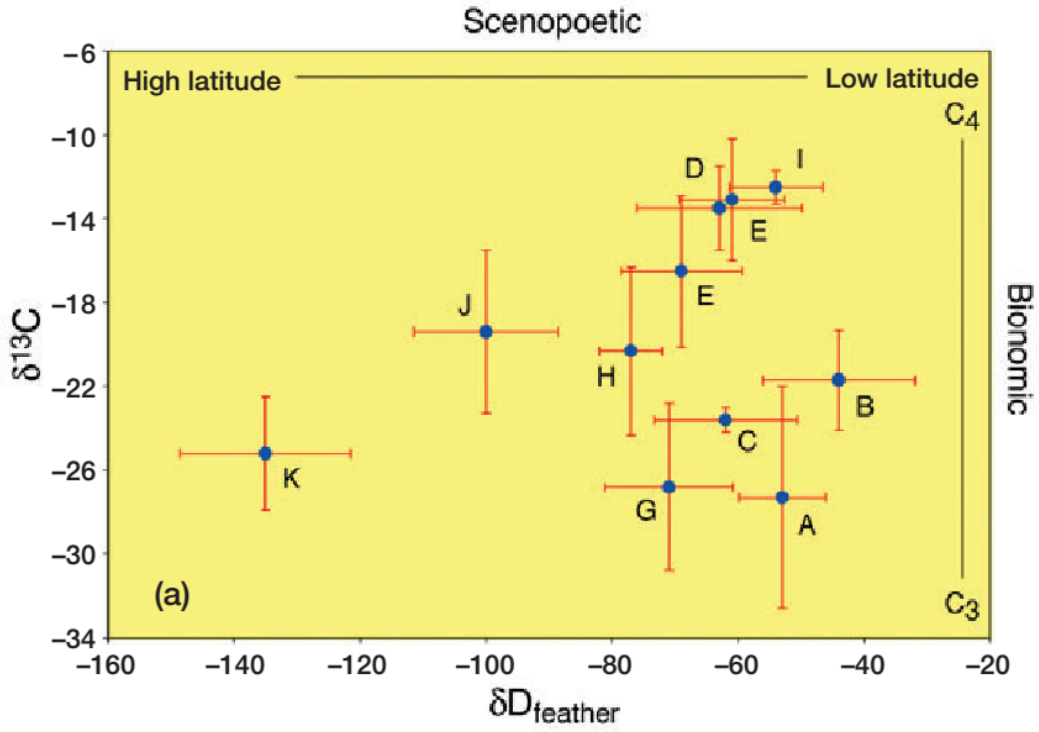


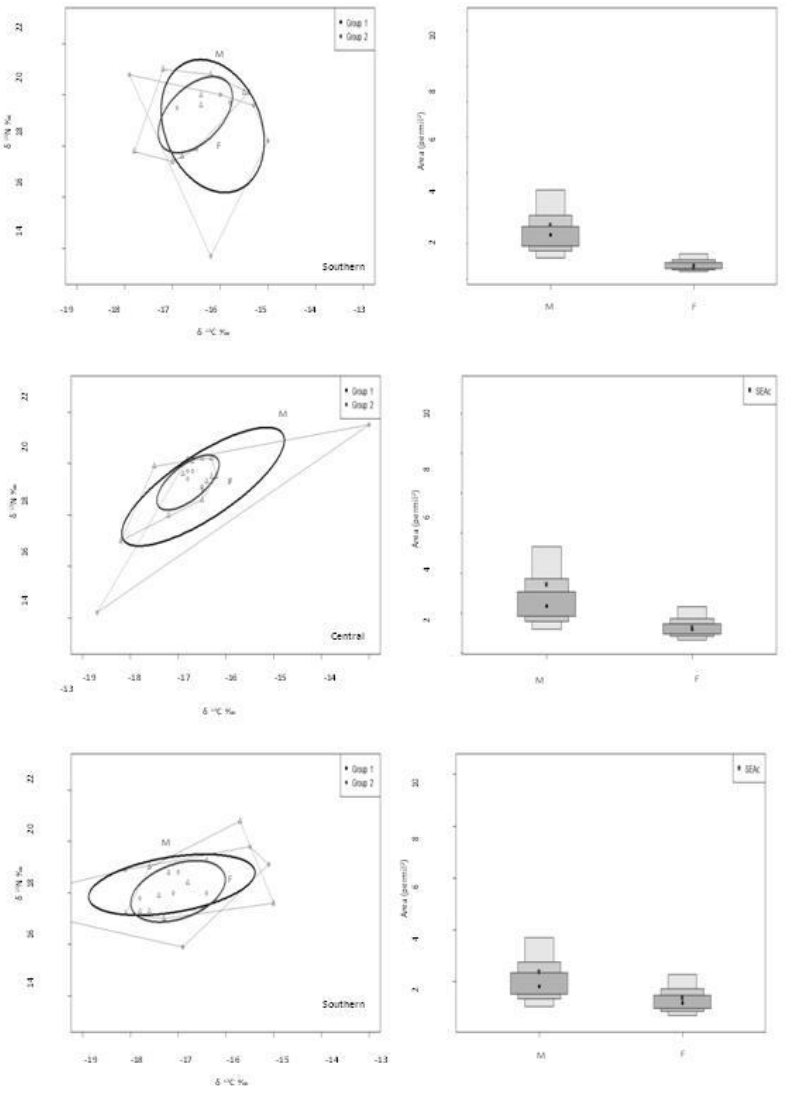
Table 1. A summary of common isotope systems and expected patterns in δ-values used to examine scenopoetic and bionomic dimensions of ecological niche space

Gradient	*Isotope system*	*High δ-values*	*Low δ-values*	*Scenopoetic*	*Bionomic*
Trophic level	$\delta^{13}C$ / $\delta^{15}N$	High levels	Low levels		✓
C3–C4 Vegetation	$\delta^{13}C$	C_4 plants	C_3 plants		✓
Marine–terrestrial	$\delta^{15}N$ / $\delta^{13}C$ / $\delta^{34}S$	Marine	Terrestrial	✓	✓
Latitude (terrestrial)	$\delta^{2}H$ / $\delta^{18}O$	Low latitudes	High latitudes	✓	
Latitude (marine)	$\delta^{13}C$ / $\delta^{15}N$	Low latitudes	High latitudes	✓	
Altitude	$\delta^{13}C$	High altitudes	Low altitudes	✓	
Altitude	$\delta^{2}H$	Low altitudes	High altitudes	✓	
Inshore–offshore	$\delta^{13}C$	Inshore	Offshore	✓	
Benthic–pelagic	$\delta^{13}C$ / $\delta^{34}S$	Benthic	Pelagic	✓	✓
Aridity	$\delta^{13}C$ / $\delta^{15}N$	Xeric	Mesic/hydric	✓	
Eutrophication	$\delta^{15}N$ / $\delta^{13}C$	Polluted	Pristine	✓	
Temperature	$\delta^{18}O$	Cooler	Warmer	✓	
Geologic substrate	$\delta^{87}Sr$	Young rocks	Old rocks	✓	
Oxic–anoxic	$\delta^{15}N$ / $\delta^{13}C$ / $\delta^{34}S$	Oxic	Anoxic	✓	
Methanogenesis	$\delta^{13}C$	Photosynthetic	Methanogenic	✓	

APPLICATIONS

Niche comparison (SIBER)

- ✓ Bayesian Ellipses (= isotopic niche)
- ✓ Overlap between isotopic niches.



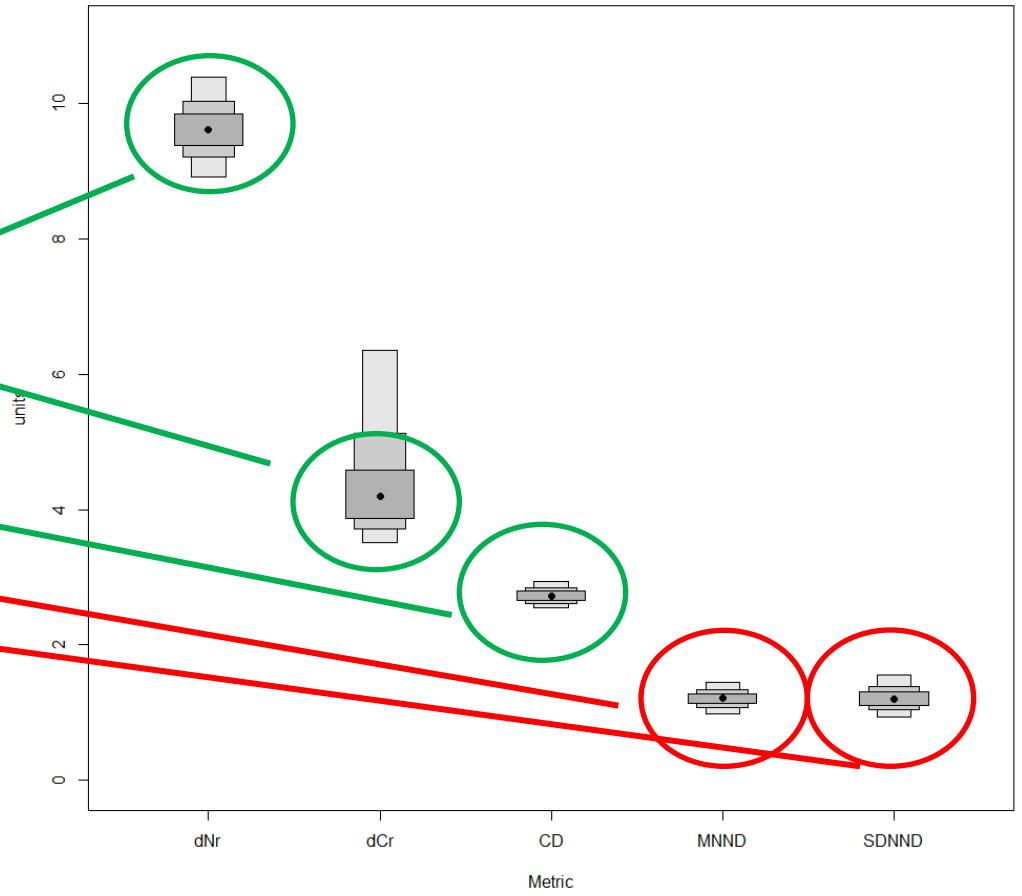
* Stable Isotope Bayesian Ellipses in R (Jackson et al., 2011)

APPLICATIONS

Trophic structure topology

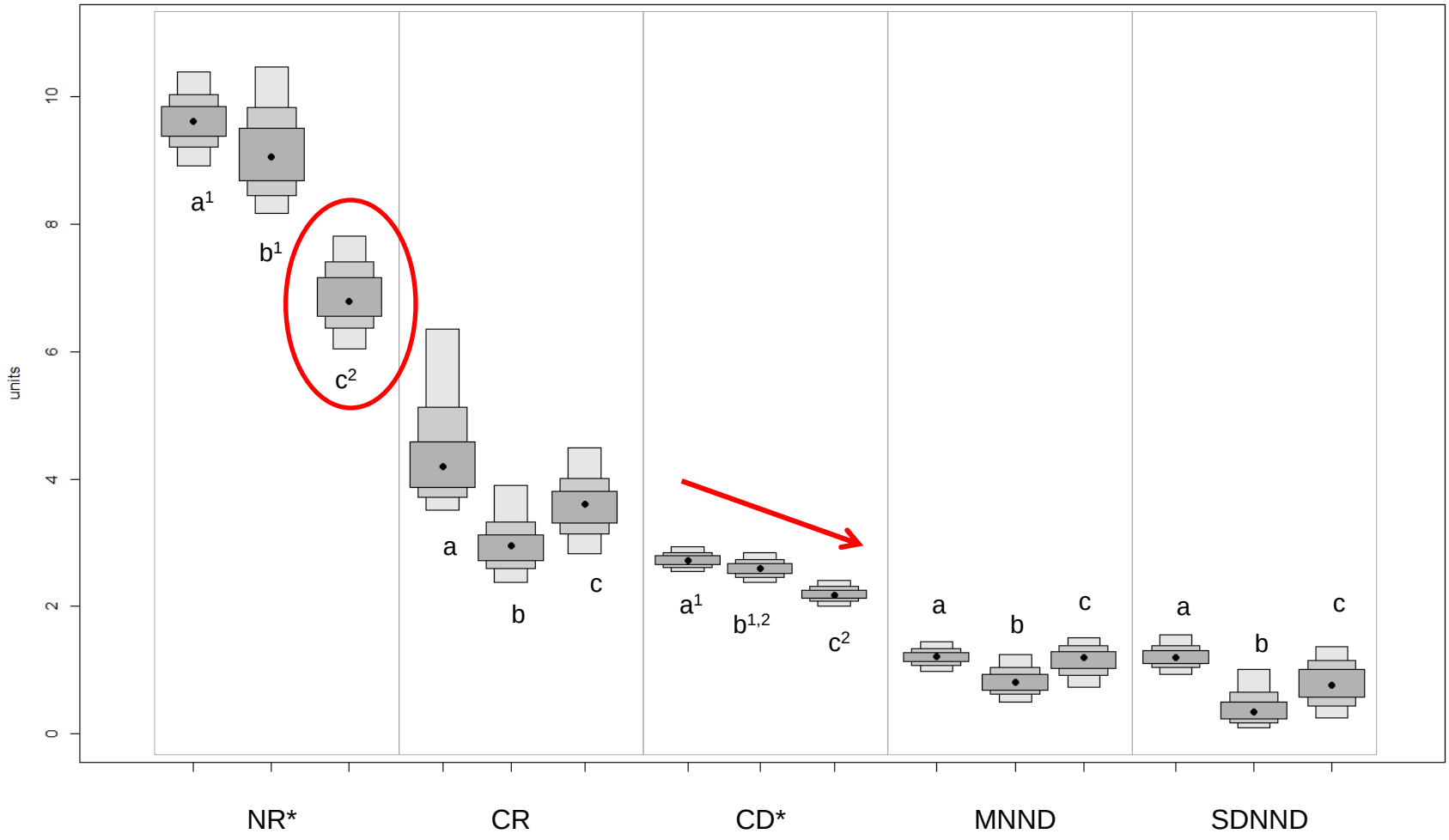
Layman metrics

1. NR → estructura vertical de la red.
2. CR → estructura horizontal de la red.
3. CD → grado medio de la diversidad trófica de la red.
4. MNND → densidad
5. SDNND → homogeneidad



Medida del espaciamiento en $\delta^{13}C$-$\delta^{15}N$

Medida la diversidad trófica y solapamiento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NR*
CR
CD*
MNND
SDNND

Layman metrics

Ecology, 88(1), 2007, pp. 42–48

CAN STABLE ISOTOPE RATIOS PROVIDE FOR COMMUNITY-WIDE MEASURES OF TROPHIC STRUCTURE?

Craig A. Layman,[1,5] D. Albrey Arrington,[2] Carmen G. Montaña,[3] and David M. Post[4]

1) **δ^{15}N Range (NR):** Distance between the two species with the most enriched and most depleted δ^{15}N values. Representation of vertical structure within a food web. Larger range in δ^{15}N among consumers suggests more trophic levels and thus a greater degree of trophic diversity.
2) **δ^{13}C range (CR):** Distance between the two species with the most enriched and most depleted δ^{13}C values. Increased CR would be expected in food webs in which there are multiple basal resources with varying δ^{13}C values, providing for niche diversification at the base of a food web.
3) **Total area (TA):** Convex hull area encompassed by all species in δ^{13}C – δ^{15}N bi-plot space. Measure of the total amount of niche space occupied, and thus a proxy for the total extent of trophic diversity within a food web.

Layman et al. 2007

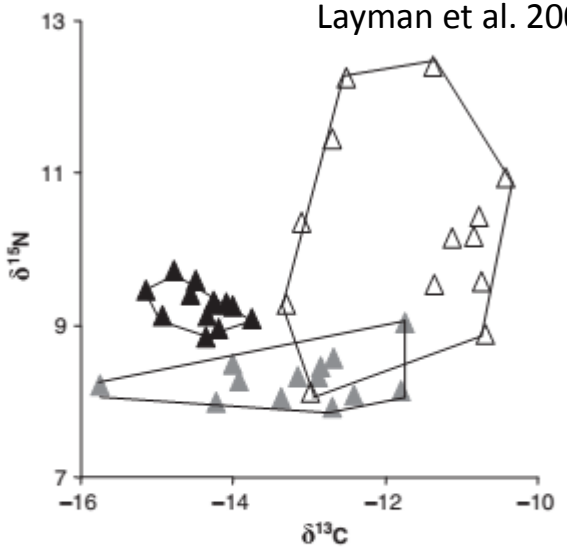


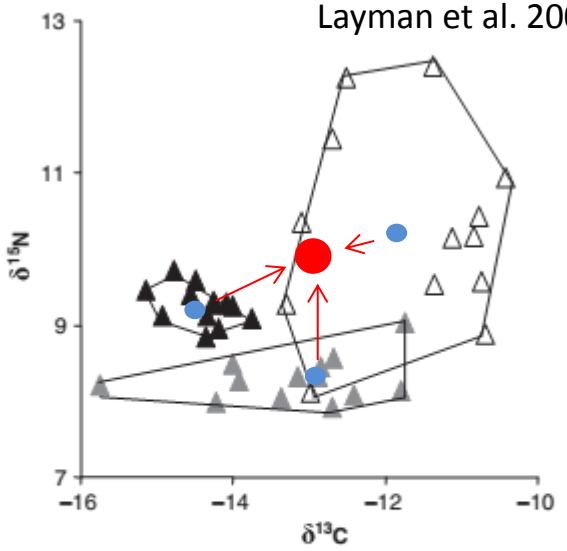
Figure 1 Each symbol represents an individual snapper and the lines represent the convex hull area used as a measure of niche width. White triangles are individuals from an unfragmented site, grey triangles from a partially fragmented site, and black triangles from a highly fragmented site (Cross Harbour, Sucking Fish, and Marsh Harbour, respectively, in Table 1).

4) Mean distance to centroid (CD): Average Euclidean distance of each species to the $\delta^{13}C$ –d15N centroid, where the centroid is the mean $\delta^{13}C$ and $\delta^{15}N$ value for all species in the food web.
Measure of the average degree of trophic diversity within a food web.
Better reflect the overall degree of trophic diversity in the food web.

5) Mean nearest neighbor distance (NND): Mean of the Euclidean distances to each species' nearest neighbor in bi-plot space, and thus a measure of the overall density of species packing.
Food webs with a large proportion of species characterized by similar trophic ecologies will exhibit a smaller NND (increased trophic redundancy) than a web in which species are, on average, more divergent in terms of their trophic niche.

6) Standard deviation of nearest neighbor distance (SDNND): A measure of the evenness of species packing in bi-plot space that is less influenced than NND by sample size. Low SDNND values suggest more even distribution of trophic niches.

Layman et al. 2007



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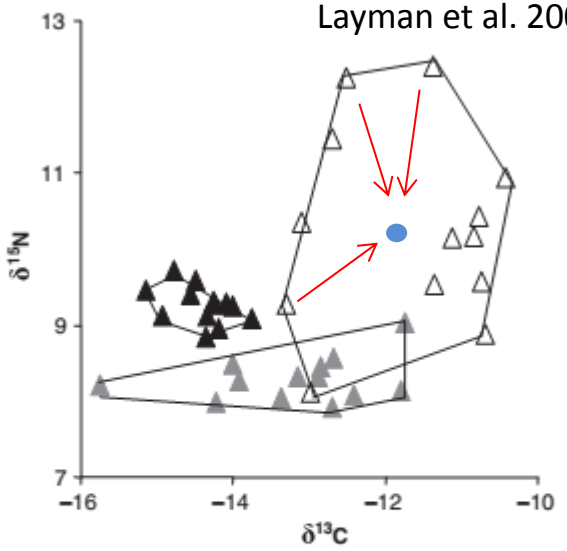

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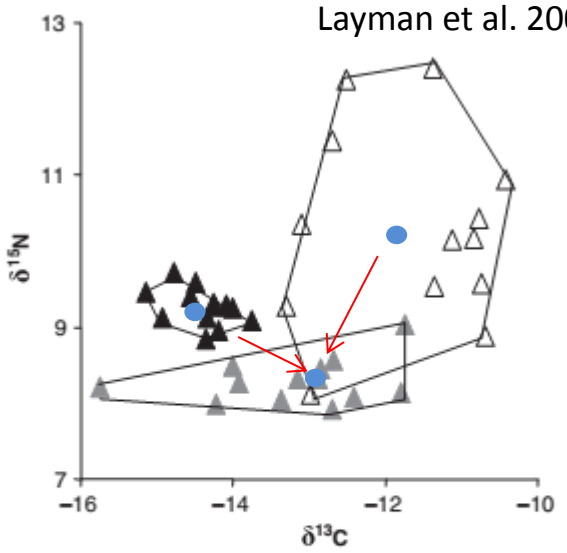
Layman et al. 2007



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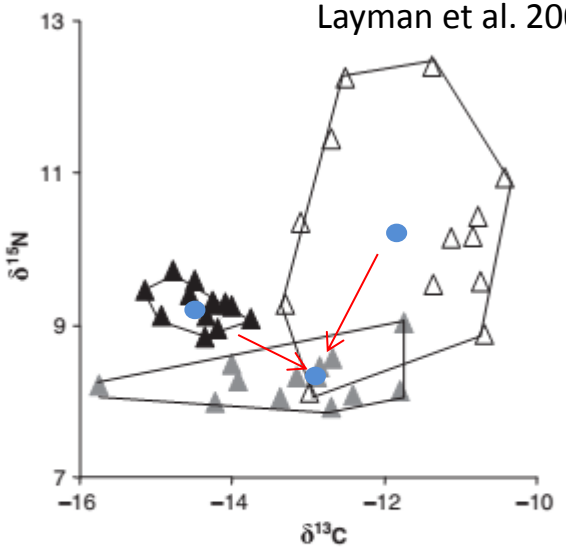

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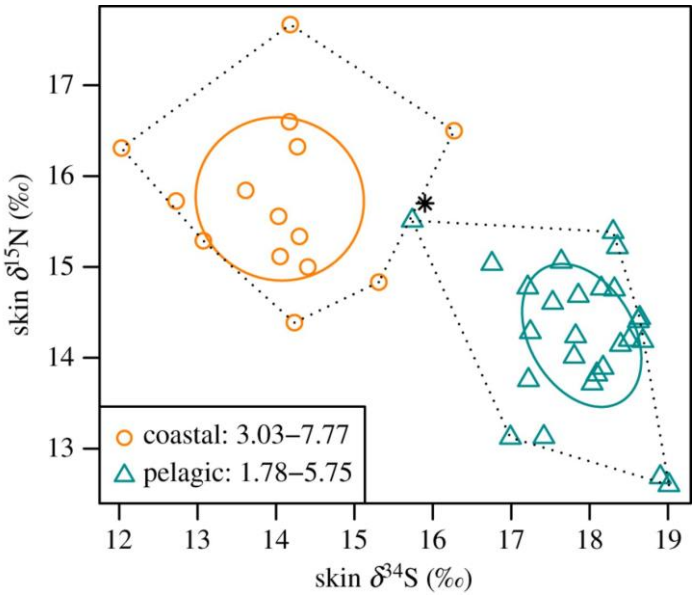
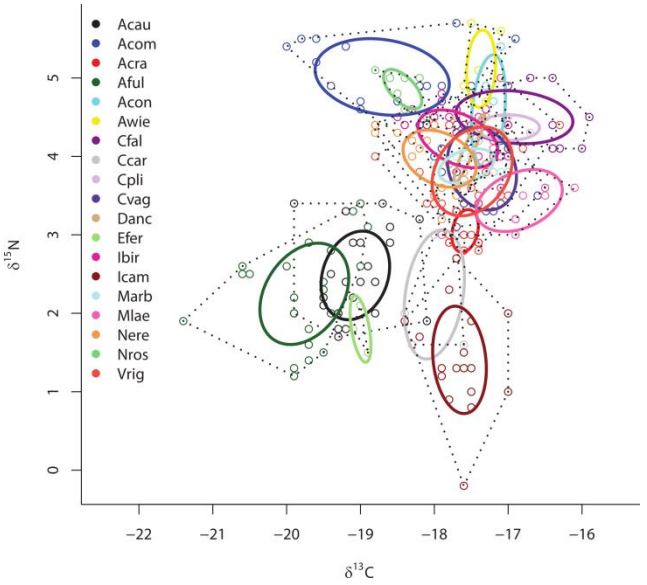
Journal of Animal Ecology

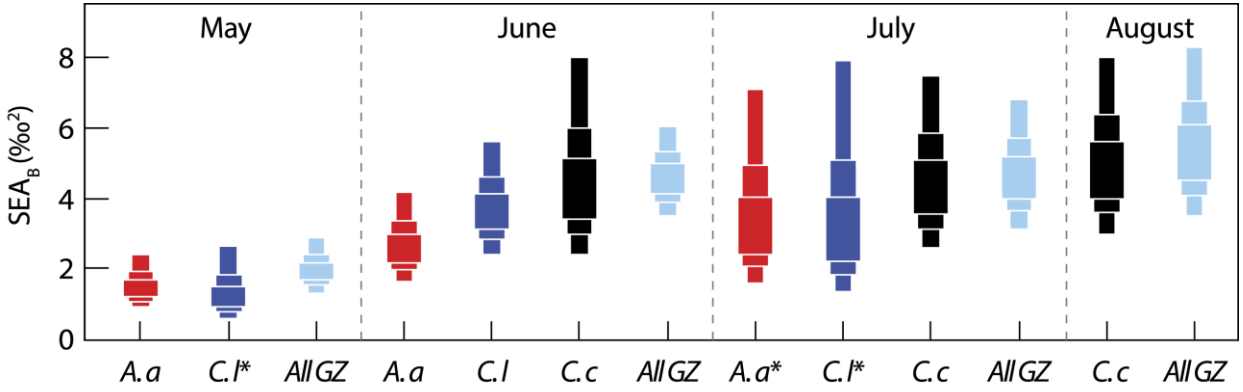
Journal of Animal Ecology 2011, **80**, 595–602 doi: 10.1111/j.1365-2656.2011.01806.x

Comparing isotopic niche widths among and within communities: SIBER – Stable Isotope Bayesian Ellipses in R

Andrew L. Jackson[1]*, Richard Inger[2], Andrew C. Parnell[3] and Stuart Bearhop[2]







Ecological Indicators 95 (2018) 32–40

Contents lists available at ScienceDirect

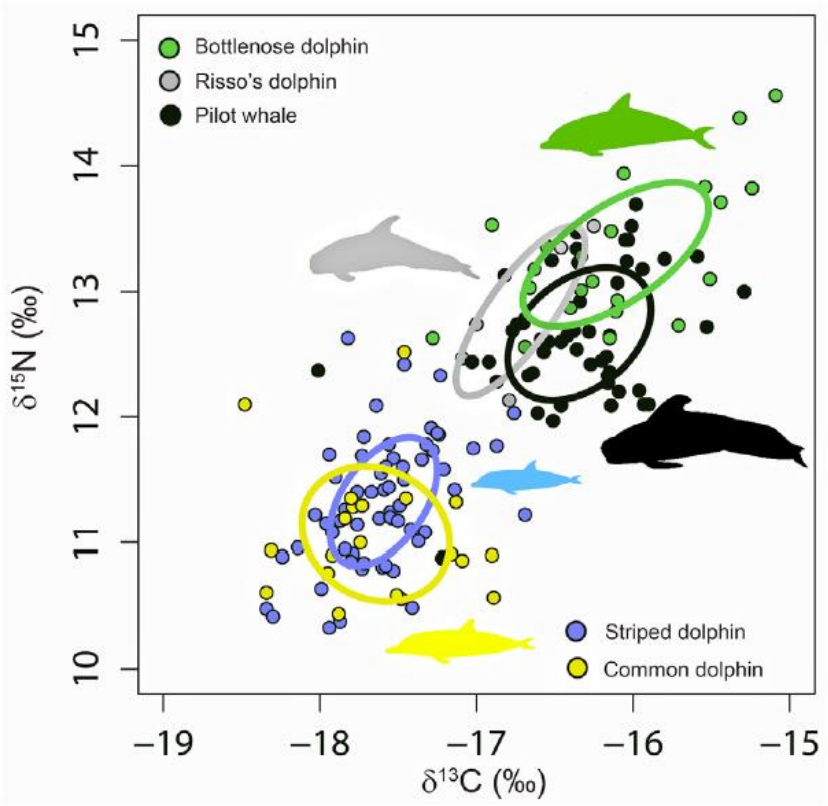
Ecological Indicators

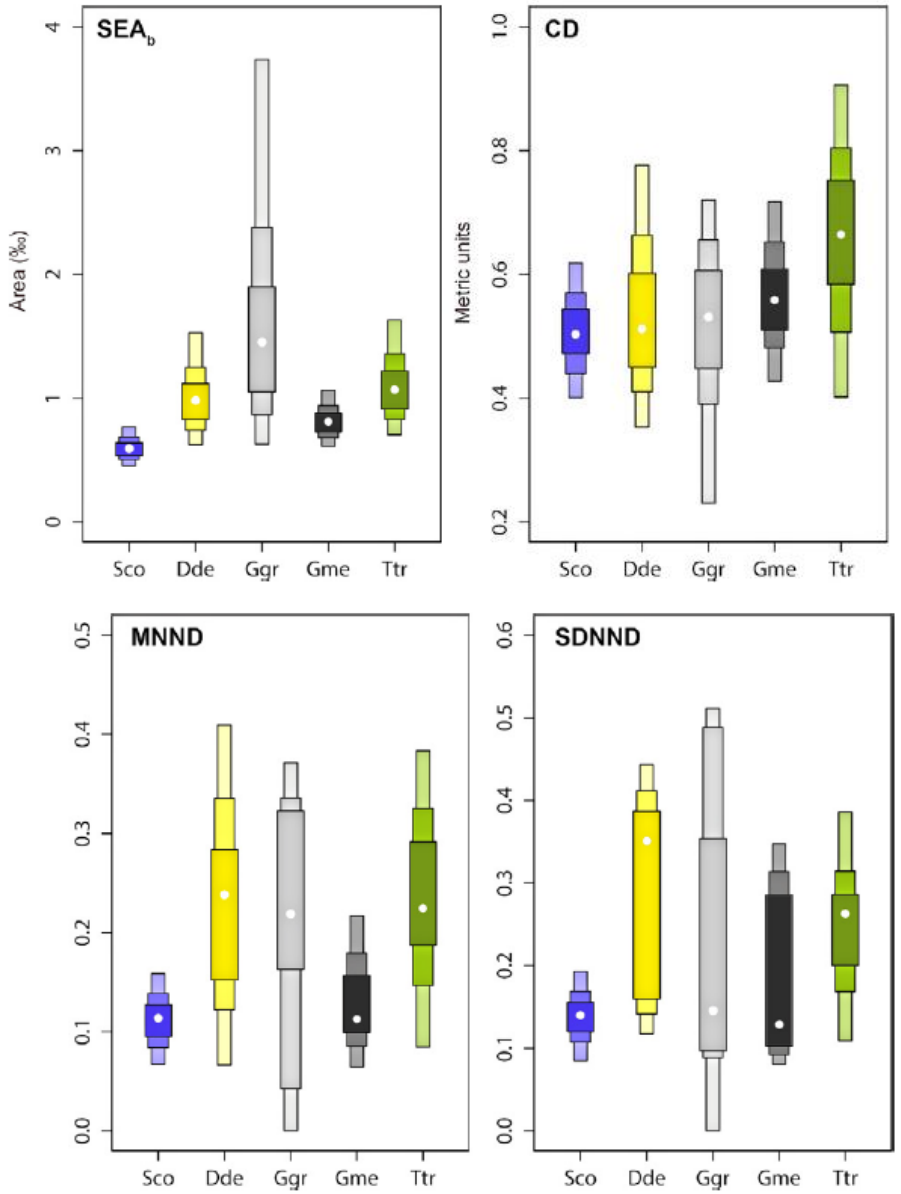
journal homepage: www.elsevier.com/locate/ecolind

Original Articles

Living apart together: Niche partitioning among Alboran Sea cetaceans

Joan Giménez[a,*], Ana Cañadas[b], Francisco Ramírez[c], Isabel Afán[d], Susana García-Tiscar[e], Carolina Fernández-Maldonado[f], Juan José Castillo[g], Renaud de Stephanis[h]

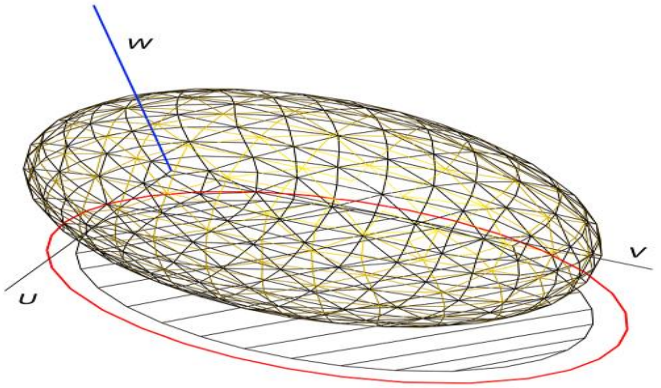


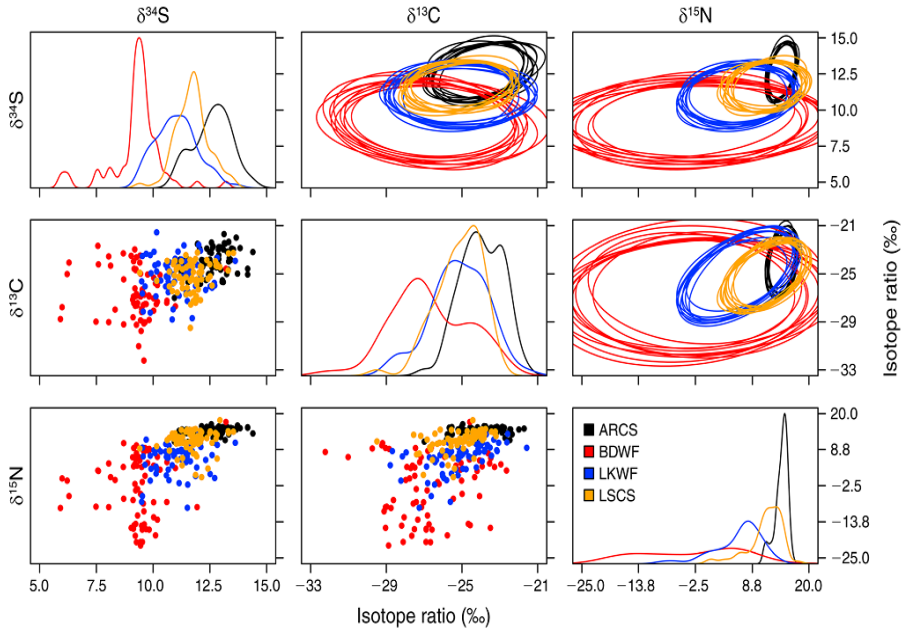


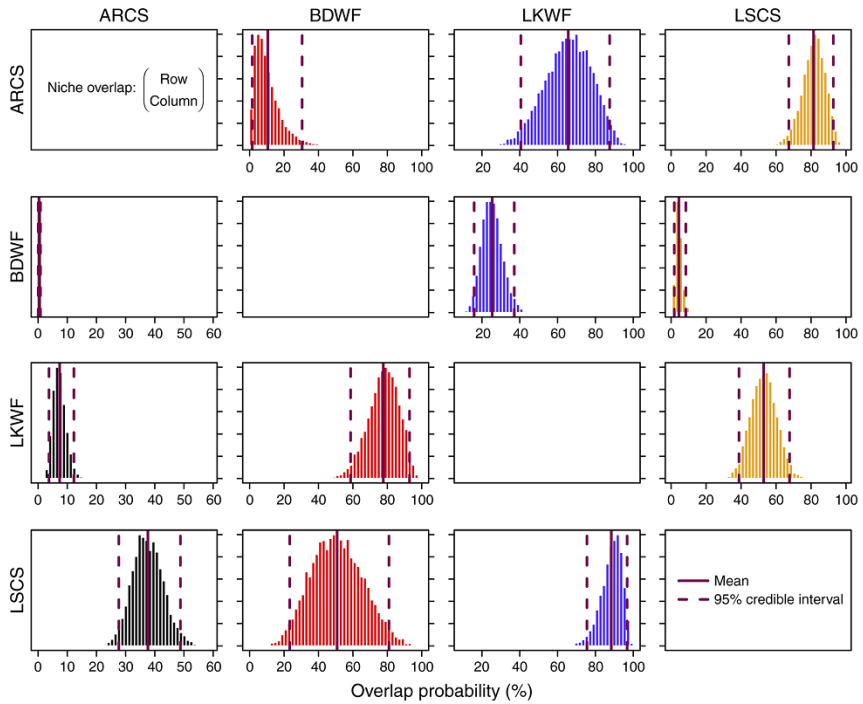
Ecology, 96(2), 2015, pp. 318–324

A new probabilistic method for quantifying *n*-dimensional ecological niches and niche overlap

Heidi K. Swanson,[1,4] Martin Lysy,[2] Michael Power,[1] Ashley D. Stasko,[1] Jim D. Johnson,[3] and James D. Reist[3]







Received: 30 November 2016 | Revised: 16 May 2017 | Accepted: 4 June 2017
DOI: 10.1002/aqc.2814

WILEY

RESEARCH ARTICLE

Towards the identification of ecological management units: A multidisciplinary approach for the effective management of bottlenose dolphins in the southern Iberian Peninsula

Joan Giménez[1] | Marie Louis[2,3] | Enrique Barón[4] | Francisco Ramírez[1] | Philippe Verborgh[5] | Pauline Gauffier[5] | Ruth Esteban[5] | Ethel Eljarrat[4] | Damià Barceló[4] | Manuela G. Forero[1] | Renaud de Stephanis[4]