

# Niches and Habitats

## EFB 390: Wildlife Ecology and Management

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February 21, 2022



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### What is a ecological niche?

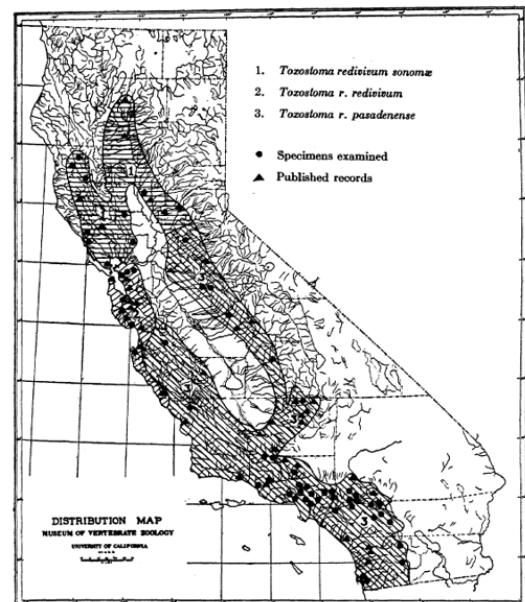
20th century ecologists developed a so-called **competitive exclusion principle**, which said that two organisms with the same needs in the same place cannot co-exist.

"No 2 species of birds or mammals will be found to occupy precisely the same niche"

*Grinnell (1917) "The niche relationships of the California Thrasher"*

According to Grinnell:

1. **First order determinant** is abiotic:  
physiology/temperature/precipitation/etc..
2. **Second order determinant** is 'faunal' – i.e.,  
biotic interactions and especially competition.

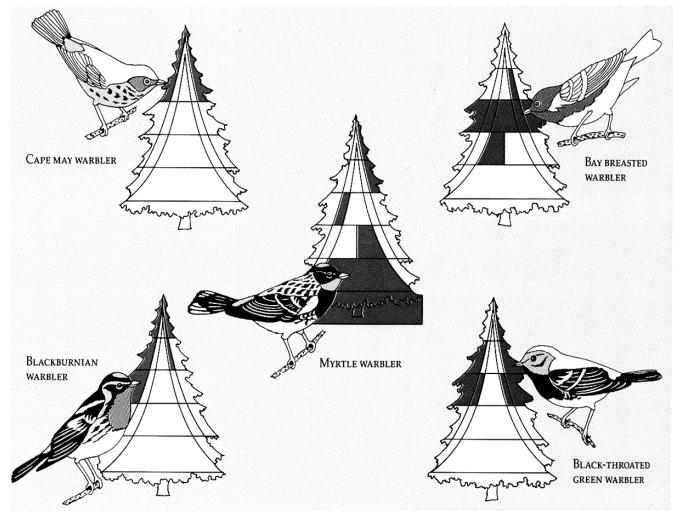


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# But niches can be very specific!

Seems like species can do a nice job of *partitioning* their niches.

## Partitioning of microhabitat.



MacArthur (1954) warblers

## Niche partitioning of resources

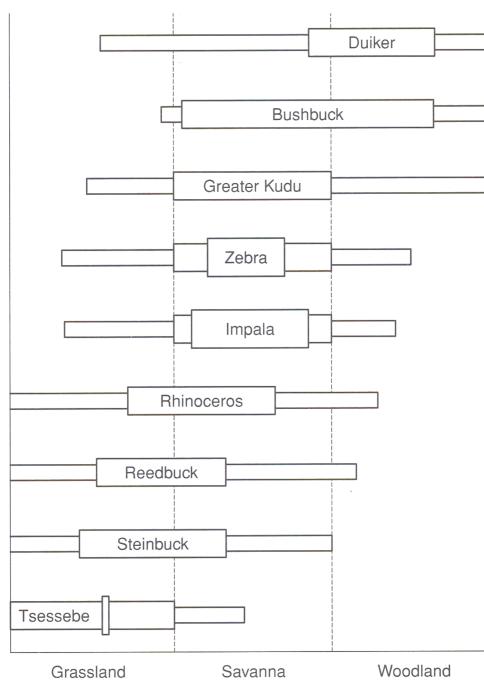


Fig. 9.10 Habitat partitioning and overlap by ungulates in Kyle National Park, Zimbabwe. The width of the boxes reflects the degree of preference. (After Ferrar and Walker 1974.)



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# Niche partitioning in time

Asiatic cheetahs on the brink of extinction with only 50 left alive

With UN funds being cut this month, conservationists call for last-ditch effort to save animal which clings on only in Iran



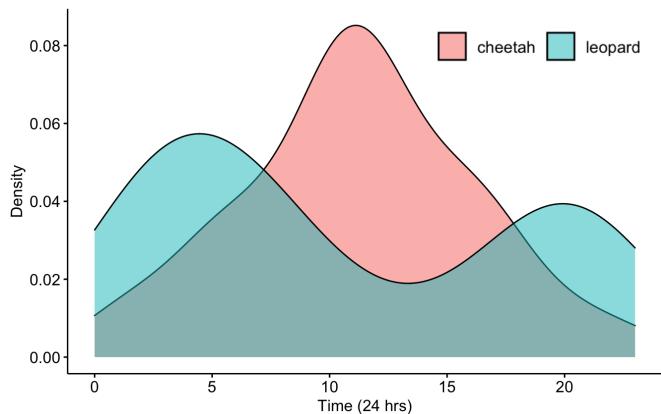
Zoology in the Middle East, 2019  
<http://dx.doi.org/10.1080/09397140.2019.1632538>

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## Inter-dependent movements of Asiatic Cheetahs *Acinonyx jubatus venaticus* and a Persian Leopard *Panthera pardus saxicolor* in a desert environment in Iran (Mammalia: Felidae)

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## Daily activity patterns



## Grinnell (1917) Niche

- Competition among species can be part of the ‘niche’
- Other resources (biotic, abiotic) and ‘space’ can also be part of the niche
- In this definition: ‘habitat’ (structure) is only part of the niche

So:

**habitat < niche**

# Elton (1927) Niche

Emphasizes the functional role of a species within a community (not where it lives, but what it does).

So: **habitat**  $\neq$  **niche**

- **Niche** is the **profession** of a species
- **Habitat** is the **address** where that species actually lives.

"when an ecologist sees a badger, they should include in their thoughts some definitive idea of the animal's place in the community to which it belongs, just as if they had said 'there goes the vicar'".

For example: the **niche** filled by *birds of prey that eat small animals*

- In an oak wood this niche is "occupied" by **tawny owls**.
- In open grassland it is "occupied" by **kestrels**.



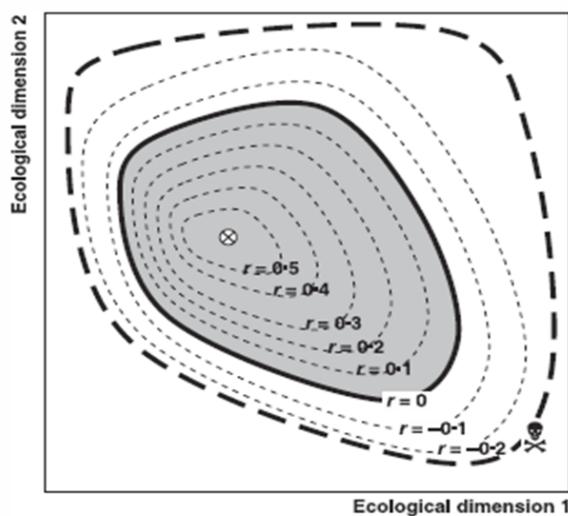
Japanese badger priest

Elton (1927) *Animal Ecology*

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# Hutchinson (1957) Niche

The range of physical and biological conditions (including limiting resources) needed for a species to maintain a stable or increasing population size



Two dimensions can be Soil Moisture and Temperature for a plant.



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# $n$ -dimensional hypervolume

← Tweet

Brian J. Enquist  
@bjenquist

Still one of my all time favorite ecol graphics - 3D fundamental niche of a squirrel Hutchinson 1978 p159  
[#hypervolume](#)

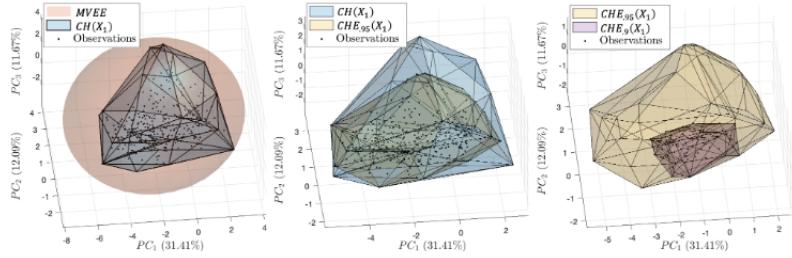
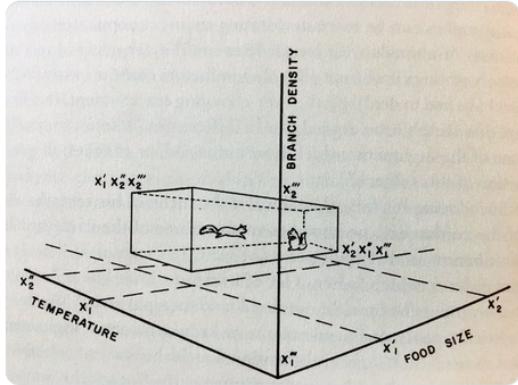


Figure 2: Comparison of the hypervolumes generated by the MVEE, CH, and CHE approaches for the species Bbar with  $n = 3$ .

A new method to estimate the ecological niche through  $n$ -dimensional hypervolumes that combines convex hulls and elliptical envelopes

Jaime Carrasco<sup>a,b,\*</sup>, Fulgencio Lisón<sup>c,d</sup>, Laura Jiménez<sup>e</sup>, and Andrés Weintraub<sup>a,b</sup>

March 4, 2022

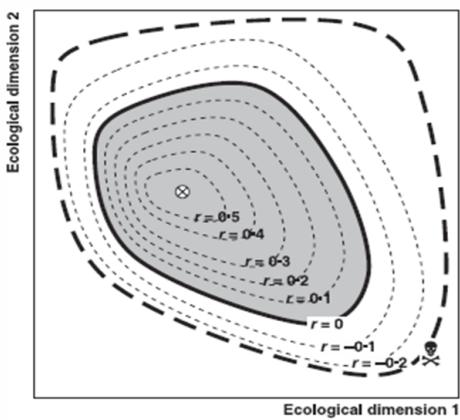
can get pretty abstract pretty fast

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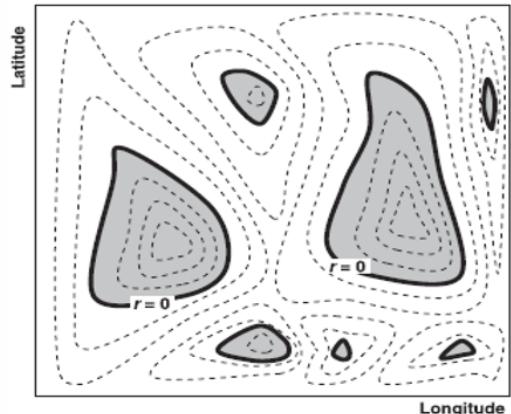
## Hutchinson Niche → Habitat

They can be mapped onto each other. Note the edge of the niche is defined where population growth  $r > 0$ .

Niche = Environmental Space



Habitat = Geographic Space



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# Niche hypervolume in practice

## Satellite data identify decadal trends in the quality of *Pygoscelis* penguin chick-rearing habitat

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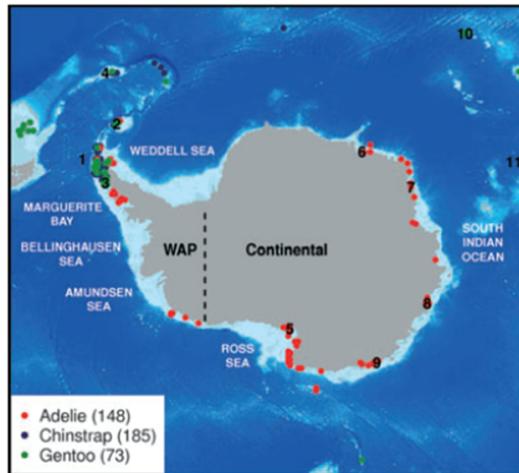


Fig. 1 Location of 406 Antarctic and sub-Antarctic penguin breeding colonies in the Southern Ocean with bathymetry in the background. Light blue represents shallow regions whereas deeper waters are darker blue. The number of unique breeding locations for each species is given in parenthesis. The dotted line separates WAP Adélie colonies from continental Adélie colonies. Numbers 1–11 correspond to breeding colonies with documented population trends given in Table 2.

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# Niche hypervolume in practice

Most of the points outside the bubbles have decreasing population trends.

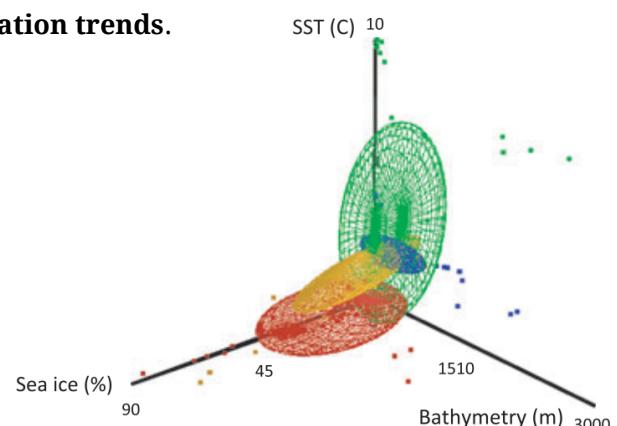
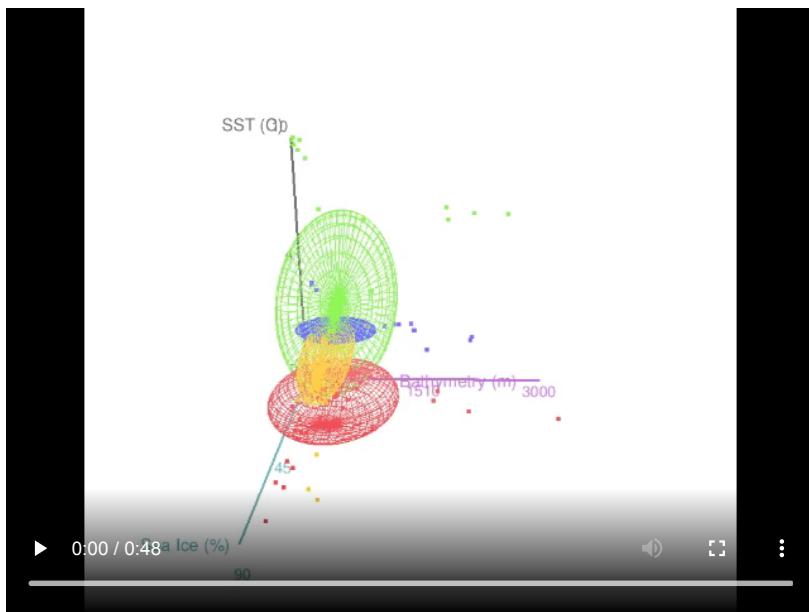


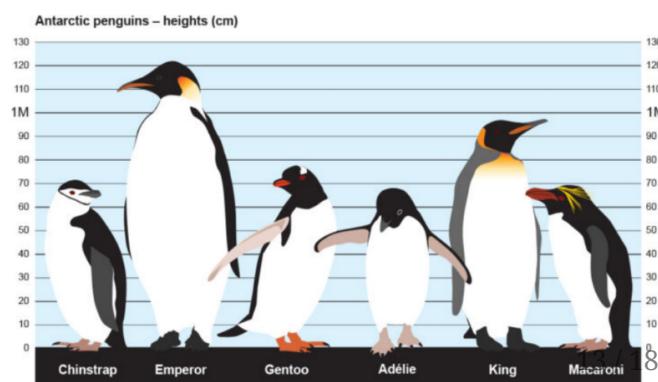
Fig. 4 Niche spaces defined by SIC, SST, and bathymetry for continental Adélie penguins (red), WAP Adélie penguins (orange), Gentoo penguins (green), and Chinstrap penguins (blue). Each point represents mean conditions at a nest site throughout the satellite record. See Fig. S3 for a rotating plot of niche spaces.

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# How to visualize a niche hypervolume



- Adélie penguin
- Western Antarctic Adélie penguin
- Gentoo penguin
- Chinstrap penguin

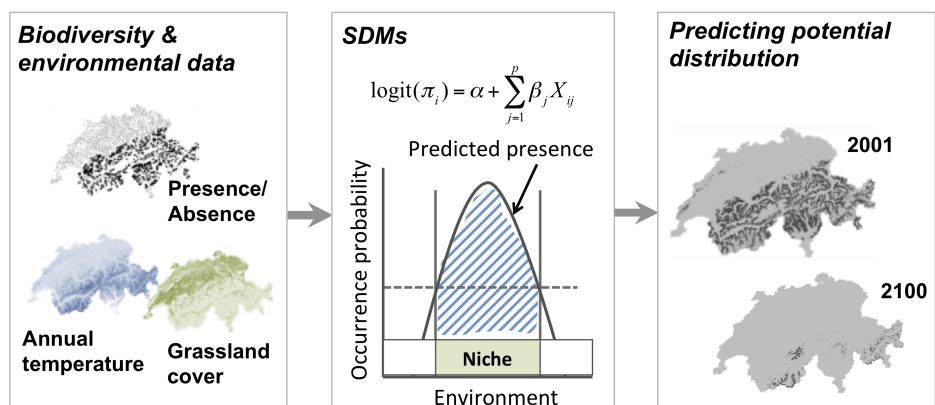


## Niche concept underlies most Species Distribution Modeling (SDM)

aka: environmental (or ecological) niche modeling (ENM) or simply range mapping

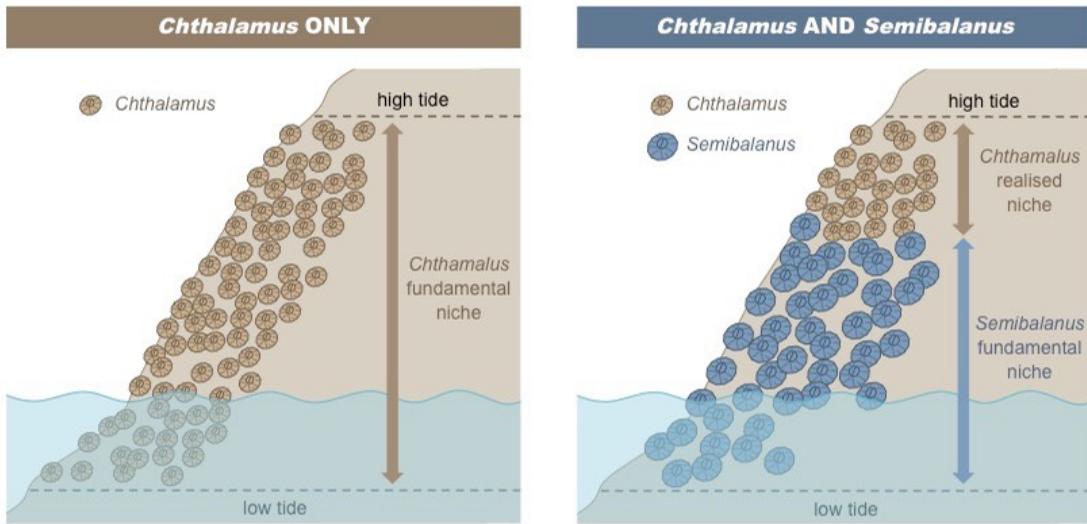
Large-scale mapping of **Species Distributions** against covariates ... e.g. temperature, precipitation, elevation, human impacts, landcover, vegetation, etc.

Very useful for making, e.g., climate change predictions.



# Fundamental vs. realized niche

- **fundamental** - what a species *could* be
- **realized** - where a species actually *is*



**Antarctica** is *not* polar bear habitat, but it **IS** polar bear fundamental niche!

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## Niche summary

- The concept of **niche** emerged to explain why animals exist and co-exist in particular areas AND behave in certain ways.
- Under typical current usage: **niche** is environmental/biological ‘space’, **habitat** occurs in geographic space.
  - Niche is the ‘profession’ of a species....
  - Habitat is the ‘address’ of a species....
- Niche is a property of a *species*, habitat is property of an *individual* (or *subpopulation*) within Niche space.
- Niche is useful for modeling **global ranges**.
- Habitat is useful for looking at **populations of interest** in specific locations.



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# More important definitions

## Habitat use

The way in which an individual or species uses habitat to meet its life history needs.

## Habitat selection

The **process** involving decisions made by an animal about what habitat it would use. Depends on **scale of selection**.

*Hall and Krausman are very picky about these, as you will see when you work on this week's assignment.*

## Habitat availability

The relative frequency of habitats that are *accessible* to an individual.

## Habitat utilization

The relative frequency of time spent in available habitats.

## Habitat preference

The disproportional use of some resources over others.

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# Some References

- Cheraghi, F., M. R. Delavar, F. Amiraslani, K. Alavipanah, E. Gurarie, L. Hunter, S. Ostrowski, H. Jowkar, and W. F. Fagan. 2019. Inter-dependent movements of Asiatic Cheetah and Persian Leopard in their environment. *Zoology in the Middle East* 1.
- Cimino, M. A., W. R. Fraser, A. J. Irwin, and M. J. Oliver. 2013. Satellite data identify decadal trends in the quality of Pygoscelis penguin chick-rearing habitat. *Global change biology* 19:136–148.
- Elton, C. S. 2001. *Animal ecology*. University of Chicago Press, Chicago.
- Grinnell, J. 1917. The niche-relationships of the California Thrasher. *The Auk* 34:427–433.
- Hall, L. S., P. R. Krausman, and M. L. Morrison. 1997. The Habitat Concept and a Plea for Standard Terminology. *Wildlife Society Bulletin* 25:173–182.
- Hutchinson, G. 1978. *An Introduction to Population Biology*, Yale U. Press, New Haven, Conn 260.
- Hutchinson, G. E. 1957. The multivariate niche. Pages 415–421 *Cold Spring Harbor Symposia on Quantitative Biology*. Krausman, P. R. (n.d.). *Some Basic Principles of Habitat Use*:6.
- MacArthur, R. H. 1958. Population Ecology of Some Warblers of Northeastern Coniferous Forests. *Ecology* 39:599–619.

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