

# *Drivers of freshwater fish biodiversity depend on location and isolation in the circumpolar Arctic*

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*Photo: Gates of the Arctic National Park, NPS.gov*



# Describing patterns of diversity is a first step in determining the status of Arctic freshwater fishes

- Fish are integral in freshwater ecosystems
- Little information on the processes that drive biodiversity



Photo credit: USFWS



# Fish biodiversity is vulnerable to stressors

- Climate change
- Fishing pressure
- Introduced species
- Development/habitat alteration

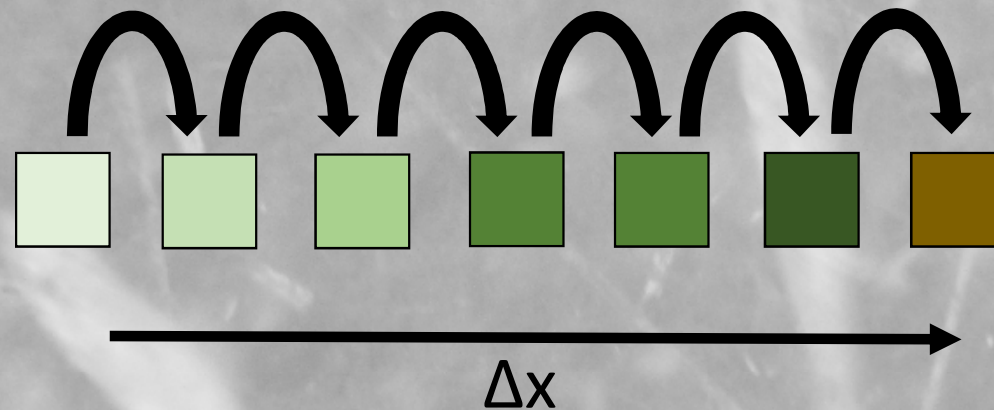


Photo credit: ShoreZoo



## Establish a baseline for monitoring

- Ability to detect temporal and spatial changes in biodiversity
- Inform monitoring and decision making



# Objectives

- Determine broad scale patterns of fish richness & composition
  - Arctic zone
  - Ecoregion



# Objectives

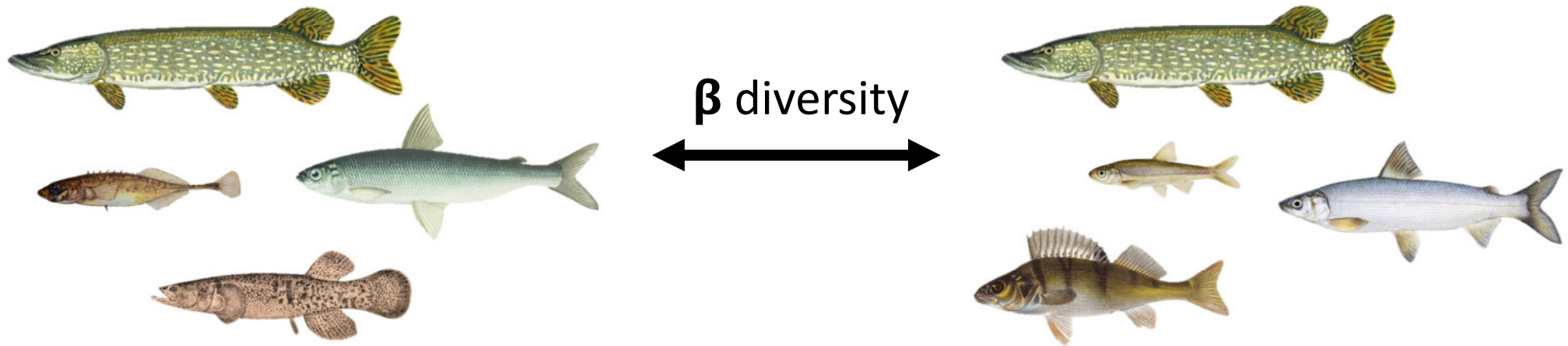
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# Objectives

- Determine broad scale patterns of fish richness & composition
  - Arctic zone
  - Ecoregion
- Determine the process underlying fish community dissimilarity
  - Species replacement v. loss

# How do communities vary across ecoregions & zones?

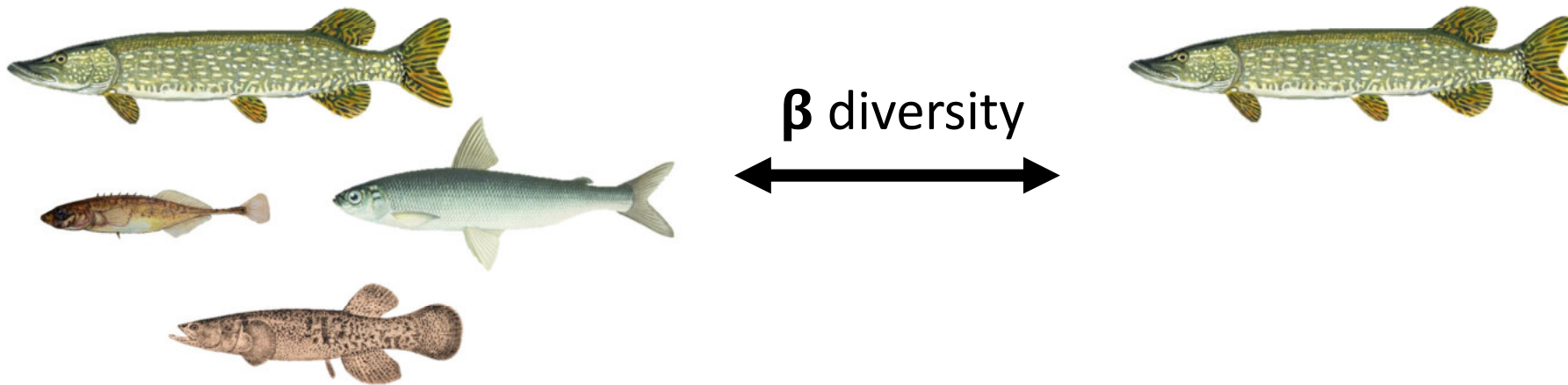


- Area/size
- History (i.e., glaciations)
- Geomorphology
- Climate

- Surface geology
- Hydrology
- Proximity to sea
- Habitat heterogeneity

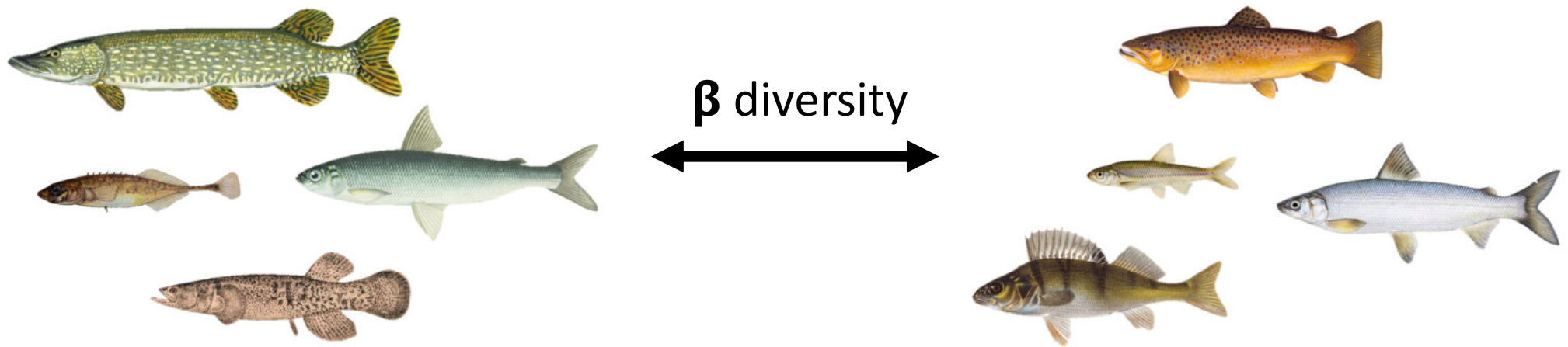


# How do communities vary across ecoregions & zones?



Dissimilarity via loss  $\rightarrow$  Nestedness

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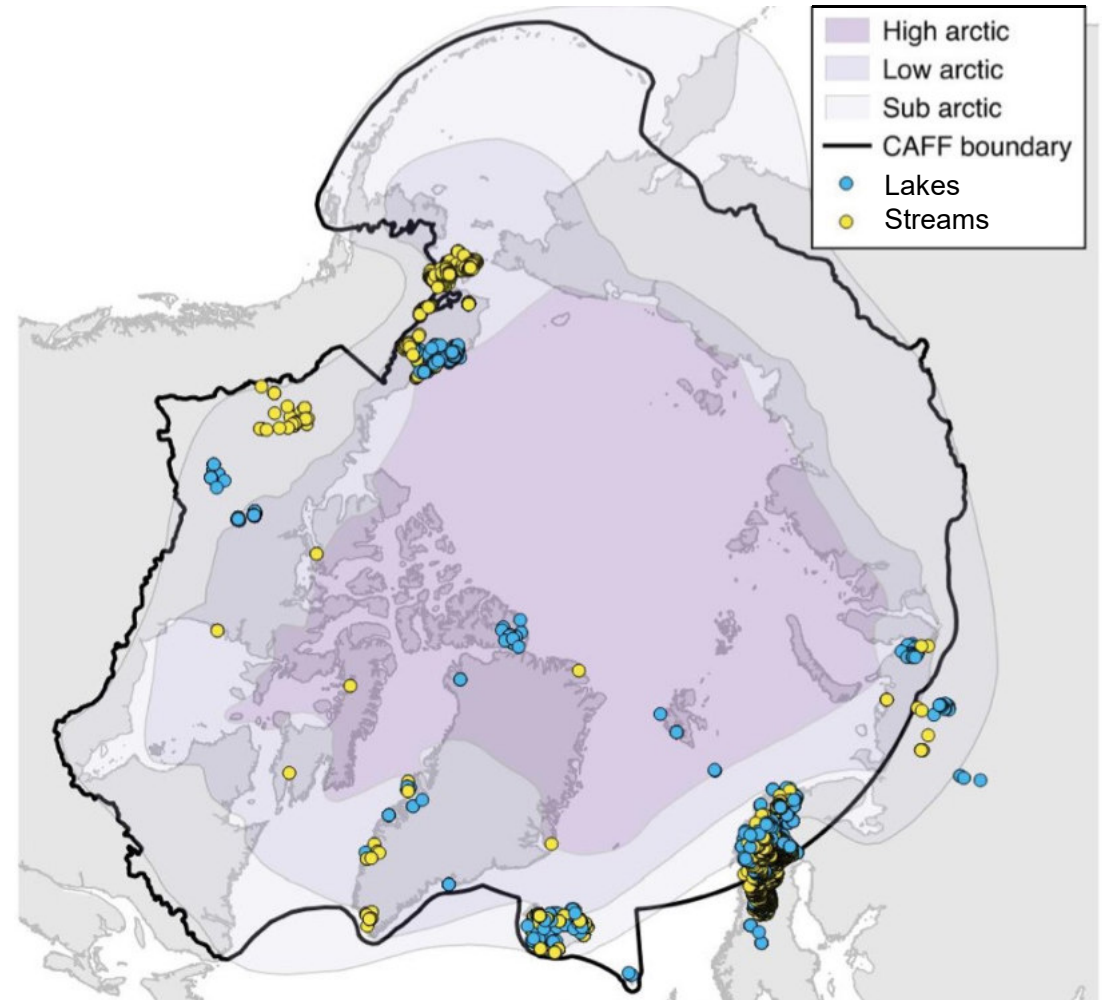


Dissimilarity via replacement  $\rightarrow$  Turnover

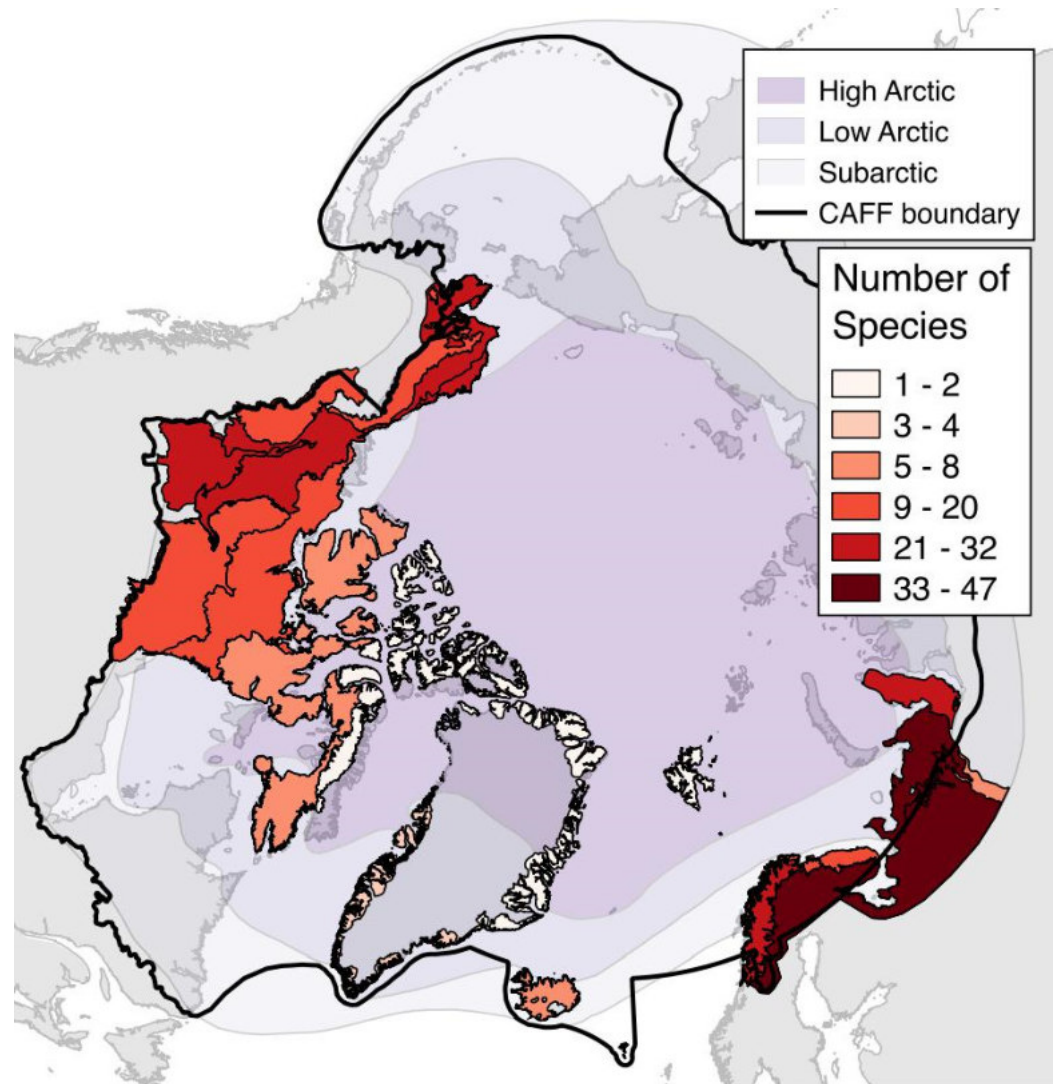


## Samples are patchy in space and time

- 3,148 stations from CBMP
  - 67% streams, 33% lakes
- 299 hydrobasins
- 4 zones
- 25 ecoregions
- 55 species in database
  - 44% of all known species
- Community matrices

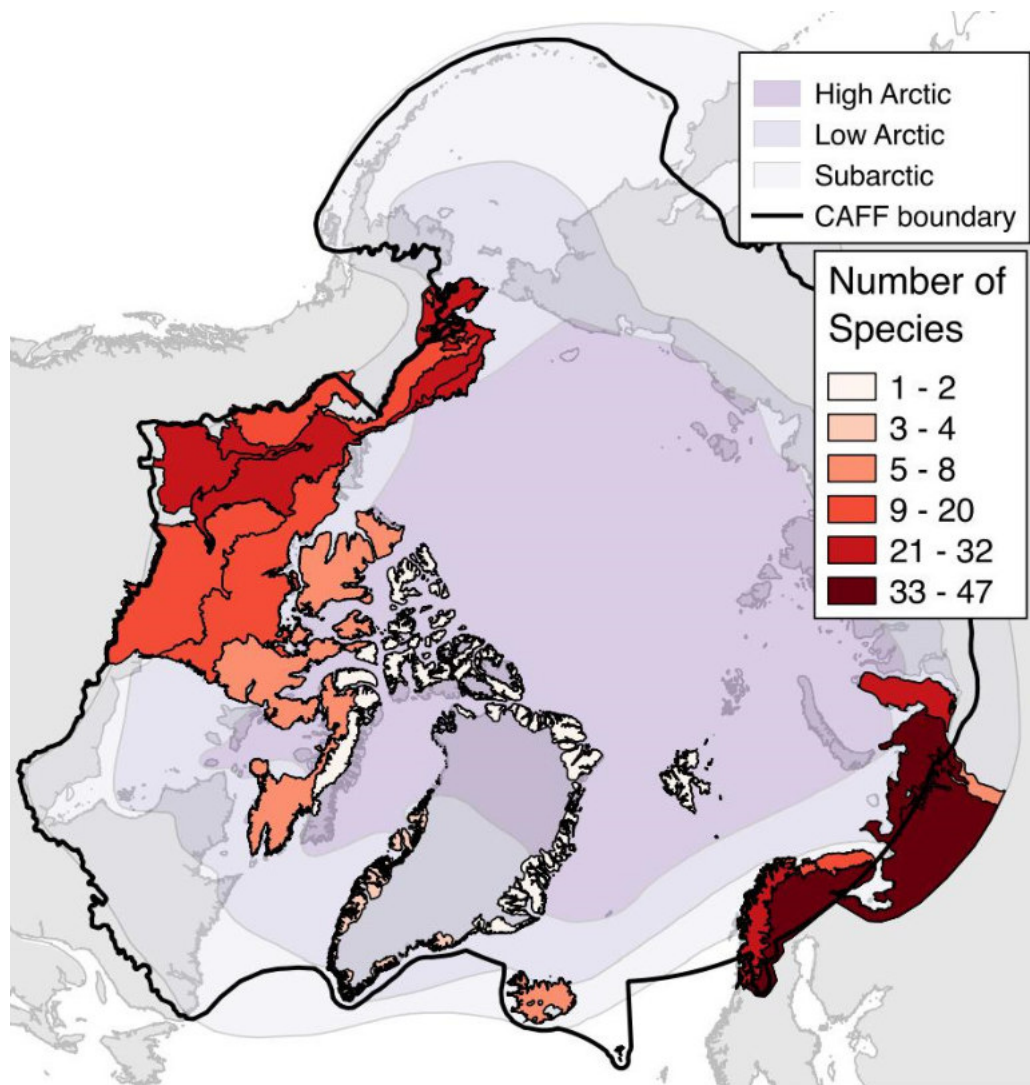
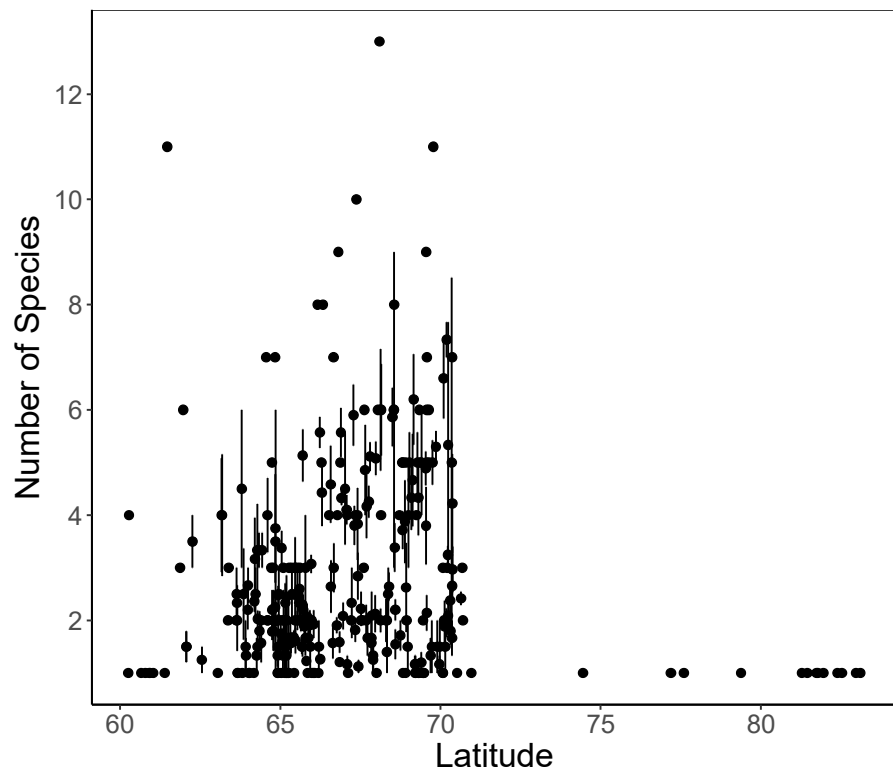


## Richness related to modern & historic environment

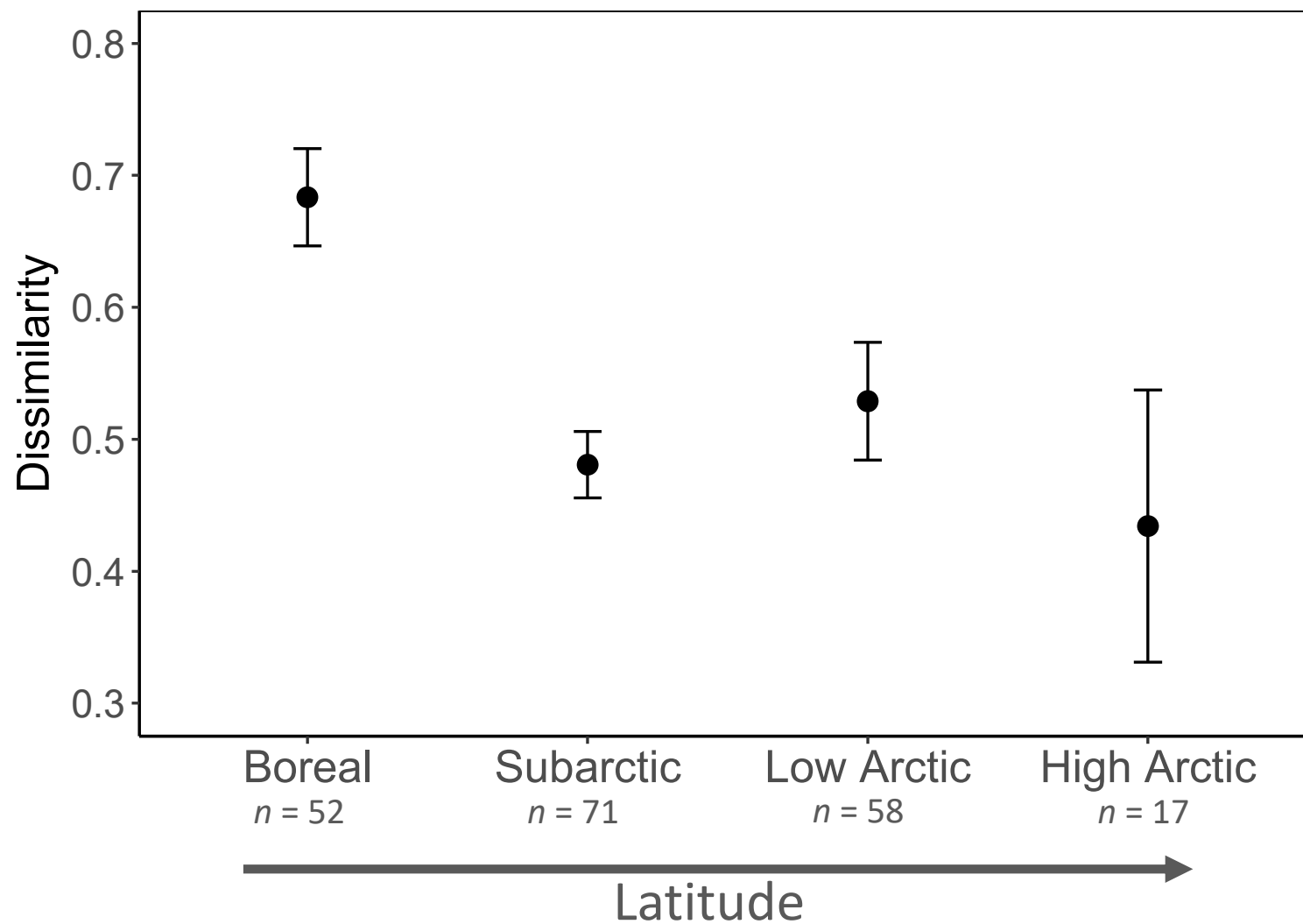




## Richness related to modern & historic environment

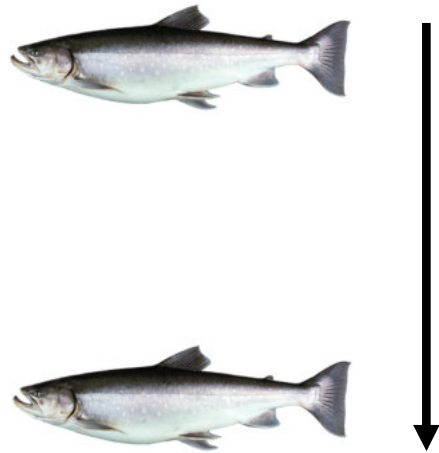


## Beta diversity reduced in high Arctic





# No variation in high Arctic species assemblages

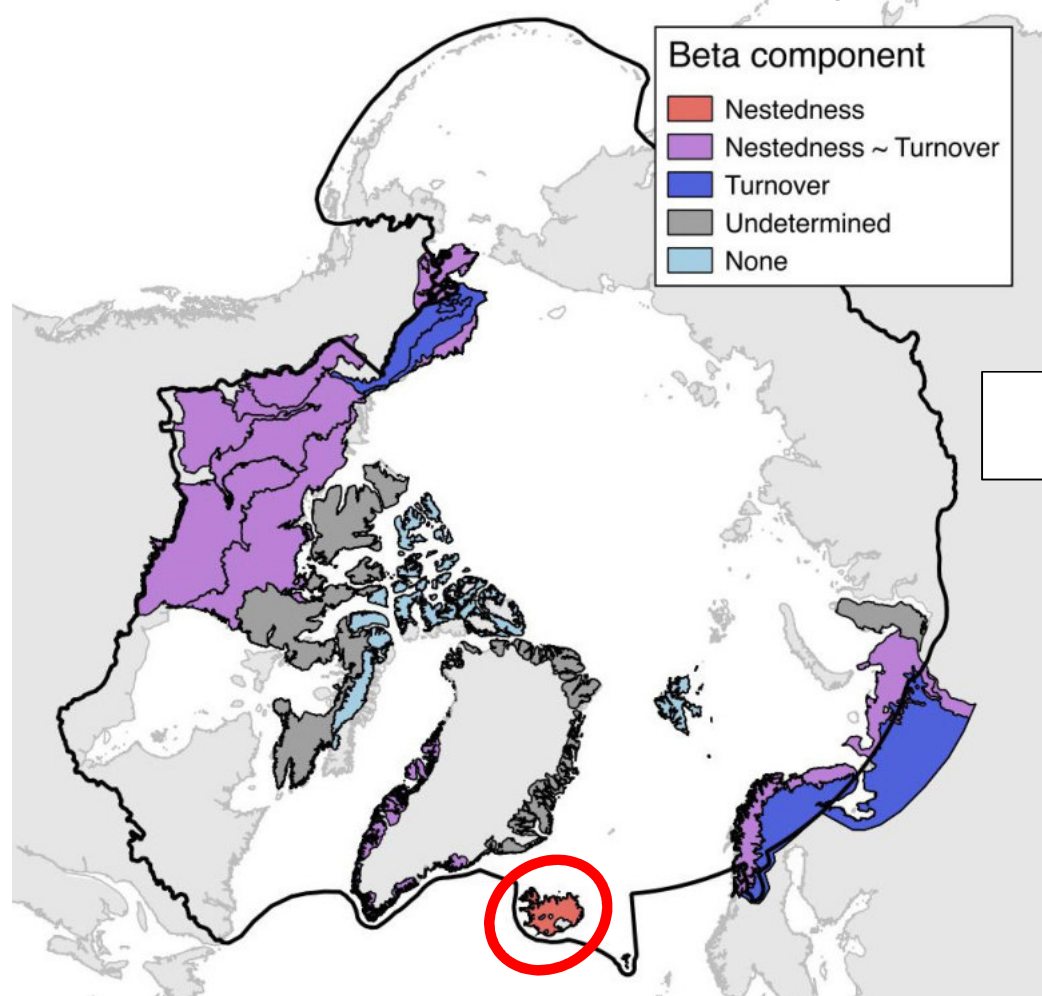
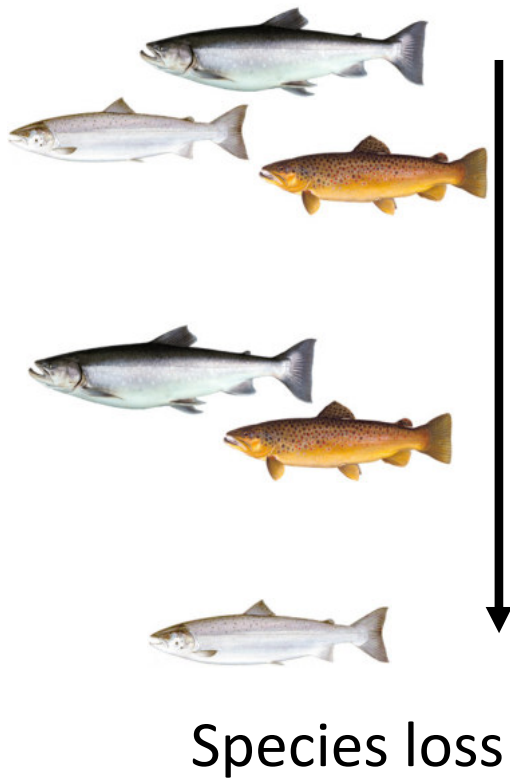


No change



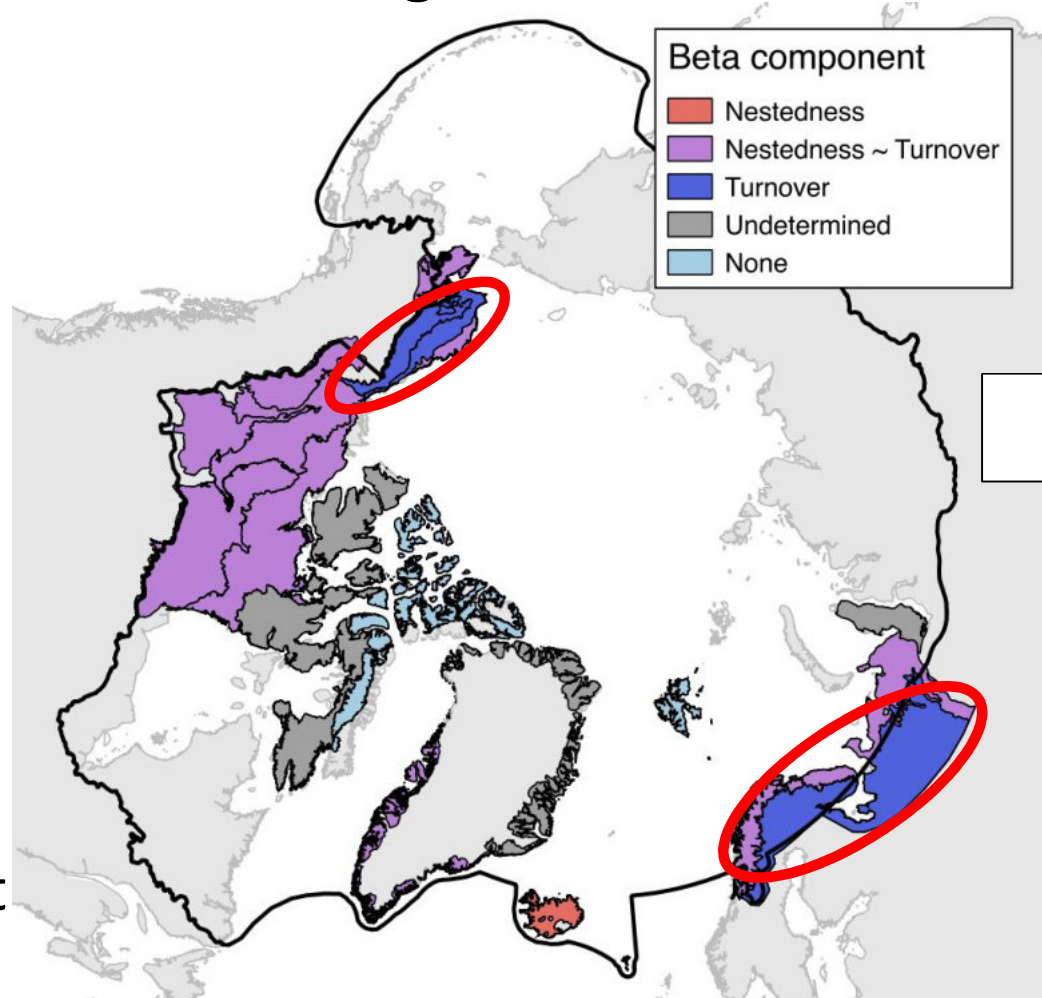
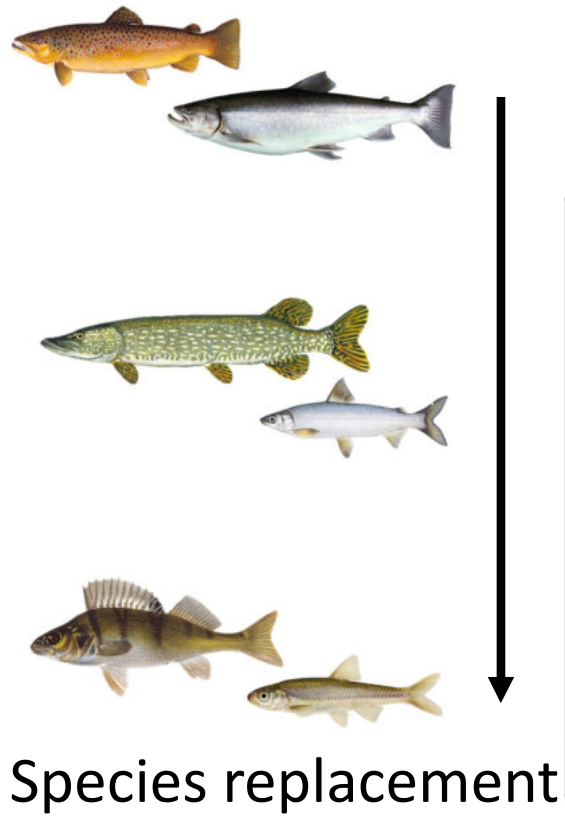
$$\beta_{\text{nest}} = \beta_{\text{turn}} = 0$$

# Isolation resulted in nested patterns



$$\beta_{\text{nest}} \gg \beta_{\text{turn}}$$

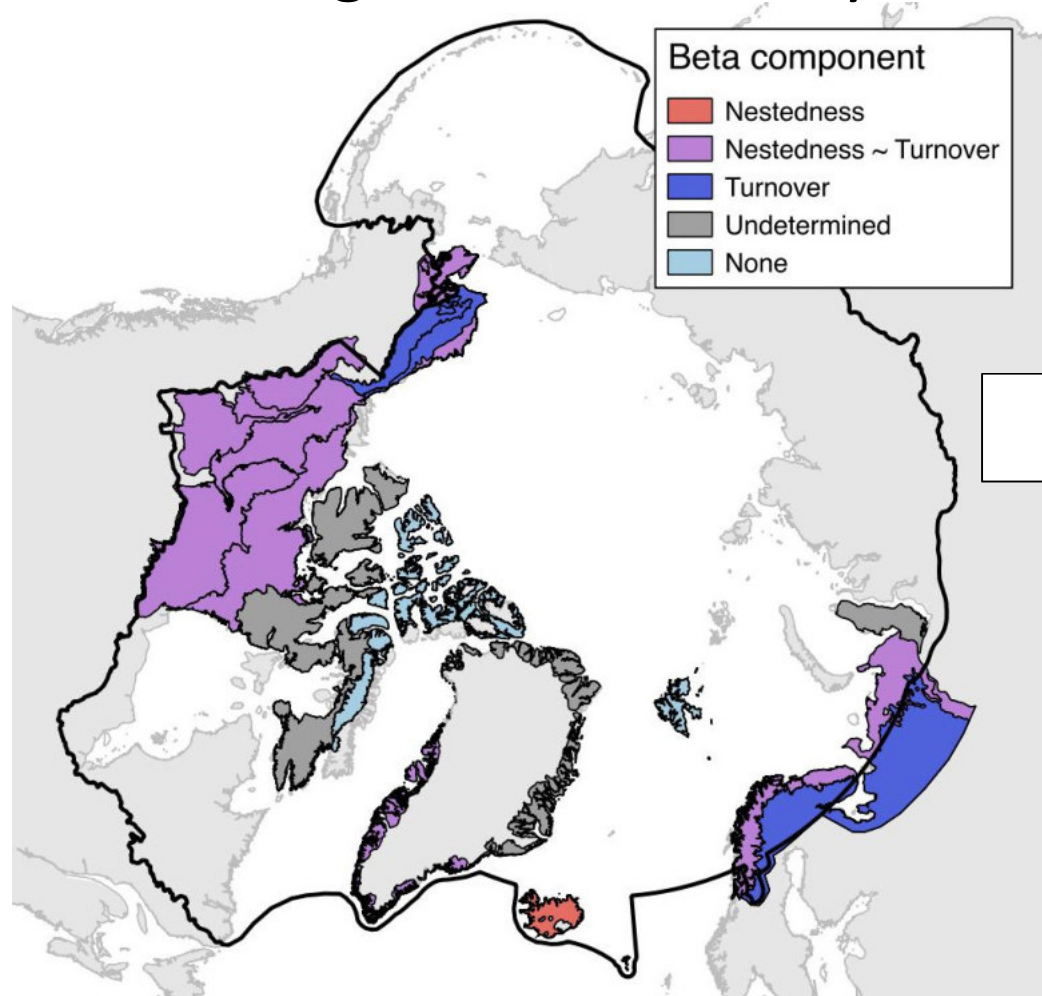
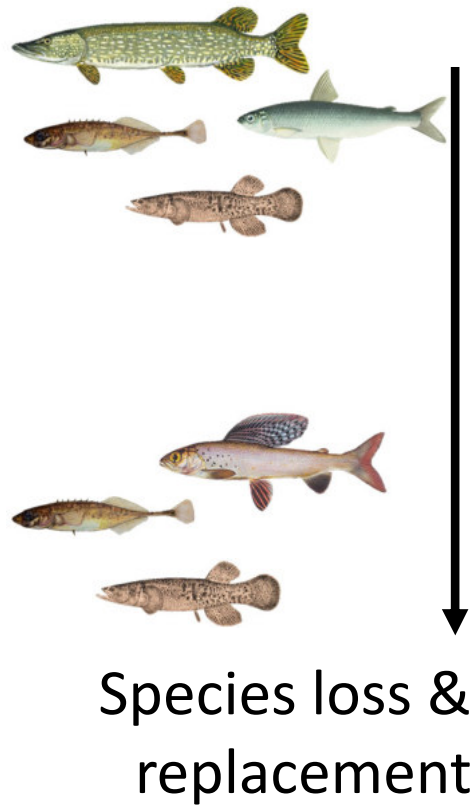
# Spatial & environmental gradients contributed to turnover



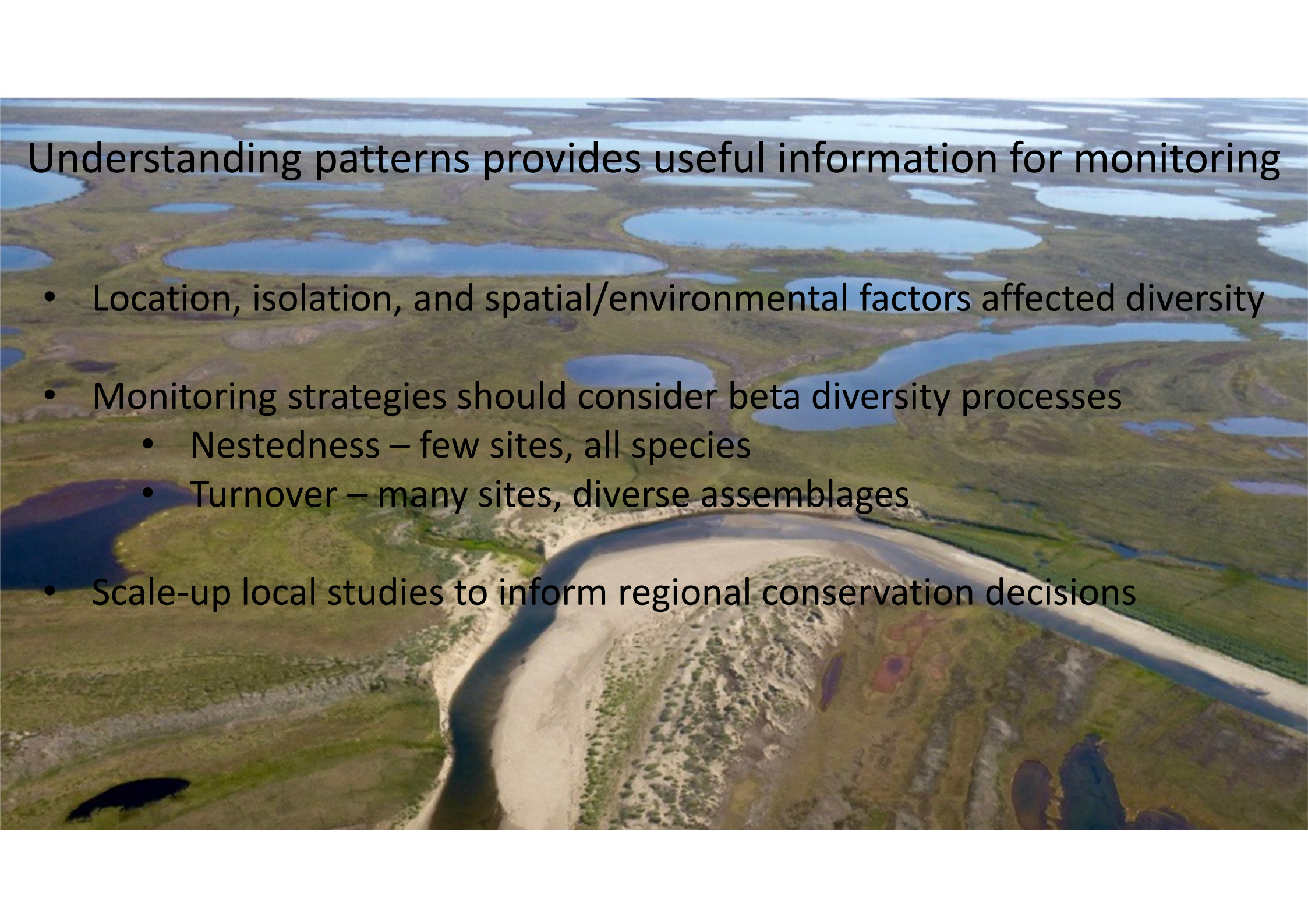
$$\beta_{\text{nest}} \ll \beta_{\text{turn}}$$



# Beta diversity in most ecoregions is caused by nestedness & turnover



$$\beta_{\text{nest}} \approx \beta_{\text{turn}}$$



## Understanding patterns provides useful information for monitoring

- Location, isolation, and spatial/environmental factors affected diversity
- Monitoring strategies should consider beta diversity processes
  - Nestedness – few sites, all species
  - Turnover – many sites, diverse assemblages
- Scale-up local studies to inform regional conservation decisions



Thank you!



More Information: [caff.is/freshwater](http://caff.is/freshwater)

*Photo: NPS*