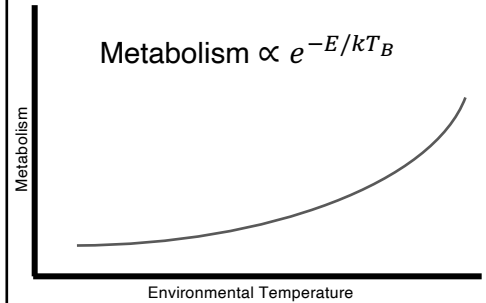
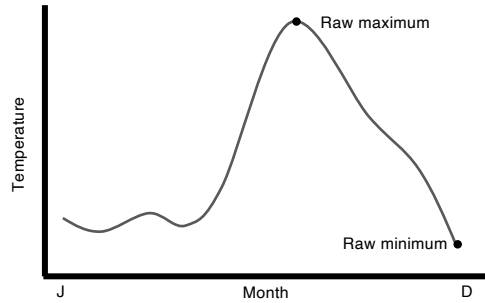


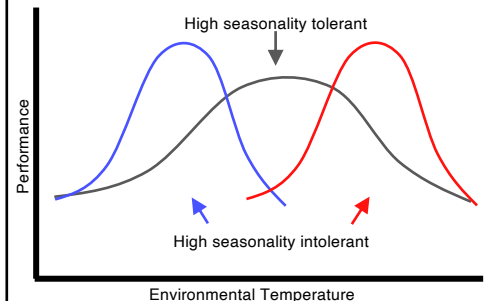
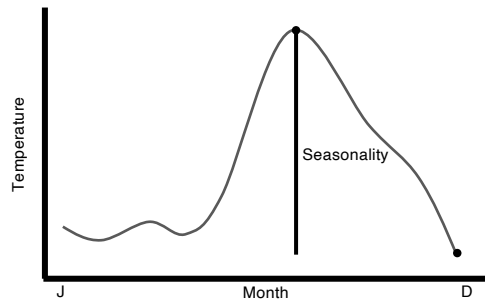
Metabolic hypothesis

Metabolism scales exponentially with temperature, therefore we expect more arrivals and departures in years with warmer temperature extremes



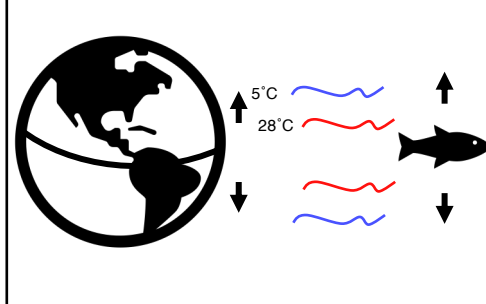
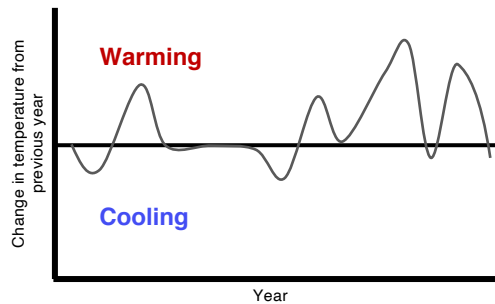
Seasonality hypothesis

Species that live in highly seasonal environments have unique adaptations that widen their thermal performance curve, therefore we expect few arrivals and departures in years with high seasonality



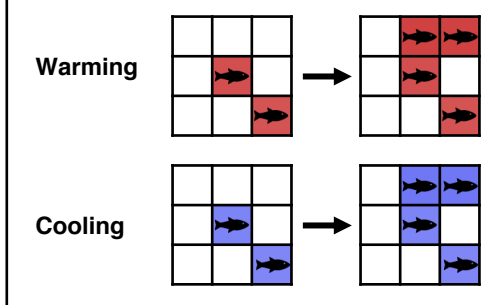
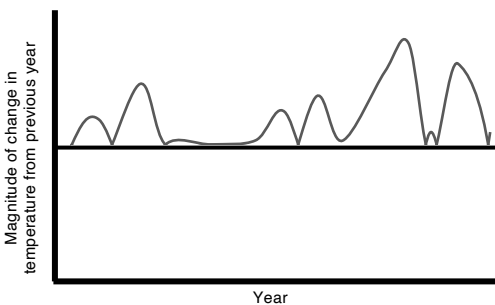
Tropicalization hypothesis

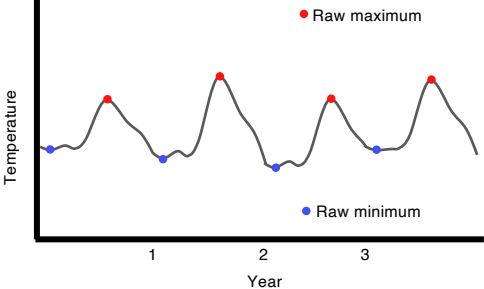
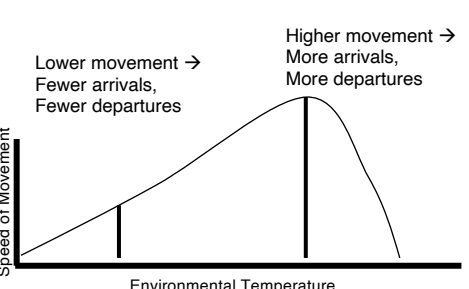
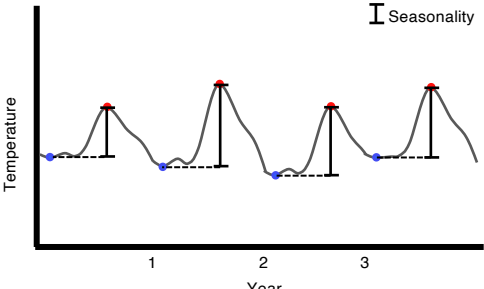
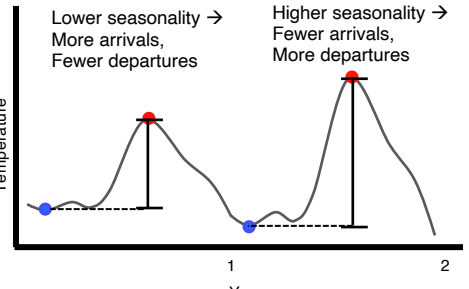
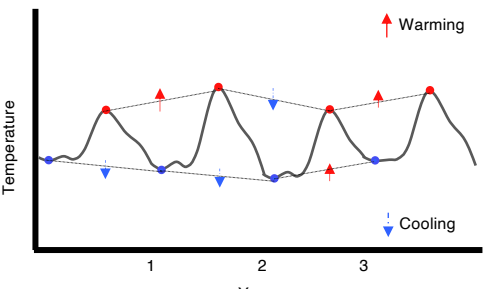
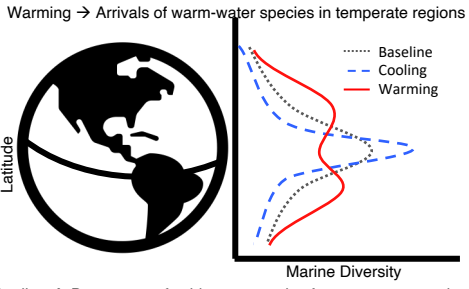
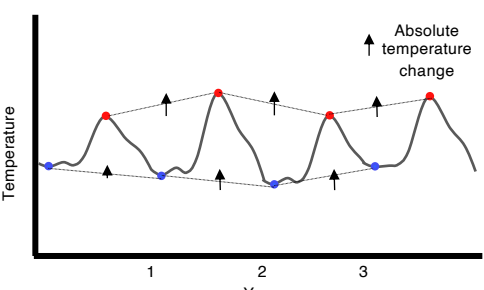
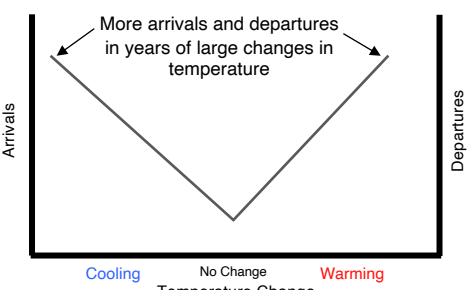
Arrivals and departures correspond with the magnitude and direction of temperature change as species track temperature isotherms poleward

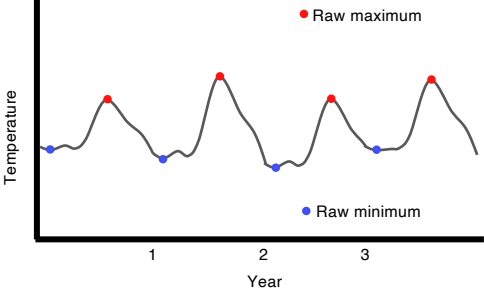
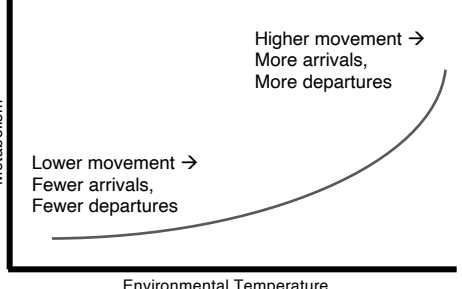
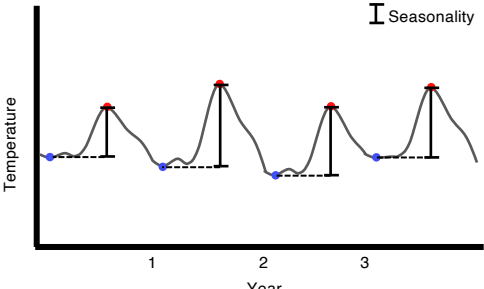
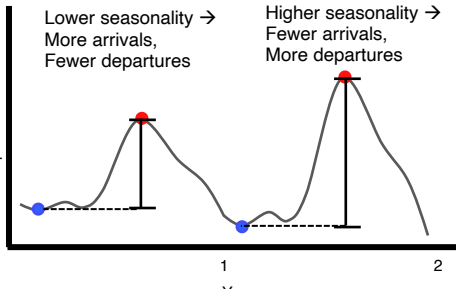
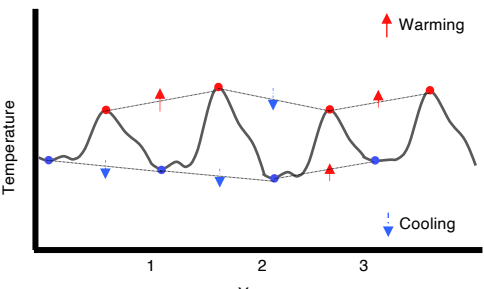
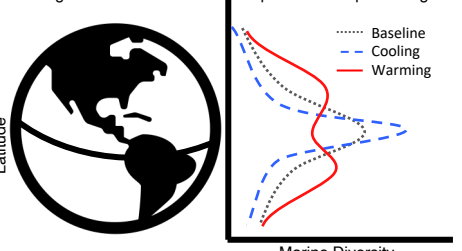
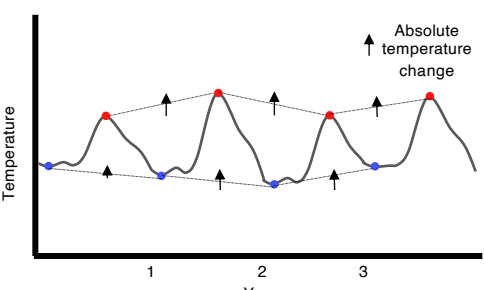
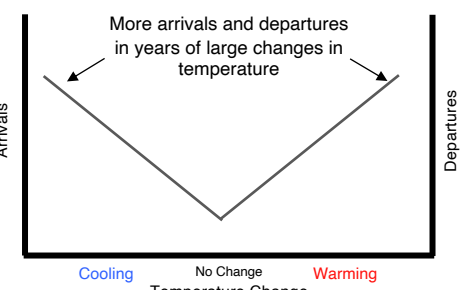


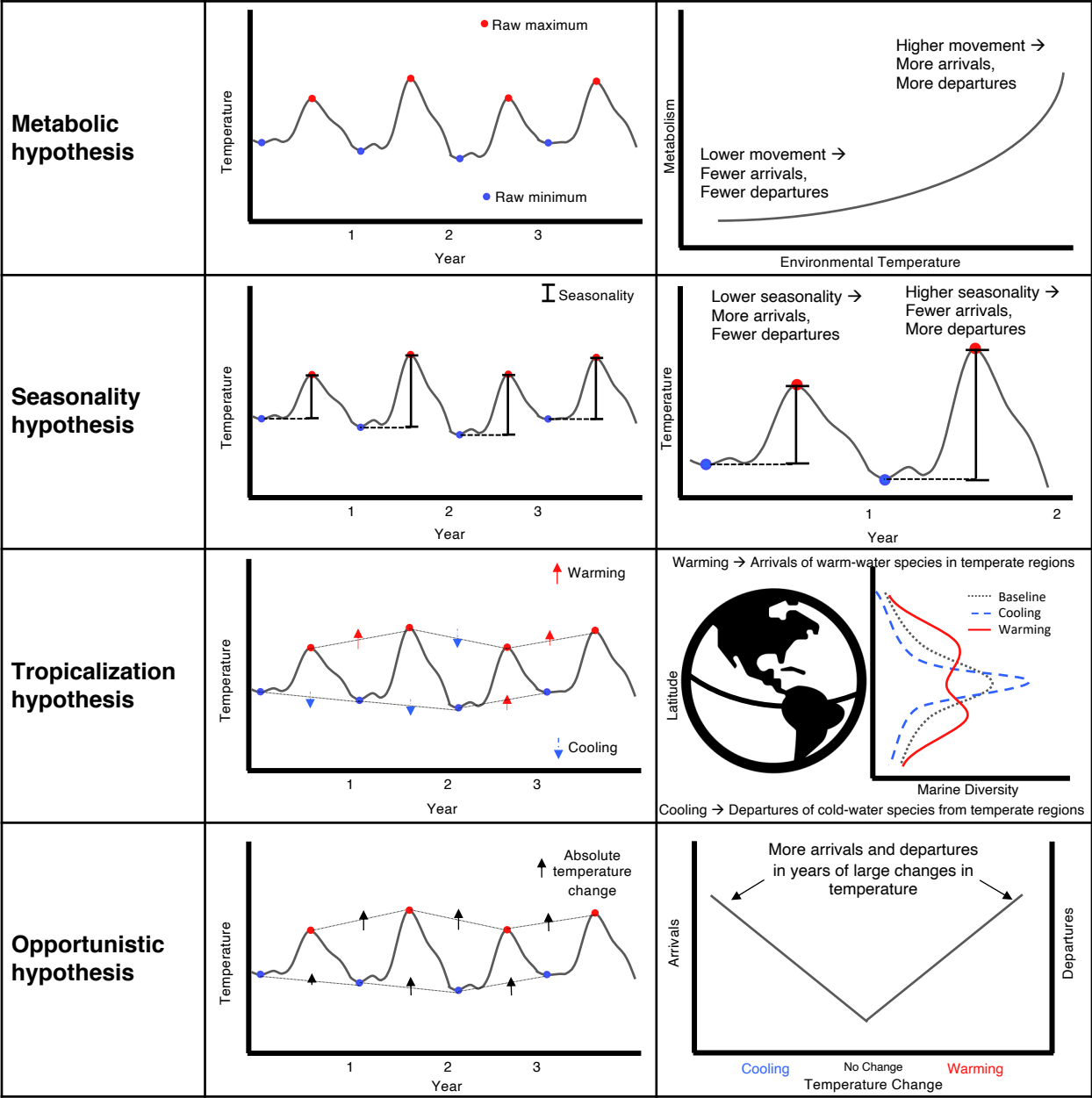
Opportunistic hypothesis

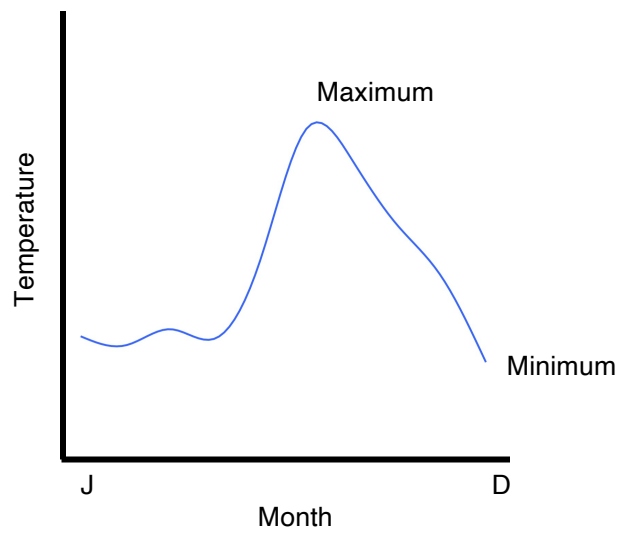
Arrivals and departures correspond with the magnitude of temperature change regardless of whether a region has experienced warming or cooling as species move through space to track preferred temperature conditions



<p>Metabolic hypothesis</p> <p><i>Smith et al. 1998</i> <i>Claireaux et al. 2006</i> <i>Dillon et al. 2012</i></p>	 <p>Temperature</p> <p>Year</p> <p>• Raw maximum</p> <p>• Raw minimum</p>	 <p>Speed of Movement</p> <p>Environmental Temperature</p> <p>Lower movement → Fewer arrivals, Fewer departures</p> <p>Higher movement → More arrivals, More departures</p>
<p>Seasonality hypothesis</p> <p><i>Conover 1992</i> <i>Yamahira and Conover 2002</i> <i>Beaukhof et al. 2019</i></p>	 <p>Temperature</p> <p>Year</p> <p>└ Seasonality</p>	 <p>Temperature</p> <p>Year</p> <p>Lower seasonality → More arrivals, Fewer departures</p> <p>Higher seasonality → Fewer arrivals, More departures</p>
<p>Tropicalization hypothesis</p> <p><i>Jablonski et al. 2013</i> <i>Brown 2014</i> <i>Vergés et al. 2016</i></p>	 <p>Temperature</p> <p>Year</p> <p>↑ Warming</p> <p>↓ Cooling</p>	 <p>Latitude</p> <p>Marine Diversity</p> <p>..... Baseline</p> <p>--- Cooling</p> <p>— Warming</p> <p>Warming → Arrivals of warm-water species in temperate regions</p> <p>Cooling → Departures of cold-water species from temperate regions</p>
<p>Opportunistic hypothesis</p> <p><i>Godínez-Domínguez et al. 2000</i> <i>Funes-Rodríguez et al. 2006</i> <i>Day et al. 2018</i></p>	 <p>Temperature</p> <p>Year</p> <p>↑ Absolute temperature change</p>	 <p>Arrivals</p> <p>Departures</p> <p>More arrivals and departures in years of large changes in temperature</p> <p>Cooling No Change Warming</p> <p>Temperature Change</p>

<p>Metabolic hypothesis</p> <p><i>Smith et al. 1998</i> <i>Claireaux et al. 2006</i> <i>Dillon et al. 2012</i></p>	 <p>Temperature</p> <p>Year</p> <p>• Raw maximum</p> <p>• Raw minimum</p>	 <p>Metabolism</p> <p>Environmental Temperature</p> <p>Higher movement → More arrivals, More departures</p> <p>Lower movement → Fewer arrivals, Fewer departures</p>
<p>Seasonality hypothesis</p> <p><i>Conover 1992</i> <i>Yamahira and Conover 2002</i> <i>Beaukhof et al. 2019</i></p>	 <p>Temperature</p> <p>Year</p> <p>Seasonality</p>	 <p>Temperature</p> <p>Year</p> <p>Lower seasonality → More arrivals, Fewer departures</p> <p>Higher seasonality → Fewer arrivals, More departures</p>
<p>Tropicalization hypothesis</p> <p><i>Jablonski et al. 2013</i> <i>Brown 2014</i> <i>Vergés et al. 2016</i> <i>Chaudhary et al. 2021</i></p>	 <p>Temperature</p> <p>Year</p> <p>↑ Warming</p> <p>↓ Cooling</p>	<p>Warming → Arrivals of warm-water species in temperate regions</p>  <p>Latitude</p> <p>Marine Diversity</p> <p>..... Baseline - - - Cooling — Warming</p> <p>Cooling → Departures of cold-water species from temperate regions</p>
<p>Opportunistic hypothesis</p> <p><i>Godínez-Domínguez et al. 2000</i> <i>Funes-Rodríguez et al. 2006</i> <i>Day et al. 2018</i></p>	 <p>Temperature</p> <p>Year</p> <p>↑ Absolute temperature change</p>	 <p>Arrivals</p> <p>Departures</p> <p>More arrivals and departures in years of large changes in temperature</p> <p>Cooling No Change Warming</p> <p>Temperature Change</p>





Seasonality

