

Impact of Sea Ice Movement

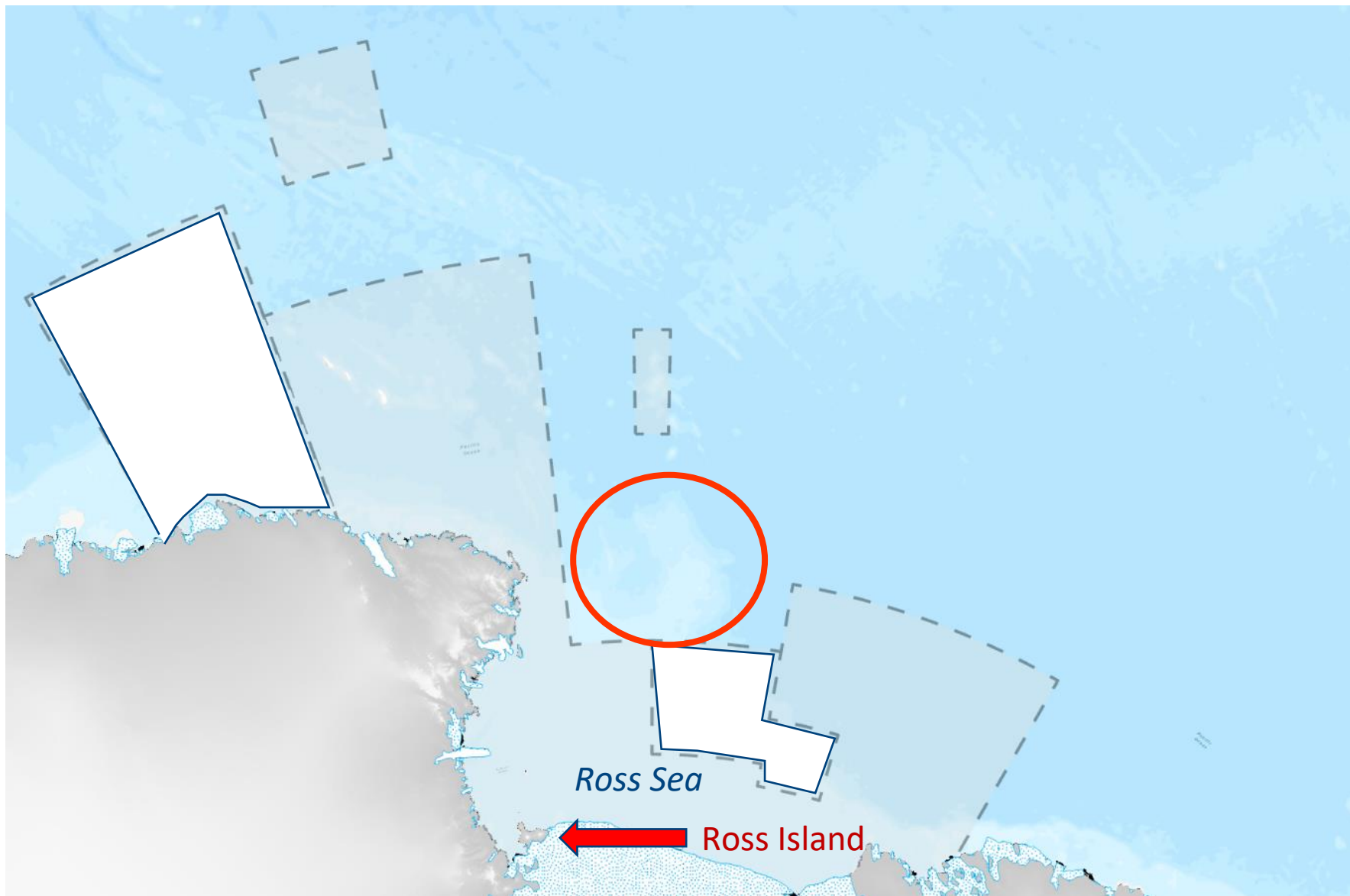
On Adélie Penguin Migration in the Ross Sea



NASA Team Meeting
September 2022







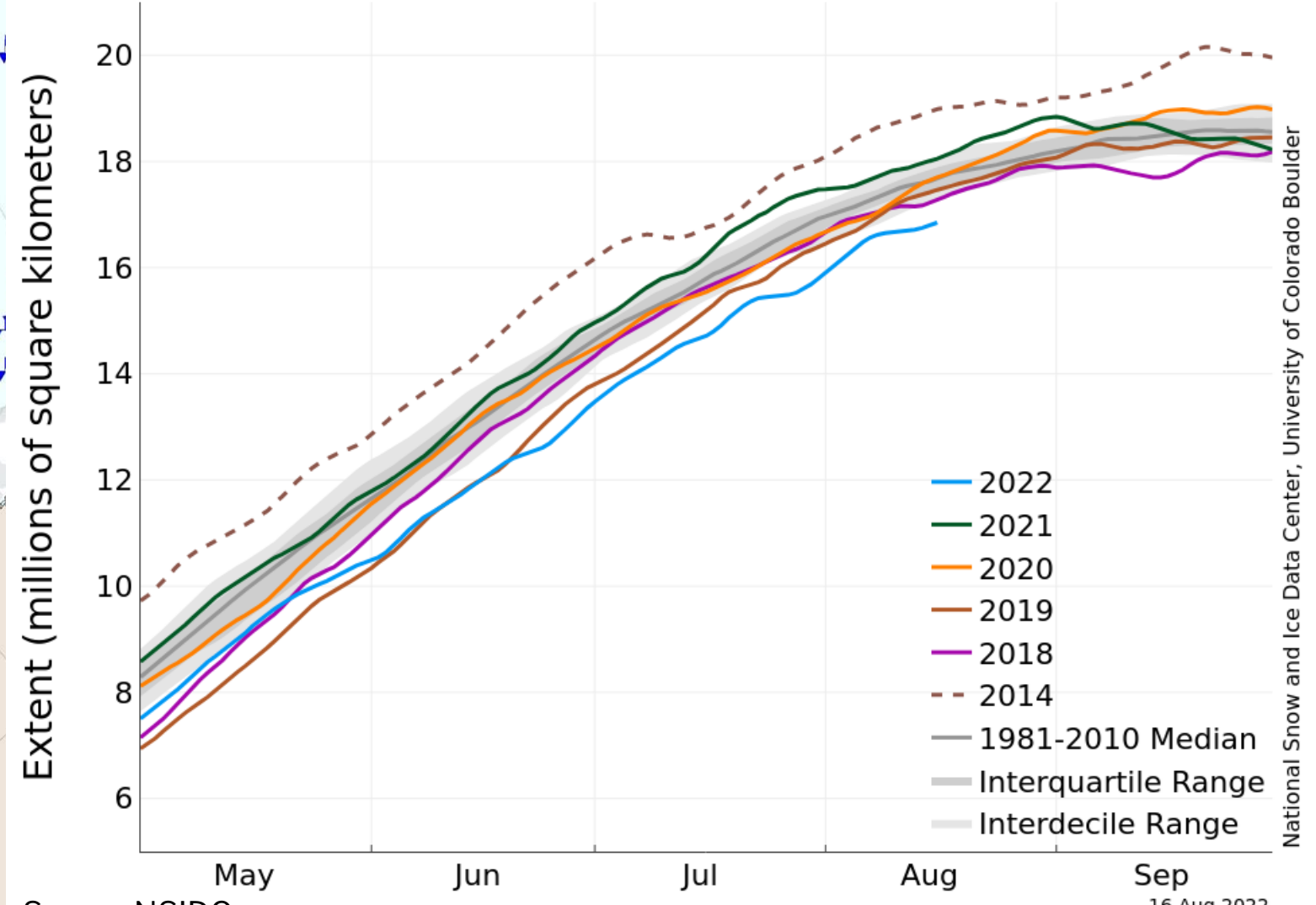
The Ross Sea Region Marine Protected Area

- New protections
- Increasing pressures
- Global warming

Seasonal Changes – Austral Winter



Antarctic Sea Ice Extent (Area of ocean with at least 15% sea ice)



Source: NSIDC

16 Aug 2022

National Snow and Ice Data Center, University of Colorado Boulder

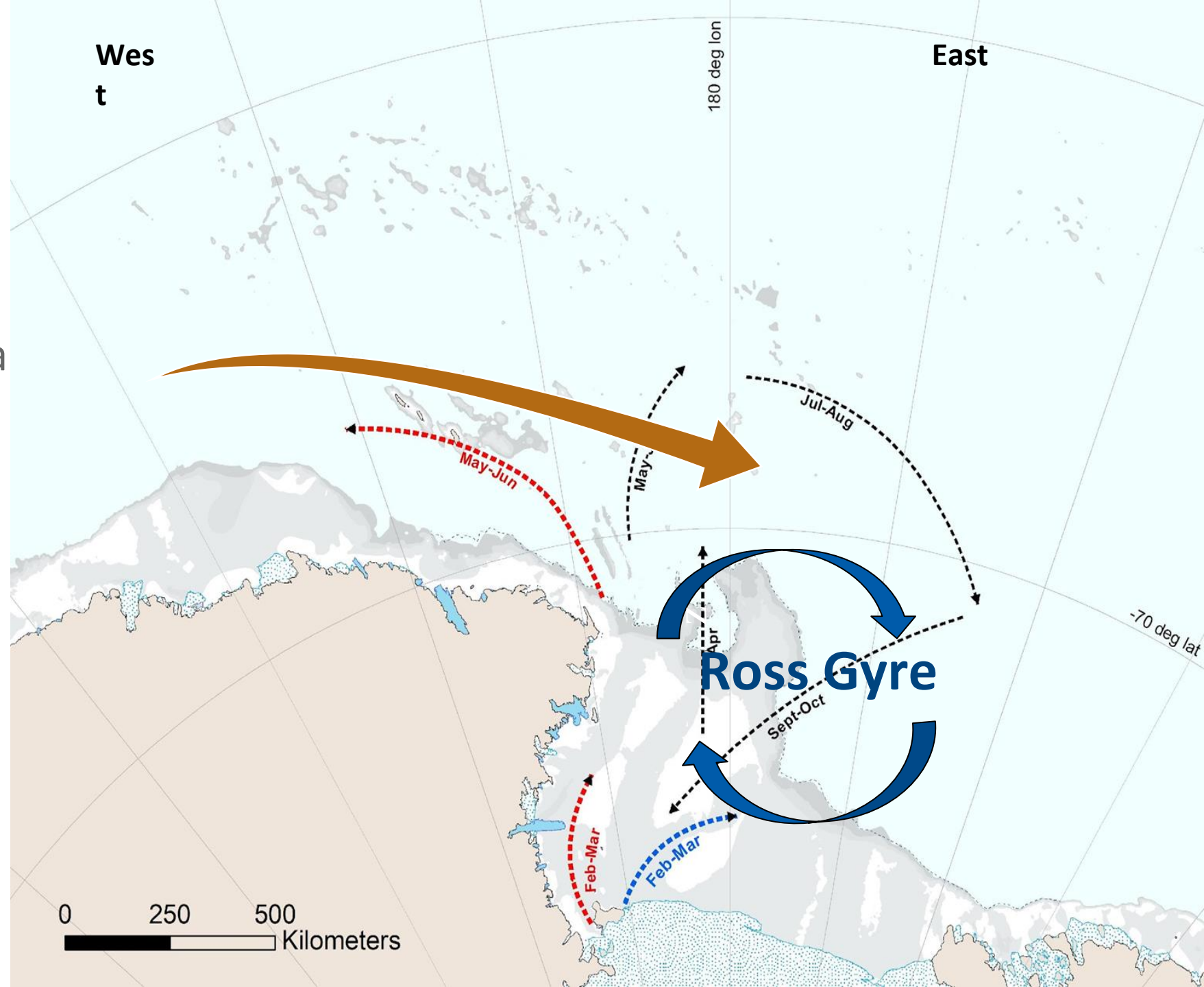
Enter the Adélie –

- Indicator species
- Ice dependence -Molting, feeding, resting
- High energetic costs
- Finding food in dynamic landscape
- Impacts on survival



Migration

- Do penguins use the sea ice movement to aid them in their migration?



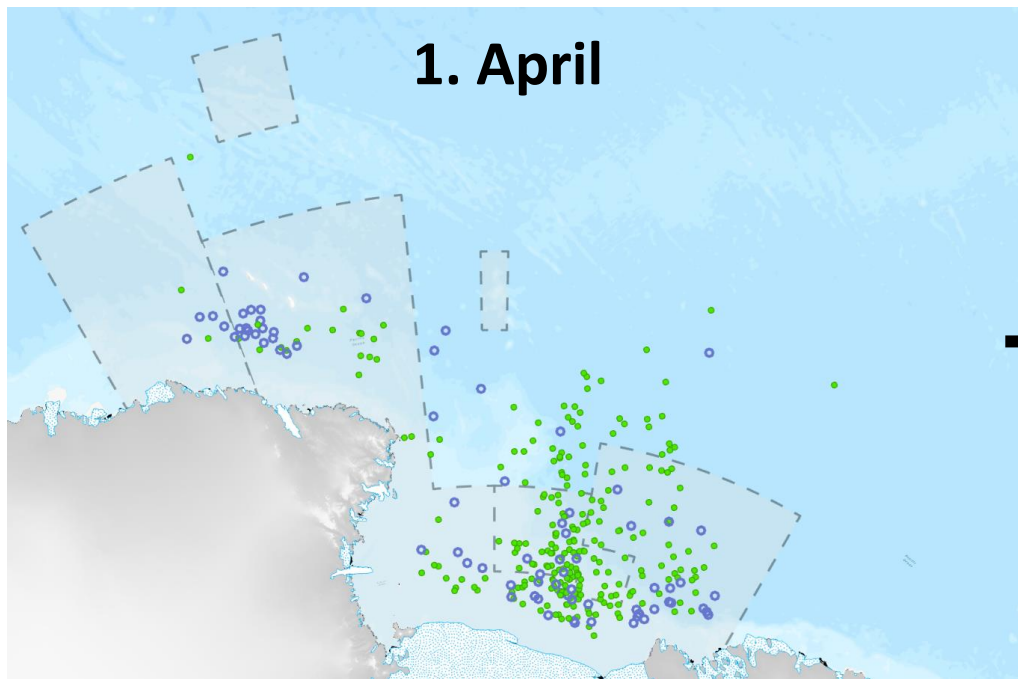
Cape Crozier



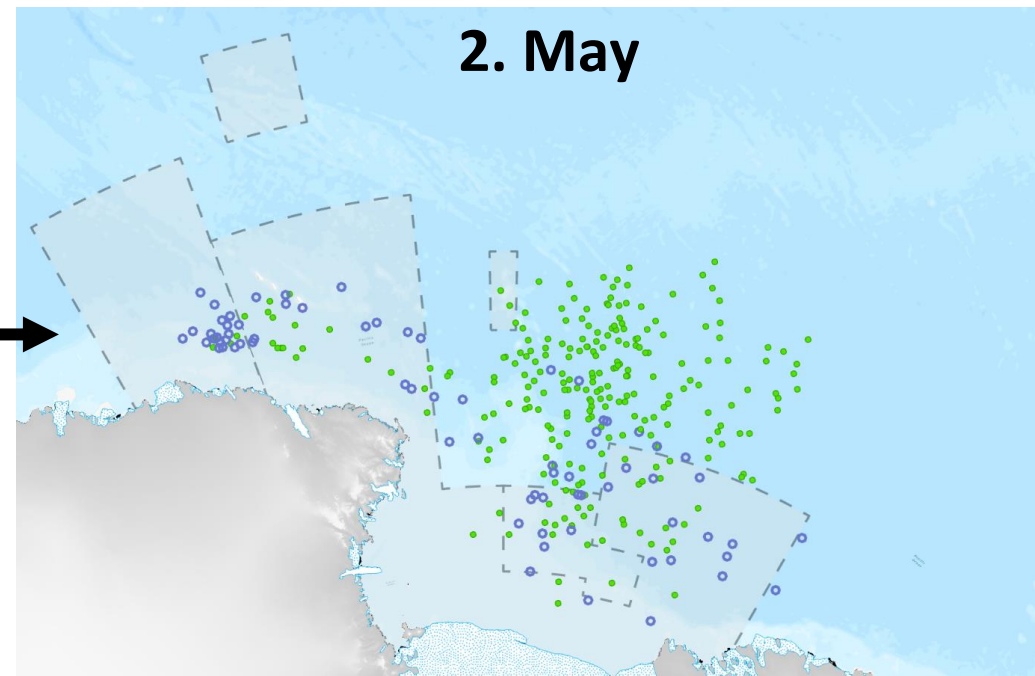
Cape Royds



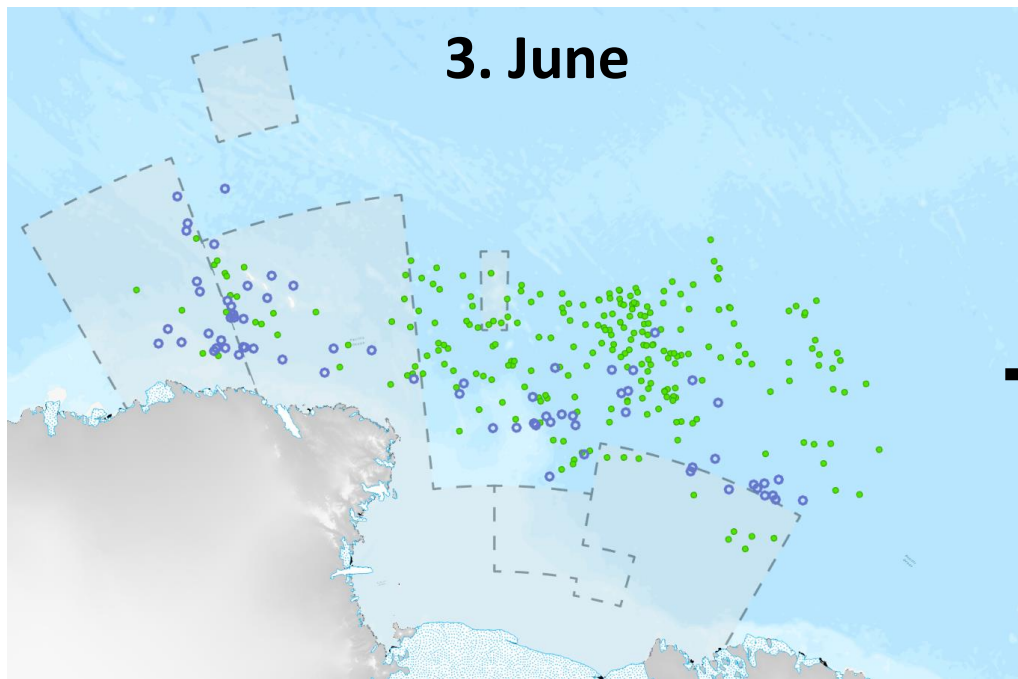
1. April



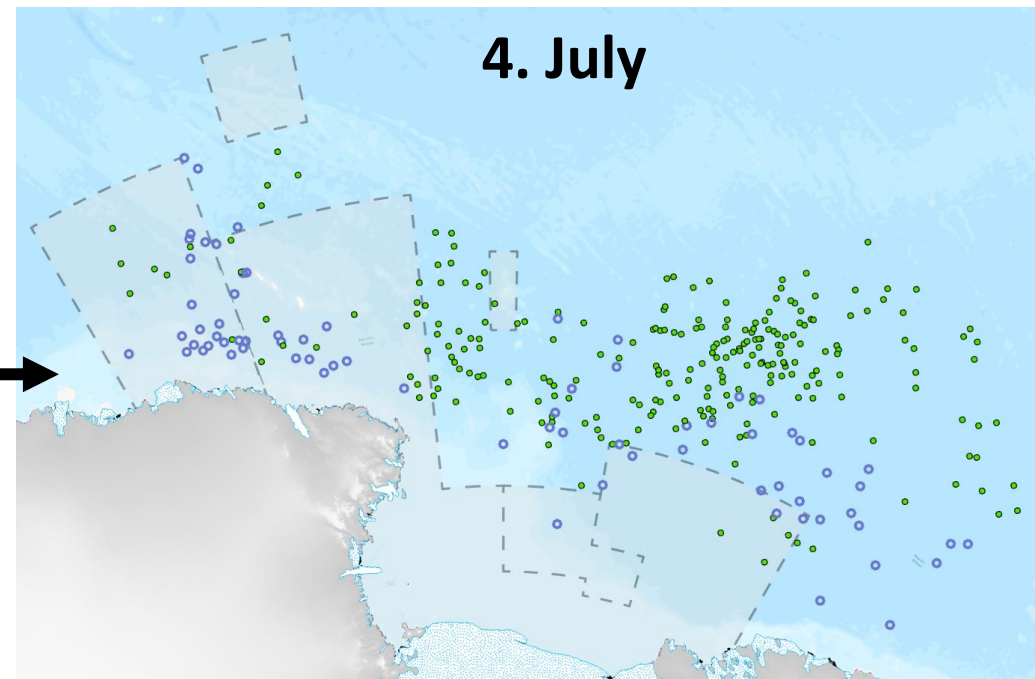
2. May



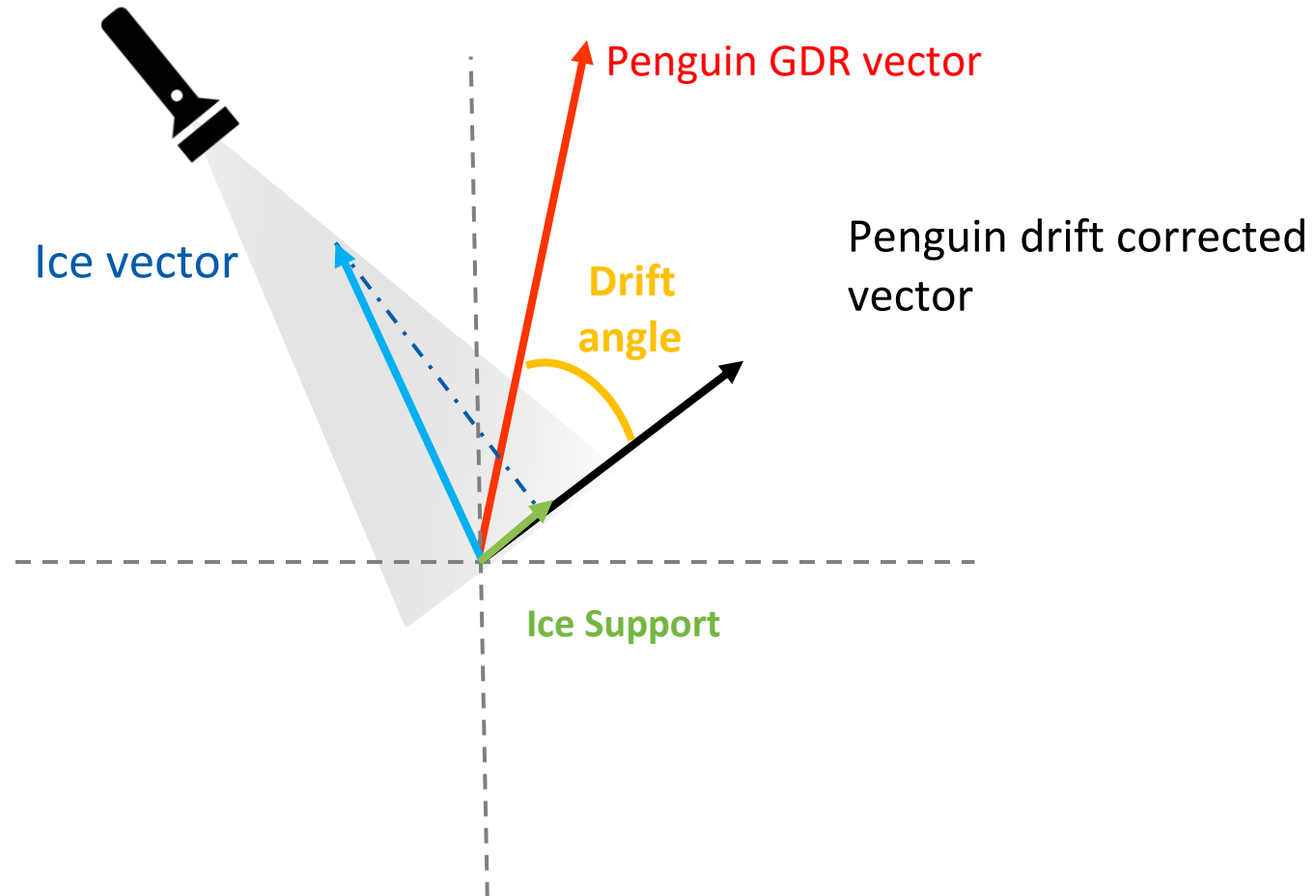
3. June



4. July



Develop Metrics of Ice Support



8 Connections to Sea Ice Movement Would Shift Effectiveness of the MPA



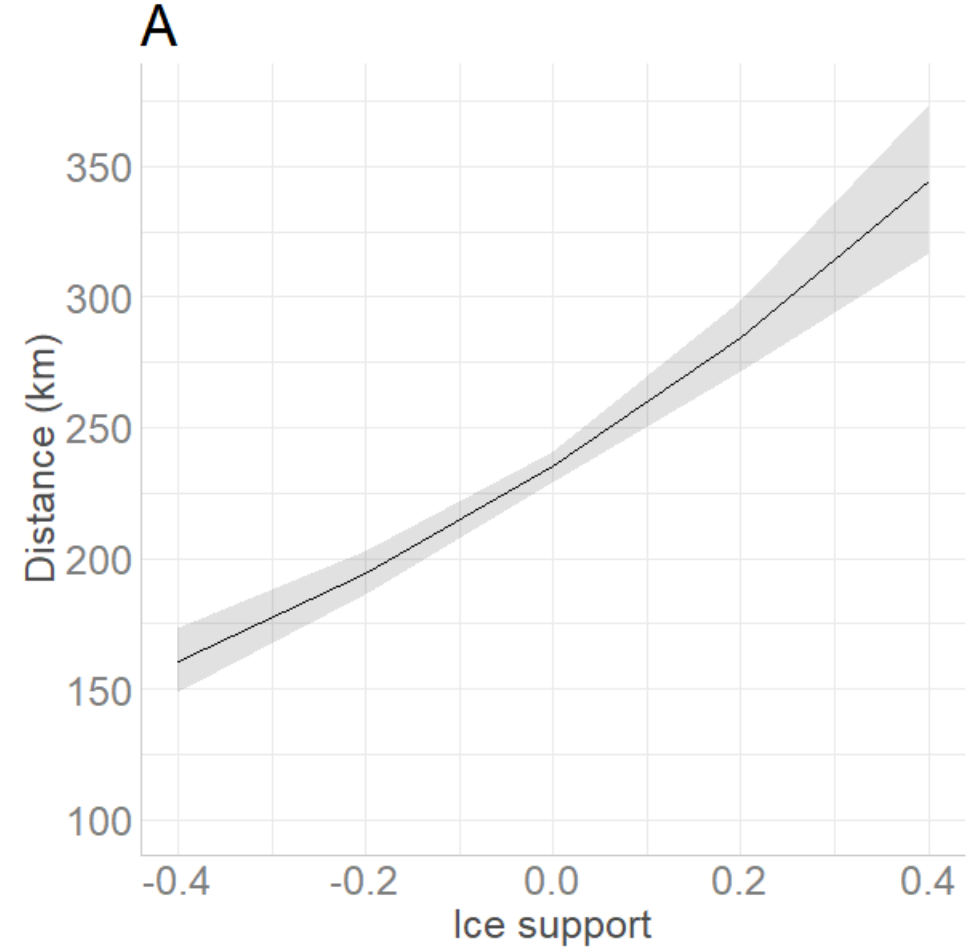
1. Distance Travelled- Penguins will travel longer distances when movement aligned with sea ice movement

1. Ice Support Timing – Penguins will receive more support *early and late* in migration in tandem with Ross Gyre

1. Ross Gyre Speed - Penguins will be found further north with higher speeds of the Ross Gyre

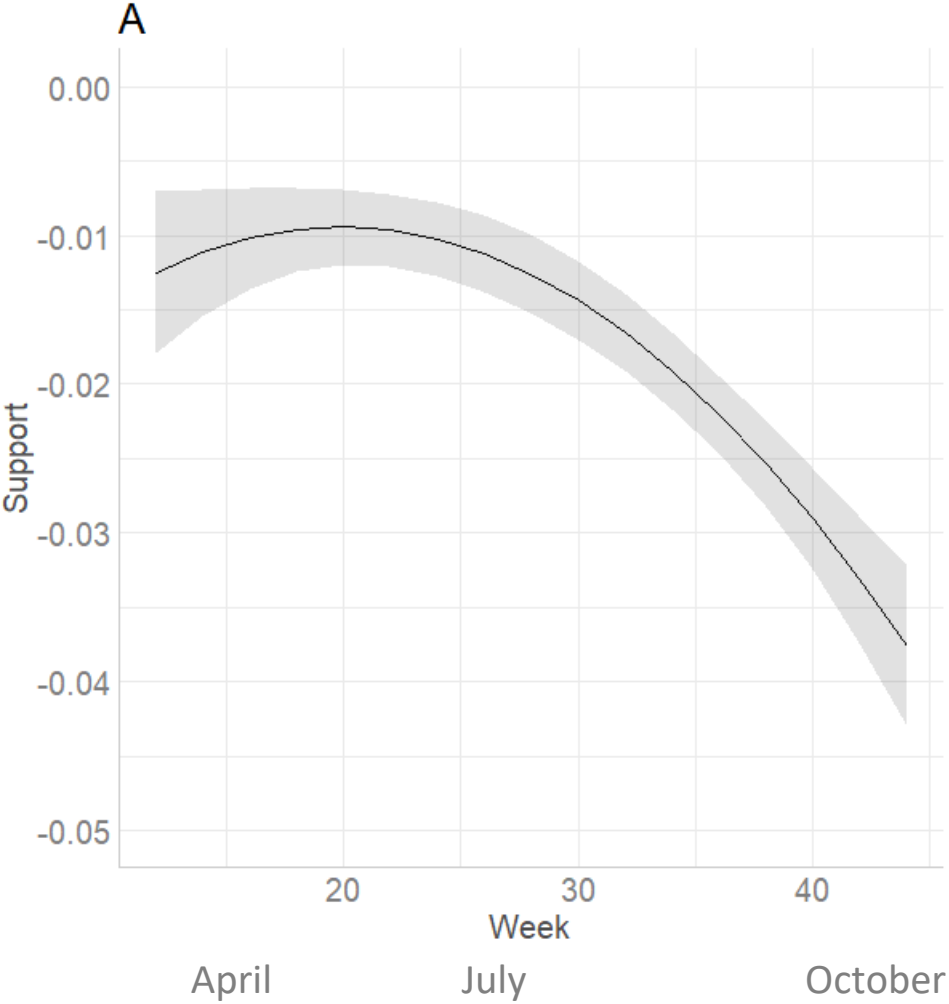
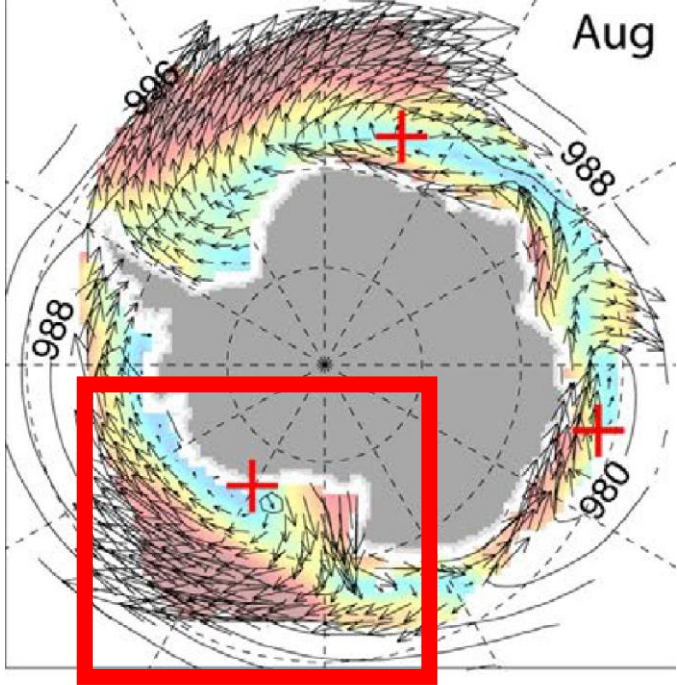
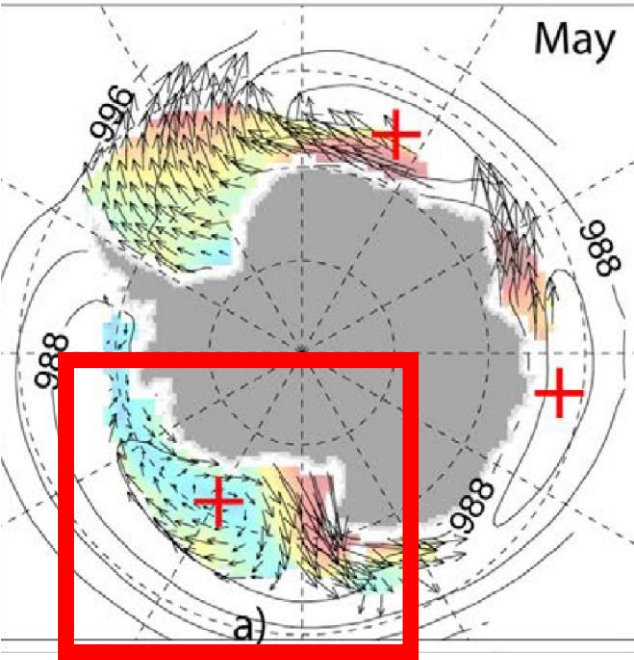
Results: Higher Distances Associated with Higher Ice Support

- Highest assistance values can result in distances of ~175km more per five-day period



Lower CL: 0.77 Estimate: 0.95 Upper CL: 1.14

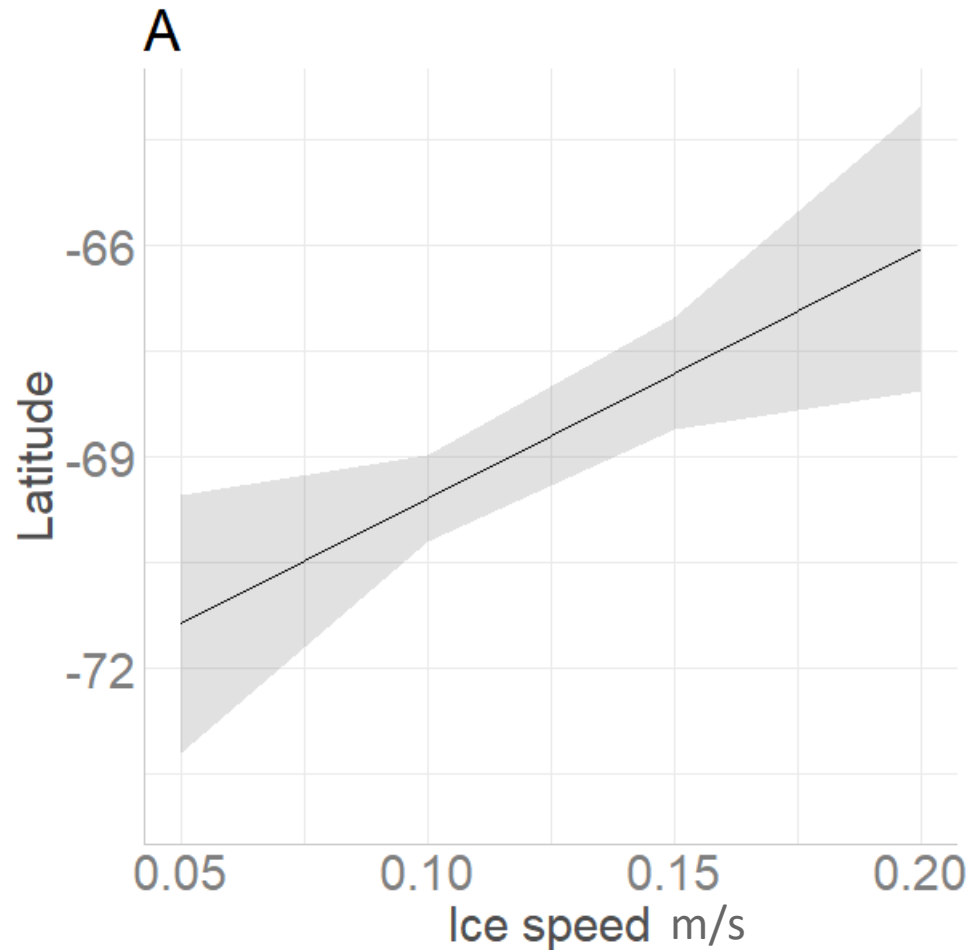
Results: Ice Support Decreases Over a Year



Maps from Kwok et al 2017 <https://doi.org/10.1525/elementa.226>

Lower CL: -0.32 Estimate: -0.02 Upper CL: -0.12

Results: Higher Gyre Speeds Push Penguins Further North



- An increase in mean ice velocity of 0.1 m/s in one month results in a 3.9 decimal degrees northward shift the following month.

$(\beta = 35.52 \pm 12.35, p = 0.007)$

A group of approximately 15 penguins, likely Adelie penguins, are running on a snowy beach towards the ocean. The penguins are in various stages of motion, with some splashing water as they run. The background shows the blue ocean and a bright, overcast sky.

Ecological Implications

Changes in winds, sea ice
movement and extent



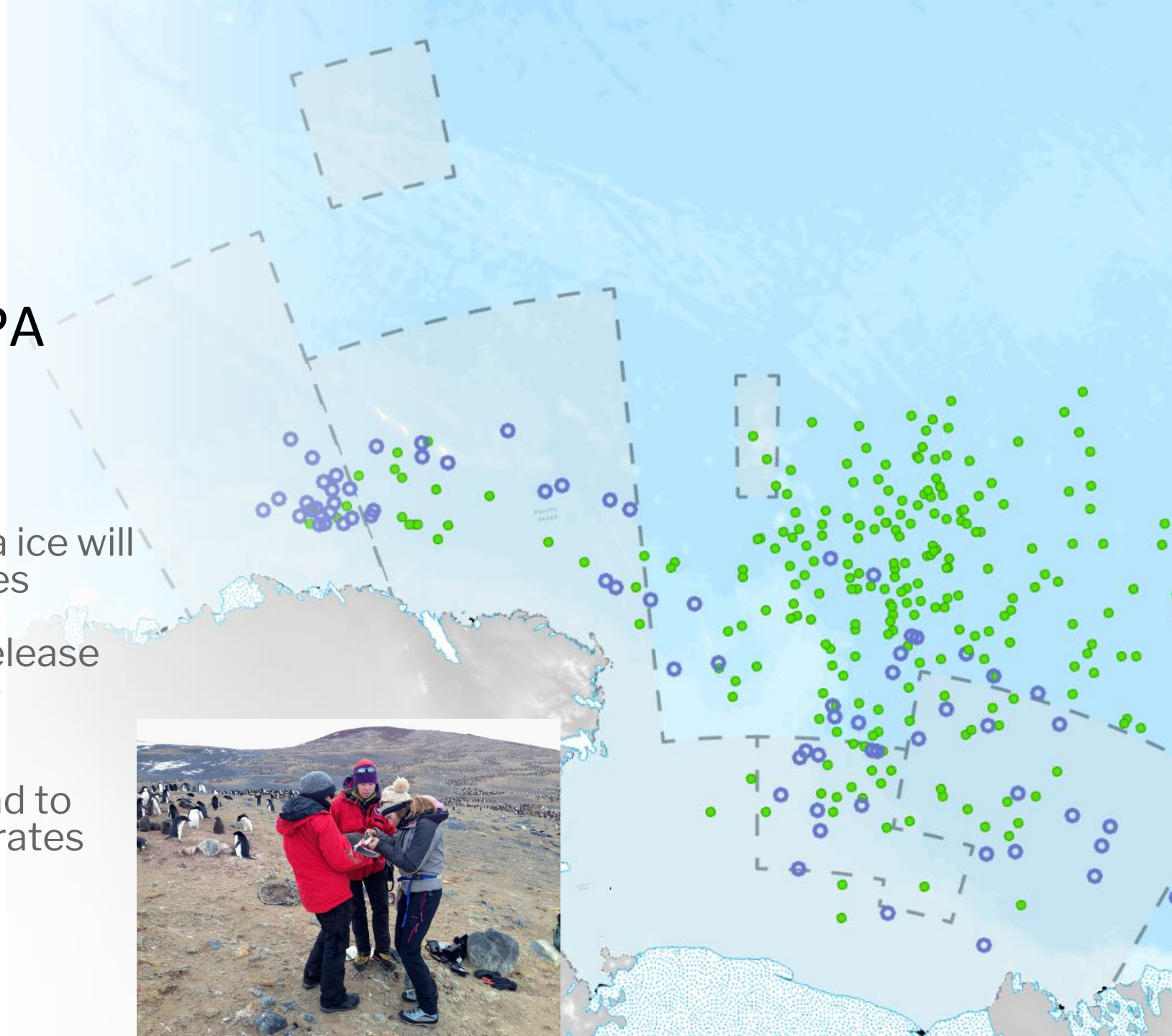
Balancing energy
expenditures



Potential mechanistic
link impacting
population numbers

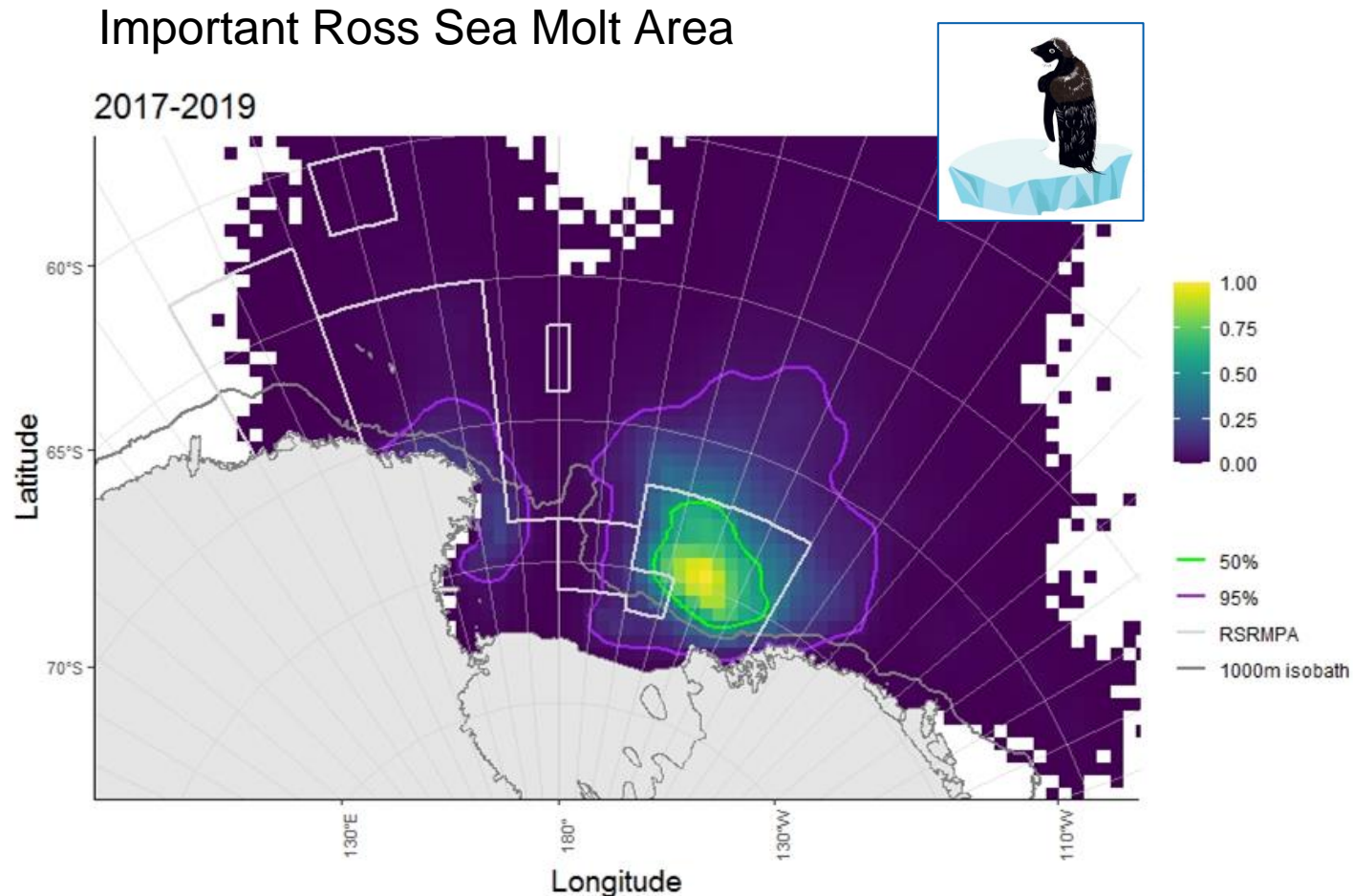
Implications for the MPA

- Unbalanced protections
- Stronger gyre and shrinking sea ice will cause more energy expenditures
- Energetic offset of predation release from toothfish fishery may help temporarily
- Climate change effects may lead to lower survival and recruitment rates



Additional analyses completed:

- Assessed best metric of foraging success (Lescroël et al. 2021)
 - Penguins that dive more gain more weight
 - Informs analysis of important winter foraging areas (in progress)
- Evaluated impact of sea ice concentration on critical molting habitat (Schmidt et al. in prep)
 - Eastern Ross sea contains critical sea ice based molting habitat for Ross Sea Adélie penguins
 - Ross Sea Region MPA currently protects core from direct impacts of fishing
 - Sea ice availability during molt may be an additional important constraint limiting where Adélie penguins can thrive in a changing climate



Thank you!

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