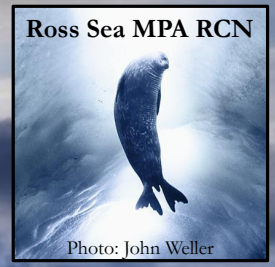


Two complementary frameworks for coordinating and leveraging available resources to conduct and maintain marine ecosystem observations in Antarctica

Sharon Stammerjohn (INSTAAR/CU-Boulder)
PAL LTER Team and RCN Team for the Ross Sea MPA

Photo: Guy Williams

Two Different Funding Strategies

NSF Long-Term Ecological Research (LTER) Program

Goal: address ecological questions that cannot be resolved with short-term observations to advance understanding of long-term dynamics across the food web; funding for 6-yr increments, highly competitive renewal process, max $1.275 million/year (in 2023)

'PAL LTER': marine ecosystem west of the Antarctic Peninsula

NSF Research Coordination Network (RCN) Program

Goal: create a novel network in a new or developing area of science that fosters new collaborations & coordination, across disciplinary, organizational, geographic, and international boundaries; funding for 5 years, max $500,000 total

'MPA RCN': Ross Sea region Marine Protected Area (MPA)

Overarching Hypothesis

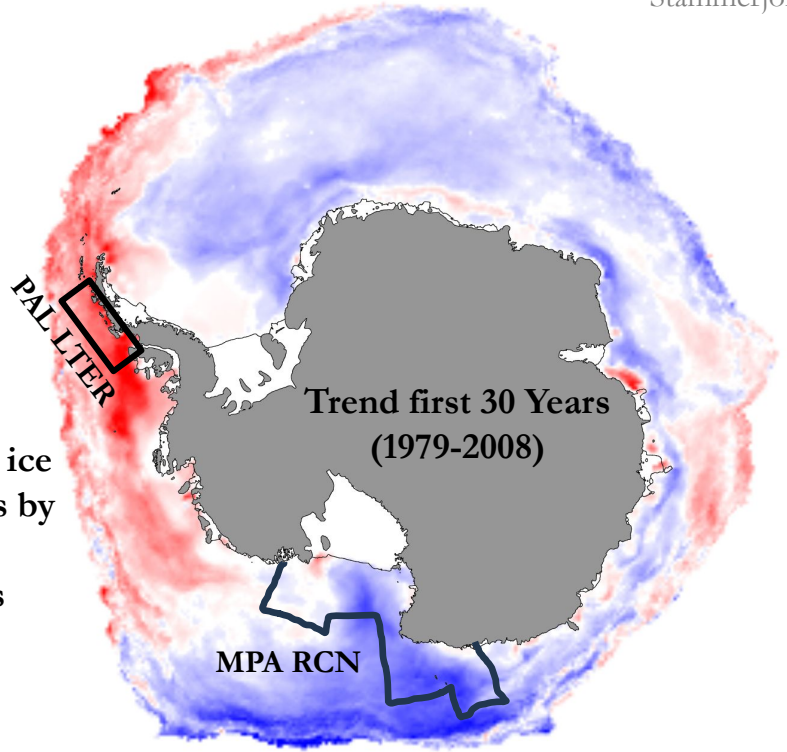
Sea ice plays a central role in structuring population dynamics & life history strategies across the entire food web; ongoing changes in sea ice will drive systemwide ecological changes

Photo: PAL LTER

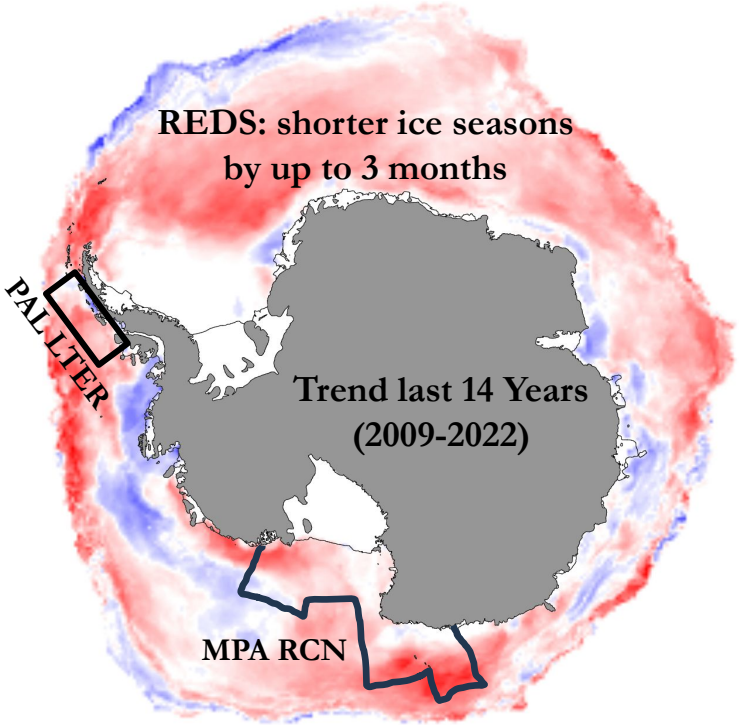
Antarctic Annual Ice Season Duration Changes

Stammerjohn et al 2025

REDS: shorter ice seasons by up to 3 months



BLUES: longer ice seasons by up to 3 months

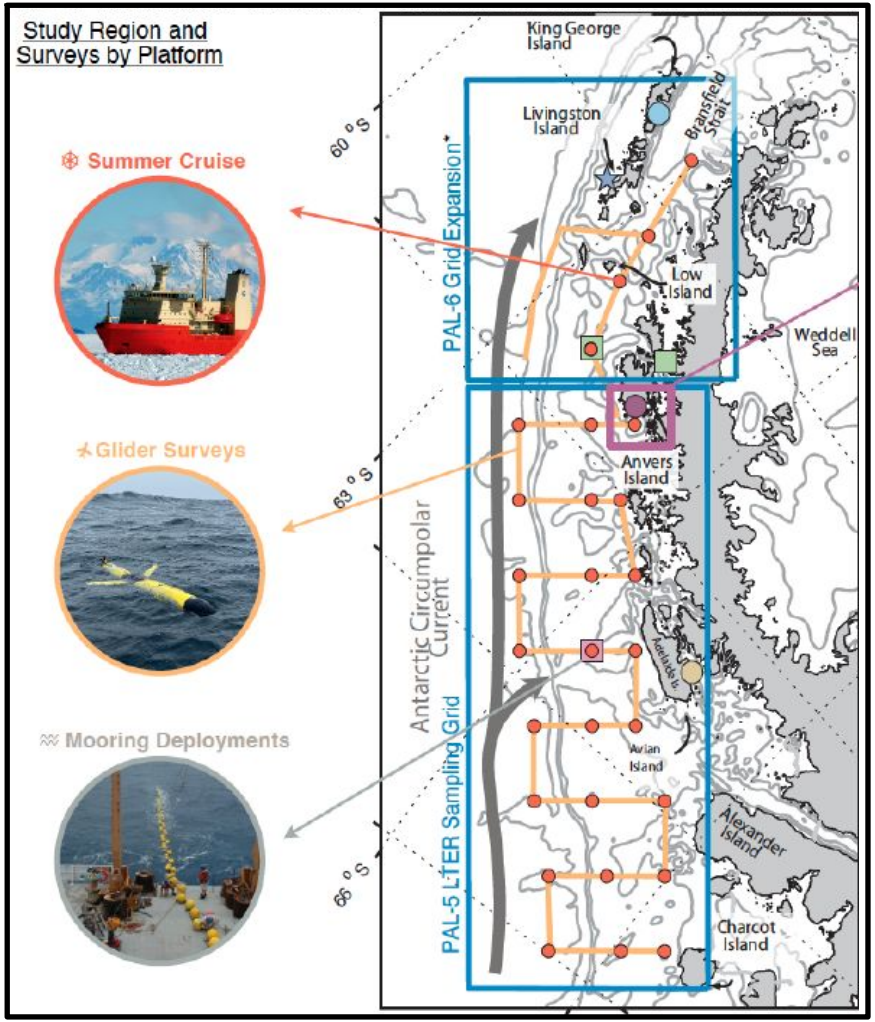


Recent changes point to shifts in sea ice-ocean interactions

(Purich & Doddridge 2023; Hobbs et al 2024)

PAL LTER Observational Program

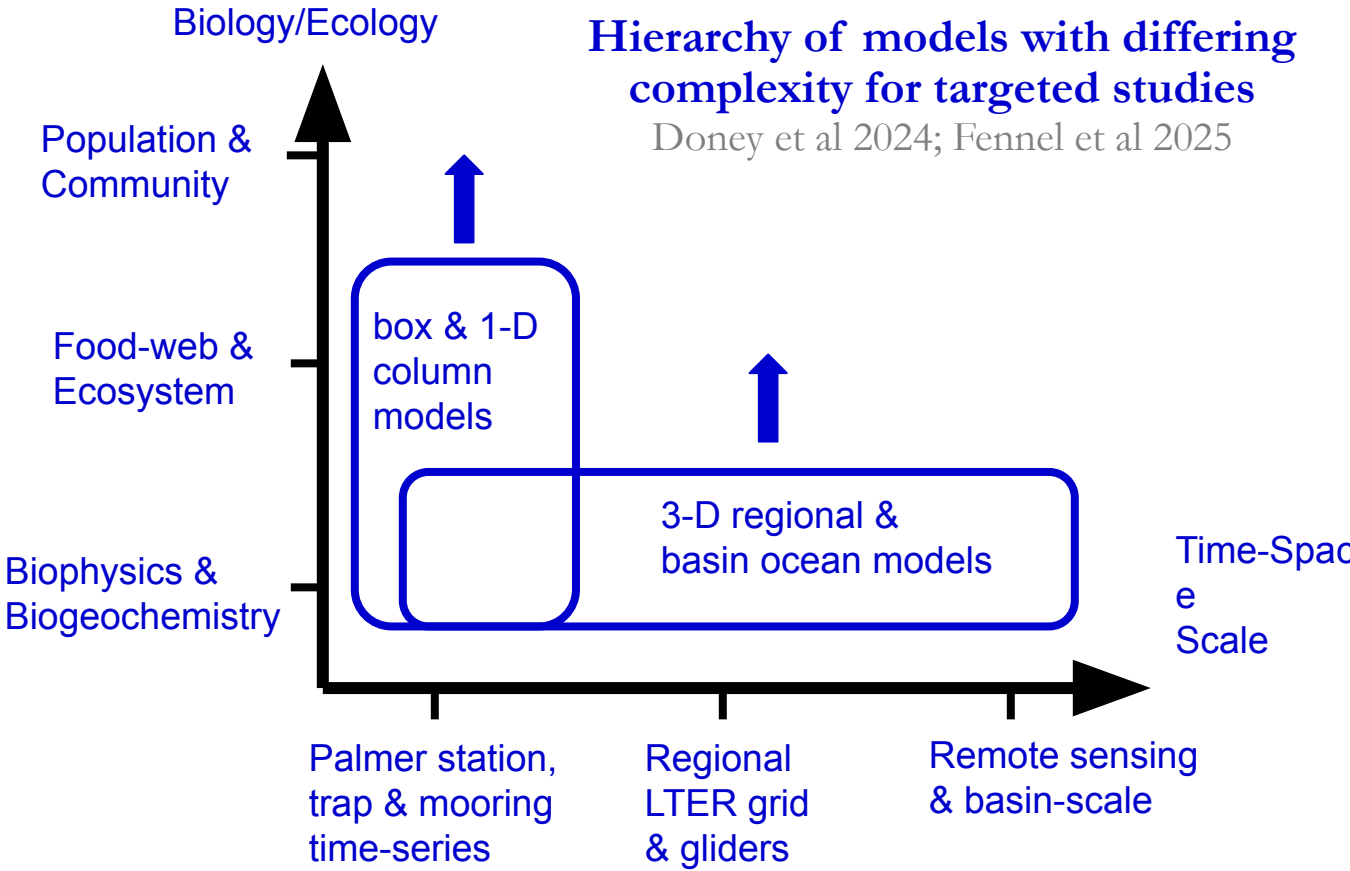
- **Started 1990-96**; now in 6th 6-year cycle; next renewal 2027-32
- **10 Lead Investigators** (Schofield & Steinberg, co-Lead PIs), highly inter-disciplinary, hundreds of students
- **PAL Grid** sampled every austral summer, 1993-2020; thereafter every-other-year
- **Nearshore Sampling** from Palmer Station every austral season (~Oct-Mar)
- **Autonomous observations** increase with time to expand space/time observations & changes in ship/station availability



PAL LTER Data/Model Synthesis

Challenges

- Not all time/space scales are sampled/observed
- Different disturbances operate over different time/space scales
- Food webs are tightly coupled, but with differential disturbances (per species, trophic level)



Hierarchy of models with differing complexity for targeted studies

Doney et al 2024; Fennel et al 2025

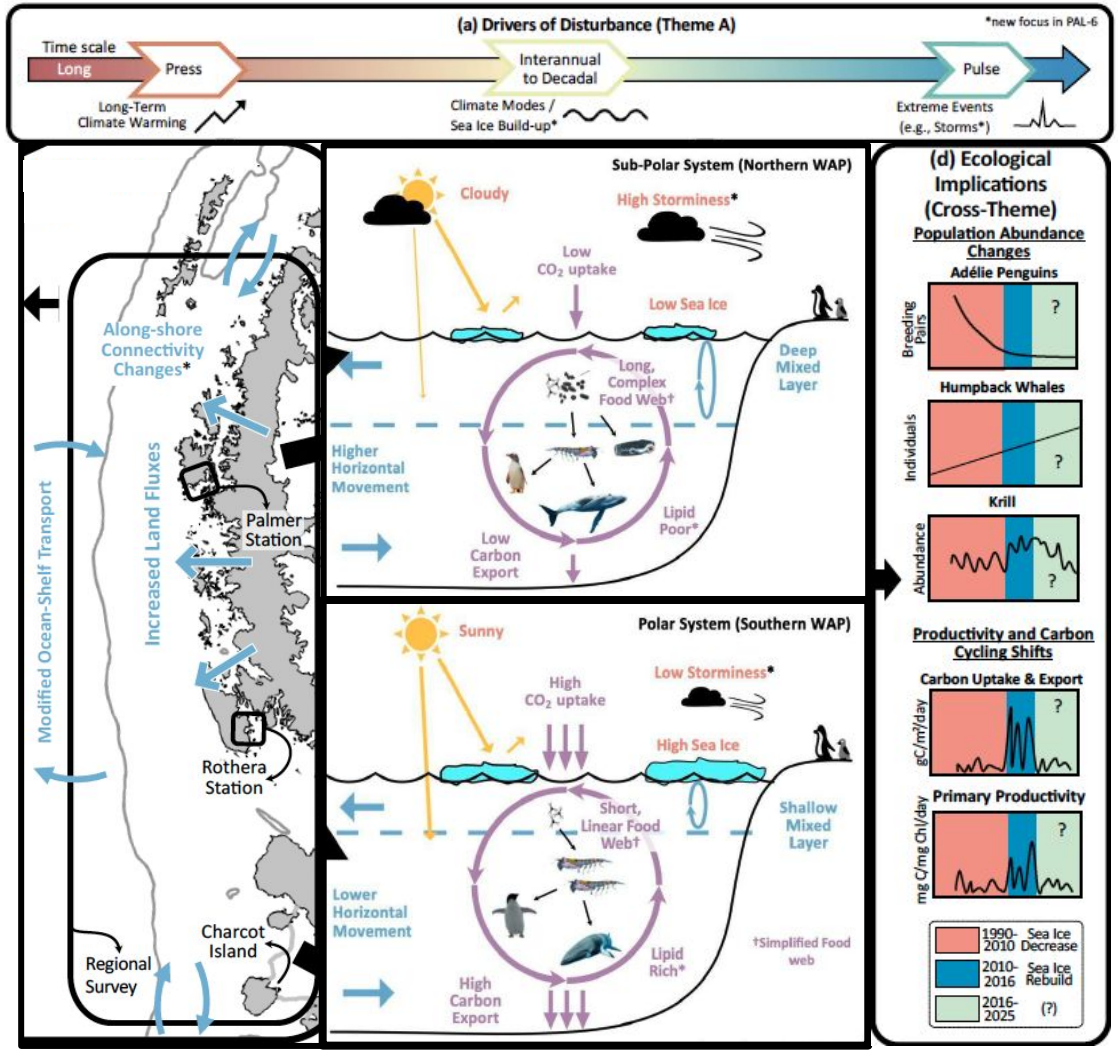
PAL LTER Conceptual Model

(Schofield et al 2024)

Only through NSF's LTER program could we investigate such an interdisciplinary and highly coupled system

Through PAL LTER, we are able to document how the ecological response to multiple space/time disturbances result in significant system-wide consequences for

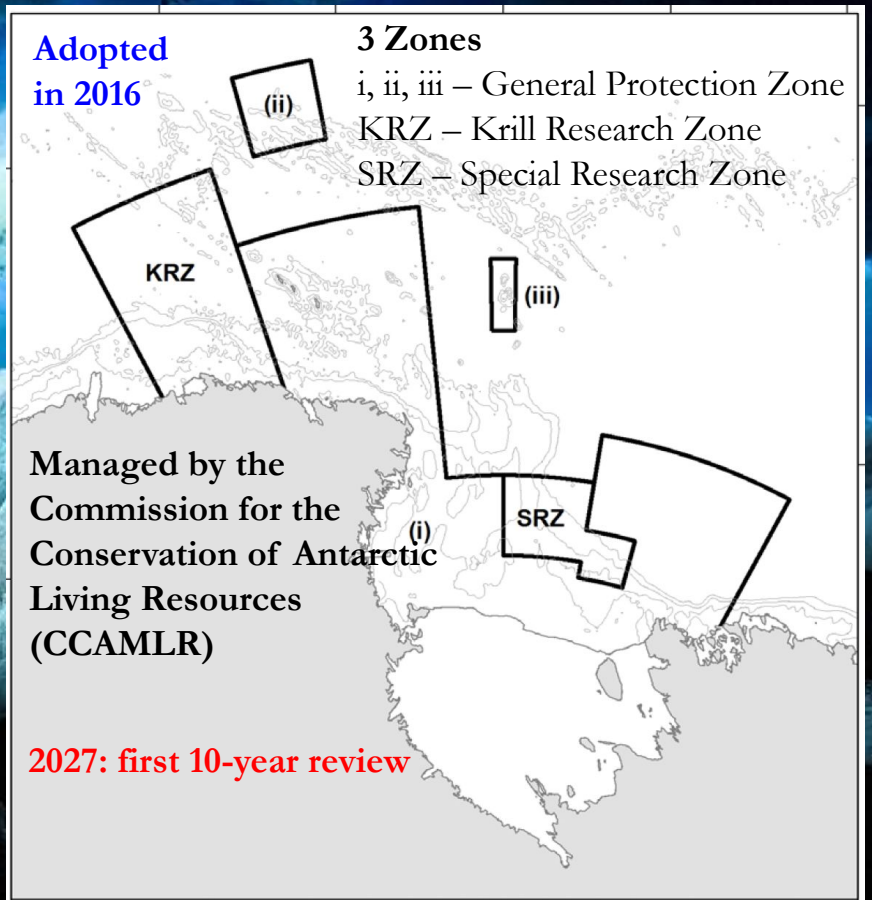
- **population abundance**
- **ecosystem productivity**
- **carbon cycling**



Ross Sea Region MPA (> 2 million km^2 - world's largest)

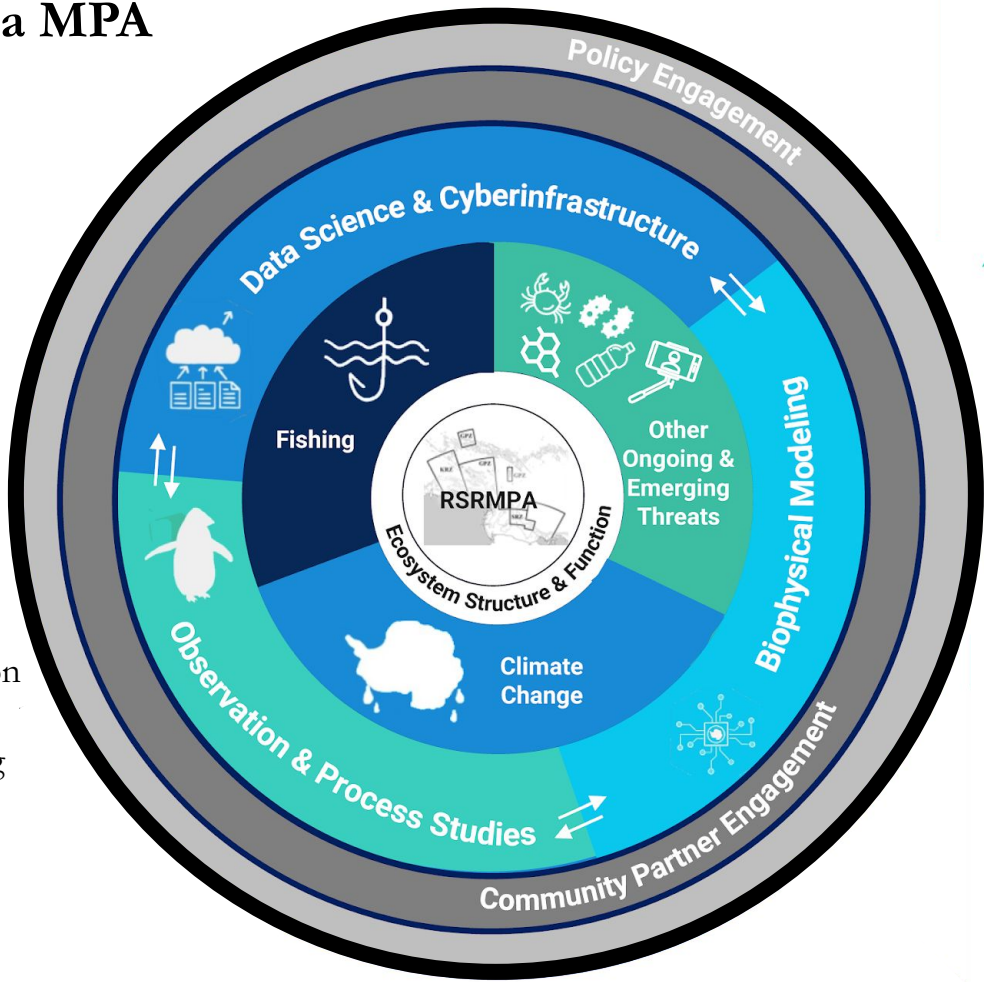
The MPA RCN was created to facilitate policy-engaged interdisciplinary science in support of Research & Monitoring of the Ross Sea region MPA

Photo: John B. Weller



MPA RCN Framework for the Ross Sea MPA

(Brooks et al 2024)



A Network of networks to

- Facilitate collaboration
- Coordinate activities
- Seek external funding

5 Components

(5 Working Groups)

1. Observations & Process Studies
2. Data Science & Cyberinfrastructure
3. Biophysical Modeling
4. Policy Engagement
5. Community Engagement

Towards building an observing system for studying the Ross Sea marine ecosystem, the PAL LTER serves as an excellent model

Figure: Jack Pan

MPA RCN, Lead PI Cassandra Brooks (ECR, CU-B)

14 Steering Committee Members (5 ECRs, 7 Countries, 7 CCAMLR Representatives)

Inaugural 4-Day Meeting

NCAR Boulder, June 3-6 2025

- Participants: 43 in-person, 85 online
- 22 countries represented
- Wide range of career stages, disciplines, affiliations
- Formed Working Groups, discussed short- & long-term priorities/activities
- Identified & outlined products to submit to CCAMLR in support of the 2027 review

For More Information

PAL LTER

Schofield et al 2024 (doi: 10.1016/j.tree.2024.08.007)

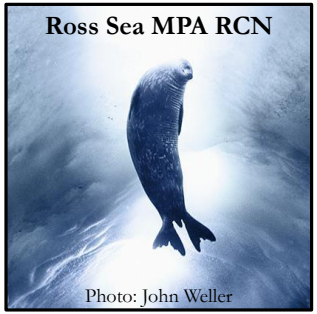
Website: pallter.marine.rutgers.edu

MPA RCN

Brooks et al 2024 (doi: 10.1111/conl.13053)

Website: www.rosssearesearch.org/

(To join the MPA RCN listserv or working group: rossseaworkshop_us@colorado.edu)



Extra Slides

PAL LTER

Leadership Team

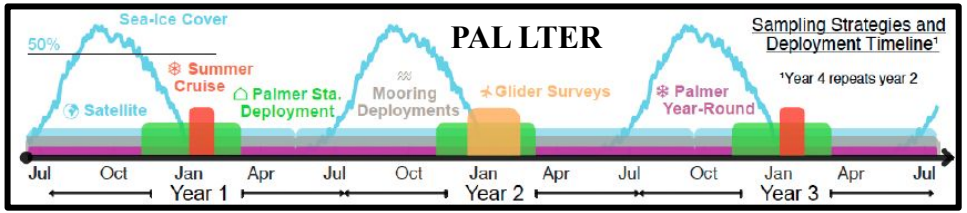
Megan Cimino (NOAA-UCSC)
Scott Doney (U Virginia)
Ari Friedlaender (UCSC)
Janice McDonnel (Rutgers)
Michael Meredith (BAS)
Carlos Moffat (U Delaware)
Oscar Schofield (Rutgers)
Sharon Stammerjohn (U Colorado)
Deborah Steinberg (William & Mary)
Benjamin Van Mooy (WHOI)

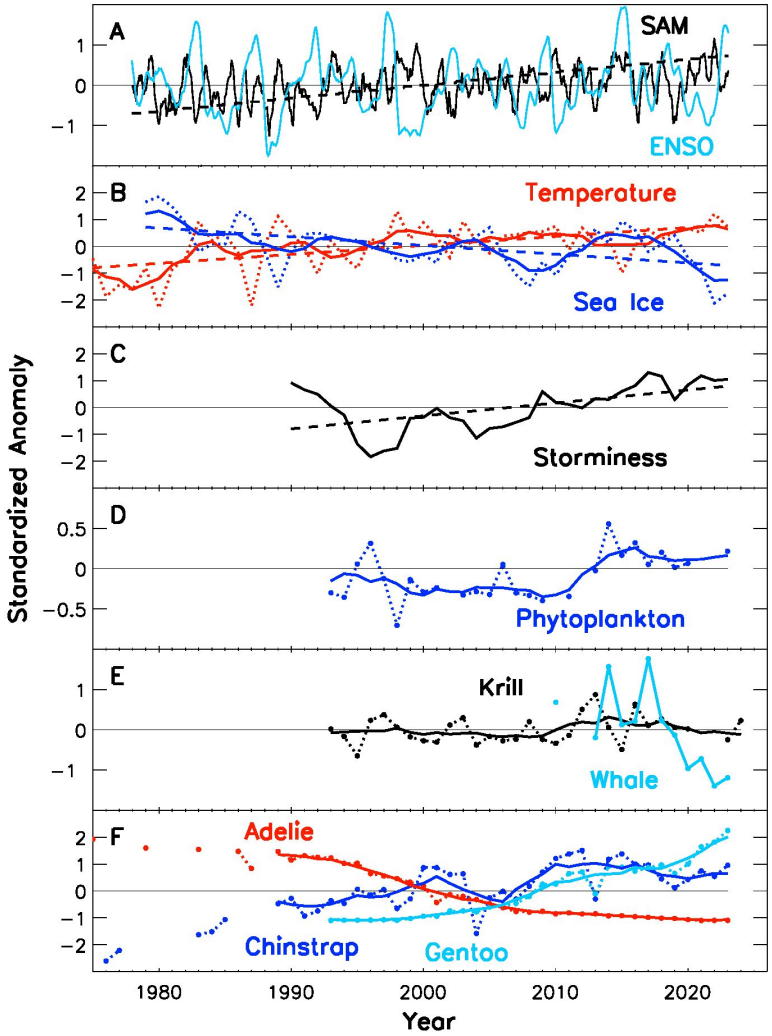
Other Partners

Argentina Jubany Time Series
British Antarctic Survey
NOAA-AMLR Team
NSF SOCCOM

Changes in Ecosystem Productivity

- **High vs. low Sea-Ice Years result in high vs low:**
  - primary productivity (Nardelli et al 2023)
  - krill recruitment (Saba et al 2014)
  - whale pregnancy rates (Pallin et al 2023)
  - Adelie penguin population (Cimino et al 2023)
- **Long-term Warming & Sea-Ice Decline resulted in** (Schofield et al 2024)
  - decrease in ice-obligate species
  - increase in ice-avoiding species
  - mixed shifts in other species
- **Glacial meltwater inputs appear offset some impacts from sea-ice decreases** (Pan et al 2025)





An International RCN for the Ross Sea region Marine Protected Area

(5-years: 2025-2029)

University of Colorado Boulder

*Cassandra Brooks (Lead PI)

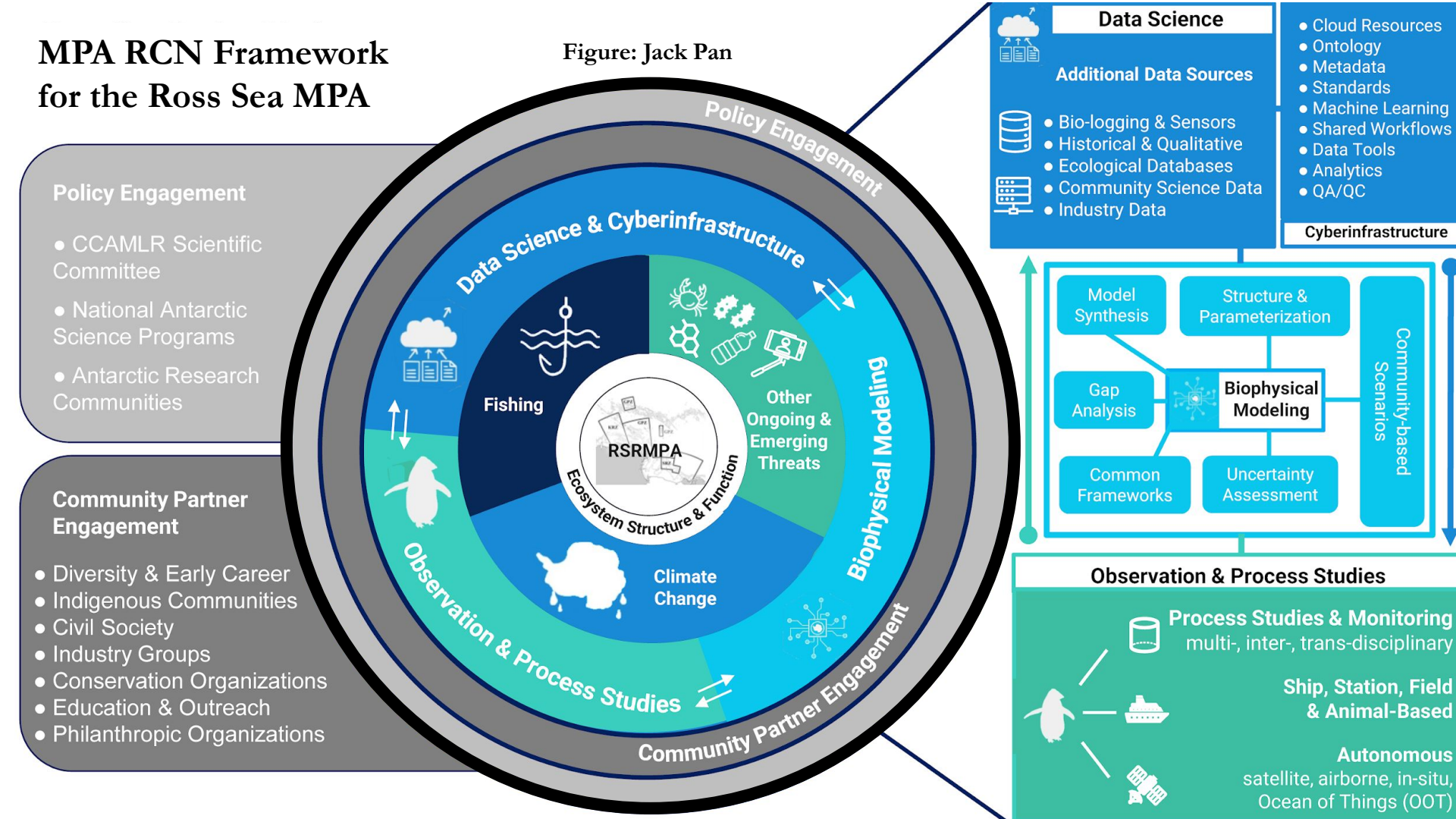
Steering Committee Members

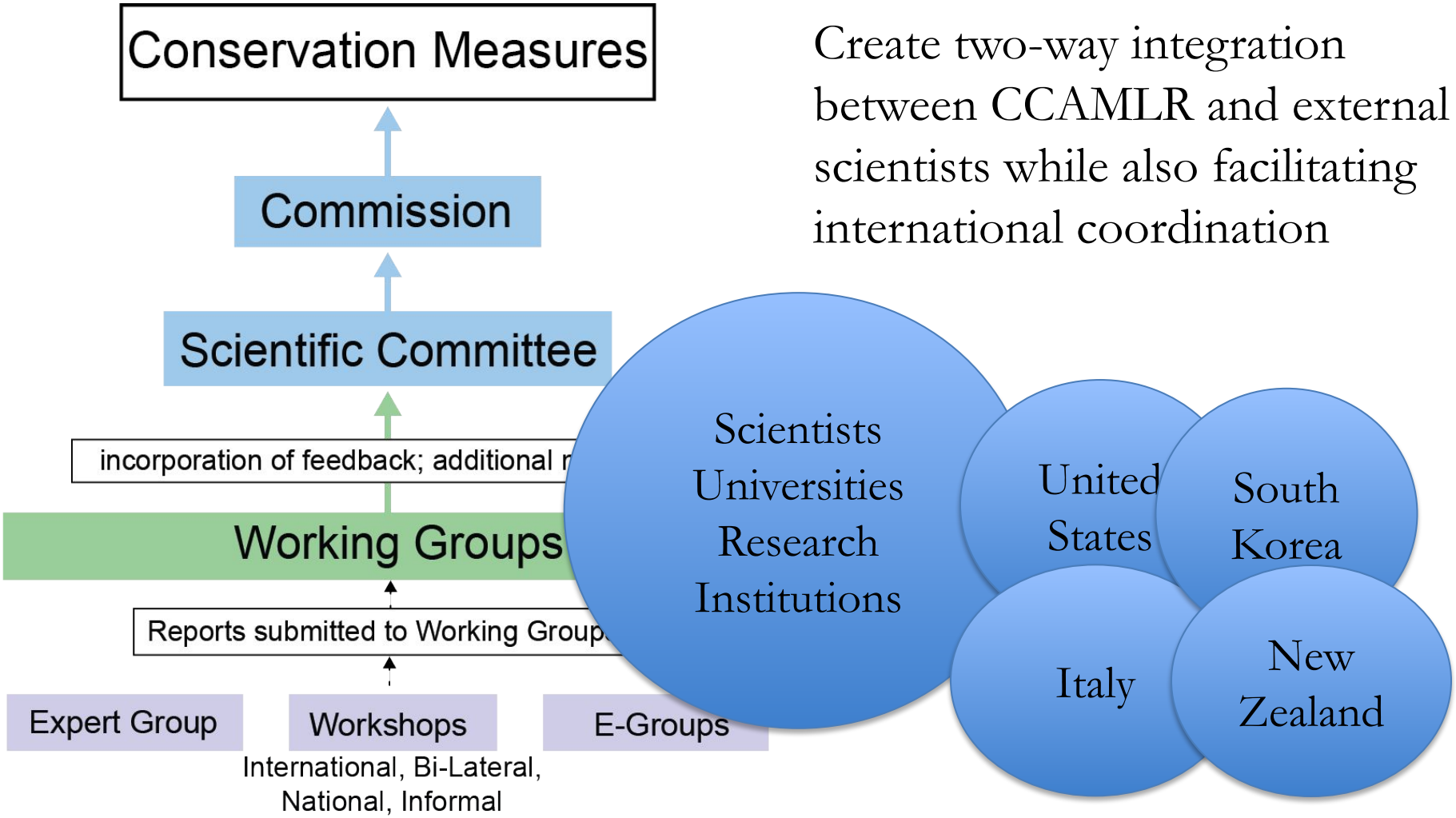
Grant Ballard (USA)
*Claire Chistian (ASOC)
*Laura Ghigliotti (Italy)
Eileen Hofmann (USA)
*Jeong-Hoon Kim (South Korea)
Michelle LaRue (USA/NZ)
Cara Nissen (Germany, Netherlands)
Alex Orona (USA)
Jack Pan (USA)
*Jeongseok Park (South Korea)
*Steve Parker (CCAMLR Secretariat)
Sharon Stammerjohn (USA)
*Nathan Walker (NZ)
John Weller (USA)

*CCAMLR Representative

MPA RCN Framework for the Ross Sea MPA

Figure: Jack Pan





Create two-way integration between CCAMLR and external scientists while also facilitating international coordination

Objectives of the RSRMPA (Conservation Measure 91-05)

(i) to conserve natural ecological structure, dynamics and function throughout the Ross Sea region…

(ii) to provide reference areas for monitoring natural variability and long-term change…

(iii) to promote research and other scientific activities on marine living resources…

(iv) to conserve biodiversity by protecting representative portions of benthic and pelagic regions…

(v) to protect large-scale ecosystem processes…

(vi) to protect core distributions of trophically dominant pelagic prey species…

(vii) to protect core foraging areas for land-based top predators…

(viii) to protect coastal locations of particular ecological importance…

(ix) to protect areas of importance in the life cycle of Antarctic toothfish…

(x) to protect known rare or vulnerable benthic habitats…

(xi) to promote research and scientific understanding of krill…

Photo: John B. Weller

Examples of Short-Term Working Group Priorities

- Develop communication toolkits & media strategies to broaden RCN participation/raise MPA awareness; draft a Strategic Engagement Plan
- Compile/update key datasets (biological inventories, population censuses, predator diets, animal tracking) and update Ross Sea ecological indices (Ballard et al, 2012)
- Identify modeling tools/data that can address observational gaps, assess MPA objectives, evaluate MPA effectiveness
- Populate the RCN data science platform (the Big Blue Cloud/BBC*) with above data (*developed by Jack Pan under NASA funding to Ocean Motion Technologies)
- Develop BBC visualizations/analytical tools to facilitate coordination/collaboration
- Submit results and make products available to CCAMLR for the 2027 Review

Photo: Cassandra Brooks