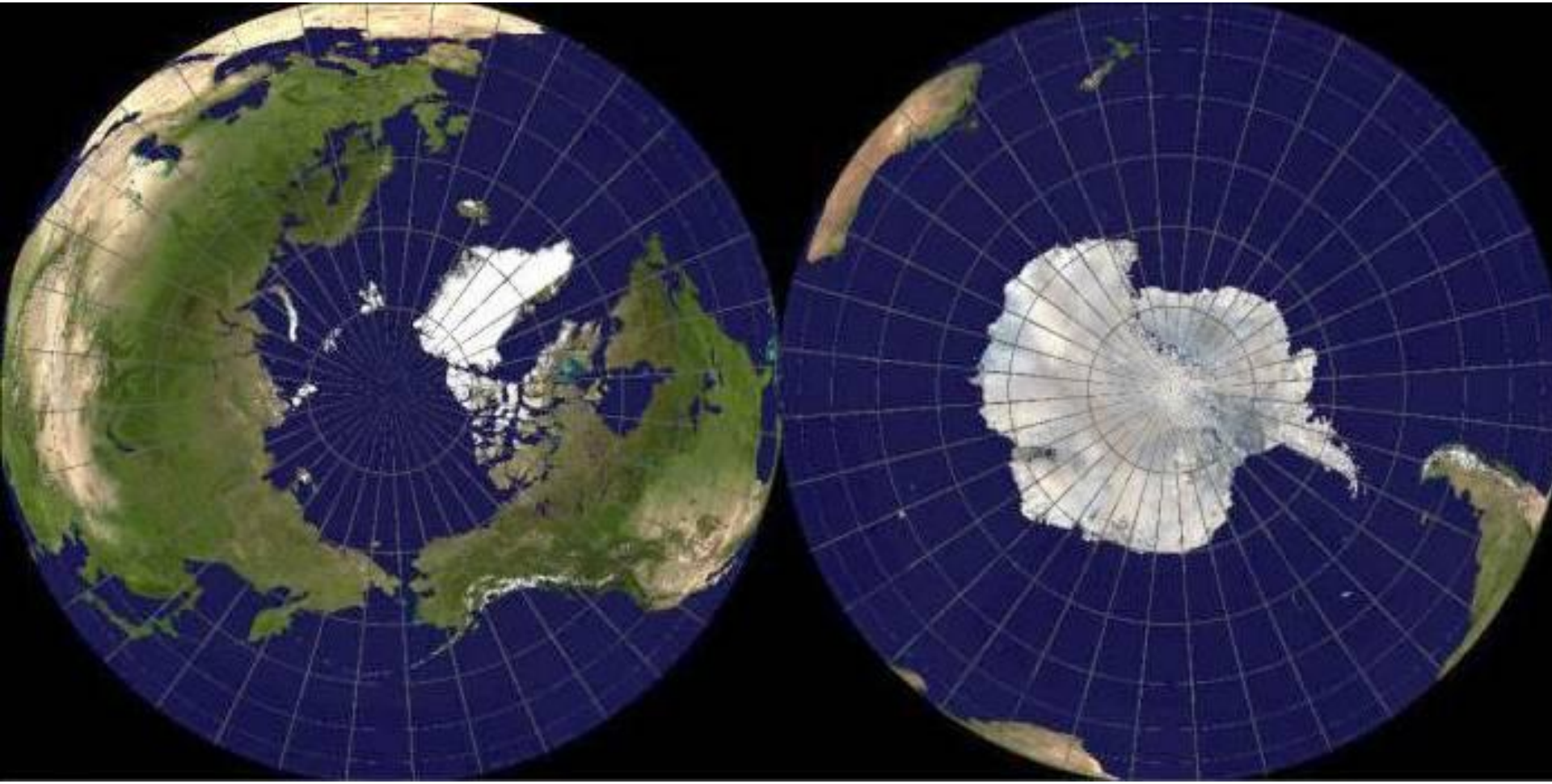
Schmidt Ocean Institute Planning Workshop
Aug. 19, 2014, Kahuku, Hi.

Polar Oceanography in a Warming World: Challenges and Opportunities for the Future

Dr. Phil McGillivary
USCG PACAREA & Icebreaker Science Liaison

An Arctic & Antarctic Perspective on Polar Oceanography



Quote (to P. McG.):

"Most people will never get to the polar regions, so you have to bring the polar regions to them."

Dr. Michael Ledbetter,
former NSF OPP Arctic program manager

Societal Information Needs from the Polar Regions

1) Arctic sea ice melting effects on weather
2) Glacier/Ice Shelf melt & Sea Level Rise
3) Methane release from melting permafrost & seafloor warming
4) Changing population dynamics of arctic species
4) Changes in Arctic fisheries (Alaska, Norway)
5) Alien species introductions

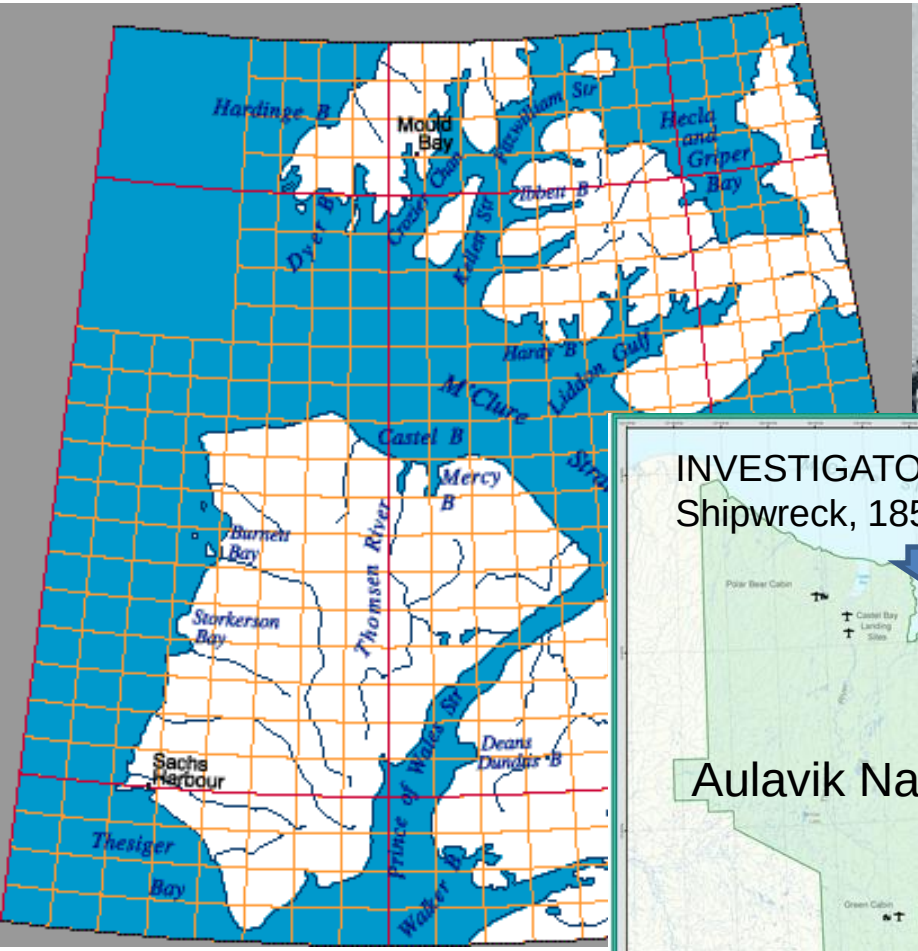
The Big Unknowns North

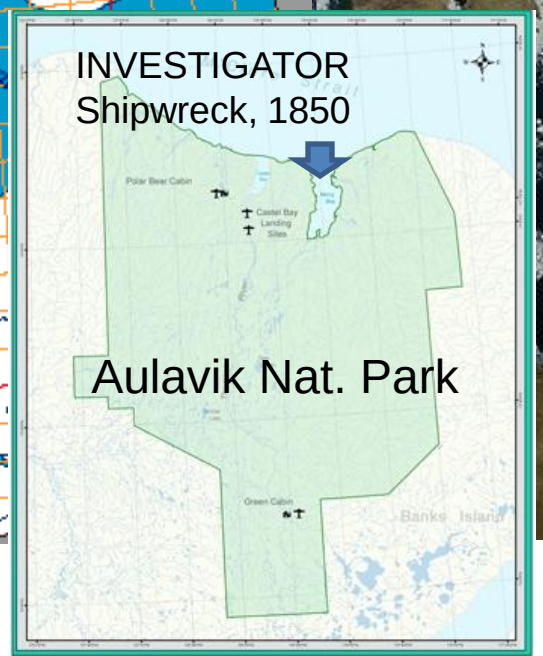
- 1) *The “Hot Tubs”: M’Clure Strait
- 2) *Greenland’s Underwater Rainforest: the North Open Water benthos
- 3) *Arctic Ocean Ethnography: Chukotka sites from TEK & current info
- 4) *Arctic Mining effects on Maritime Saami - their TEK at risk
- 5) Interactions of Cold Corals & Fisheries: esp. Greenland, Norway
- 6) Methane hydrates & methane flux: North Slope & Russian Arctic
- 7) Lost history: submerged & eroding u/w archaeology sites
- 8) Lost ships – various locations, incl. Bering Straits & NWP
- 9) How to monitor wide-ranging marine population dynamics: polar bears, walrus, whales, ice seals, seabirds
- 10) Arctic Cod: spawning grounds = unknown for this keystone species
- 11) Sea Ice Dynamics: is climate change causing more or less ice ridging? What is the risk to shipping?

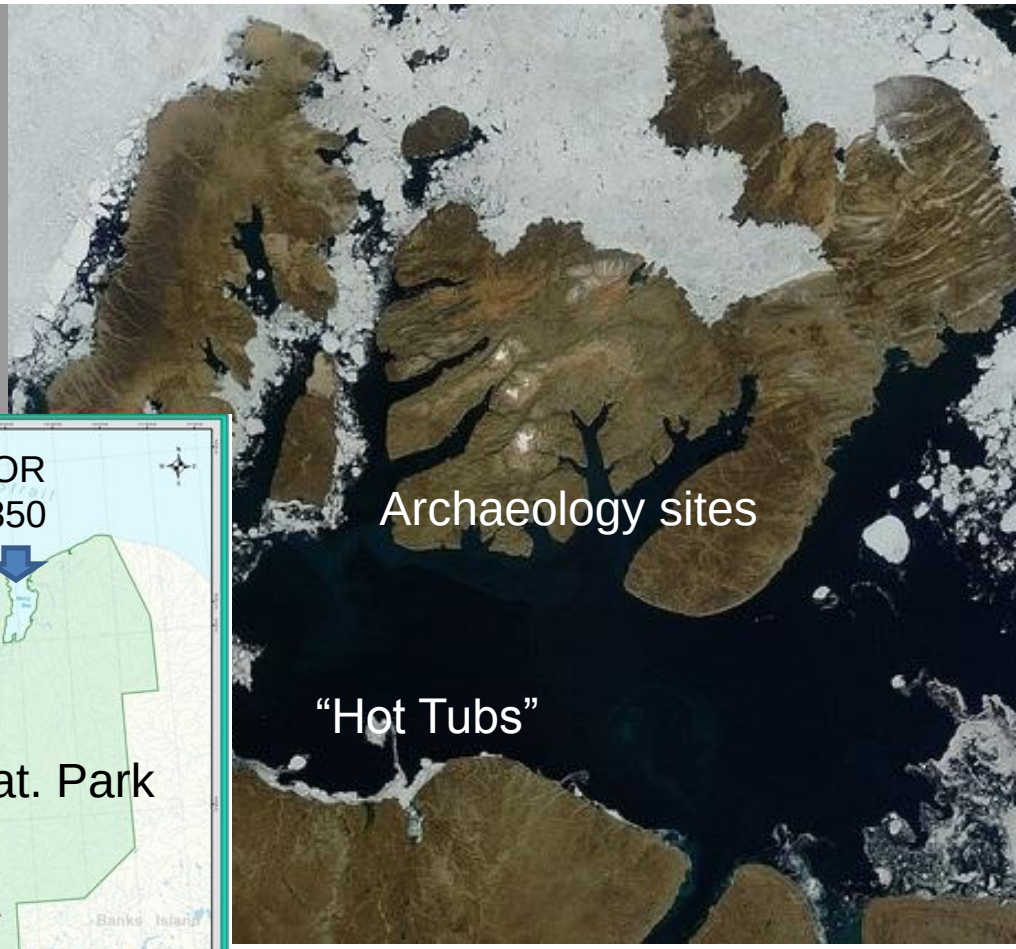
* Focus of Discussion

Arctic Site Map:

The “Hot Tubs” in the M’Clure Strait and Aulavik National Park
The Submarine Limestone Sinkhole Warm Springs
result in Biological & Archaeological Hot Spots



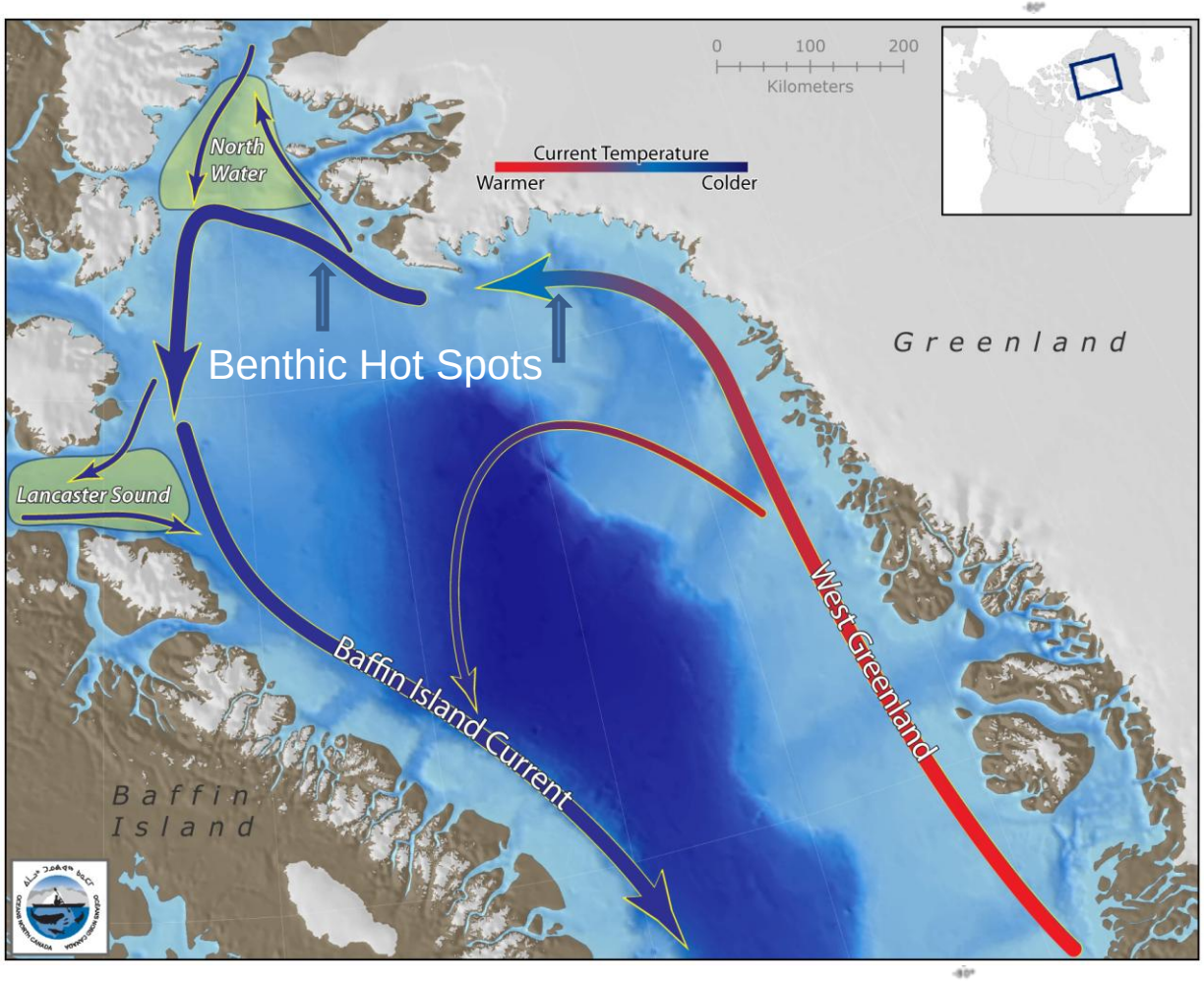


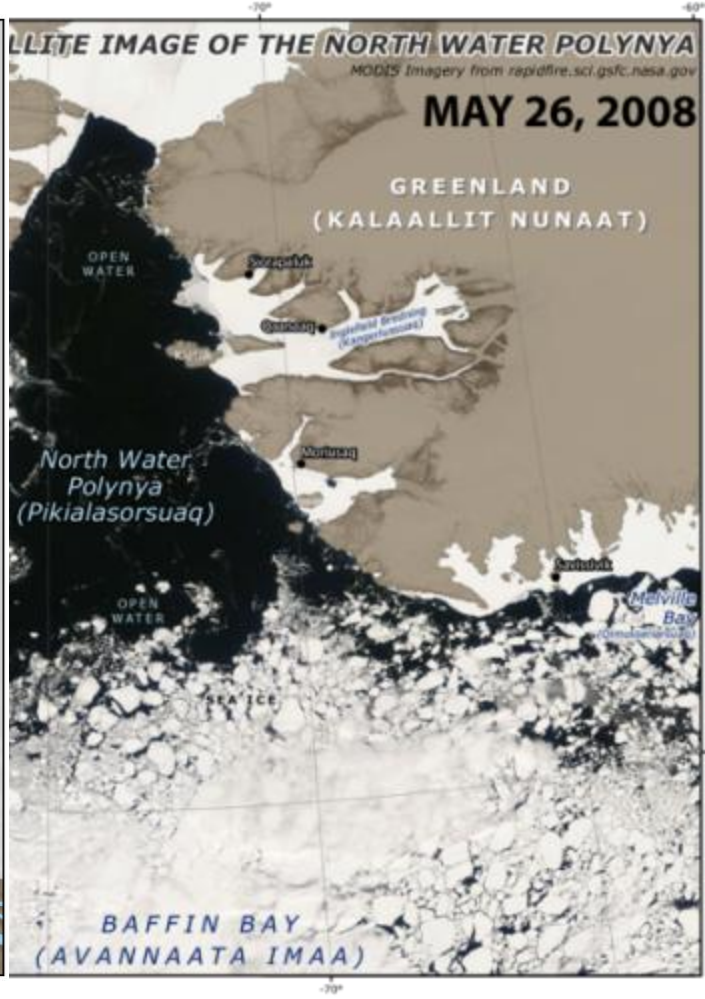


Arctic Site Map:

North Water Polynya area, Greenland

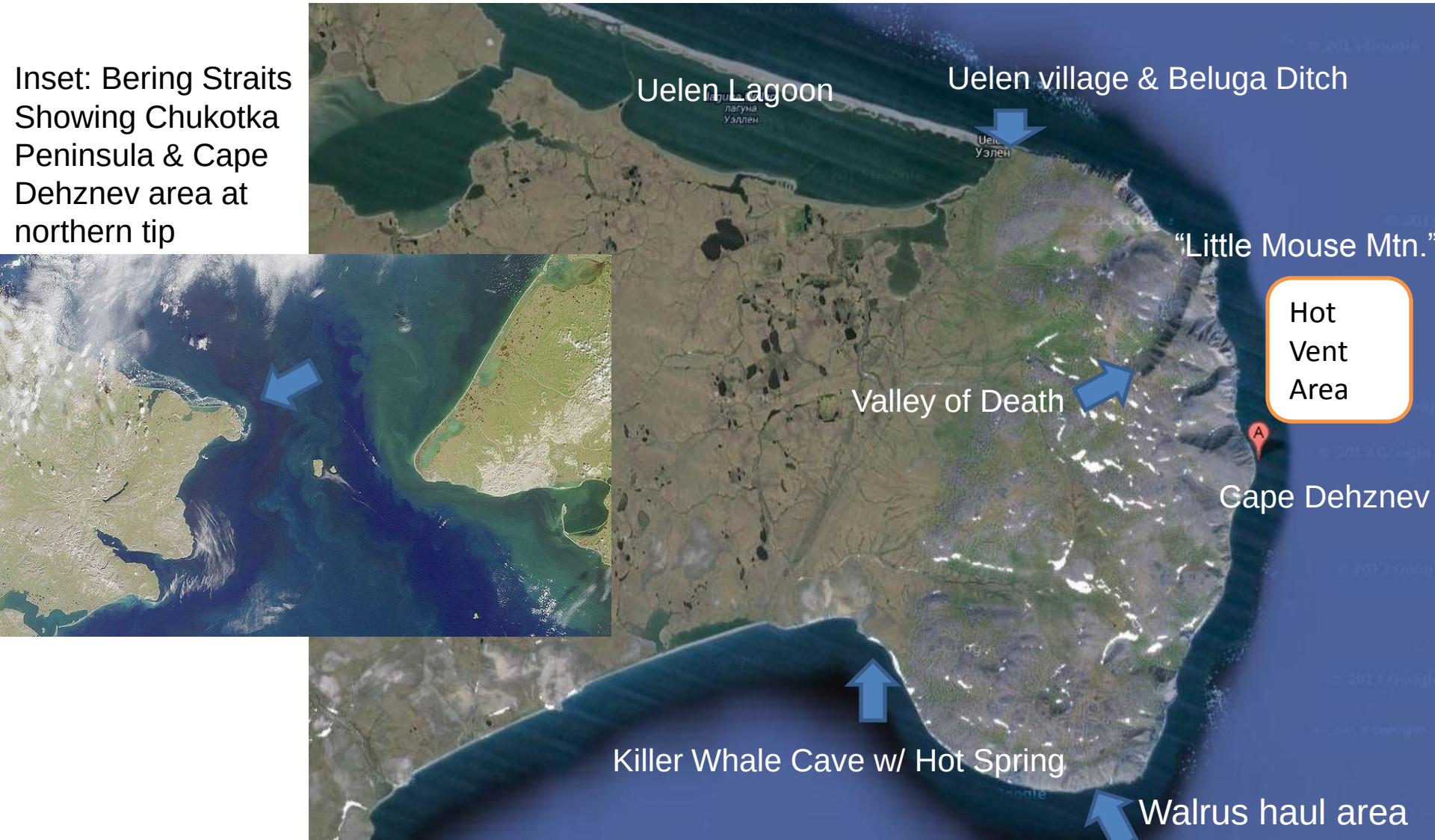
Canadian expeditions have been unable to fully study high biomass benthos area





Arctic Site Map:

Chukotka sites (south to north):
The Killer Whale Sea Cave; Little Mouse Mountain (Cape Dehznev); and,
The Beluga 'Ditch' @Uelen Lagoon

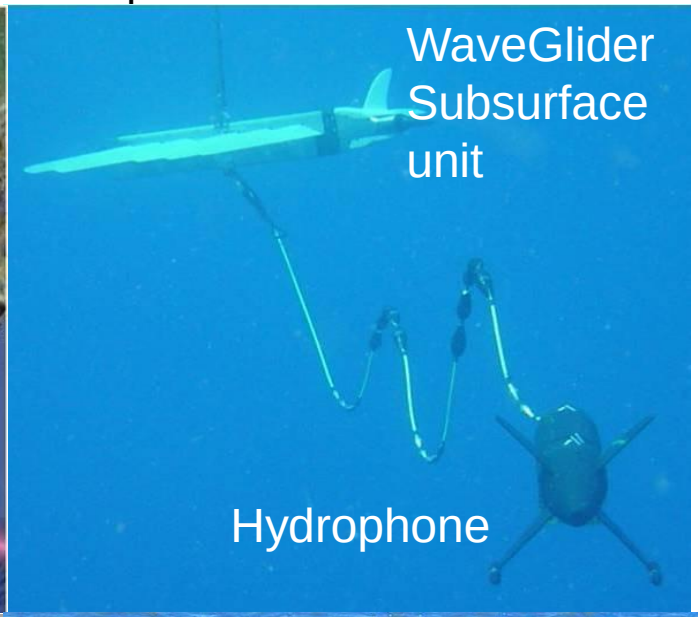


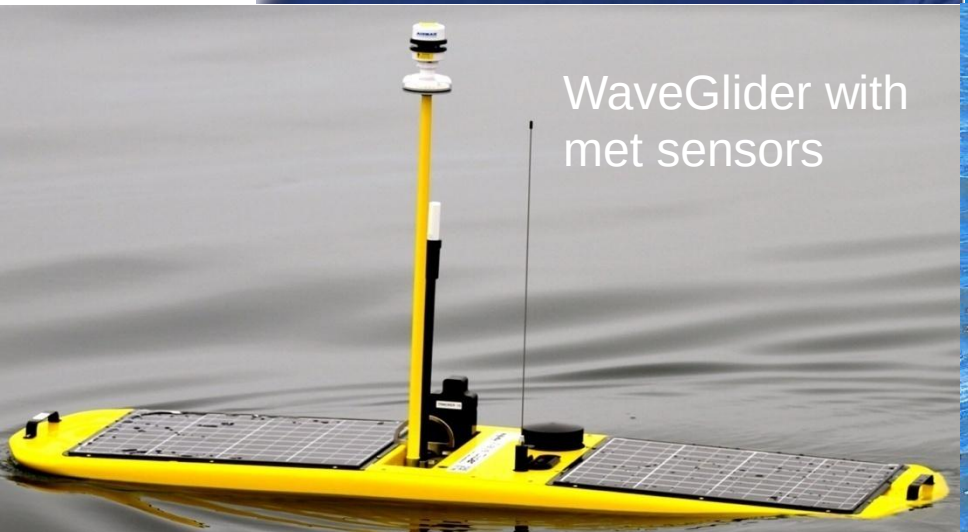
Arctic Mining Effects on the Environment & People

- Arctic mining effects native people, especially the Saami.
- Saami, Chukchi & other Arctic traditional ocean knowledge is at risk.
- Marine Ethnology IS Science! From Nansen & others' first Arctic cruises an Ethnologist was always aboard!
- See: http://barentsobserver.com/en/business/2014/06/new-arctic-industry-research-program-fram-centre-underway-19-06

Enabling Technologies:

WaveGliders or other Autonomous Surface Vessels (ASVs) for persistent methane flux monitoring, and acoustic monitoring; best if also coupled with Unmanned Aircraft from ASV for vertical sampling at 2 & 4 m with stable platforms for UAS launch & recovery.



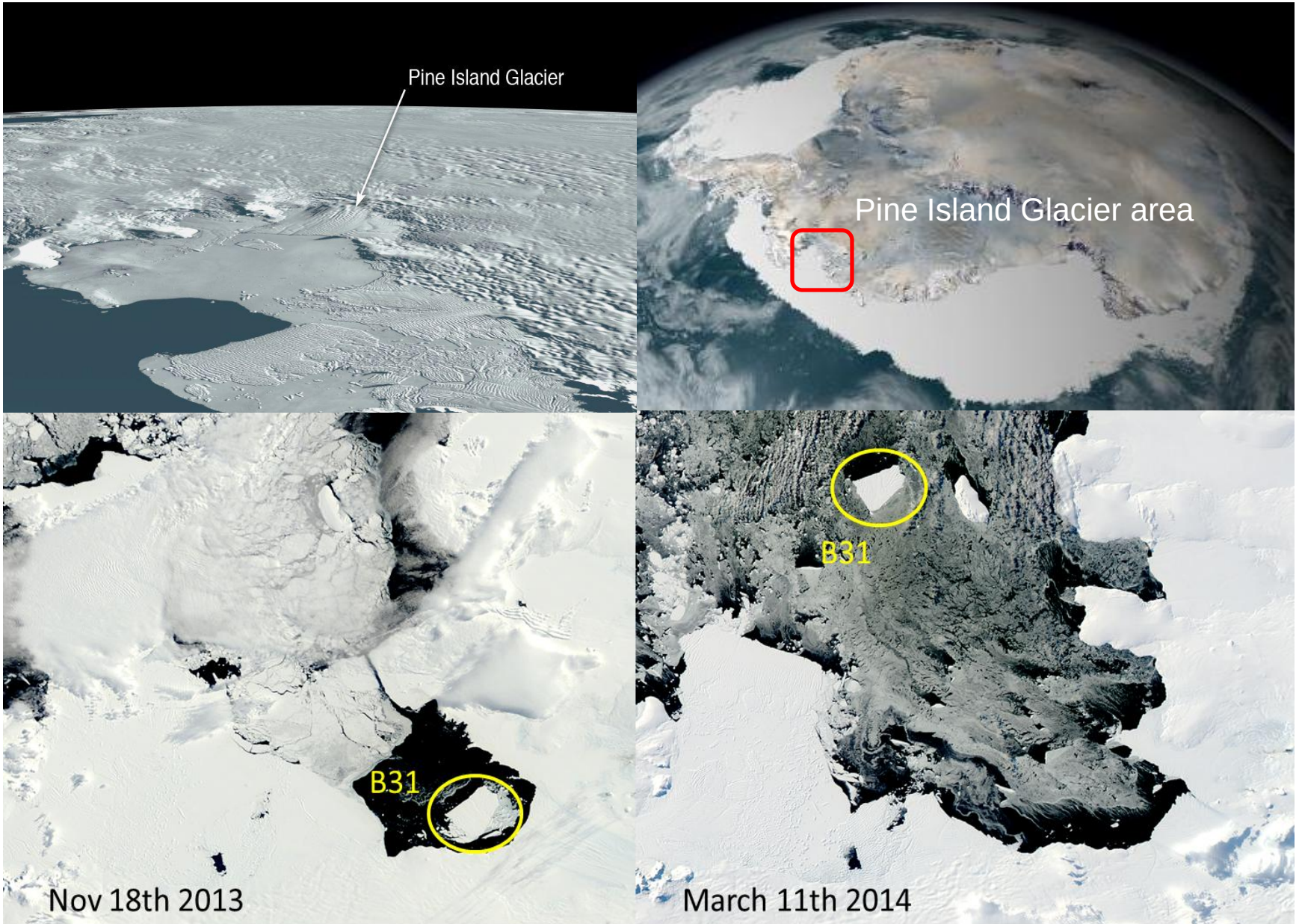


The Big Unknowns South

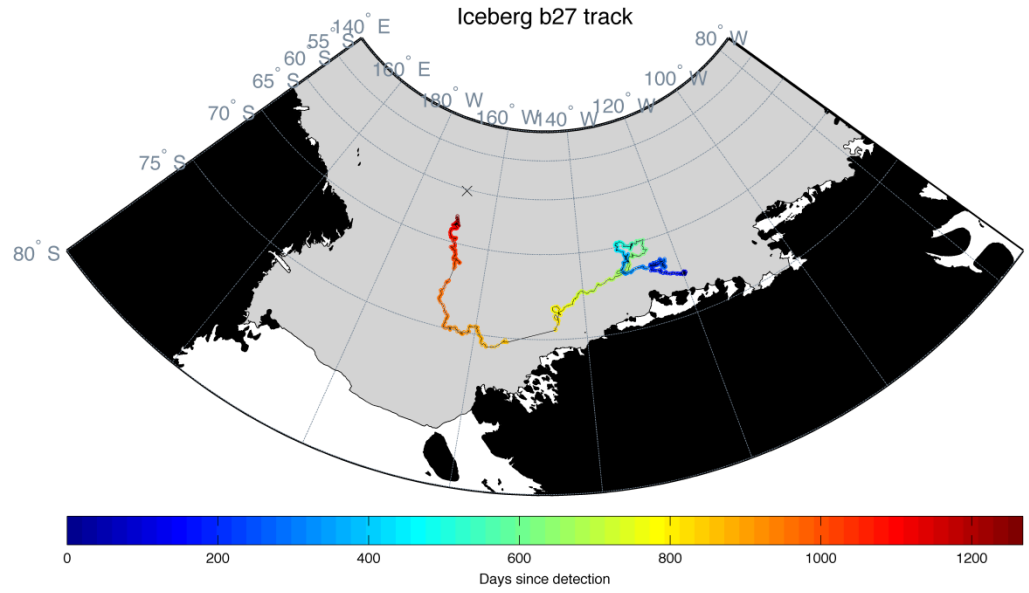
- *Iceberg productivity & dynamics
- *Air-sea gas flux in polynyas & around Icebergs
- *Submarine volcanos
- *Antarctic Shelf Benthos & Alien Species Invasions
- What is happening under the Ross Ice Shelf? Melting?
- Whale population dynamics, and use of Ross Sea
- Fisheries re: proposed Ross Sea Marine Protected Area
- Climate Effects on Antarctic Circumpolar Current

*Focus of Discussion

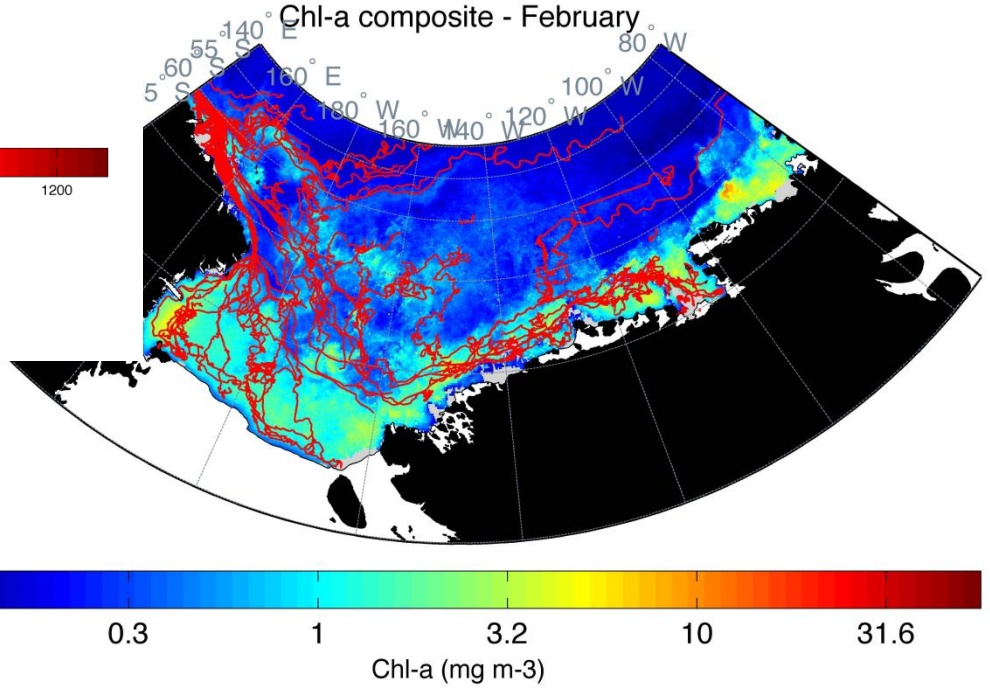
B31 Iceberg, Pine Island Glacier, 21x12mi, calved Nov. 2013



B31 Iceberg, Pine Island Glacier, And Anticipated Drift Trajectory, example of B27 and all recorded PIG icebergs (from Maria Vernet, SIO)



Start: 11/23/2009, end: 05/14/2013, duration: 1268 days

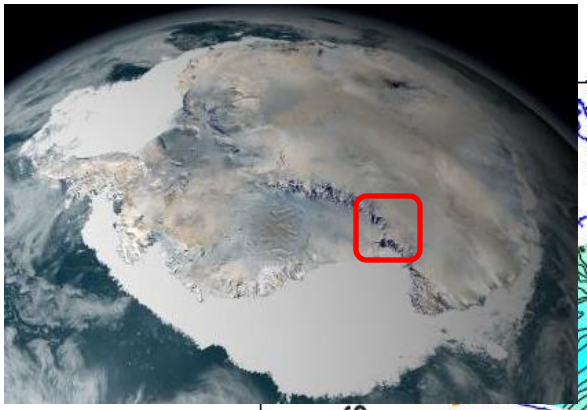


Franklin Island Hot Vents, Ross Sea, Antarctica

discovered by Larry Lawver & Terry Wilson, unpublished, but see:

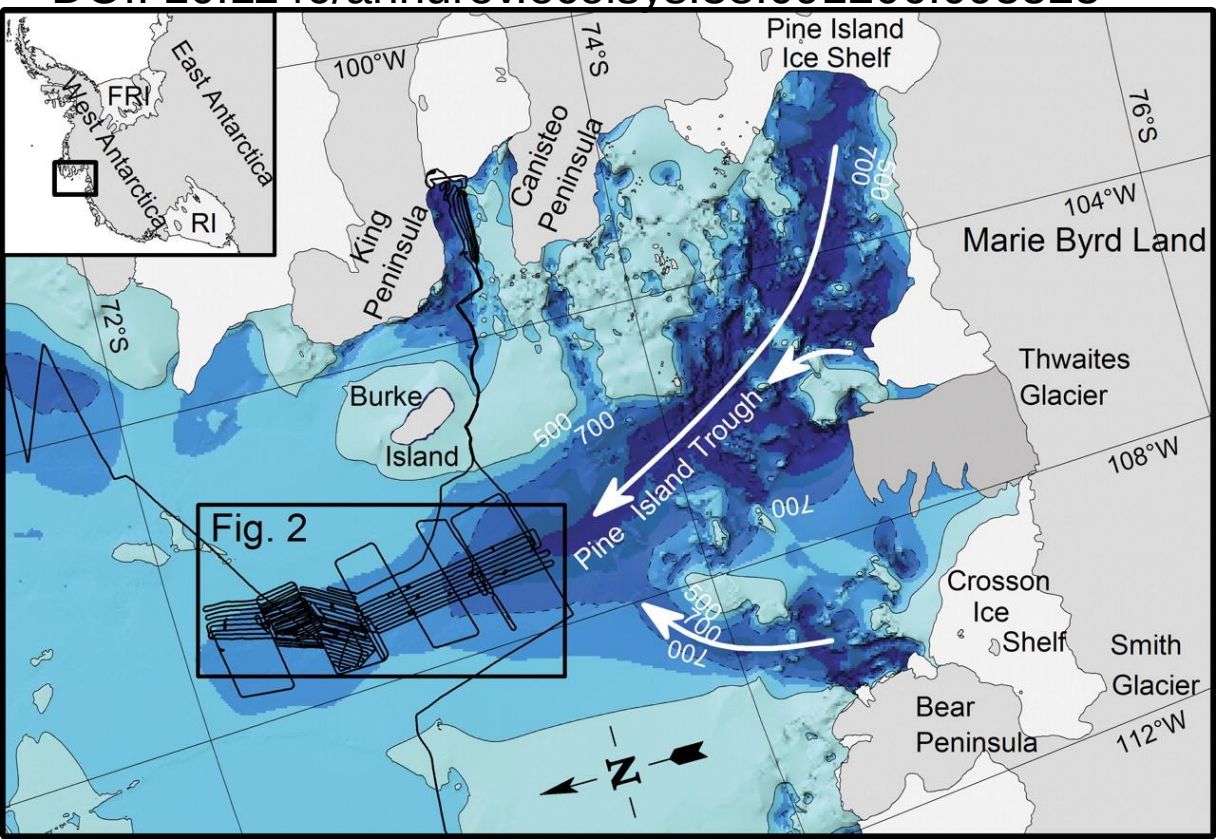
L.Lawver, J.Lee & F.Davey, 2012. Flat-topped mounds in western Ross Sea: carbonate mounds or subglacial volcanic features? Geosphere 8(3):645-653.

Tuyas are subglacial volcanic eruptions usually flat-topped and steep-sided. Below: from British Columbia (background) & Hogg Rock, Oregon (in foreground). Also in Ross Sea per ref. above.

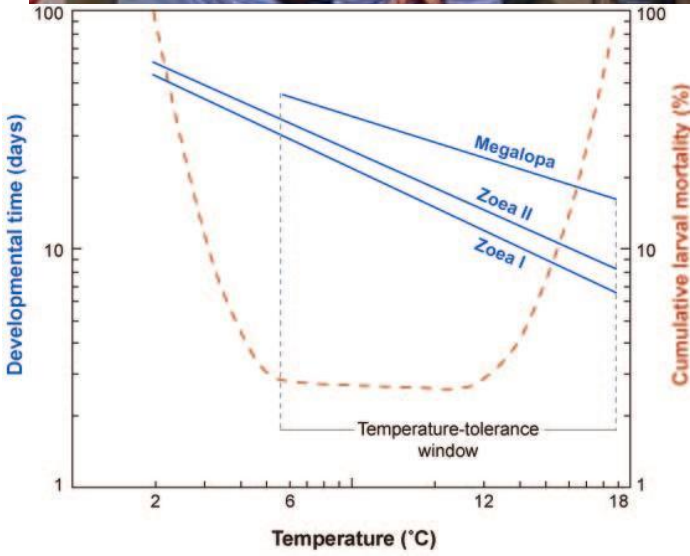


Alien Species Effects on the Antarctic Shelf Benthos

For 30+Million years Antarctic shelf benthos evolved without sharks, rays or crustaceans of note due to temperature limitations. That could change with <2oC warming, c.f. Rich Aronson, et al., 2007. Climate Change and Invasibility of the Antarctic Benthos. Annual Review of Ecology, Evolution, and Systematics, 38:129-154. DOI: 10.1146/annurev.ecolsys.38.091206.095525



Sven Thatje & Sub-antarctic King Crab



Enabling Technologies for Polar Research in the Future

1) Increased use of Unmanned Aircraft Systems (UAS) from ships and also from Autonomous Surface Vessels (ASVs) with persistent re-powering by either laser or microwave systems. Laser system already COTS (http://www.lasermotive.com); microwave system test planned fall 2014 (http://www.escapedynamics.com).
2) Small, low cost, low energy meta-material LEDs for u/w hi bandwidth comms (@600-700MB/sec). Demos planned for late 2014/early 2015.

   Will enable high bandwidth data collection and transfer from AUVs to ASVs and also to UAS.
3) RVs with cloud computer systems (aka: Software Defined Networking systems), enabling multi-ship, and multi-autonomous component control & ready reconfiguration, c.f. joint UCB, Stanford & Fincantieri Shipyard project, Genoa, Italy.
4) Still a need for an AUV "pickup truck" to go considerable distances under the ice to deploy and recover sensor systems.
5) Fluid Lensing optical methods (c.f. http://www.vedphoto.com under Research).

Other Priority Areas for Marine Protected Area Research:
Maluku Islands, Indonesia:
Highest Abundance & Diversity of Whales Anywhere,
Only Lagoon of Indonesian Archipelago in Global Center of Highest Marine Biodiversity
Relatively Pristine since avoided during Indonesia – Timor Conflict