

Freshwater Ecology in Utqiagvik

Christian G. Andresen



Assistant Professor

Geography Department

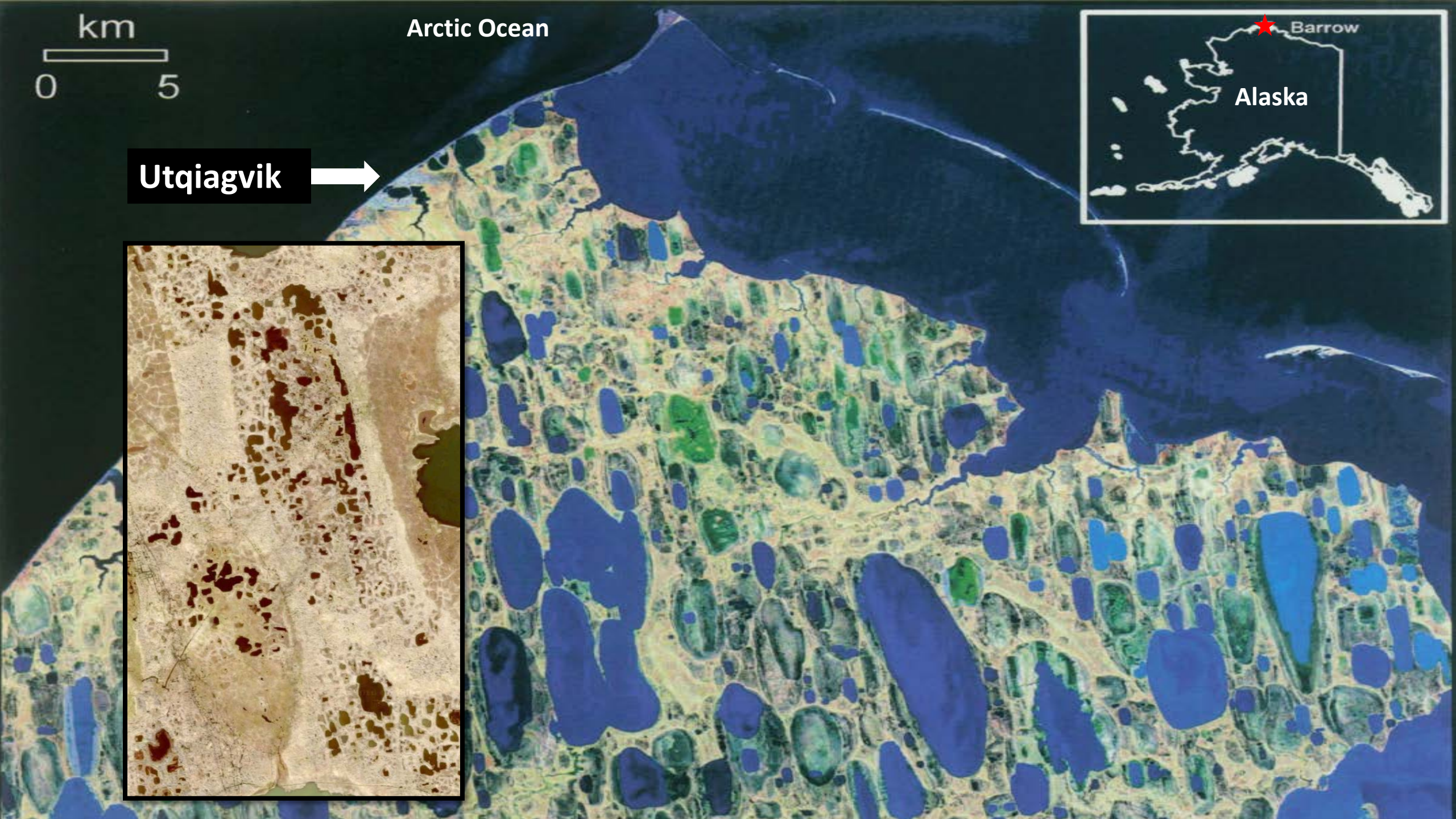
University of Wisconsin Madison

km
0 5

Arctic Ocean



Utqiagvik



Early work in freshwater systems

- Aquatic invertebrates
(Chironomidae)
 - 1940s-NARL's Laurence Irving & Per Sholander
 - 1970s- Mac Butler
 - Phenology
 - Life-cycles



1970s Tundra Biome Project

The International Biological Program (IBP) Tundra Ponds (John Hobbie, Alexander, McRoy, Stanley, Miller, Tiezen)





How are thaw ponds changing over the past 50 years?



Resampling of “IBP” Tundra Ponds starting in 2008

1972



John Hobbie

2010



Vanessa Lougheed, Univ. Texas at El Paso

IBP Tundra Ponds Data Rescue



Data rescue by Dr. Vanessa Lougheed (UTEP)

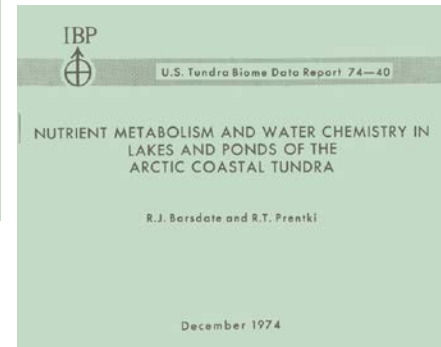
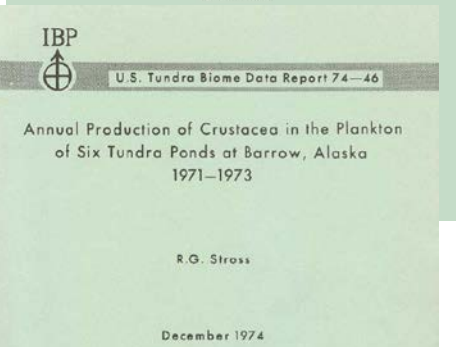
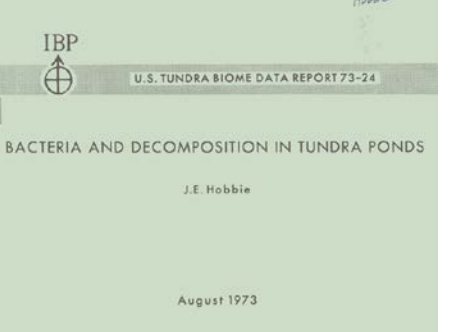
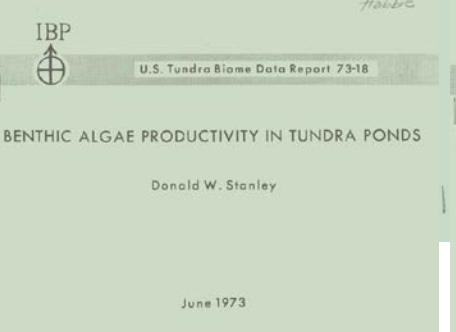
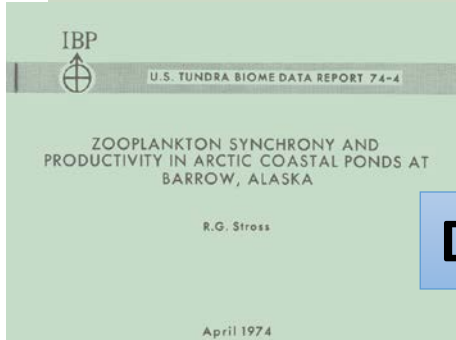
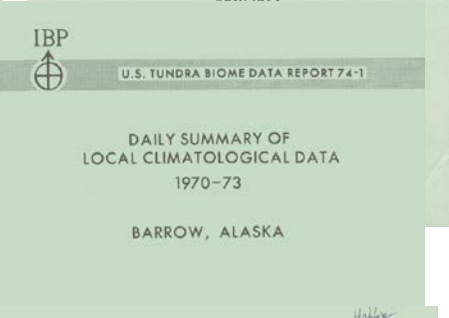
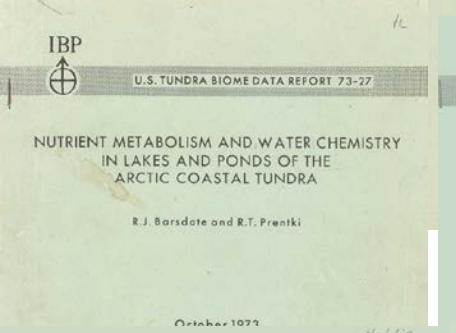
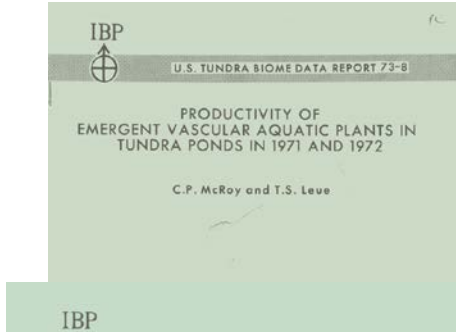
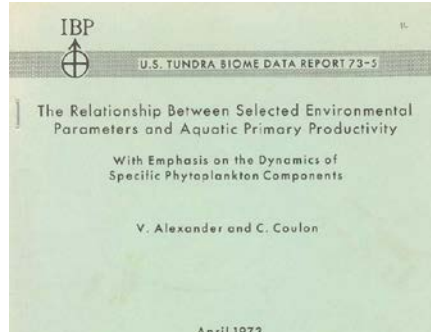
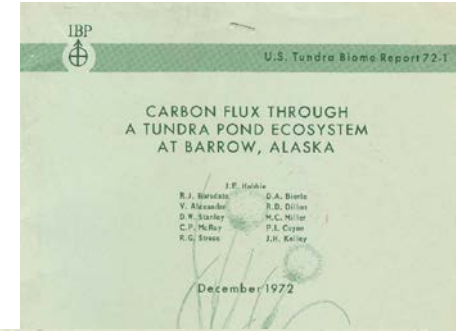


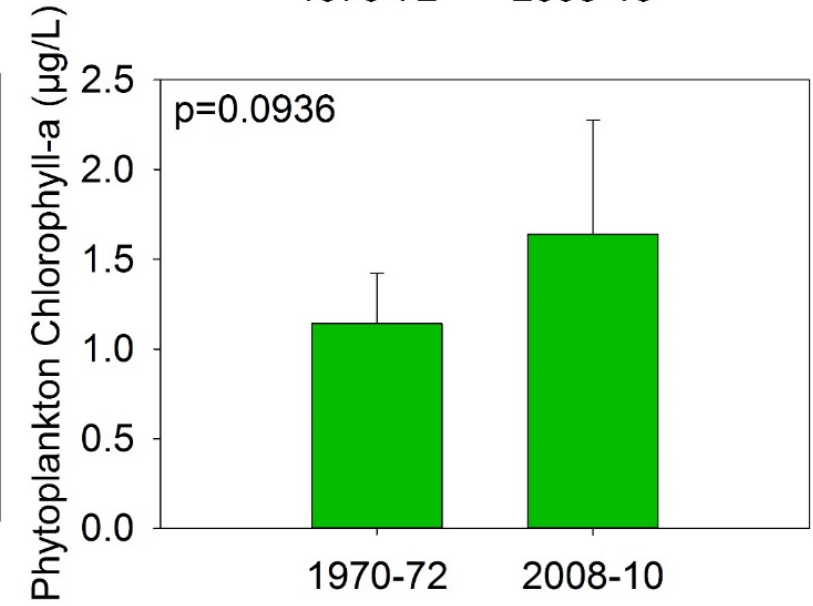
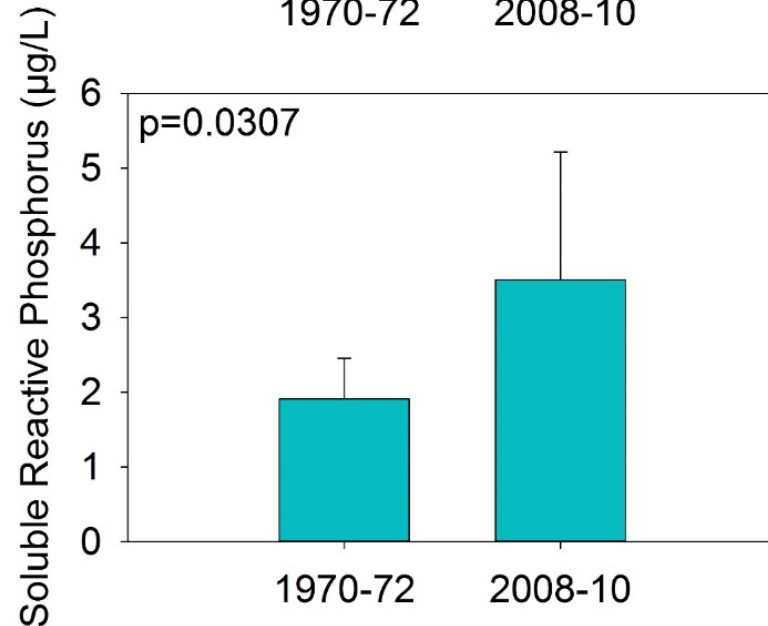
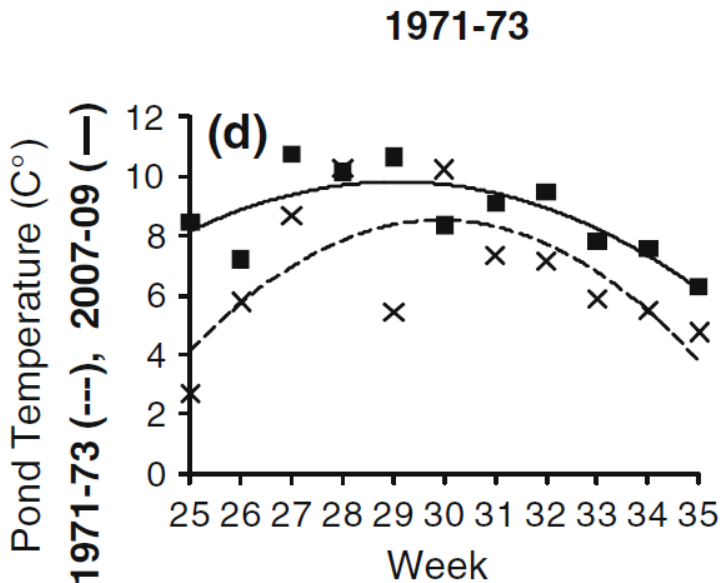
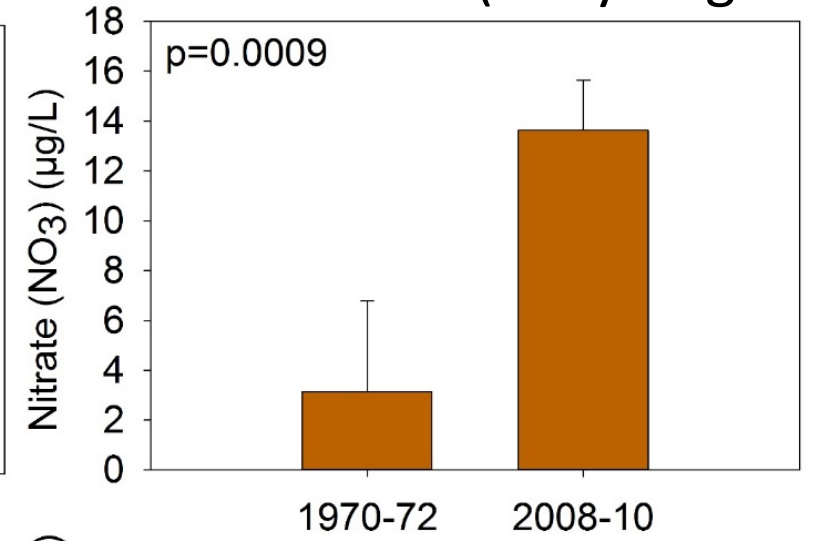
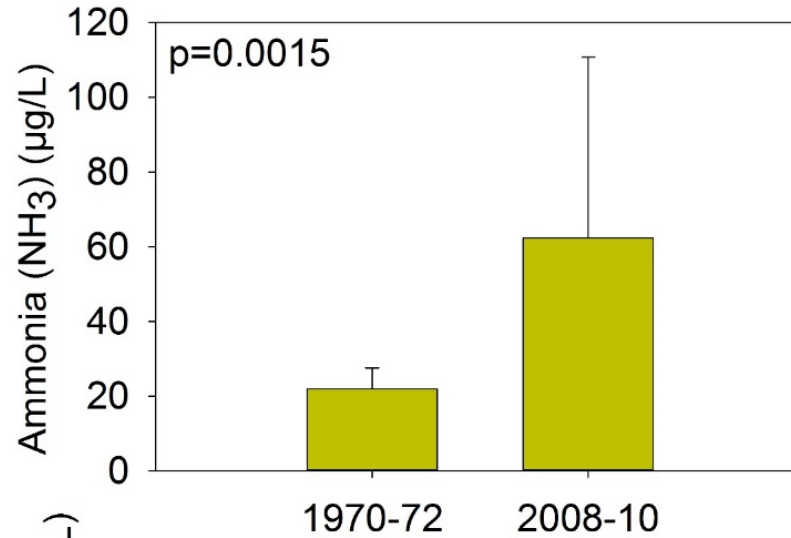
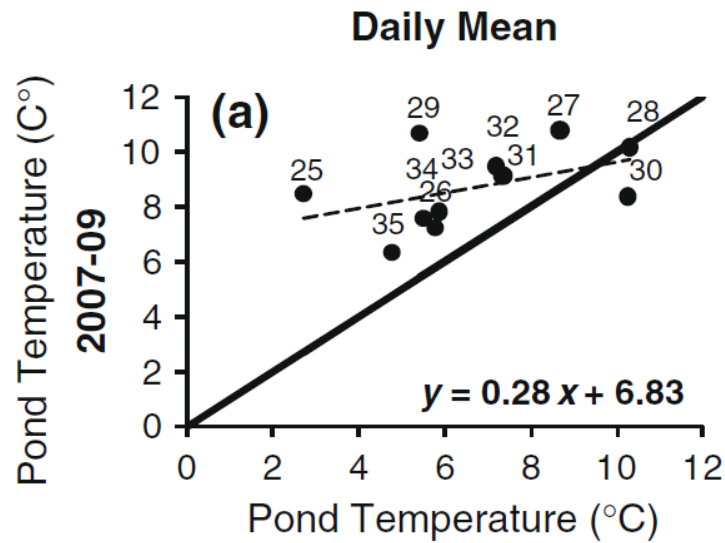
Table 68. Pond B, nitrogen and silica chemistry, 1971. Abbreviations: DIN and PN refer respectively to dissolved inorganic nitrogen (NH₃-N + NO₃-N + NO₂-N) and particulate nitrogen. Concentrations are μg/liter.

Date	NH ₃ -N	NO ₃ -N	NO ₂ -N	DIN	PN	SiO ₃ -Si
0321 9 June	18	14	0.6	33	63	71
0333 14 June	19	40	0.0	60	108	126
0345 21 June	41	40	0.6	49	160	126
0357 28 June	20	7	0.8	33	56	53
0362 5 July	12	29	0.0	48	160	9
0377 12 July	18	40	0.1	60	108	71
0384 19 July	46	59	0.3	105	166	126
0421 26 July	22	9	0.2	31	52	56
0436 2 Aug.	37	22	0.2	59	78	9
0456 9 Aug.	25	0	0.0	25	31	130
0469 11 Aug.	19	5	0.4	24	—	—
0476 16 Aug.	16	—	0.0	16	—	74
0490 21 Aug.	—	—	—	—	—	70
0491 23 Aug.	15	0	0.4	15	—	62

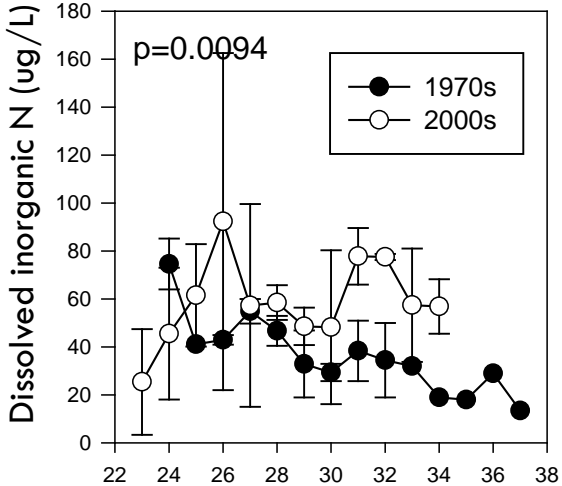
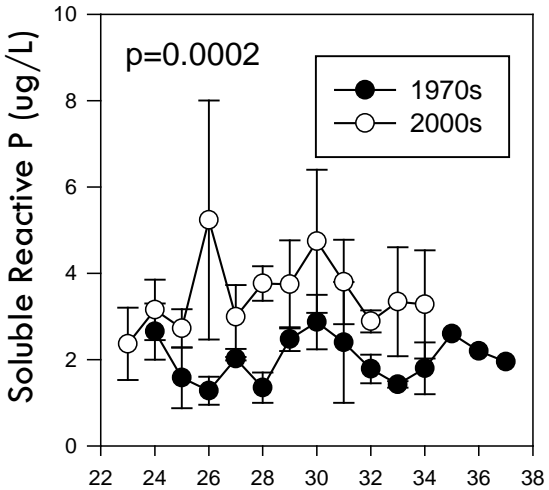
Date	DRP	DUP	TPP	TP
0321 9 June	3.7	4.4	7.0	15.1
0333 14 June	2.3	16.3	17.8	36.4
0345 21 June	5.2	10.3	10.9	26.4
0357 28 June	0.7	12.3	7.1	20.1
0362 5 July	1.1	12.6	6.4	17.6
0377 12 July	2.4	12.2	5.8	19.4
0384 19 July	1.4	6.3	2.5	9.5
0421 26 July	0.7	11.2	3.0	17.0
0436 2 Aug.	1.8	9.6	4.9	11.1
0456 9 Aug.	2.4	6.8	4.0	17.0
0469 11 Aug.	1.3	10.1	—	15.2
0476 16 Aug.	5.2	—	—	—
0490 21 Aug.	1.1	—	—	—
0491 23 Aug.	0.8	12.6	9.3	23.1

Increase in temp, nutrients and algal biomass

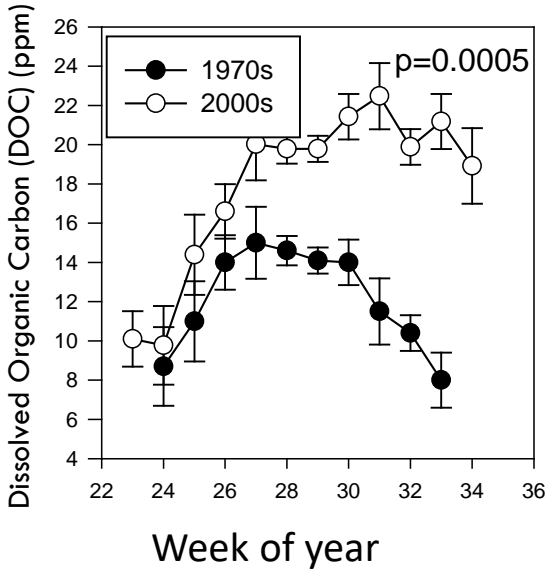
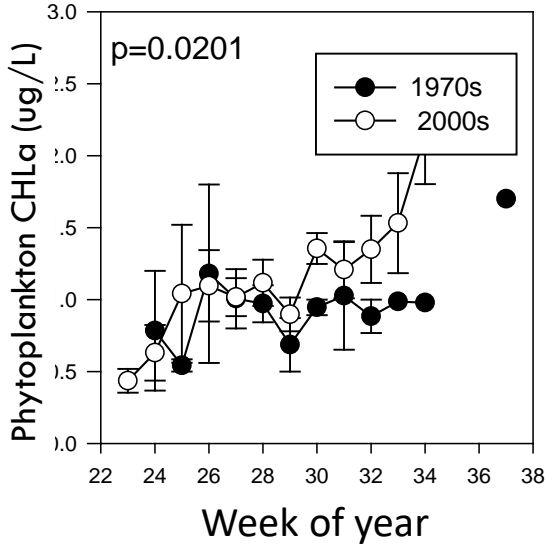
(Early August)



SEASONAL changes in nutrients and algal biomass

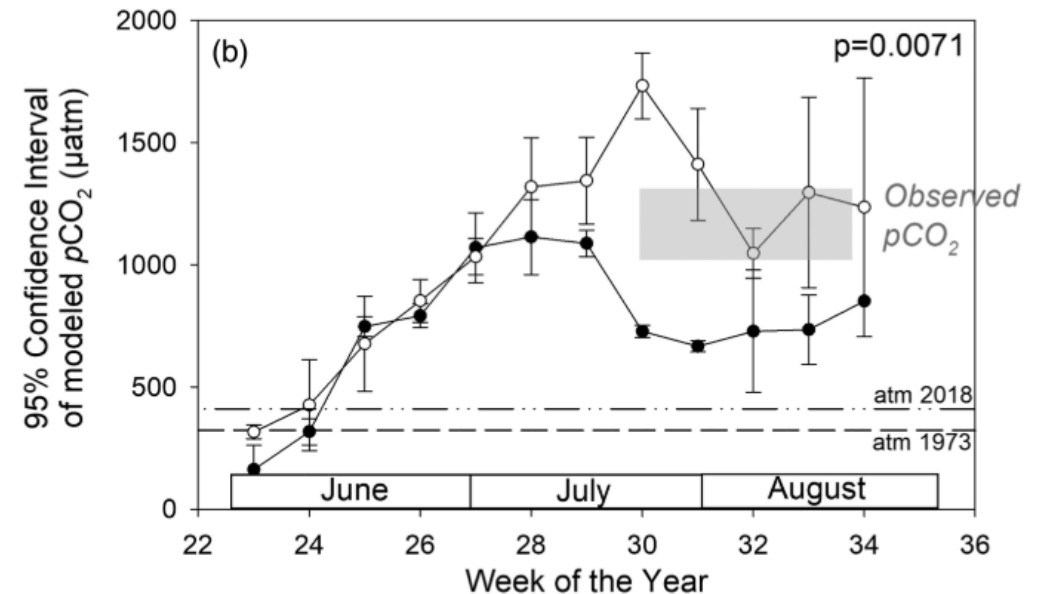
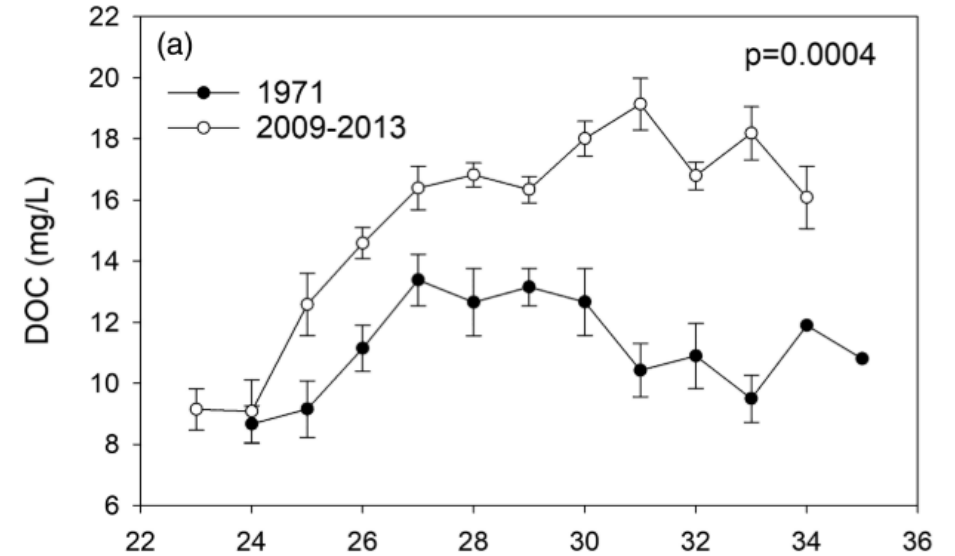
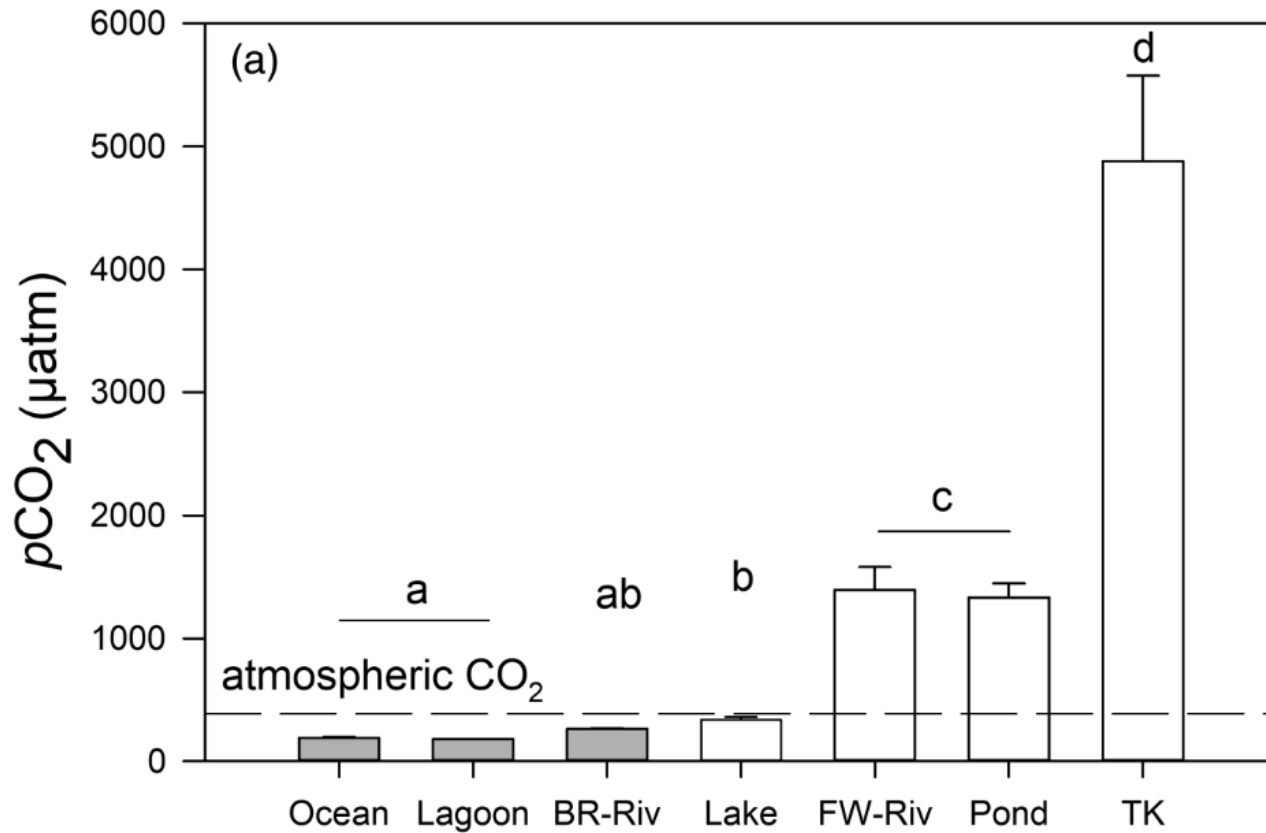


Trends hold up over season, and with 3 more summers of data.



Higher CO₂ emissions from freshwater systems

- Streams and ponds have highest CO₂
- Associated to DOC mineralization



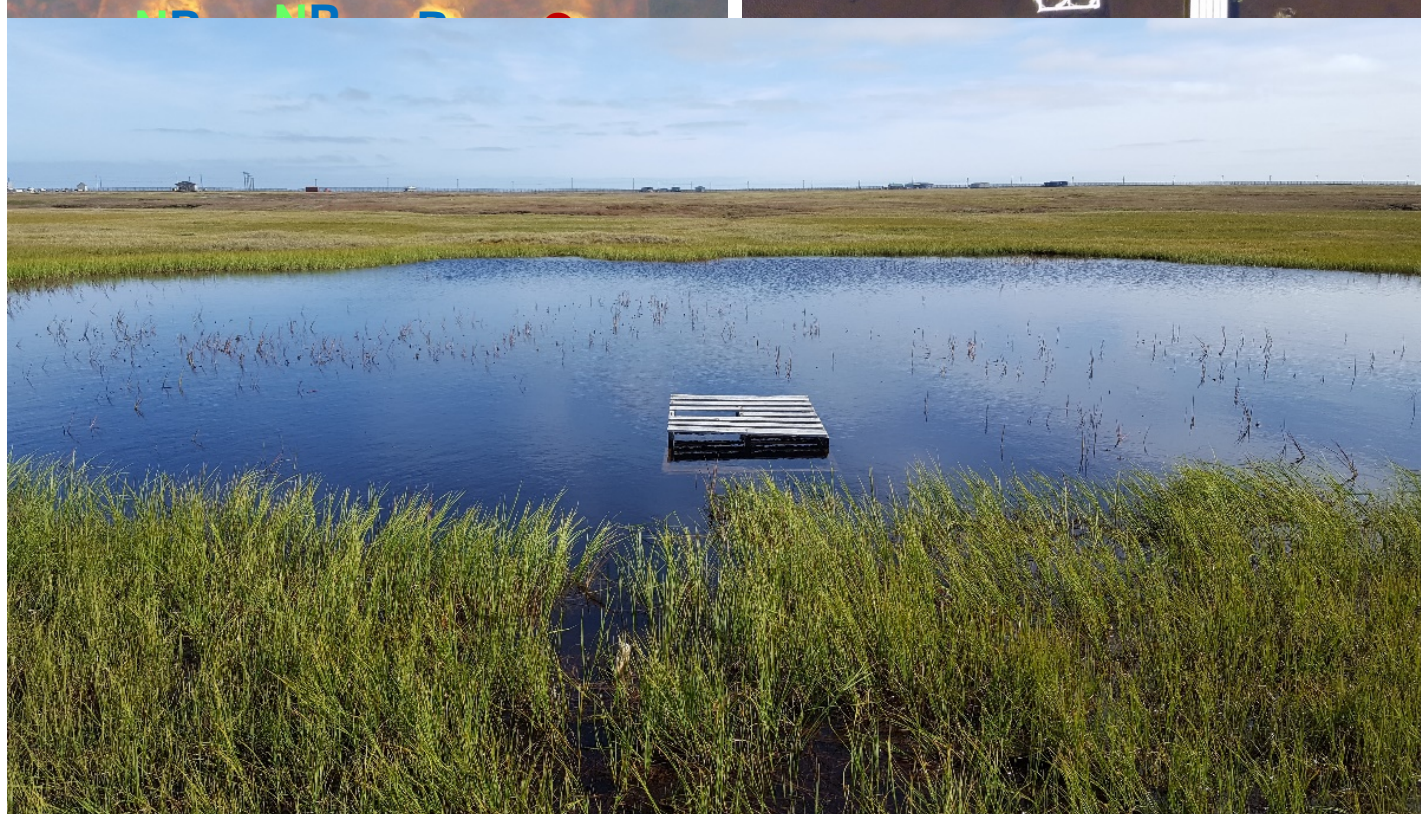
What are the impacts of increased nutrients on primary producers?

Lougheed et al, 2015

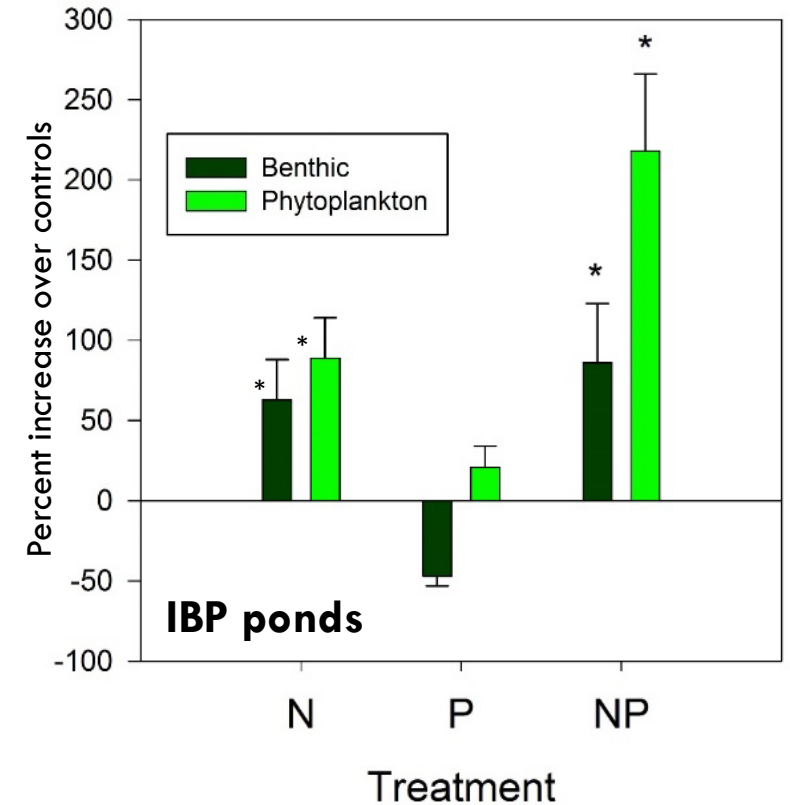
Benthic algae NDS Mesocosms

1970s: Phytoplankton limited by phosphorus (P)
(whole pond enrichment)

NP co-limitation (2010s)



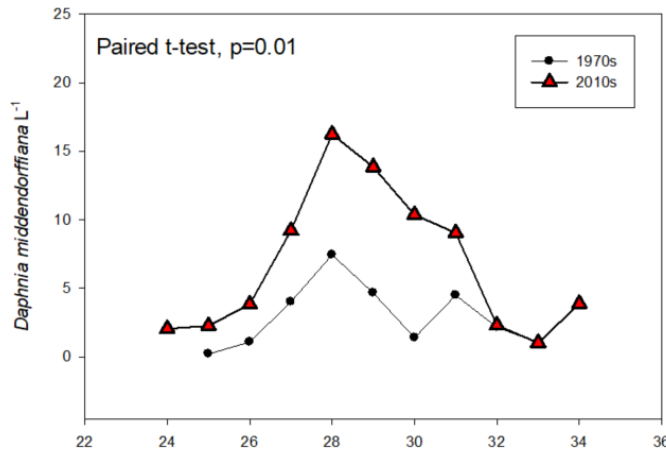
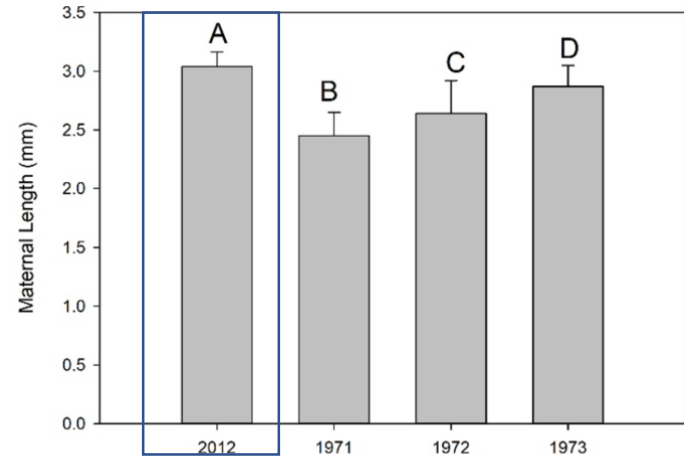
Change from P limitation (1970s) to NP co-limitation (2010s)



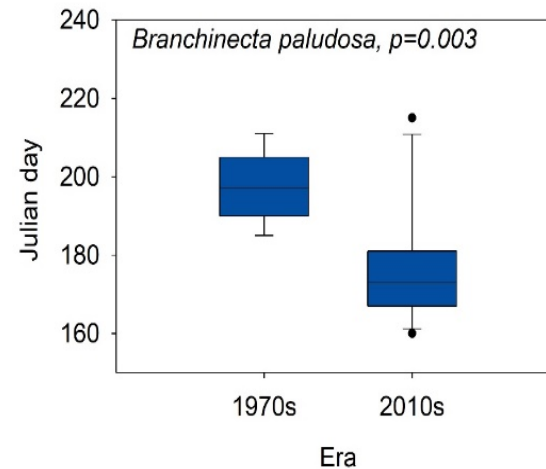
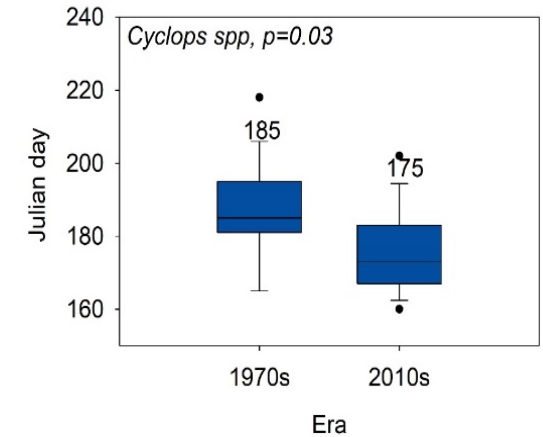
Shift associated to long-term increase in available P

Further Change at Lower Trophic Levels

Larger & more abundant daphnia



Earlier PEAK ABUDANCE



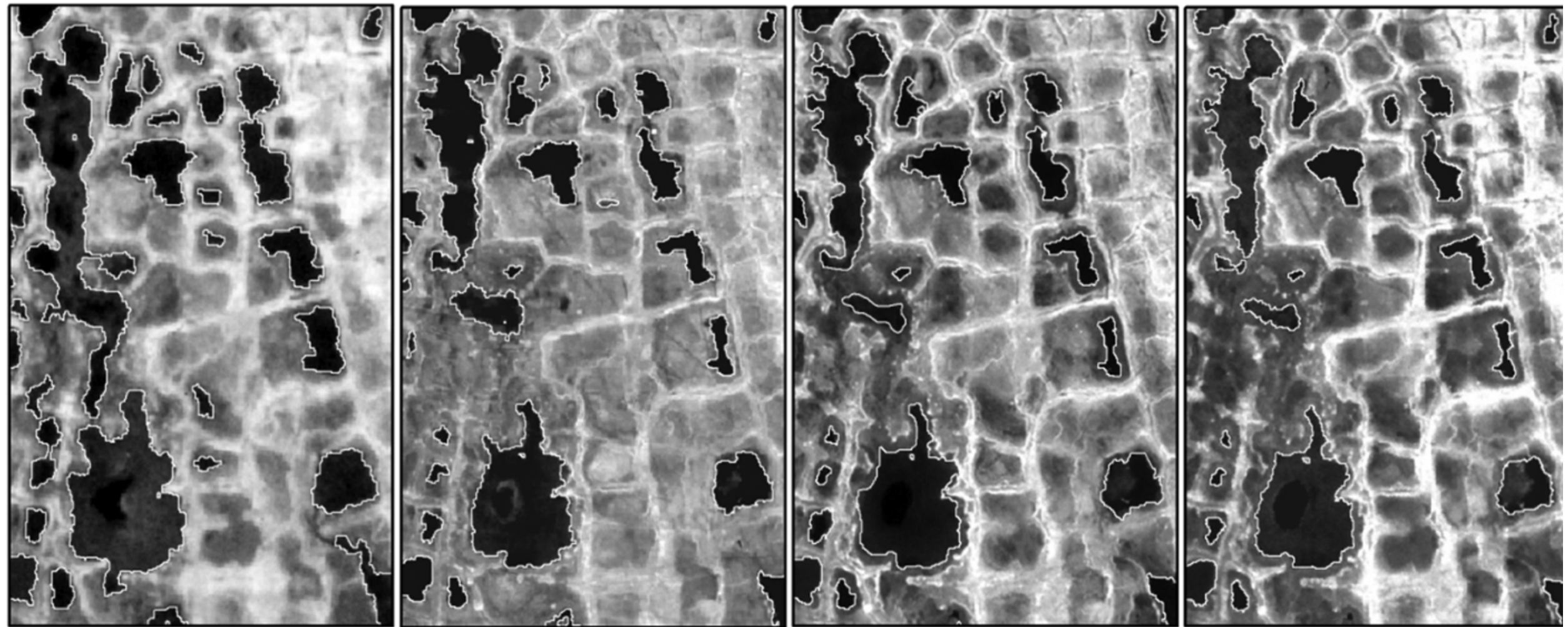
How is the morphology of ponds changing?

1948

2002

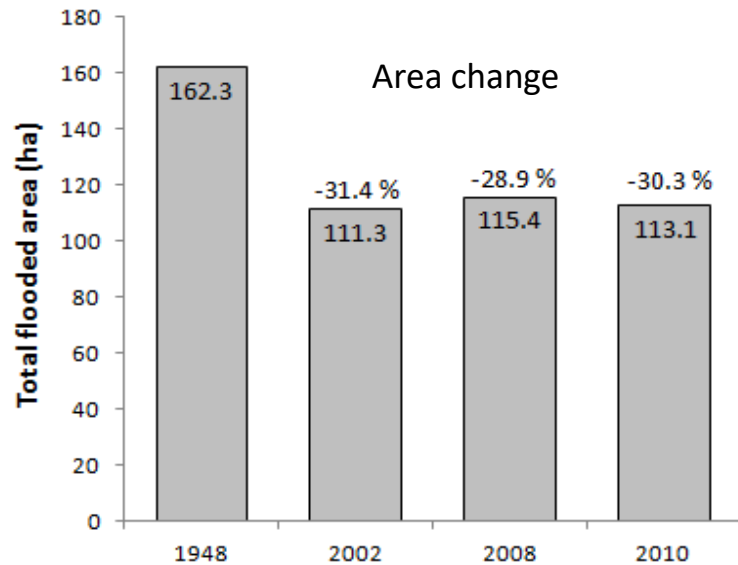
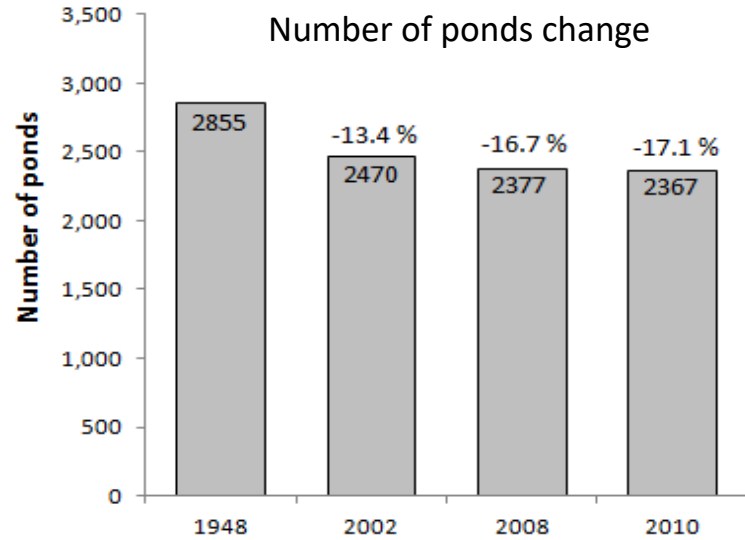
2008

2010

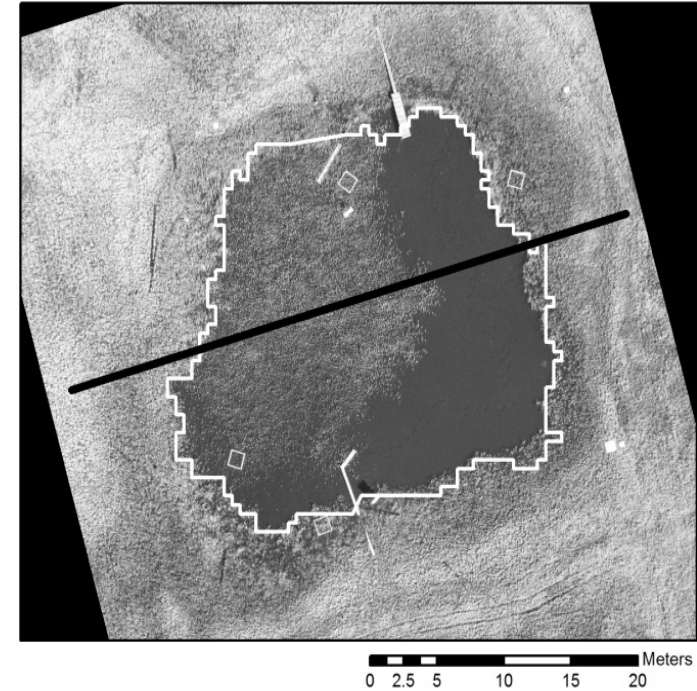
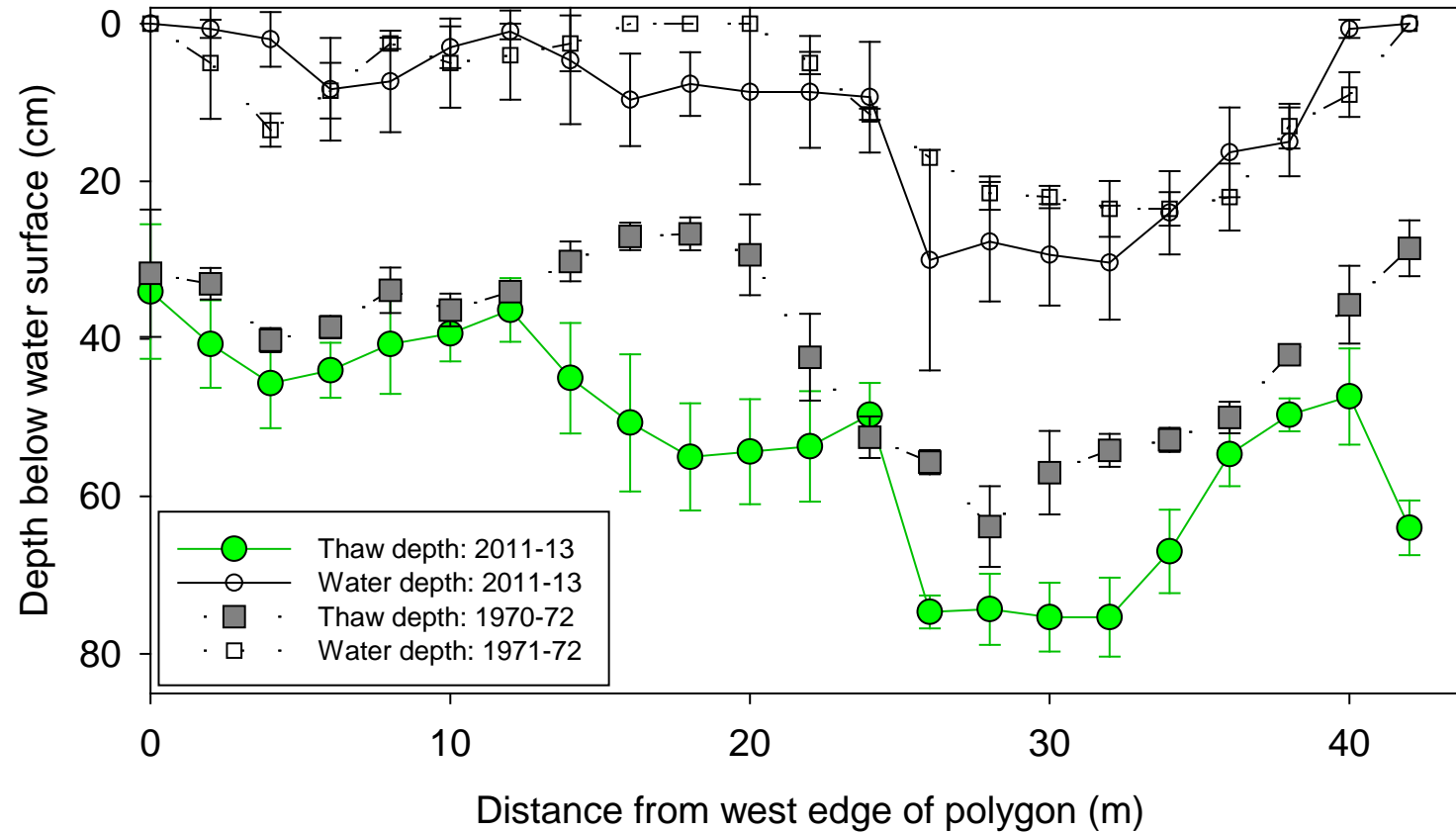


0 12.5 25 50 75 100 Meters

Ponds are shrinking and disappearing



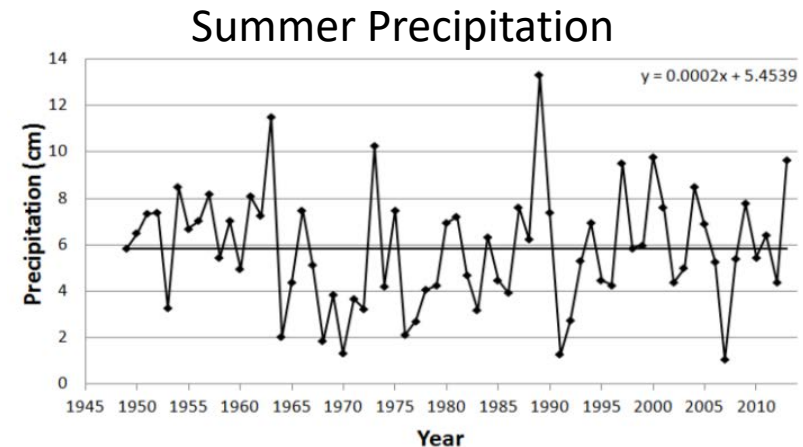
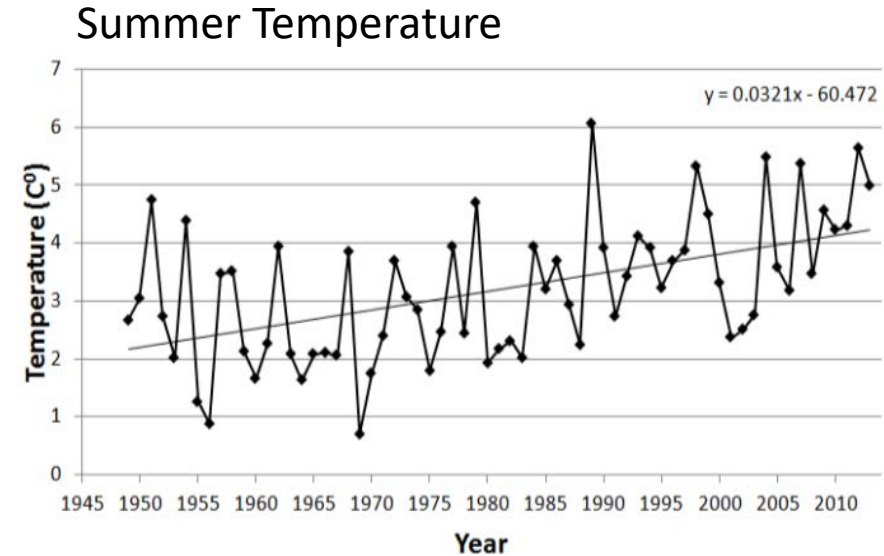
Active layer depth increased
No change in water depth



Increased water temperature → Thermal erosion

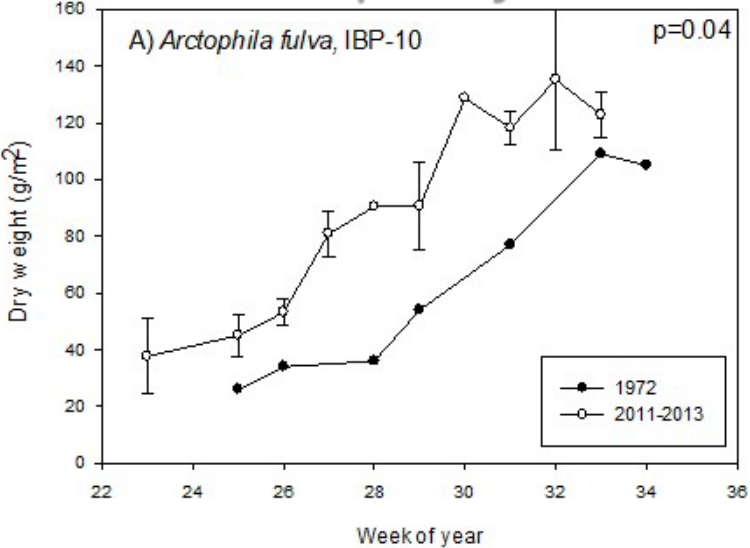
Why are ponds disappearing?

- Potential ET increase (?)
- Permafrost thaw
 - Lateral drainage (?)
 - Nutrient release (*Heikoop et al., 2015, Reyes and Lougheed 2014*)
- Vegetation encroachment
 - Increased cover and density (*Andresen et al 2017, Villarreal et al 2012*)
 - Implications for energy and carbon fluxes (e.g. **Methane**)

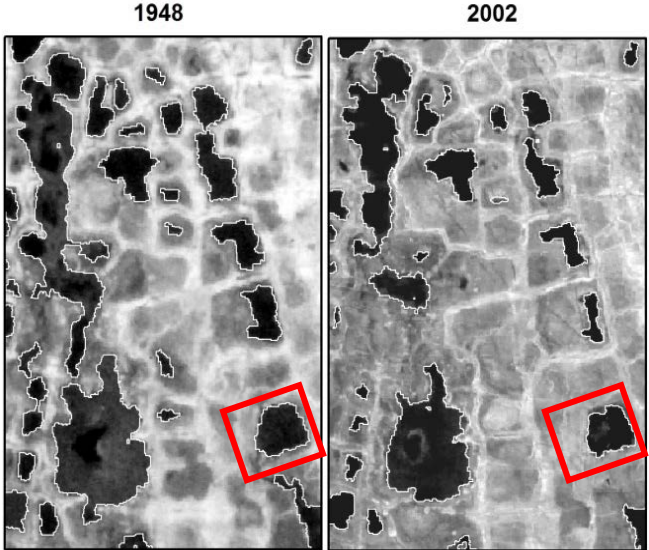
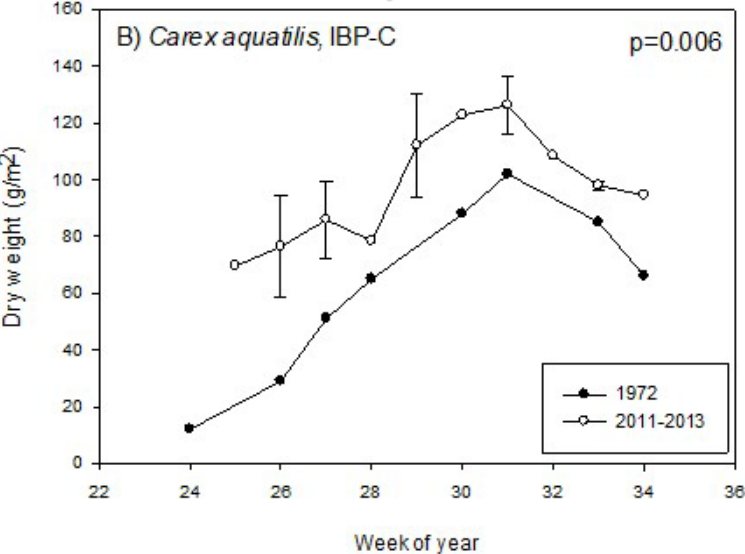


Biomass & Cover have increased

Arctophila fulva



Carex aquatilis



ATMOSPHERIC SCIENCES

News



Aquatic Plants May Accelerate Arctic Methane Emissions

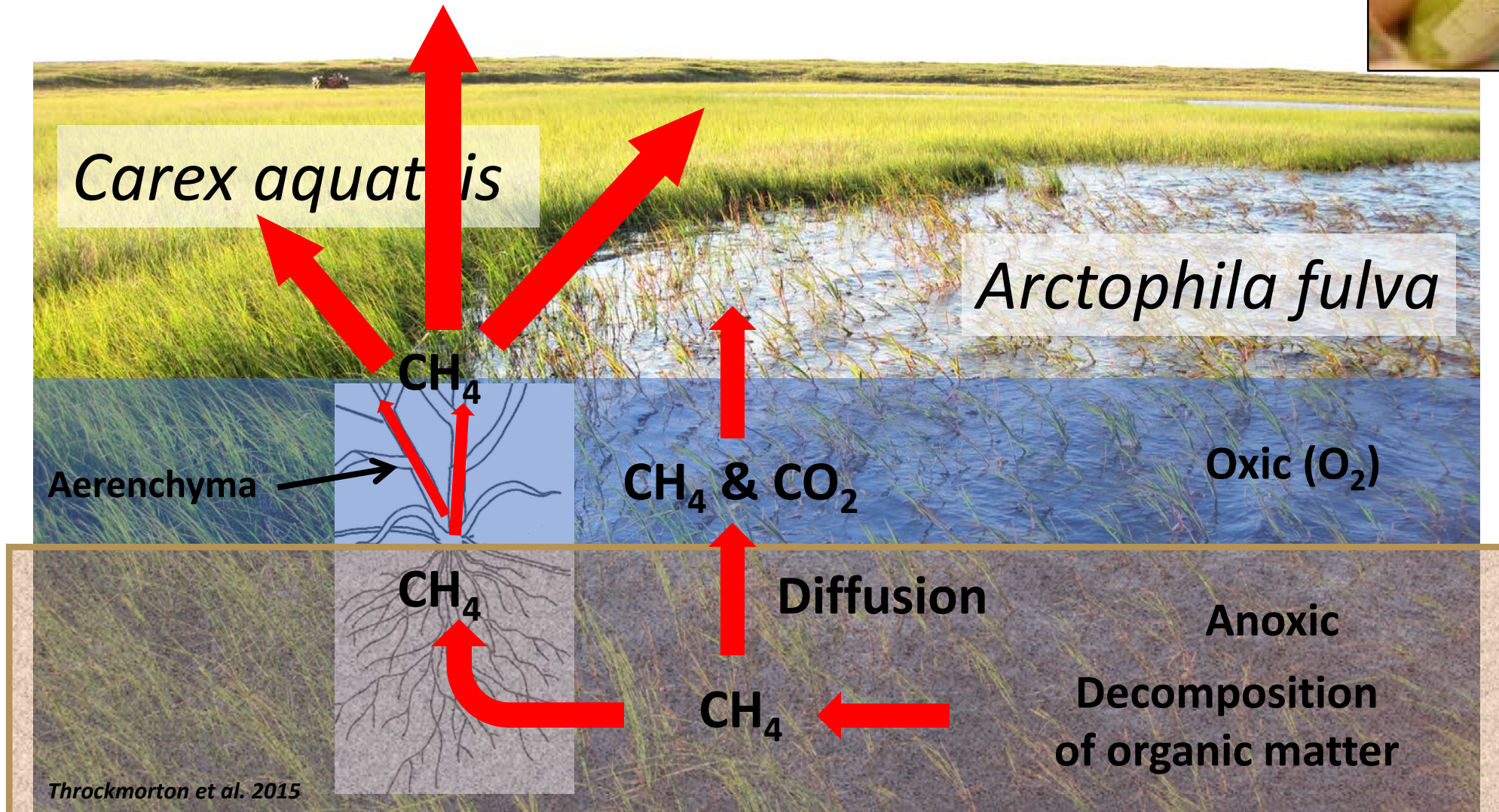
About two thirds of the gas produced by a study area near Barrow, Alaska, came from increasingly abundant greenery covering only 5% of the landscape, researchers estimate.



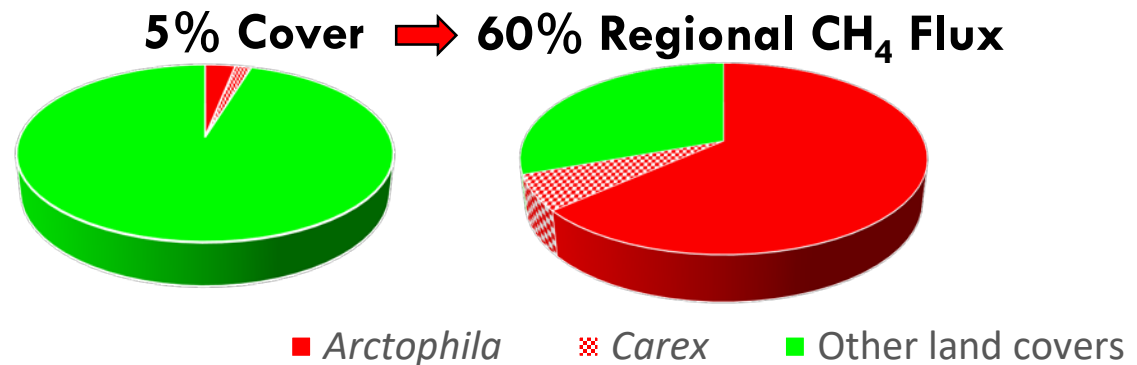
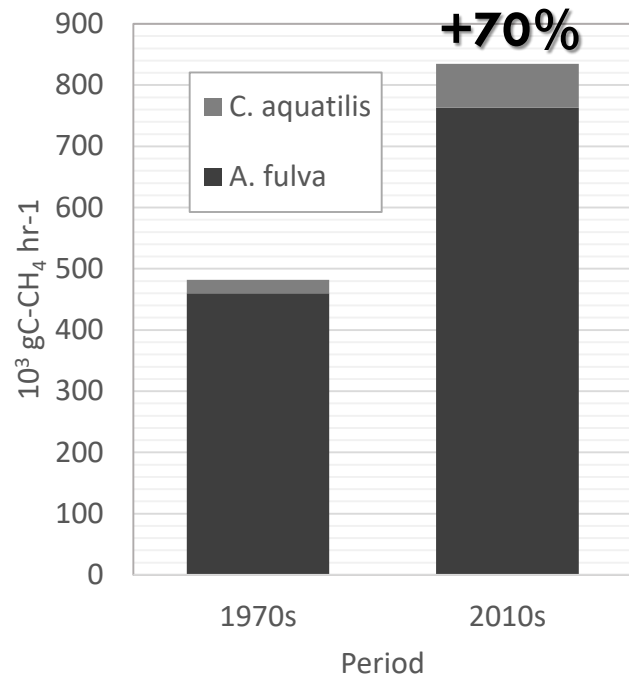
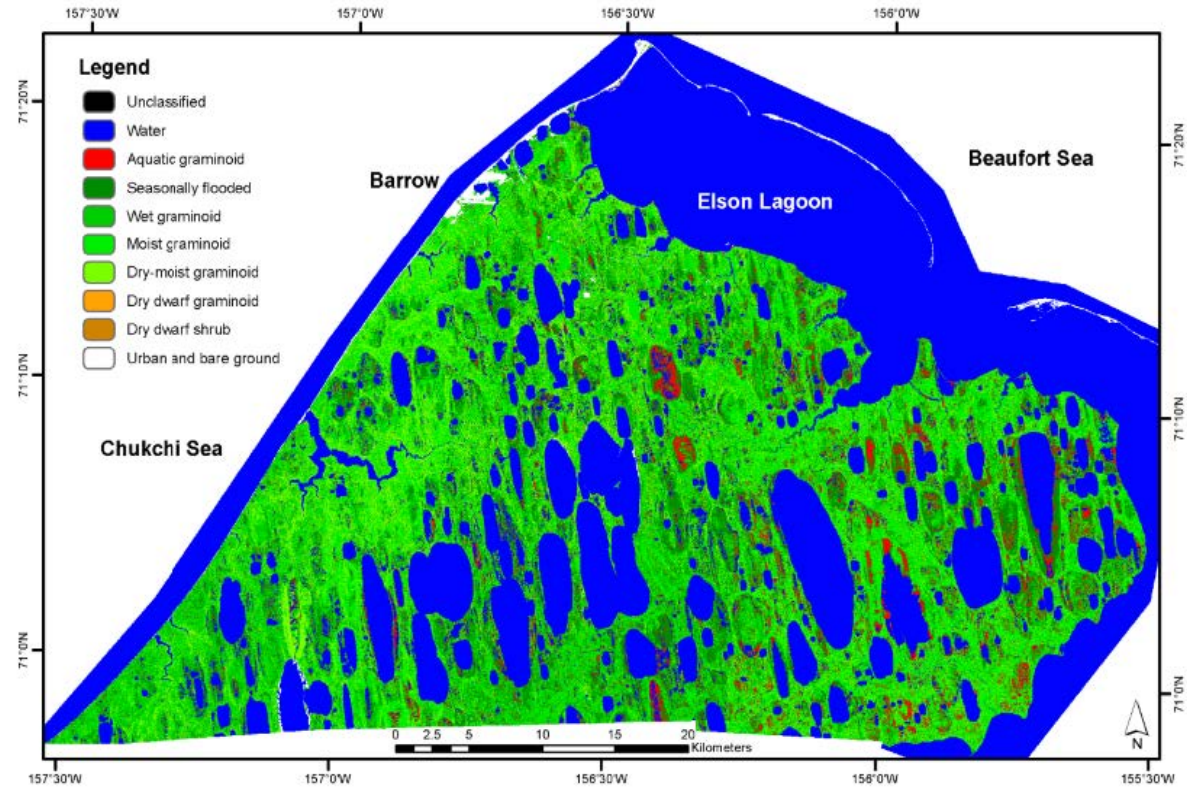
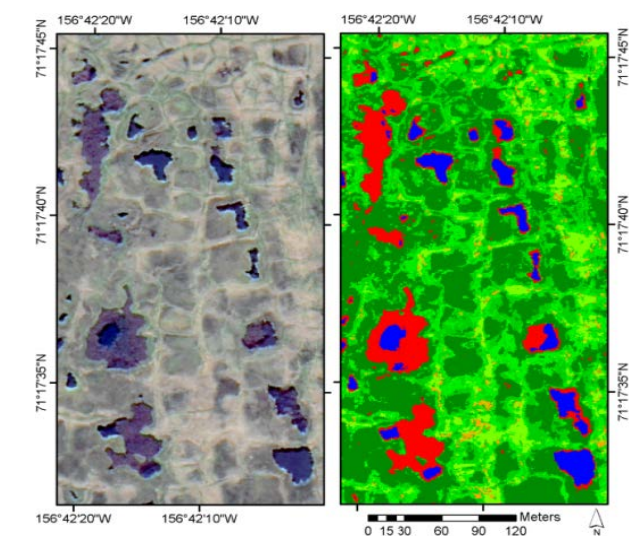
Aerenchyma



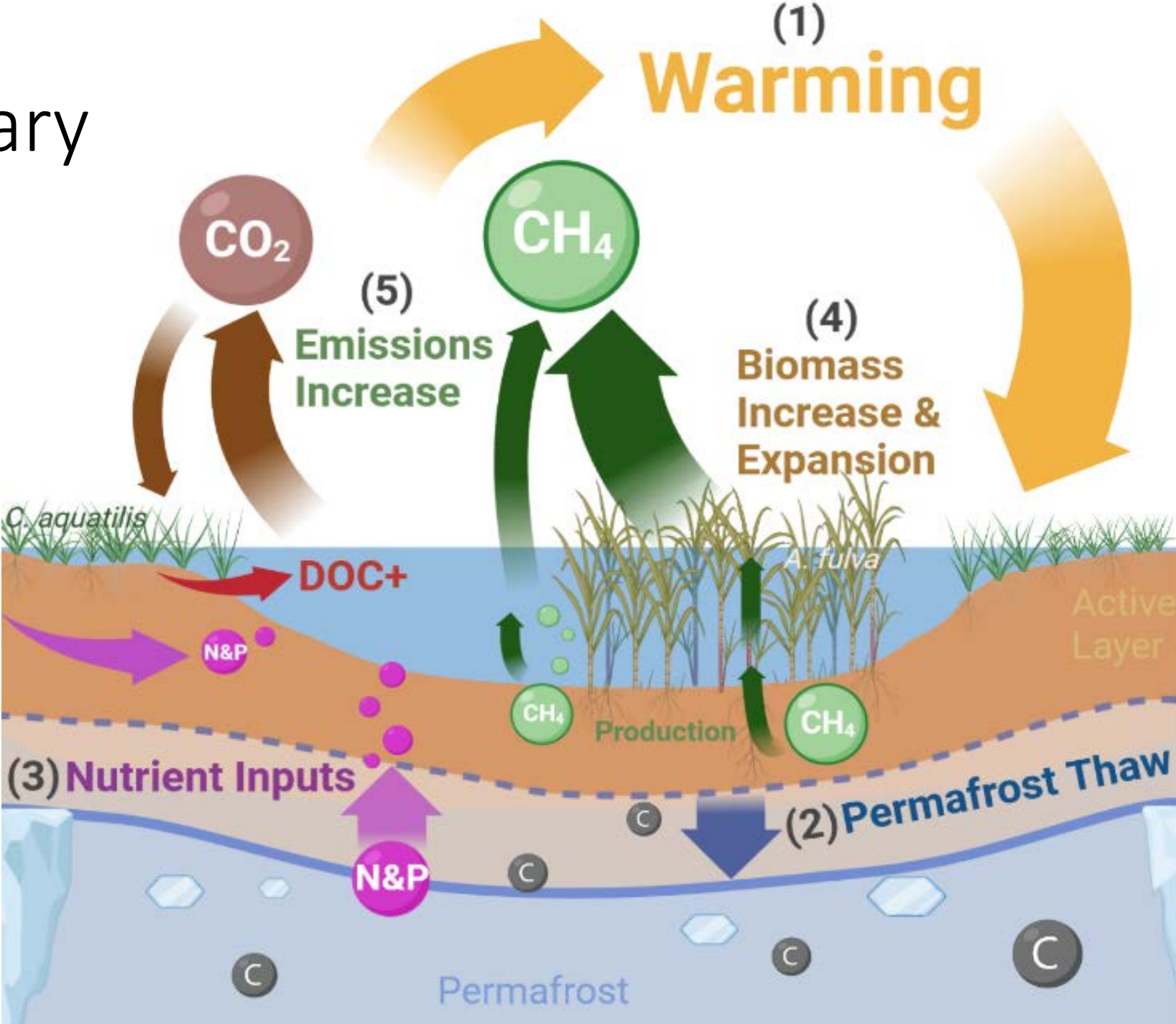
Methane Production in Arctic wetlands will increased atmospheric warming



What is happening at a regional scale?



Summary



Thank you

