

# How would an arctic ecosystem function without lemmings?

*.....when scientific legacy, serendipity, and opportunity synergize science that challenges conventional wisdom*

**Craig E. Tweedie<sup>1</sup>, Mark J. Lara<sup>1,2</sup>, David R. Johnson<sup>1,3</sup>,  
Christian G. Andresen<sup>1</sup>, Bob. D. Hollister<sup>4</sup>, Steve Oberbauer<sup>5</sup>**

1. UTEP, 2. UAF, 3. St. Mary's College, 4. GVSU, 5. FIU



**CYBER-ShARE**







# Motivation

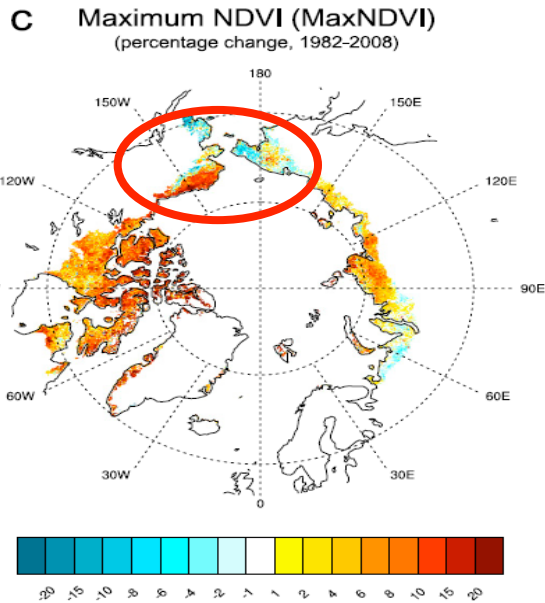
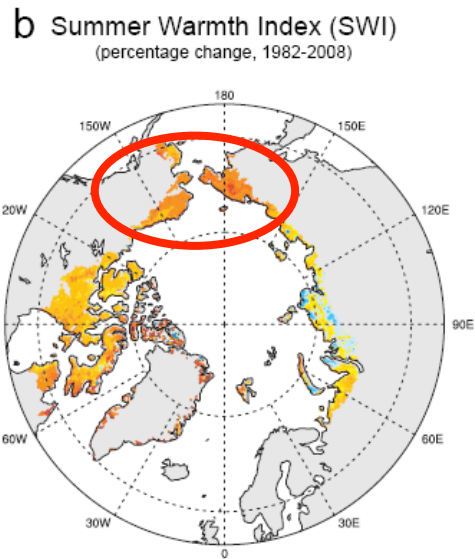
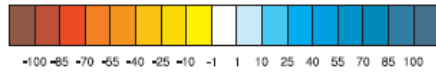
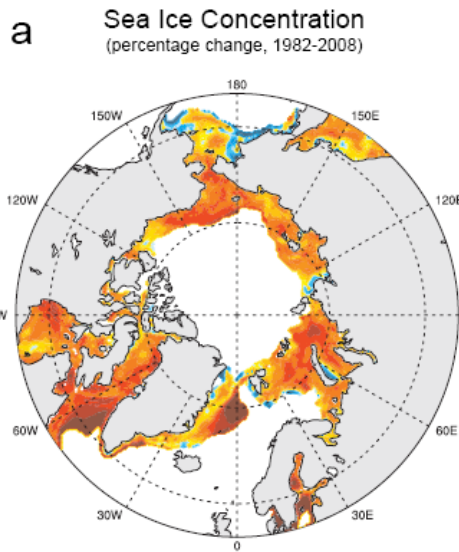
Legacy

Serendipity

Science

New Paradigm?

Acknowledgements



Bhatt et al. 2010

**The Arctic is greening – but how, why, what causes variability... what changes in ecosystem structure and function are associated with this change?**





# IPY-Back to the Future...

.....re-sampling old research sites to assess change in arctic ecosystem structure and function



Motivation

**The Legacy**

Serendipity

Science

New Paradigm?

Acknowledgements



Pat Webber 1963/2010

AOOSM, Seattle 2015/11/18

Contact: Craig Tweedie [ctweedie@utep.edu](mailto:ctweedie@utep.edu)

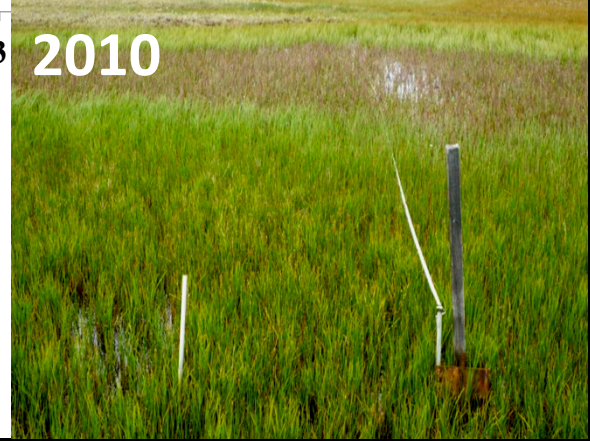
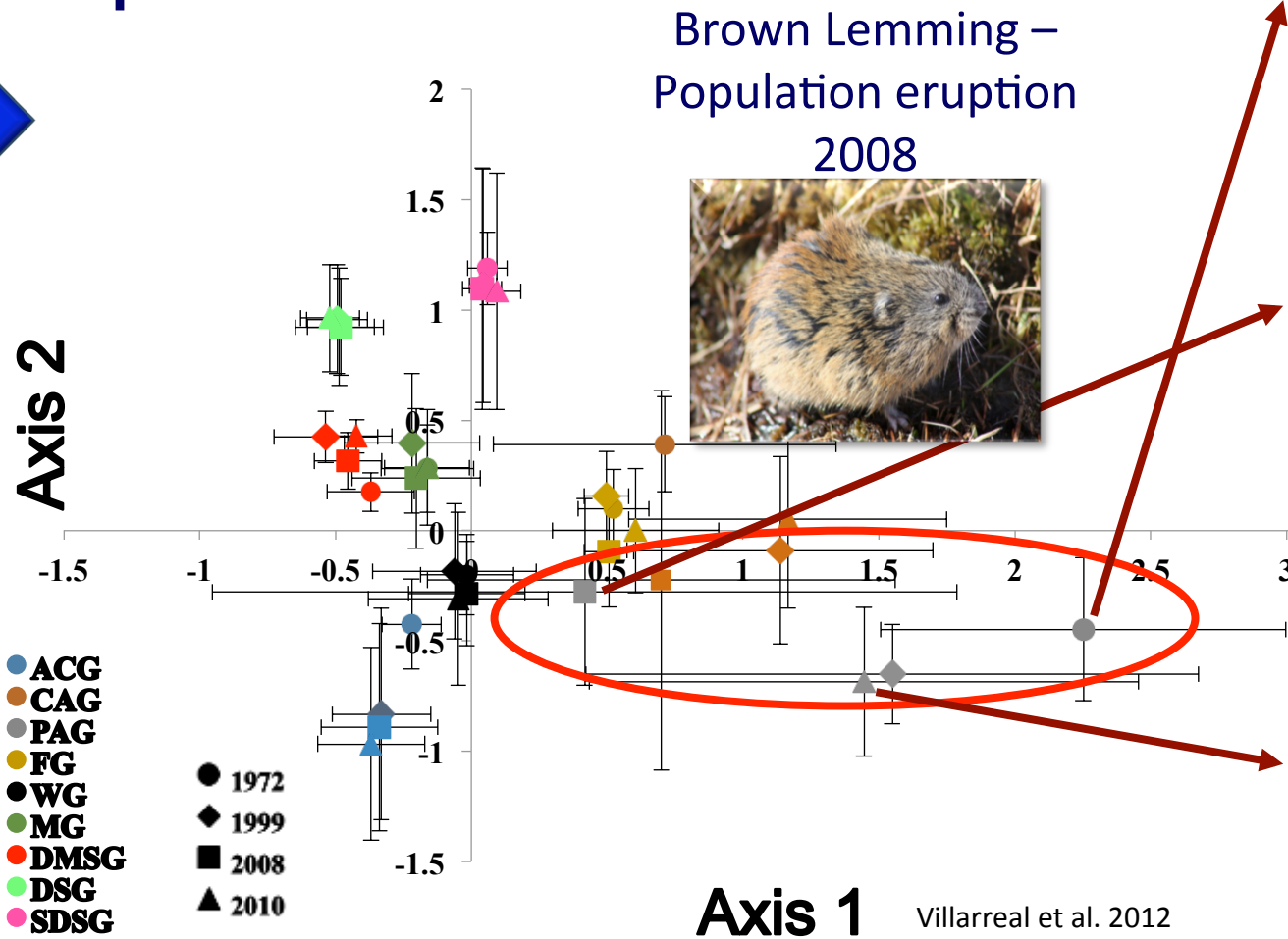






- Motivation
- The Legacy**
- Serendipity
- Science
- New Paradigm?
- Acknowledgements

# 1972-2010 ~ largest change in wet plant communities..... Variability in 2008 resampling shown for some plant communities in ordinations of species importance

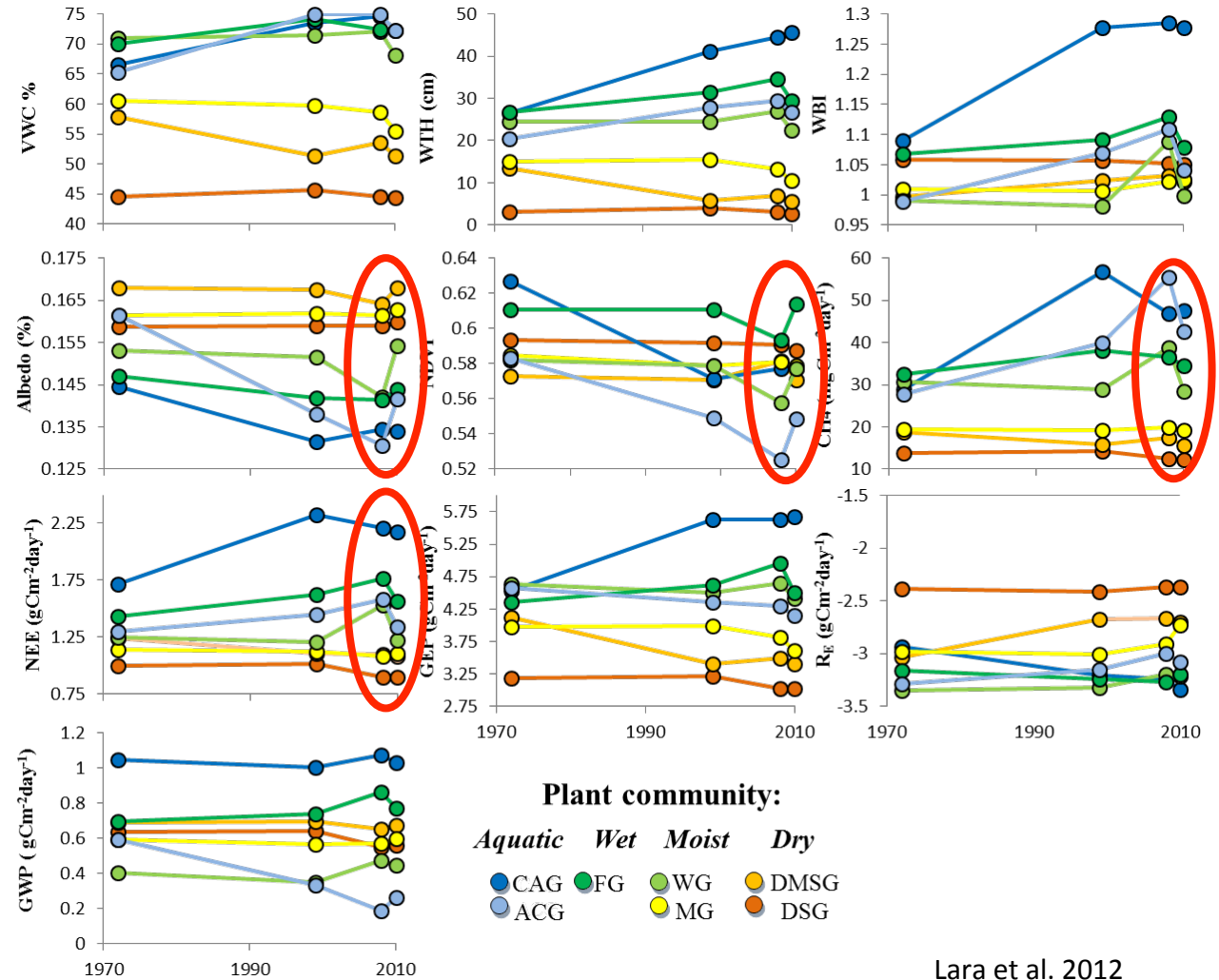




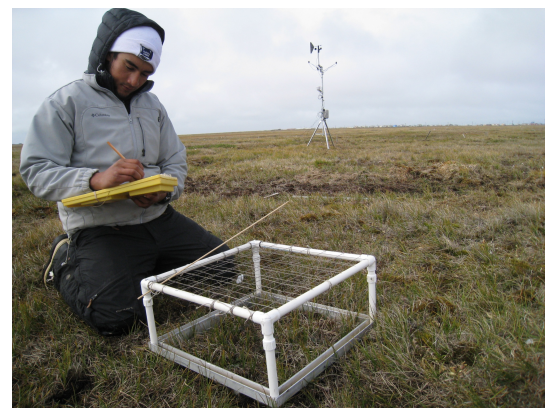


- Motivation
- The Legacy**
- Serendipity
- Science
- New Paradigm?
- Acknowledgements

# Relatively little community change ~ largest change in wet plant communities



Lara et al. 2012



Brown Lemming – Population eruption 2008







# Evidence of herbivory in satellite NDVI record for different geomorphic classes near Barrow



Motivation

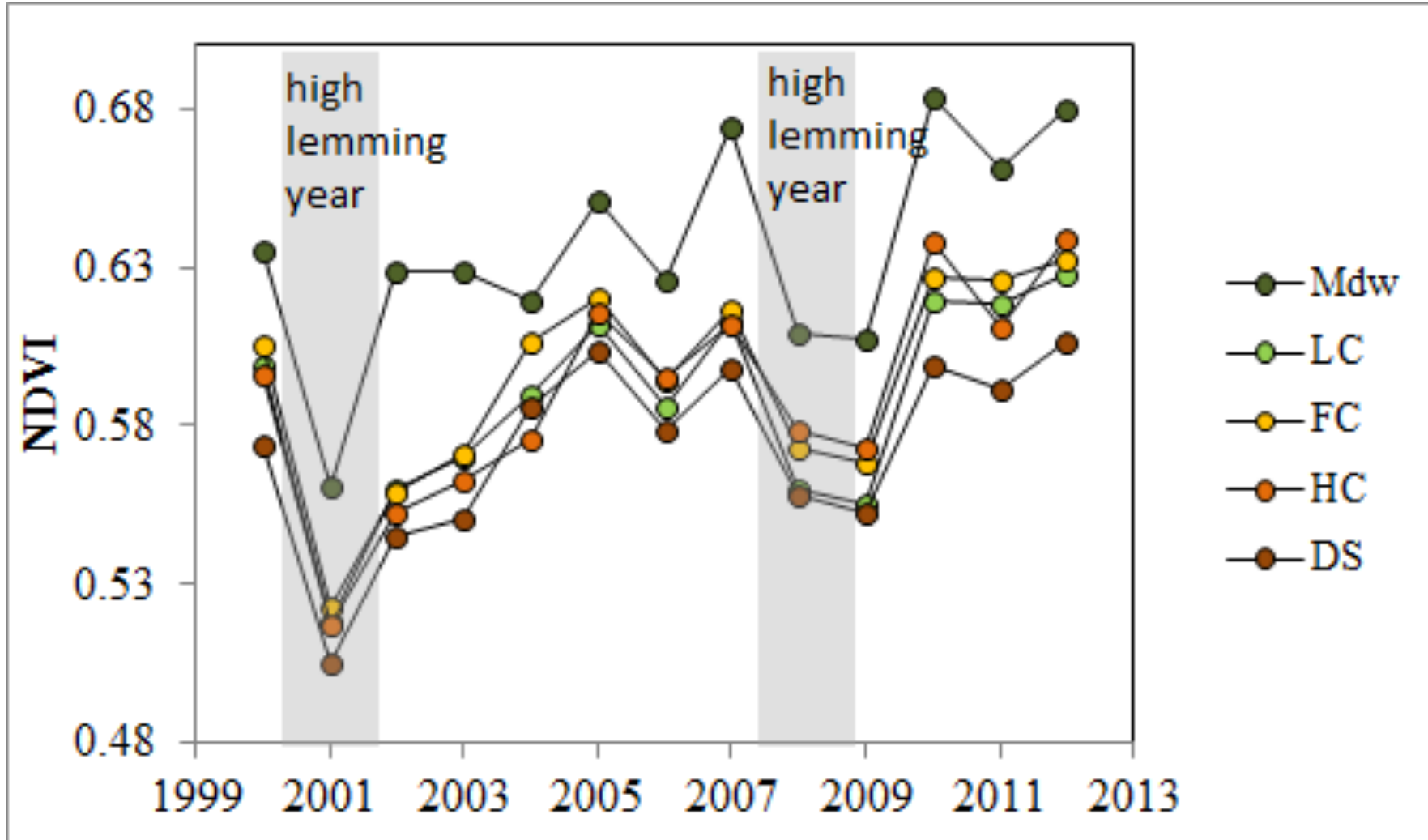
**The Legacy**

Serendipity

Science

New Paradigm?

Acknowledgements



Lara et al. 2015







# The Barrow Area Information Database (BAID) documents who has done what type of research and where.... And where more information including data can be found ~ 12,000 sites dating back to the 1940's



- Motivation
- Legacy
- Serendipity**
- Science
- New Paradigm?
- Acknowledgements

**www.barrowmapped.org**

Research Locations: 164 results, showing 71 - 80

- Lemming Trapping Area 5  
Discipline: Mammalogy Funding: ONR Region: Barrow Investigator: Marsh, Mike End Year: 1958 Initiative: Independent Project Name: The effect of herbivores on arctic flora Keyword: Zoology Start Year: 1956 Keyword: Herbivory
- Lemming Trapping  
Discipline: Mammalogy Project Name: The effect
- Lemming Trapping  
Discipline: Mammalogy Project Name: The effect
- Lemming Trapping  
Discipline: Mammalogy Project Name: The effect
- Lemming Trapping  
Discipline: Mammalogy Project Name: The effect
- Lemming Trapping  
Discipline: Mammalogy Project Name: The effect
- Herbivory Control  
Discipline: Plant-Animal Project Name: ONR Leno
- Herbivory Control  
Discipline: Plant-Animal Project Name: ONR Leno
- Herbivory Control  
Discipline: Plant-Animal Project Name: ONR Leno
- Herbivory Control  
Discipline: Plant-Animal Project Name: ONR Leno

What is BAID?  
Applications to Support Research and Community Planning

- 12,000+ data collection sites (1947-present)
- 100+ DGPS surveys per year
- Info on 1500+ individuals
- 3000+ vegetation plots
- DGPS support
- Time Series Imagery
- Detailed land cover mapping
- Coastal Monitoring

BAID provides a range of map-centric information. This includes assistance to document research activities through Differential GPS, high resolution vegetation mapping, coastal monitoring and much more







~70 historic herbivore exclosures that may be the oldest in the Arctic are situated in the Barrow area.... 12 of these remain intact ~ serendipitous opportunity to assess how ecosystems may be structured and function in the absence of herbivores.



Motivation

Legacy

**Serendipity**

Science

New Paradigm?

Acknowledgements

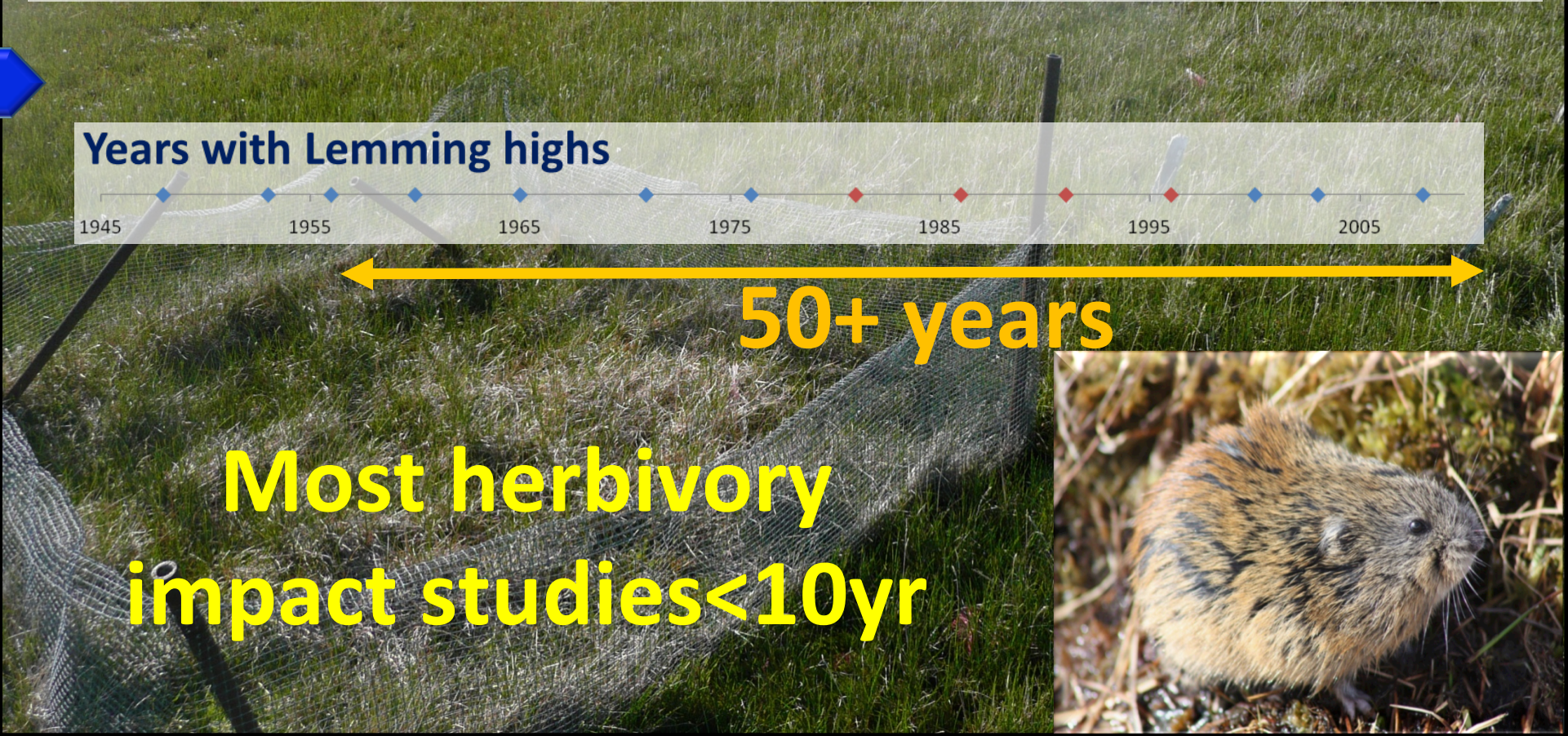






**~70 historic herbivore exclosures that may be the oldest in the Arctic are situated in the Barrow area.... 12 of these remain intact ~ serendipitous opportunity to assess how ecosystems may be structured and function in the absence of herbivores.**

- Motivation
- Legacy
- Serendipity**
- Science
- New Paradigm?
- Acknowledgements



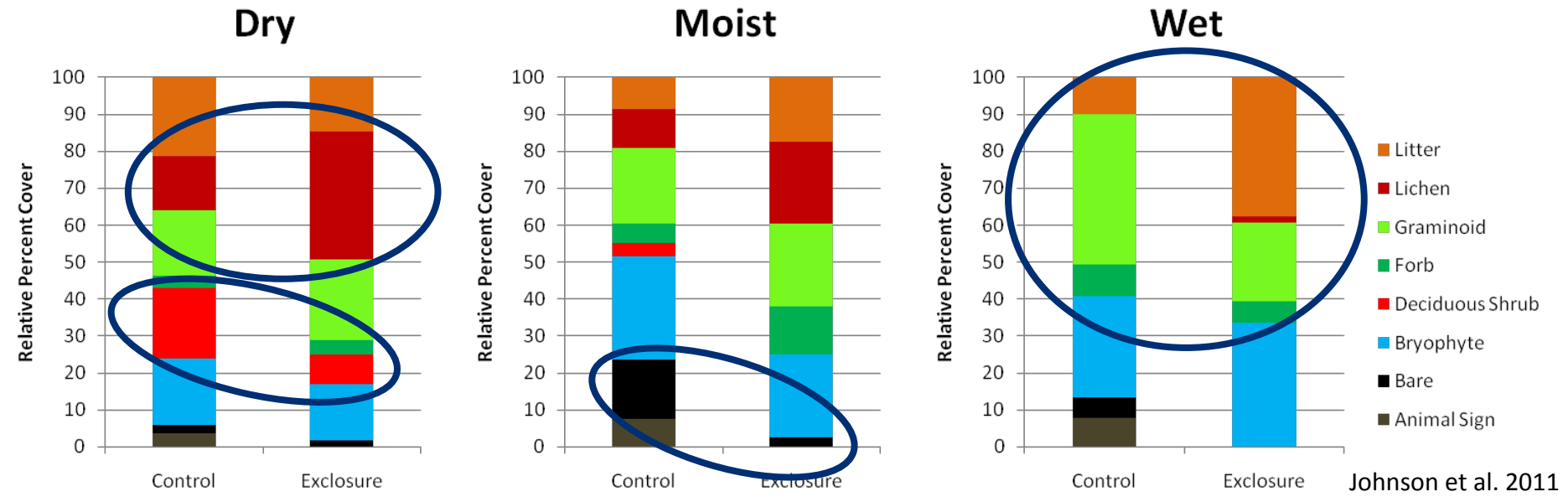




# Tundra ecosystems structure alters with a sustained absence of herbivory



- Motivation
- Legacy
- Serendipity
- New Science**
- New Paradigm?
- Acknowledgements



Johnson et al. 2011



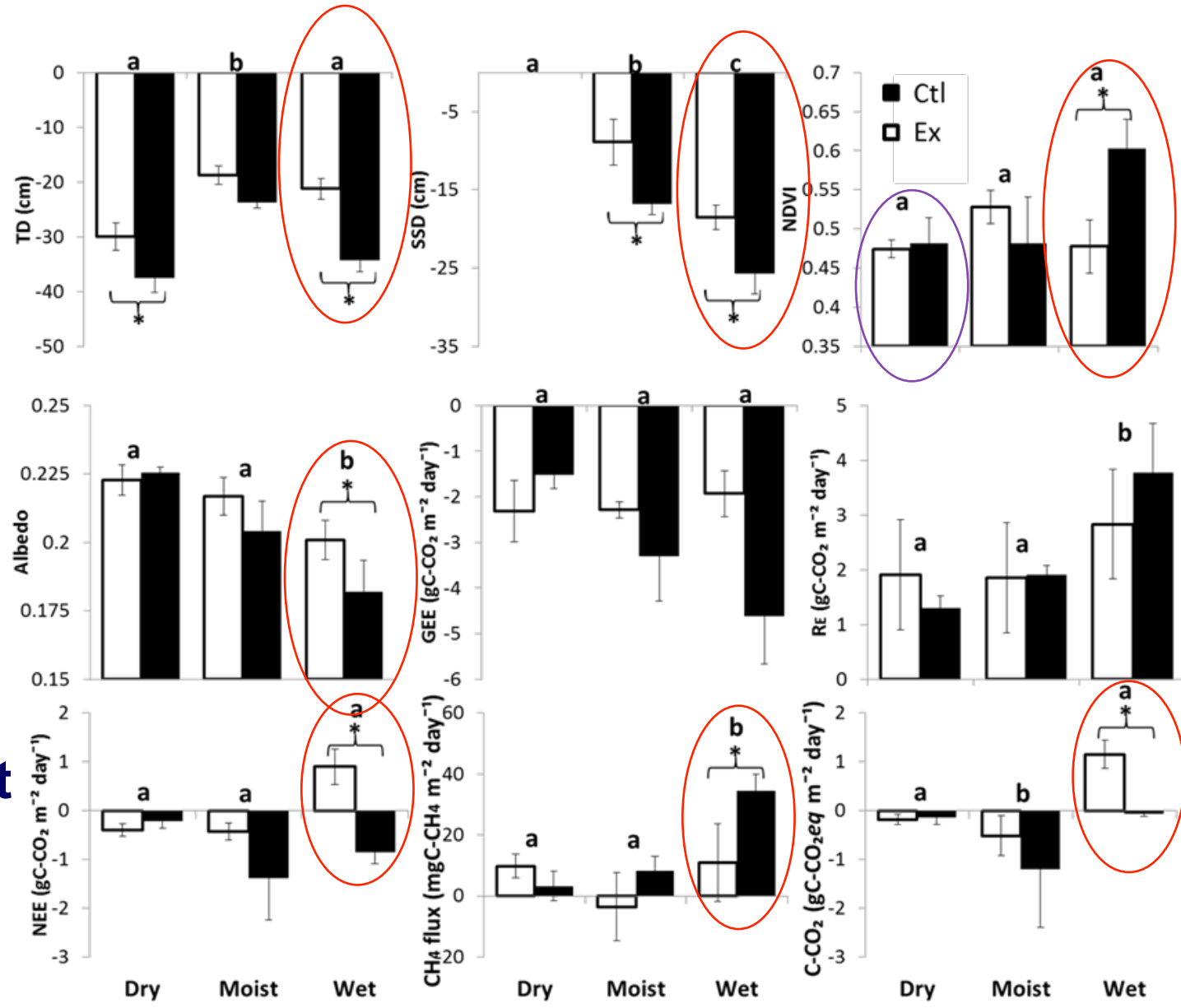




- Motivation
- Legacy
- Serendipity
- New Science**
- New Paradigm?
- Acknowledgements

**Tundra ecosystem function at peak growing season is altered with sustained herbivore exclusion**

**Response greatest in wet tundra**



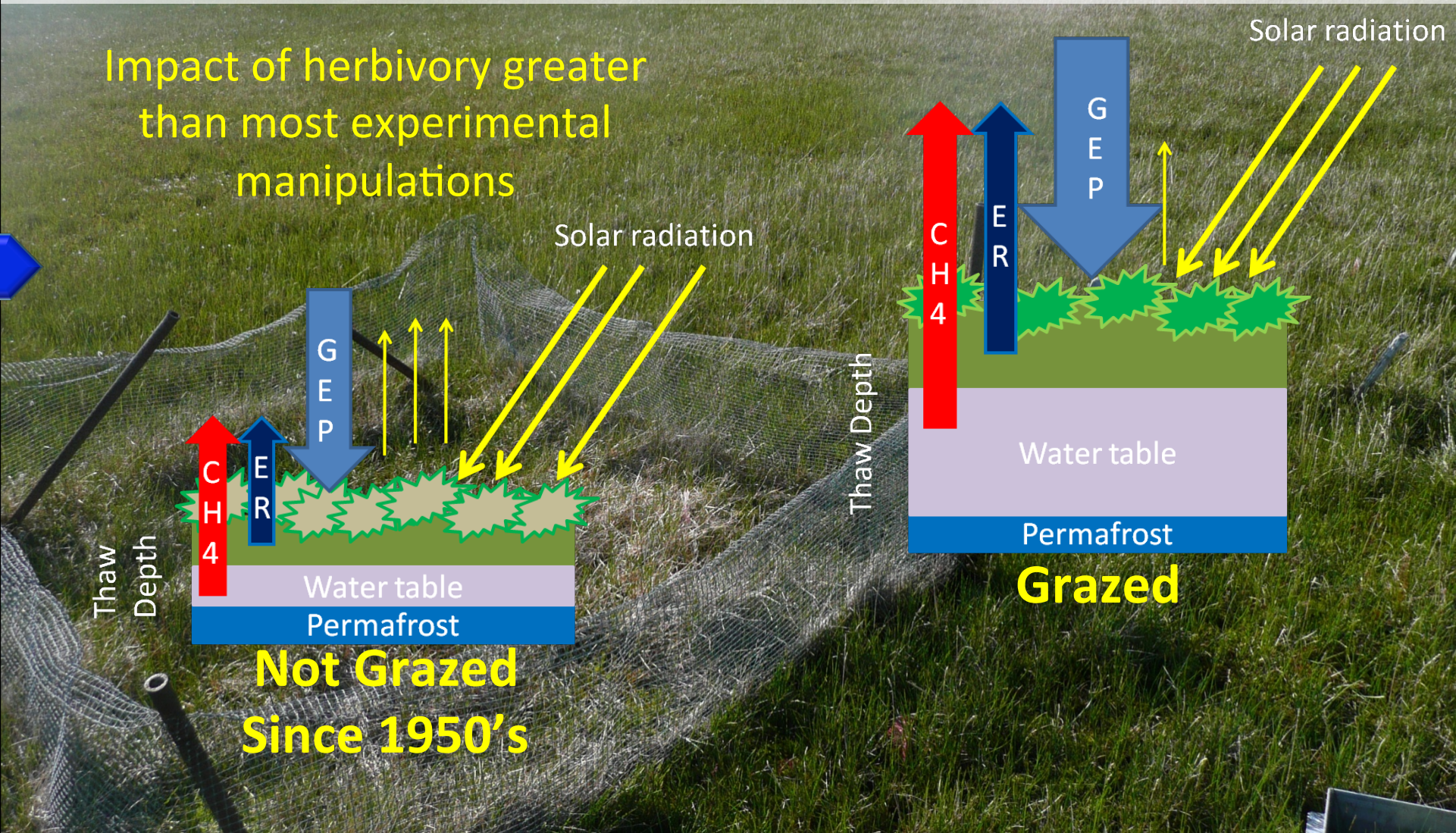




- Motivation
- Legacy
- Serendipity
- New Science**
- New Paradigm?
- Acknowledgements

# Tundra ecosystem structure is altered with sustained herbivore exclusion

Impact of herbivory greater than most experimental manipulations

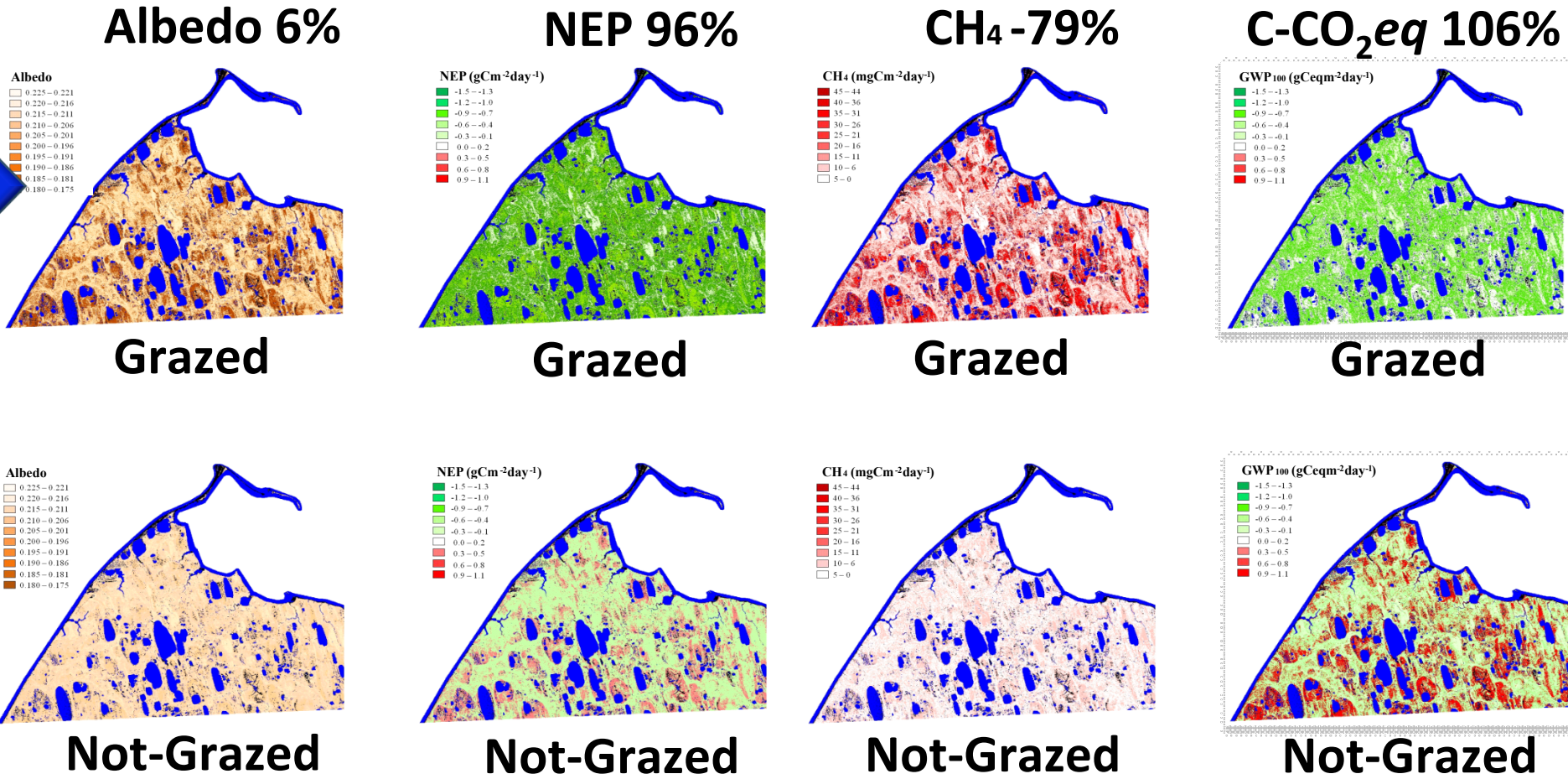






# The intellectual exercise of scaling measurements to the landscape scale is even more revealing

- Motivation
- Legacy
- Serendipity
- New Science**
- New Paradigm?
- Acknowledgements







# Ecosystems in the Barrow landscape would likely not be structured or function the way they do now without lemmings... summary of findings



Motivation

Legacy

Serendipity

**New Science**

New Paradigm?

Acknowledgements

1. Ecosystem structure and function altered in all land cover types ~ pronounced in wet land cover types.
2. Ecosystem would not be the historic peak season carbon sink without lemmings.
3. Results markedly different to findings from short term studies.
4. Herbivory response greater than most other experimental manipulations.
5. Uncertainties – scalability to other regions of the coastal plain, role of lemming population density, timing of resampling since last lemming high, small sample size, snapshot at peak season only.....







- Motivation
- Legacy
- Serendipity
- Science
- New Paradigm?**
- Acknowledgements

## Implications for arctic observing.....

1. Rescuing and resampling historic sites and data can lead to discovery that is arguably impossible with any other approach and presents an opportunity to not reinvent the wheel.
2. Have we underestimated the need to observe one of the most important factors controlling structure and function? – lemmings poorly monitored, challenging to monitor in typical funding cycles/ student theses...
3. Most ecosystem models not parameterized for herbivory impacts.
4. Coastal Plain ecosystems may be on the cusp of a tipping point –
  - Longest time between recorded lemming highs in Barrow
  - Sustained fox eradication by USFWS since 2005
  - Geese populations exploding ~improved over winter habitat
  - Is herbivory switching from a pulse-recovery (lemming) to persistent (geese) grazing model.... Impact on lemming populations?
  - Demise of lemmings will likely impact other trophic levels.
  - Barrow-area landscape is warming and drying – cumulative impacts?
5. Showcases challenges for interagency exchange, funding models, data and site rescue and preservation, protection of focal research areas, multi-angle approaches to observing.... More?







Motivation

Legacy

Serendipity

Science

New Paradigm?

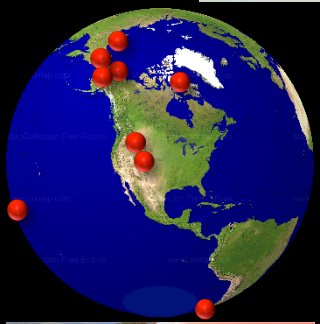
**Acknowledgements**

## Acknowledgements

- We thank the Ukpeagvik Iñupiat Corporation for the use of their lands for research.
- Funding was provided by the US National Science Foundation with contributions from grants 0732885, 1023654, and 1433330. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the authors and do not necessarily reflect the views of the US National Science Foundation.







Motivation

Legacy

Serendipity

Science

**New  
Paradigm?**

Acknowledgements



Credit: Florencia Mazza Ramsay







Motivation

Legacy

Serendipity

Science

**New  
Paradigm?**

Acknowledgements



Credit: Florencia Mazza Ramsay







Motivation

Legacy

Serendipity

Science

**New  
Paradigm?**

Acknowledgements



Credit: Florencia Mazza Ramsay

