Cultural adaptation, compounding vulnerabilities and conjunctures

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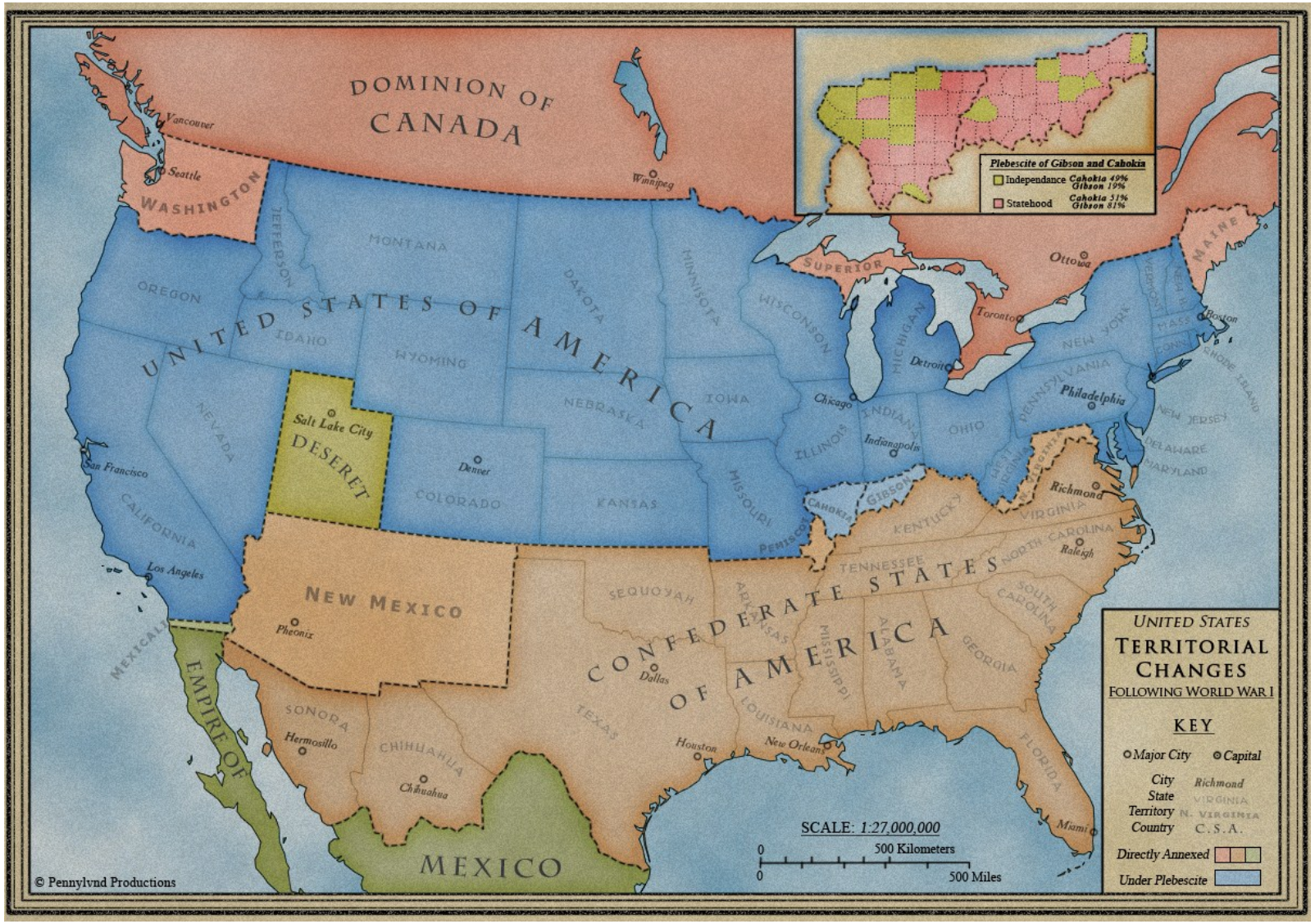
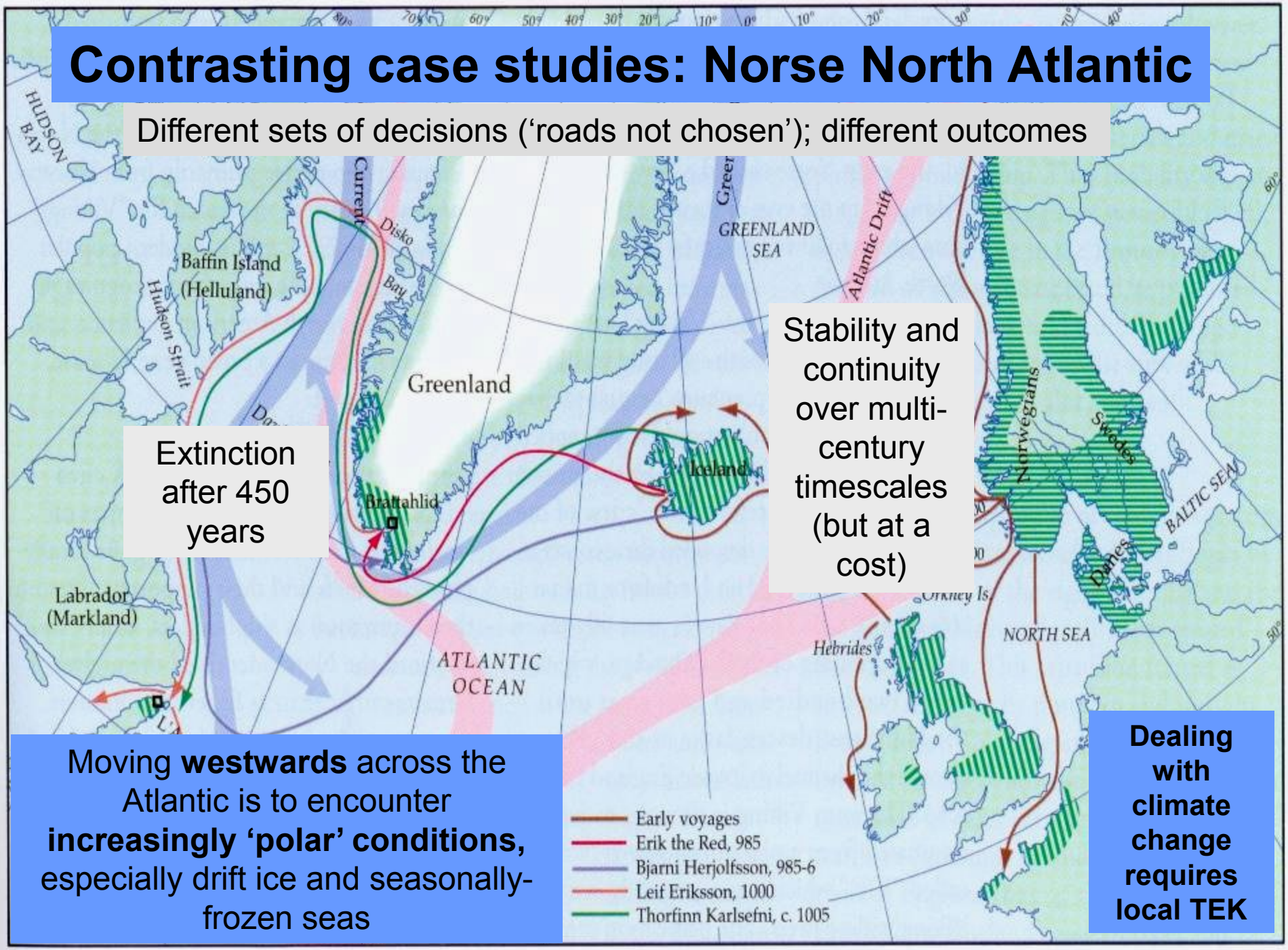
Roads not taken…



Contrasting case studies: Norse North Atlantic

Different sets of decisions ('roads not chosen'); different outcomes



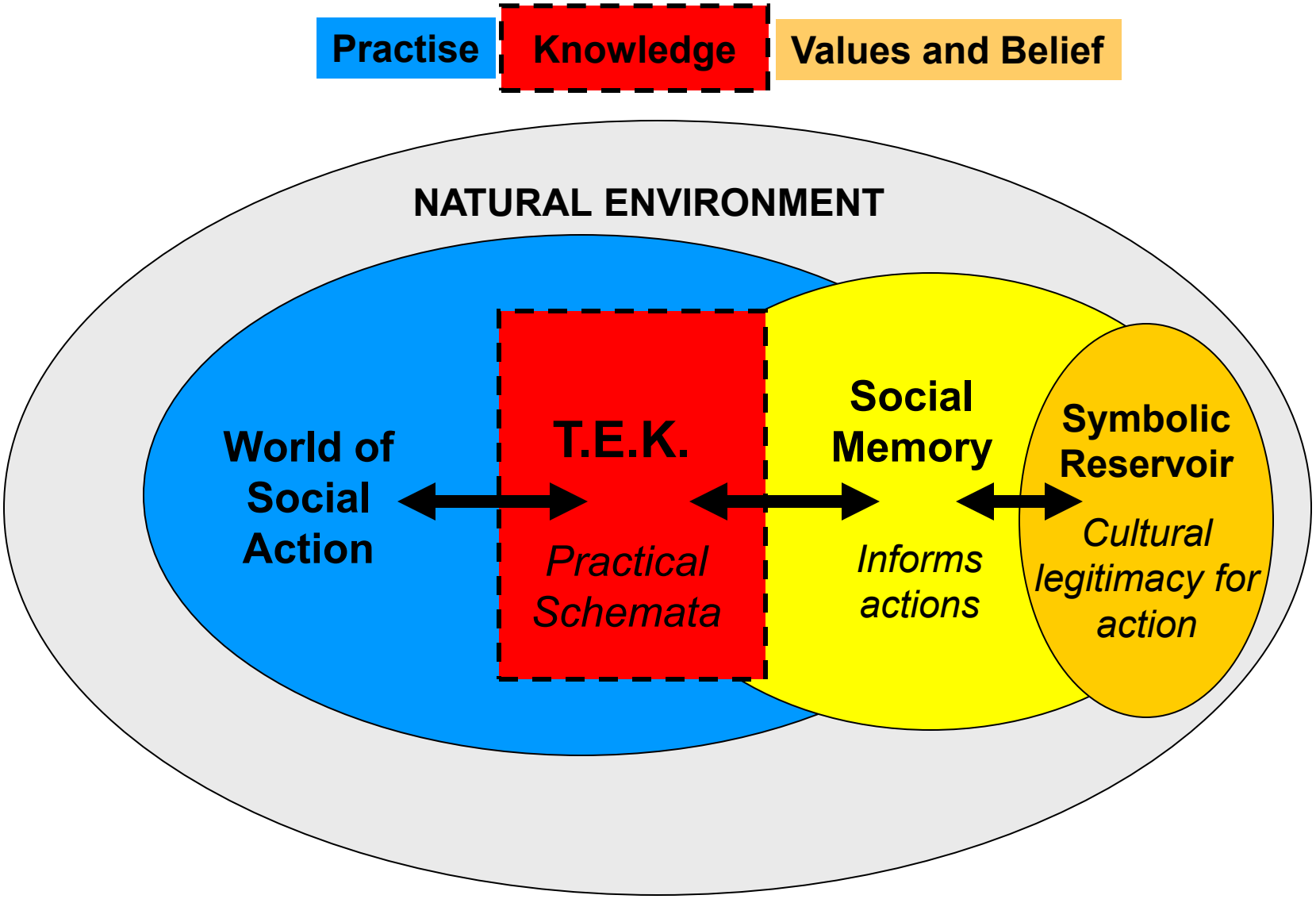
Extinction after 450 years

Stability and continuity over multi-century timescales (but at a cost)

Moving **westwards** across the Atlantic is to encounter **increasingly 'polar' conditions,** especially drift ice and seasonally-frozen seas

Dealing with climate change requires local TEK

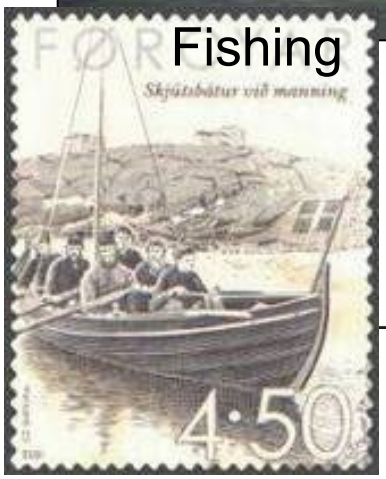
Cultural Schemata: Filtering Experience, Legitimizing Action: the key role of Traditional Ecological Knowledge

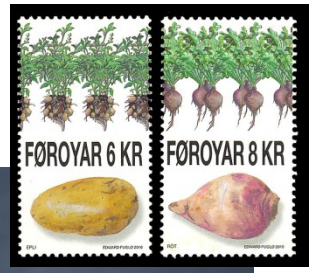


McIntosh RJ, Tainter JA, McIntosh SK (eds) (2000) *The Way the Wind Blows: climate history, and human action* (Columbia University Press, New York).

Different choices & outcomes 1: Faroes

Settlement endures in the face of climate change: trade and the communal exploitation of fish, birds and marine mammals key to long term resilience

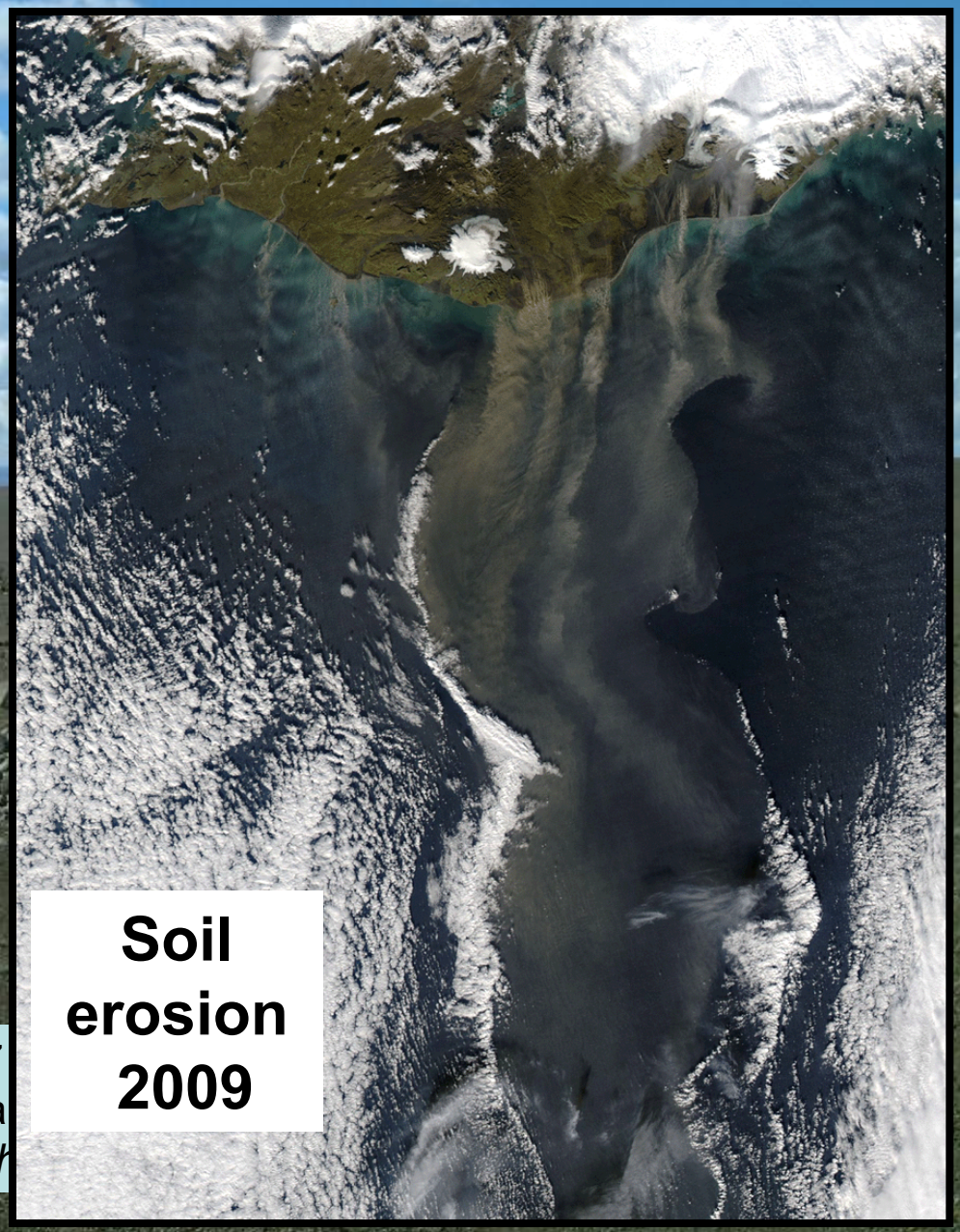




Introduced domestic animals, some cultivation

Different choices & outcomes 2: Iceland

Successful adaptation and long-term success linked to **extensive landscape degradation.**



McGovern T, H., Vésteinsson, O. et al. 2007
Historical ecology of human impact a
American Anth

Different choices & outcomes 2: Iceland

Early environmental management and regulation; sustainable exploitation of finite resources (e.g. birds).

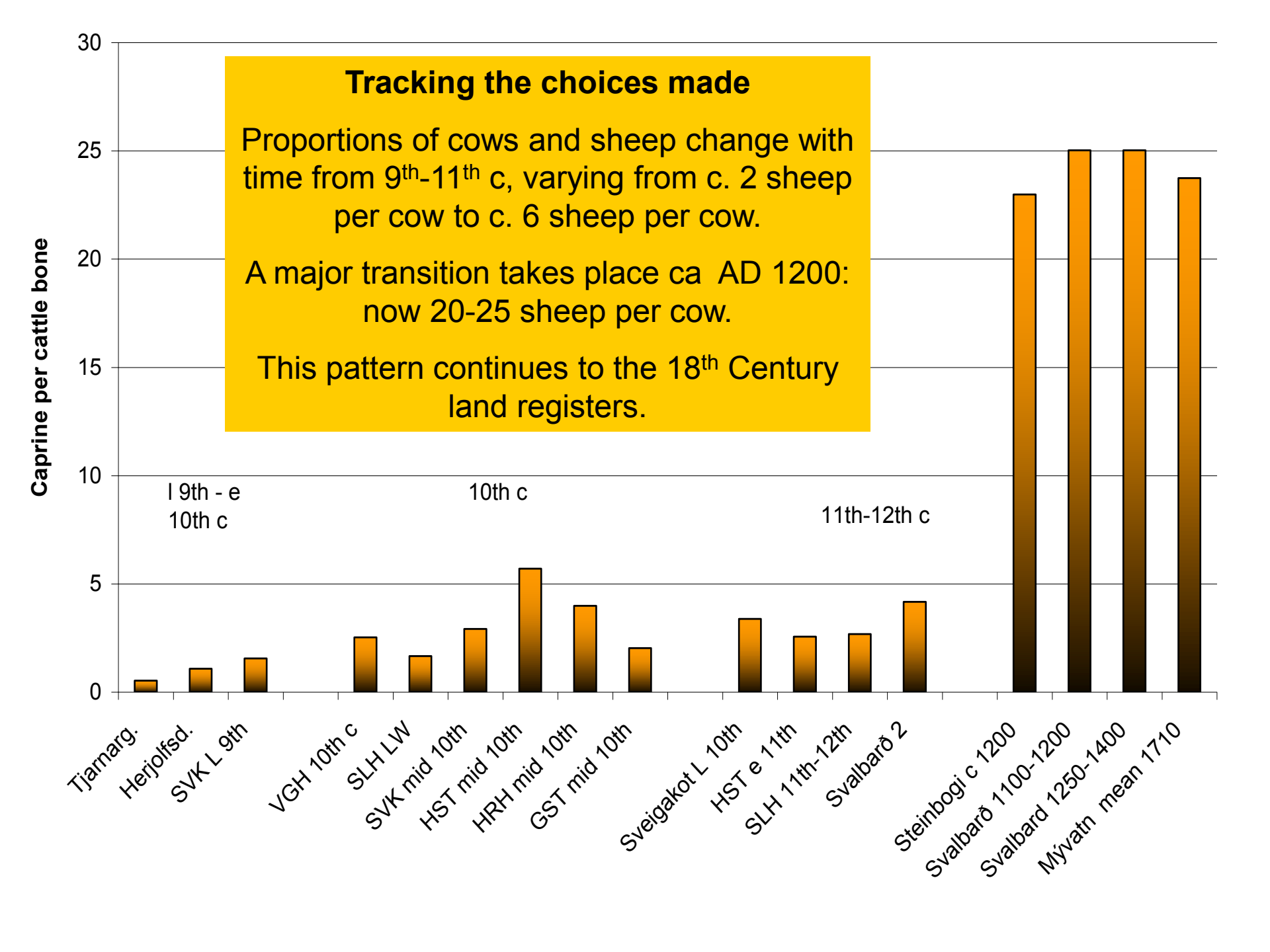
Iceland

When faced with **predictable changes** (e.g. woodland clearance) adaptations made to conserve a landscape ‘fit for purpose’.

When faced with **unpredictable change** (e.g. climate hazards) natural capitals drawn down to maintain settlement.

Economic change- development of bulk commodity trading (of fish and wool)

Dugmore, A.J., Church, M.J., et al. 2006 'An over-optimistic pioneer fringe? Environmental perspectives on medieval settlement abandonment in Thórsmörk, south Iceland.', In Arneborg, J. & Grønnow, B. (eds.) *The Dynamics of Northern Societies*. PNM, 10 333-344


Tracking the choices made
Proportions of cows and sheep change with time from 9th-11th c, varying from c. 2 sheep per cow to c. 6 sheep per cow.
A major transition takes place ca AD 1200: now 20-25 sheep per cow.
This pattern continues to the 18th Century land registers.
Caprine per cattle bone
30
25
20
15
10
5
0
l 9th - e 10th c
10th c
11th-12th c
Tjarnarg.
Herjolfsd.
SVK L 9th
VGH 10th c
SLH LW
SVK mid 10th
HST mid 10th
HRH mid 10th
GST mid 10th
Sveigakot L 10th
HST e 11th
SLH 11th-12th
Svalbarð 2
Steinbogi c 1200
Svalbarð 1100-1200
Svalbard 1250-1400
Mývatn mean 1710

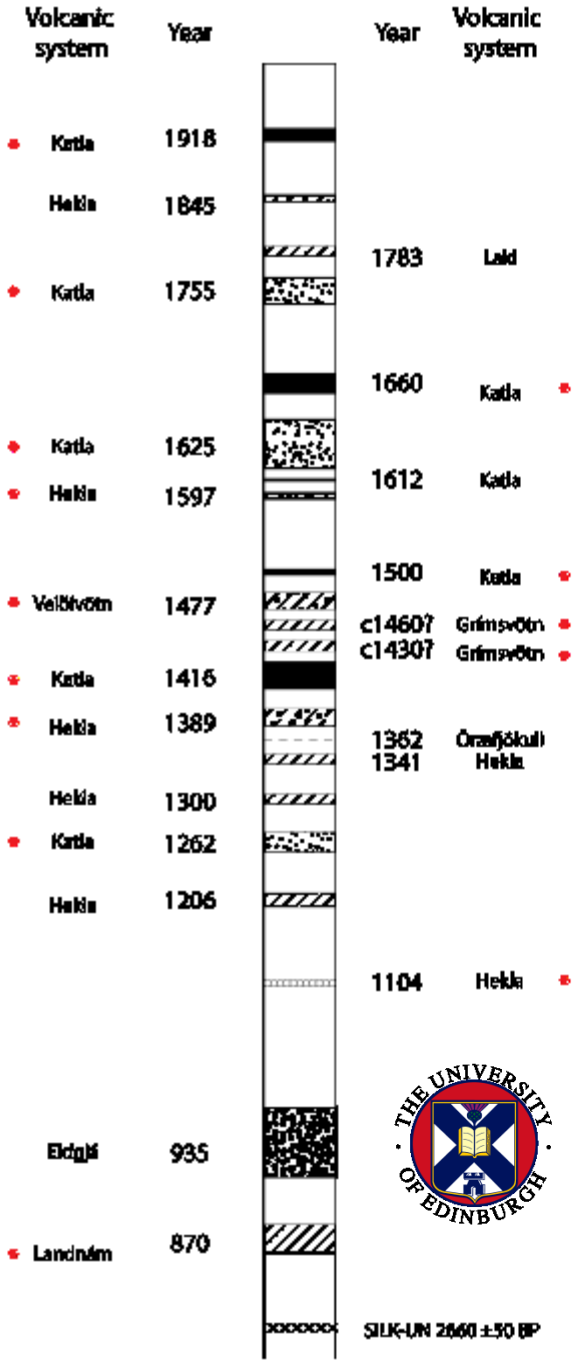
Tephrochronology of Skaftártunga, South Iceland

Understanding the consequences of choices and external impacts (eg volcanic eruptions, climate hazards, disease).

Precise data needed

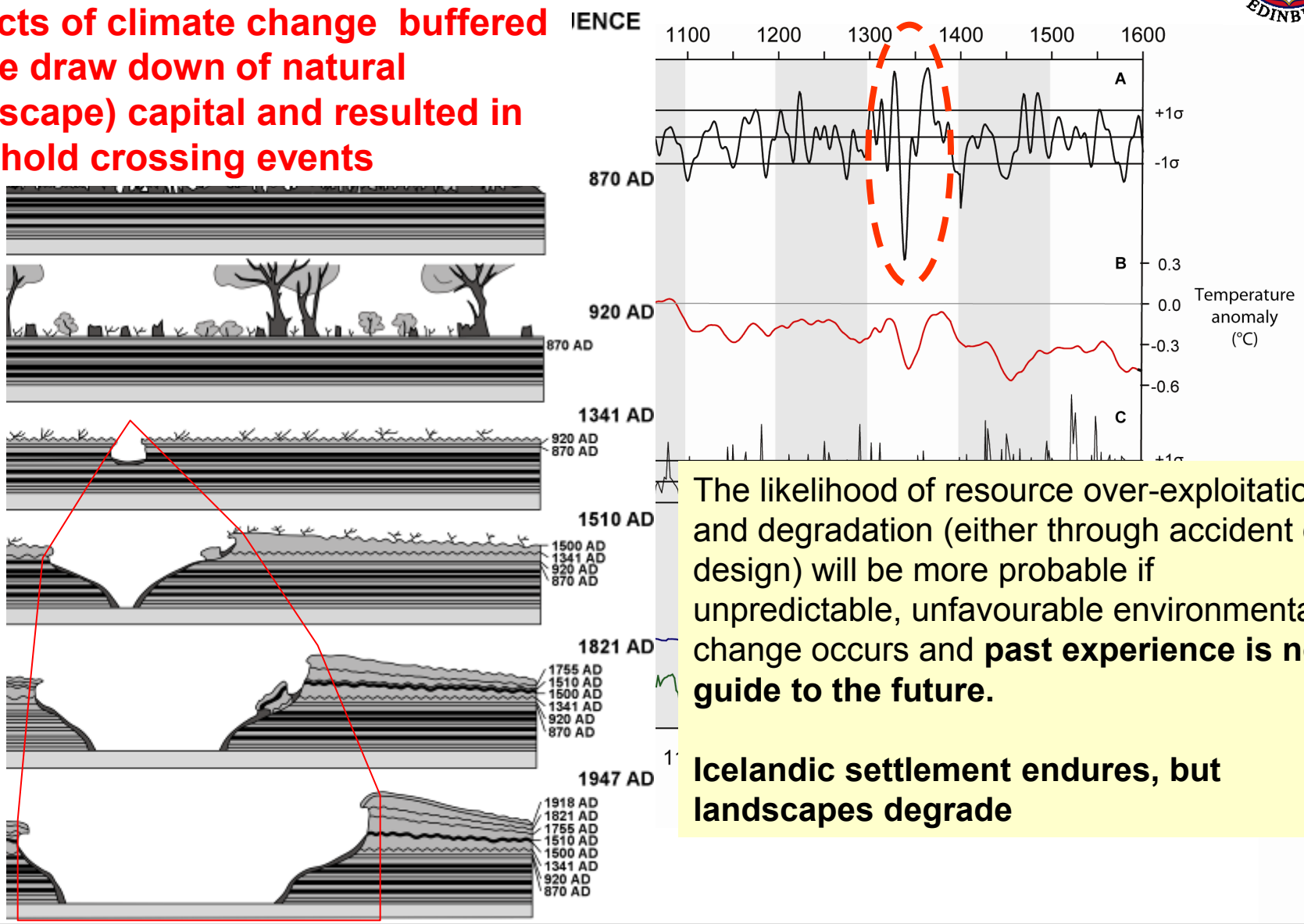
High resolution sequences (c.1mm sediment accumulation per year)

Outstanding tephrochronology



Climate, memory and management

Impacts of climate change buffered by the draw down of natural (landscape) capital and resulted in threshold crossing events

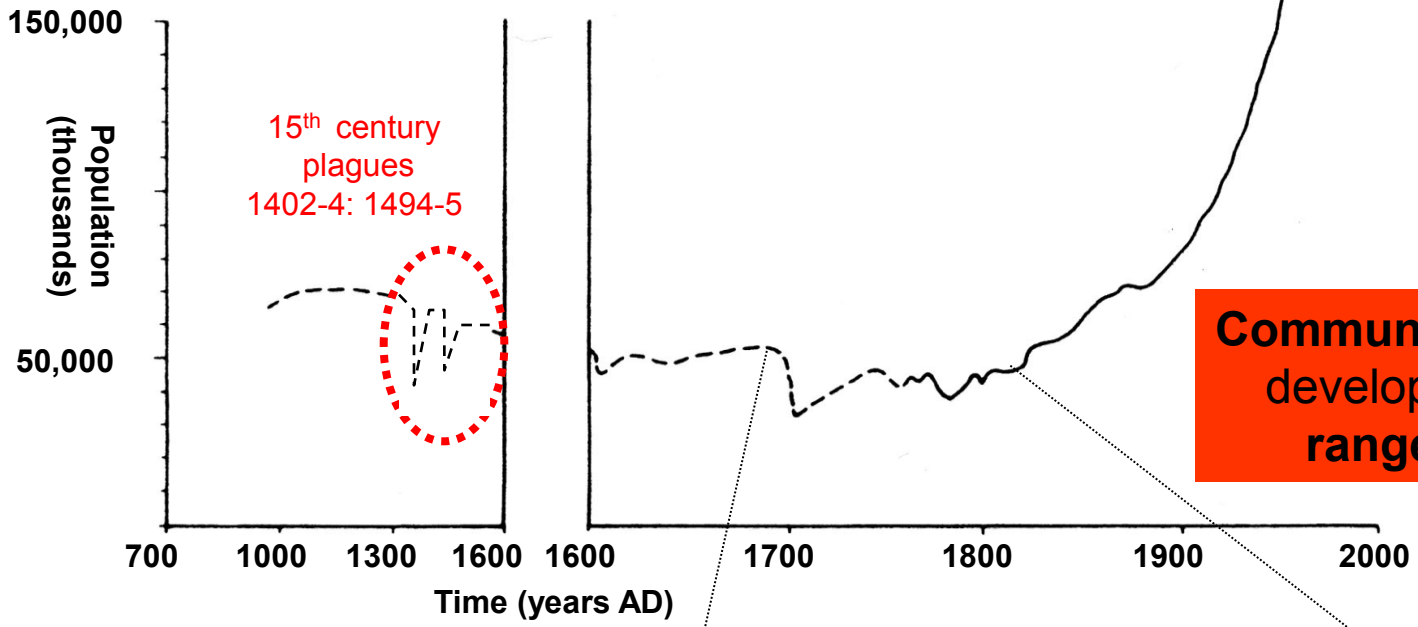


The likelihood of resource over-exploitation and degradation (either through accident or design) will be more probable if unpredictable, unfavourable environmental change occurs and **past experience is no guide to the future.**

Icelandic settlement endures, but landscapes degrade

Dugmore, A.J., Gísladóttir, G., Simpson, I.A. and Newton A.J. 2009 'Conceptual models of 1,200 years of Icelandic soil erosion reconstructed using tephrochronology' *Journal of the North Atlantic* 2, 1-18

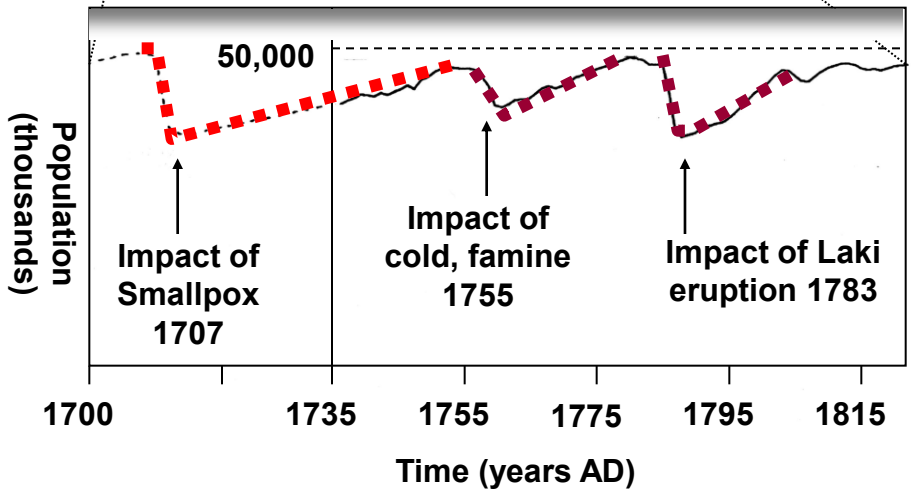
Different choices & outcomes 2: Iceland



Communal resilience developed to face a **range challenges**

Flexibility at the cost of economic development?

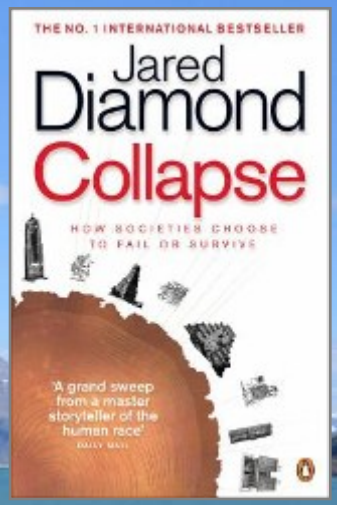
Modifying or **abandoning this ability to deal with setbacks in favour of economic development** did not seem like an acceptable strategy until modern times….



Vasey, Daniel. E. 1996. Population regulation, ecology, and political economy in preindustrial Iceland. *American Ethnologist* 23(2):366-392.

Different choices & outcomes 3: Greenland

985- c1450 AD



Diamond's *Collapse*:

Possible reasons for the end of Norse Greenland

- Mal-adaptation (taboo about fish eating)
- Human impacts (soil erosion)
- Climate change (it got cold & they died…)
- Oppressive elites (and foreign too).

…or not? New developments cast doubt on this thesis

Initial colonisation effort

25 ships set out –
11 fail to arrive. What drove this settlement?
It must have been more than a good name for the land…

Drivers for colonization,
opportunities to gain prestige
(how to ‘get rich’);
find trade goods, found a colony
(alternatives to raiding for silver and slaves).

Dugmore, Andy, Christian Keller & Thomas H. McGovern, 2007. Reflections on climate change, trade, and the contrasting fates of human settlements in the North Atlantic islands, *Arctic Anthropology* 44(1): 12-37.

Walrus made extinct in Iceland by the Vikings- vast numbers of walrus in Greenland

Source of valuable ivory and hides (for cables)

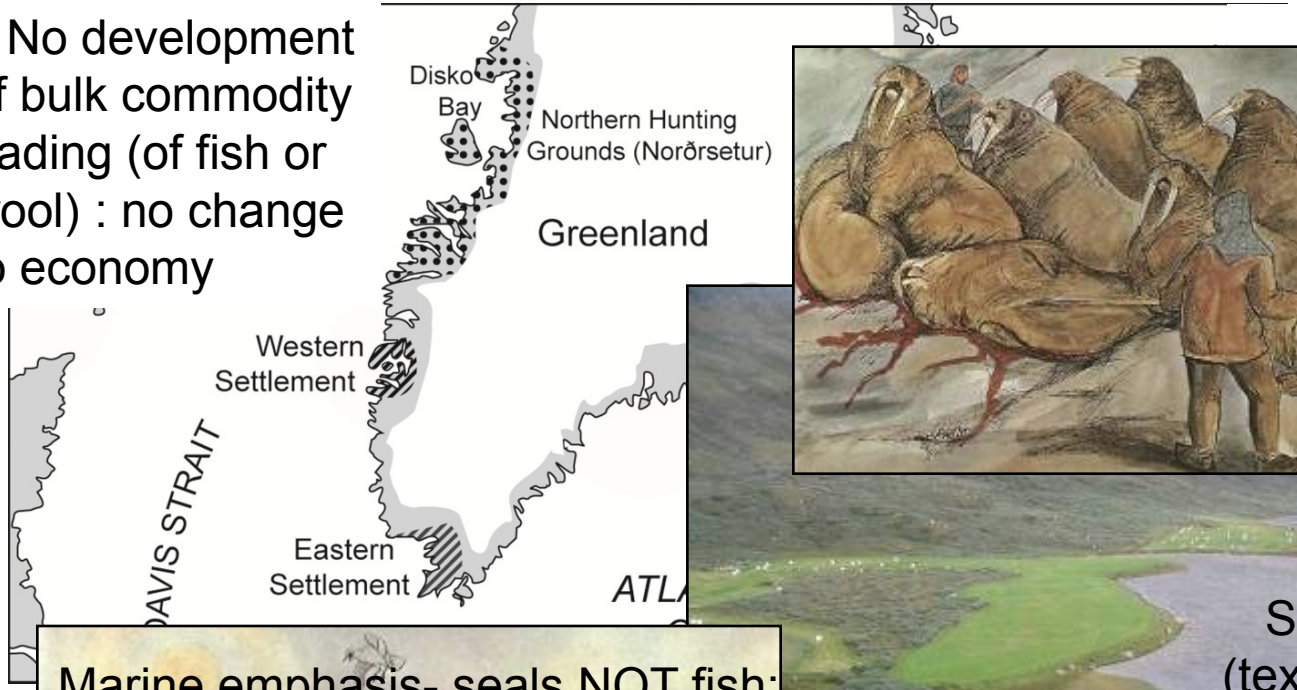
Viking trade goods:
Furs, not available in Iceland

White fur was particularly valuable;
all furs are best collected in winter time…

Different choices & outcomes 3: Greenland

Toughest environment for Norse settlers

No development of bulk commodity trading (of fish or wool) : no change to economy



Generation of prestige trade goods in remote areas- communal effort

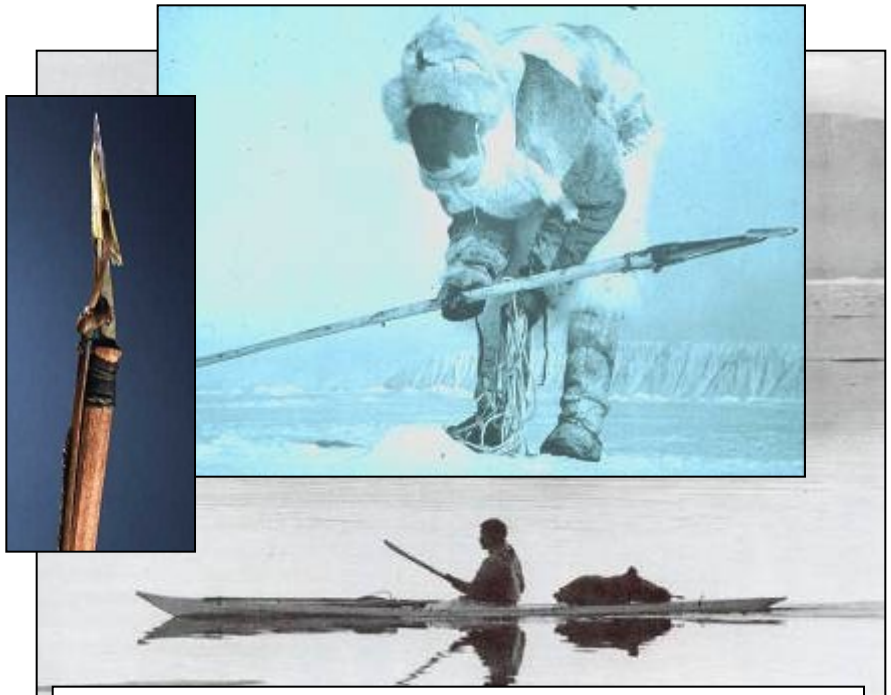
Marine emphasis- seals NOT fish: Communal effort

Sustainable farming (textiles, dairy products)

Sustainable subsistence (in common with other Norse areas of settlement) based on pastoralism and wild resources

Greenland adaptations: Earlier…..Later

Communal hunt of migrating seals, boats, nets, dogs and clubs



Toggle harpoon, specialised spears, kayak, dog sleds

Norse

Massive, short-lived communal effort in the spring

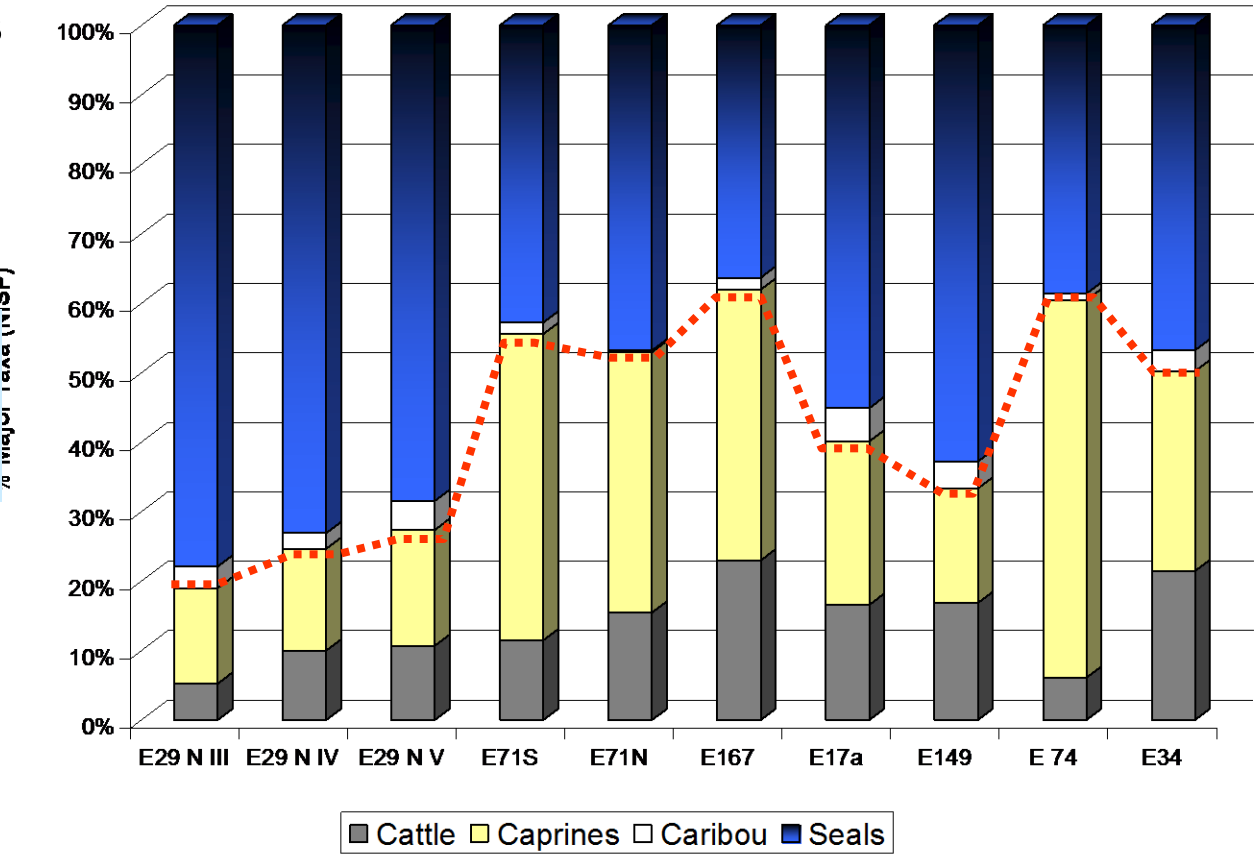
Thule Inuit

Individualistic hunting in winter conditions

Dugmore, A.J., McGovern T.H. et al., 2009 'Norse Greenland settlement and limits to adaptation' In W. N. Adger, I. Lorenzoni and K. O'Brien, eds. *Adapting to Climate Change: Thresholds, Values, Governance* Cambridge University Press, Cambridge 96-113.

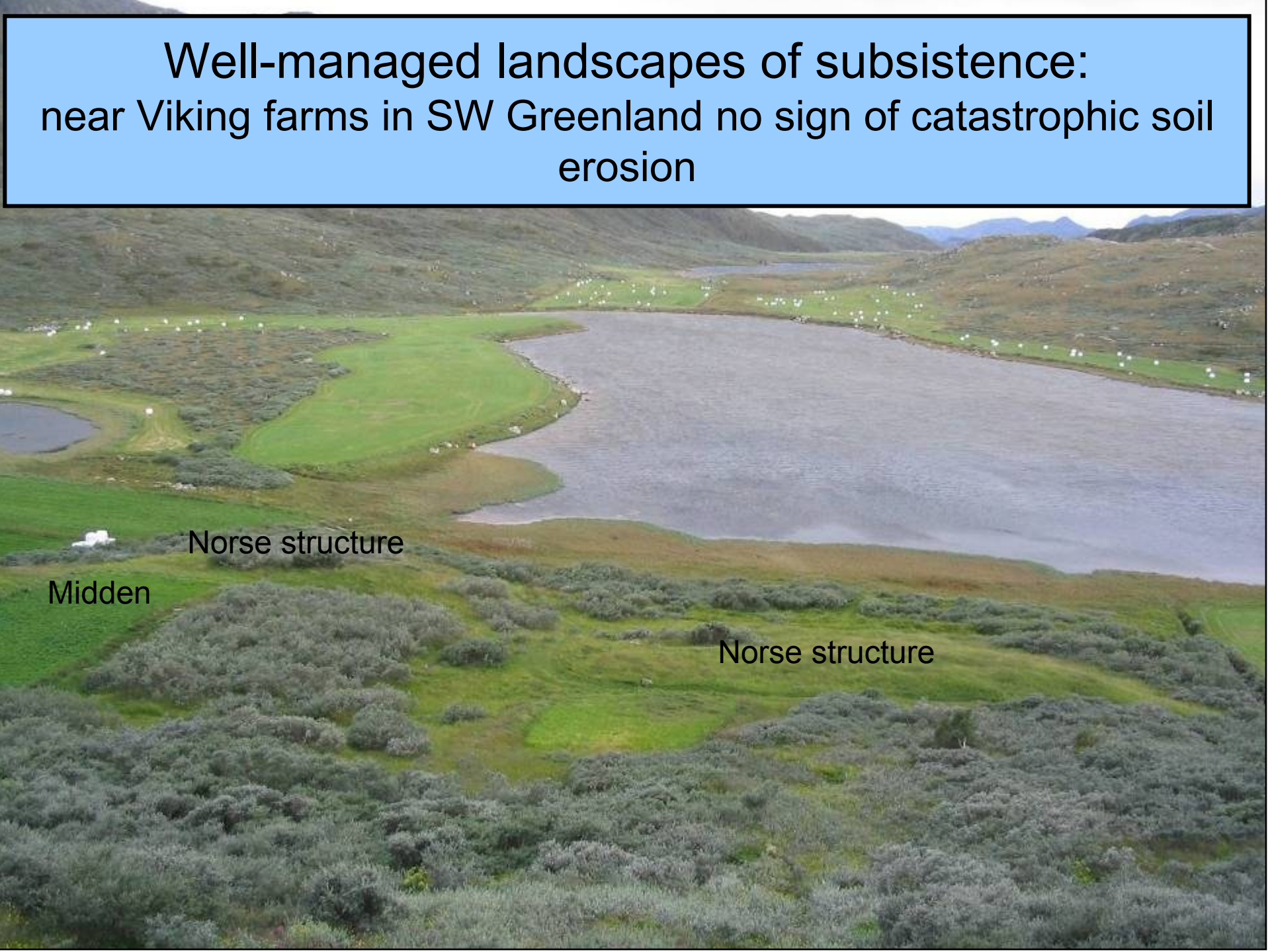
Bone data from farms in the Eastern Settlement SW Greenland

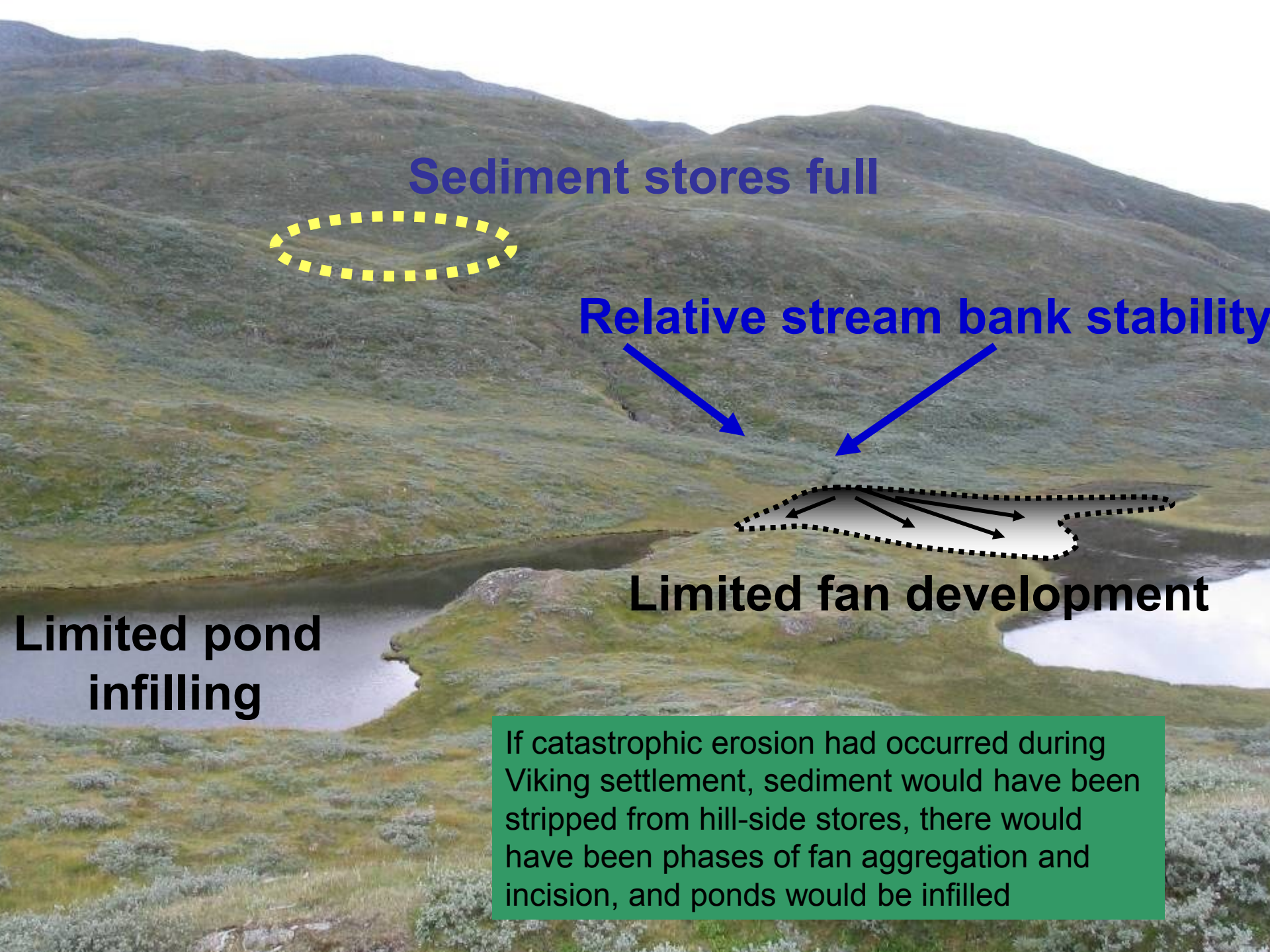
Development of new TEK: many **seals** utilized by Norse.



Small numbers of **caribou bones** found throughout record (early-late). Norse had the means to exterminate the caribou (dogs, drive lines) but chose not to. Development of new TEK: **sustainable practice on century timescales.**

Well-managed landscapes of subsistence:
near Viking farms in SW Greenland no sign of catastrophic soil erosion

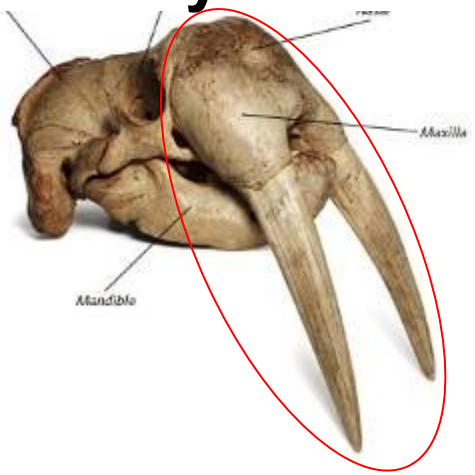


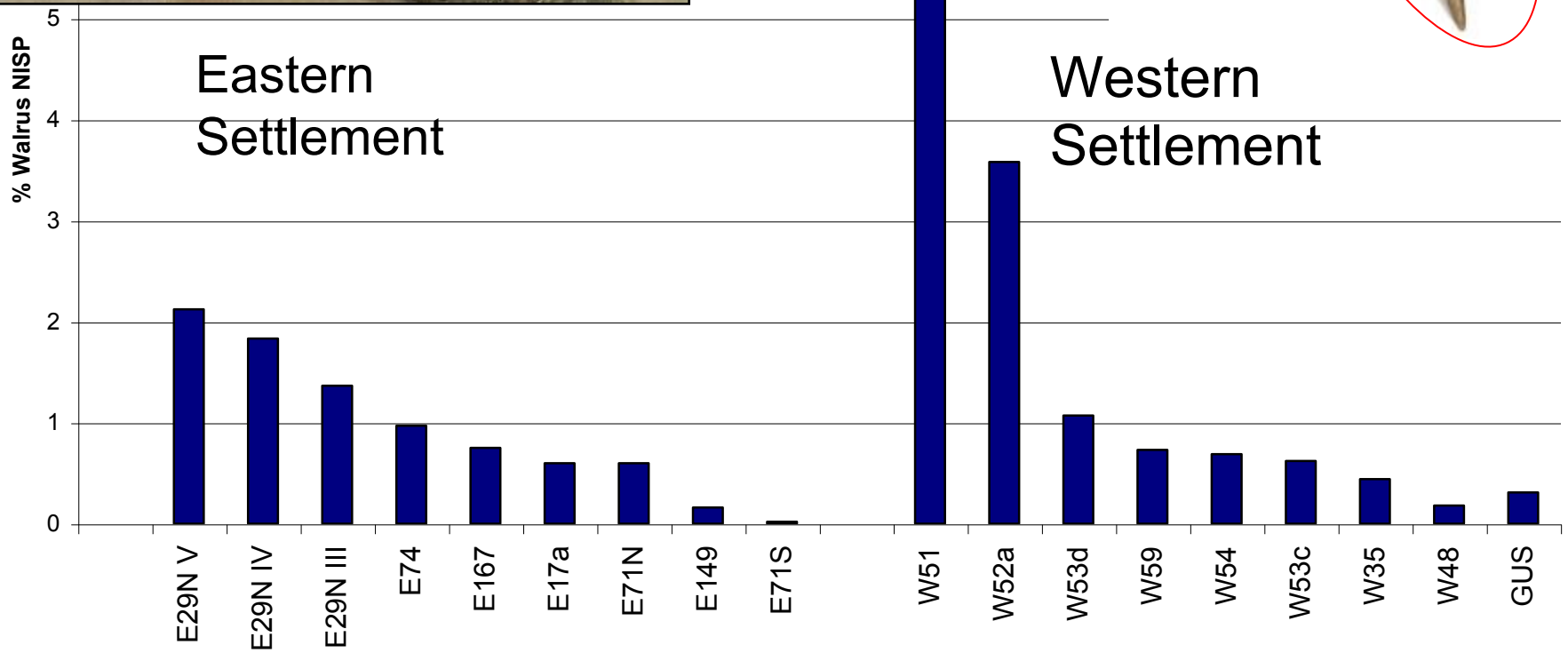


If catastrophic erosion had occurred during Viking settlement, sediment would have been stripped from hill-side stores, there would have been phases of fan aggregation and incision, and ponds would be infilled

Cash generation

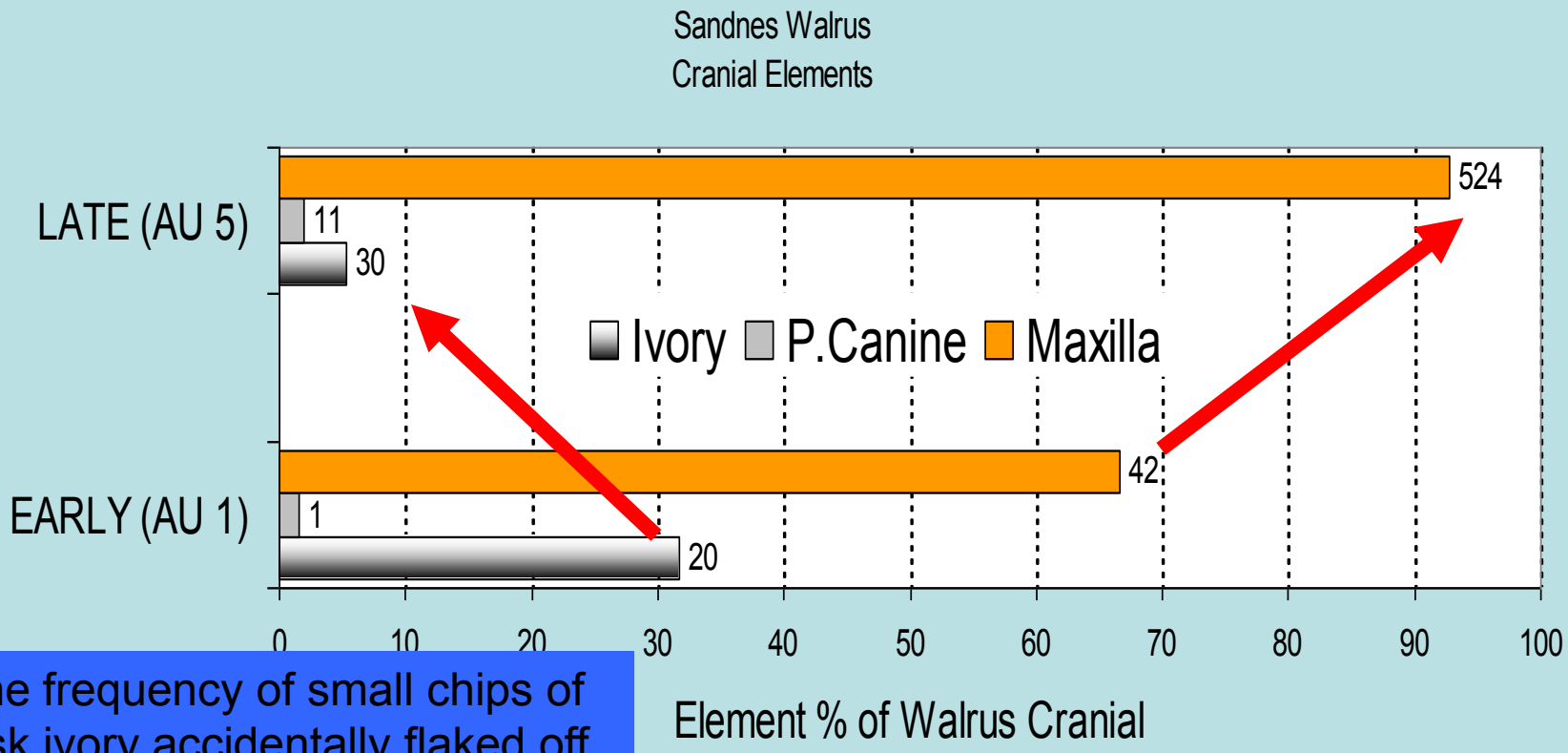
Walrus skull bones in Greenland: evidence of **community-wide involvement**





Walrus bone fragments are at large and small farms, at coastal and inland sites

Norse Greenland economy: improving quality control- intensification not innovation



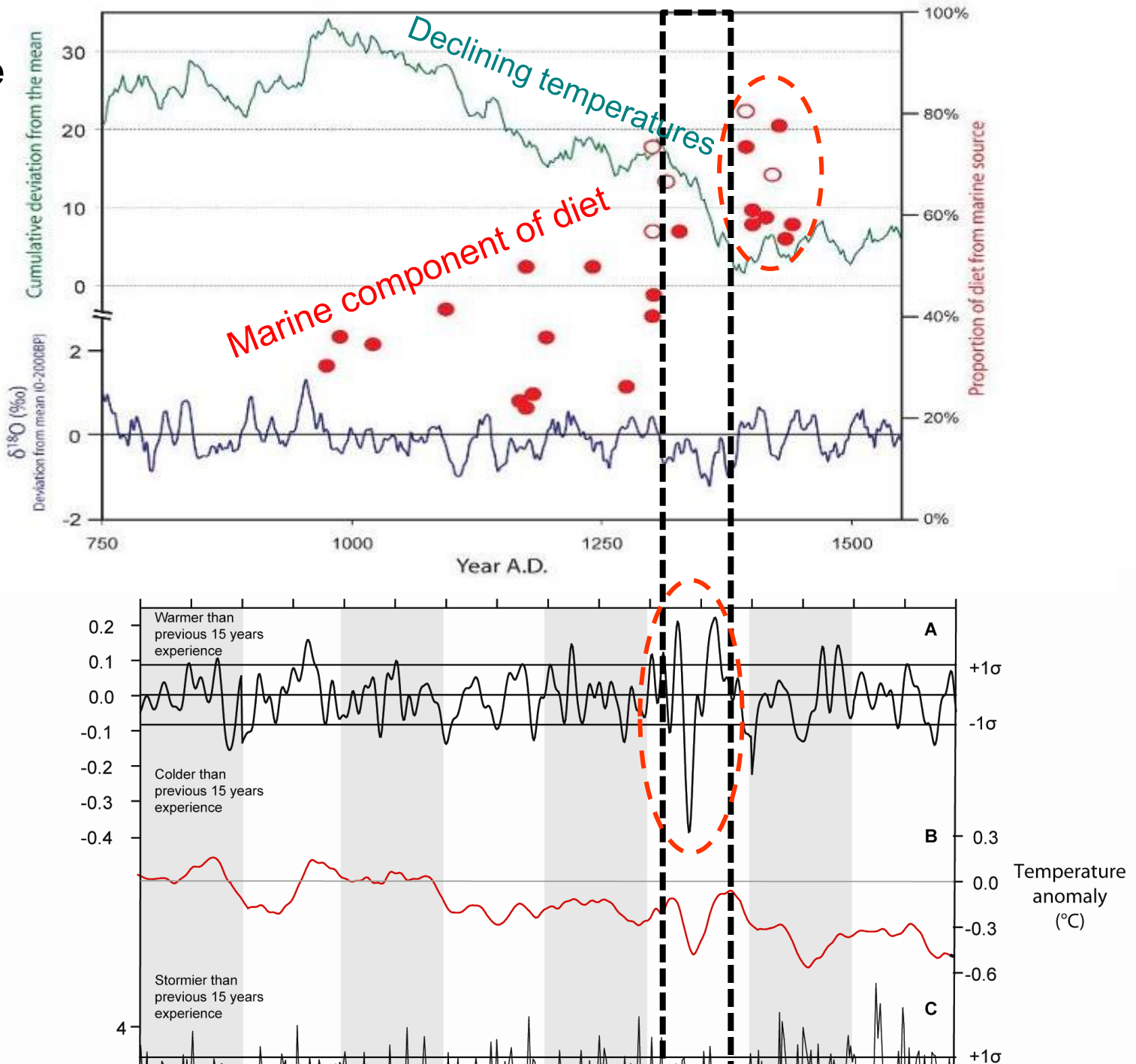
The frequency of small chips of tusk ivory accidentally flaked off during tusk extraction drops with time and experience. The Norse are improving quality control in ivory production. **Intensified use of marine resource**

McGovern T.H., Amorosi T., Perdikaris S. and Woollett J.W. 1996 'Zooarchaeology of Sandnes V51: Economic change at a Chieftain's farm in West Greenland.' *Arctic Anthropology* 33(2):94-122.

Behaviour in face of climate change

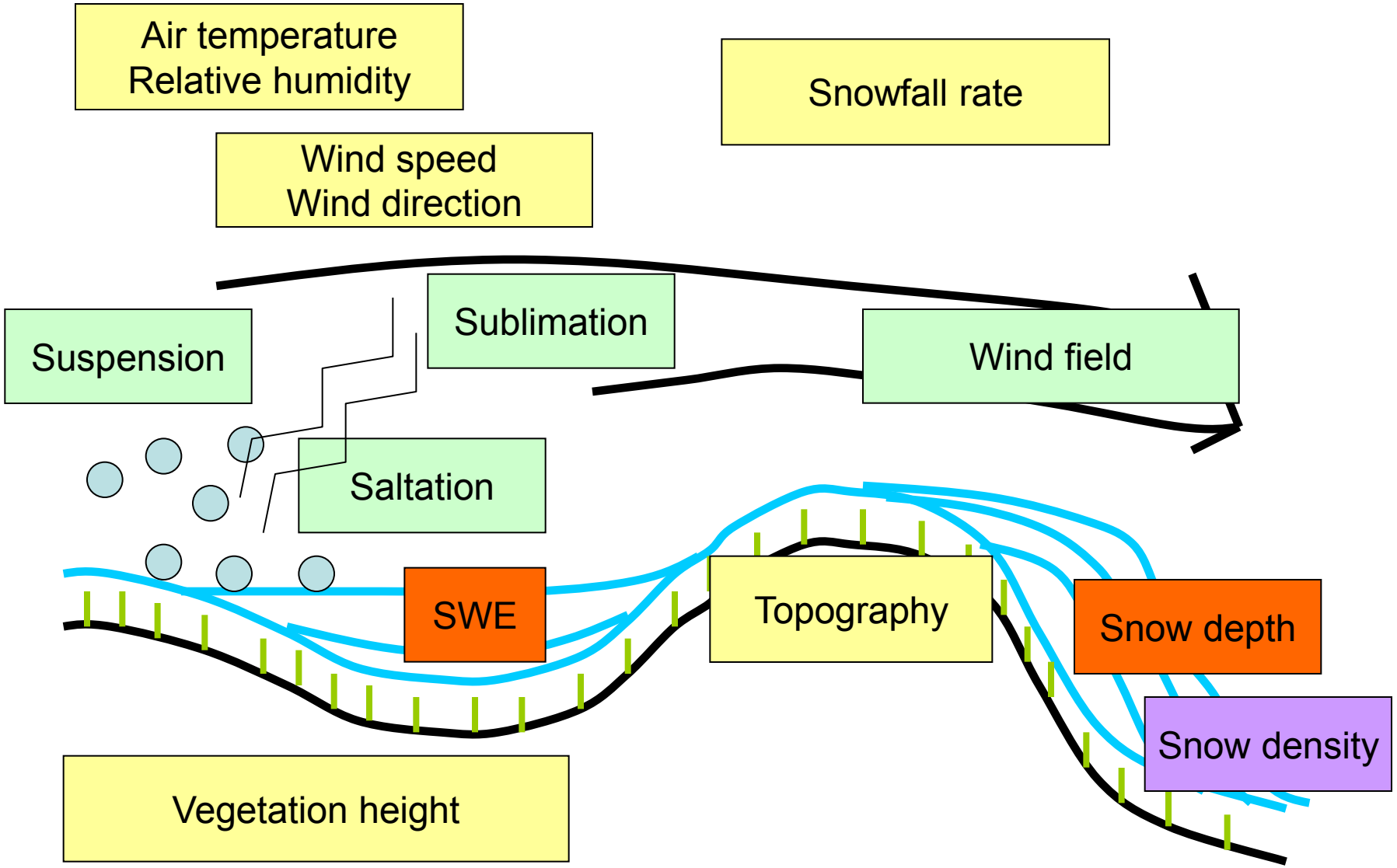
As cumulative temperatures decline, marine component of Norse diet increases (up to 80%)

Was the challenge of unpredictable, unfavourable environmental change 13th-14th centuries a spur to the intensification of marine mammal exploitation in Norse Greenland?



Modelling snow distribution: DBSM

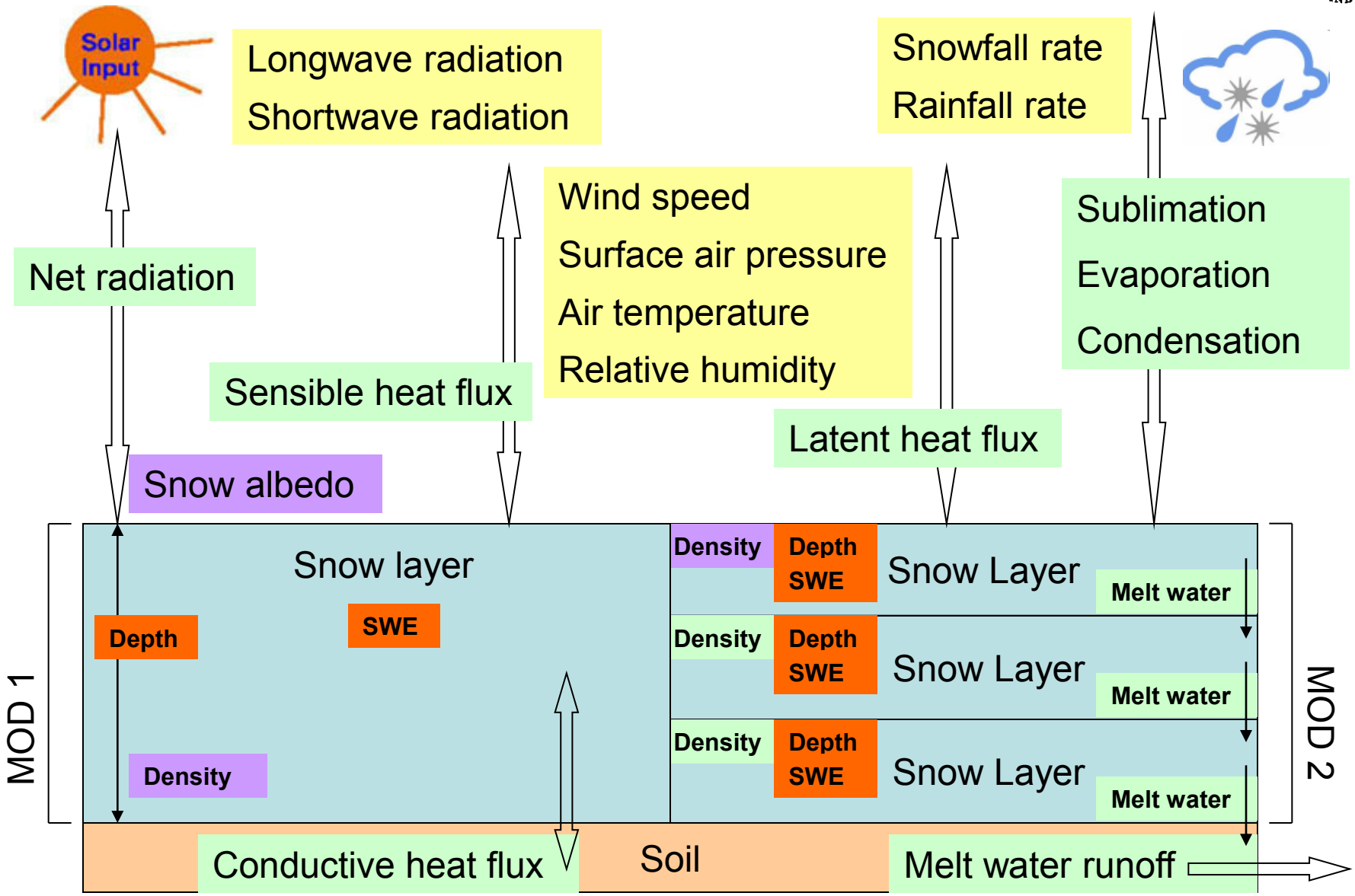
Laura Comeau
PhD thesis



Input data	Modelled processes/variables	Calibrated parameter	Modelled output

Modelling snow melt: CoSDAS

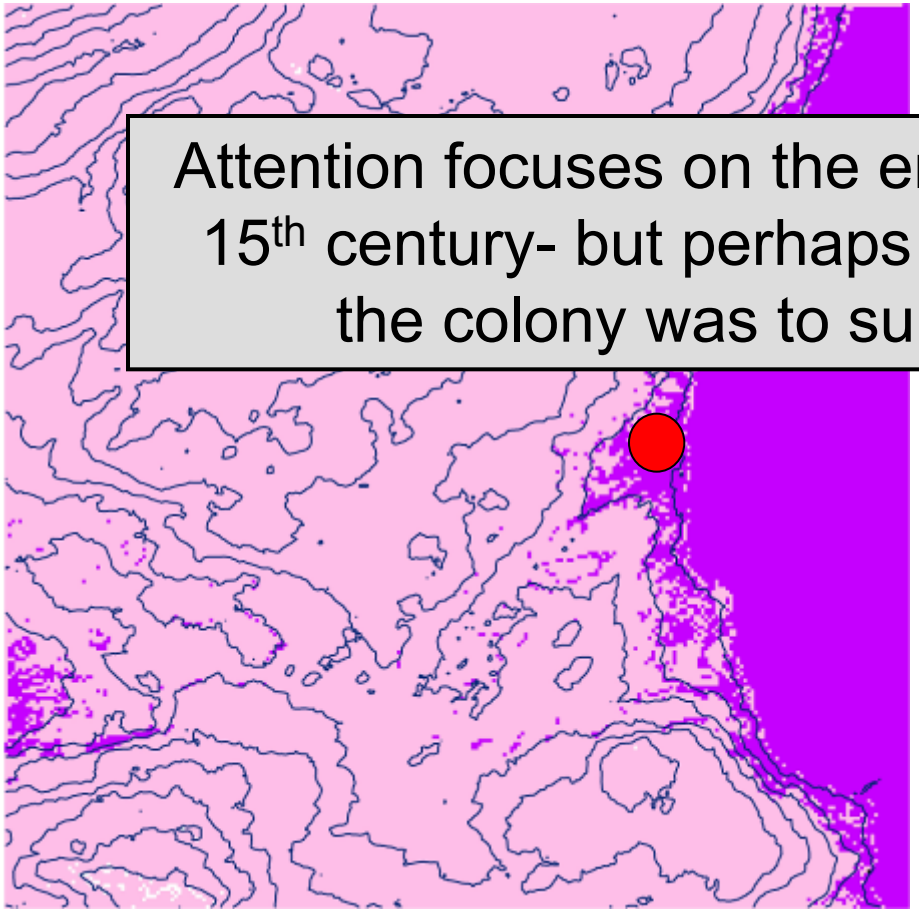
Laura Comeau
PhD thesis



Input data	Modelled processes/variables	Calibrated parameter	Modelled output

Brattahlið: January

Attention focuses on the end of Norse Greenland in the 15th century- but perhaps the most remarkable feat of the colony was to survive the 14th century…



Temp min
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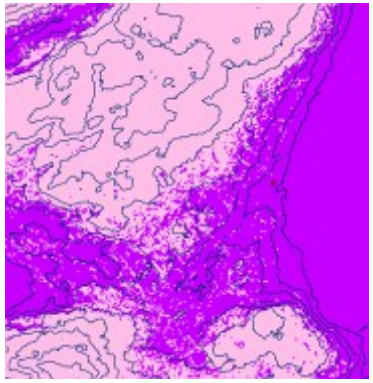
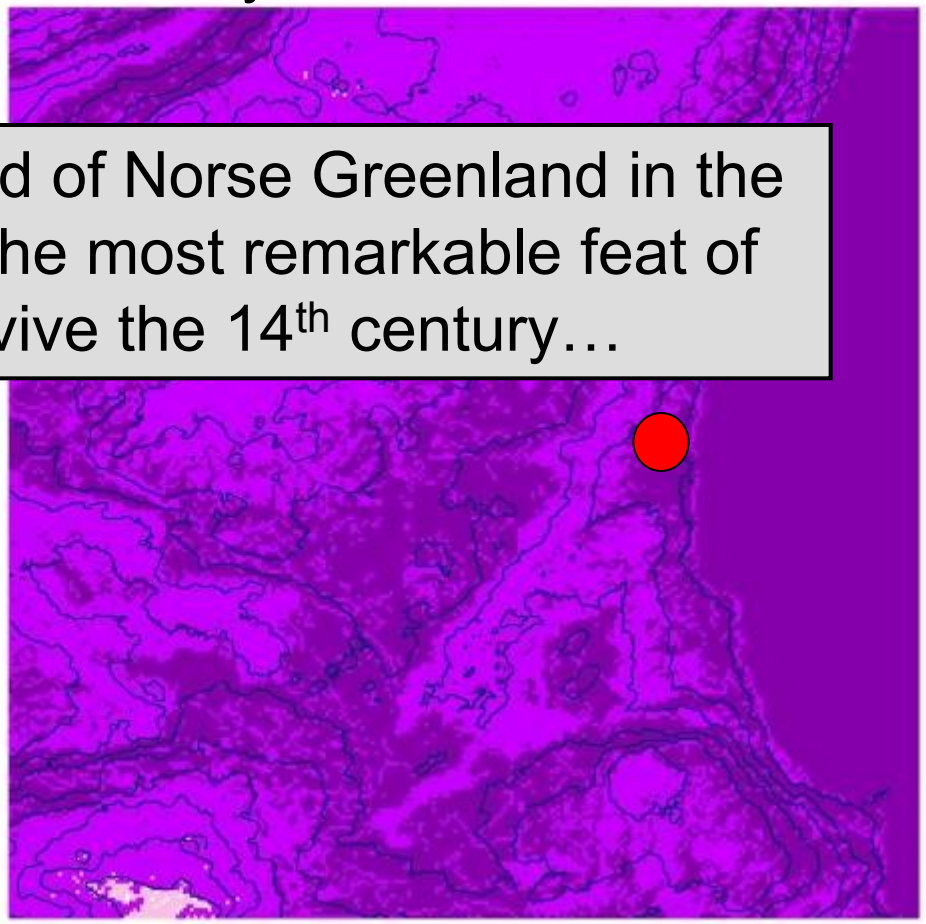


Temp 1999-2000

Snow depth (m)

- 0
- 0 - 0.5
- 0.5 - 1
- 1.0 - 1.5
- 1.5 - max



Temp max
(1101-2 AD)

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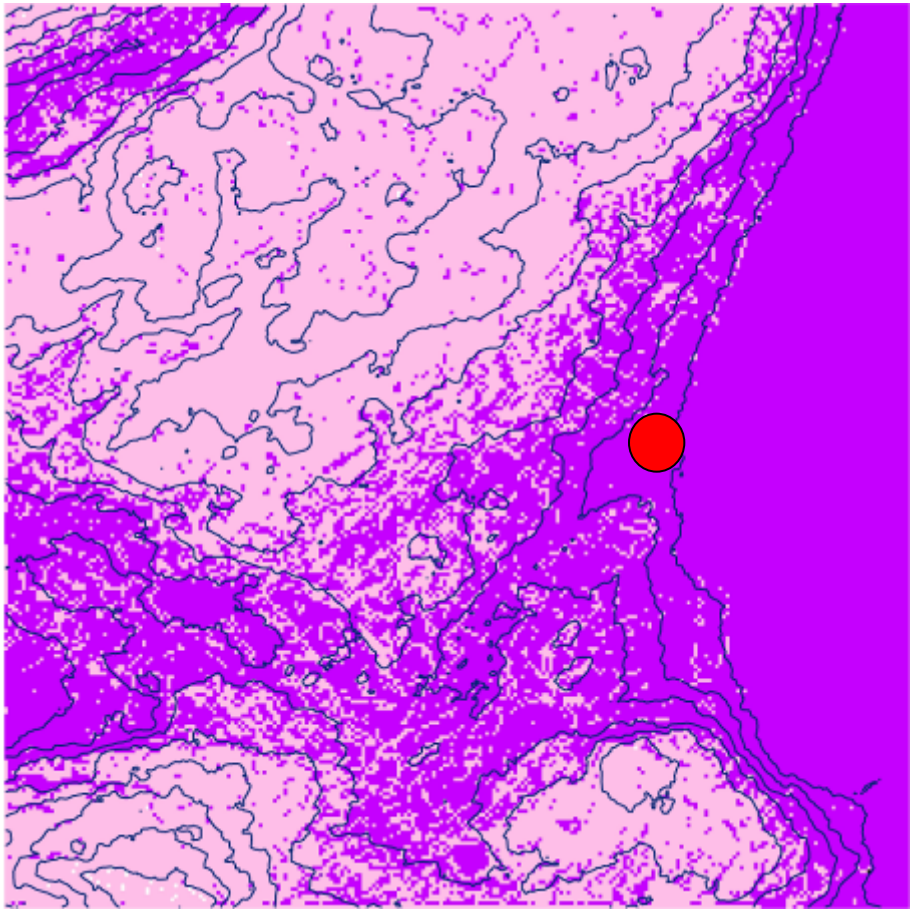
Brattahlið: February



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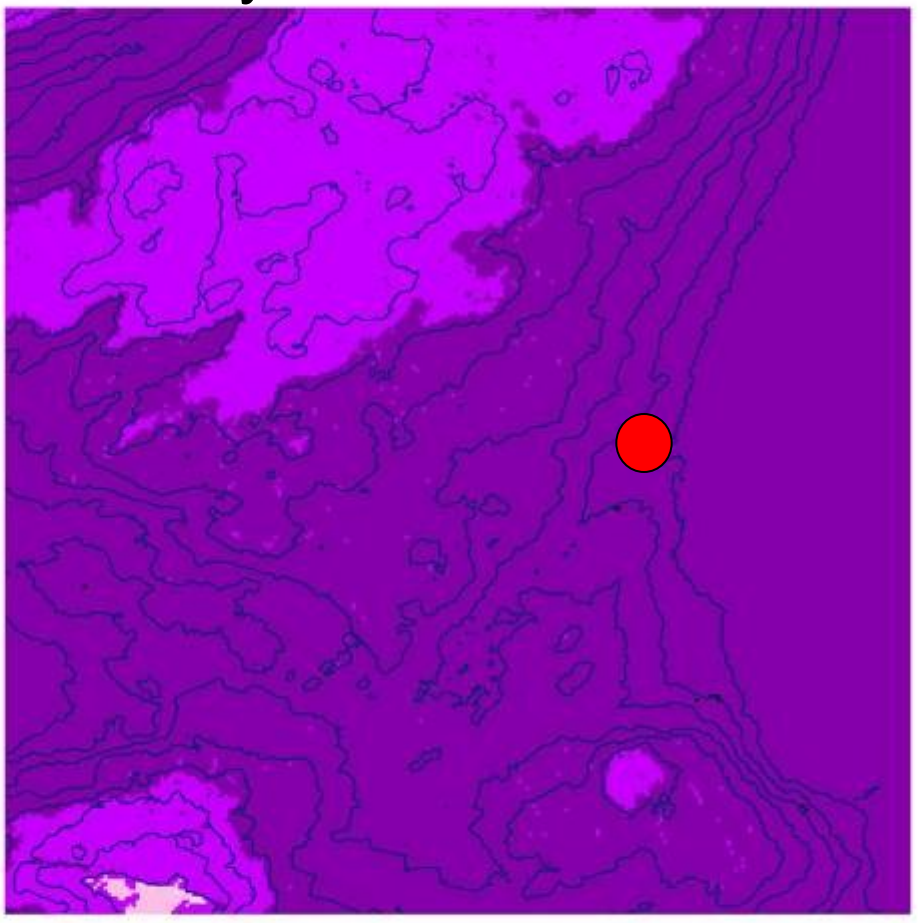
(1372-3 AD)



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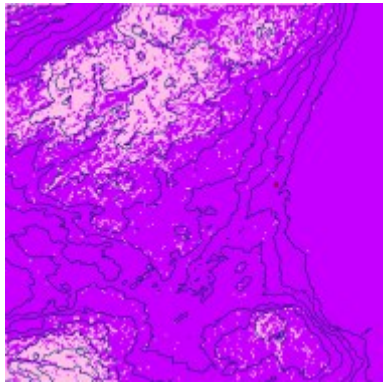

Temp 1999-2000

Snow depth (m)

- 0
- 0 - 0.5
- 0.5 - 1
- 1.0 - 1.5
- 1.5 - max

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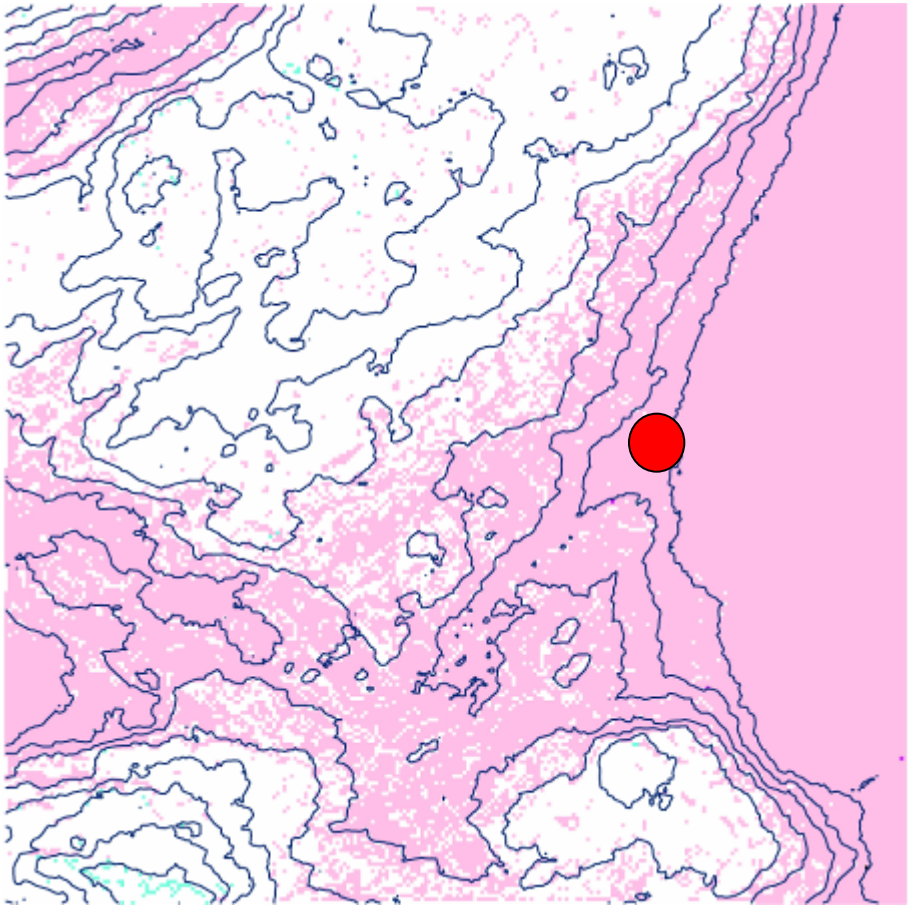
Brattahlið: March



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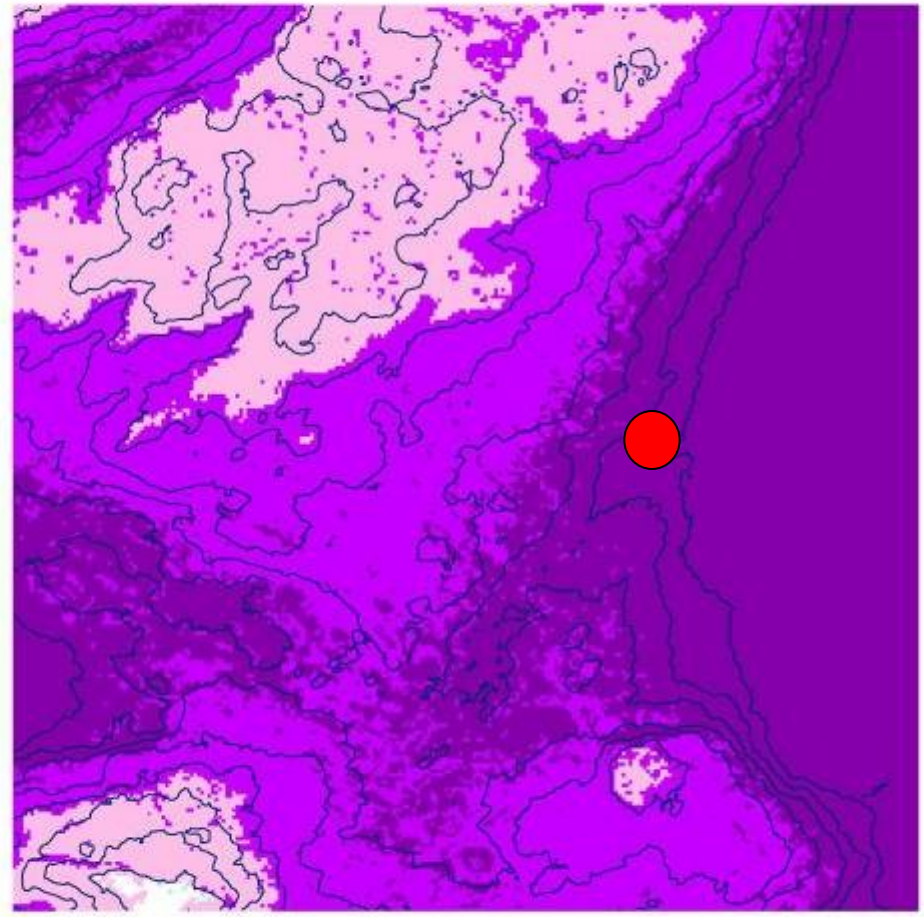

Temp max
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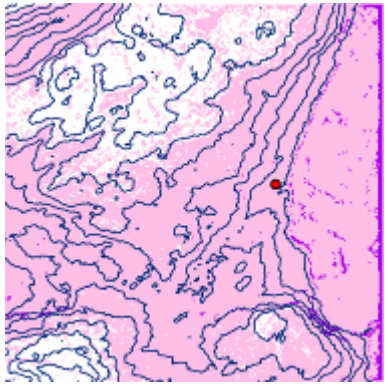

Temp 1999-2000

Snow depth (m)

- 0
- 0 - 0.5
- 0.5 - 1
- 1.0 - 1.5
- 1.5 - max

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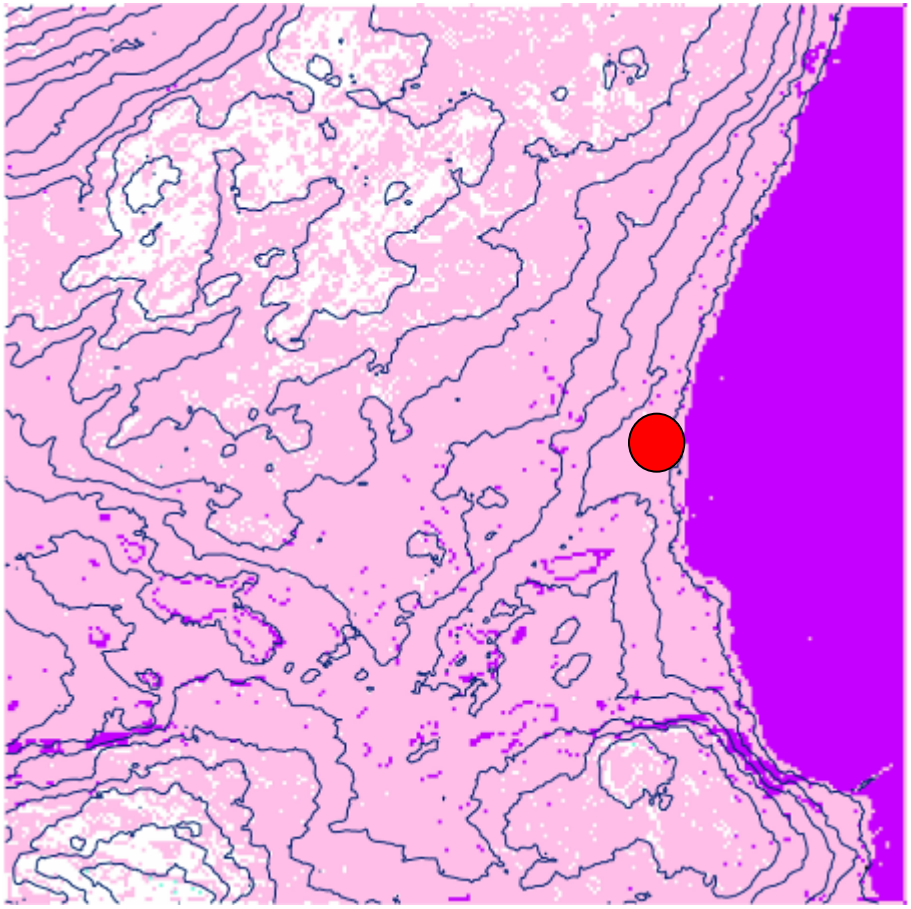
Brattahlið: April



Temp min
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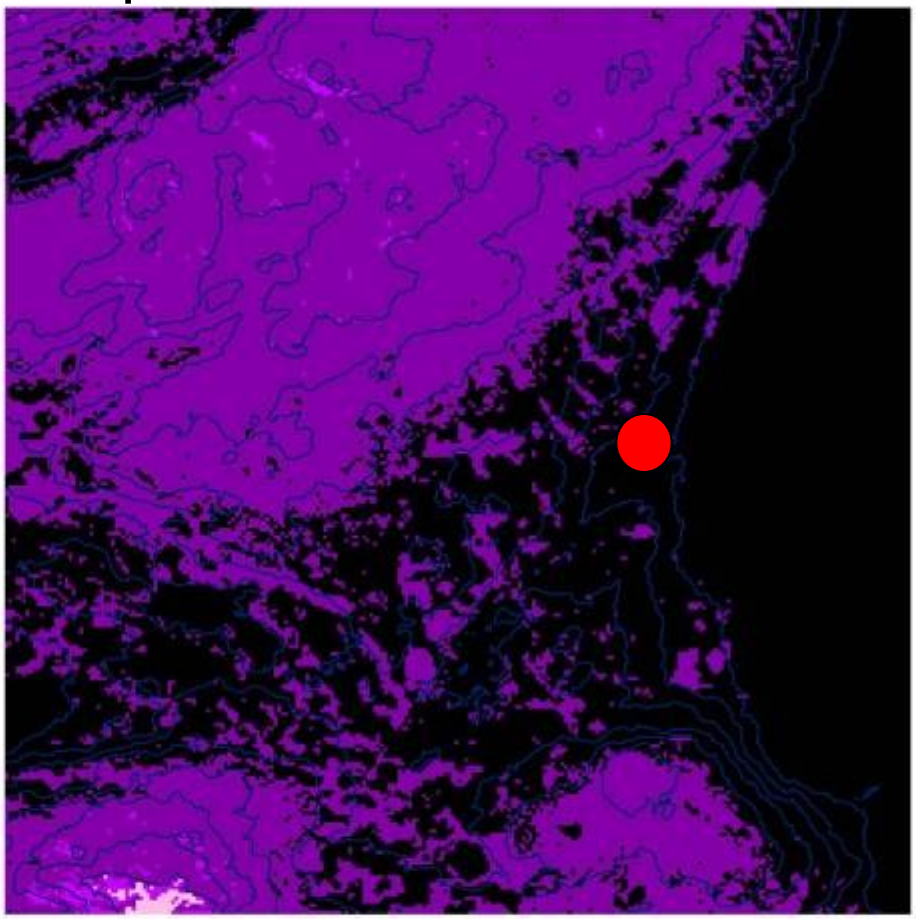

Temp max
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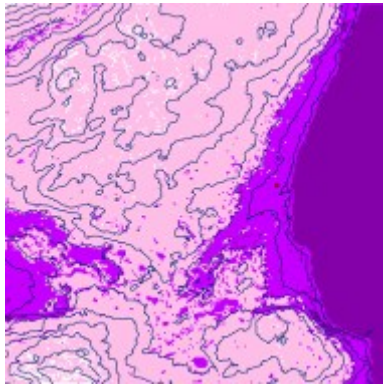

Temp 1999-2000

Snow depth (m)

- 0
- 0 - 0.5
- 0.5 - 1
- 1.0 - 1.5
- 1.5 - max

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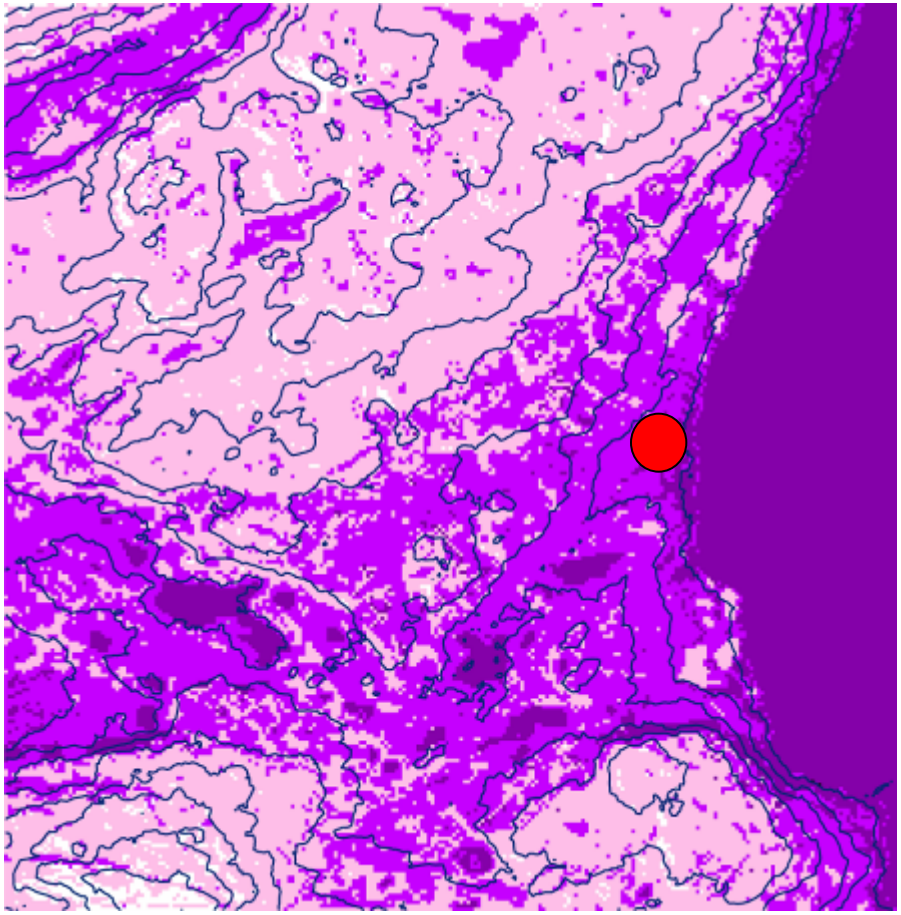
Brattahlið: May



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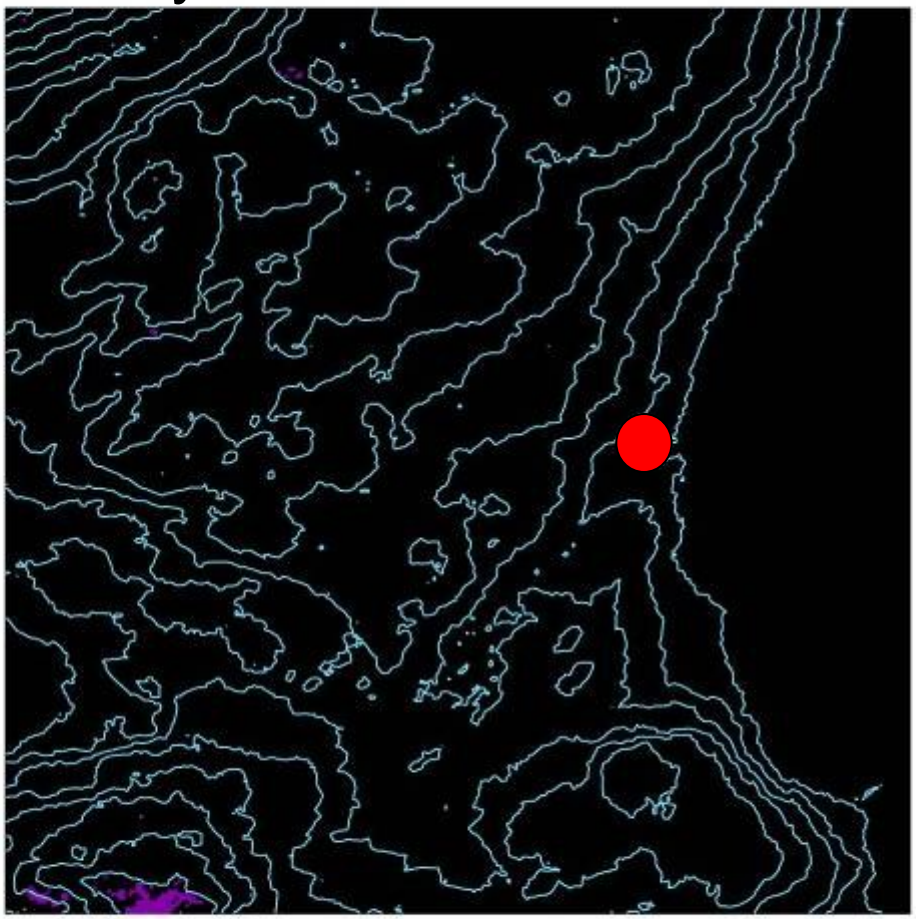

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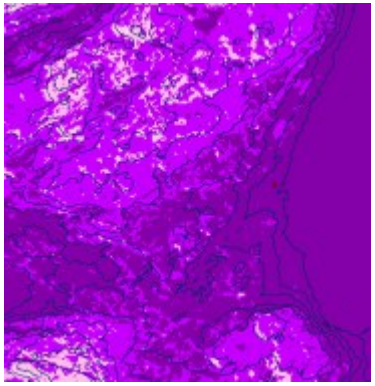

Temp 1999-2000

Snow depth (m)

- 0
- 0 - 0.5
- 0.5 - 1
- 1.0 - 1.5
- 1.5 - max

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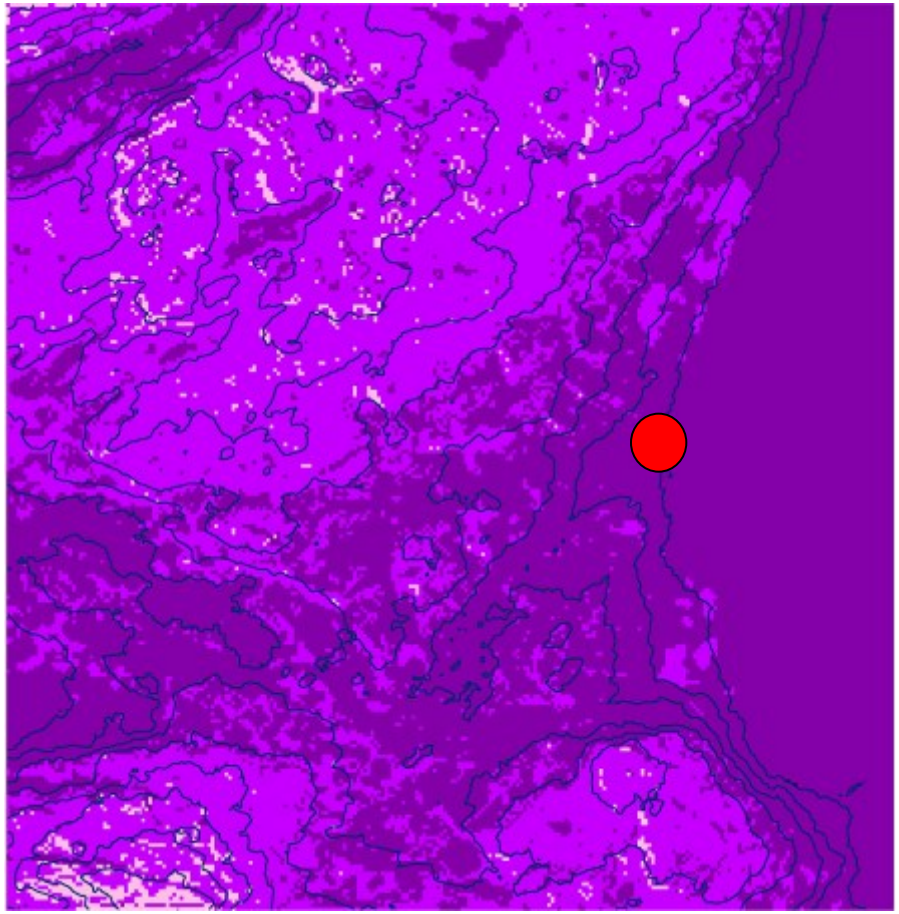
Brattahlið: June



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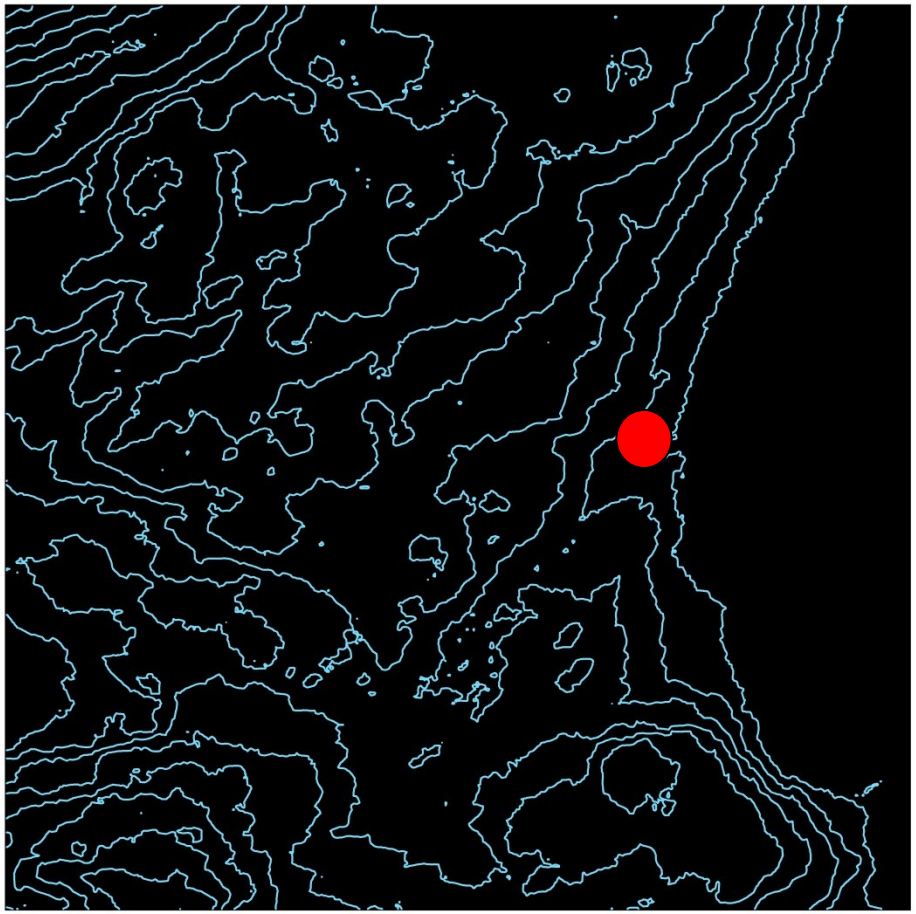

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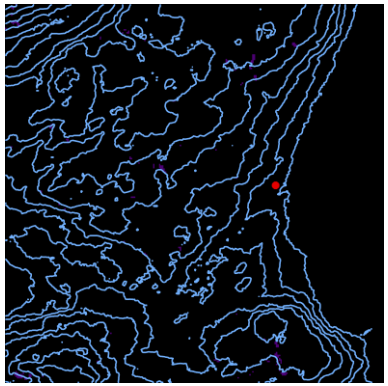
(1101-2 AD)



Temp 1999-2000

Snow depth (m)

- 0
- 0 - 0.5
- 0.5 - 1
- 1.0 - 1.5
- 1.5 - max

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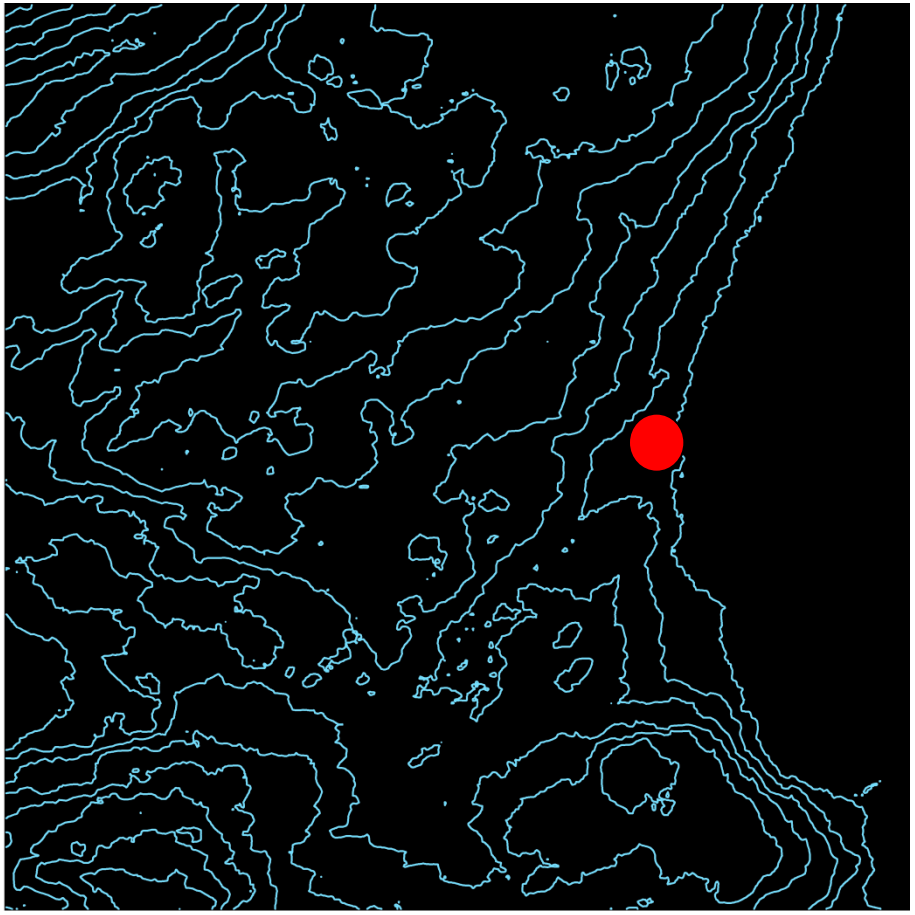
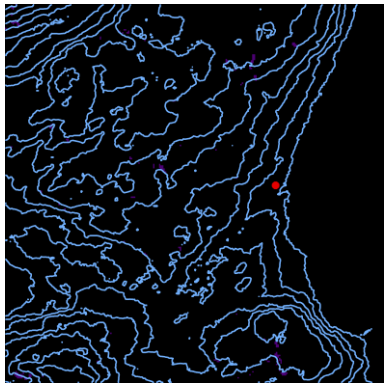
Brattahlið: July



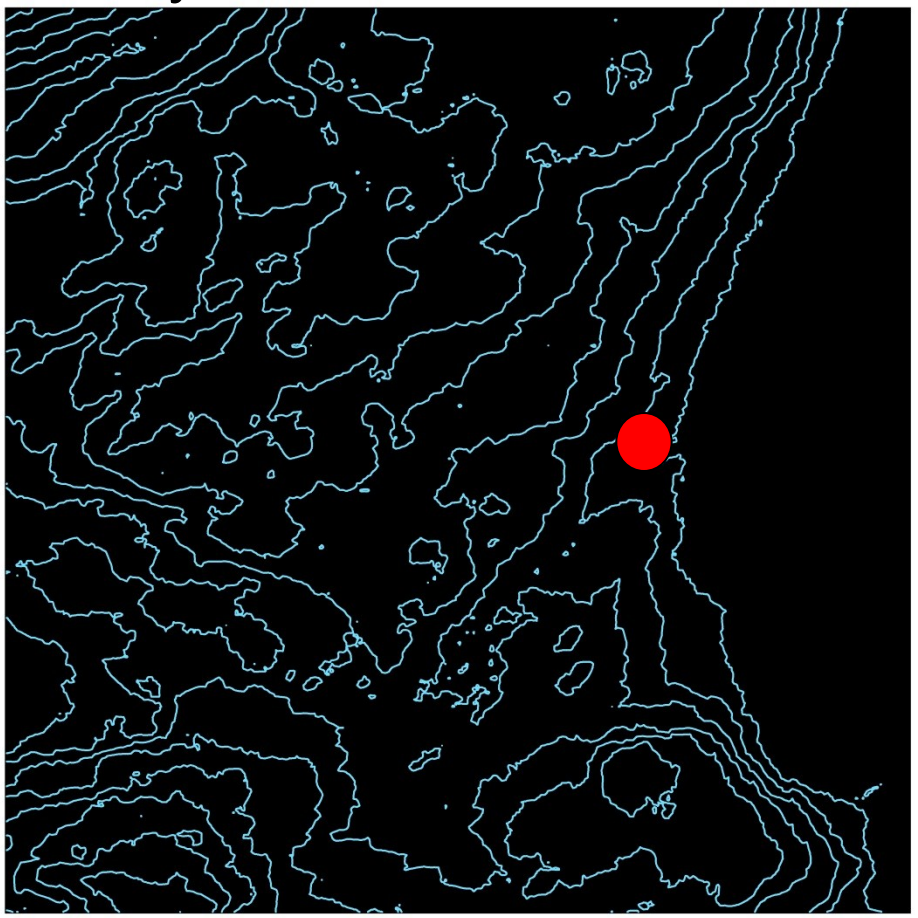
Temp min
(1372-3 AD)



Temp 1999-2000

Snow depth (m)

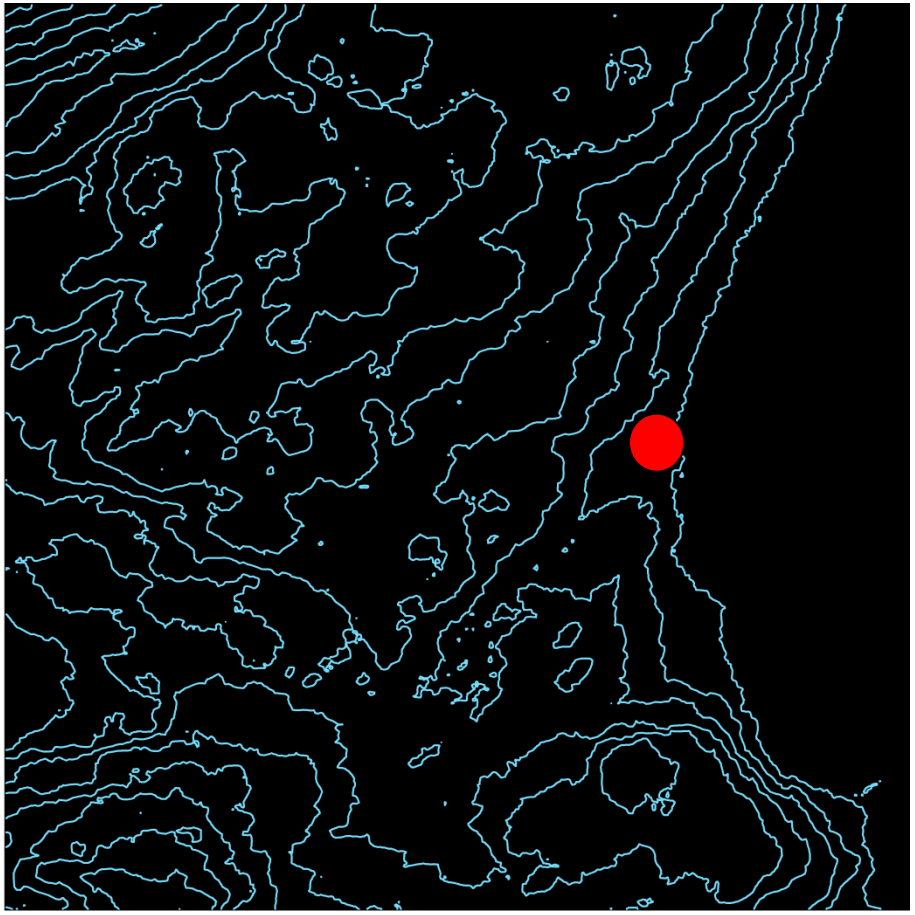
- 0
- 0 - 0.5
- 0.5 - 1
- 1.0 - 1.5
- 1.5 - max



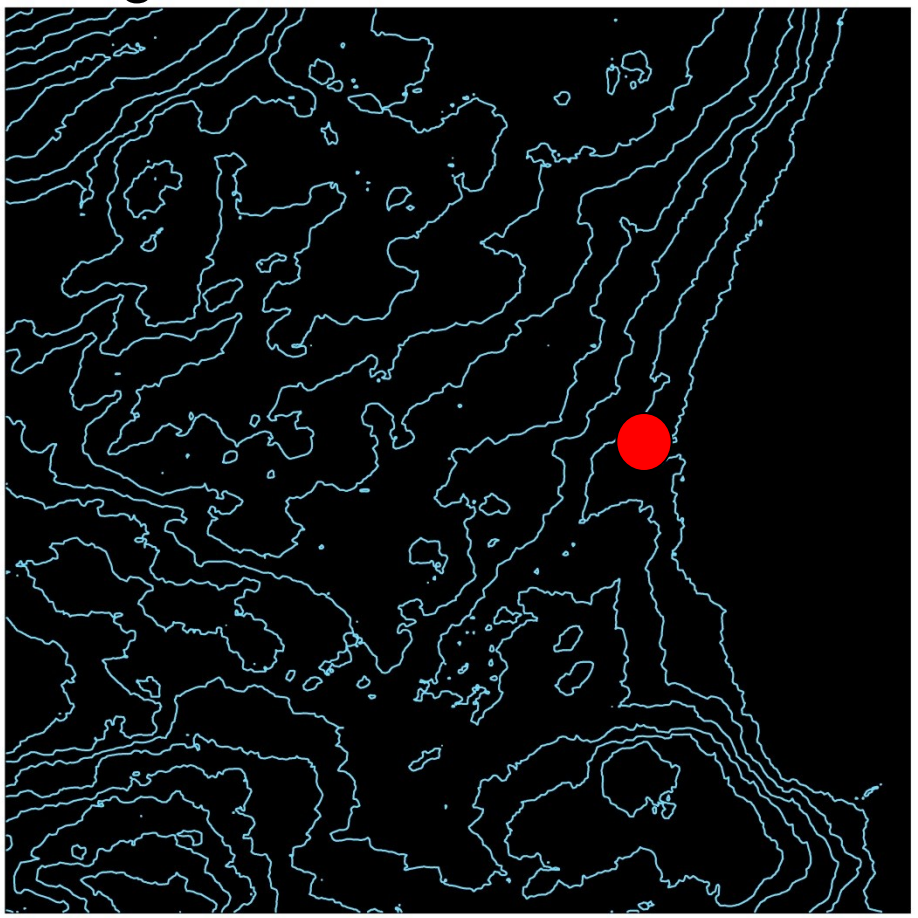
Temp max
(1101-2 AD)

Laura Comeau
PhD thesis

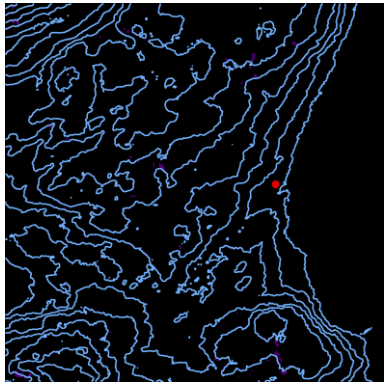
Brattahlið: August



Temp min
(1372-3 AD)



Temp max
(1101-2 AD)



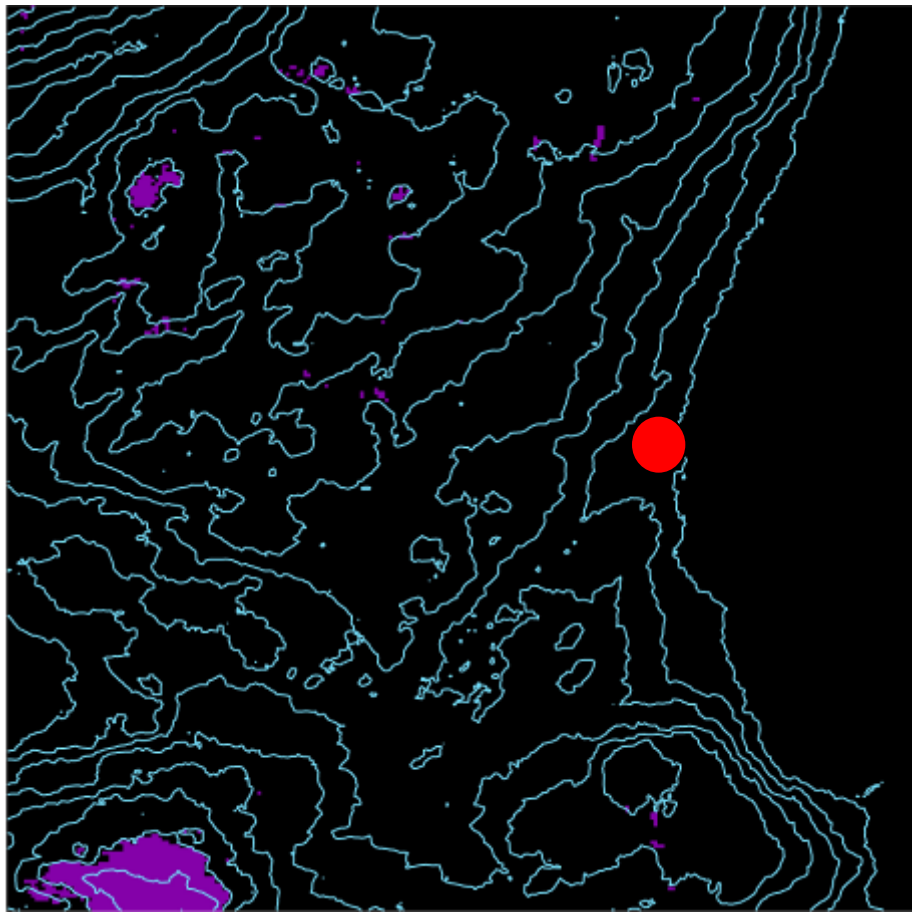
Temp 1999-2000

Snow depth (m)

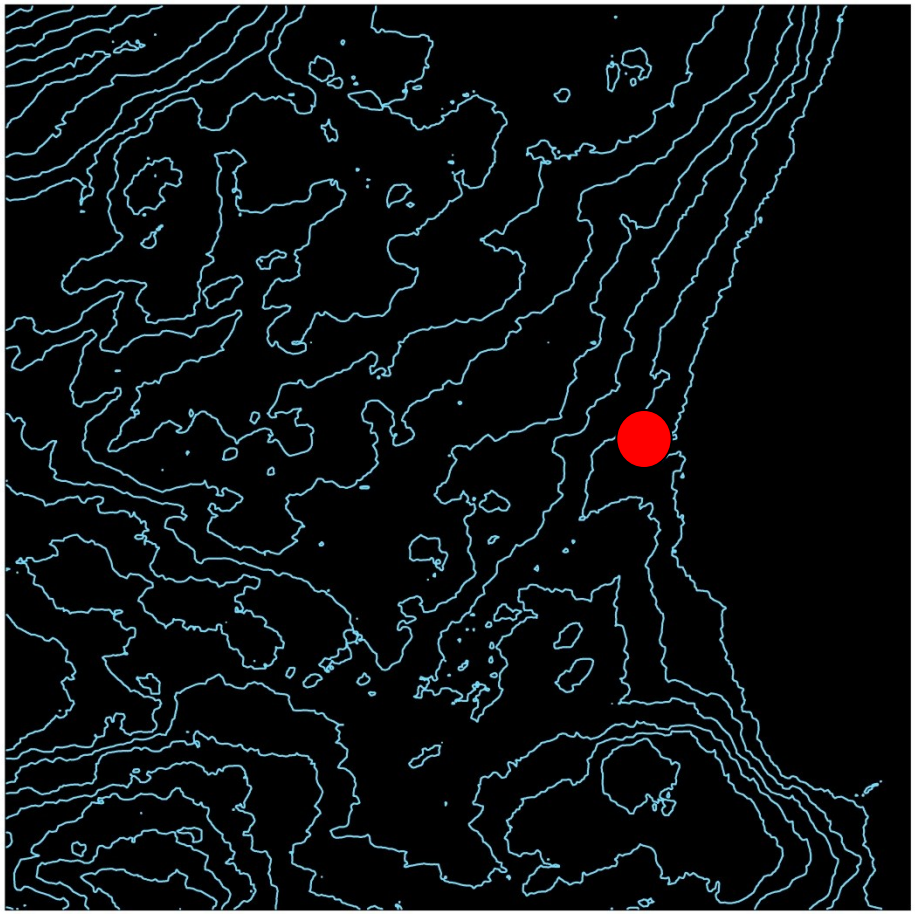
- 0
- 0 - 0.5
- 0.5 - 1
- 1.0 - 1.5
- 1.5 - max

Laura Comeau
PhD thesis

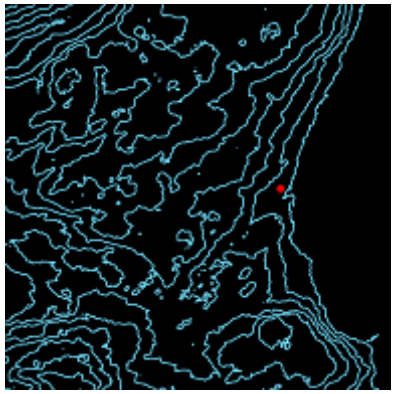
Brattahlið: September



Temp min
(1372-3 AD)



Temp max
(1101-2 AD)



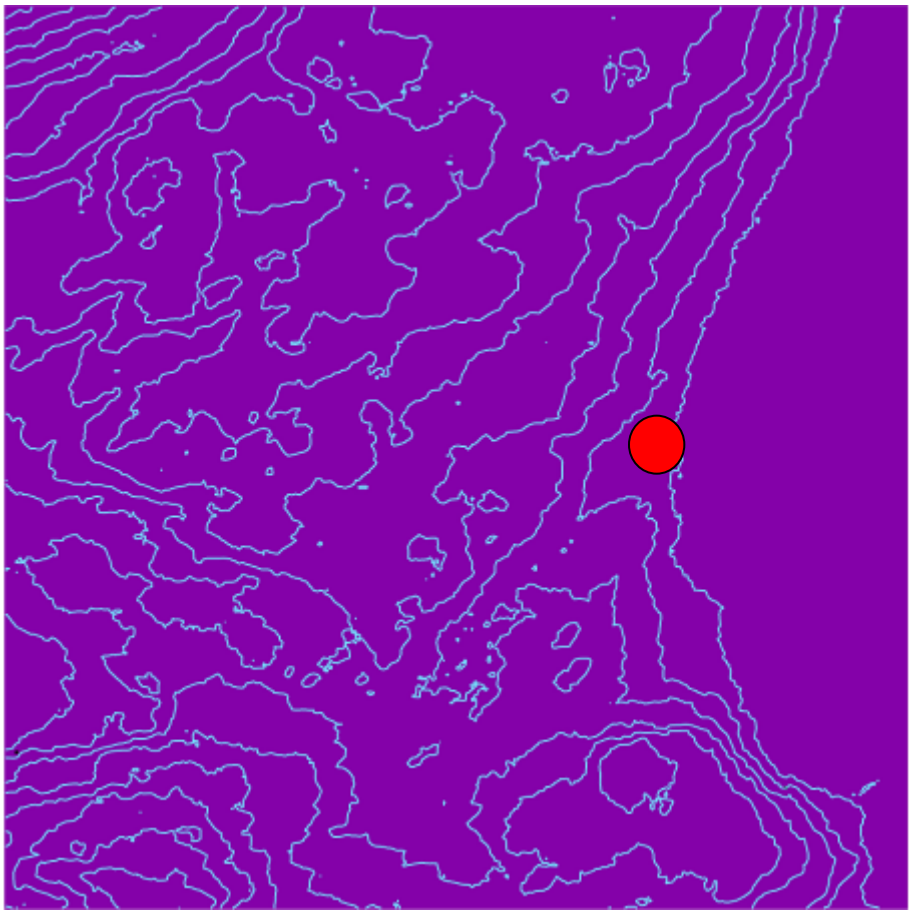
Temp 1999-2000

Snow depth (m)

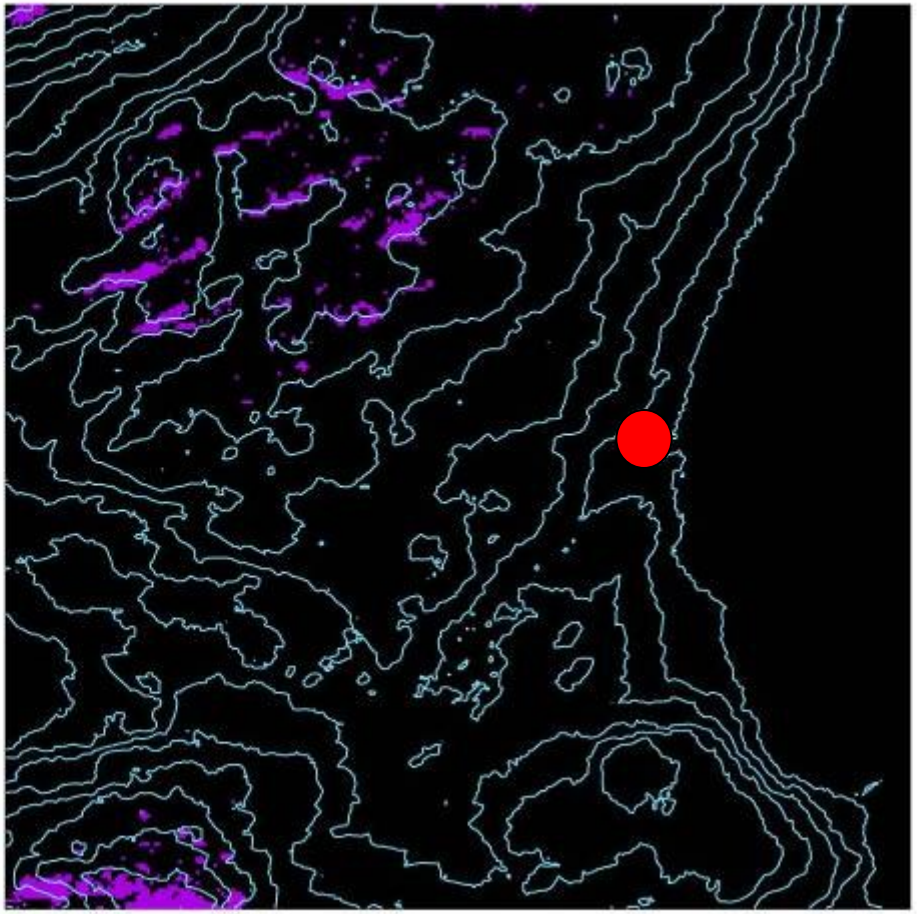
- 0
- 0 - 0.5
- 0.5 - 1
- 1.0 - 1.5
- 1.5 - max

Laura Comeau
PhD thesis

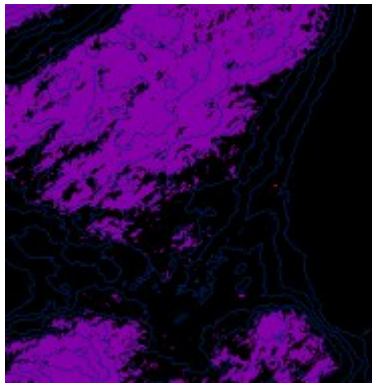
Brattahlið: October



Temp min
(1372-3 AD)



Temp max
(1101-2 AD)



Temp 1999-2000

Snow depth (m)

- 0
- 0 - 0.5
- 0.5 - 1
- 1.0 - 1.5
- 1.5 - max

Laura Comeau
PhD thesis

Type of Extreme Event	Extreme Period Began	Extreme Period Ended	Ranking of "ranks" (Lower score = stronger event)
Warm	1005	1014	5
Warm	1024	1029	11
Warm	1040	1044	8
Warm	1052	1059	3
Warm	1067	1101	1
Cool	1118	1127	8
Warm	1134	1150	2
Cool	1176	1181	7
Warm	1184	1190	7
Cool	1193	1199	10
Warm	1202	1217	9
Cool	1229	1239	6
Cool	1250	1262	1
Warm	1264	1274	4
Warm	1313	1325	6
Cool	1334	1355	4
Cool	1366	1376	5
Cool	1384	1390	9
Warm	1398	1401	12
Cool	1407	1428	1
Warm	1435	1442	10
Stormy	1451	1481	3
Cool	1456	1469	3
Cool	1475	1478	12
Cool	1488	1493	10
Stormy	1491	1504	5

12th century begins to see increased use of seals

13th century hazards of unprecedented severity

Rank = 1

14th century continuing hazards of great severity

Rank 4

Rank 5

15th century end game hazards and conjunctures

Rank = 1

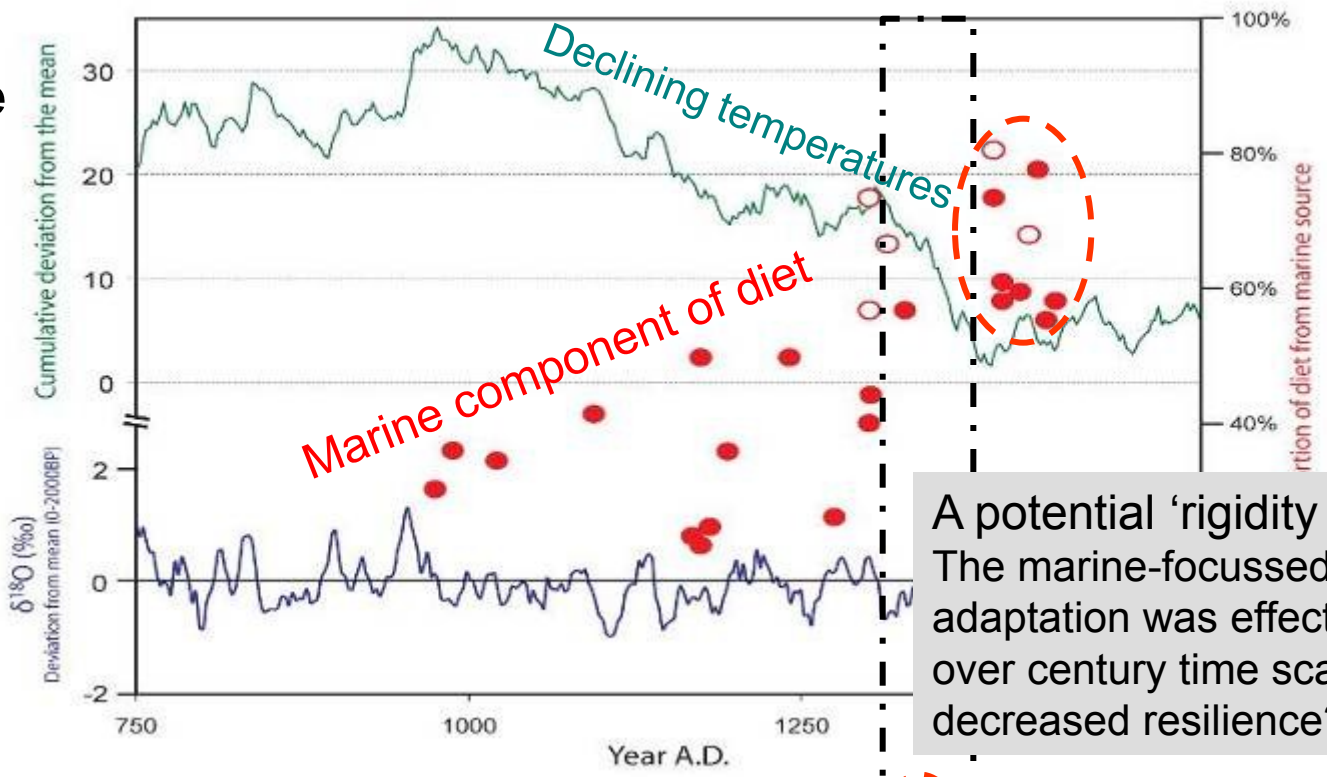
Overlap of storm and cold

Rank 3

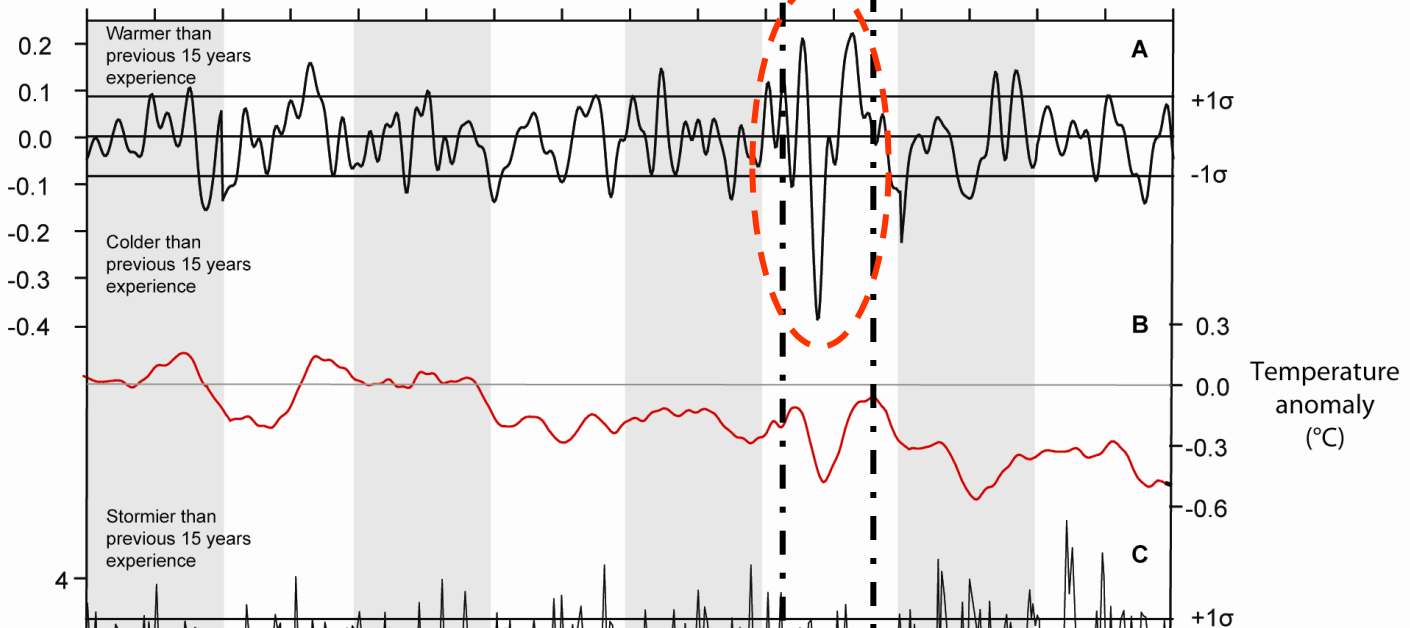
Behaviour in face of climate change

As cumulative temperatures decline, marine component of Norse diet increases (up to 80%)

Was the challenge of unpredictable, unfavourable environmental change 13th-14th centuries a spur to the intensification of marine mammal exploitation in Norse Greenland?

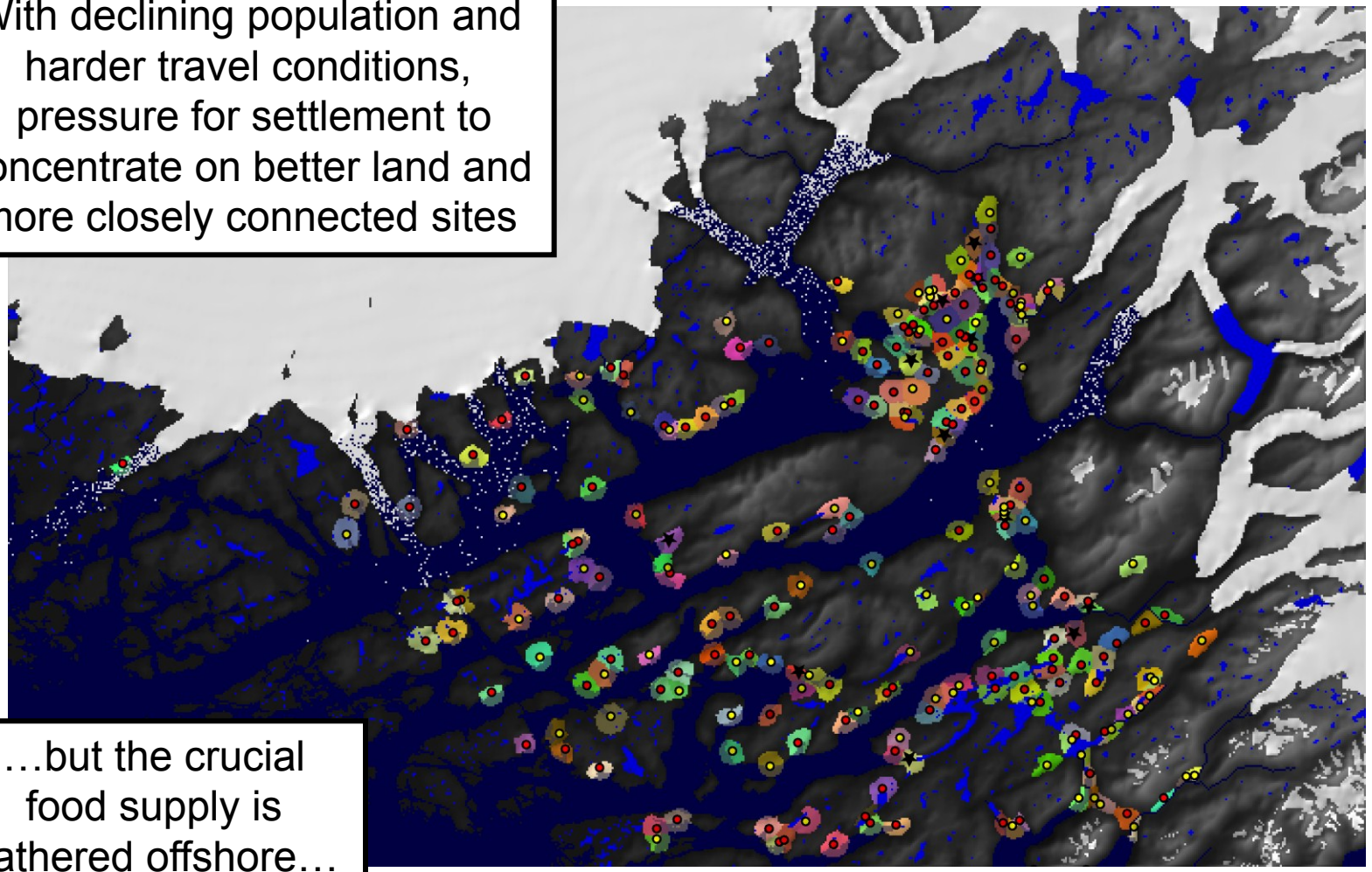


A potential 'rigidity trap'? The marine-focussed adaptation was effective over century time scales but decreased resilience?



Travel time and connectedness

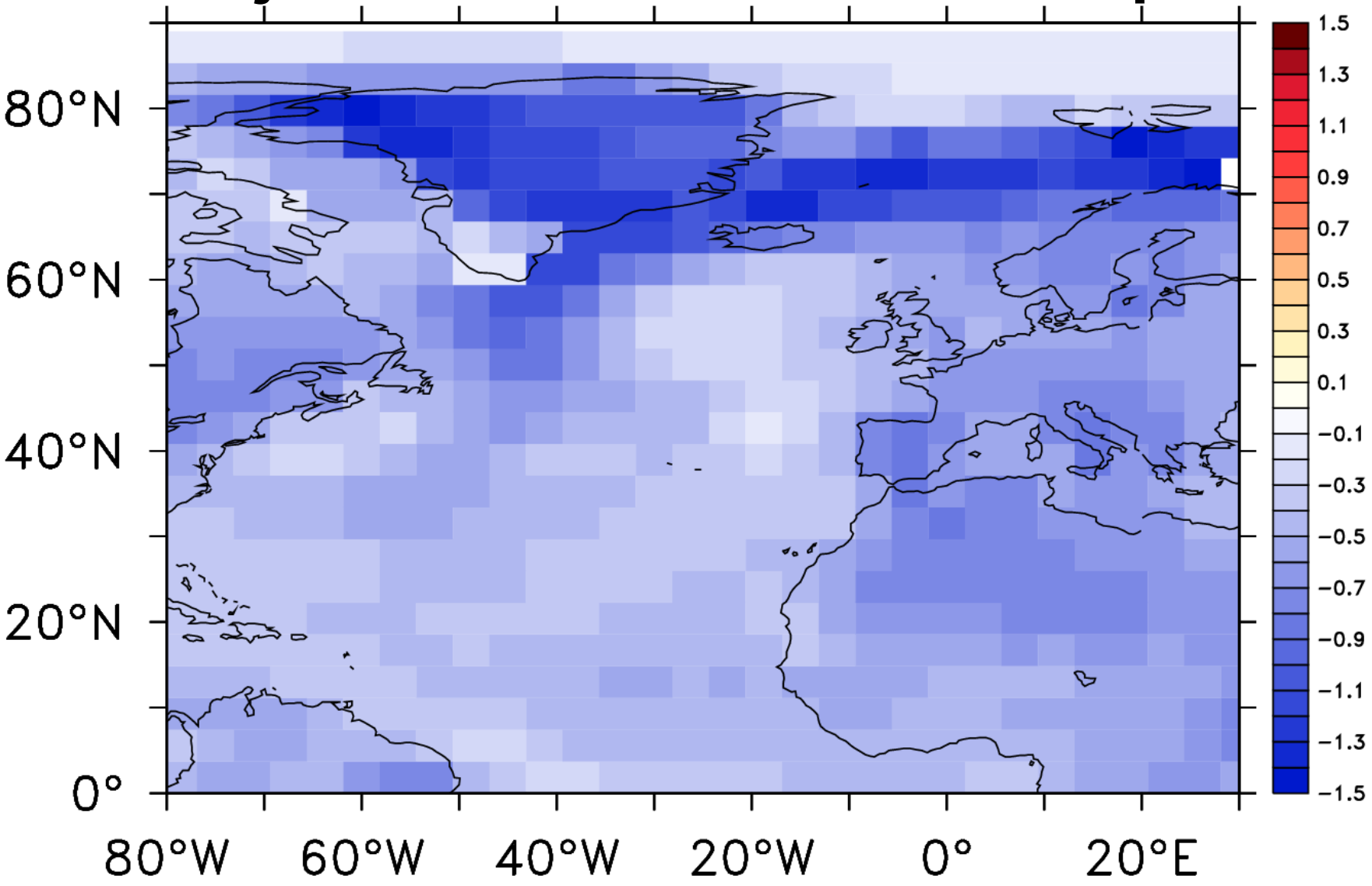
With declining population and harder travel conditions, pressure for settlement to concentrate on better land and more closely connected sites



…but the crucial food supply is gathered offshore…

- Inner fjord farm sites well connected.
- settlements in the outer fjords and skerries more isolated

1258 AD
A major low latitude volcanic eruption



Stimulus to intensify marine mammal utilisation

↓

On small farms herds and flocks fall below minimal replacement levels. Key role for magnate farms in maintaining the long term viability of farming system. **Consolidation of power; greater stratification of society**

↓

Increased conformity- limited base of TEK

↓

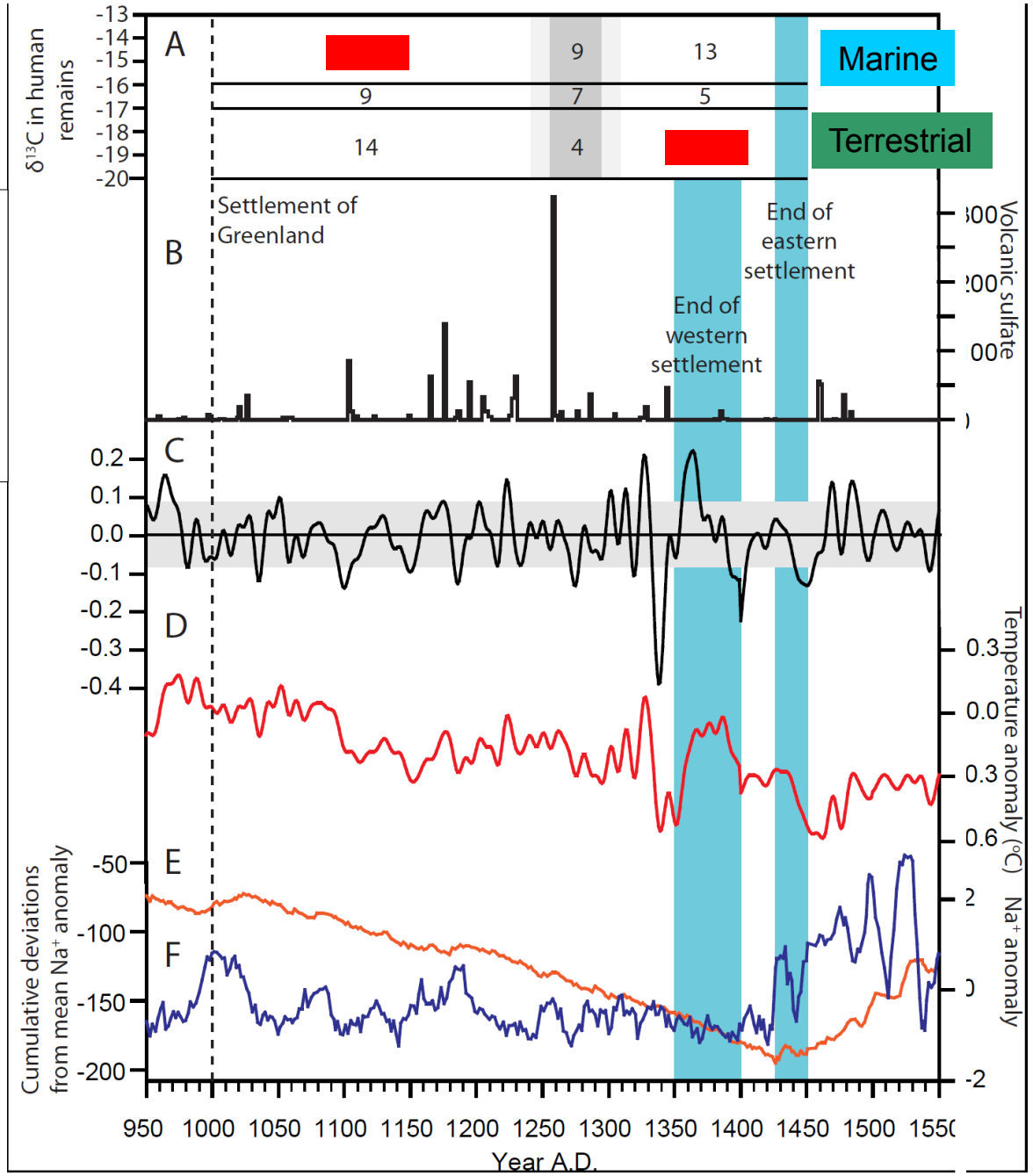
No evidence of *métis* community

↓

No adoption of Inuit winter hunting

↓

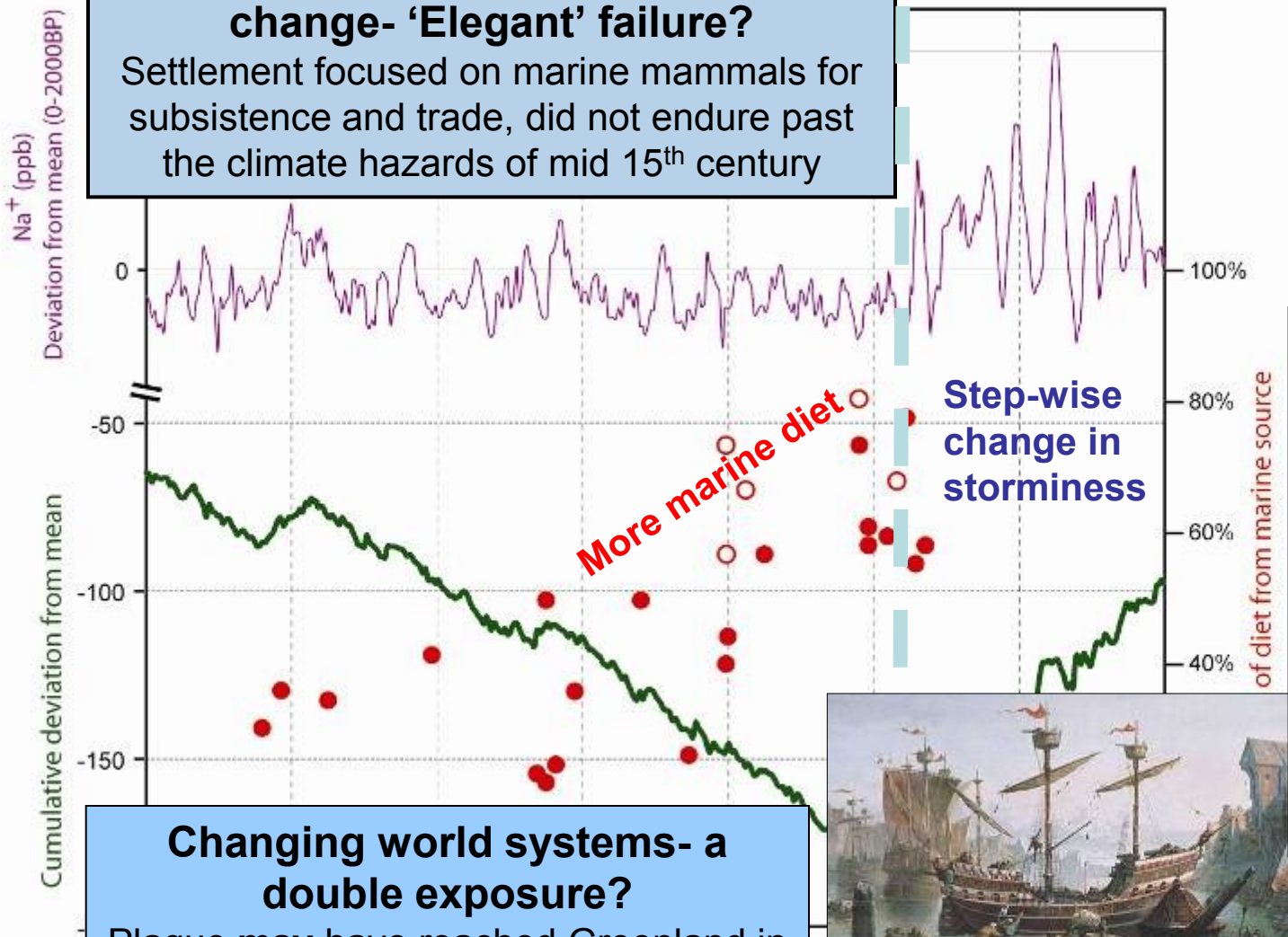
Conjunctures of 15th century end Norse settlement



Dugmore, A.J., Keller, C. and McGovern, T.H. 2007. 'The Norse Greenland settlement: Reflections on climate change, trade and the contrasting fates of human settlements in the Atlantic islands' *Arctic Anthropology* 44,1, 12-36

Exposure to step-wise climate change- 'Elegant' failure?

Settlement focused on marine mammals for subsistence and trade, did not endure past the climate hazards of mid 15th century



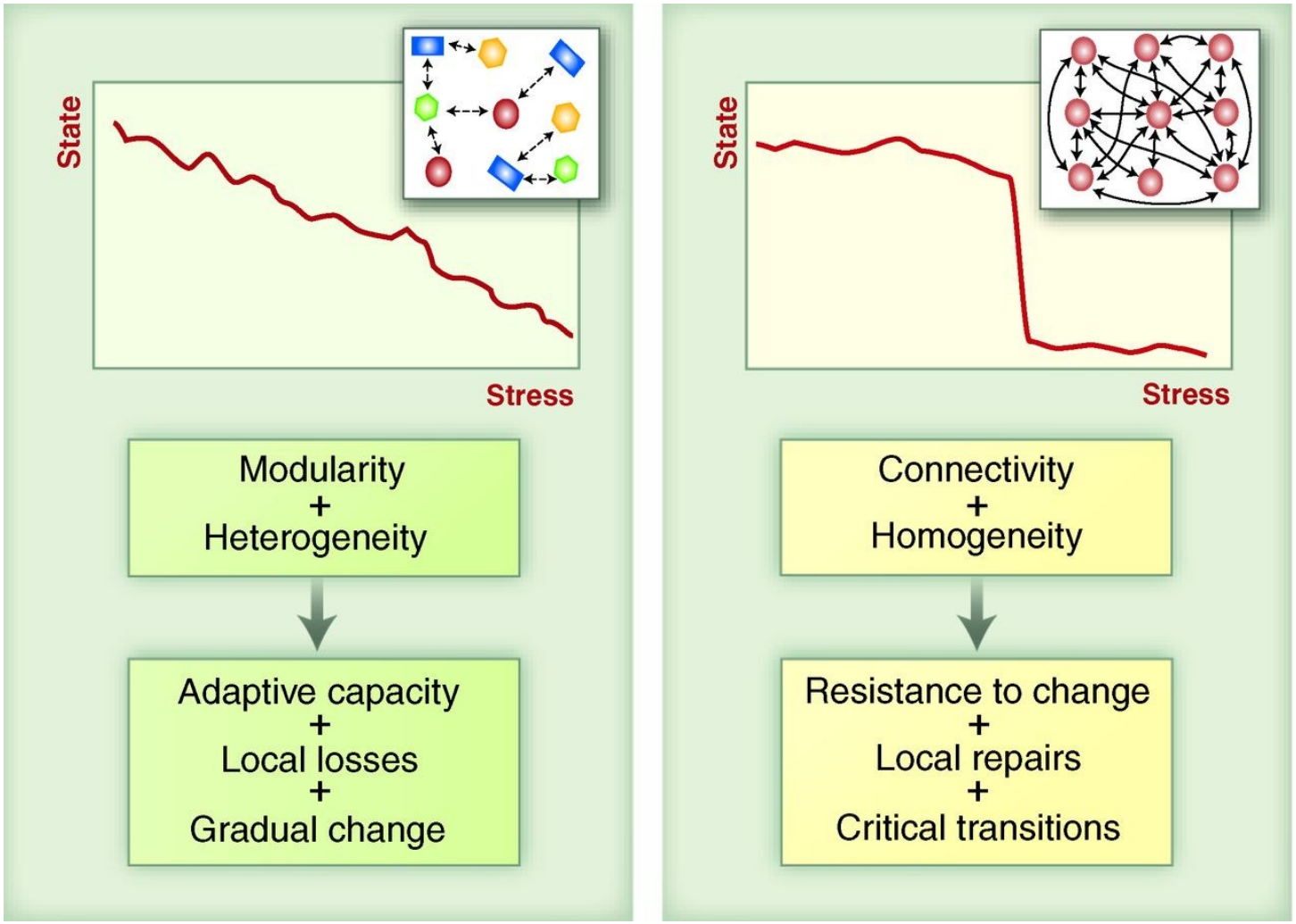
Triple exposure-culture contact?

Inuit; source of conflict, or source of trade goods (furs)?
No TEK transfer.

Changing world systems- a double exposure?

Plague **may** have reached Greenland in 15th century; it certainly caused the collapse of the Norwegian economy (market for ivory)…

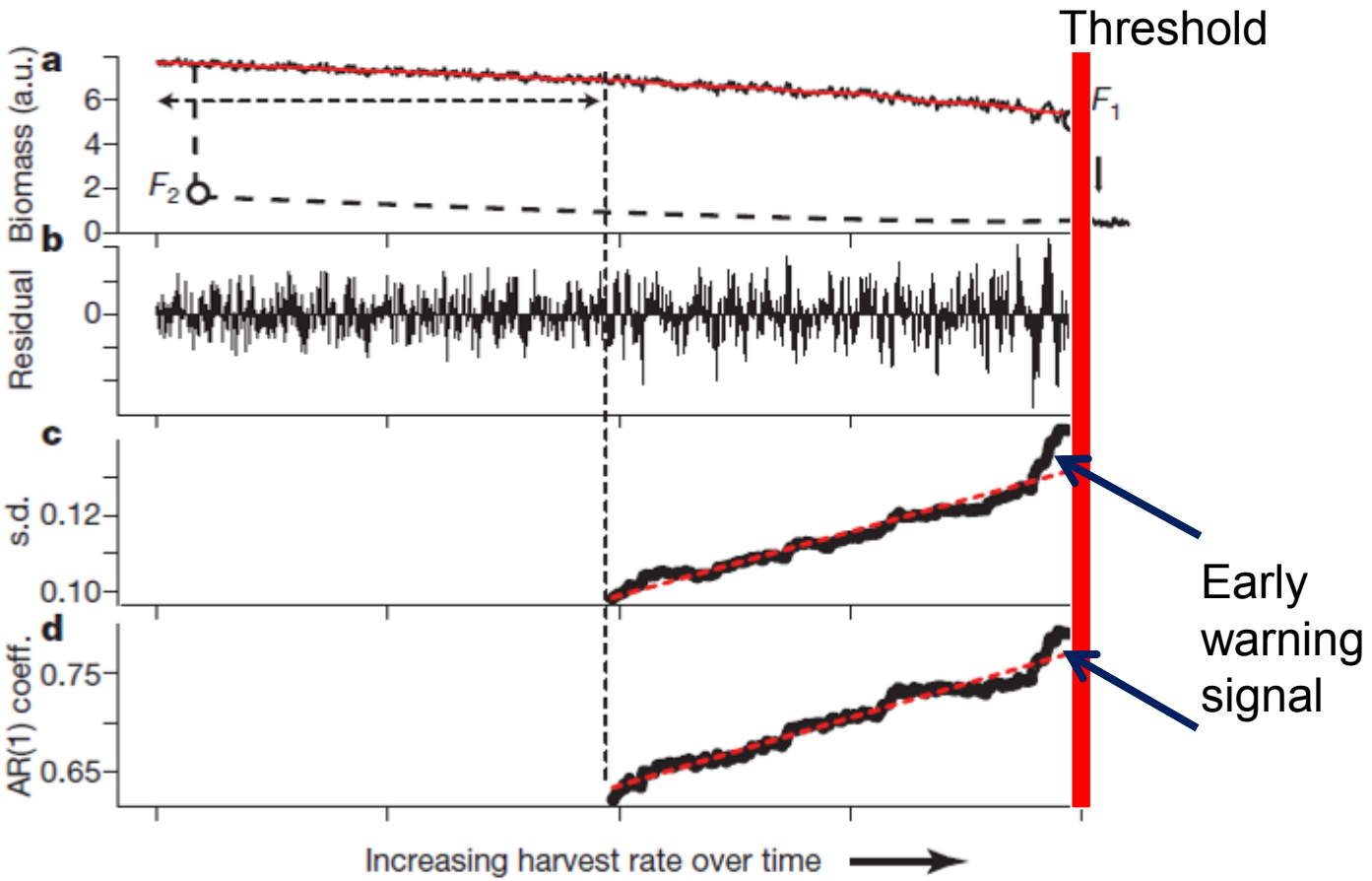
The connectivity and homogeneity of the units affect the way in which distributed systems with local alternative states respond to changing conditions.



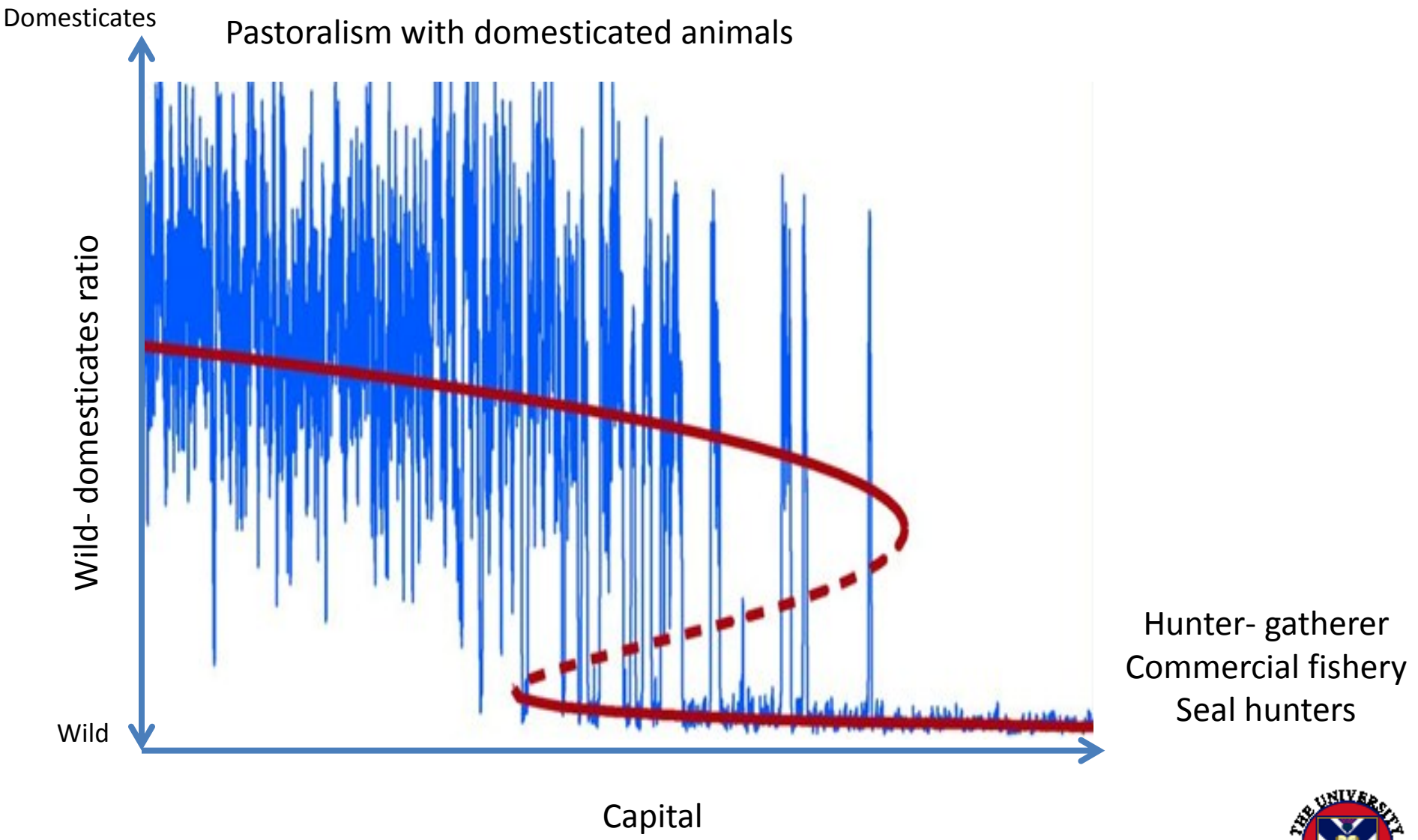
M Scheffer et al. Science 2012;338:344-348

Early warning signals

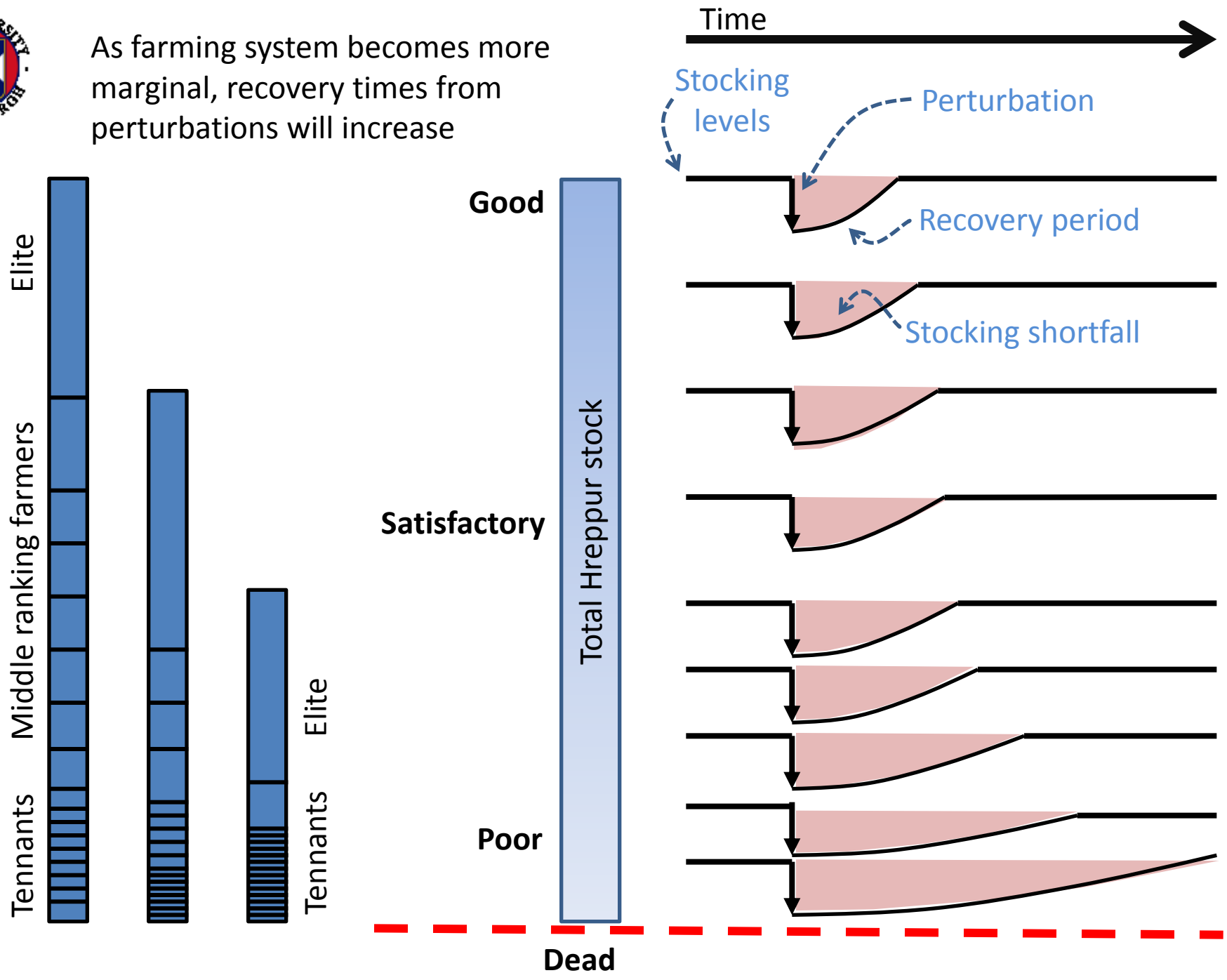
Critical slowing down can occur before an abrupt transition- the recovery time from a perturbation becomes longer (slower) variance and auto correlation will increase



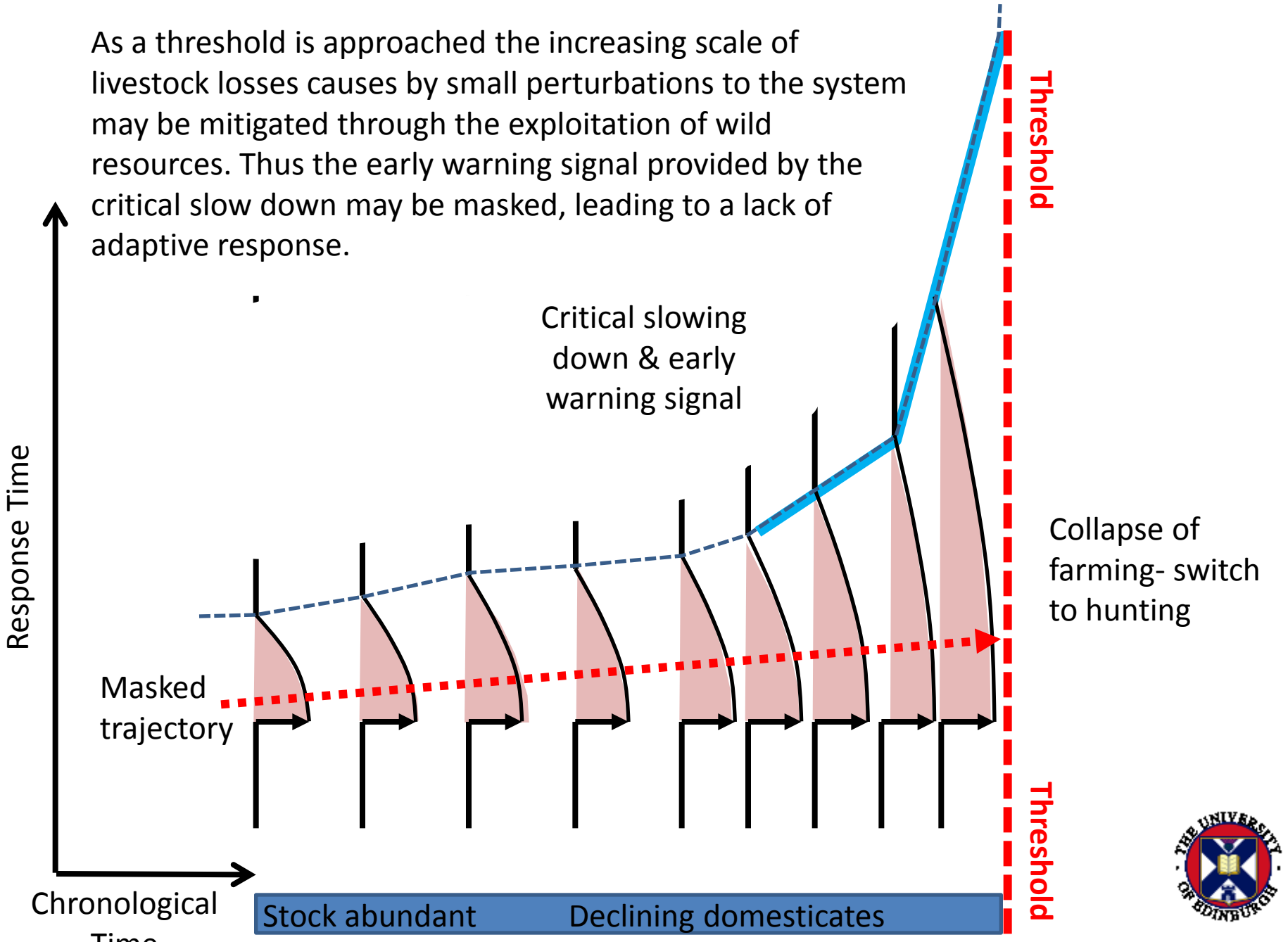
Scheffer M, et al., (2009) Early-warning signals for critical transitions *Nature* **461**, 53-59


Domesticates
Pastoralism with domesticated animals
Wild- domesticates ratio
Wild
Capital
Hunter- gatherer
Commercial fishery
Seal hunters

As farming system becomes more marginal, recovery times from perturbations will increase



As a threshold is approached the increasing scale of livestock losses causes by small perturbations to the system may be mitigated through the exploitation of wild resources. Thus the early warning signal provided by the critical slow down may be masked, leading to a lack of adaptive response.



Lessons from the Viking Atlantic

People can...

- creatively adapt to new environments
- build up centuries of community-based managerial expertise
- wisely conserve fragile resources for communal subsistence
- codify the results, establish laws and sound TEK
- maintain century-scale sustainable patterns of life and society
- develop ‘elegant solutions’ to environmental problems

- intensify social hierarchies and conformity
- limit the development of TEK
- fall into ‘rigidity traps’, discover the limits to adaptation
- ***and face collapse and extinction.***

Lessons from the Viking Atlantic

Specialization vs. resilience

- Coping strategies/adaptations may be too specialized to withstand unexpected variation
- 'Many voices' can lead to clumsy solutions: loss of voices (concentration of power) may lead to elegant failure

Terrestrial vs Marine

- Icelandic pastoralism proved more resilient that Greenlandic seal hunting but at a cost of landscape degradation

Prestige trade vs bulk commodities

- Distant markets for prestige goods (ivory and fur from Greenland) did not endure
- Distant markets for bulk commodities (wool and fish from Iceland) flourished

Lessons from the Viking Atlantic

Scales and cross-scale interactions

- Distances matter; the utilization of dispersed resources carries cost, especially when settlement is fixed. Dispersed systems are vulnerable to increased travel cost

- A system reliant on distant sources of trade goods and distant markets is vulnerable to disruption (of trade routes, of markets)

Societal 'Collapse' in a North Atlantic context: the utility of 'completed experiments'

- The past offers 'completed experiments' of human society
- We can explore the probable effect of choices and values on outcomes
- We can create qualitative models based on rules and narratives
- Qualitative models can help us to understand complex systems and their outcomes- using the past to inform ideas of future change

Related papers

- **Dugmore AJ, McGovern TH, Vésteinsson O, Arneborg J, Streeter R, Keller C (2012) 'Cultural Adaptation, Compounding Vulnerabilities and Conjunctures in Norse Greenland'. *Proceedings of the National Academy of Sciences* 109 (10) 3658-3663.**
- Dugmore AJ, Vésteinsson O (2012) 'Black sun, high flame and flood; volcanic hazards in Iceland'. *In:* Cooper J, Sheets P (Eds) *Surviving Sudden Environmental Change: Answers from Archaeology (*Boulder: University Press of Colorado) 67 - 90.
- **Streeter R, Dugmore AJ, Vésteinsson, O. (2012) Plague and landscape resilience in pre-Modern Iceland. *Proceedings of the National Academy of Sciences* 109 (10): 3664-3669.**
- Dugmore AJ, Streeter R, Keller C, McGovern TH, Smiarowski K, Masden, CK Perdikaris S (2012) 'Elegant failures' and 'clumsy solutions' to climate change adaptation: new lessons in human security from the settlement of the North Atlantic islands'. *In* O'Brien K, Wolf J. Sygna L. (eds) *The Changing Environment for Human Security: New Agendas for Research, Policy, and Action. (*Earthscan Publications: London) (in press for 2012)

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