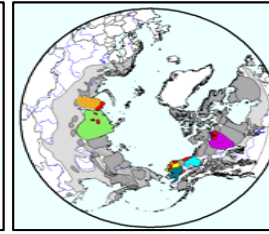
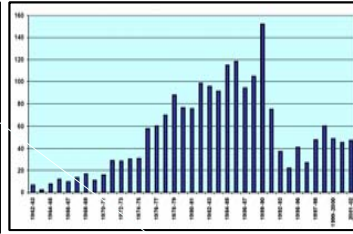


Heterogeneity and Resilience of Human-Rangifer Systems: A Circumpolar Social-Ecological Synthesis



- **Gary Kofinas, UAF**
- **Matt Berman, UAA**
- **Brad Griffith, UAF**

- **Gennady Belchanski, Russian Academy of Sci.**
- **David Douglas, USGS**
- **Bruce Forbes, Arctic Centre**
- **Konstantin Klokov, St Petersburg State Univ.**
- **Leonid Kolpashikov, N. Agri. Research Institute**
- **Stephanie Martin, UAA**
- **Craig Nicolson, U MA**
- **Don Russell, Environment Canada**

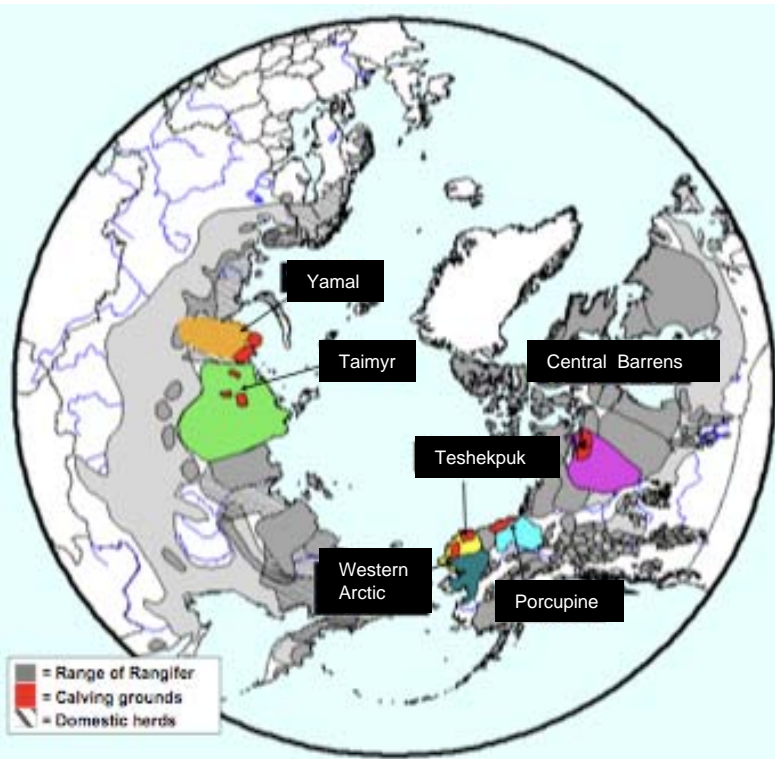
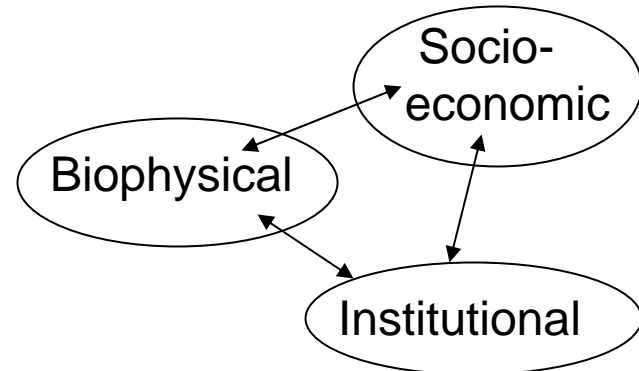
- **Colin West, UAA post doc; Tracey Smith, UAF grad student; Joe Kluberton, UAF grad student; Karen Hibbard-Rode, UAF grad student; John Eric Humphries U Chicago / UAA intern**

Approach to Synthesis

Overarching Question:

What is the relative resilience of Human-Rangifer Systems to forces of global change?

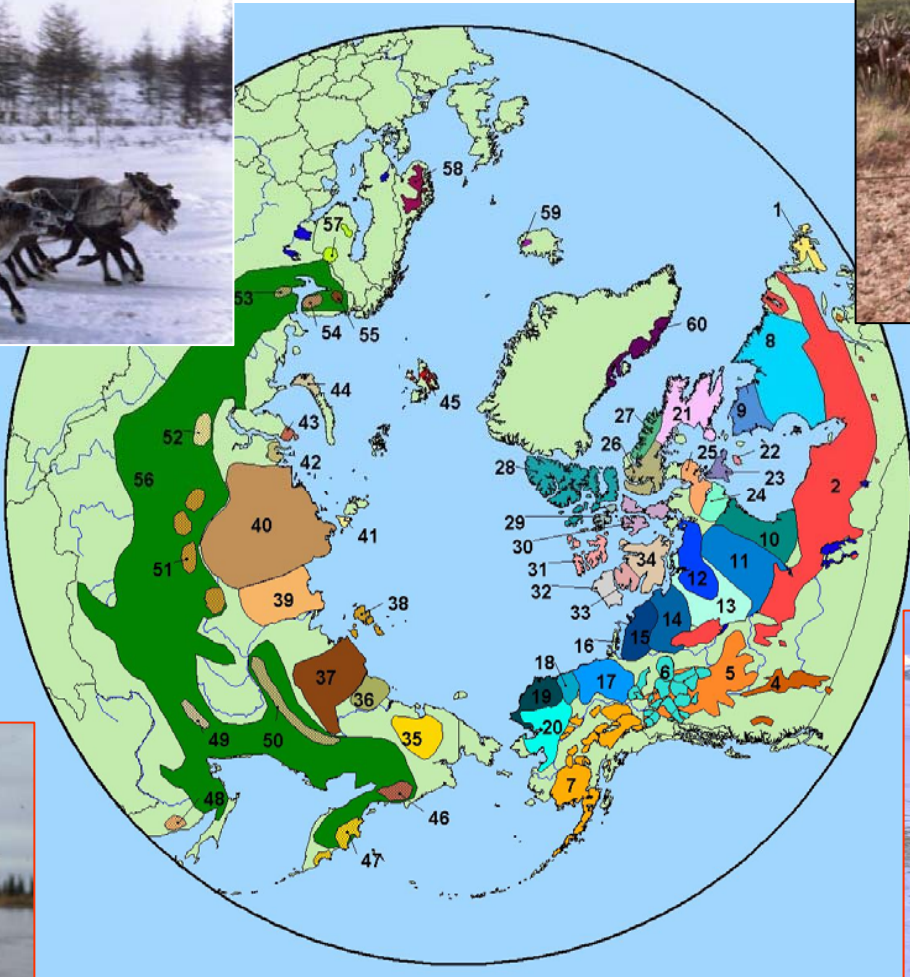
Components and linkages



Methods: Circum-Arctic & Regional Scales

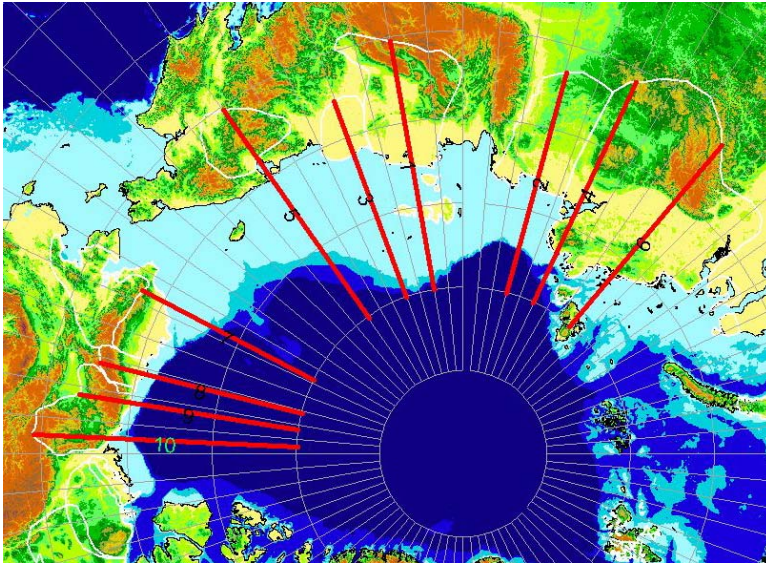
- 1) Retrospective and comparative analyses
 - understand driving factors and internal processes;
 - understand heterogeneity and its implications to resilience;
- 2) Develop social-ecological models for exploring system dynamics.

Use social-ecological complexity to our advantage



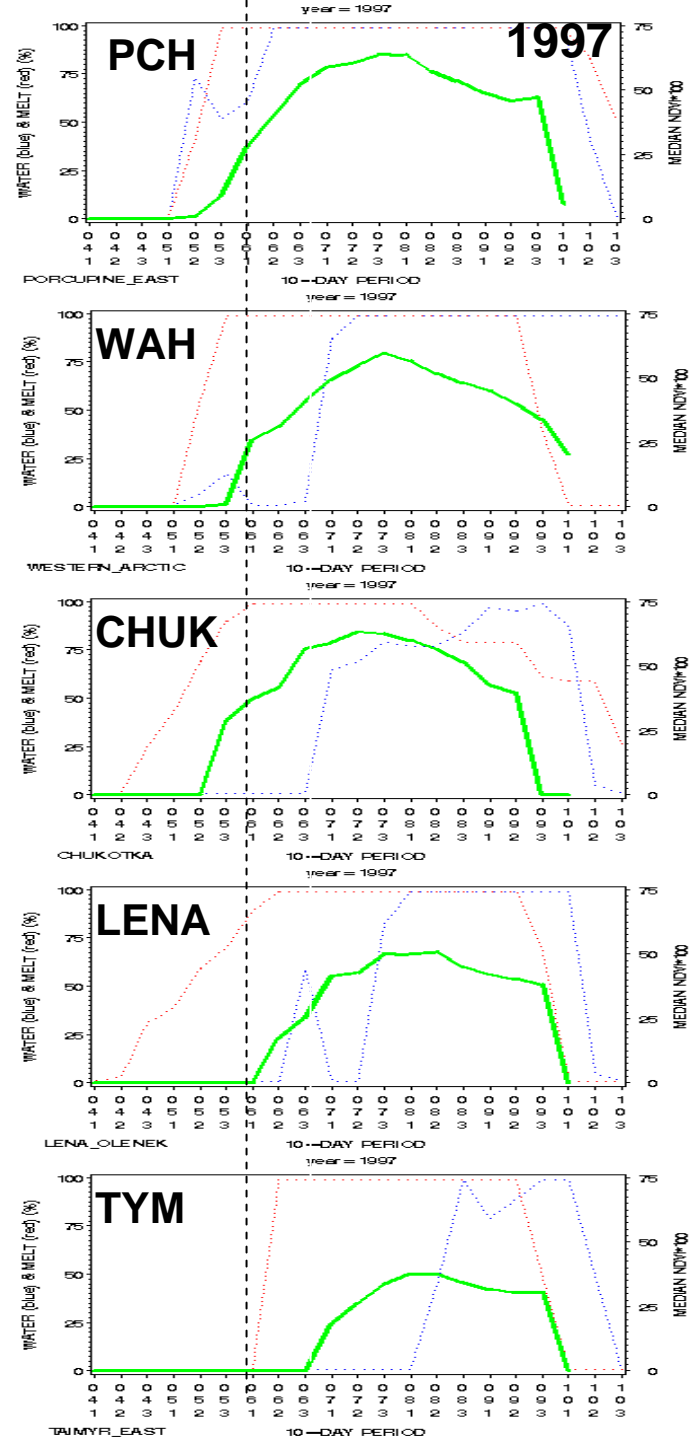
NDVI transects from sea to calving grounds

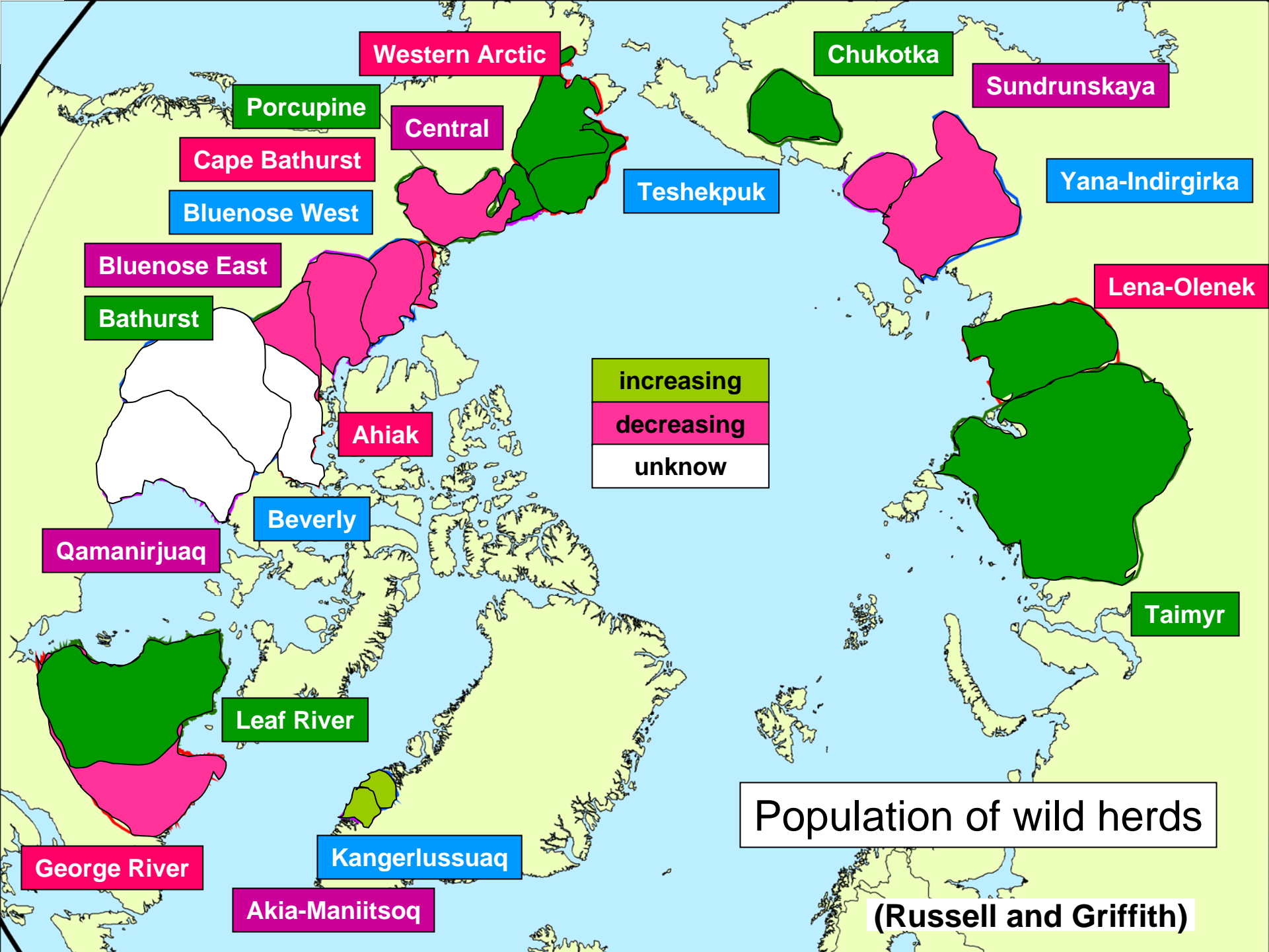
(Griffith and Douglas)



We build on Griffith's research on the positive relationship between NDVI onset and reproductive performance of caribou. Onset of green-up and beginning of senescence are critical to caribou, not NDVI peak or biomass. Greatest variation in NDVI was for green-up initiation which ranged from the third week of April to the second week of July on an annual basis among all herds. There was substantial inter-annual variation within herd ranges and suggestion of decadal differences among herd ranges. Among years, NDVI metrics tended to respond independently among herds. However, Western Russian herd ranges tended to green-up approximately 10-20 days later than N. American herds.

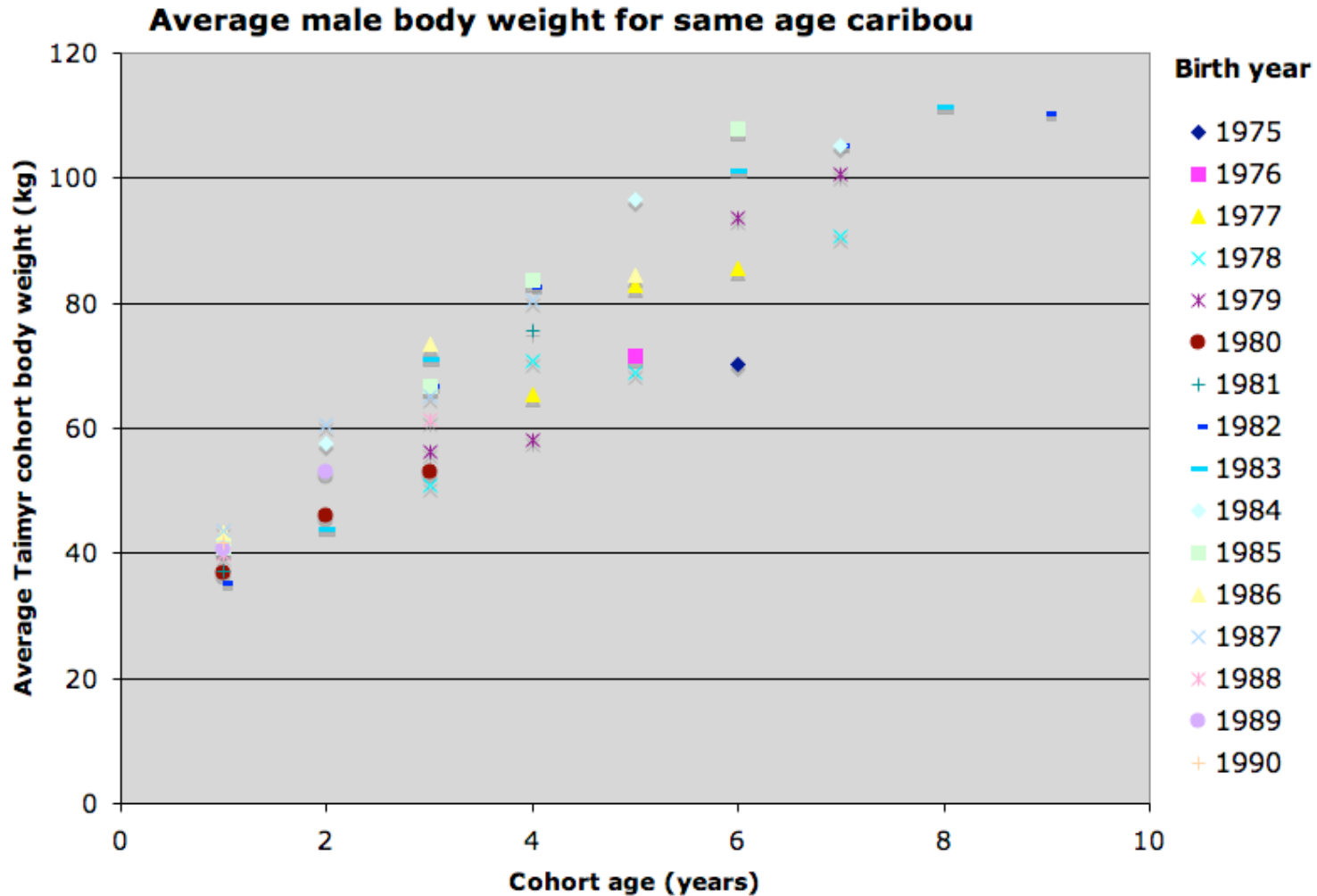
Later green-up and shorter growing seasons likely depress population growth. Relationships among seaward and landward portions of the transects will be investigated during the next year.





Taimyr body size analysis

Record mining to create
dataset of 2968
records

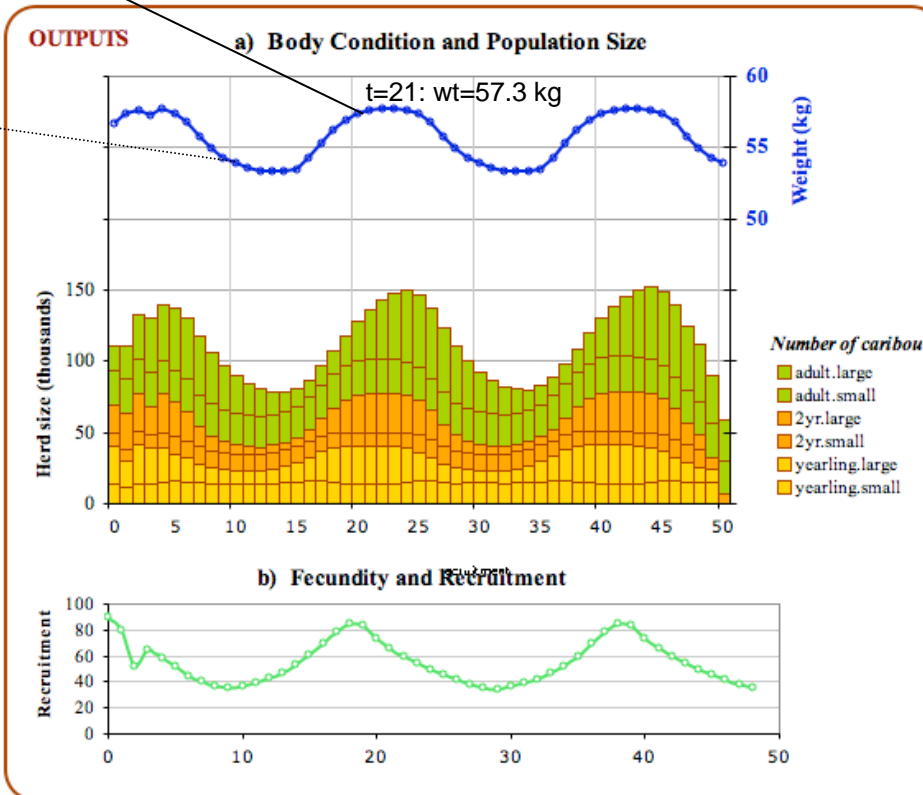
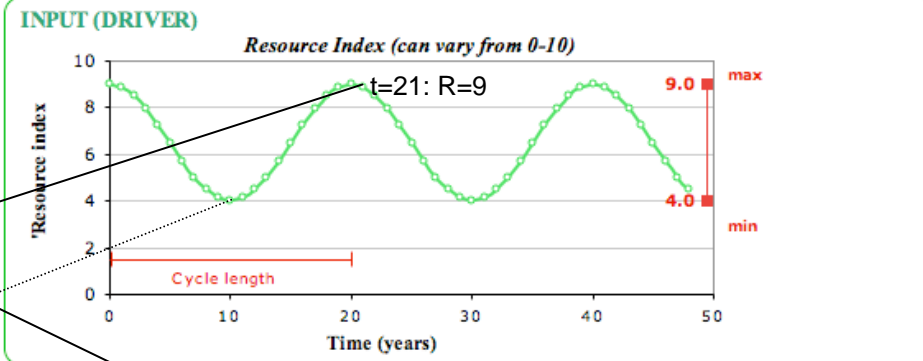
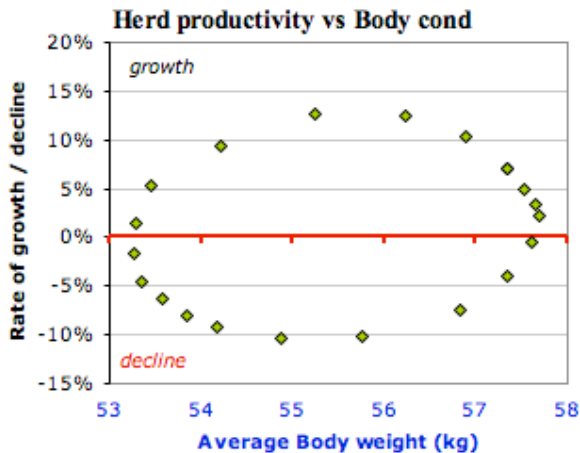
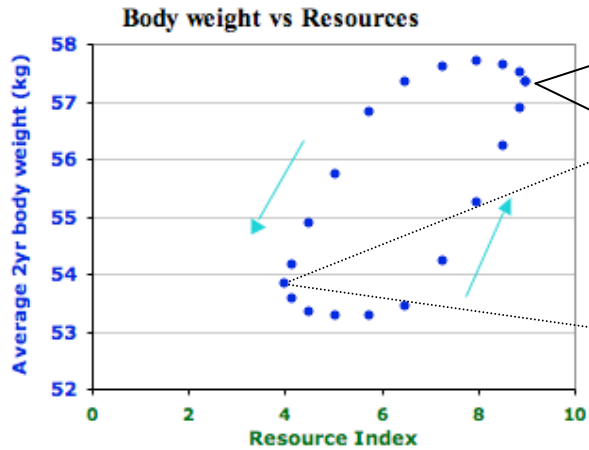


(Russell)

Frame-size cycling model output

(Nicolson, Russell, White,)

'Phase space' diagrams



Rangifer as Commodity/Rangifer Markets

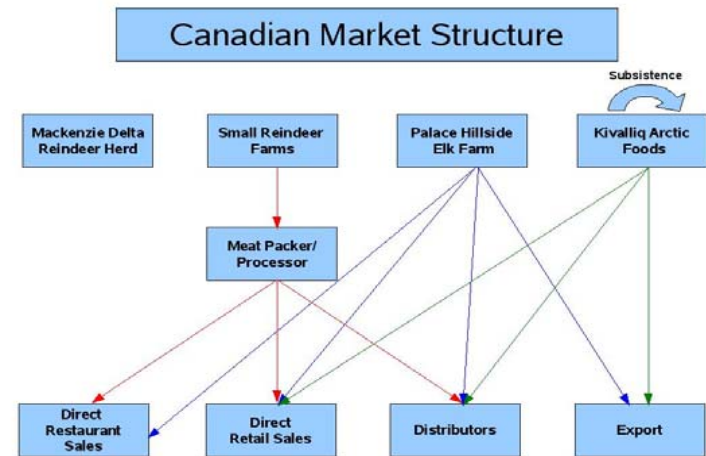
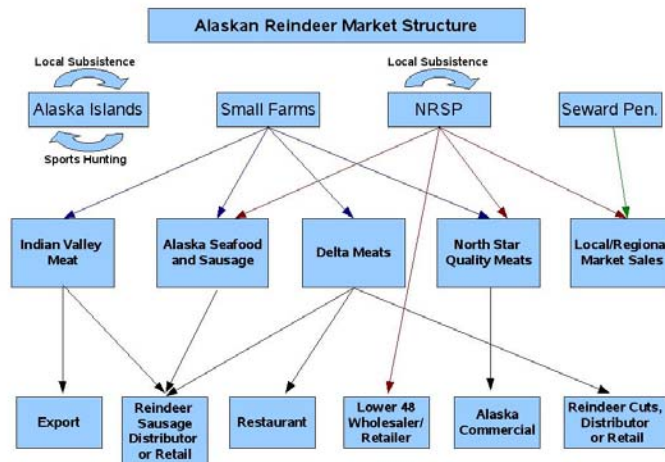
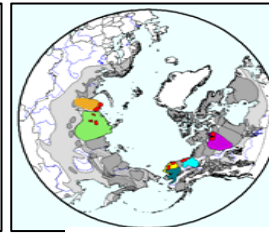
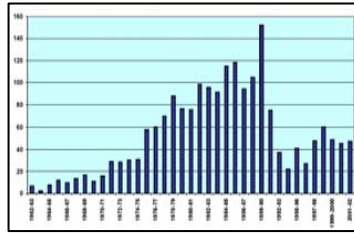
(Humphries and Berman)

Herding types:

- Large herds
- Ranching
- Tight husbandry

Commercial Meat Hunting:

- Government controlled
- Unregulated hunting



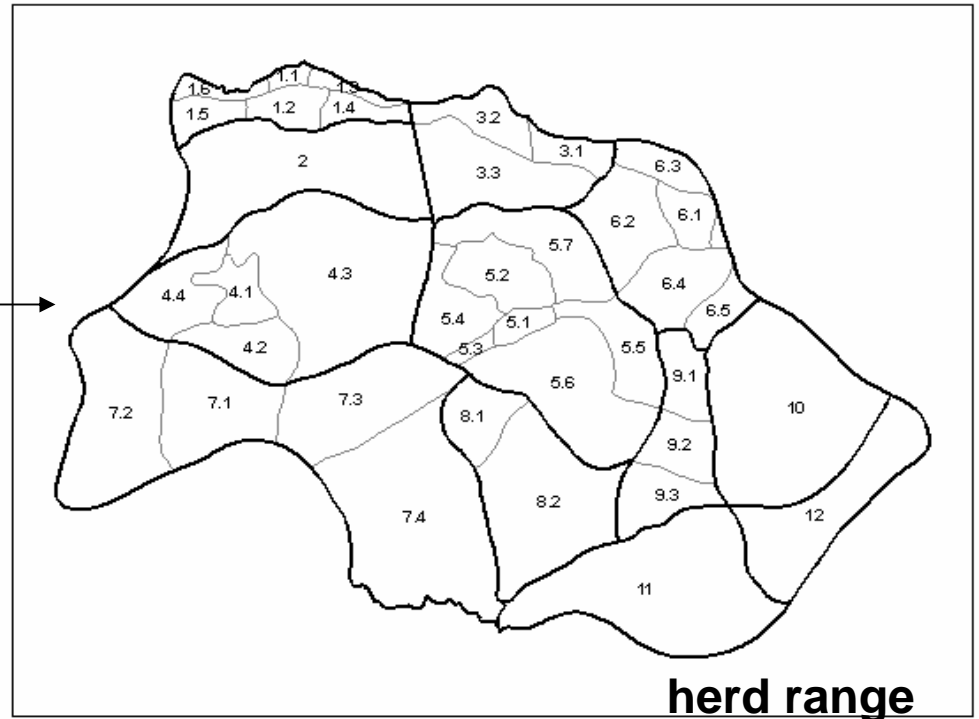
Pre- and Post-Perestroika Social-Ecological Transformations

RESILIENCE		Status	in	1960-1970			Trends			Present			status	
		Dom.R No	Wild R No	Pas tures	Reindeer Economy	Dom.R No	Wild R No	Pastures	Reindeer Economy	Dom.R No	Wild R No	Pas tures	Reindeer Economy	
Yamal	Nenets (tundra)	H	L	O	Hd Co	↑	≡	↓	≡		H	L	O	Hd Co
	Forest Nenets	M	L	U	Hd Co+Ht Sb	≡	≡	↓	≡		M	M	U	Hd Co+Ht Sb
	Khants	M	L	U	Hd Co	↓	≡	↑	≡		L	L	U	Hd Sb
	Selkups	M	L	U	Hd Co	×	↑	≡	Hd →Ht	Co →Sb	A	L	U	Ht Sb
Taimyr	Nenets	H	M	N	Hd Co	≡	↑	≡?	Hd → Hd +Ht		H	M	?	Hd Co+Ht Sb
	Evenks	M	L	N	Hd Co	↓	≡	↓	≡	Co →Sb	L	L	?	Hd Sb
	Nganassan	H	H	N	Hd Co+Ht Sb	×	↑↑	↓	Hd →Ht	(Co →Sb)	A	H	?	Ht Co (Sb)
	Dolgans	M	H	U	Hd Co+Ht Sb	↓	↑↑	↓	Hd → Hd +Ht	Co →Sb	L	H	?	Ht Co+Hd Sb
N. Evenkia	Evenks	M	M	U	Hd Co	×	↑↑	?	Hd →Ht	Co →Sb	M	H	?	Ht Sb
	Yakuts	M	M	U	Hd Co	↓	↑↑	?	Hd → Hd +Ht	Co →Sb	M	M	?	Hd Sb+Ht Sb
Yakutia	North-West	H	L	N	Hd Co	↓	↑	?	Hd → Hd +Ht	Co →Sb	L	M	N?	Hd Sb+ Ht Sb
	North-East	H	L	N	Hd Co	↓	↑	↑	Hd → Hd +Ht	Co →Sb	L	M	N?	Hd Sb +Ht Sb
	South	M	L	U	Hd Co	↓	≡	≡	Hd → Hd +Ht	Co →Sb	L	L	U	Hd Sb+Ht Sb
Chukotka	North	H	L	O	Hd Co	↓	↑	↑	Hd → Hd +Ht	Co →Sb	L	M	U	Hd Co
	North-East	H	A	O	Hd Co	↓		↑	≡	Co →Sb	L	A	U	Hd Co
	Centre	H	L	O	Hd Co	↓	↑↑	↑	Hd → Hd +Ht	Co →Sb	M	H?	?	Hd Co
	West	M	L	N	Hd Co	×	↑	↑	Hd →Ht	Co →Sb	A	M?	U	Hd Co
	South	H	L	N	Hd Co	↓	↑	↑	Hd → Hd +Ht	Co →Sb	L	L?	U	Hd Co
	South-East	H	A	O	Hd Co	×		↑	×		A	A	U	Hd Co

(Klokov)

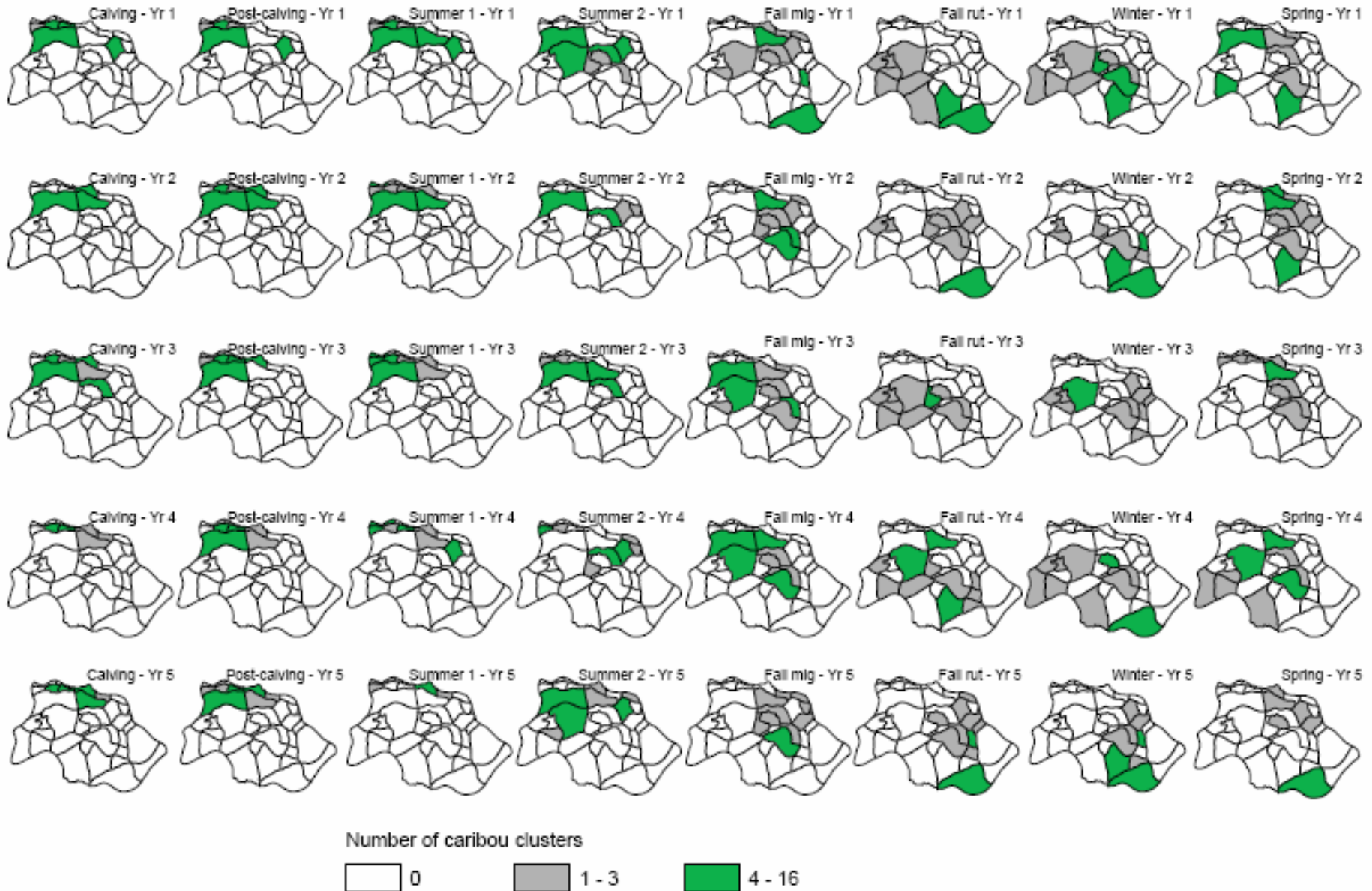
Simulation Modeling Caribou Availability

- Zones and sub-zones
- Based on empirical data and expert knowledge of hunters and biologists
- Availability a function of
 - Caribou distribution and
 - Hunter access



(Nicolson, West, Berman, et al)

Caribou Clusters by Season and Hunting Sub-zone



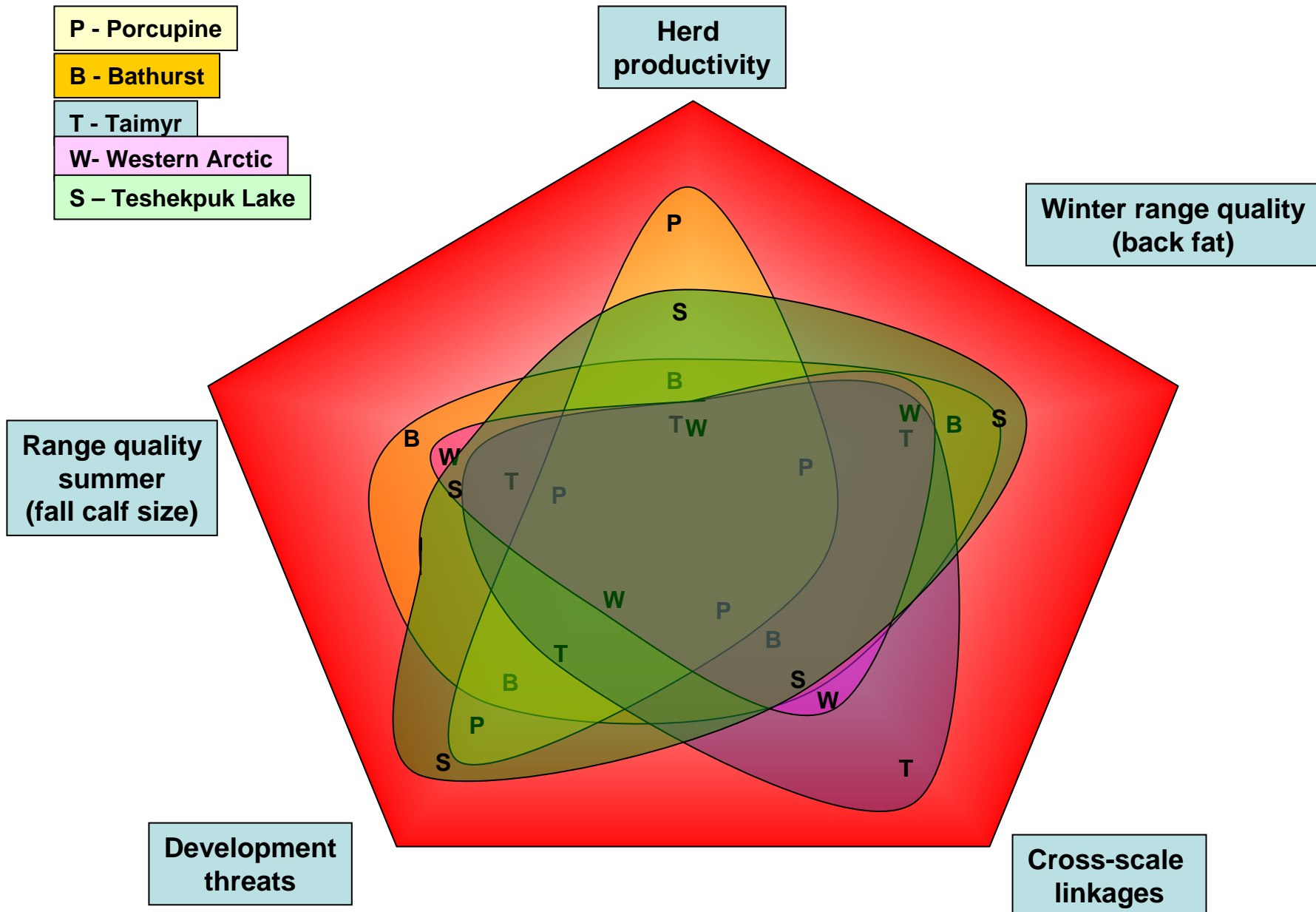
(Nicolson, West, Berman, et al)

North American cross-scale governance & habitat management

<i>Herd</i>	<i>Regime</i>	<i>type of activity/threat level</i>	<i>Capacity of regime to assess development</i>
Western Arctic Herd	Multi stakeholder working group	Coal reserves on calving grounds ; distant future	Limited: high dependence on NGOs and agencies
Teshekpuk Herd	Home rule with agency jurisdiction	Oil leasing on calving grounds ; immediate	Limited; overwhelmed with OCS and near shore activities
Porcupine Herd	International and Canadian co-management	Proposed leasing on calving grounds ; immediate	Limited: regime subject to political vagaries; advocacy viewed as distraction
Bathurst Herd	No formal arrangement; planning process	Diamond mines on winter grounds; deep water port on calving grounds ; immediate	Moderate but disjointed: Land Claims settlements supporting First Natives
Beverly and Qamanirjuaq Herds	Long standing formal co-management	Uranium mining and leasing on calving grounds and summer range; immediate	Limited to Moderate: weak staff support; high dependence on state agencies

(Smith and Kofinas)

Visualizing vulnerability



A few observations; outstanding questions



- Regional heterogeneity in drivers and emergent conditions
 - Explore patterns of population cycling and synchronicity more carefully
- High resilience of caribou traditional hunting and herding in spite of social and ecological perturbations
 - Understand variability in strategies and responses between groups
- Limited success of introduced herding in NA
 - Understand interaction in ecological conditions, external market drivers, and internal responses

The SES Synthesis Enterprise



- Regular / face-to-face interactions are critical
 - Biweekly conference calls
- Understanding “The System” means focusing on the linkages
 - Organize around component interactions
- Use expert knowledge in simple models
 - Start early and then revise
 - Involve the experts
- Graduate education is an engine
 - Students working in teams with students and with faculty