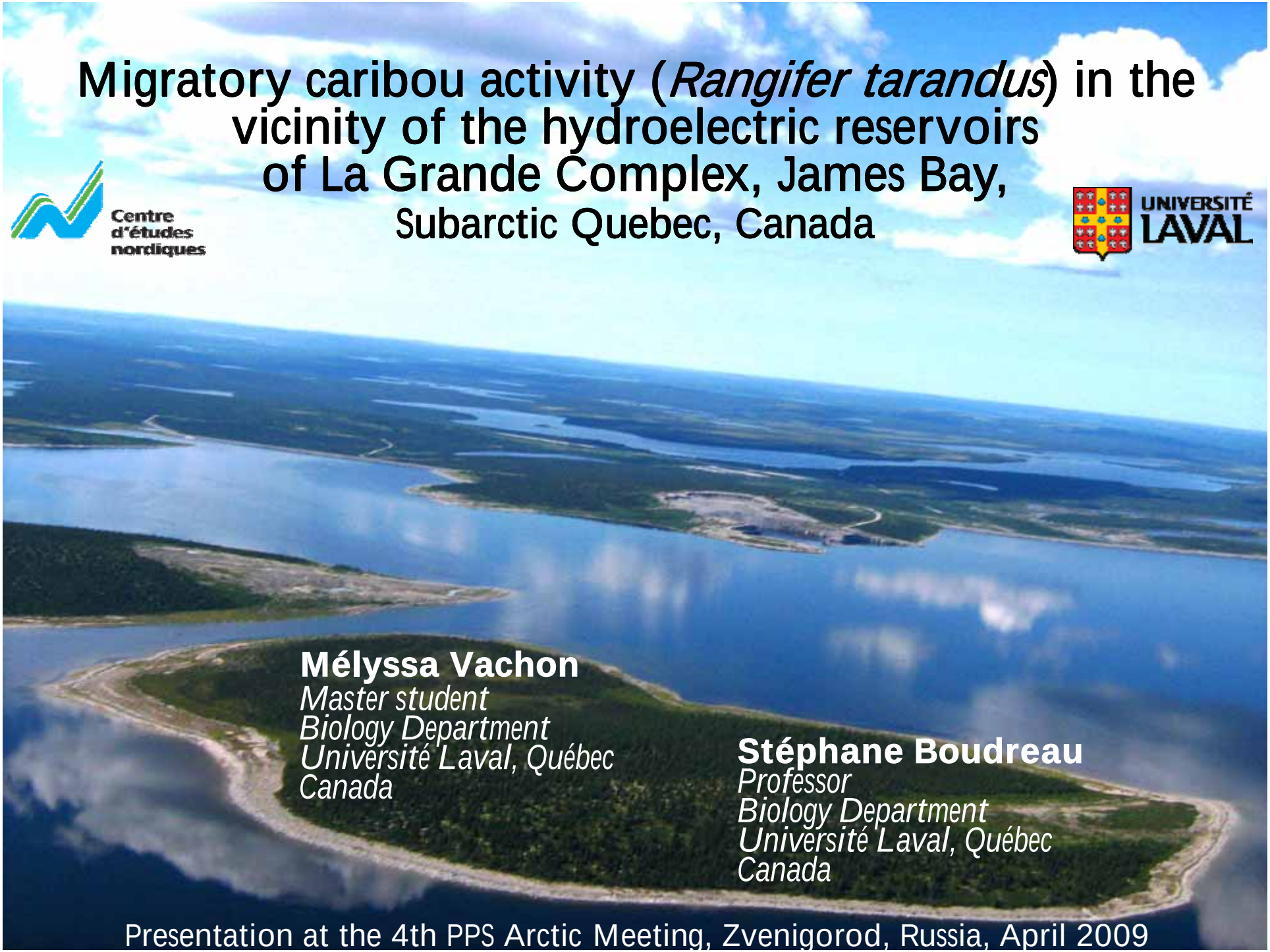
Migratory caribou activity (*Rangifer tarandus*) in the vicinity of the hydroelectric reservoirs of La Grande Complex, James Bay, Subarctic Quebec, Canada



Mélyssa Vachon
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Professor
Biology Department
Université Laval, Québec
Canada

Presentation at the 4th PPS Arctic Meeting, Zvenigorod, Russia, April 2009

Migratory species

Overhunting & poaching

American bison[1]
(North America)

Mongolian gazelle
(China & Mongolia)

Saïga antiloppe
(Kazakhstan & Russia)

Migratory species

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Anthropogenic barriers

Mongolian gazelle
(railroads, Mongolia)

Tibetan antelope
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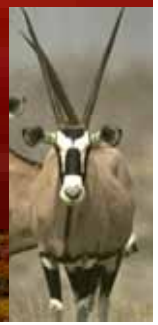
Habitat loss

Wildebeest
(agriculture, Kenya)

African elephant
(agriculture, Tanzania)

Hartebeest sp.
(agriculture, Tanzania)

Oryx
(agriculture, Tanzania)



Caribou & Industrial Development

✓ ***Population:***

4 800 000 animals / 24 herds (½ >100 000) Polar circle

✓ ***Fluctuations:***

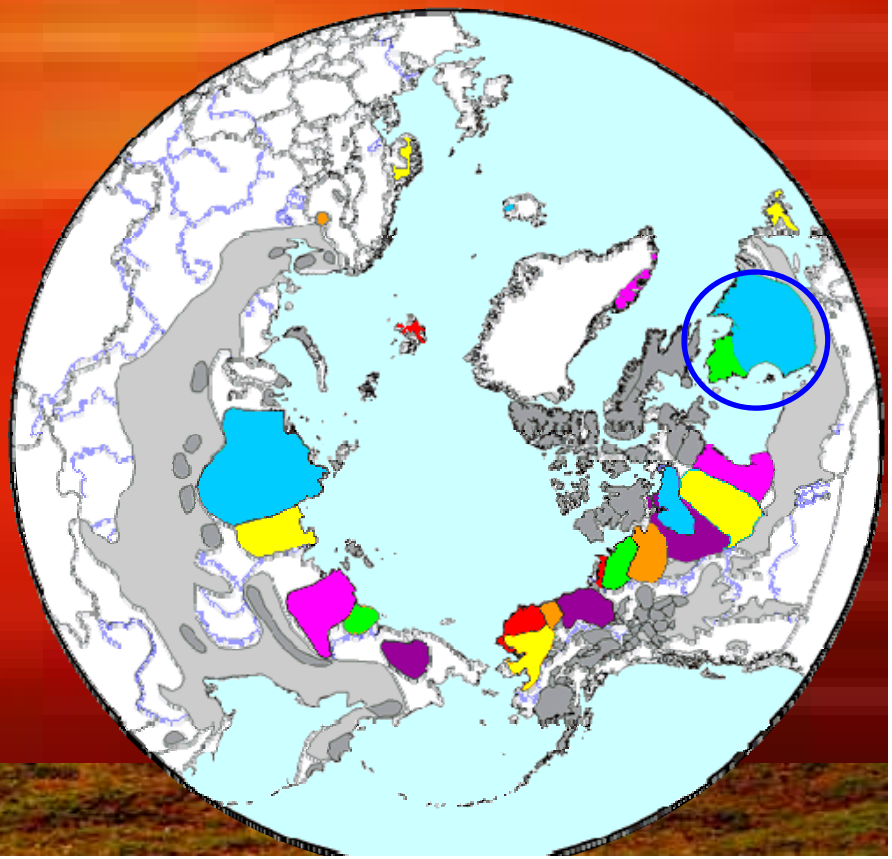
- Decline 1950
- Growth 1970 +

✓ ***Oil & Hydroelectricity Development (1970)***

✓ ***Occupy the Arctic since > 2 M years***

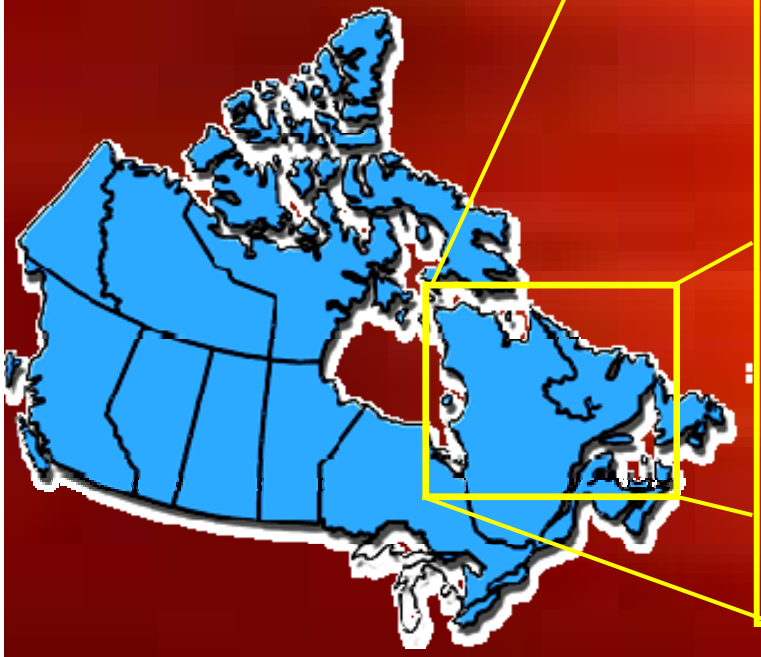
✓ ***Short & long term consequences***

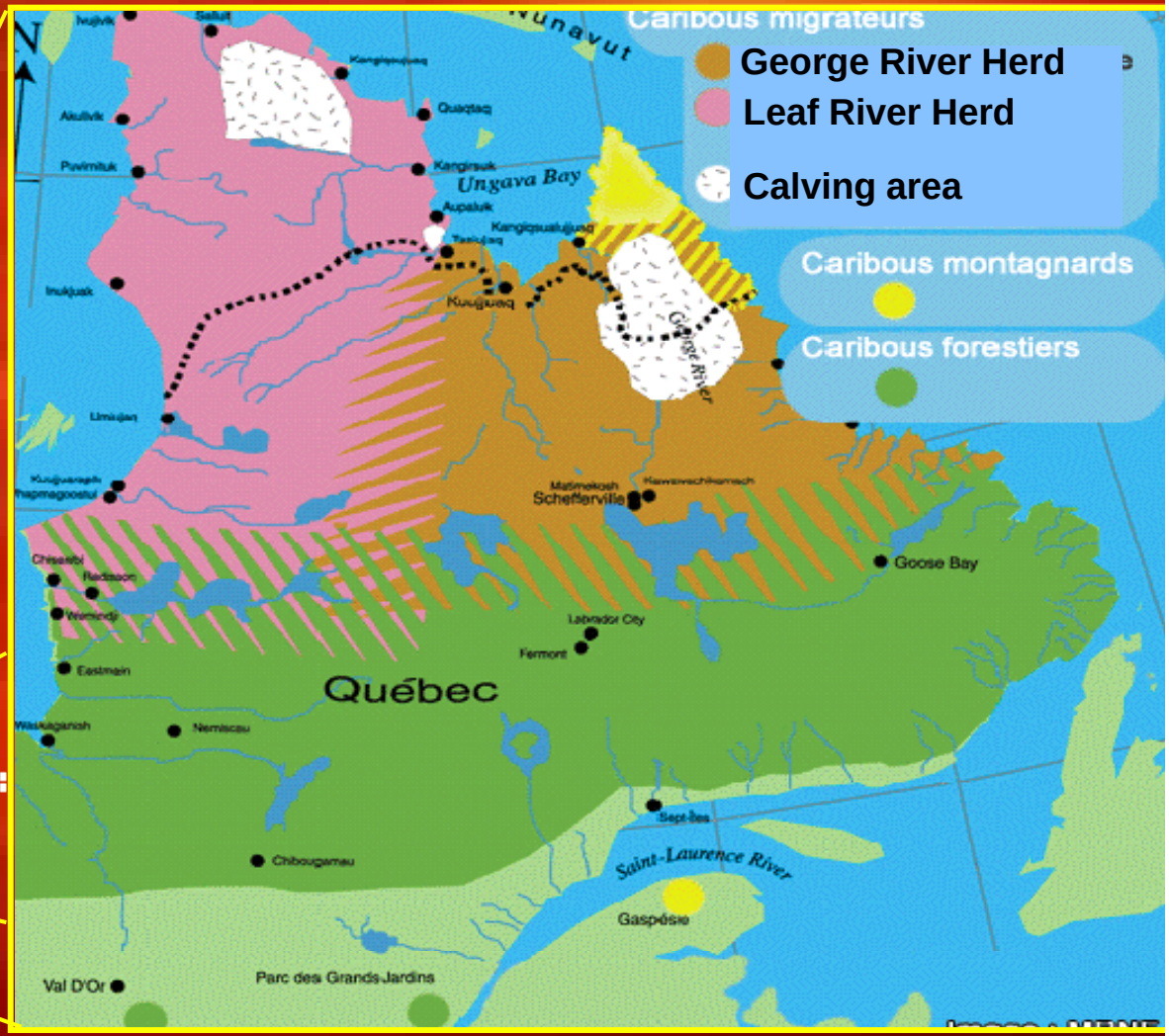
✓ ***Research project in Alaska & Norway***



Herds of Northern Quebec

- ✓ George River Herd
- ✓ Leaf River Herd



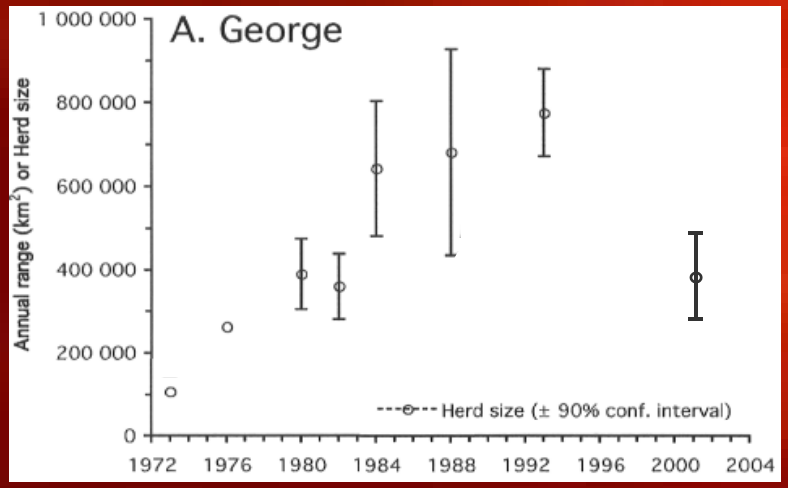


George-River Herd

GRH

✓ ***Demography***

- ↑ End XIXe
- 1950: very low
- 1988: 682 100 ± 36%
- 1993: 775 891 ± 13,4%
- 2001: 385 000 ± 28%



(Couturier *et al.* 2007)

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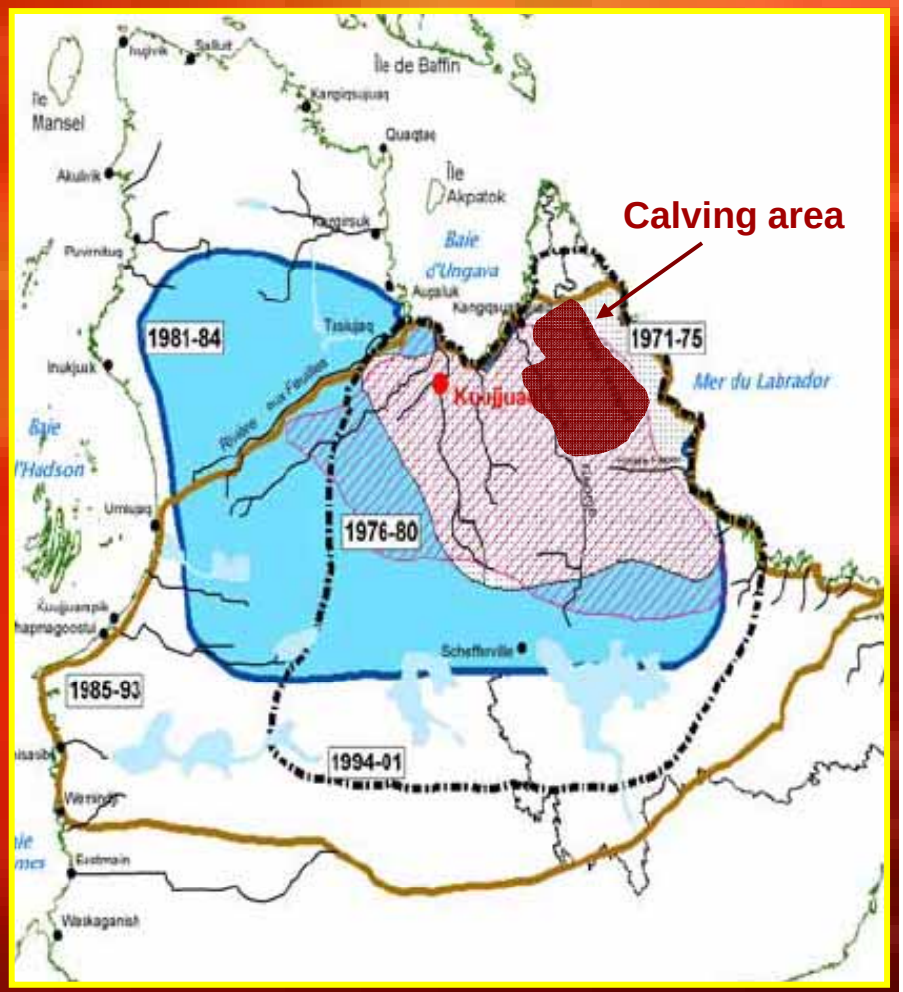
✓ ***Demography***

- ↑ End XIXe
- 1950: very low
- 1988: 682 100 ± 36%
- 1993: 775 891 ± 13,4%
- 2001: 385 000 ± 28%

✓ ***Range***

- 160 000 km² 1971-75
- 606 000 km² 1989
- 257 000 km² 2002

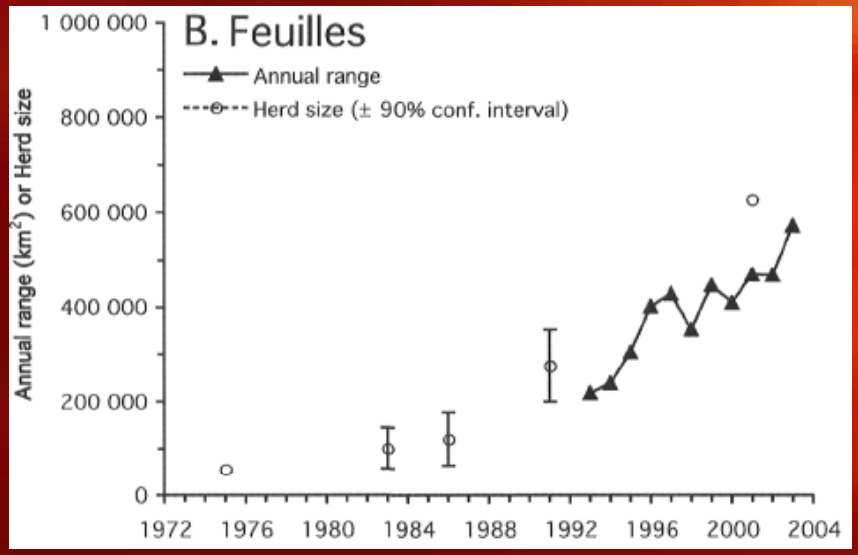


Leaf River Herd

LRH

✓ ***Demography***

- 1975: 56 000 animals
- 1991: 276 000 (± 27,5%)
- 2001: 628 000



(Couturier *et al.* 2007)

Leaf River Herd

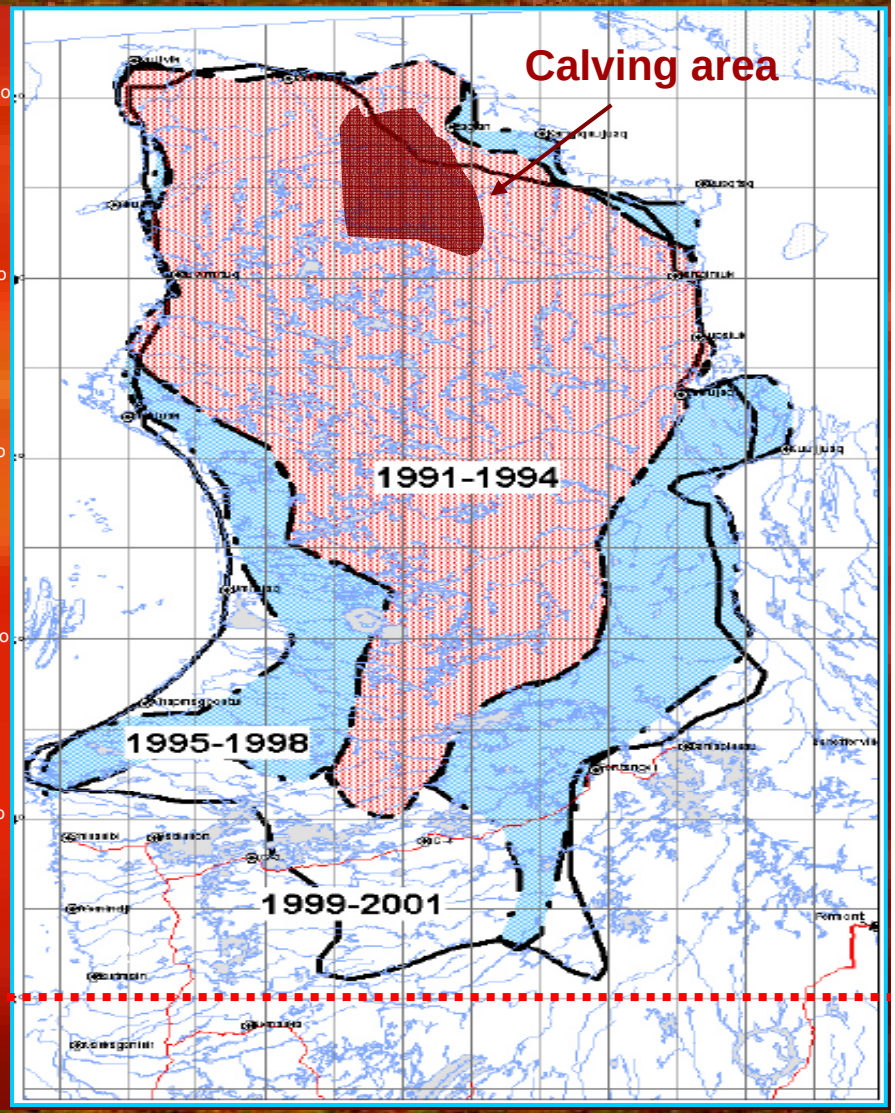
LRH

✓ ***Demography***

- 1975: 56 000 animals
- 1991: 276 000 (± 27,5%)
- 2001: 628 000

✓ ***Range***

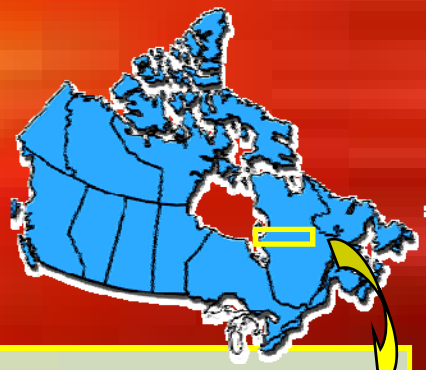
- 218 000 km2 1993
- 573 000 km2 2003



La Grande Complex

Hydroelectric Development

- ✓ *James Bay, Northern Quebec*
- ✓ *8 generating stations along the La Grande river*
- ✓ *800 km, 54th parallel, Caniapiscau to James Bay*
- ✓ *Southern boundaries of the GRH & LRH range*



Objectives

General

- ✓ ***General description of caribou activity in the vicinity of the La Grande Complex revealed by tree-ring data***

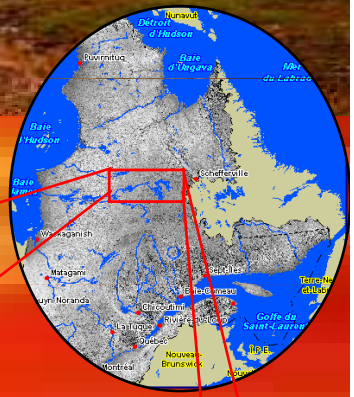
Specifics

- ✓ ***Activity pattern before, during and after the LG4 and Caniapiscau flooding***
- ✓ ***Verify if the island are used as rest areas***

Study area

Area

- ✓ *53º 45' S & 54º 58', GRH & LRH*
- ✓ *East part of the La Grande Complex*
- ✓ *LG4 to Caniapiscau reservoirs*



✓Taïga

- ✓ *Spruce-lichen woodland*
- ✓ *Spruce-moss forest*
- ✓ *Peatland*

Methods

Trampling scars

- ✓ ***Impact of caribou hooves on conifer roots***
- ✓ ***Scars can be dated because radial growth stop at the lesion***
- ✓ ***Change in scar frequency = change in caribou activity***
- ✓ ***250 scars/site***

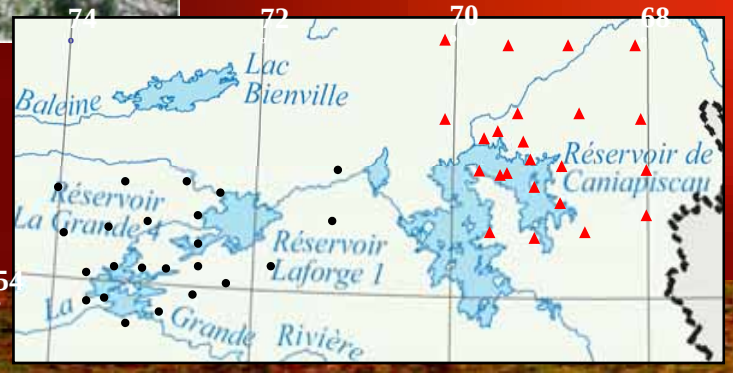
(Morneau et Payette, 1998)

Sampling & Analyse

Sampling sites & scars

✓ ***Land & Air***
- Roads TT, LG4, LA1, LA2
- Transects 25-35 km

✓ ***Sampling scars***
- Summer 2007-08
- 300 roots cross-section (250 scars)



Sampling & Analyse

Sampling sites/scars

✓ ***Land & Air***
- Roads TT, LG4, LA1, LA2
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✓ ***Sampling scars***
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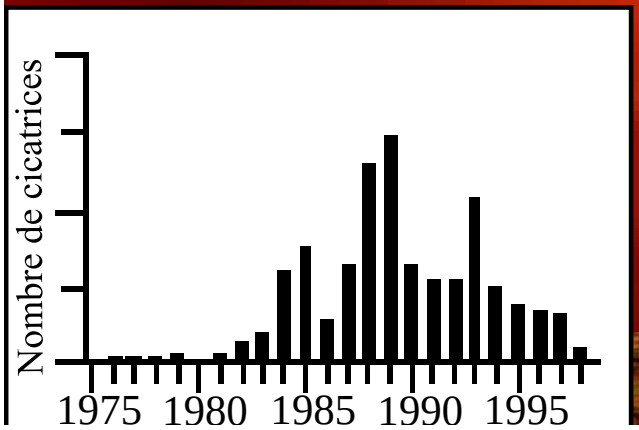
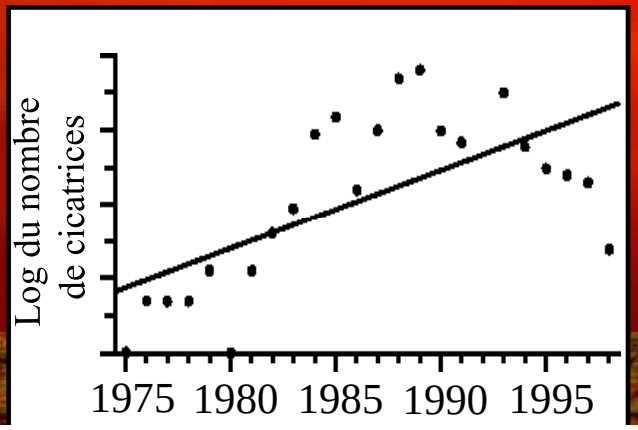
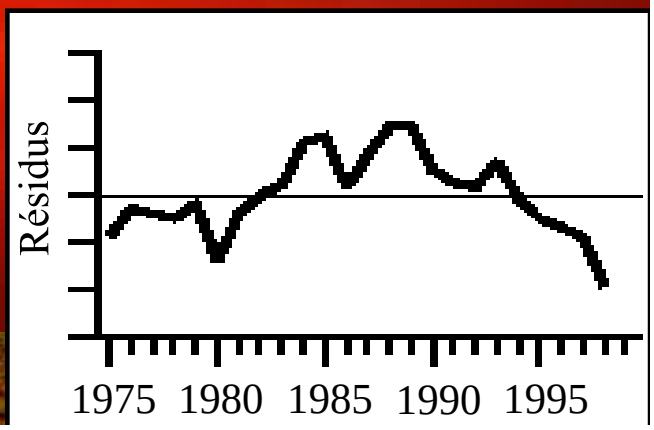
Caribou activity index

- ✓ ***Build an age-frequency distributions of trampling scars for each site***
- ✓ ***Apply a log-linear regression to remove an exponential trend from the age structure of scars***
- ✓ ***Use the residual values of the regression as an indicator of the activity***
- ✓ ***Cluster analyse using Pearson's correlation coefficient***





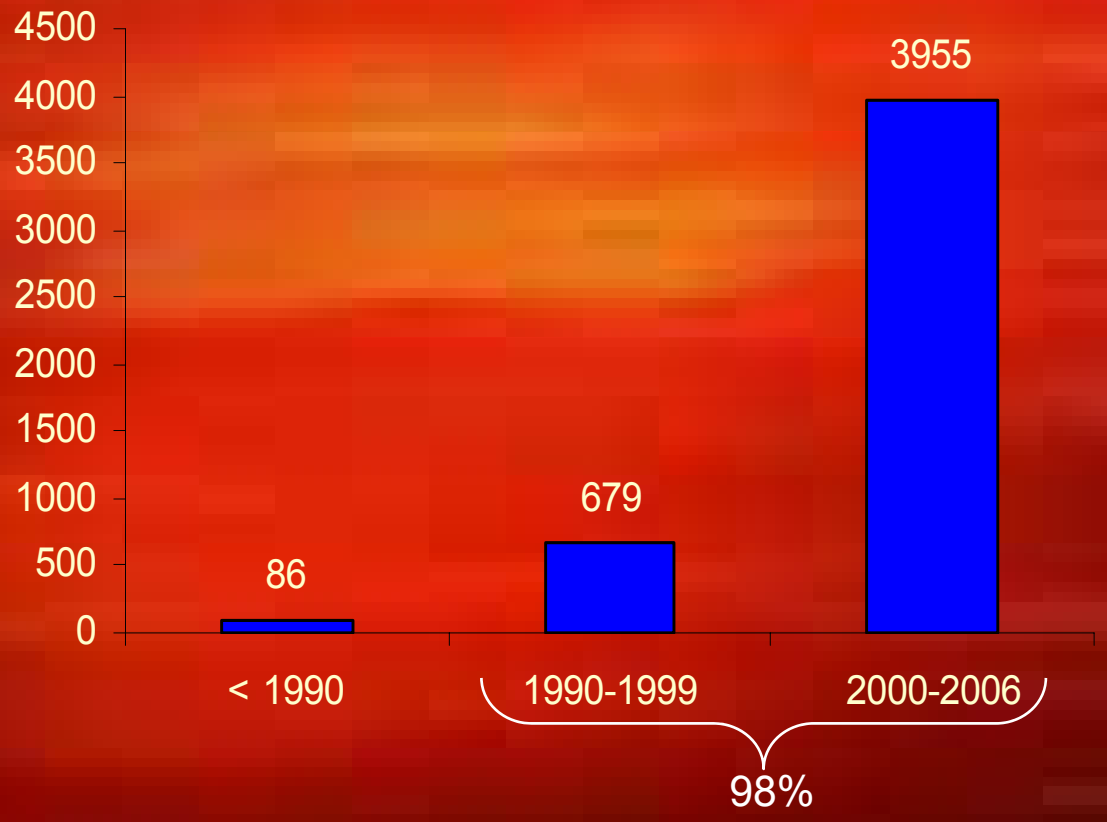


La Grande 4

Scars distribution

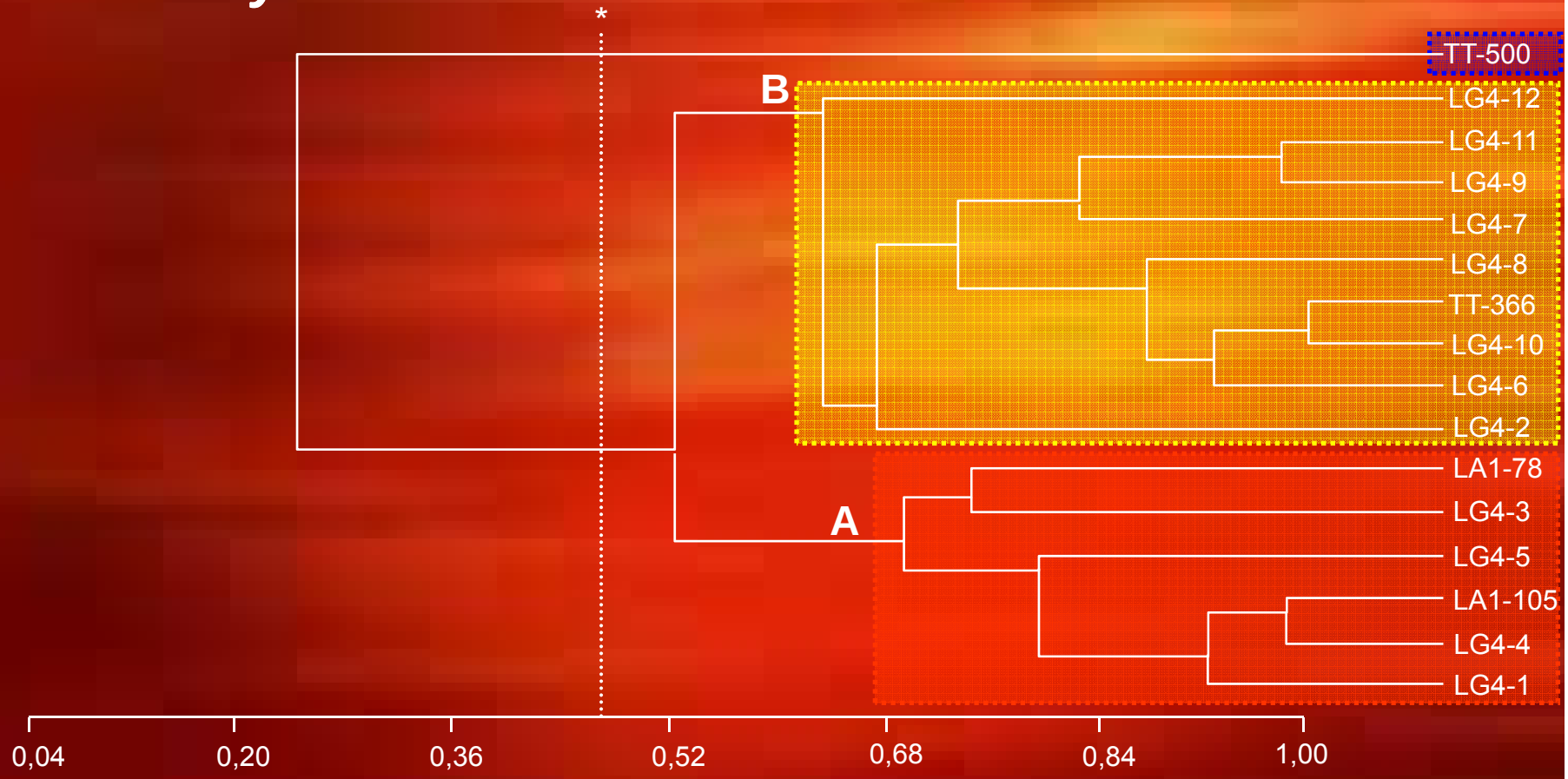
✓ ***Scars used:***

- 23 sites
- 4720 total
- 4634 (1990-2006)
- 16/23 sites > 100 scars



La Grande 4

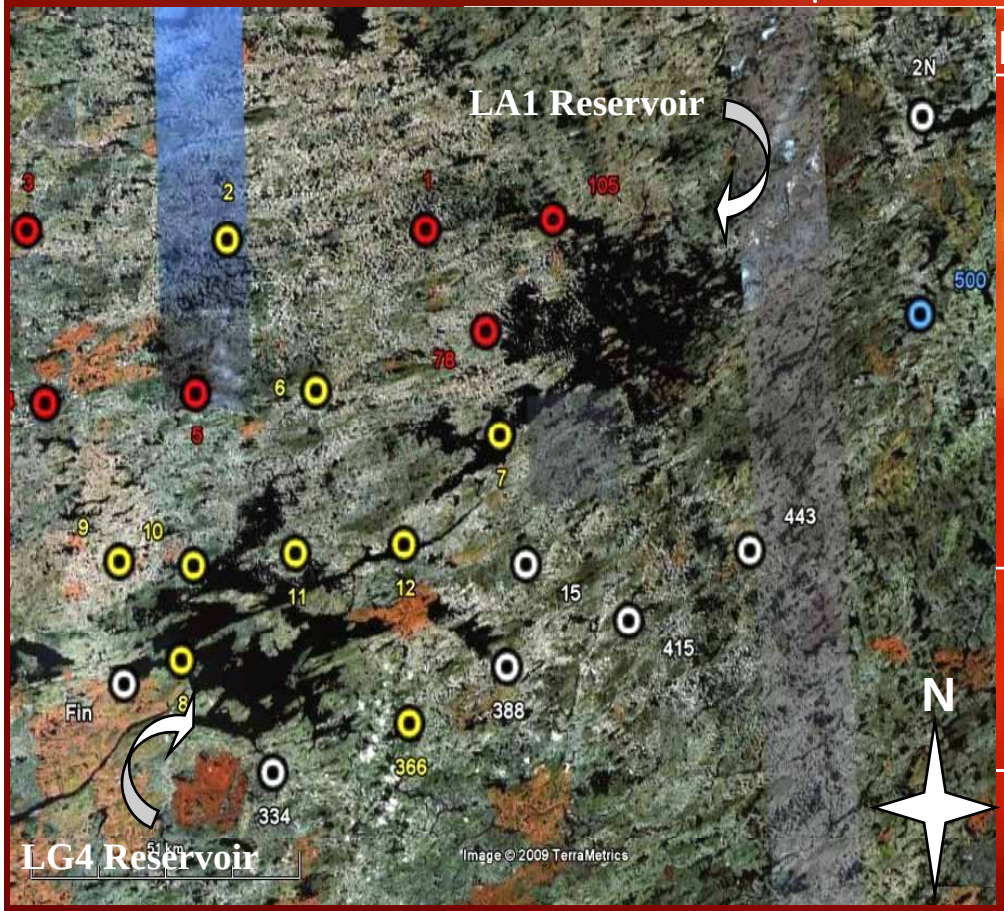
Cluster analysis

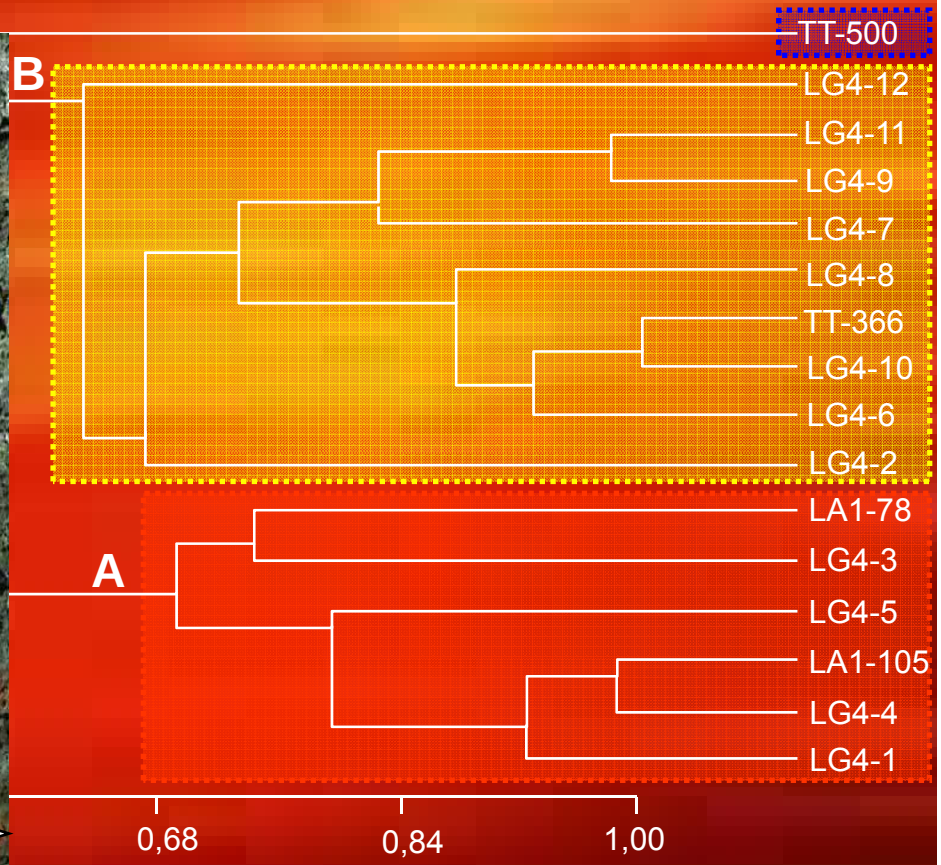


* Pearson coefficient threshold: 0,497

La Grande 4

Cluster analysis

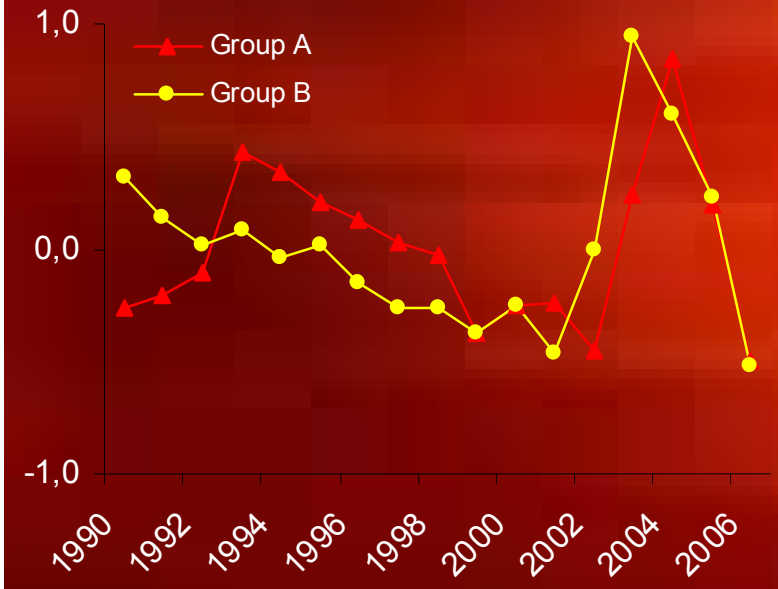


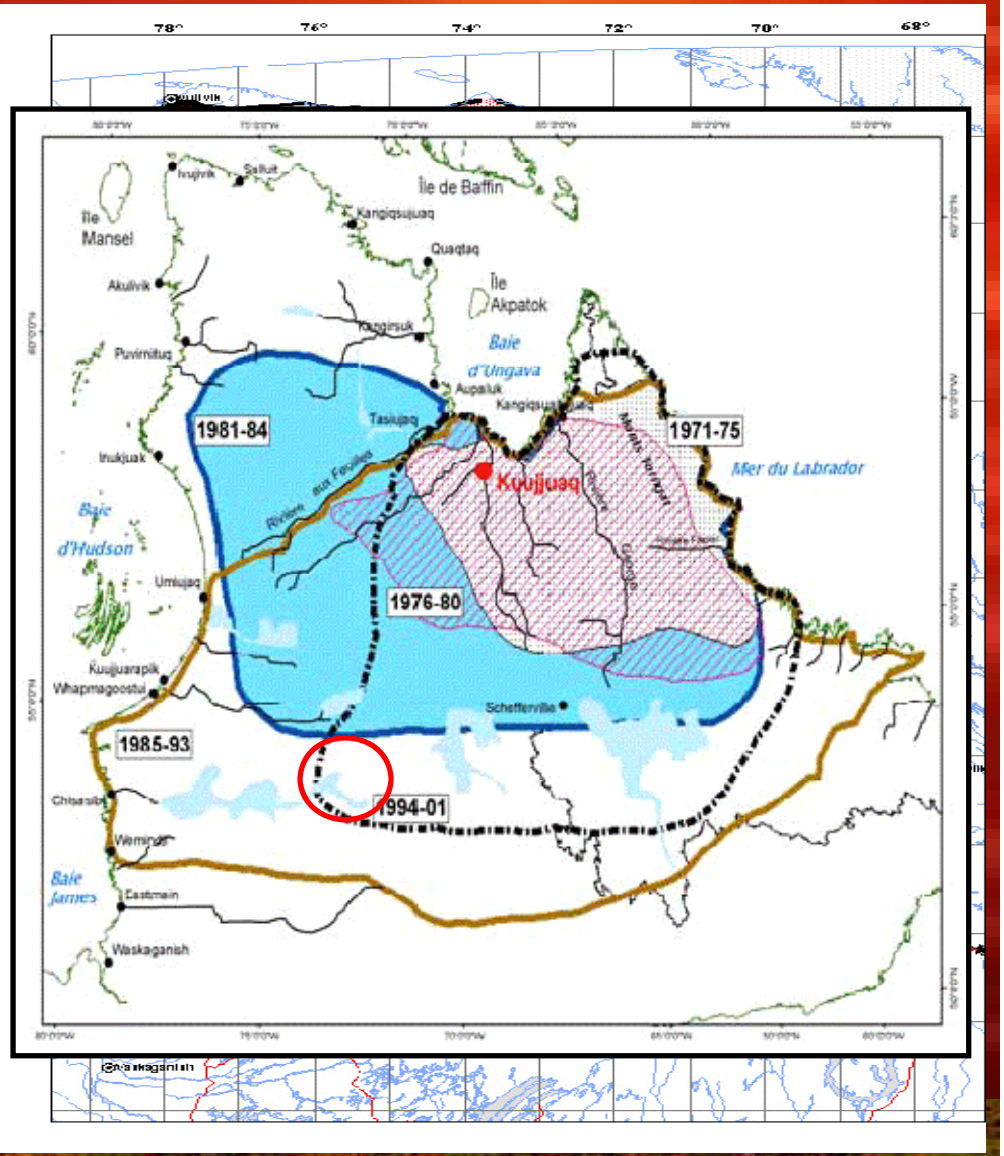


La Grande 4

Range, Census & Activity

- ✓ ***Reservoir 1984-86, no direct effects***
- ✓ ***Range***
  - GRH 1985
  - LRH 1999





La Grande 4

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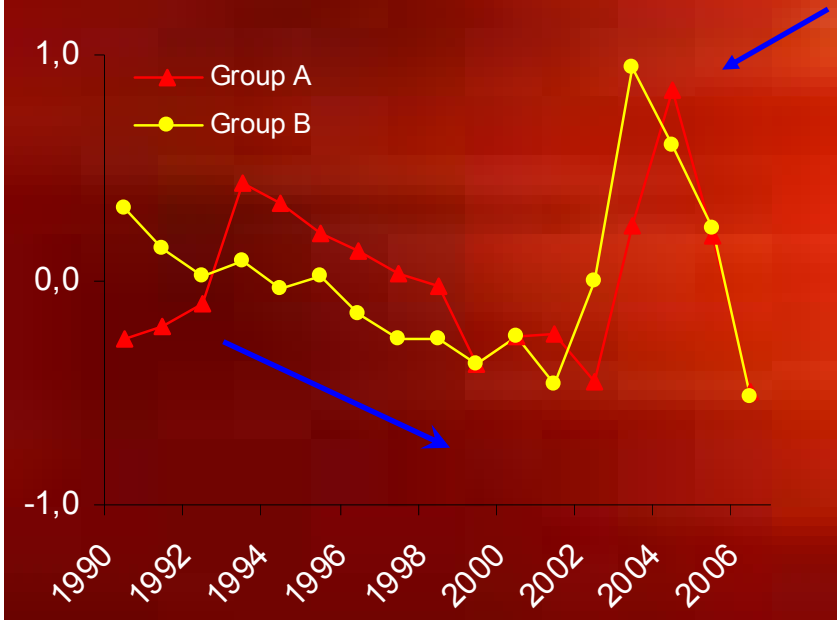
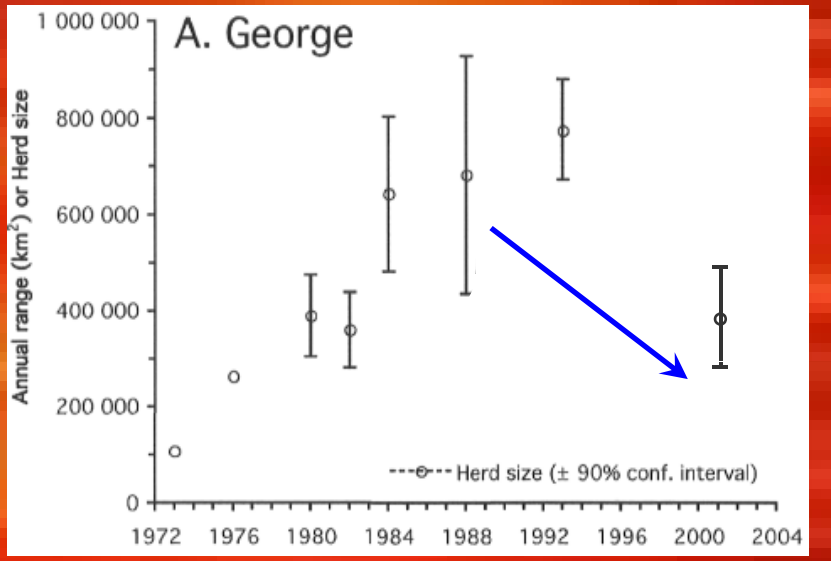
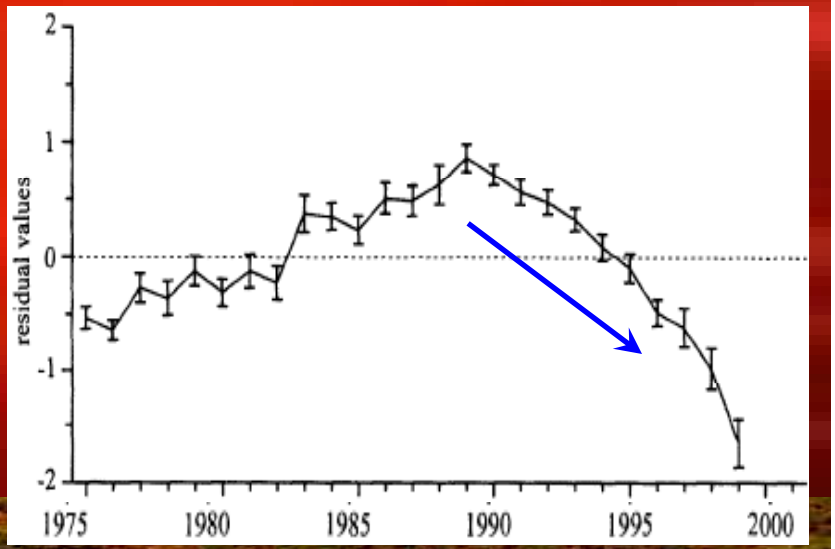




Couturier, 2007



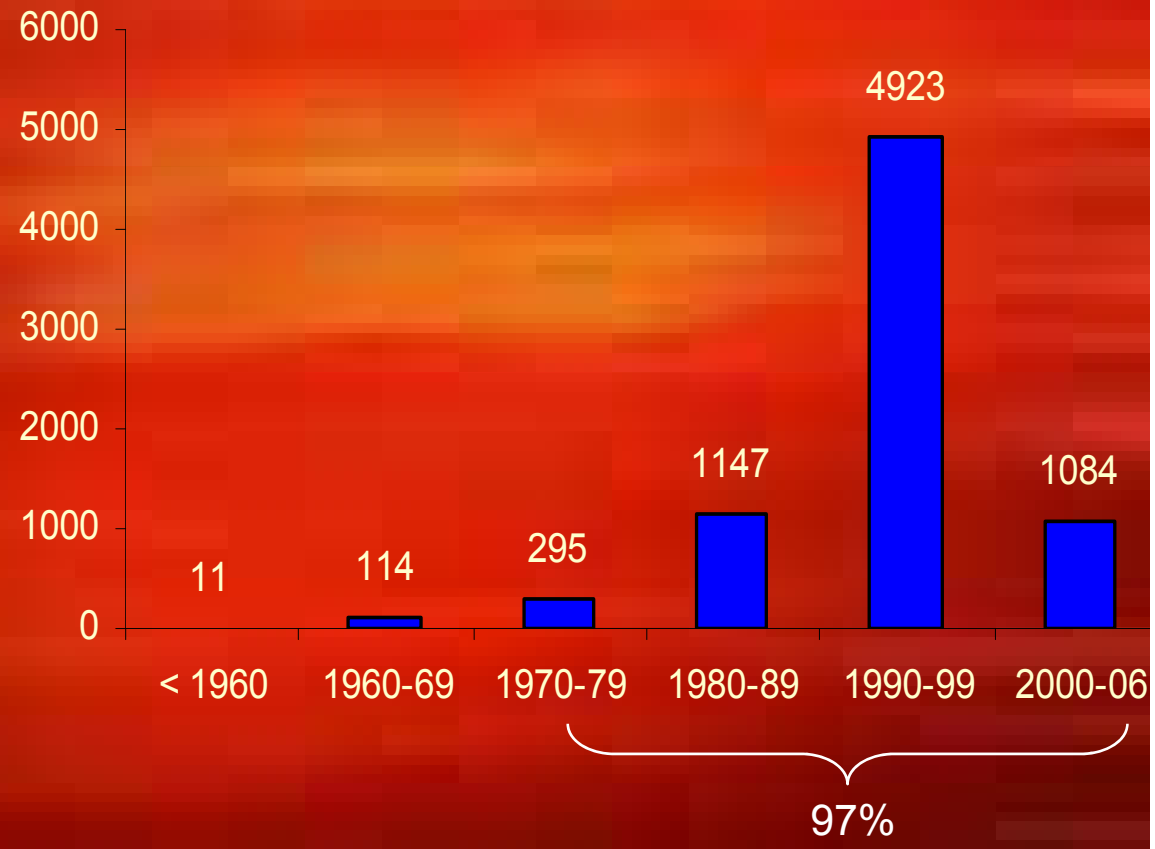
Boudreau *et al*. 2003

Caniapiscau

Scars distribution

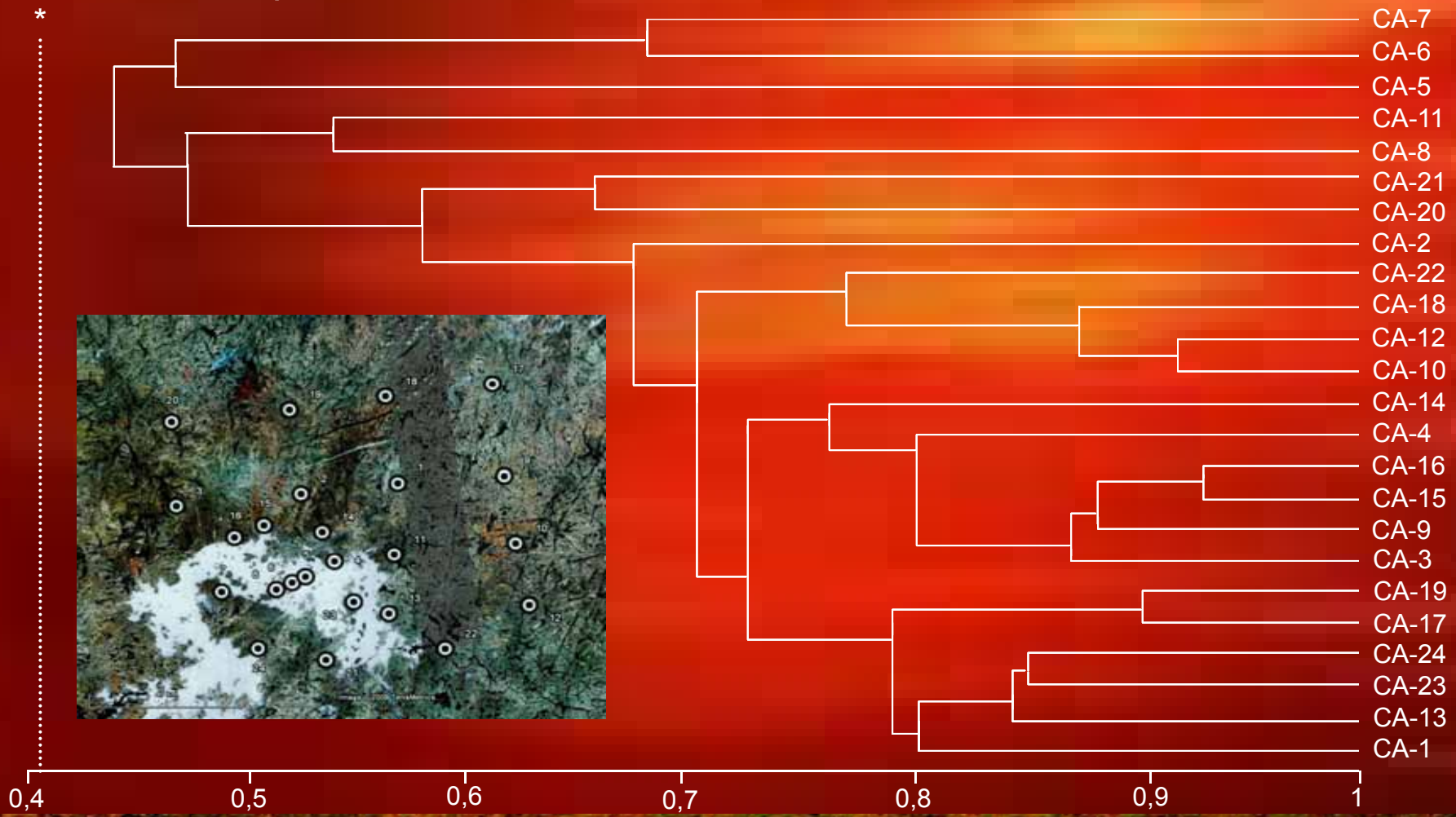
✓ ***Scars used:***

- 7638 total
- 24 sites 295 scars/sites
- Scarce before 1975
- **7319 (1975-2006)**



Caniapiscau

Cluster analyse

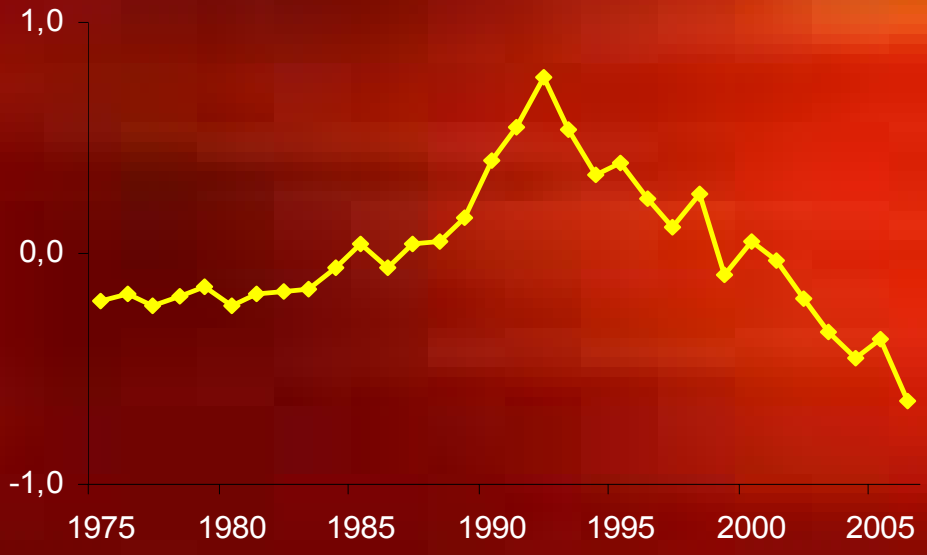


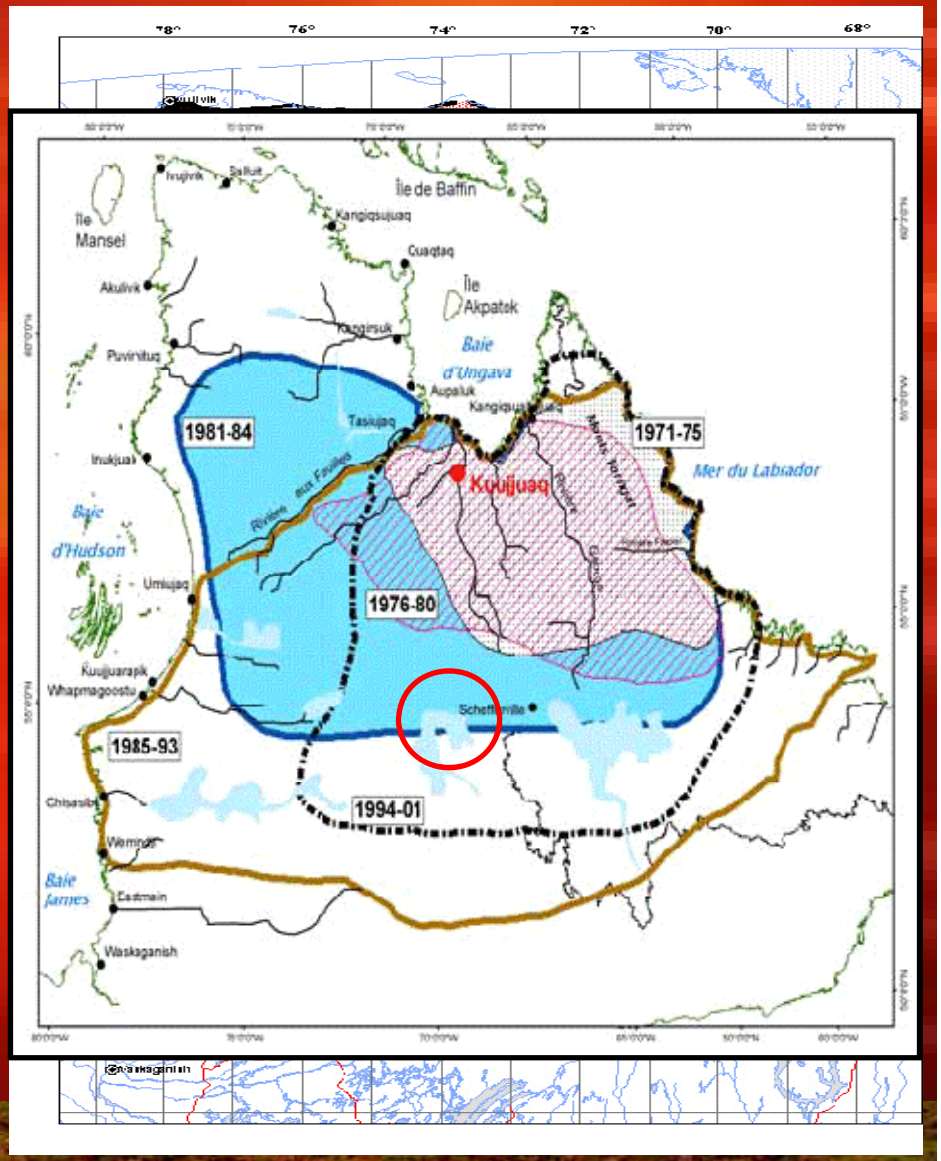
* Pearson coefficient threshold: 0,404

Caniapiscau

Range, Census & Activity

- ✓ ***Index for 1975-2006***
- ✓ ***Reservoir 1982-84***
- ✓ ***Range***
  - GRH 1981
  - LRH 2001





Caniapiscau

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  - GRH 1985
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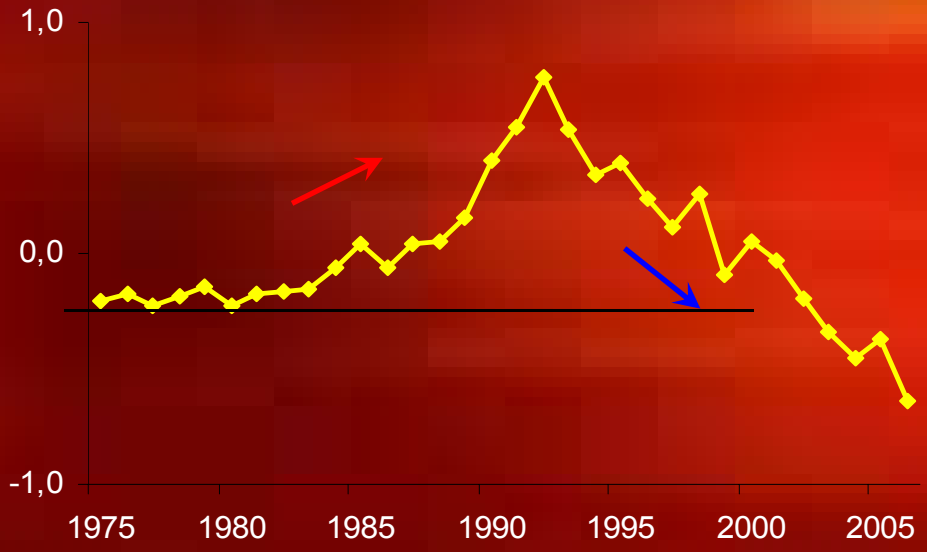
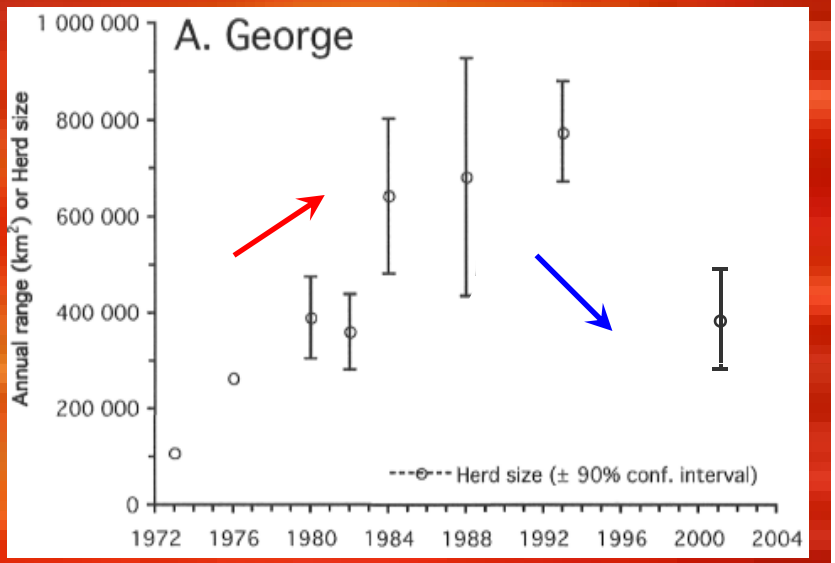
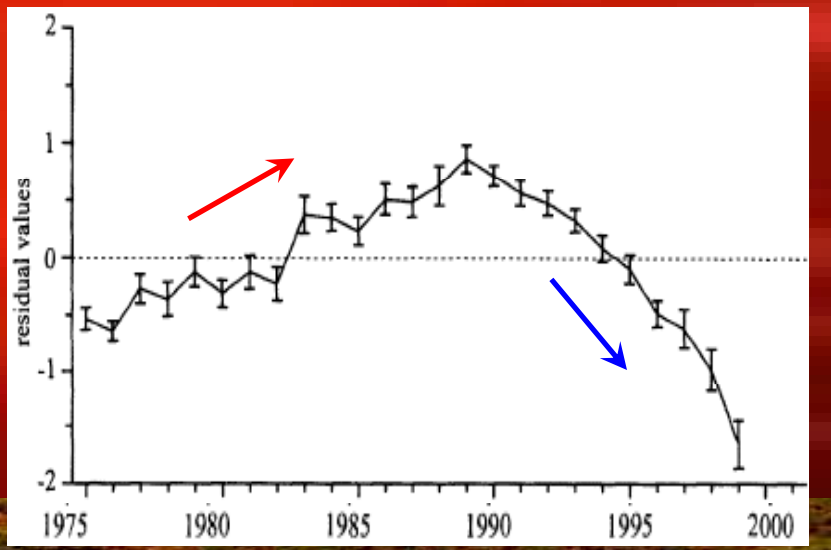




Couturier, 2007



Boudreau *et al*. 2003

Caniapiscau

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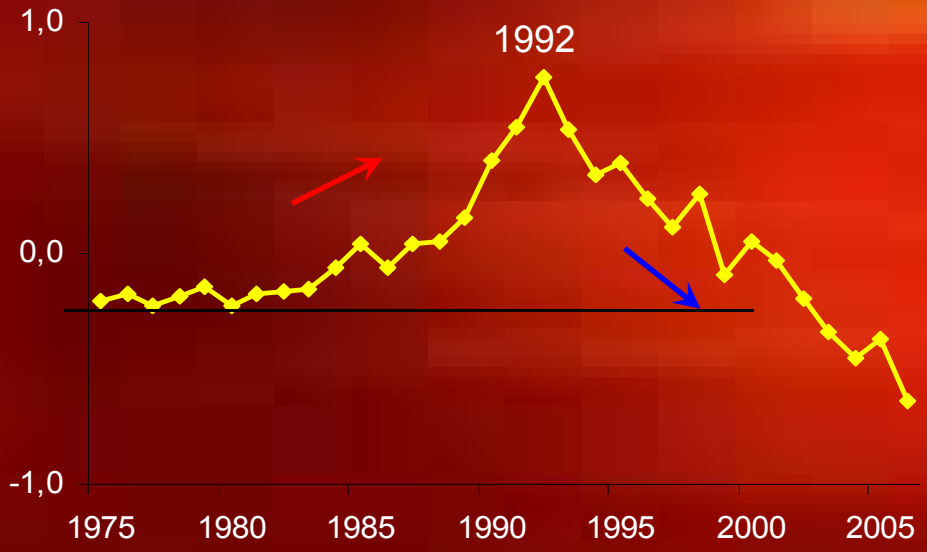

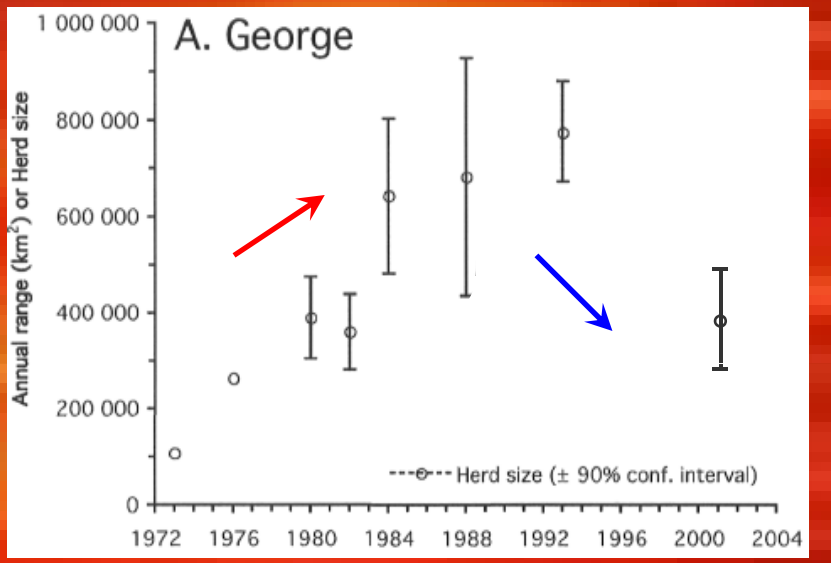

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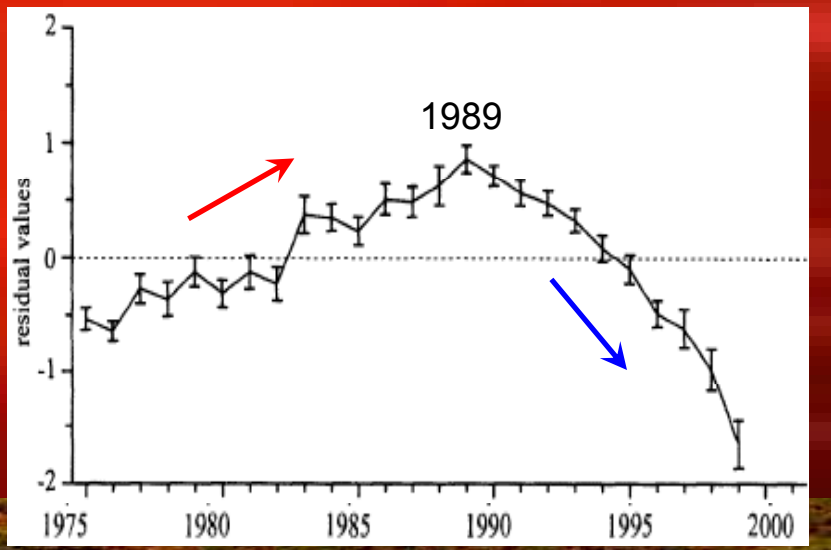


Boudreau *et al*. 2003

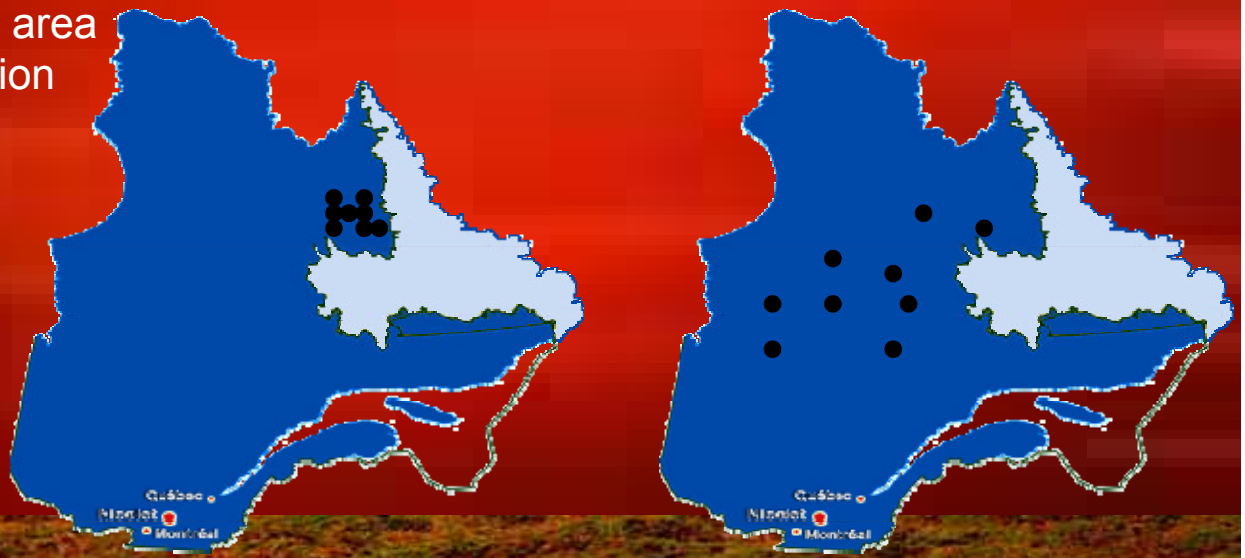
Caniapiscau

Trend in caribou activity reflect 2 potential phenomena

✓ ***Fluctuation of population size***

✓ ***Change in geographical distribution***

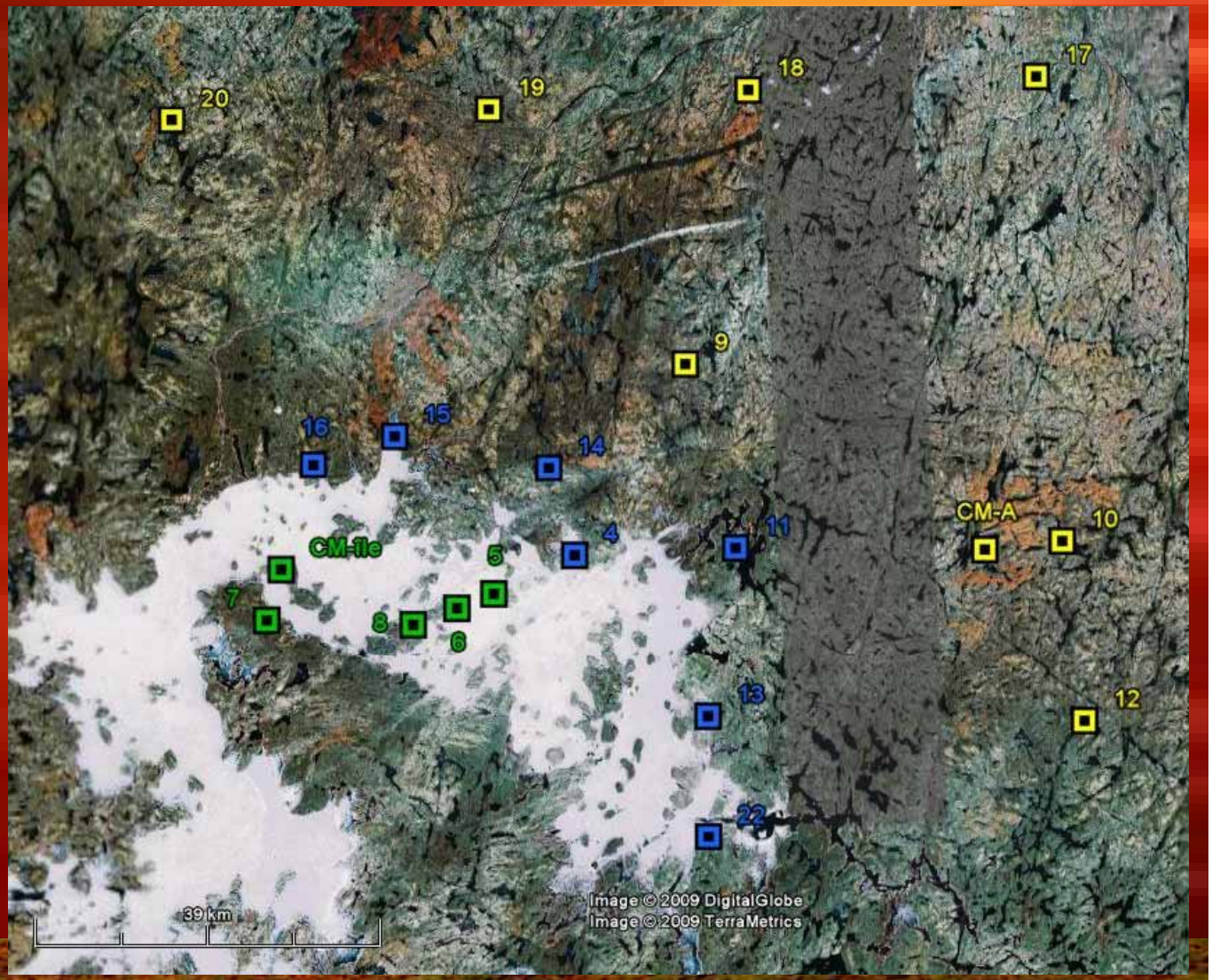
- Increase or decrease of activity ≠ change in population size
- Boudreau *et al.* study *vs* this study
- Might explain the delay in 1990
- Fall & Spring range are more important than summer range
- Interannual variability of used area
- Compare with telemetry location



Islands vs Land

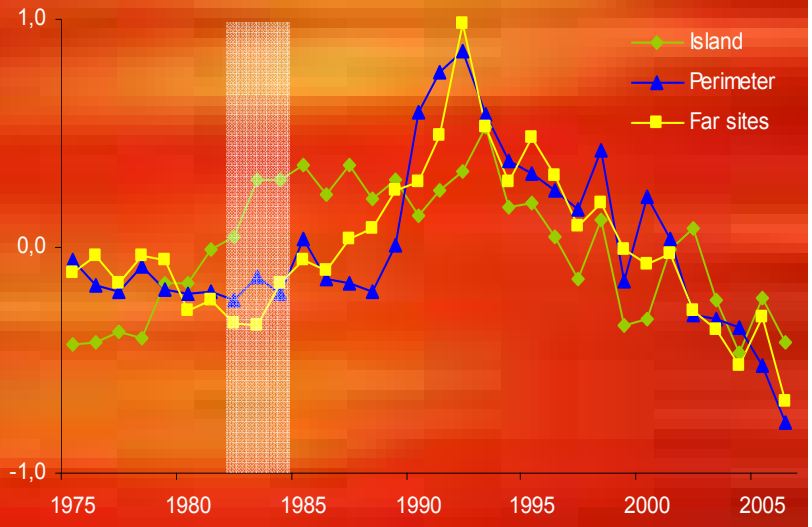
Sites Localisation

- ✓ *Island*
- ✓ *Perimeter*
- ✓ *Inland sites*

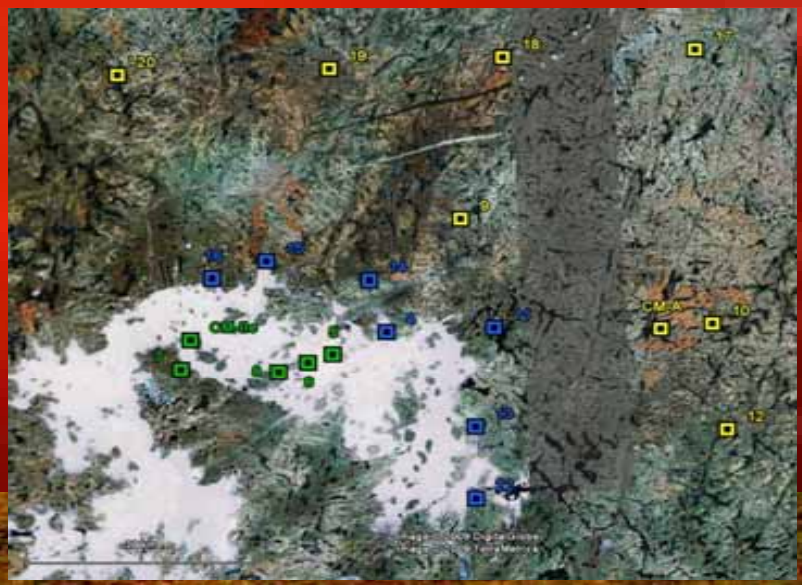


Islands vs Land

Curve of activity on Island, Perimeter & Far Sites



- ✓ ***During (> island)***
  - Gradual arrival of GRH from North & North-East (from summer habitat)
  - lichen woodland good source of food
  - New feeding zone
  - High concentration on a small superficy
- ✓ ***After (island stable, land ↑)***
  - habituation waiting for ice cover to cross
  - if true, less scars on island because of snow cover



Conclusion

- ✓ *Describe caribou activity for the last decade*
- ✓ *Recent presence in LG4 region*
- ✓ *Earlier presence in Caniapiscau region*
- ✓ *Activity index related to fluctuations of population size & geographic distribution*
- ✓ *Flooding influence, but habituation*
- ✓ *Compare telemetry locations & photo census to get a complete portray*

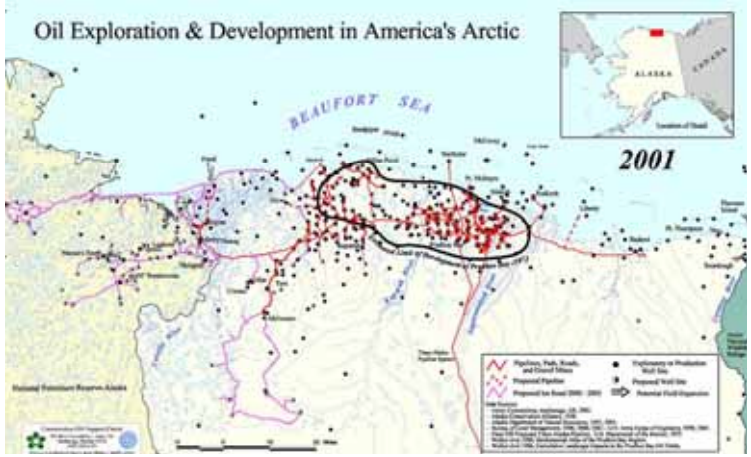
NSERC
CRSNG

INTERNATIONAL
POLAR YEAR
2007-2008
ANNÉE POLAIRE INTERNATIONALE

Chaire de recherche nordique en écologie des perturbations /
Northern research chair in disturbance ecology

Caribou & Industrial Development

Oilfield Prudhoe Bay, Alaska



✓ ***CACH territory june & july***

✓ ***Divided opinion on effect***

✓ ***Effets sur les individus***

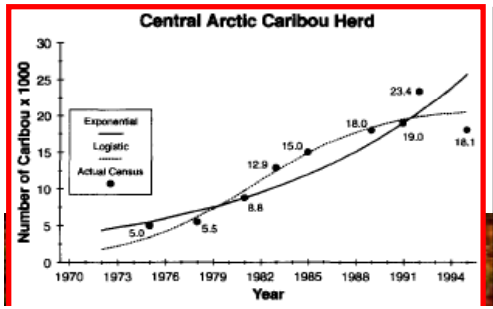
- Abondance parturientes avec développement[22,23,24,25,26], plus sensibles que [27,28]
- Évitent la bordure des routes (< 2km) et 3 x + nombreuses à > 4km[22]
- Combinaison routes et pipelines > déplacements[29,30] > dépenses énergétiques[30]
- Abondants sur champ pétrolier et distribution indépendante des installations[31]
- Effets temporaires, densité en bordure de la route, 10 ans plus tard, rétablie[26]
- Adaptation ou distribution naturelle[26]

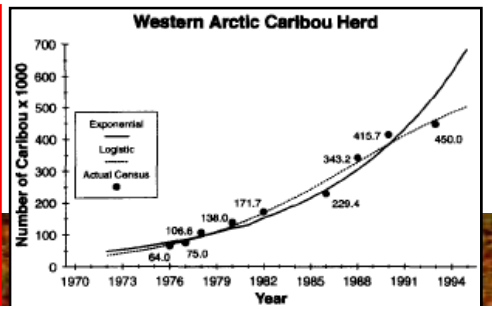
Caribou et développement industriel

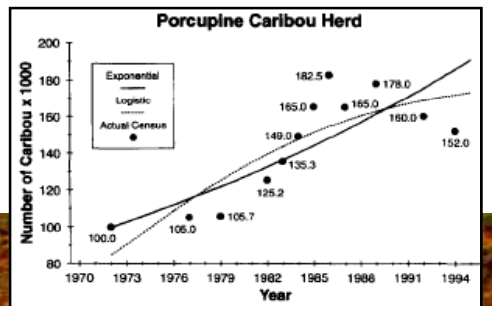
Champ pétrolifère de la Baie Prudhoe

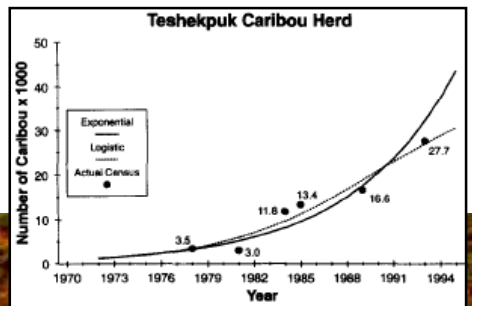
✓ ***Effets sur le troupeau***

- Productivité du troupeau atténué[23,32]
- Impacts potentiels (anthropiques vs environnementaux)[27,33]
- 6000 têtes en 1978 à 27 000 en 2000[23]
- TAC vs 3 autres troupeaux du Nord de l'Alaska[33]
  - taux de croissance
  - ratio faon/femelle
  - densité
- Facteurs naturels *(densité, la prédation, les parasites, la condition de l'habitat)* vs facteurs anthropiques = difficilement différenciables





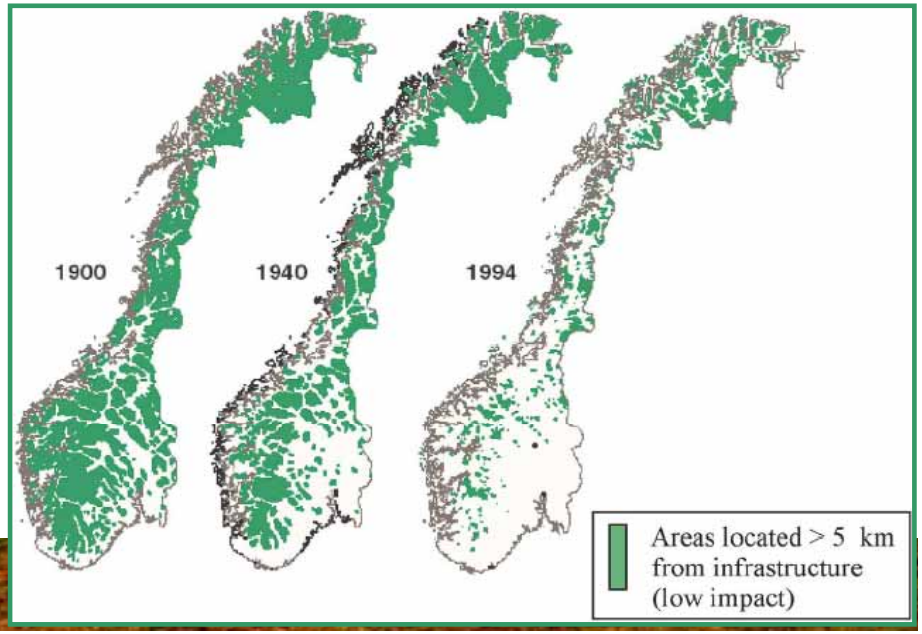




Caribou et développement industriel

Développement hydroélectrique en Norvège

- ✓ ***Pays nordique ayant subi le plus haut taux de développement d'infrastructures[34]***
- ✓ ***26 sous-populations***
- ✓ ***des constructions = densité***
- ✓ ***Évitement des infrastructures = compétition pour la nourriture***
- ✓ ***plus sensible que***
- ✓ ***Impacts plus importants lorsque combinaison des perturbations***
- ✓ ***Entrave aux routes de migrations par installations et inondations***
- ✓ ***Perte d'habitat d'été***

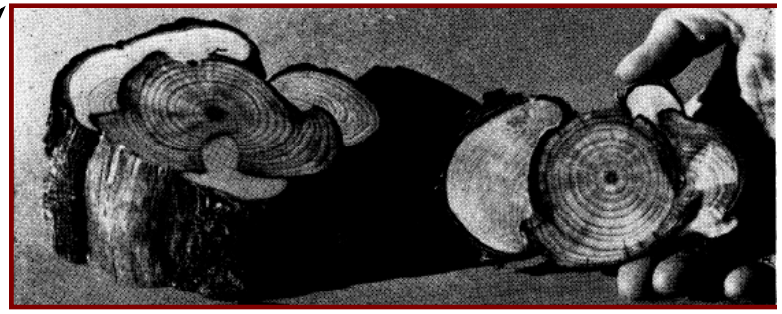


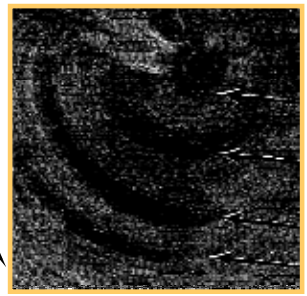
Methods

Tree-ring analysis

✓ ***Animal population dynamic***

- Beaver
- Voles & porcupine
- Moose
- Snowshoe hare





Trampling scars

✓ ***Past caribou activity***

Tree-ring analyse

✓***Trampling scars***

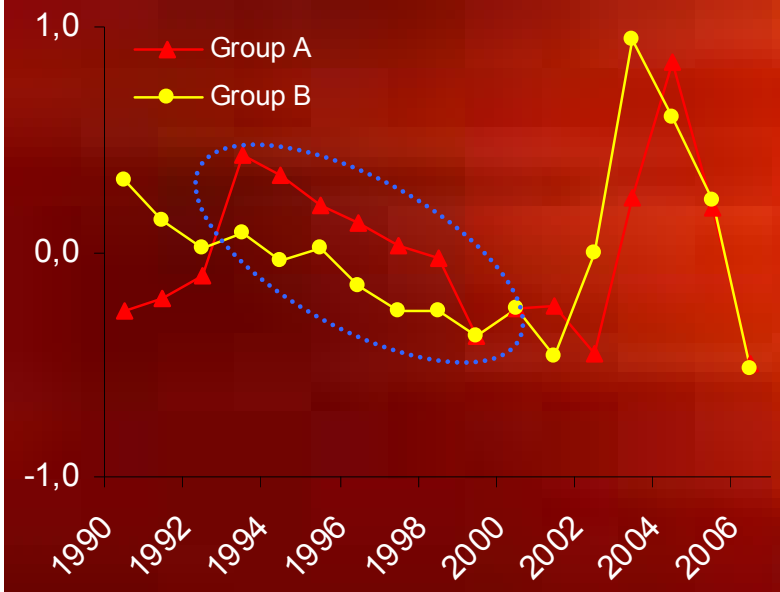
- Impact of caribou hooves stop radial growth at the lesion
- Conifer roots are easily damaged by caribou trampling
- Capacity to produce scars is maintained over the years

- Superposed scars
- Minimum of 250 scars/site is suggest
- Age frequency distribution = index of caribou activity

La Grande 4

Range, Census & Activity

- ✓ ***Reservoir 1984-86, no direct effects***
- ✓ ***Range***
  - GRH 1985
  - LRH 1999
  - activity curve = GRH demographic trend



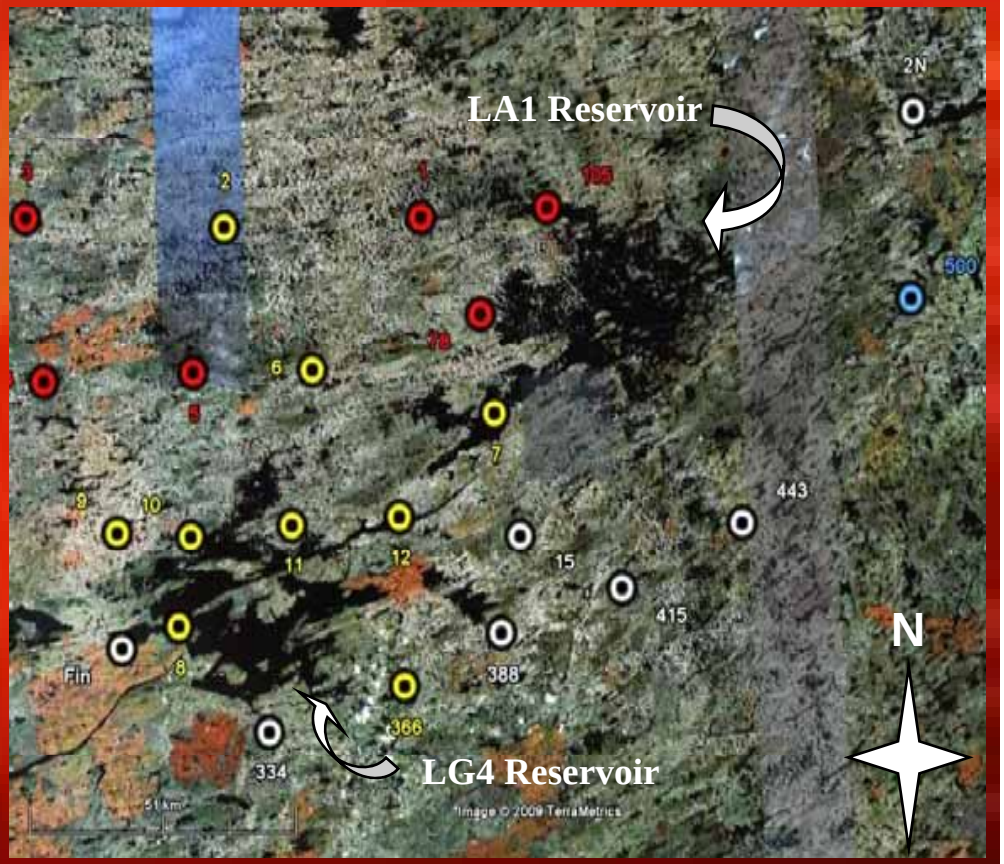
Highest activity in group A

- ✓ ***Peak of GRH***
- ✓ ***Environmental factors:***
  - Fire
  - Food availability
  - Climate
  - Snow cover…
- ✓ ***Variability of trajectory***

La Grande 4

Scarcity of trampling scar (south)

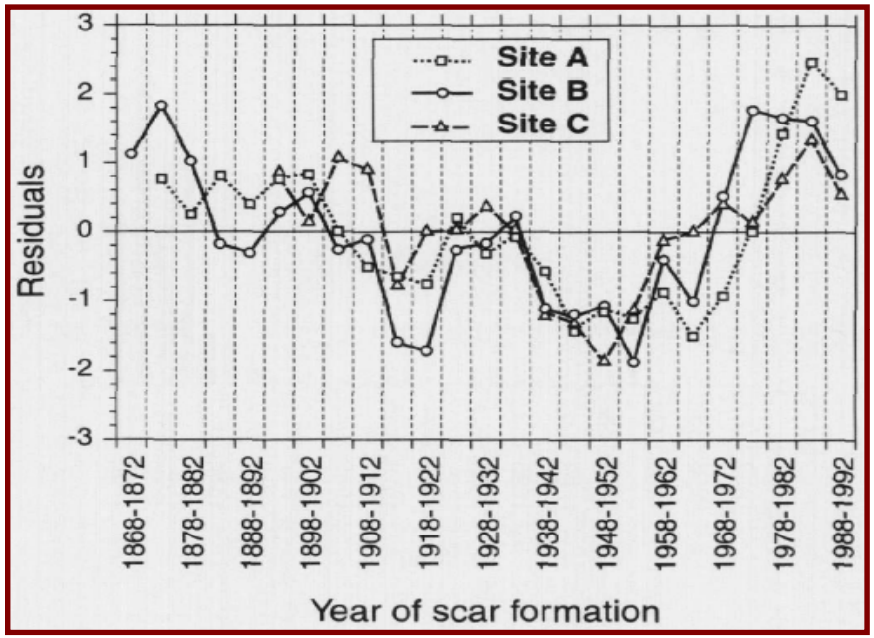
- ✓ ***Air vs Land Sampling***
  - More efficient
  - Lower abundance of trail
- ✓ ***Infrastructures***
  - Human disturbance (HQ, Outfitters)
  - Roads TT, LA1 & LA2 (maintenance)
- ✓ ***Waiting for ice cover***
  - use ice cover to cross
  - snow or ice cover = no scar formation



Tree-ring analyse

GRH past activity

- ✓ ***end XIXe: frequentation***
- ✓ ***early XXe – 1950: decline***
- ✓ ***1950 – 1970: growth***
- ✓ ***1970 – late 1980: rapid growth***
- ✓ ***1990… decrease***

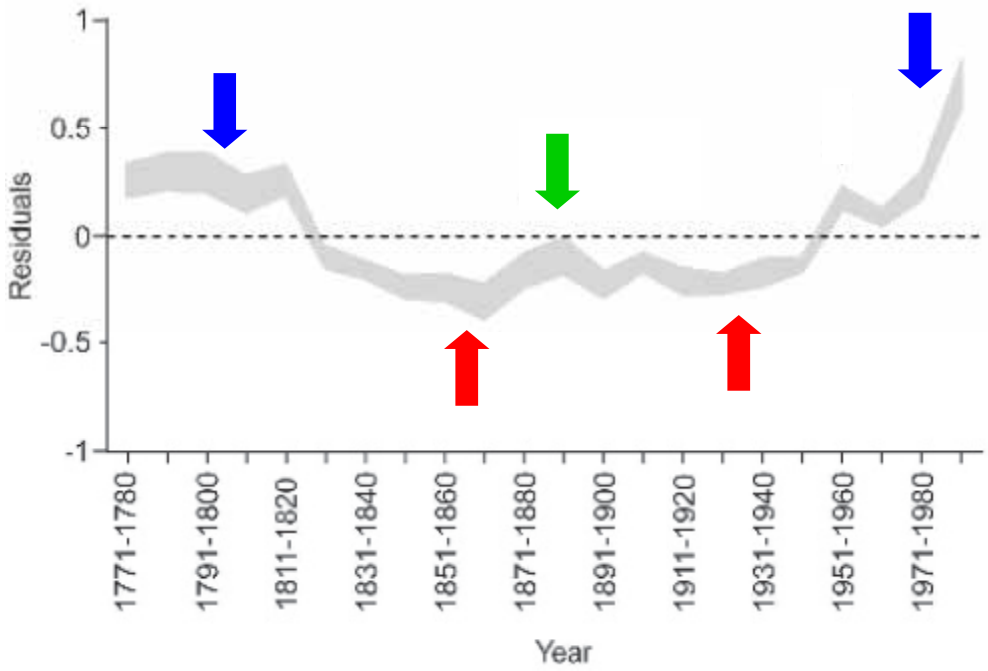


- ✓ ***Same trend as census***

Tree-ring analyse

LRH past activity

- ✓ ***2 major periods of activity:***
  - late 1700 – early 1800
  - late 1900
- ✓ ***Low-to-moderate period:***
  - late 1800 – early 1900
- ✓ ***2 minor periods:***
  - mid 1800 & 1900



- ✓ ***Method open possibility of assessing caribou activity in time & space***