Managing Canada's Arctic National Parks in a Rapidly Changing World

Designing and Implementing Ecological Integrity Monitoring

Forum on Ecoregional Monitoring
Anchorage, Alaska
April 2009

Torngat Mountains National Park, Labrador

Presentation Outline

- Why monitor?
- What's the question?
- PCA program design
- Implementation progress
- A developing program for Arctic national parks
- What about climate change?
- Success through cooperation

PCA Legislation

Parks Canada Legislation

"Maintenance or restoration of *ecological integrity*, through the protection of natural resources and natural processes, shall be the first priority of the Minister when considering all aspects of the management of parks."

Section 8. (2) Canada National Parks Act (2001)

Ecological Integrity Defined

"….'ecosystem integrity' means, with respect to a park, a condition that is determined to be characteristic of its natural region and likely to persist, including abiotic components and the composition and abundance of native species and biological communities, rates of change, and supporting processes".

Section 2. (1) Canada National Parks Act (2001)

Reporting on Corporate Plan Expectations

Level	Expected Results	Indicators	Performance Expectations	Accountability
Strategic Outcome	Same as SO	Overall state of EI in national parks (from SOPRs)	Maintain or improve the overall EI in all national parks from March 2008 to March 2013	Executive

Level	Expected Results	Indicators	Performance Expectations
PA2	Management actions result in improvements to EI indicators in NPs	State of EI indicators in national parks	*90%* of national parks have *at least 1 improved EI indicator* from March 2008-13

Reporting on Corporate Plan Expectations

Level	Expected Results	Indicators	Performance Expectations	Accountability
Strategic Outcome	Same a SO	(from SOFRs)	March 2015	Executive

What is the state of park EI?

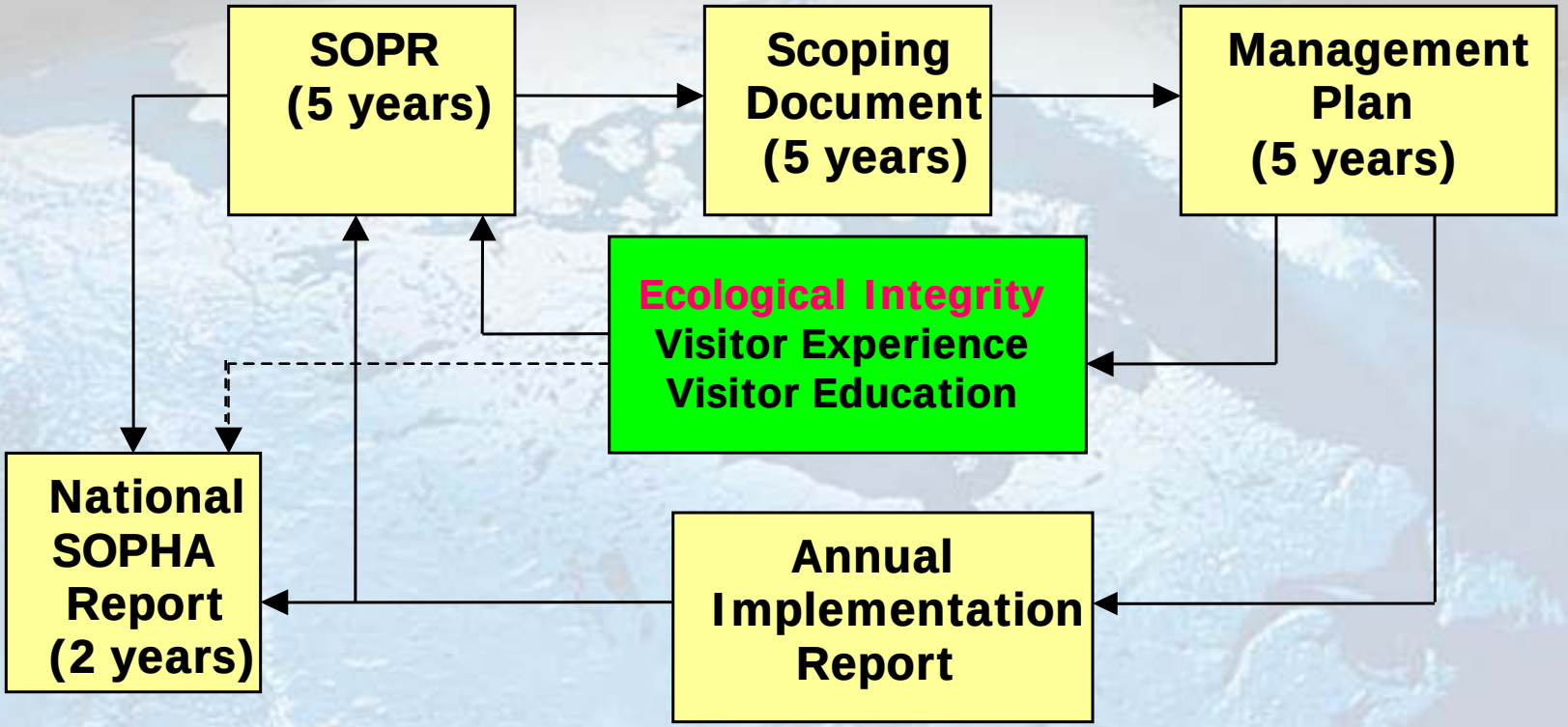
Park Condition Monitoring

Level	Expected Results	Indicators	Performance Expectations
P/	EI indicators in NPs	parks	

How do our management actions affect park EI?

Park Effectiveness Monitoring

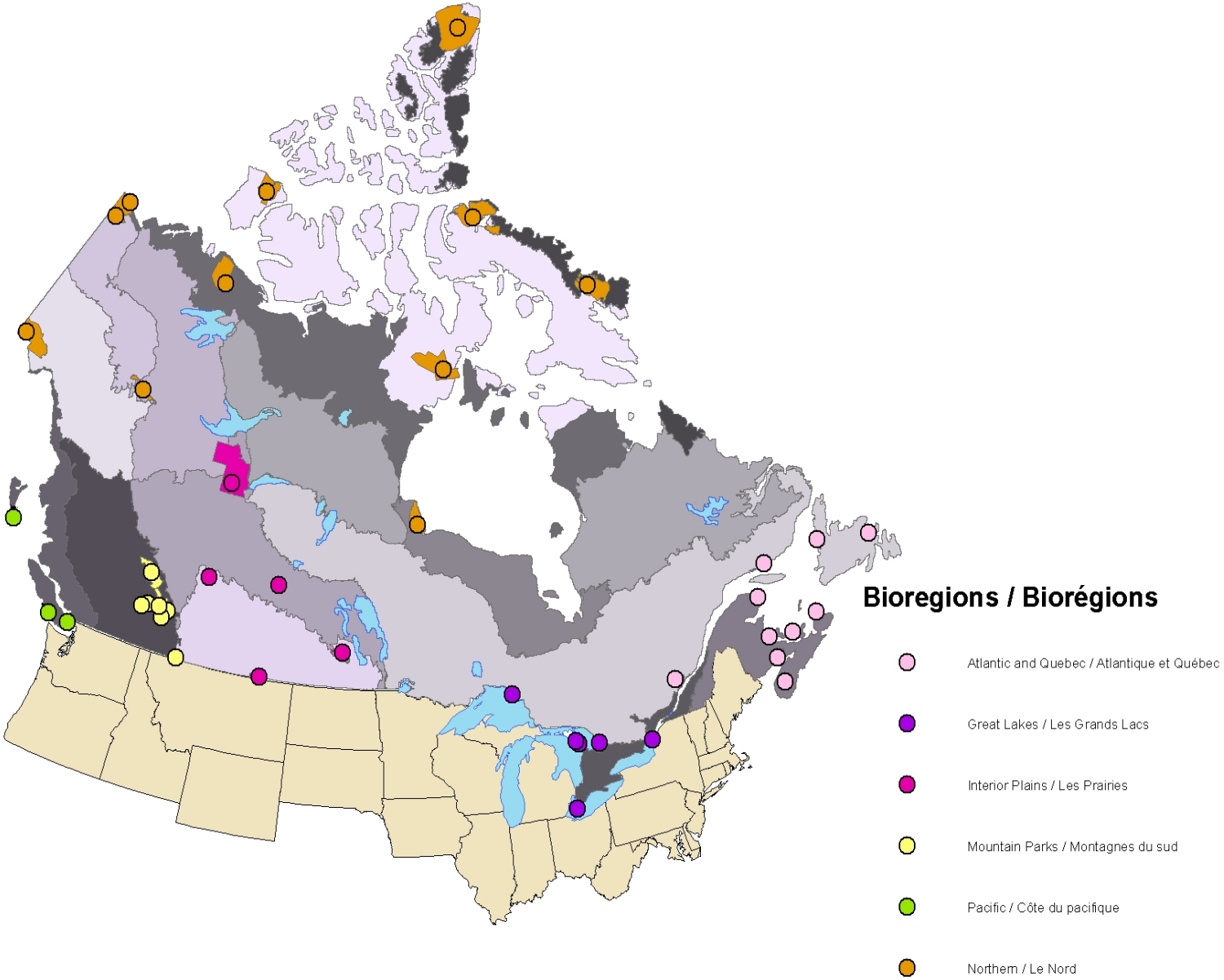
Monitoring as a Management Tool



State of the Park Report Summary
Gros Morne National Park

Indicator: Ecosystem Type	Percentage of Park Area	Condition and Trend	Rationale
Forest	44	↓	High moose density - regeneration affected. Habitat loss from forestry. High percentage non-native mammals
Barrens	35	↓	Woodland caribou decline. Increasing human use. Increasing non-native species
Wetland	11	↓	Damage from snowmobiles. Woodland caribou declines.
Freshwater	8.8	↔	Healthy fish and invertebrate populations.Atlantic salmon, brook trout concerns
Seacoast	0.2	↑	Recovering from historic grazing, trampling and human use. Seabird populations healthy
Marine	1	↓	Over-exploitation of fish species, pollution, garbage

Bioregional Groups of Canada's National Parks by Ecozone
Les groupes biorégionaux des parcs nationaux de Canada, par écozone



February 2004

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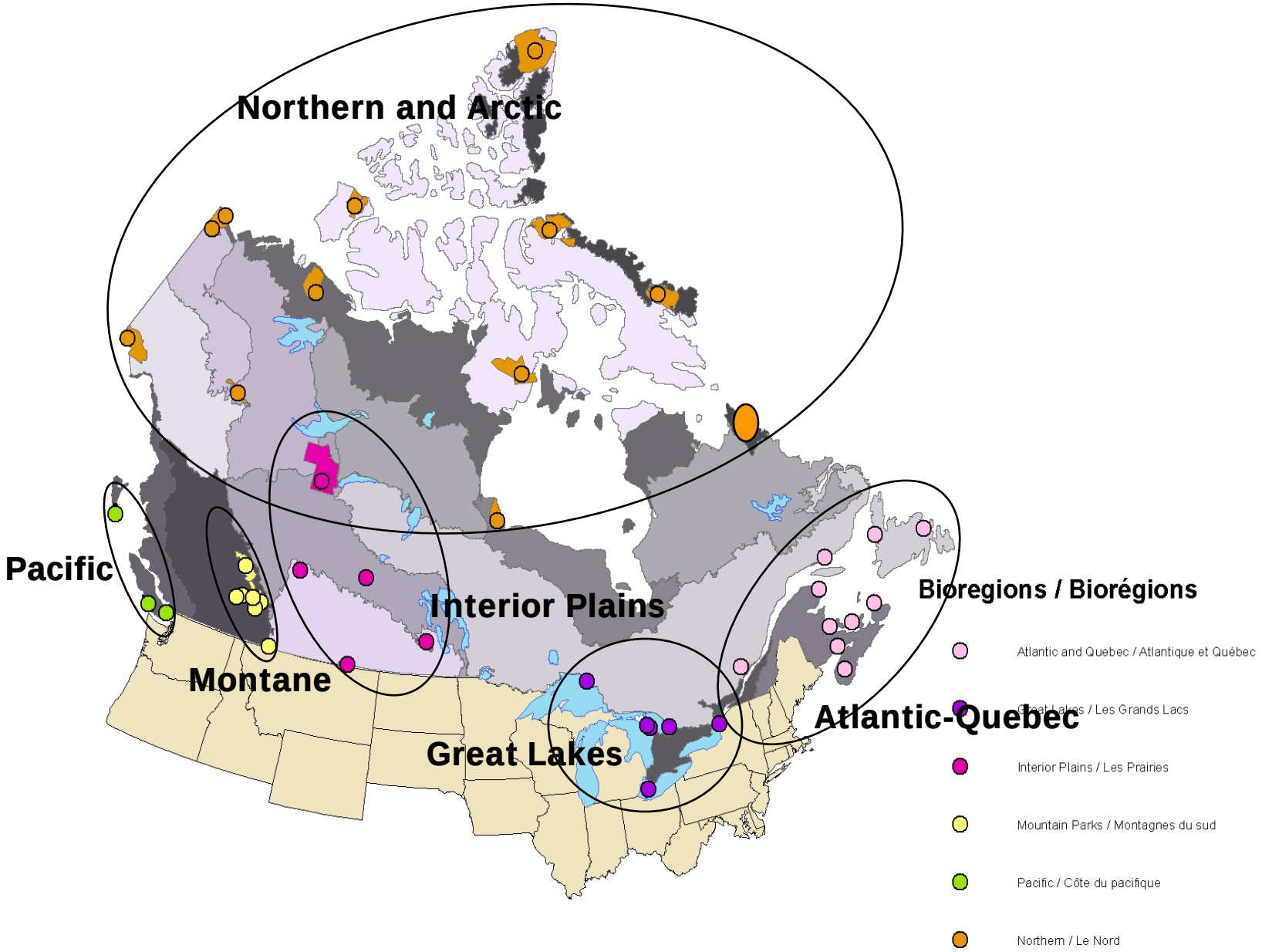


February 2004

EI INDICATORS by BIOREGION

The North	Pacific Coastal	Interior Plains	Great Lakes	Quebec Atlantic	Montane Cordilleran
Forest	Forests and woodlands	Forest	Forest	Forest	Terrestrial Ecosystems
Tundra	Non-forest	Grasslands	Non-forest	'Barrens'	
Wetlands	Lakes and wetlands	Wetlands	Wetlands	Wetlands	Aquatic Ecosystems
Freshwater	Streams and rivers	Lakes	Lakes	Freshwater (Lakes)	Native Biodiversity
Glaciers	Islets/shorelines	Streams	Streams	Freshwater (Streams)	Geology and landscapes
Coastal	Inter-tidal		Great Lakes Shore	Coast	Climate and atmosphere
Marine	Sub-tidal			Marine	support for EI

PCA EI MONITORING FRAMEWORK

Biodiversity

Species Lists
- native species
- alien invasive species

Focal Species
- mortality/natility
- immigration/emigration
- viability/persistence

Trophic Structure
- size class distribution
- predation levels

Structure/Processes

Local Ecosystems
- suite of measures that monitor most important structure and process changes at a local ecosystem scale

Landscapes
- suite of measures that monitor most important structure and process changes at a landscape ecosystem scale

Stressors/Drivers

Inside Park
- most critical in-park stressors/drivers

Outside Park (GPE)
- most critical GPE stressors/drivers

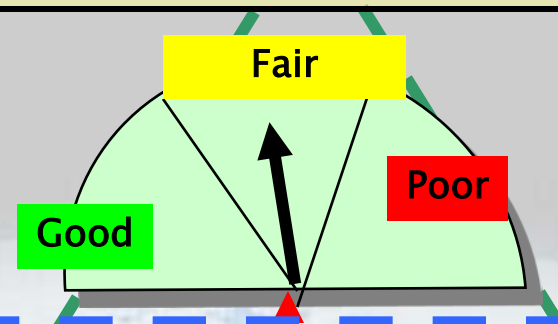
Outside Park (Long Distance)
- most critical long distance stressors/drivers

Ecologically Comprehensive

EI INDICATOR	EI FRAMEWORK		
	Biodiversity	Processes	Stressors
Tundra	√	√	√
Wetlands	√	√	√
Lakes	√	√	√
Streams	√	√	√
Coastal	√	√	√
Marine	√	√	√
Glaciers	√	√	√

Final Results SOPR Information

Tundra EI Indicator



Local Level Tundra EI

Landscape Level Tundra EI

ASSESSMENT

Models

↑

Measures

↑

Data

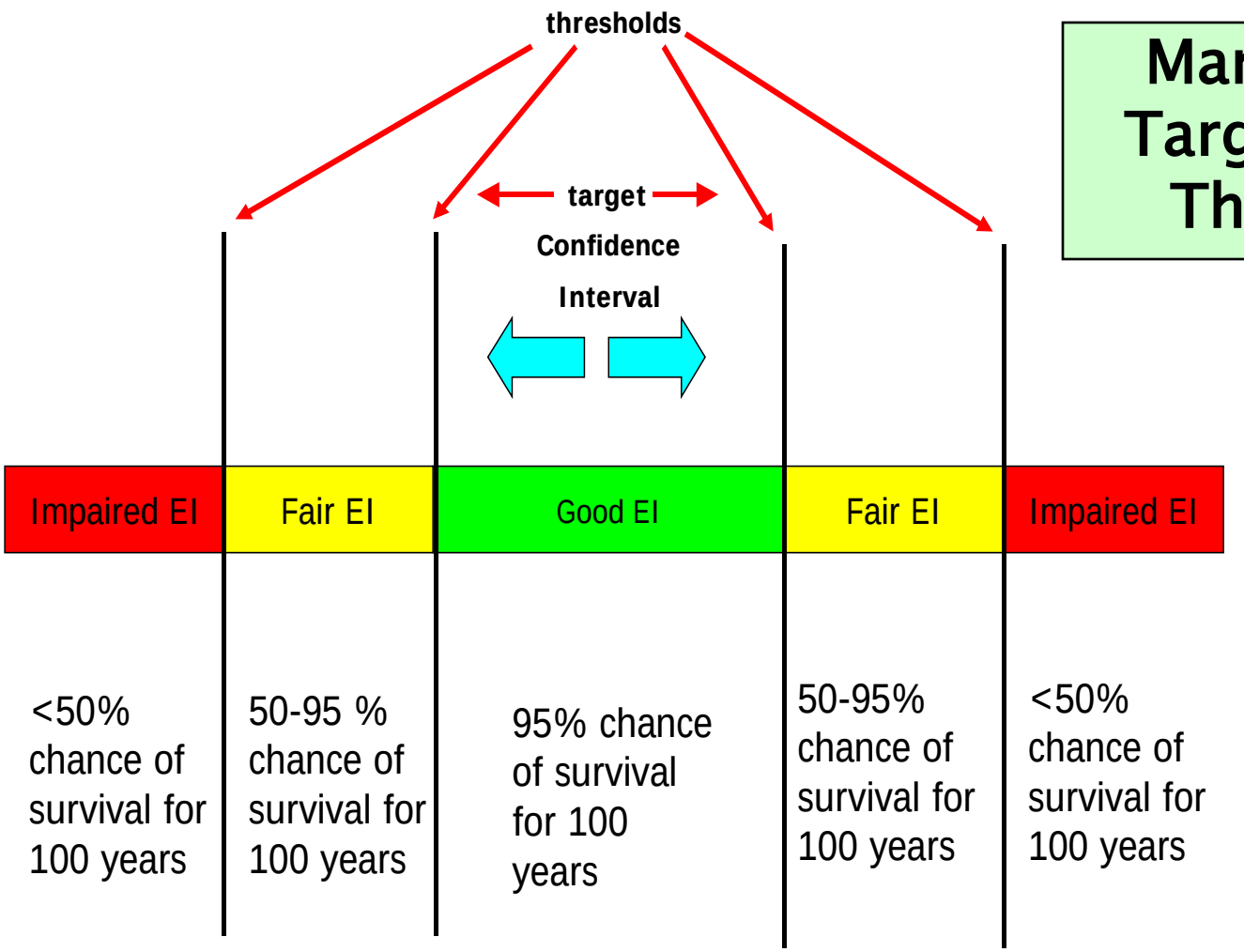
species (α) diversity, species relative abundance, alien invasive species, soil decomposition, active layer depth, soil temperature, soil arthropods, small mammals

plots

tundra community (β) diversity, habitat index, tree line shifts, tundra shrub increase, tundra productivity (NDVI/NPP), phenology

remote sensing

Management Targets and EI Thresholds



% Chance of survival – Mountain Caribou

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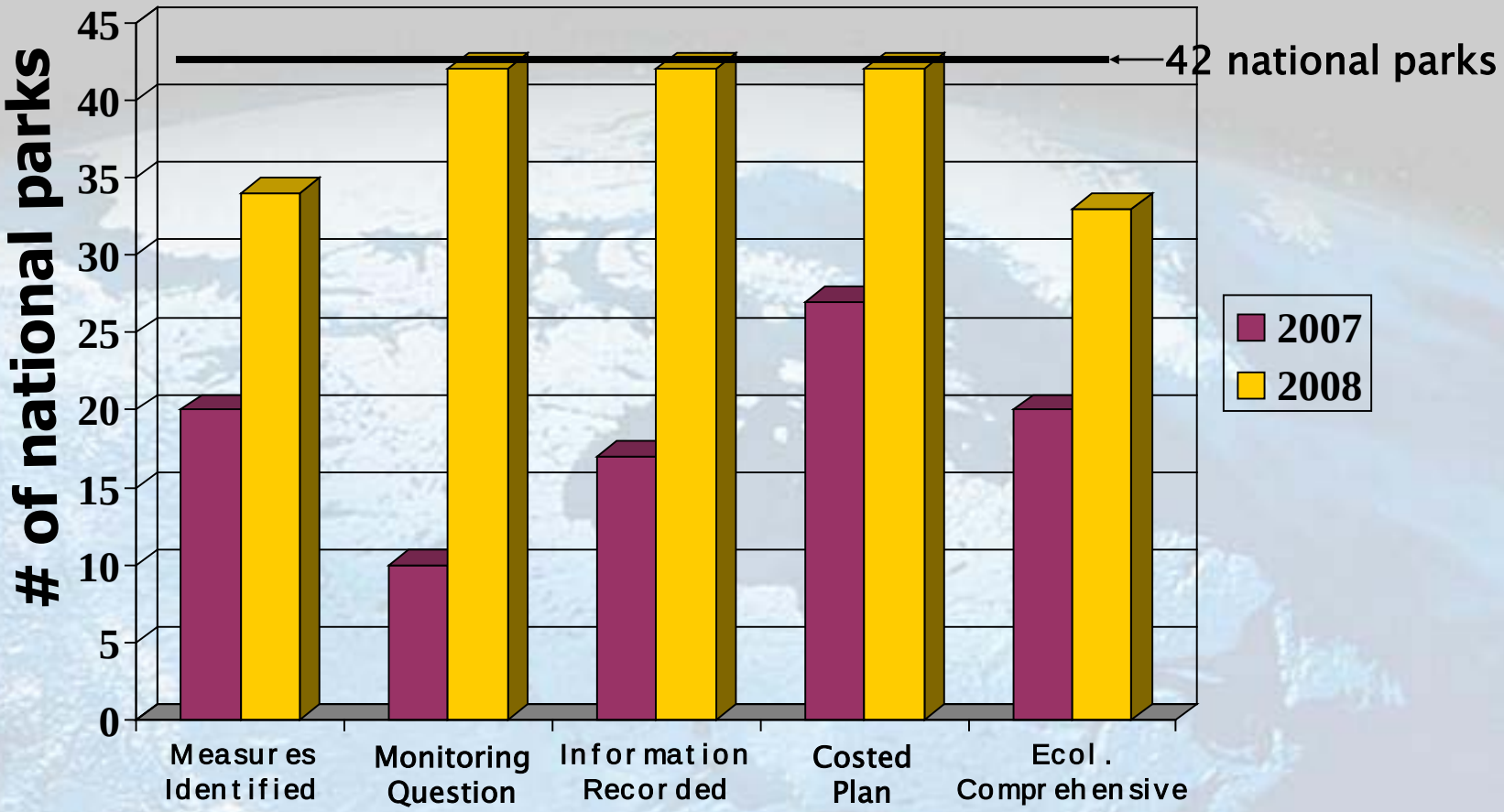
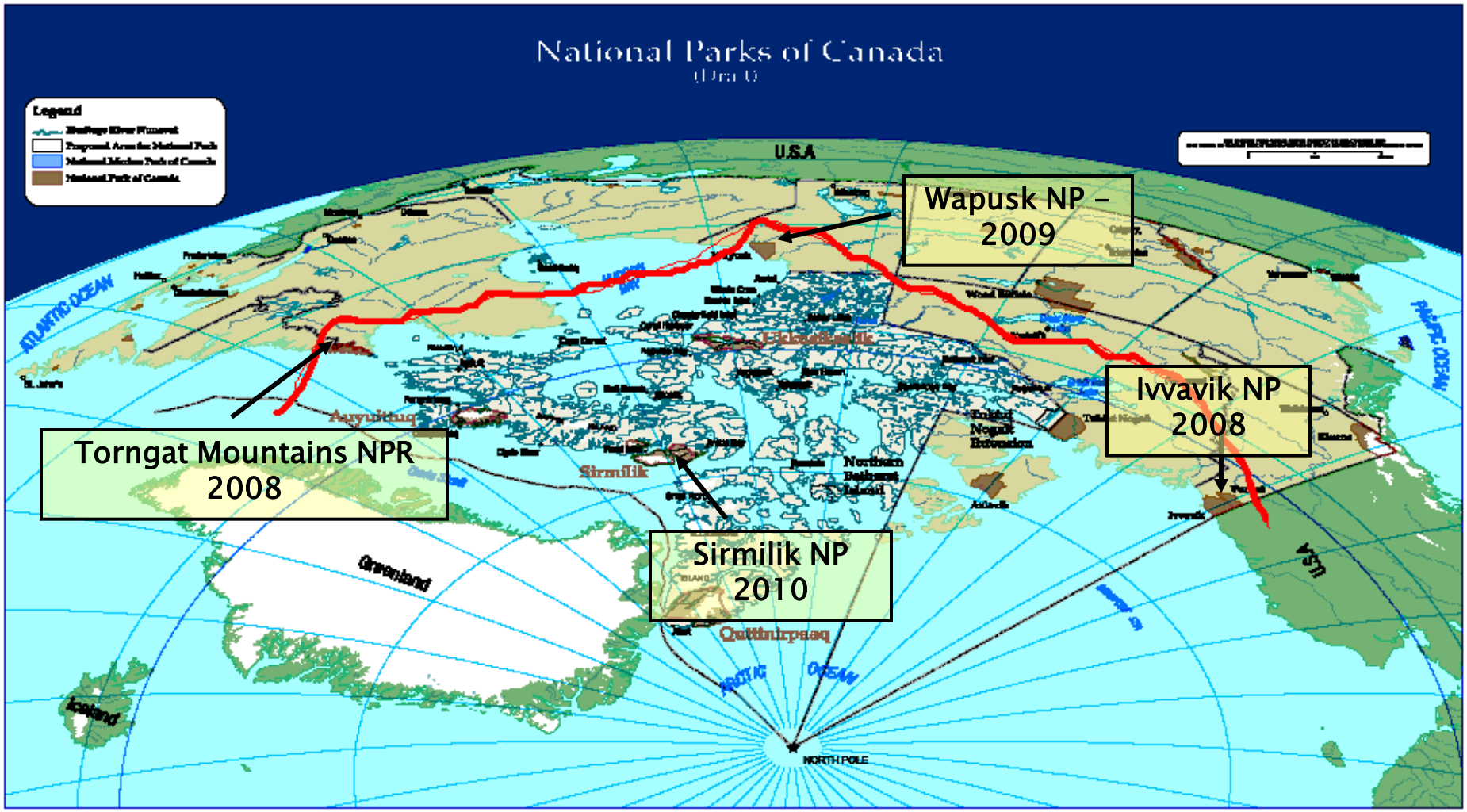
Program Progress To Date



Northern Challenges

1. Staffing – not enough science staff to do the work to design and implement the program – science/technical staff hirings
2. Large parks, expensive access and the costs of field sampling for EI monitoring – larger reliance on RS (IPY – ParkSPACE); multi-stage sample design for ground plots
3. Lack of arctic-specific technical and scientific expertise to establish and maintain EI monitoring programs – cultivate academic and government partners – IPY
4. Lack of baseline ecological information to understand key ecological issues and design cost effective EI monitoring and reporting programs – process based inventories – IPY
5. Difficult of accounting for Inuit concerns and issues through EI monitoring – park co-management boards



International Polar Year

ParkSPACE – CSA/CCRS

Develop Remote Sensing Tools

- ParkSPACE project – CSA funded – CCRS partners
- WP1 – develop new RS approaches for inventory and monitoring Artic ecosystems – process based inventories, NPP/NDVI, wetlands and RS2, regional permafrost modeling
- WP2 – Operationalization of Arctic RS: staffing and training, protocols, data management, monitoring questions
- WP3 – Communication and Outreach

Landscape Scale EI Measures in Development for Arctic Parks (1)

Tundra	• Change in area of tundra ecotypes • Change in tundra vegetation biomass/LAI • Change in tundra growing season length • Change in tundra snow phenology
Freshwater	• Change in lake ice phenology • Change in river ice phenology • Change in lake surface area
Wetlands	• Change in area of wetland ecotypes • Change in wetland physiognomy/structure • Change in wetland vegetation biomass/LAI • Change in wetland snow phenology

Landscape Scale EI Measures in Development for Arctic Parks (2)

Coastal	• Change in area of coastal ecotypes • Change in biomass/LAI of coastal ecotypes • Change in sea ice phenology • Change in rate of shoreline erosion • Change in sea surface temperatures
Forest	• Change in area of forest ecotypes • Change in forest vegetation biomass/LAI • Change in forest growing season length • Change in forest snow phenology

Multi-Stage Monitoring Sample Design

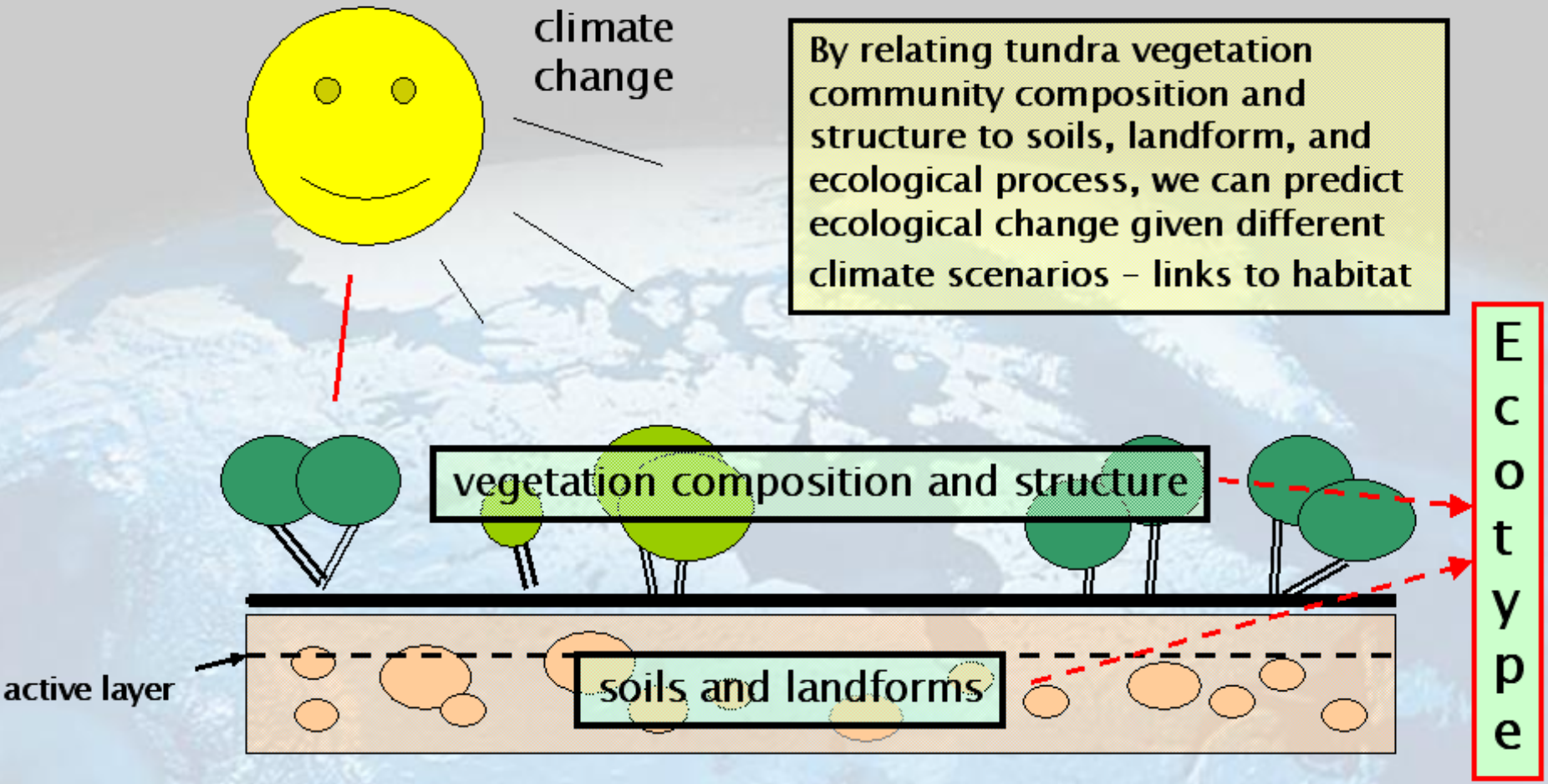
GPE	RS coverage of park GPE
Park	Limited ground sampling linked to focal watershed sampling; RS coverage
Focal Watershed	Integrated multi-scale sampling of terrestrial, wetland, freshwater and coastal ecosystems within one park watershed
Focal Ecotypes	2-3 ecotypes per Indicator selected for establishing replicated long term tundra/wetland monitoring plots; stream/lake habitats

Need for Inventory – ParkSPACE WP1/IPY

- need to understand distribution and composition of ecological communities across the park landscape
  - mapping and classifying terrestrial, wetlands and estuarine/shoreline ecosystems
  - sampling and inventory of freshwater and pelagic marine ecosystems

- also need to understand the ecological drivers that control the distribution and composition of ecological communities – link communities to drivers and modelling
  - 'ecotype' and 'bioclimate' concepts for terrestrial
  - assessment of drivers for freshwater and pelagic marine ecosystems

Terrestrial Ecosystem Mapping – Delineating Ecotypes



Similar ecological conditions affecting Ecotypes results in similar plant communities that can be classified into vegetation associations

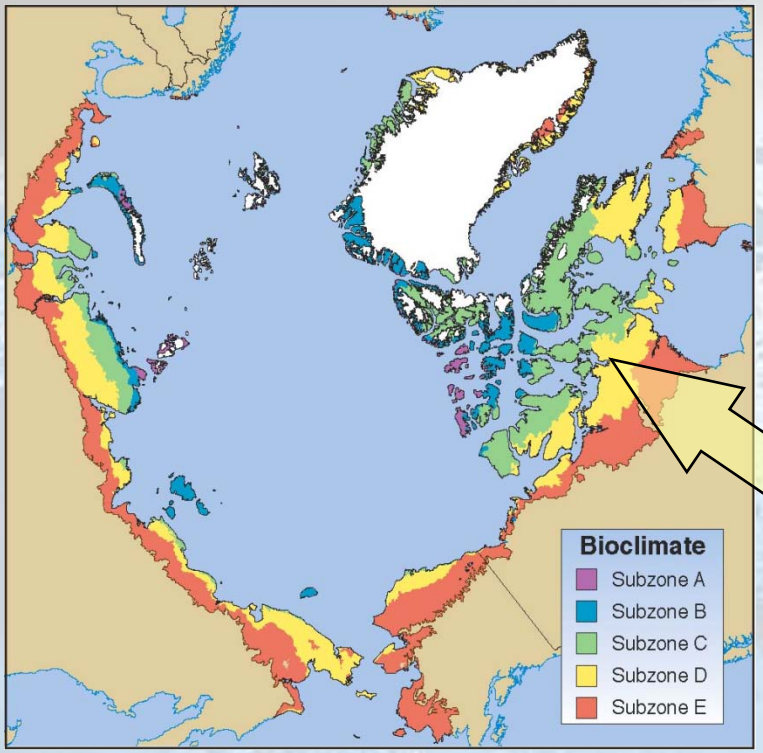
Revised FGDC Hierarchy	Example
Upper Level	
Level 1 – Formation Class	Cryomorphic Shrub and Herb Vegetation
Level 2 – Formation Subclass	Polar Tundra Shrub and Herb Vegetation
Level 3 – Formation	Polar Dwarf Shrub Tundra
Mid Level	
Level 4 – Division	North American Dwarf Shrub Tundra
Level 5 – Macrogroup	Southern Arctic Dwarf Shrub Tundra
Level 6 – Group	Southern Arctic Dwarf Shrub Tundra – Edmonson Plain
Lower Level	
Level 7 – Alliance	Dwarf Birch–Labrador tea Alliance
Level 8 – Association	Dwarf Birch–Labrador tea– Arctostaphylos Association

Zonal Ecotypes

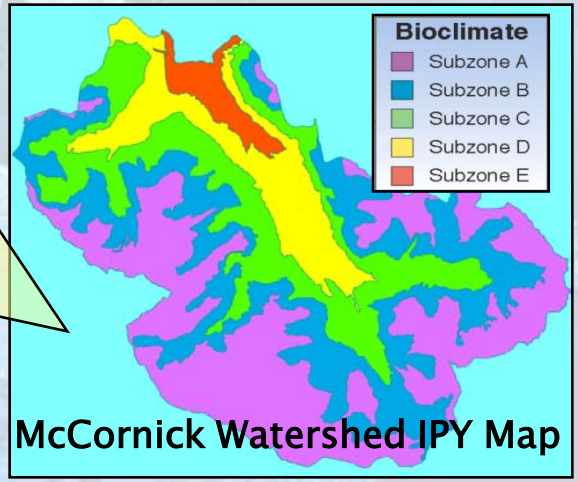
Developing a Bioclimate Classification

Code	CAVM name	TMNPR Project Name	Elevation Distribution In TMNPR[1]
A	Polar Desert	Lichen-Herb Tundra	> 900 m
B	High Arctic Tundra	Herb-Lichen - Cushion Tundra	600 - 900 m
C	Low Arctic Tundra	Dwarf Shrub Tundra	300 - 600 m
D	High Hypoarctic Tundra	Low Erect Shrub - Dwarf Shrub Tundra	50 - 300 m
E	Low Hypoarctic Tundra	Low Erect Shrub Tundra	0 - 50 m

[1] for TMNPR south of Nachvak Fiord

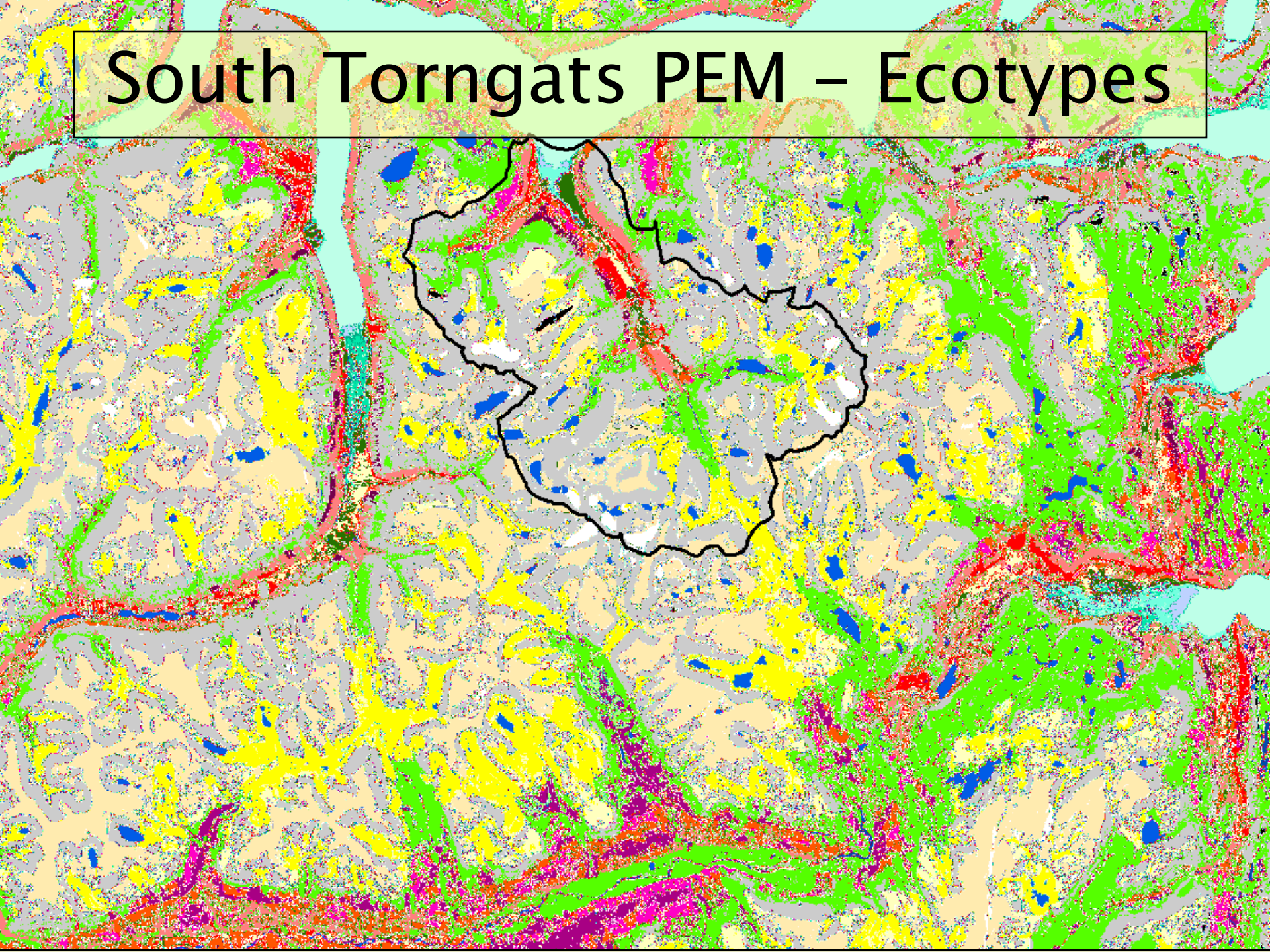


Circum-Arctic Vegetation Map (CAVM)

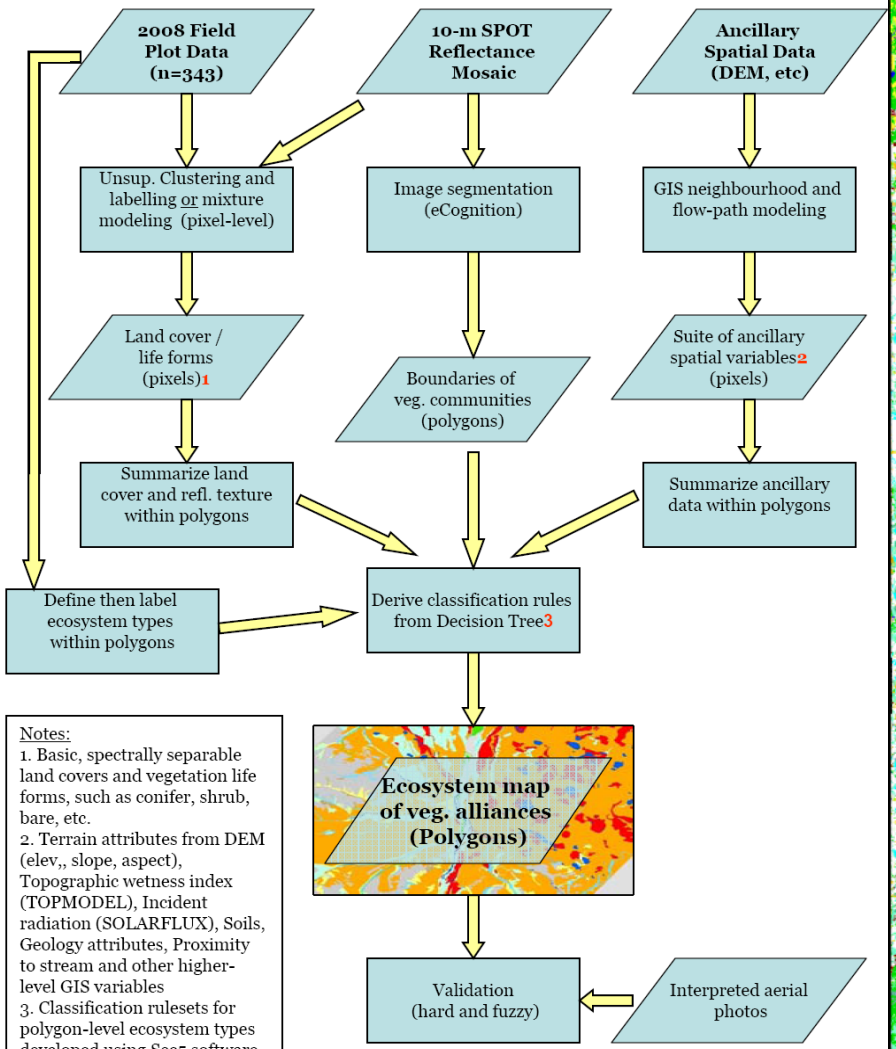


McCornick Watershed IPY Map

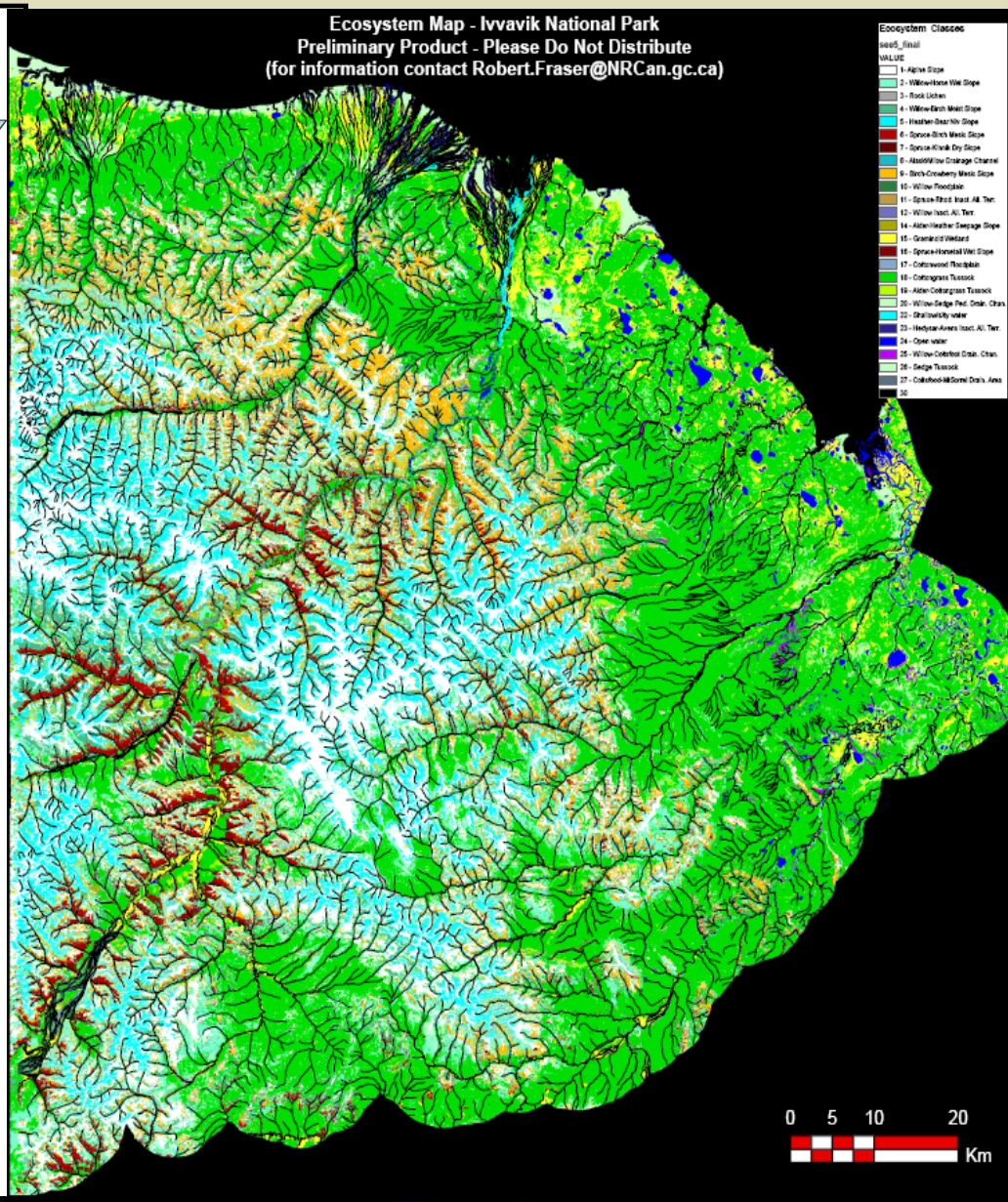
South Torngats PEM – Ecotypes



GRIP-2 Proposed Ecological Classification Approach



Notes:
1. Basic, spectrally separable land covers and vegetation life forms, such as conifer, shrub, bare, etc.
2. Terrain attributes from DEM (elev,, slope, aspect), Topographic wetness index (TOPMODEL), Incident radiation (SOLARFLUX), Soils, Geology attributes, Proximity to stream and other higher-level GIS variables
3. Classification rulesets for polygon-level ecosystem types developed using See5 software.



Example EI Measures
Long Term Tundra/Wetland Plots

Plot-based
(museum volunteers/park technical)

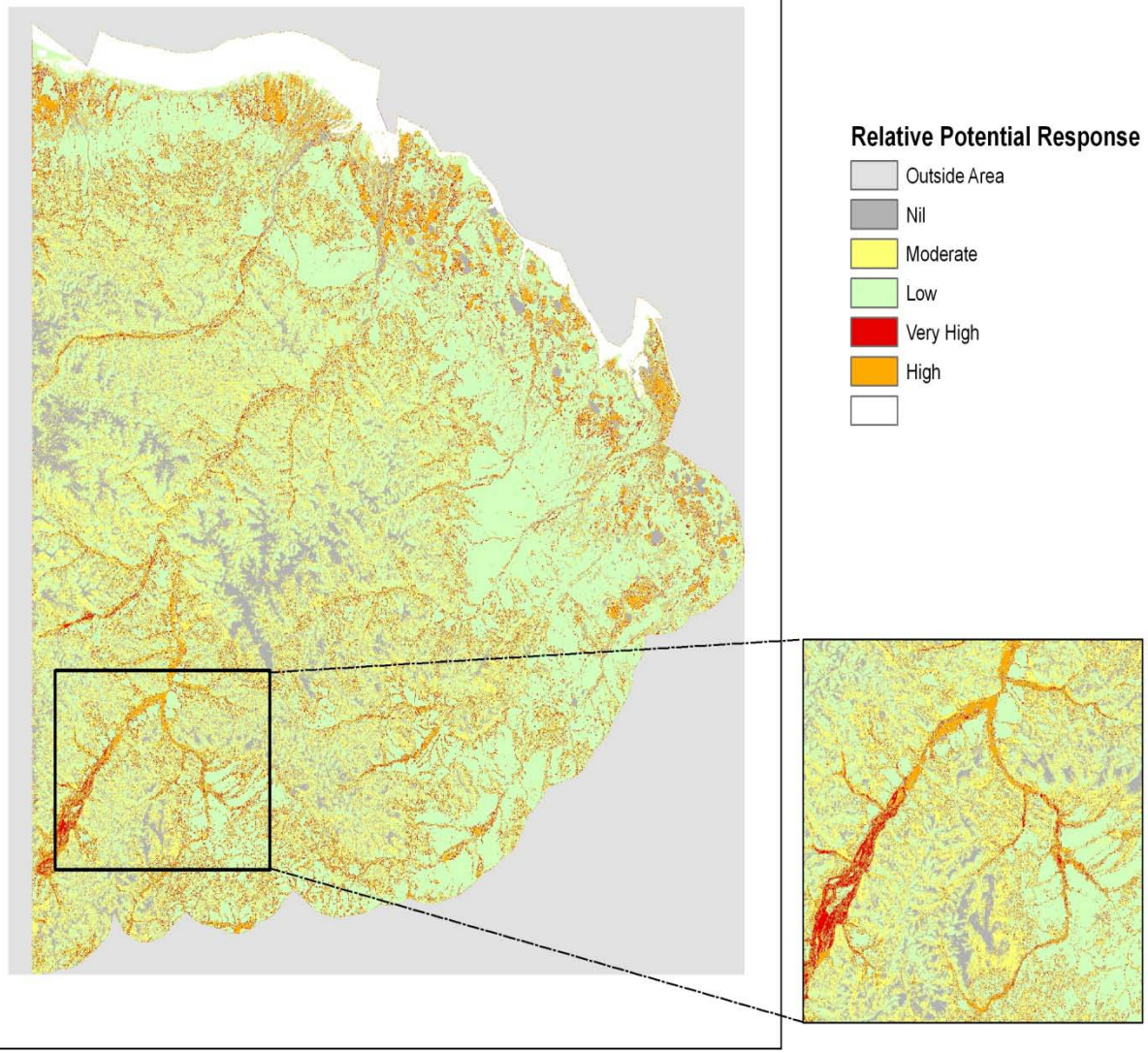
1. Change in plant species (5 yrs)
2. Change in plant species relative abundance (5 yrs)
3. Plant productivity change (5 yrs)

Ecotype-Related
(park biologists)

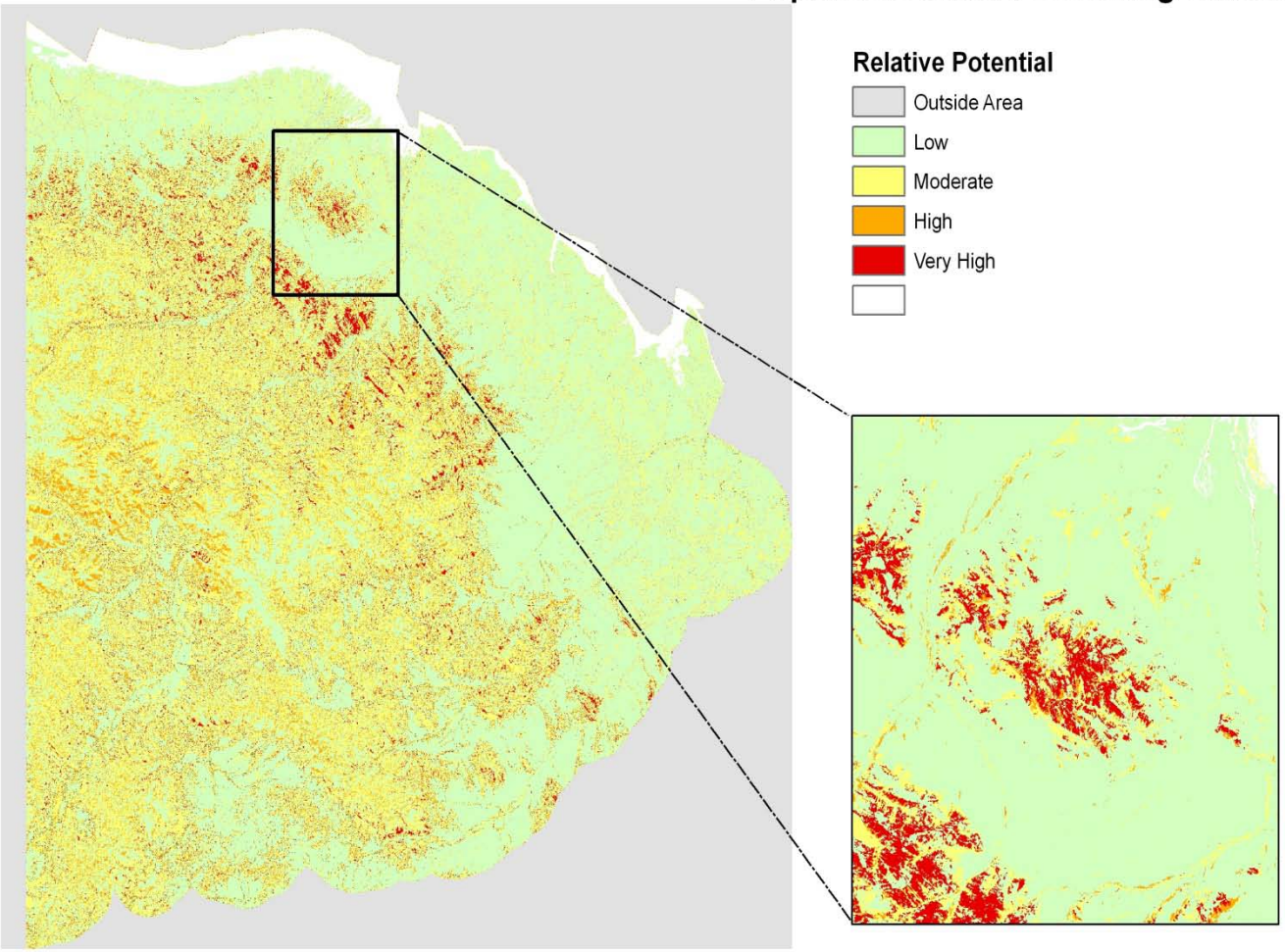
4. tundra songbirds (2 yrs)
5. soil arthropods (5 yrs)
6. lemmings (2 yrs)

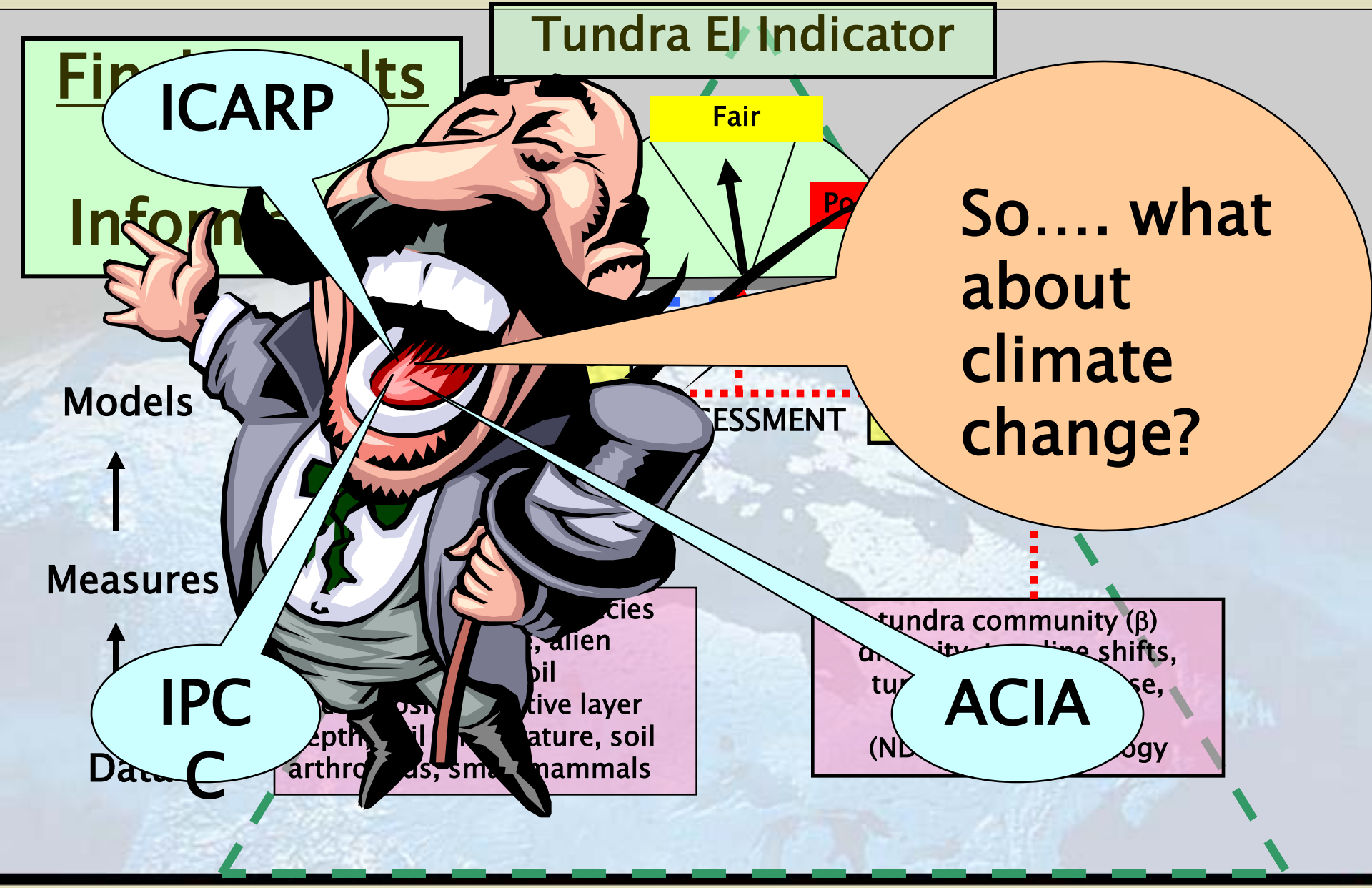
Plot Adjacent
(park technical)

7. Soil decomposition (annual)
8. Active layer depth – frost tube (annual)
9. Soil temperature (annual)


Relative Potential Rresponse To A
40% Increase In Annual Precipiotation
Relative Potential Response
Outside Area
Nil
Moderate
Low
Very High
High

Relative Potential For Shrub Expansion Under A Warming Climate




Tundra EI Indicator
Fair
ICARP
So…. what about climate change?
Models
Measures
IPCC
ACIA
ESSMENT
tundra community (β)

‘On the Horns of a Dilemma’

Ecological change to result from predicted climate change

1. alters our fundamental conservation paradigm of what a ‘protected area’ is, i.e., representative of a relatively stable natural area – inherent in our definition of EI ‘…likely to persist’
2. also changes the notion that we can base monitoring thresholds (‘maintain EI’) on an analysis of historical rates of change that represent natural variability of a ‘protected area’
3. Requires new thinking on these fundamental issues – ‘stationarity is dead’ (Milly et al. 2008. Science, Vol 319, pp 573-574)
4. Underscores the role of existing protected areas, and monitoring within protected areas, as benchmarks of ecological change

Ecological Integrity

"….'ecosystem integrity' means, with respect to a park, a condition that is determined to be characteristic of its natural region and *likely to persist*, including abiotic components and the composition and abundance of native species and biological communities, rates of change, and supporting processes".

"(Dynamic) Ecological Integrity"??

"….'(dynamic) ecosystem integrity' means, with respect to a park, a condition that is determined to be *characteristic of the evolving natural region it represents*, including abiotic components and the composition and abundance of native species and biological communities, rates of change, and supporting processes".

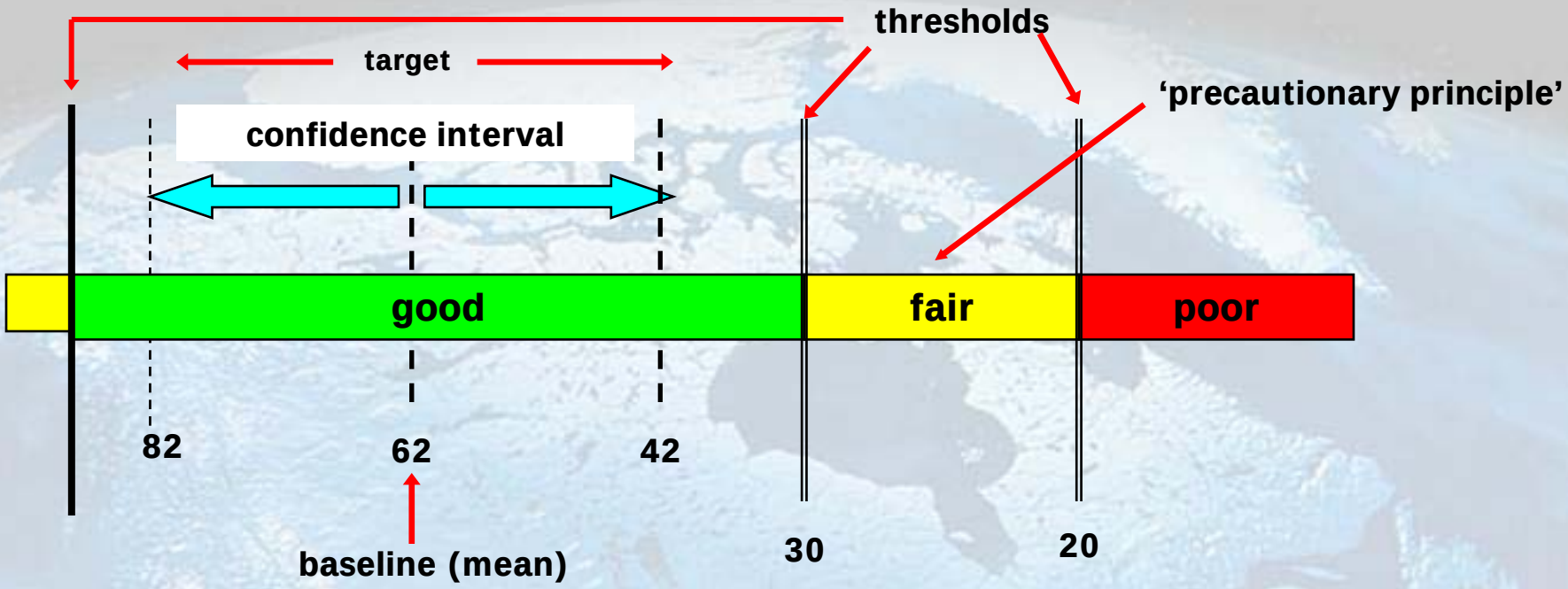
New Conservation Directions

1. accept change
2. ‘navigate’ the unknown
3. look forward – not back
4. embrace risk
5. manage for social-ecological resilience

National Parks Covered by the Northern Strategy

Western Newfoundland	Torngat Mountains NPR, 2005	Labrador Inuit Land Claim Agreement, 2005 (Nunavik Land Claim Agreement)
Nunavut	Quttinirpaaq,1988 Auyuittuq,1972 Ukkusiksalik, 2007? Sirmilik, 2001	Nunavut Land Claims Agreement, 1993
Western Arctic	Aulavik 1984 Ivvavik 1984 Tuktut Nogait 1984	Inuvialuit Final Agreement, 1984
Manitoba	Wapusk, 1996	Wapusk Mgt Brd includes York Factory First Nation and Fox Lake Cree Nation (+feds, province, Churchill)
Yukon	Vuntut, 1995	Vuntut-Gwitchin First Nations Final Agreement, 1995

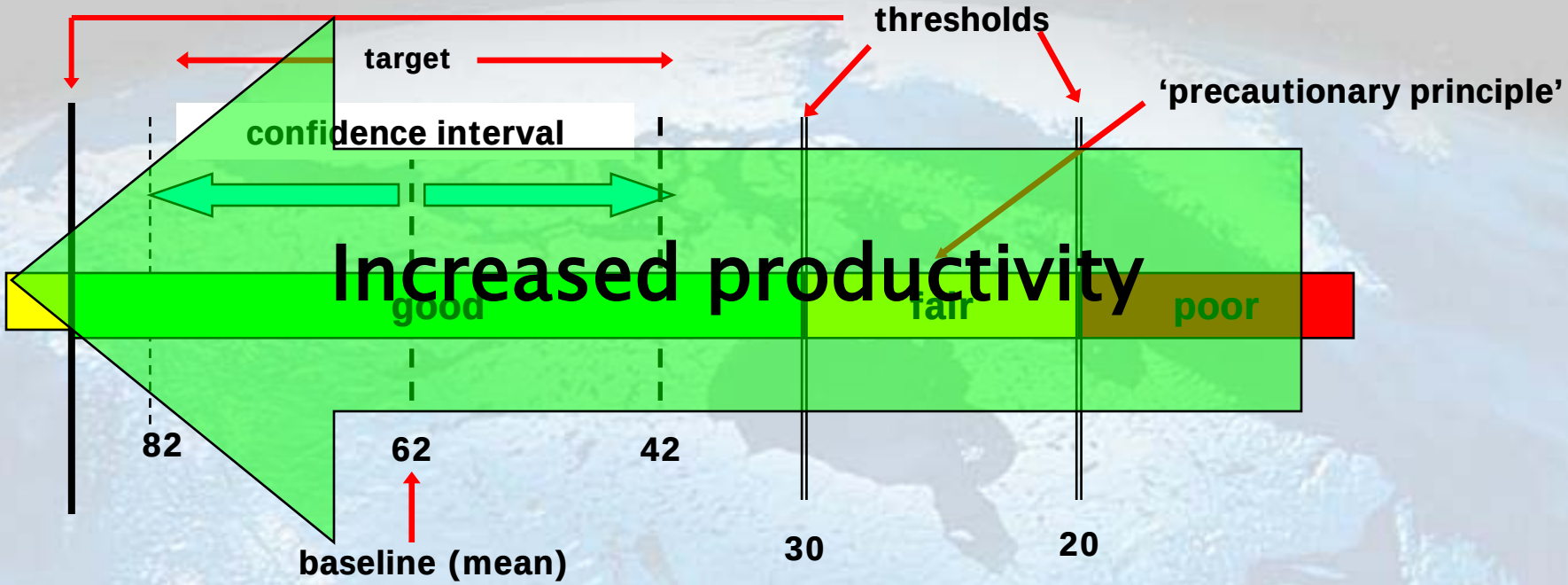
What About Thresholds?



Dry Weight Loss of Decay Sticks

(percent dry weight loss)

What About Thresholds?



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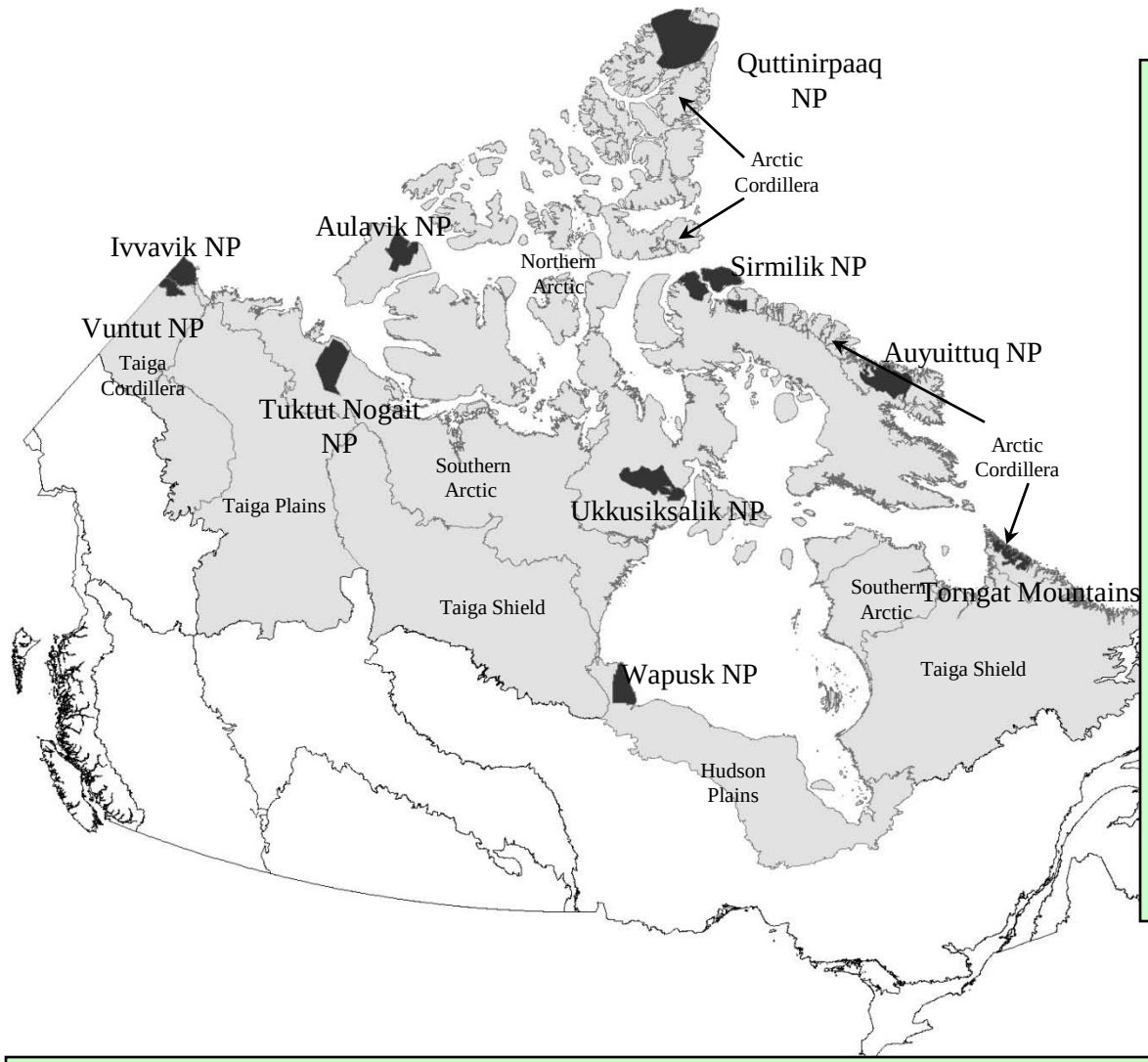


Arctic National Parks As Anchors of Arctic Monitoring

1. very large (166,000 km²)
2. mostly still intact – 'baselines' of change
3. high terrestrial ecological representation
4. co-managed with Indigenous partners
5. Staff present in the North and operational in the field
6. More science monitoring staff than any other agency

Success Through Cooperation (1)

Success Through Cooperation (2)

Protected Areas as INORMS

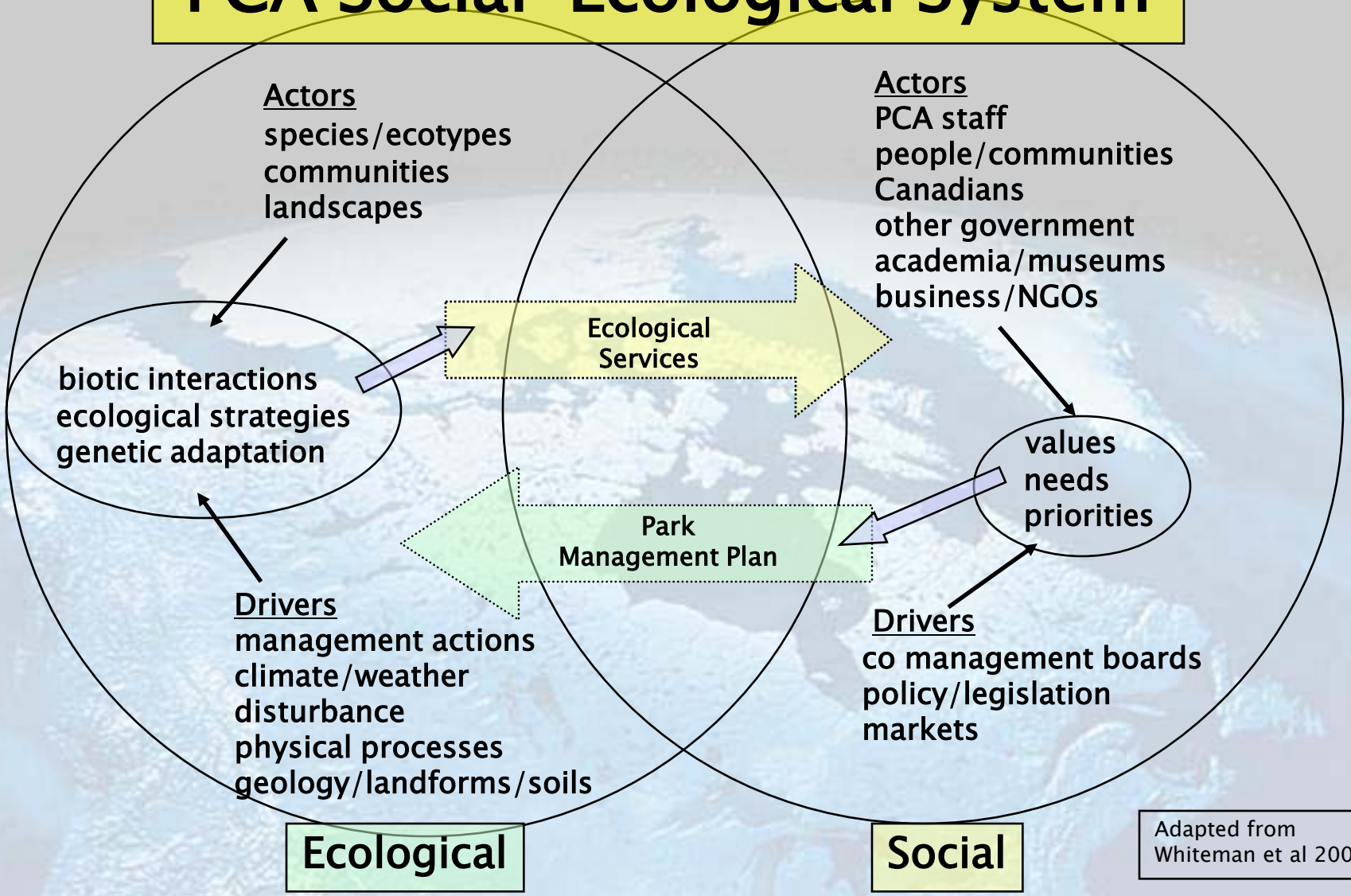
i. parks as ecological reference areas to track ecological change in the Canadian Arctic – focus and optimize federal initiatives
ii. Build on ongoing cooperation to formalize science for climate adaptation (other govs, academics, museums)
iii. Focus on social ecological resilience; promote community monitoring and citizen science
iv. Target monitoring,research and modelling for operational systems, e.g., protected areas
v. Link to other initiatives nationally and internationally – CBMP, SAON – standardize core variables and protocols
vi. CPAN revival – circum-arctic PA monitoring workshop

Success Through Cooperation (3)

- With good long term data from national parks we can better assess the evolving condition of Arctic terrestrial ecosystems and the impacts of planned development
- PCA working alone can do only a very basic job of the monitoring, research and modelling activities required to make informed park management decisions
- clear need to work together with all actors for common objectives – "Arctic Adaptation Cooperative" (…and soon)

working together for a common future

PCA Social–Ecological System



Adapted from Whiteman et al 2004