

DISTRIBUTION & ABUNDANCE CHANGES IN ARCTIC MAMMALS: *Worlds in flux*

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Example Accomplishments

Terrestrial

- Distribution changes in 16 of 67 species
- Barriers to distribution change identified for 23 additional species



Marine

- Abundance trend data for 35% of 78 populations of the 11 species of true Arctic marine mammals



Goals

- Summarize prominent patterns of change in recent mammal distributions and abundances (c. < 50 years)
- Outline dominant future issues
- Suggest potential actions for future stewardship

Pattern: **VERY LITTLE DIRECT EFFECT OF WARMING**

Direct Effect : *Distribution or abundance changes as direct result of changing climate envelope*

- Warming could either:
 - Reduce winter energy costs
 - Increase summer heat stress
- Winter warming - what proportion of energy cost does warming remove?
 - Most likely for hibernators
 - Grizzly bear (expansion)
 - Not likely for active spp.
 - Red fox ???



FUTURE ...

- Heat stress for large ungulates
 - Summer temps above Upper Critical Temperature
- Reduced cold stress for energy - storers (hibernators, beavers) ?
 - Depends heavily on snow pack



Pattern: **MOST DOCUMENTED CHANGES IN DISTRIBUTION FOLLOW CHANGES IN HABITAT**

INDIRECT EFFECTS OF WARMING

HABITAT EXPANSION

- Suitable habitat expands beyond historical distribution and species follows

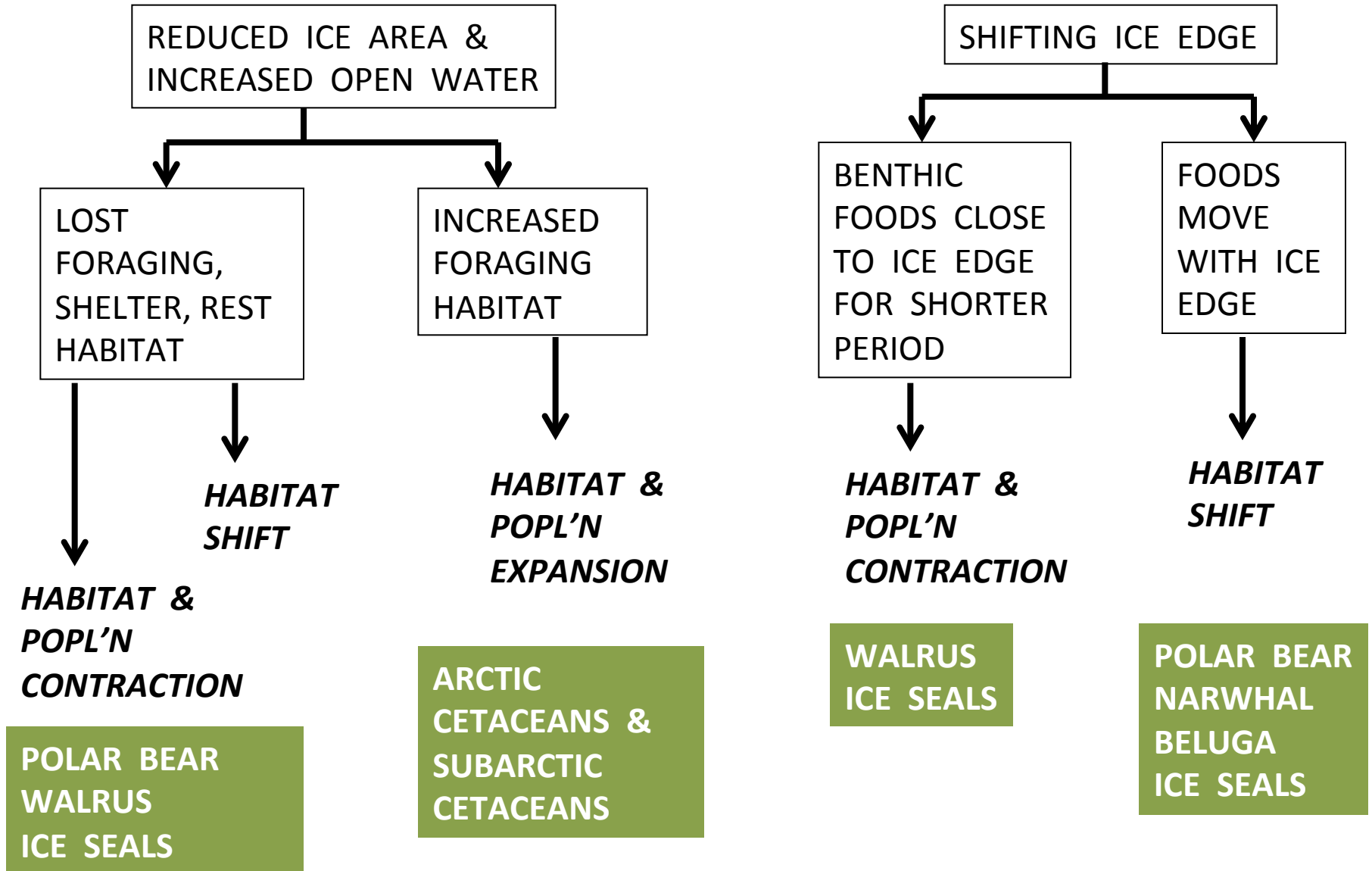
HABITAT CONTRACTION

- Suitable habitat contracts within historical distribution and species moves

HABITAT SHIFT

- Suitable habitat (often seasonal) moves within existing distribution, and species follows

MARINE SUMMER (Subset)



FUTURE

CONTINUED UPHEAVAL FOR ICE-DEPENDENT SPECIES

- FOOD LIMITATION
 - CHANGING FOOD WEBS
 - Moving where ?
 - Timing ?
 - New species ?
 - CHANGING DIETS
 - COMPETITION
- HABITAT LIMITATION
 - SHORELINE REST - Where ?
 - DENNING - Where ?
 - PUPPING & WHELPING - Where ?
- LIMITATION BY STRESS & DISEASE
 - CUMULATIVE STRESSORS REDUCE BODY CONDITION
 - Current body condition, stress and disease levels ?
 - USEFUL MONITORING PARAMETERS



FUTURE

INCREASING CONCERN.....OCEAN ACIDIFICATION

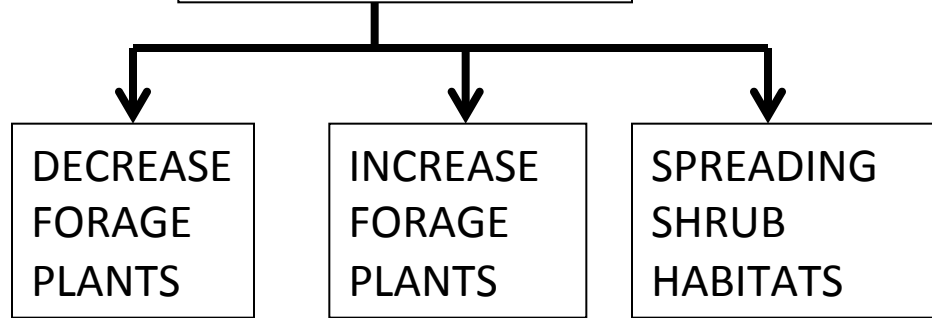
ISSUES:

- LIFE HISTORIES AND SURVIVAL OF PRIMARY AND SECONDARY PRODUCERS
- BOTTOM – UP EFFECTS ON ALL MARINE MAMMALS



TERRESTRIAL SUMMER – HERBIVORES (Subset)

INCREASING NPP *
& DECOMPOSITION



HABITAT & POPL'N CONTRACTION

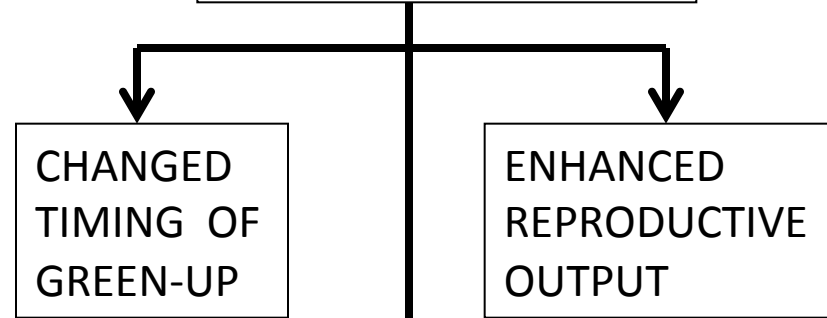
**CARIBOU
LEMMINGS**

HABITAT SHIFT

HABITAT & POPL'N EXPANSION

**SUB-ARCTIC
HERBIVORES**

EARLIER & LONGER
GROWING SEASON



HABITAT & POPL'N CONTRACTION

**MIGRATORY
CARIBOU**

**INCREASED
PARASITE
LOAD**

***HABITAT
SHIFT***

MUSKOX

**ENHANCED
REPRODUCTIVE
OUTPUT**

HABITAT & POPL'N EXPANSION

**VOLES
SHREWS**

* NPP = NET PRIMARY PRODUCTION

FUTURE

CONTINUED EXPANSION OF SUBARCTIC BIOME & RE-ORGANIZATION OF TUNDRA COMMUNITIES

PLANTS

- Community composition & forage species
 - What drives emerging transitions ?
 - Where will they occur ?

HERBIVORES

- Response to changing forage ?
- Influence on community composition ?
- Competition – subarctic & tundra spp ?

CARNIVORES

- Competition – subarctic & tundra spp ?

PARASITES, STRESS & DISEASE

- Monitoring

An aerial photograph of a vast, snow-covered mountain range. The terrain is rugged with numerous ridges and valleys. In the lower-left foreground, a polar bear is visible, partially obscured by the snow. The sky is a pale, overcast blue.

FUTURE ...
CONTINUED CHANGES IN SNOW PACK
(Crucial Feature of Habitat Structure)

TIMING

- **GEOGRAPHY OF ONSET AND MELT**

DEPTH

- **TOPOGRAPHIC DETERMINANTS OF DEPTH**
- **INSULATION PROFILES DURING WINTER**

DENSITY

- **THAW – REFREEZE RISK PROFILES**

Pattern: **MANY TERRESTRIAL SPECIES FACE A MARINE BARRIER**

- All are small bodied insectivores and herbivores
- At least 17 spp.



TUNDRA VOLE CAMERON ECKERT



BROWN LEMMING FRITZ MUELLER

Examples of Marine Barriers

ISLAND ENDEMICIS



ARCTIC GROUND
SQUIRREL



NEARCTIC BROWN
LEMMING



FUTURE ...

Are Marine Barriers a Conservation Issue ?



MAY BE

- Regions with narrow low arctic
- Island endemics

INTRODUCTIONS ??

NO

Why not ?

- Avoid disruptions to existing simple food webs
 - novel predation
 - novel prey
 - novel competition

Pattern: **FOR MANY SPECIES WE KNOW TOO LITTLE**

Terrestrial

- Insufficient distribution data for 35 of 67 spp. (mainly Insectivores & Small Herbivores)



Marine

- Insufficient distribution and abundance data for sub-arctic species (Rorquals & Beaked Whales)



FUTURE ... POSSIBLE DISRUPTORS

- Extreme Weather
 - Ocean Storms
 - Tundra Fires
 - Interrupted Winters & Springs
- Shifts in Ocean Currents
- Climate Engineering
 - Sulphate seeding
 - Acid rain
 - Reduced sunlight



NECESSARY ACTION

NEW PROTECTED AREAS

- Terrestrial
 - High diversity & productivity
 - Refugial areas
 - Connectivity
 - Land refuges for marine spp.
- Marine
 - Coastal zones / deltas
 - Polynyas - seasonal



NECESSARY ACTION

MINIMIZE DISTURBANCE

- Terrestrial
 - Buffers & timing windows for sensitive areas
 - Limited intensity (footprint) of industrial activity
 - Limits on tourism
- Marine
 - Routing, seasonality & speed of marine vessels
 - Timing and intensity of industrial activity



SUSTAINABLE LONG-TERM SUBSISTENCE USE

- Terrestrial & Marine
 - Monitor Population Size - CBMP
 - Monitor Harvest, Body Condition, Contaminants, Pathogens (community-based / science direction)
 - Sustainable fisheries mgmt & technologies
 - Reindeer range assessment & mgmt
 - Co-management with local knowledge



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