

IMPACTS OF CLIMATE CHANGE ON WILDLIFE

DR. SCOTT MILLS
SEPTEMBER 23, 2008

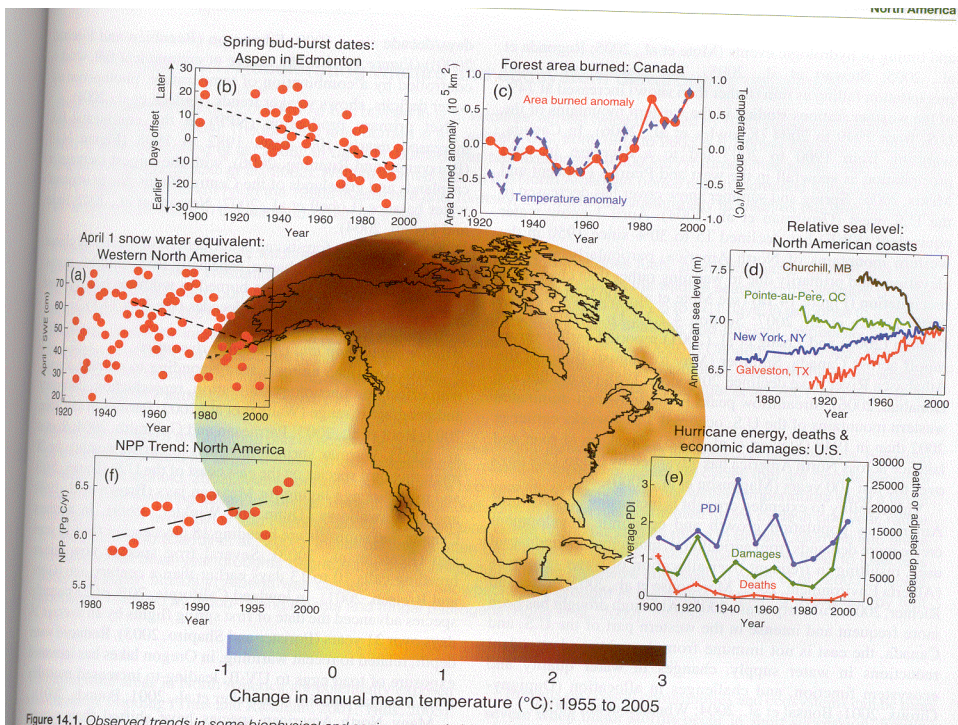


Figure 14.1. Observed trends in some biophysical and socio-economic indicators.

Volume 1, Issue 1 of
Ecology (1920),
first 2 articles:

“The control of pneumonia and influenza by the weather”

“Evidence of climatic effects in the annual rings of
trees.”

**CLIMATE CHANGE EFFECTS ON
WILDLIFE:
ADAPT IN PLACE, MOVE,
OR DIE**

L. Scott Mills,
Wildlife Biology Program
University of Montana

Examples of Adapting In Place

- Red squirrels in northern CA breed 18 days earlier than 10 years ago.
- Frogs initiating calls 10-13 days earlier than century ago.
- 70% of 23 butterfly spp. Advanced date of 1st spring flights by 24 days over 31 year period.
- Also: bud burst, egg laying, emergence, etc.

Two ways that organisms adapt in place:

- Phenotypic plasticity (a.k.a. "acclimation").
 - Adjust morphology, behavior, or physiology
- Evolution by natural selection
 - Genetic changes

Example of plasticity: Yukon red squirrels

1989-2003, 664 marked females.

2 degrees C temp increase,
Less precip.,
Increase in white pine cones.

18 days (6 days/generation)
advance
Of mean lifetime parturition date.

62%: plasticity
(proximal drivers unknown)

Fitness maintained .



Evolution in place via natural selection

- Can happen on ecological scales, when:
- Large population size and/or rapid population growth.
 - short generation times.
 - Directional and constant selection.
 - Medium levels of gene flow.

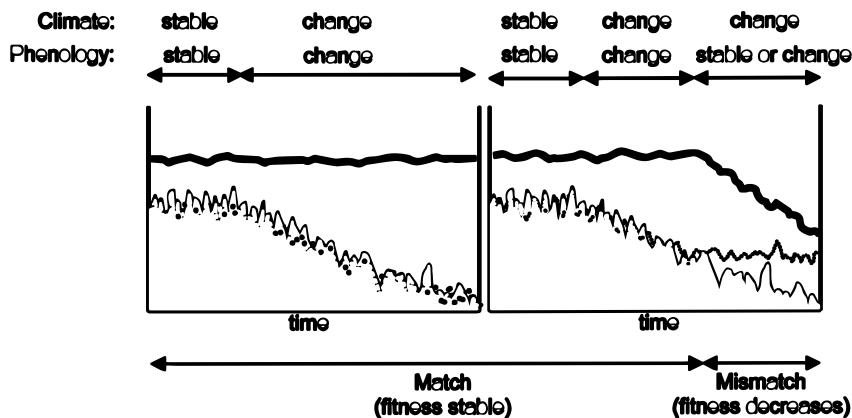


Example of Evolution in Place: guppies and predators

Trait	Time interval (years)	Number of generations
Male coloration*	2.5	4.4
Male age and size at maturity†	4	7.0
Female age and size at maturity†	7.5	13.0
Offspring number and size‡	11	19.1
Reproductive effort‡	11	19.1
Predator escape‡	20	35.0
Schooling/predator inspection§	34	59.2

Reznick et al. 2008

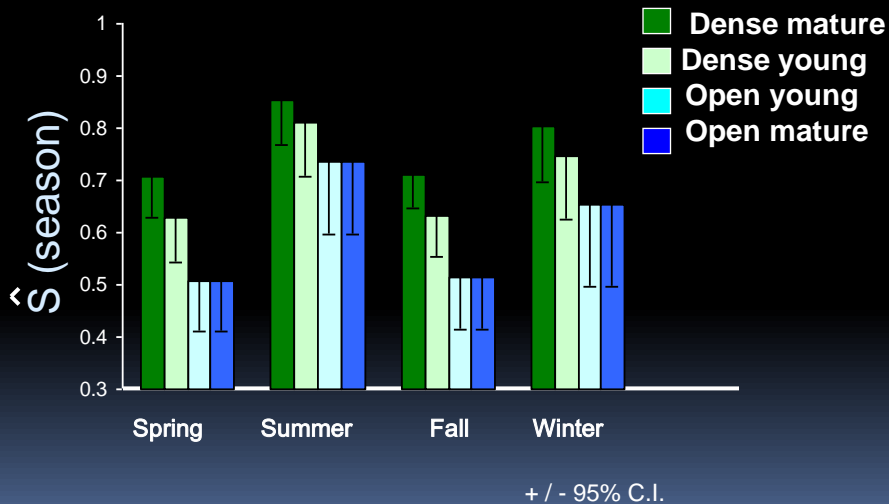
The question becomes whether adaptation in place can maintain fitness as climate changes:



→ One example we're beginning to explore: snowshoe hare coat color



Hares are most vulnerable in spring & fall



Snowshoe hares

- Major food item in northern forests, for lynx and many other predators.
- Molt is controlled in large part by daylength.
- Briefer snowpack season is a strong signal of climate change.
- > Can hares evolve appropriate changes?



So some species will adapt
in place...
Others will move.

Lots of examples of “adaptation” via range shifts or
other changes in animal movement:

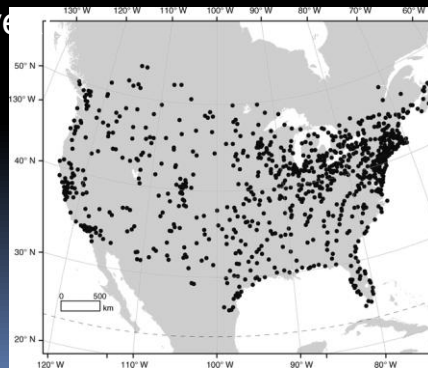
e.g. 254 spp N. Am. Birds [Christmas Bird Count]:

Northern boundary : 1.5 km/year

Center of occurrence: 0.5 km/year

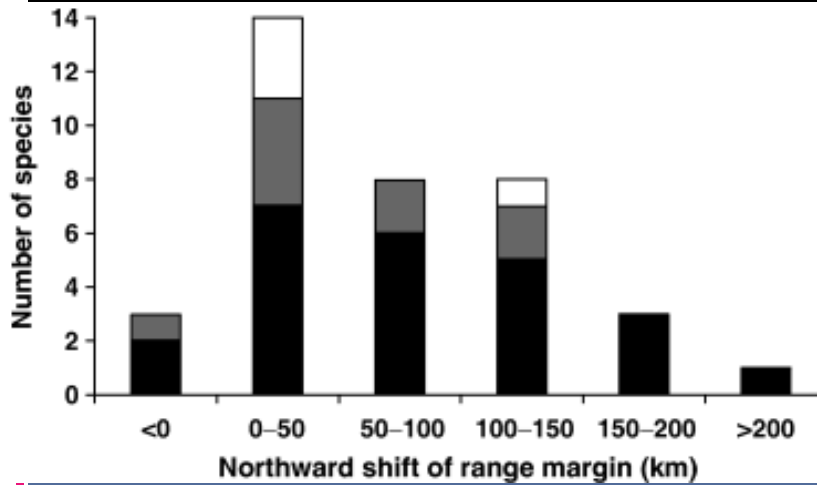
Center of abundance 1 km/year

(La Sorte and Thompson 2007):



Dragonflies and damselflies are shifting northwards too.

Comparing 1960-70 to 1985-95; white = northern; hatched = ubiquitous; black = southern



Hickling et al. 2005

Populations that can't move, deal with it, or adapt

... will die

Pied Flycatchers

- Caterpillars peak in abundance earlier in year
- Flycatchers have decreased time between breeding ground arrival and laying eggs.
- But daylength trigger for migration = mismatch.
- Mismatch = population decline.



Both and Visser 2001, Both et al. 2006

Temperature-dependent sex determination:
lots of reptiles, amphibians, fish

Tuatara

- 100 MY old lineage.
- 1 degree C shift → All males



Waterfowl

- Temperature/precip → wetland abundance and water levels → reproductive output & brood survival → primary drivers of population growth.
- Prairie pothole region: produces majority of NA ducks.



SO: Birds do it, butterflies do it, squirrels do it...



But invasives & diseases
tend to do it better...



Diseases are also
predisposed to prosper

Spread and increasing severity: LOTS!

... malaria, Lyme disease, yellow fever,
plague, shistoma, west nile...



Stomoxys flies during
Canine distemper outbreak...

Cane toads in Australia

Introduced 1935 to control insect pests.

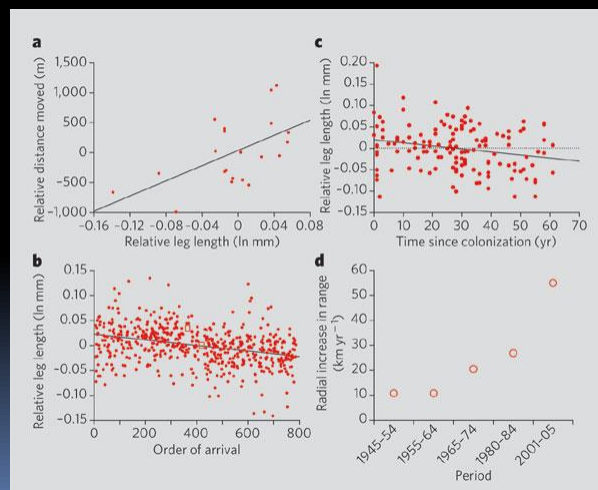
Now, 1 million km²,
Highly toxic,
Ravaging biodiversity



CANE TOADS:

Have evolved longer legs, which lets them:
Move faster, increase rate of colonization!

Phillips et al. 2006



AND Remember:

Climate change is occurring in the context of other human activities

Example: Hawksbill turtles

(Kamel and Mrosovsky 2006)

- Critically endangered
- TSD (warmer = mostly females)
- Mostly females in many places.

“Nesting beaches per se may still remain, giving the illusion of critical habitat, but systematic destruction of forested areas could be catastrophic for hawksbill demography and continued survival”.

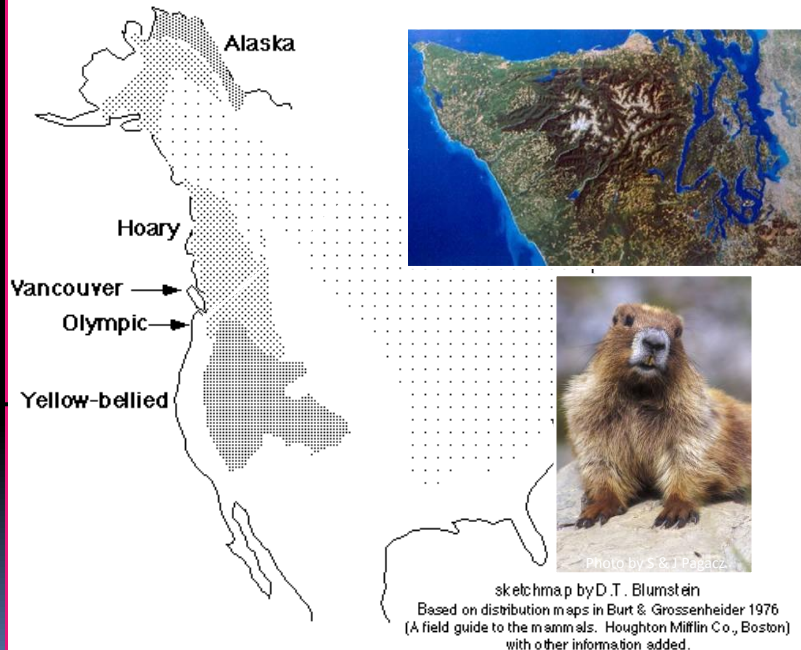


A story where climate change would be expected to drive wildlife, but hasn't yet, at least:

Olympic marmots

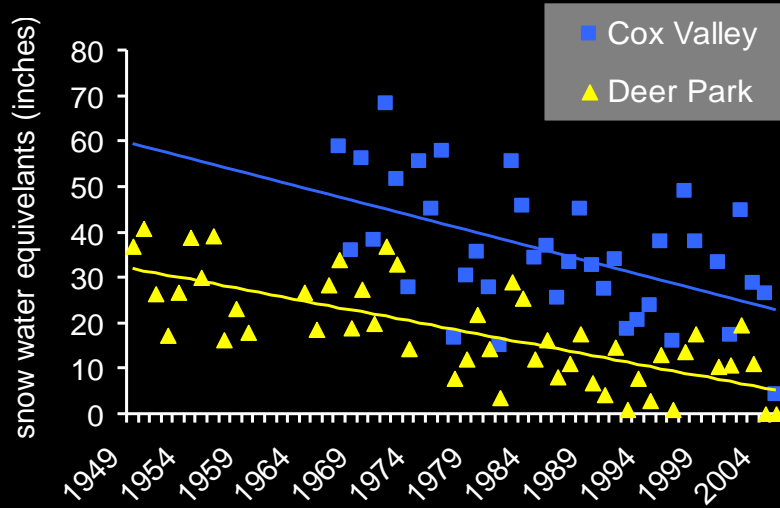


Ranges of North American marmots (approximate)



Climate Change Signal on Olympic Peninsula

May 1 snow-water equivalents in ONP





Coyote range expansion



1900



1930

From Moore and Parker 1992, modified

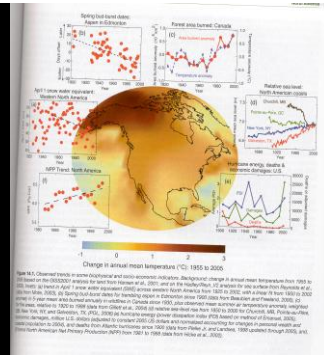
So, for declining Olympic marmots:

- Climate Change appears to have a relatively minor effect.
- Coyotes appear to cause this decline



Conclusions

- As certain as the winter is to turn to spring, climate is changing and is affecting wildlife.
- Wildlife responses do and will vary by species, which may adapt in place, move, or die.
- We have to consider climate change in the context of other human-caused stressors on wildlife (both a challenge and hopeful).



The Good News is:

- Recognition is the first thing (eg IPCC report being recognized for Nobel Prize).
- Climate Change is mobilizing humans on an unprecedented scale
 - Eg Western Governor's Association Recommendations.

