The News Summary

–

communicating your work to journalists and the general public

https://www.youtube.com/watch?v=Afh7_Pn0bLQ

https://www.youtube.com/watch?v=V3MEcpOG4Yg&t=921s
12:55-14:40

ARTICLE

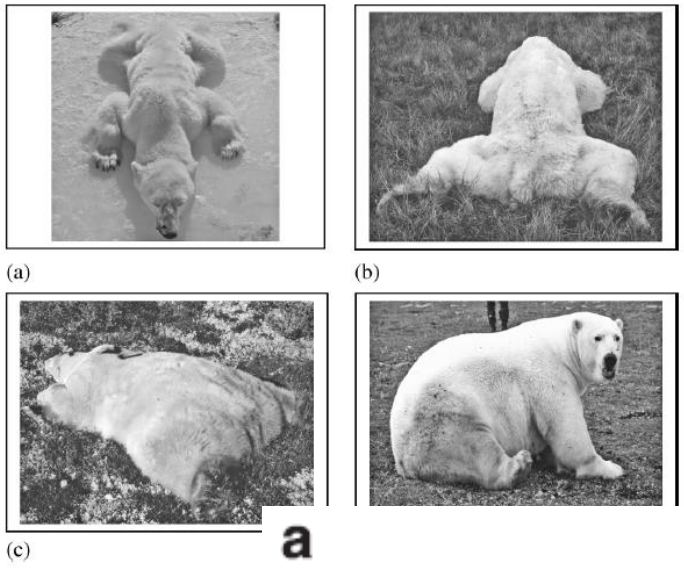
Received 1 Nov 2010 | Accepted 11 Jan 2011 | Published 8 Feb 2011

DOI: 10.1038/ncomms1183

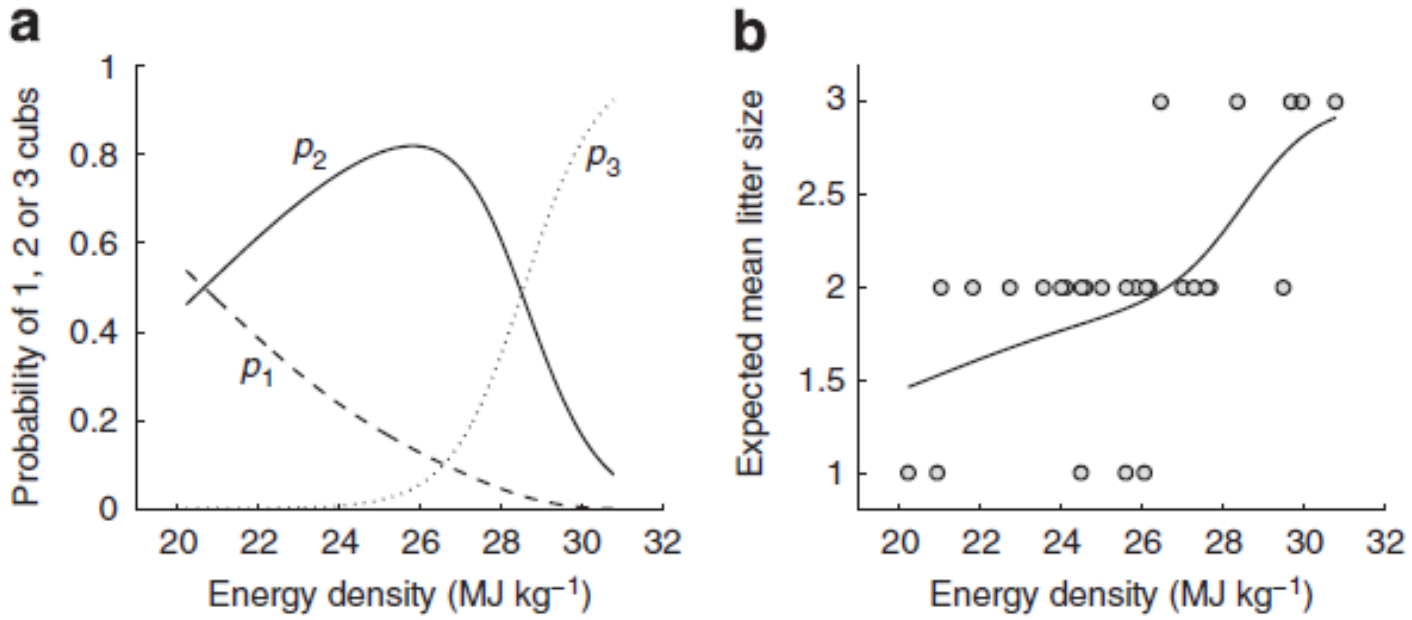
Predicting climate change impacts on polar bear litter size

Péter K. Molnár[1,2,†], Andrew E. Derocher[2], Tin Klanjscek[3] & Mark A. Lewis[1,2]

Predicting the ecological impacts of climate warming is critical for species conservation. Incorporating future warming into population models, however, is challenging because reproduction and survival cannot be measured for yet unobserved environmental conditions. In this study, we use mechanistic energy budget models and data obtainable under current conditions to predict polar bear litter size under future conditions. In western Hudson Bay, we predict climate warming-induced litter size declines that jeopardize population viability: ~28% of pregnant females failed to reproduce for energetic reasons during the early 1990s, but 40–73% could fail if spring sea ice break-up occurs 1 month earlier than during the 1990s, and 55–100% if break-up occurs 2 months earlier. Simultaneously, mean litter size would decrease by 22–67% and 44–100%, respectively. The expected timeline for these declines varies with climate-model-specific sea ice predictions. Similar litter size declines may occur in over one-third of the global polar bear population.



With ongoing ice loss, polar bears have increasingly long fasts to endure. The thinner a bear, the smaller its litter size

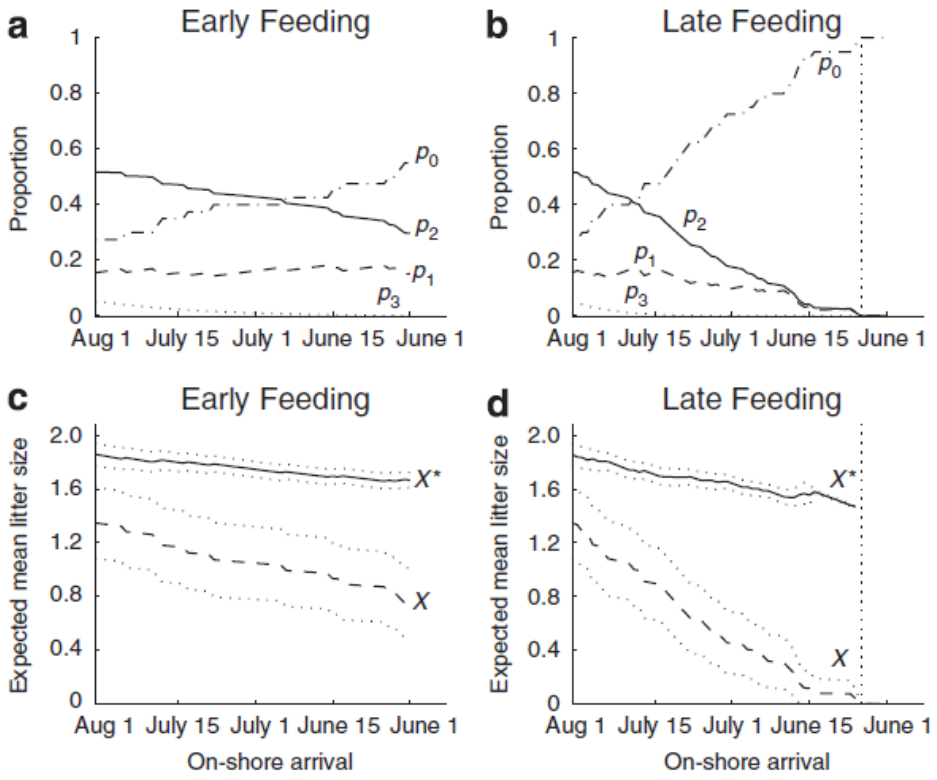


Example: polar bear reproduction under climate change;

Molnar *et al.* 2011, Nature Comm 2, 186.

$$\underbrace{\frac{dE}{dt}}_{\text{Rate of change in storage energy}} = \underbrace{\delta\beta}_{\text{Feeding}} \underbrace{-(a\cdot(\rho_{STR}\,kL^3+\alpha^{-1}E)^b+c\cdot(\rho_{STR}\,kL^3+\alpha^{-1}E)^d\cdot v)}_{\text{Movement}}$$

$$\underbrace{-m\cdot(\rho_{STR}\,kL^3+\alpha^{-1}(1-\varphi)\cdot E)}_{\text{Somatic maintenance}}$$



Molnar *et al.* 2011, Nature Comm 2, 186.

POLAR BEAR BIRTHS COULD PLUMMET WITH CLIMATE CHANGE

This research is embargoed from publication or broadcast until 11 a.m. eastern, Feb. 8

University of Alberta researchers (Drs. Péter Molnár, Andrew Derocher, and Mark Lewis) studied the reproductive ecology of polar bears in Hudson Bay and have linked declining litter sizes with loss of sea ice.

The researchers say projected reductions in the number of newborn cubs is a significant threat to the western Hudson Bay polar bear population, and if climate change continues unabated the viability of the species across much of the Arctic will be in question.

Using data collected since the 1990s researchers looked at the changing length of time Hudson Bay is frozen over (the polar bear's hunting season) and the amount of energy pregnant females can store up before hibernation and birthing.

An early spring-ice breakup reduces the hunting season making it difficult for pregnant females to even support themselves, let alone give birth to and raise cubs, during a denning period that can extend up to 8 months, and during which food is unavailable.

During the early 1990s, researchers estimate, 28 per cent of energy deprived pregnant polar bears in the Hudson Bay region failed to have even a single cub. Researchers say energy deprived pregnant females will either not enter a maternity den or they will naturally abort the birth.

Using mathematical modeling to estimate the energetic impacts of a shortened hunting season, the research team calculated the following scenarios:

If spring break up in Hudson Bay comes one month earlier than in the 1990s, 40 to 73 per cent of pregnant female polar bears will not reproduce.

If the ice breaks up two months earlier than in the 1990s, 55 to a full 100 per cent of all pregnant female polar bears in western Hudson Bay will not have a cub.

The polar bear population of western Hudson Bay is currently estimated to be around 900 which is down from 1,200 bears in the past decade.

OF THE ROYAL SOCIETY B

Proc. R. Soc. B (2008) **275**, 217–226
doi:10.1098/rspb.2007.1307
Published online 21 November 2007

Modelling the mating system of polar bears: a mechanistic approach to the Allee effect

Péter K. Molnár[1,2,3,*], Andrew E. Derocher[2], Mark A. Lewis[1,2] and Mitchell K. Taylor[4]

[1]*Centre for Mathematical Biology, Department of Mathematical and Statistical Sciences, University of Alberta, Edmonton, Alberta, Canada T6G 2G1*
[2]*Department of Biological Sciences, University of Alberta, Edmonton, Alberta, Canada T6G 2E9*
[3]*Department Biologie II, Ludwig-Maximilians-Universität München, Großhaderner Strasse 2, 82152 Planegg-Martinsried, Germany*
[4]*Department of the Environment, Government of Nunavut, PO Box 1000, Igloolik, Nunavut, Canada X0A 0L0*

Allee effects may render exploited animal populations extinction prone, but empirical data are often lacking to describe the circumstances leading to an Allee effect. Arbitrary assumptions regarding Allee effects could lead to erroneous management decisions so that predictive modelling approaches are needed that identify the circumstances leading to an Allee effect before such a scenario occurs. We present a predictive approach of Allee effects for polar bears where low population densities, an unpredictable habitat and harvest-depleted male populations result in infrequent mating encounters. We develop a mechanistic model for the polar bear mating system that predicts the proportion of fertilized females at the end of the mating season given population density and operational sex ratio. The model is parametrized using pairing data from Lancaster Sound, Canada, and describes the observed pairing dynamics well. Female mating success is shown to be a nonlinear function of the operational sex ratio, so that a sudden and rapid reproductive collapse could occur if males are severely depleted. The operational sex ratio where an Allee effect is expected is dependent on population density. We focus on the prediction of Allee effects in polar bears but our approach is also applicable to other species.

Keywords: component Allee effect; two-sex model; *Ursus maritimus*; sex-selective harvest; population density; operational sex ratio

Prolonged sex-selective harvest has led to female-biased sex ratios in all Canadian polar bear populations, leading to concerns that males could be depleted to a point where many females become unable to find a mate. To evaluate the sustainability of current harvesting strategies we develop a model that predicts the proportion of females that are able to find a mate, given the number of males and females in a population. We evaluate the model in light of data from Lancaster Sound, Canada, and conclude in accordance with observations that current male numbers are sufficiently high in this population to fertilize all females. However, we also find that a sudden and rapid reproductive collapse could occur if males are depleted beneath a certain male:female sex ratio. As this threshold sex ratio depends on the overall population density, it needs to be evaluated separately for each polar bear population. Low density populations require a higher proportion of males to maintain high female fertilization rates. Given these results, we recommend a precautionary harvesting approach.

Media Summary

Prolonged sex-selective harvest of polar bears has led to female-biased sex ratios. This gives rise to the concern that males could become depleted to a point where females cannot find a mate. We develop a model that predicts the proportion of females that are able to find a mate. Using data from Lancaster Sound, Canada, we show that male numbers are currently high enough to fertilize all females. However, a sudden and rapid reproductive collapse could occur if the sex ratio drops below a critical threshold. As this sex ratio depends on local bear densities, the ratio must be evaluated separately for each polar bear population. Low densities require a higher proportion of males to maintain high female fertilization rates. Given these results, we recommend a precautionary harvesting approach.

You should focus on

- Why was the study done?
  - (i.e. the biological or social significance of the problem that you addressed)
- How did you approach the problem?
  - (summarize the approach for the reader; this is often the hardest part because you need to explain a rather sophisticated methodology in an understandable way; as a rule of thumb, to keep things accurate yet approachable, focus on **why** you used a model and **what** it does, **but not on how** it does it).
- What did you find?
- What is the biological significance of your findings?
- What are the caveats to your findings?

Word limit: 1 paragraph of 300 words or less.

Know your audience, avoid technical jargon!