IUNC Red List Assessment: Polar Bear

Report

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1. Introductions

Polar Bears (Ursus maritimus) are facing a range of threats that might impact their future population status. This report reproduced the IUCN Red List Assessment of Polar Bears with some modifications, using a probabilistic approach to take into account uncertainties in the assessment.

We assumed and estimated linear relationships between habitat availability and Polar Bear abundance. The approach to assess the category of Polar Bear is that estimating a global ice-abundance relationship using a reduced dataset that included a maximum of two abundance estimates for each subpopulation, and then used these relationships to predict future abundance of each subpopulation as a function of predicted sea-ice conditions. Under this approach, the 6 subpopulations with at least two estimates of abundance exerted similar influence on the ice-abundance relationship.

2. Methods

2.1. Generation Length

> Modification: They propagate percentiles, but you are to use a probabilistic approach to take into account uncertainties in the assessment.

`GL`: Generation Length (years)

The mean of subpopulation GL mean estimates was 11.5 years (95% CI = 9.8, 13.6).

Mean generation length of 6 selected subpopulations:

```
# A tibble: 6 x 4
  Abbreviation `Generation length(years)` `95% CI lower` `95% CI uppper`
  <chr>                             <dbl>          <dbl>            <dbl>
1 DS                                 10.3            9.7             10.9
2 GB                                 12.6           11.6             13.5
3 NB                                 11.4           10.7             12.2
4 SB                                 10.7           10.3             11.2
5 SH                                 10.5           10               11
6 WH                                 13.7           13.4             14
```

2.2. Sea Ice

> Modification: You are to consider recent projections on the Last Ice Area.
>
> Last Ice Area

The sea-ice metric `ice`: the number of days per year (1979-2014) that sea-ice area exceeded the threshold `T`.

$$ice = B_0 + B_{year} \times year + \epsilon$$

The threshold area (denoted `T`) was chosen as the midpoint of the mean September sea-ice area (denoted `Area_Sept`) and the mean March sea-ice area (denoted `Area_March`):

$$T = Area\_Sept + 50\% \times (Area\_March - Area\_Sept)$$

Ice slope of 6 selected subpopulations:

```
# A tibble: 6 x 3
  Abbreviation Slope    SE
  <chr>        <dbl> <dbl>
1 DS           -1.71 0.367
2 GB           -1.88 0.368
3 NB           -0.93 0.328
4 SB           -1.75 0.363
5 SH           -0.68 0.239
6 WH           -0.86 0.217
```

2.3. Population Projections

2.3.1. Abundance Estimates

Abundance(N) estimates for 6 selected subpopulations:

```
# A tibble: 12 x 3
   Abbreviation  Year Estimate_Abundance
   <chr>        <dbl>              <dbl>
 1 DS            1996               1400
 2 DS            2007               2158
 3 GB            1986                900
 4 GB            2000               1592
 5 NB            1979                876
 6 NB            2006               1004
 7 SB            1986               1800
 8 SB            2010                907
 9 SH            1986               1000
10 SH            2012                943
11 WH            1987               1194
12 WH            2011               1030
```

2.3.2. Statistical Models and Computer Simulation

Projections started in the year 2015 and ended in year t = 2015 + (3 × GL).

Normalization of abundance was performed separately for each subpopulation `i`:

$$N_i^{norm} = \frac{N_i}{N_i^1}$$

N_i is either the first or second available abundance estimate

N_i^1 is the first available abundance estimate.

The table below is abundance(`N`) estimates added by a new column N_norm:

```
# A tibble: 12 x 4
   Abbreviation  Year Estimate_Abundance N_norm
   <chr>        <dbl>              <dbl>  <dbl>
 1 DS            1996               1400  1
 2 DS            2007               2158  1.54
 3 GB            1986                900  1
 4 GB            2000               1592  1.77
 5 NB            1979                876  1
 6 NB            2006               1004  1.15
 7 SB            1986               1800  1
 8 SB            2010                907  0.504
 9 SH            1986               1000  1
10 SH            2012                943  0.943
11 WH            1987               1194  1
12 WH            2011               1030  0.863
```

The linear model for Approach 2 included an intercept for each subpopulation and a single, global slope coefficient

$$N^{norm} = \Sigma_i B_i + B_{Global} \cdot fitted.ice + \Sigma_i \epsilon_i$$

For each draw of starting abundance for subpopulation i, we predicted mean abundance in year t as:

$$N_{i,t} = N_{i,2015} + \Delta N_{i,t} \times N_{i,2015}$$

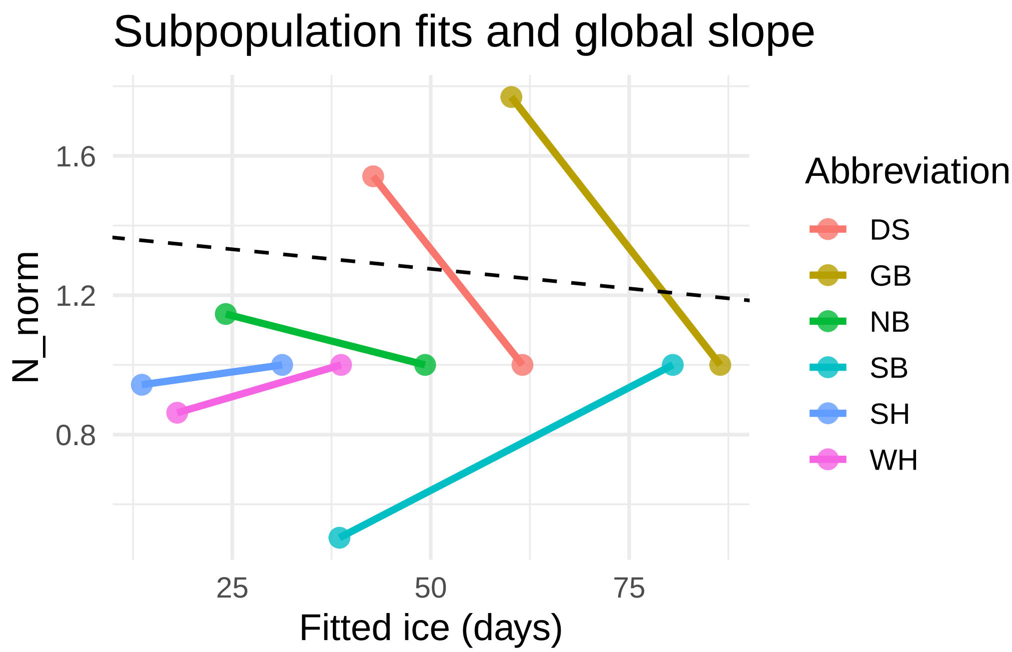
Finally, we calculated percent change in mean global population size as:

$$\Delta G = 100 \times \frac{G_t - G_{2015}}{G_{2015}}$$

3. Results

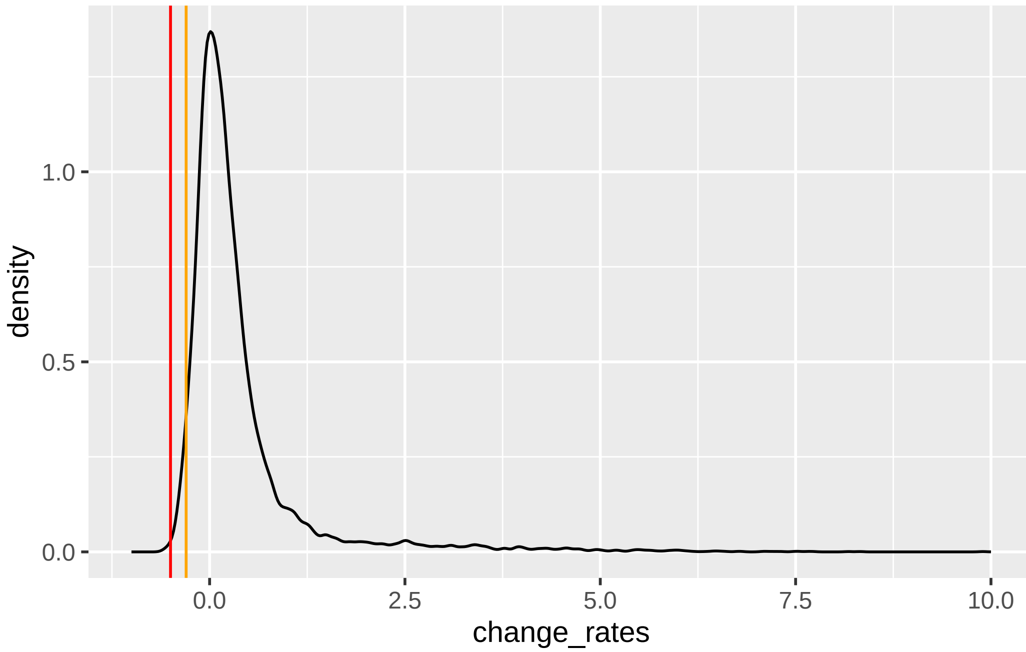
> Modification: You are also to assess uncertainty in the conclusion which could be different from the conclusion in the Red List Assessment.

Here is a linear model using the mean gl and fixed value of ice slope and N_norm, and the global slope is -0.0023:



We chose to use normal distribution to fit the generation length(GL), the ice slope(ice) and the abundance(N) of every subpopulation. By using Monte Carlo simulation, the global rates of change of Polar Bear population size was estimated. Below are a simple summary of change rates and a plot of density of change rates. The orange vertical line stands for that the decline rate of global population is at 30%, and the red line is at 50%.

```
   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
-0.5851 -0.0371  0.1472  0.3716  0.4234  9.8955
```



After three generations, this approach suggested a median percent change in mean global population size of 37.16% (95% CI = -31.21%, 310.29%). The corresponding probability of a decline greater than 30% was approximately 0.0295, and the probability of a decline greater than 50% was approximately 0.0014. We conclude that Polar Bears currently warrant listing as Vulnerable under criterion A3c.