Diversity, and Health of the tundra

Terry Callaghan

Royal Swedish Academy of Sciences,
Abisko Scientific Research Station
Sheffield Centre for Arctic Ecology, UK
University of Lund, Sweden
Aims

To give an appreciation of what “biodiversity” means

To give examples of the importance of biodiversity

To explain why we should be worried about loss of biodiversity

To explain what we should do to reduce loss of biodiversity
What is biodiversity?

The abundance and variety of biological systems including:

Genetic individuals

Species

Ecosystems and habitats

Species richness and the abundance of species are important

Functional diversity places the emphasis on roles of species such as producers, grazers, decomposers
Roles and importance of Arctic biodiversity

Food - cloudberry
Fuel - treeline timber
Fibre - shrub roots
Fodder - lichens
“Pharmaceuticals” - cyclosporin
Tourism - bird watching
Function of ecosystems - mosses such as bog moss
Feedbacks to the climate system - tundra versus taiga
Future genetic recombinations and adaptation - low temperature microbes

Future surprises ????
BIODIVERSITY AFFECTS GREENHOUSE GASSES

- E. scheucheri
- C. subspathacea
- D. psilosantha
- Total

Some species have important effects on others, acting as “nurse plants”.

They can help vegetation establishment after disturbance.

But are very sensitive to invasion of competitors.
Biodiversity estimates for the Arctic are low when compared with world biota

modified from Matvevyeva and Chernov in Nuttall and Callaghan (2000)

<table>
<thead>
<tr>
<th>Animals</th>
<th>Group</th>
<th>Number</th>
<th>% of world biota</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mammals</td>
<td>55</td>
<td>1.8</td>
<td></td>
</tr>
<tr>
<td>Birds</td>
<td>200</td>
<td>3.4</td>
<td></td>
</tr>
<tr>
<td>Insects</td>
<td>3000</td>
<td>0.3-0.4</td>
<td></td>
</tr>
<tr>
<td>Flies</td>
<td>1600-1800</td>
<td>1.0</td>
<td></td>
</tr>
<tr>
<td>Beetles</td>
<td>350</td>
<td>0.1</td>
<td></td>
</tr>
<tr>
<td>Springtails</td>
<td>400-500</td>
<td>2.0</td>
<td></td>
</tr>
<tr>
<td>Other groups</td>
<td>1600</td>
<td>---</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Plants</th>
<th>Flowering plants</th>
<th>1800</th>
<th>0.7-0.8</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mosses</td>
<td>780</td>
<td>5.7-7.0</td>
<td></td>
</tr>
<tr>
<td>Lichens</td>
<td>1300</td>
<td>5.0-6.5</td>
<td></td>
</tr>
<tr>
<td>Fungi</td>
<td>~5000</td>
<td>---</td>
<td></td>
</tr>
</tbody>
</table>

Total estimate 6000-7000
We still do not know what diversity we have in the Arctic within:-

Species

Micro-organisms

Novel bacteria from the Arctic
Threats to Arctic biodiversity

Human activities

Fragmentation of habitat, extractive industries, hunting, fishing etc, over-exploitation of pastures, abandonment of agricultural land, tourism etc.
Threats to Arctic biodiversity

Chemical contamination

AMAP has recorded contaminant levels in the Arctic but their impacts are often unknown. Atmospheric nitrogen deposition has a great potential to reduce the diversity of primitive plants, for example mosses in Iceland.
Threats to Arctic biodiversity

Ozone depletion

*Interactions between warming of the earth’s surface and cooling of the stratosphere leads to continuing loss of ozone and increases in UV-B radiation.*
Threats to Arctic biodiversity

Climate change

Amplification of global warming in the Arctic but local variability including cooling. Warming will be greatest in winter and in continental areas. Precip will change and disturbance (thermokarst, pests and fires) will increase.
Biodiversity is naturally low in the Arctic……..

….can we expect it to increase if the Arctic becomes warmer?

Species richness might increase, but the potential is less than earlier due to loss of biodiversity in the temperate regions and compression of the tundra:

some Arctic species might be lost
Past climate warming = Extinction of many large animals and loss of habitat such as tundra steppes

- Giant elk
- Woolly rhinoceros
- Sabre-toothed tiger
- Mammoth - extinct less than 6,000 years ago!
What will become extinct in the Arctic during future warming?

Globally threatened species include 43 mammals, 16 birds, 12 fish and 73 plants.
Warmer summers and winters can enhance species performance

Increased cloudberry production in ITEX shelters

Cornelissen et al.
Community structure and biodiversity will change firstly by changes in abundance of existing species

Year 0

Species immigration is slower than species loss

Year 2

Year 5

(Press et al.)
Slow but widespread changes within communities are easily over-looked because of focus on boundaries such as tree-lines. Lichens are important as food for reindeer and they fix atmospheric nitrogen.
warmers winters and extreme events can reduce species performance and eventually biodiversity

**Ice layer on the ground during winter**

Population dynamics of reindeer and sibling voles on Svalbard

_Aanes et al. 1999, Yoccoz and Imms 1999_
We need to protect biodiversity by protecting habitats - and by being innovative

Farm land has been abandoned in Northern Norway, e.g. 1959-99

- Loss of Farms: -32,000
- Loss of Farmland: -34,000 ha
- Loss of Cows: -42,000
- Loss of Ewes: -205,000

Sheep and cows maintain diversity and prevent forest growth.

Appropriate reindeer management can preserve diversity, inappropriate management can reduce it.

Svein Eilertsson
Conclusions

Biodiversity is threatened in the Arctic by a variety of environmental change factors.

We may lose red book and endemic species but also some widespread species.

Although there will be some compensation from southern species moving into the Arctic, the potential for this is less than in former times.

Loss of Arctic species can potentially affect people and ecosystem function.

We do not yet know what we have in the Arctic, so cannot guess the importance of what we can lose.
Recommendations (personal)

We need to seek political solutions to minimise harmful environmental changes.

We need to develop and employ conventional and innovative methods to protect biodiversity and habitats.

We need to document (using a “doomsday” approach) existing biodiversity and species dynamics.

We need to monitor threatened species and “typical” Arctic species, ecosystems and habitats.

We need to understand how Arctic species behave in a changing environment in order to predict threats to biodiversity, rather than waiting for critical situations to develop.

Thank You