

© International Baccalaureate Organization 2021

All rights reserved. No part of this product may be reproduced in any form or by any electronic or mechanical means, including information storage and retrieval systems, without the prior written permission from the IB. Additionally, the license tied with this product prohibits use of any selected files or extracts from this product. Use by third parties, including but not limited to publishers, private teachers, tutoring or study services, preparatory schools, vendors operating curriculum mapping services or teacher resource digital platforms and app developers, whether fee-covered or not, is prohibited and is a criminal offense.

More information on how to request written permission in the form of a license can be obtained from <https://ibo.org/become-an-ib-school/ib-publishing/licensing/applying-for-a-license/>.

© Organisation du Baccalauréat International 2021

Tous droits réservés. Aucune partie de ce produit ne peut être reproduite sous quelque forme ni par quelque moyen que ce soit, électronique ou mécanique, y compris des systèmes de stockage et de récupération d'informations, sans l'autorisation écrite préalable de l'IB. De plus, la licence associée à ce produit interdit toute utilisation de tout fichier ou extrait sélectionné dans ce produit. L'utilisation par des tiers, y compris, sans toutefois s'y limiter, des éditeurs, des professeurs particuliers, des services de tutorat ou d'aide aux études, des établissements de préparation à l'enseignement supérieur, des fournisseurs de services de planification des programmes d'études, des gestionnaires de plateformes pédagogiques en ligne, et des développeurs d'applications, moyennant paiement ou non, est interdite et constitue une infraction pénale.

Pour plus d'informations sur la procédure à suivre pour obtenir une autorisation écrite sous la forme d'une licence, rendez-vous à l'adresse <https://ibo.org/become-an-ib-school/ib-publishing/licensing/applying-for-a-license/>.

© Organización del Bachillerato Internacional, 2021

Todos los derechos reservados. No se podrá reproducir ninguna parte de este producto de ninguna forma ni por ningún medio electrónico o mecánico, incluidos los sistemas de almacenamiento y recuperación de información, sin la previa autorización por escrito del IB. Además, la licencia vinculada a este producto prohíbe el uso de todo archivo o fragmento seleccionado de este producto. El uso por parte de terceros —lo que incluye, a título enunciativo, editoriales, profesores particulares, servicios de apoyo académico o ayuda para el estudio, colegios preparatorios, desarrolladores de aplicaciones y entidades que presten servicios de planificación curricular u ofrezcan recursos para docentes mediante plataformas digitales—, ya sea incluido en tasas o no, está prohibido y constituye un delito.

En este enlace encontrará más información sobre cómo solicitar una autorización por escrito en forma de licencia: <https://ibo.org/become-an-ib-school/ib-publishing/licensing/applying-for-a-license/>.

Environmental systems and societies
Standard level
Paper 1 – resource booklet

Tuesday 11 May 2021 (afternoon)

1 hour

Instructions to candidates

- Do not open this booklet until instructed to do so.
- This booklet contains all the resources to answer paper 1.

Figure 1(a): Map showing location of Russia

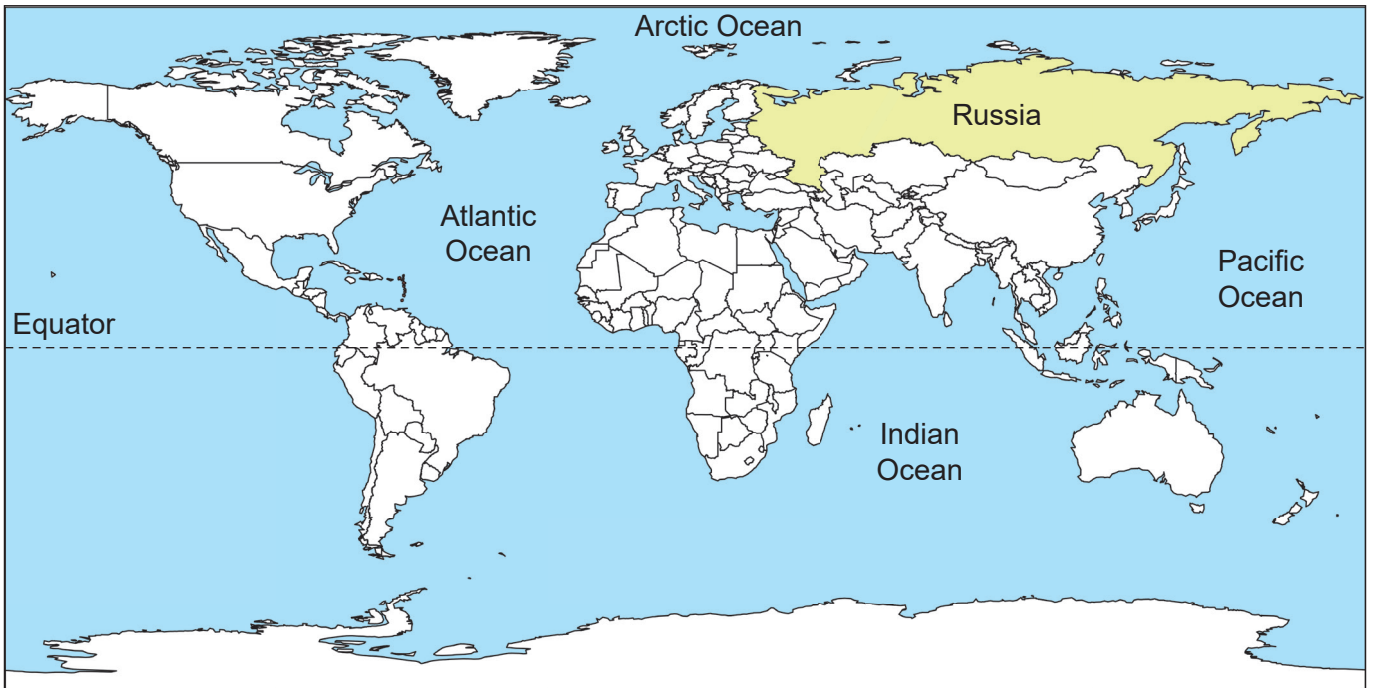


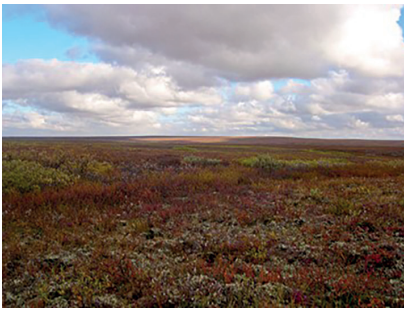
Figure 1(b): Map showing location of Siberia, a region of Russia east of the Ural mountains



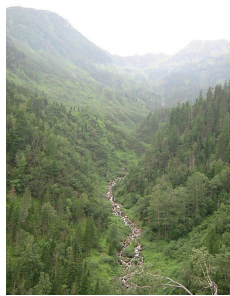
Figure 2(a)

Removed for copyright reasons

Figure 2(b): Photographs of biomes



Tundra



Taiga (boreal forest)



Steppe

Figure 2(c): Dominant agricultural activities in Siberia, Russia

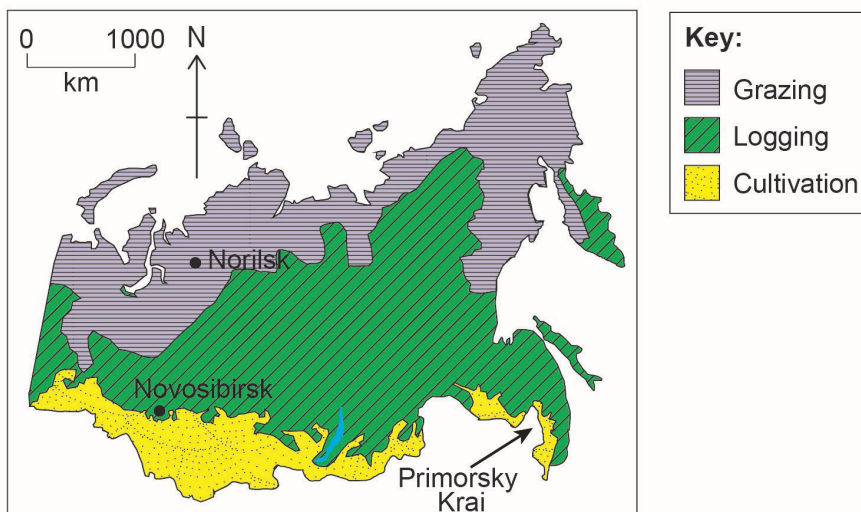


Figure 3: Climate data for Norilsk and Novosibirsk within the tundra and taiga biome respectively

Norilsk (tundra)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Average temperature (°C)	-26.9	-27.2	-21.9	-13.9	-4.8	7.0	14.3	11.4	4.0	-9.5	-20.2	-25.1
Average precipitation (mm)	24	25	37	47	57	58	65	77	65	68	40	33
Average hours of sunshine (per day)	0	1	5	8	8	8	10	6	3	2	0	0
Novosibirsk (taiga)												
Average temperature (°C)	-16.2	-14.7	-7.2	3.2	11.6	18.2	20.2	17.0	11.5	3.4	-6	-12.7
Average precipitation (mm)	19	14	15	24	36	58	72	66	44	38	32	24
Average hours of sunshine (per day)	2	4	5	7	9	10	10	8	6	3	2	2

Figure 4(a): Fact file on Siberia, Russia

- Siberia has a low population density of about 3 inhabitants per square kilometre.
- The region is rich in natural resources such as fossil fuels, metals (such as gold, silver, platinum, palladium, nickel, zinc, lead), diamonds and other gemstones.
- 80% of Russia’s oil, 85% natural gas, 80% coal and about 40% timber resources, come from Siberia.
- Mining for fossil fuels, metals and gemstones has provided an increasingly important source of employment for the population of Siberia and contributes significantly to Russia’s exports.

Figure 4(b): Russia’s exports in 2014, by value

Commodity	Proportion of exports by value (%)
Hydrocarbons	74
Metals	8
Machinery	4
Chemicals	6
Timber	2
Food and grains	1
Other	5

Figure 5(a): Fact file on indigenous peoples in Russia

- Although Russia's indigenous peoples make up only 0.2% of the total population (250 000 people), they inhabit about 67% of Russia's territory, the majority living in Siberia.
- In the mid-1980s, 70% indigenous peoples were nomadic compared to only 10% in 2014.

Figure 5(b): A family of Chukchi outside their yaranga in Siberia

The Chukchi are indigenous nomadic deer herders who live in yarangas all year round. The yaranga is made from poles of local wood covered in tree bark and animal skins. In winter, a deer skin canopy is added to the yaranga to improve insulation.



Figure 5(c): A modern wooden house in an industrial city in Siberia

The house is made mostly from wood, according to local tradition, but with some brickwork and concrete foundations.

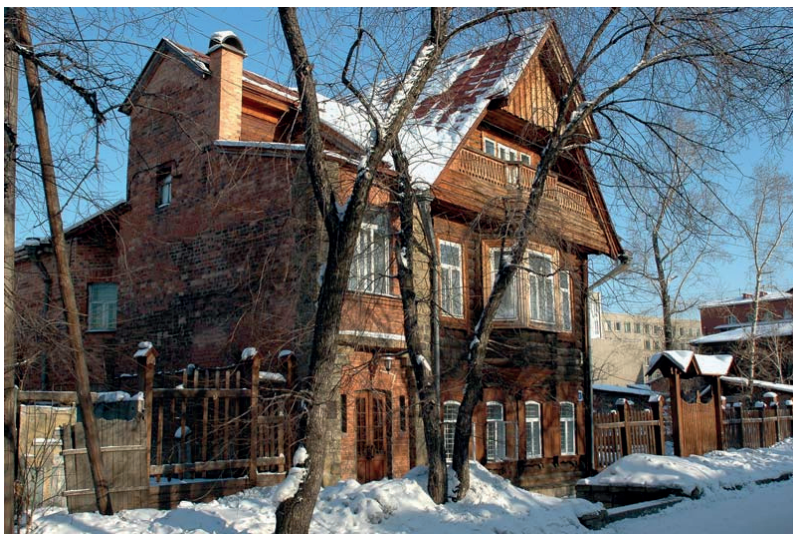


Figure 6(a): Fact file on Norilsk

- Major city in the tundra built on permafrost (subsurface soil that remains permanently frozen).
- Important centre for mining and smelting.
- Norilsk is one of the world's largest producers of palladium, platinum and nickel. (Platinum and palladium are used in catalytic converters).
- Emissions from metal mining and processing include sulphur dioxide (SO₂), nitrogen oxides (NO_x), carbon monoxide (CO) and heavy metal particulates. These have contributed to poor air quality.
- One of the main companies, Norilsk Nickel aims to reduce its emissions of sulphur dioxide from 1.1 million tons in 2016 by 75% before 2023.

Figure 6(b): Total annual sulphur dioxide and particulate emissions from smelting factories in Norilsk

The significant increase in emissions in the early 1980s is related to the opening of the third smelter, Nadezhda, in 1979.

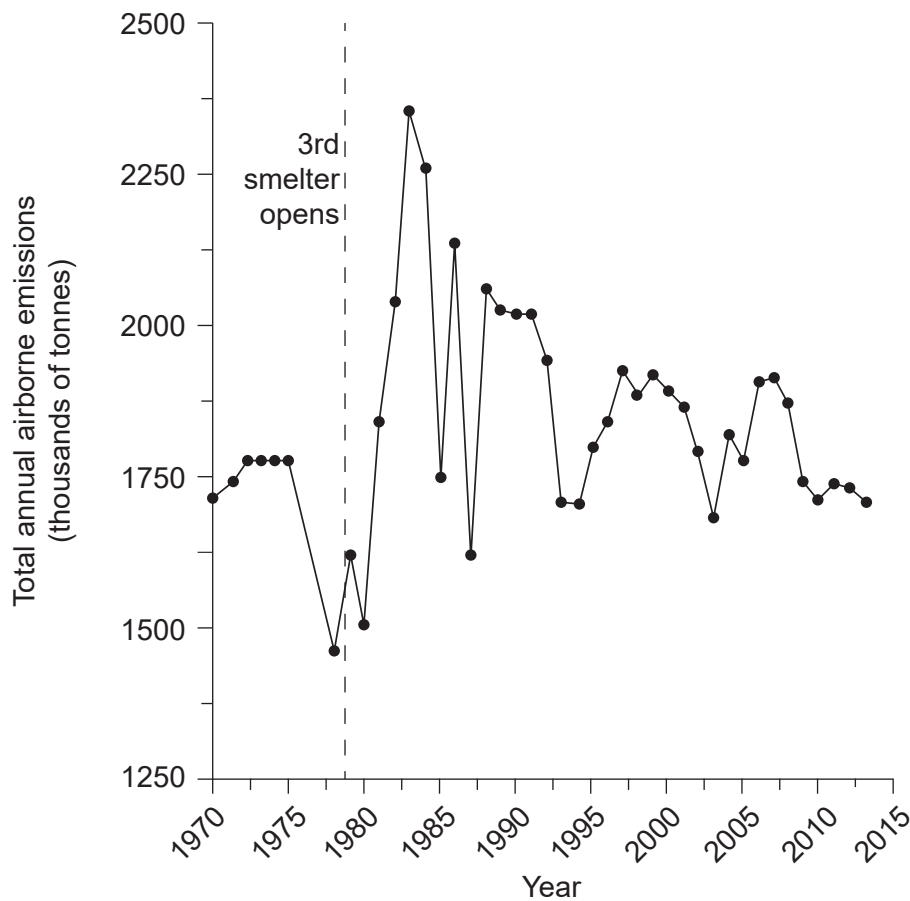


Figure 6(c): Vegetation damage associated with smelting factories in Norilsk

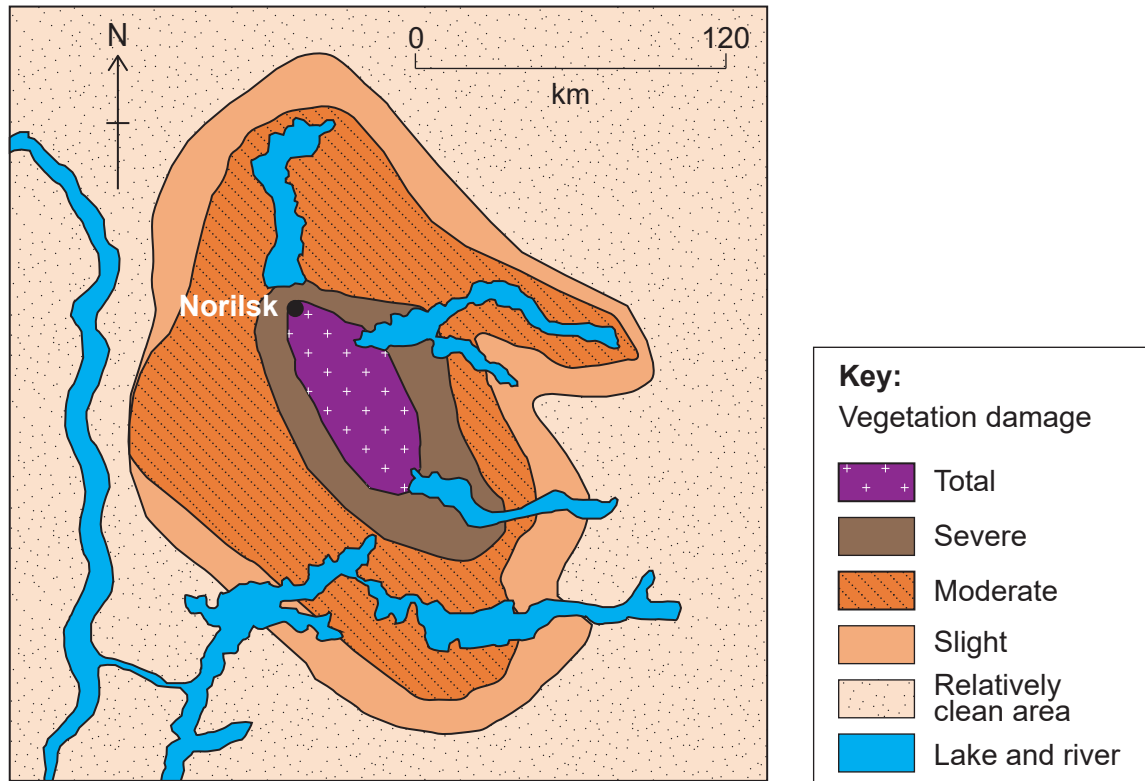


Figure 6(d): The Nadezhda smelting plant in Norilsk opened in 1979

The plant may be a possible source of the water discolouration.

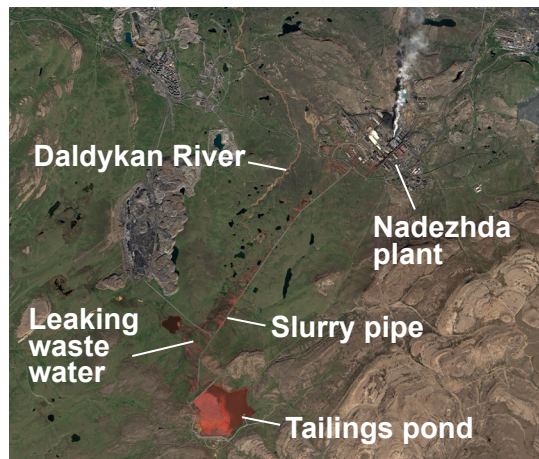


Figure 6(e): Daldykan River in Norilsk

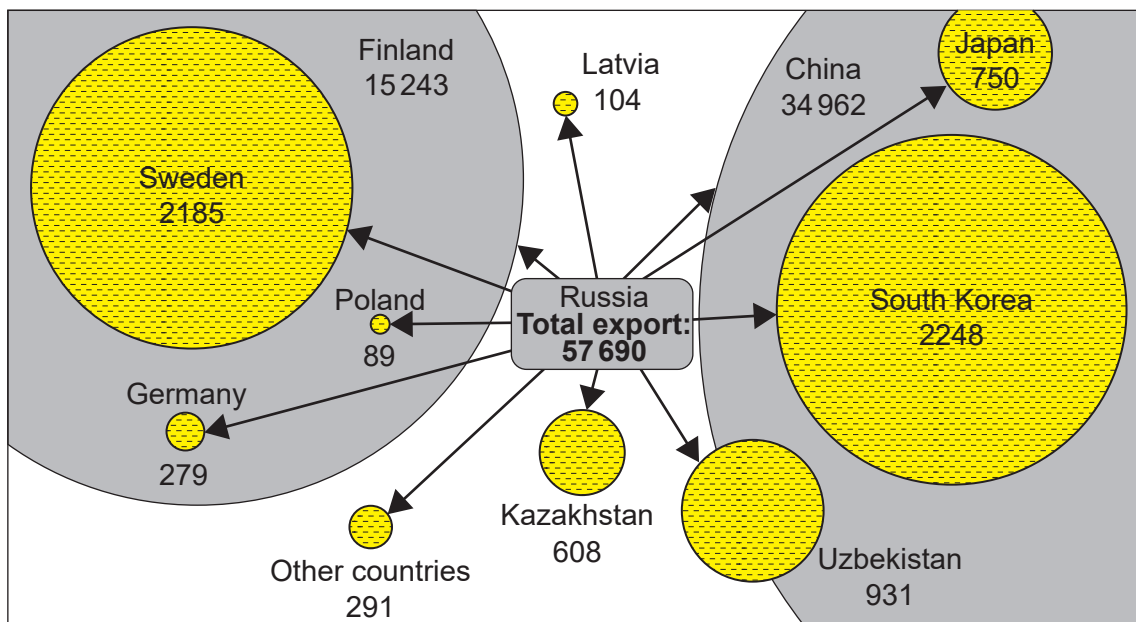


[Source: © Liza Udilova / Greenpeace]

Figure 7(a): Fact file on taiga

- Taiga is the world's largest terrestrial biome.
- The Siberian taiga contains about 20% of the world's forested areas.
- The taiga includes evergreen trees such as pine, spruce, fir, and some deciduous trees such as birch and poplar.
- Nutrient-poor soil and the climatic conditions contribute to slow rate of tree growth.
- Threats to taiga include forest fires, clearance for agriculture land, logging for timber, mining, road building and climate change.
- The region suffers deforestation rates of 20 000 km² annually.
- Conservation measures include restoration of forests through replanting and designating protected areas such as National Parks and selective logging policies.
- There is high global demand for timber with markets throughout Asia, Europe and the USA. Economic incentives to increase exports have increased timber production, destroying more of the forest ecosystems.

Figure 7(b): Total exports of timber (in units of thousand cubic metres) from Russia between 2012 and 2014



[Source: With permission from GRID-Arendal. Source adapted.]

Figure 8(a): Fact file on Siberian tiger (*Panthera tigris altaica*)

- Historically found in North and South Korea, Eastern China and Siberia but now mainly live within the Sikhote-Alin mountain range in Primorsky Krai and Khabarovsk Krai of Siberia.
- Female tigers reach sexual maturity after 4–5 years and give birth to 2–6 cubs once every two years.
- Reduction in tiger population has occurred due to:
 - loss of habitat as a result of logging and mining activity.
 - poaching for fur and tiger parts used in traditional Chinese medicines (up to US\$50 000 may be paid for a tiger).
 - loss of prey.
- Local communities have supported anti-poaching and environmental education campaigns.
- In 1940s it was estimated that there were fewer than 50 individuals remaining in the wild and by 2010 this number had increased to about 500. During this period, the following conservation measures were introduced:

1947	Russia banned hunting of tigers
1975	International trade in tigers and tiger parts banned through the Convention on International Trade of Endangered Species of Wild Fauna and Flora (CITES)
1992	The Siberian Tiger Project began attaching radio-collars to wild tigers to improve understanding of tiger ecology
2007	Udege National Park and Zov Tigra National Park were created
2010	Tiger protection was increased through policing and enforcement

Figure 8(b): Range of the Siberian tiger in 1800 and 2000

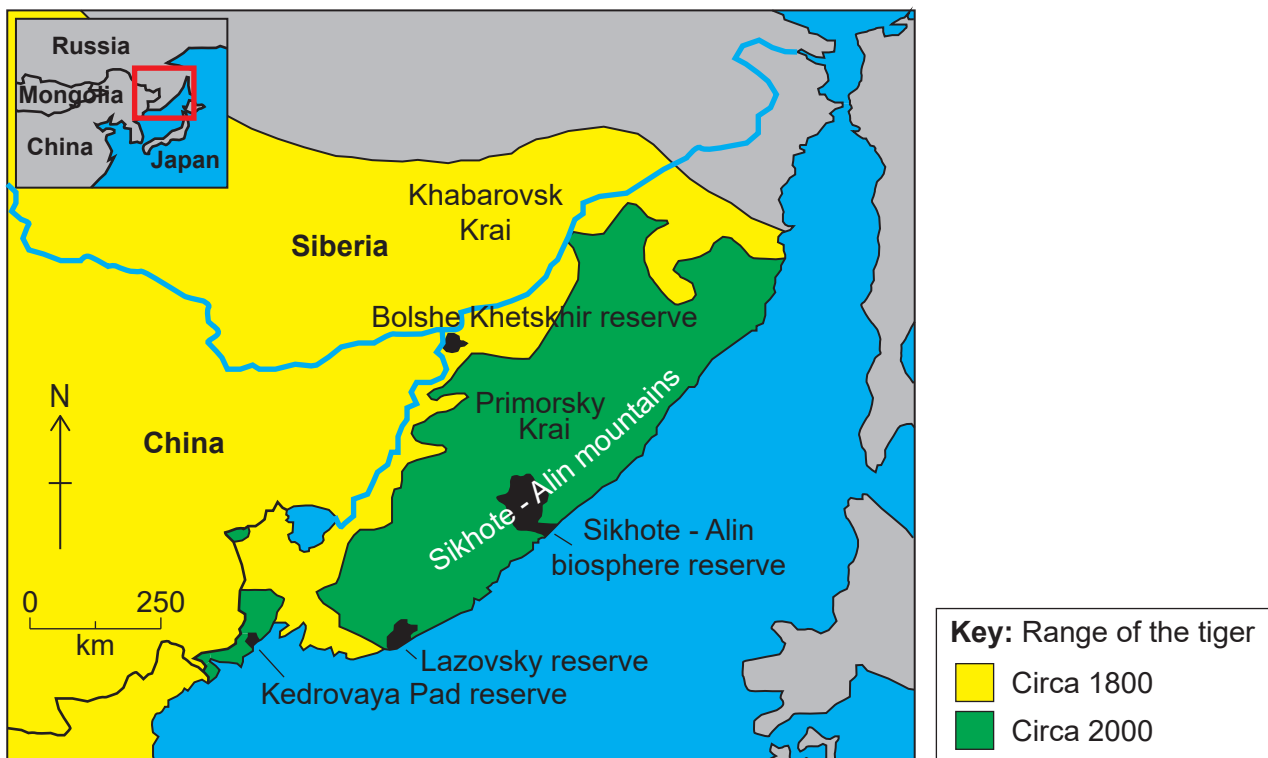


Figure 8(c): Example of a Siberian food web

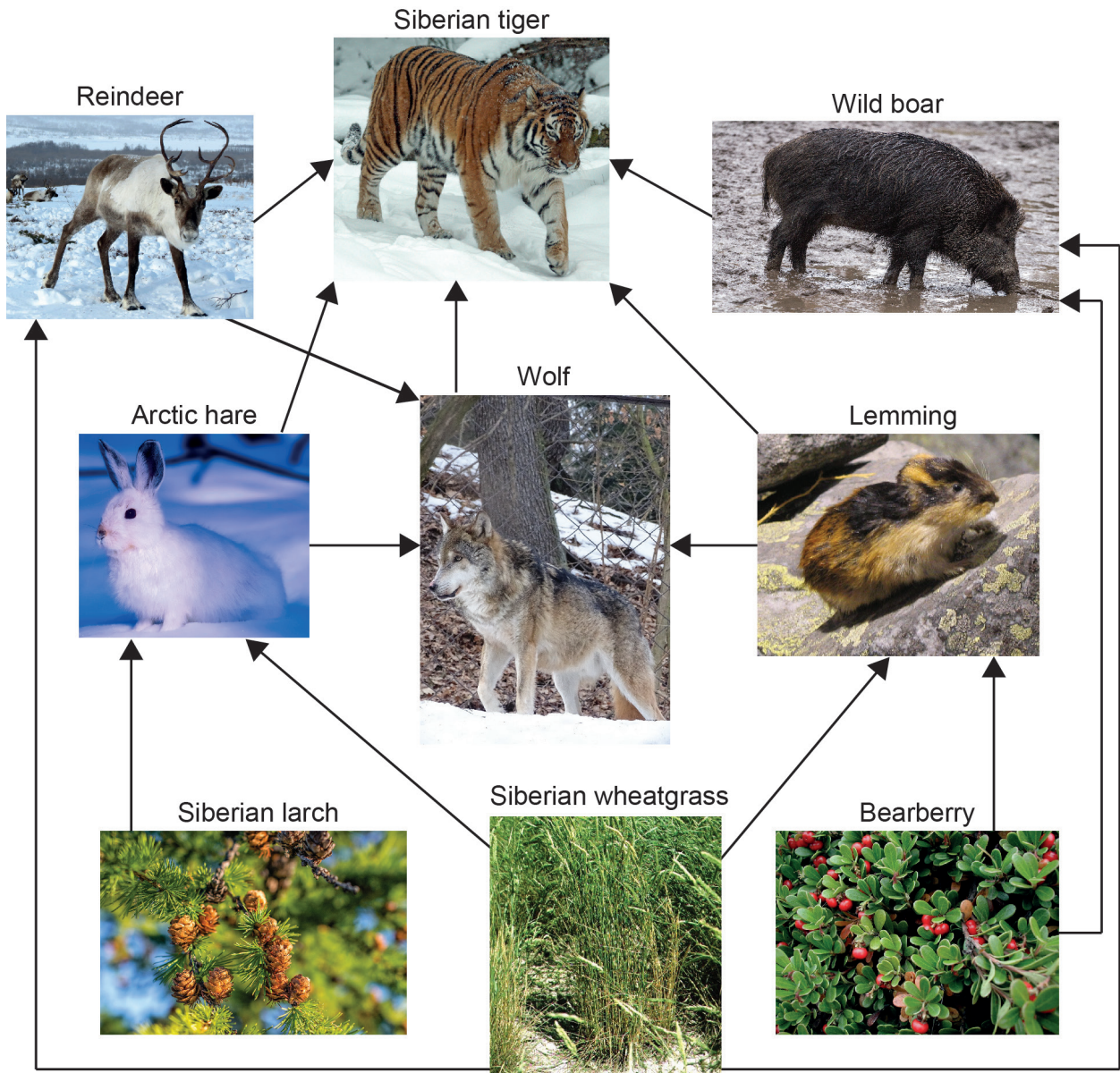


Figure 8(d): Siberian tiger population in Russia

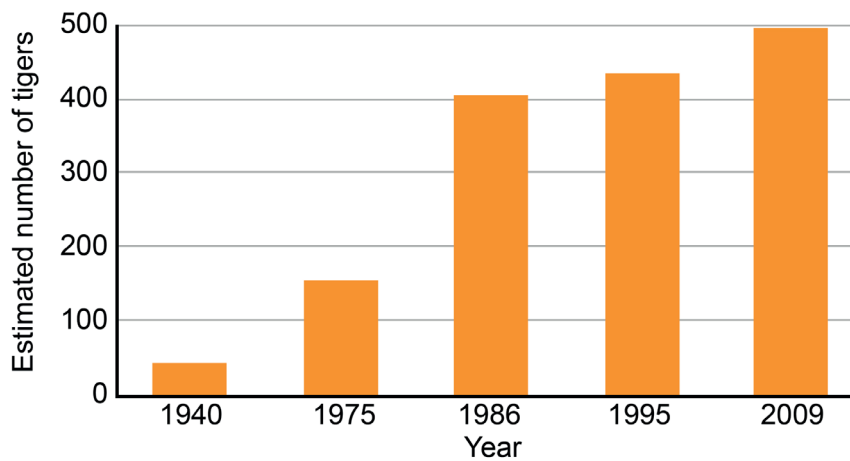


Figure 8(e): Causes of tiger mortality in and near Sikhote-Alin Biosphere Reserve, 1992-2005

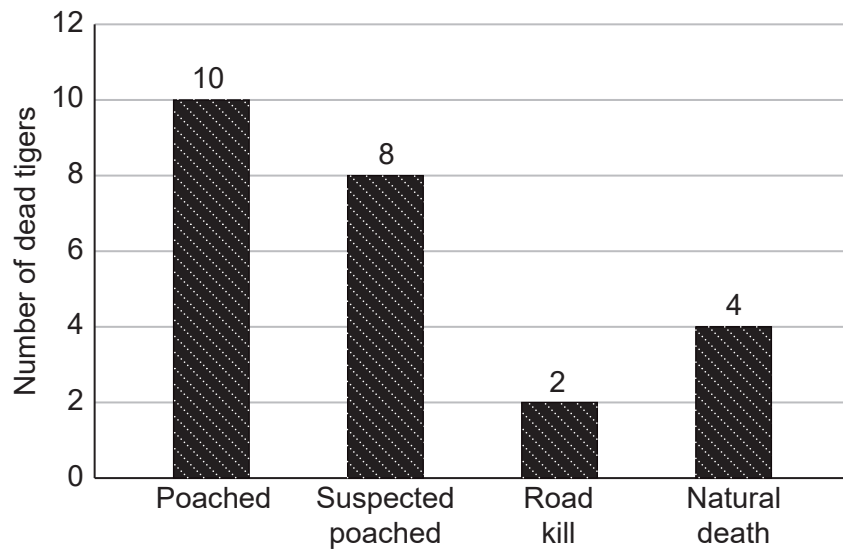
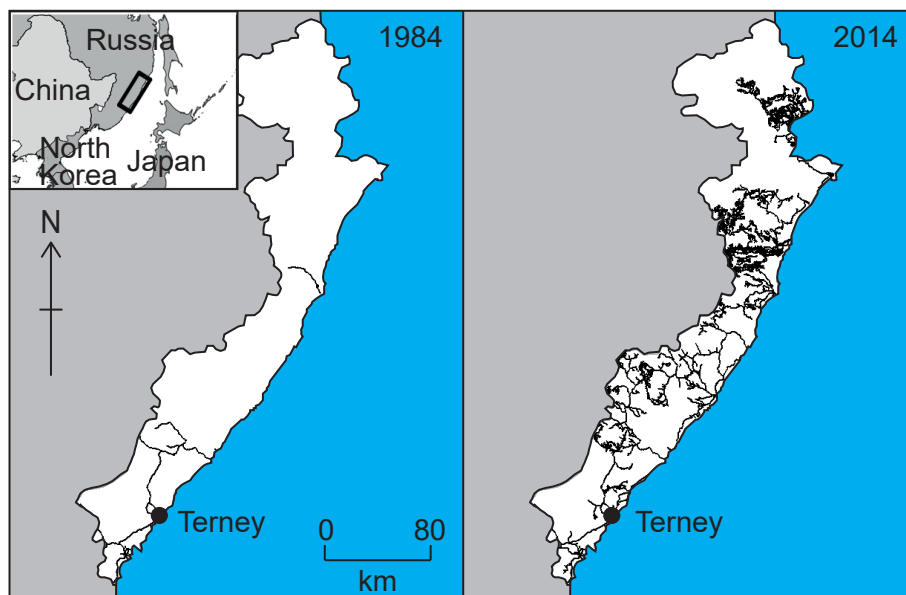


Figure 8(f): Increase of logging roads between 1984 (228 km) and 2014 (6278 km) in Primorsky Krai

In 2015, the logging company, the local authority, and an international NGO agreed to dismantle unused logging roads in the area.



References:

- Figure 2(b)** [*Tundra image*] The Bolshezemelskaja Tundra, Russia, APL,
https://commons.wikimedia.org/wiki/File:Bolshezemelskaja_tundra_1.JPG
(CC BY-SA 3.0) <https://creativecommons.org/licenses/by-sa/3.0/>.
- Figure 2(b)** [*Taiga image*] The Kazakh Steppe in the Ayagoz District, Kazakhstan, Ghilarovus,
https://en.wikipedia.org/wiki/Eurasian_Steppe (CC BY-SA 4.0) <https://creativecommons.org/licenses/by-sa/4.0/>.
- Figure 2(b)** [*Steppe image*] Mixed south Siberian taiga forest with *Abies sibirica*, *Picea obovata*, and *Pinus sylvestris*.
Talcinka stream, Khamar -Daban, Slyudyansky District, Irkutskaya oblast, Russia, Svetlana Ivanova
https://commons.wikimedia.org/wiki/File:South_Siberian_taiga_forest.jpg
(CC BY 3.0) <https://creativecommons.org/licenses/by/3.0/>.
- Figure 5(a)** Cultural Survival, 2014. *Who Are the Indigenous Peoples of Russia?* [online] Available at:
<https://www.culturalsurvival.org/news/who-are-indigenous-peoples-russia> [accessed 26 February 2019].
- Figure 5(b)** SPUTNIK / Alamy Stock Photo.
- Figure 5(c)** EMILIA/Shutterstock.com.
- Figure 6(b)** Nyland, K., Shiklomanov, N. & Streletskiy, D., 2017. Climatic- and anthropogenic-induced land cover change around Norilsk, Russia. *Polar Geography*, 40:4, 257–272, DOI: 10.1080/1088937X.2017.1370503.
- Figure 6(c)** Adapted from AMAP, 2007. *Vegetation damage zones around Norilsk*. [online] Available at:
<https://www.amap.no/documents/doc/vegetation-damage-zones-around-norilsk/647> [accessed 26 February 2019].
- Figure 6(d)** NASA Earth Observatory image by Jesse Allen, using Landsat data from the U.S. Geological Survey.
- Figure 6(e)** © Liza Udilova / Greenpeace.
- Figure 7(b)** With permission from GRID-Arendal. Source adapted.
- Figure 8(b)** Adapted from *environment: YALE*, 2010. Can China Save the Amur Tiger? Available at:
<https://environment.yale.edu/magazine/spring2010/can-china-save-the-amur-tiger>
[accessed 27 February 2019].
- Figure 8(c)** [*Reindeer*] Natalia Kollegova/Pixabay
[*Siberian tiger*] Pixabay
[*Wild boar*] Pixabay
[*Arctic hare*] Pixabay
[*Wolf*] Pixabay
[*Siberian larch*] Pixabay
[*Siberian wheatgrass*] USDA PLANTS Database
[*Bearberry*] *Arctostaphylos uva-ursi*, Sten Porse
<https://en.wikipedia.org/wiki/Bearberry#/media/File:Arctostaphylos-uva-ursi.JPG>
CC BY-SA 3.0 <https://creativecommons.org/licenses/by-sa/3.0/>
- Figure 8(e)** Russia Program, Wildlife Conservation Society.
- Figure 8(f)** Russia Program, Wildlife Conservation Society.