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THE IMPACT OF CLIMATE CHANGE ON THE RUSSIAN ARCTIC

AND PATHS TO SOLVING THE PROBLEM

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The impact of climate change on the Russian Arctic: analysis and paths to solving the problem.
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This illustrated and compact brochure presents data on the impact of climate change in the Russian Arctic. The text compiles scientific observations, witness accounts from local residents, and data on current and foreseen damage due to climate change. Alas, the situation in the Arctic is alarming, and the forecasts are discouraging. This fact must be presented in a clear and unambiguous form, and delivered to the leaders of the major world powers, as well as to UN diplomats, currently conducting negotiations towards future reduction of greenhouse gases. Climate change, however, cannot be halted immediately – in the coming decades, both man and the ecosystem will require assistance. The goal of this pamphlet is to show to those in positions of power, in a demonstrative and scientifically sound manner, that it is time to act, particularly in Arctic regions. We must take concrete steps towards adaptation to climate change, and it will be far better and more affordable to take these steps in advance.

This brochure was prepared under the auspices of the Artic Project of WWF-Russia, and contains summaries of information gathered within the project's first year.

We propose that this information be used as a basis for planning measures, aimed at adaptation to climate change in the Russian Arctic.

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1. Foreword

HOW CAN WE FIGHT GLOBAL WARMING?

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The climate is changing most dramatically in the Arctic, roughly twice as fast as the global average. In the last several decades, temperatures in various parts of the Arctic have risen between 0.7 and 4.0°C, and winters warmed more than summers. In the last 30 years, the snowy season has shortened by an average of 2 weeks. The decrease in the area of Arctic sea ice is stunning – from 7.5 million km² at the end of the 1970's, to 5.5 million km² in 2005. 2007 saw a new record – 4.3 million km². It would seem that a less severe climate should please its inhabitants, but this is not the case.

Viktor Tkachenko, resident of the Chukchi village of Ryrkarpiy, says: *"Before, it was possible to catch a seal on the ice through the end of June, but today, it's already dangerous to walk the ice in May. Even in January, there are thaws, with rain. I can't recall that happening before. Everywhere, ice cover is melting, which before would have held up year-round. Sometimes, the berries overripen, and become soft and bad tasting. There are few cloudberries, because the summer is hot."*

Grigoriy Rykhtyn, *of the village of Vankarem, reckons that "nature has seriously deteriorated, taken offense at mankind. Spring arrives 2-3 week earlier than usual. Spring is harsh, always alternating between rain and frost. The first rain comes in May, but this was not the case before. The first thaw is at the end of April. The rivers break up much earlier than usual, around the 25th of May, when before, it was June 10th-15th. Summer has become intolerably hot. On the ocean, good ice doesn't form. Before, the ocean ice broke up in the middle of May, but the ice didn't recede very far. We hunted all summer on the ice."*

Data from scientific observations, witness accounts from regular people, and information about current and future reduction due to climate change needs to be presented in a clear and resolute manner. This information must then be delivered to the leaders of the major countries, and to U.N. diplomats conducting negotiations for future curtailment of greenhouse gas emissions. This is the first, most urgent task of the WWF Russia's Arctic project. We are pursuing this actively, and this brochure is an important part of our efforts.

Alas, climate change cannot be halted quickly. In the coming decades, both nature and man will need help. This is the second, and even more complicated aim of our project.

In the first year of work on the project, we collected all available data about forthcoming changes in the climate, and their effects on people, plants and animals, and economic infrastructure. **These data were systematized and presented in the form of charts and maps – the most demonstrative format. In doing so, we created the basis for adaptation.**

At the same time, the practical work of adaption is impossible without the close cooperation of local, regional and federal authorities. In some places, namely in a number of settlements on the northern coasts of Chukotka, Yakutia (Sakha Republic), and Krasnoyarsk Krai, this work is already unfolding. **"Bear patrols" are already in action, among other real accomplishments. Other places, where the problems are still not so acute, most likely await "development of illness", also it is well-known that "prevention is cheaper than treatment".**

Thanks to the pleas of the scientific and ecological community, and, we hope, the contributions of WWF Russia, the problem was addressed in 2008 by a specialized government agency – The Hydrometeorology and Environmental Monitoring Agency (Ministry of Natural Resources and Ecology of the Russian Federation). In May 2008 in Murmansk, a conference was assembled on adaption to climate change, and plans were drawn up to begin such work in Murmansk Oblast. The EBRD (European Bank for Reconstruction and Development), with the support of the Spanish government, is beginning a project for adaption to climate change in Leningrad Oblast, which faces tough questions concerning the risk of destructive flooding. The Russian Ministry of Natural Resources and Ecology, in May of 2008, prepared a "Strategic Program of Action for the Protection of the Marine Environment against Pollution in the Russian Federation's Arctic Zone," which presents the problem of climate change in overt terms and presents the challenges of adaptation.

In 2007-2008, the process got underway, and this is already an accomplishment. WWF-Russia will actively participate in all such work in the Arctic. However, officials, scientists and meteorologists often plan, first and foremost, to study the problem and monitor changes. This is simply not enough. Our position is that the time has come to begin taking action: to support protected areas and, if necessary, expand their boundaries, to help the native population, and to adopt stricter ecological standards and rules for work in the Arctic. Of course, such a challenge is far more complex than adaptation on the level of research. Therefore, its solution will come slowly. **Without the efforts of third parties, in particular WWF-Russia, all of this may stay on the level of plans and strategies, drawn on paper.**


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2.CLIMATE CHANGE

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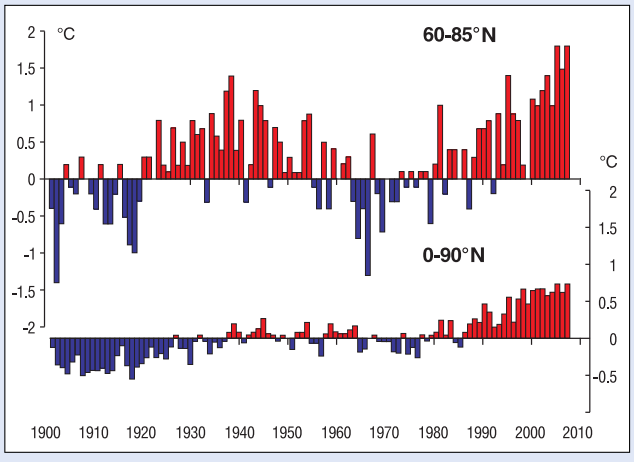
The "Report on the Specifics of Climate Conditions in the Territory of the Russian Federation in 2007" clearly indicates unprecedented climate change in the Arctic. While the global average temperature in the troposphere rose 0.7 – 0.8°C, warming in the Arctic was twice as pronounced. The rate of warming is already 4-5 times higher than the maximum rate of the 1940s.[1]

However, in referring to the Arctic, the notions of a cyclical process and forthcoming cooling are still encountered in the mass media. In recent years the rate of warming in the Arctic has surpassed that observed in 1930s and continues to rise dramatically. That said, the warming in the twentieth century was fundamentally different from that of today. In the second quarter of the twentieth century, when there was little sea ice in the Arctic (though still more than today), and when the "Cheliuskin" expedition was launched, the main cause of warming was an increase in solar radiation. But heating "from the sun" and "from greenhouse gases" are fundamentally different. In the former all atmospheric layers are warmed, while in the latter the troposphere warms while the stratosphere cools. The data from atmospheric baloons and other direct and indirect observations fully confirm this distinction.

The surface area of Arctic sea ice has shrunken dramatically. This decrease in the Arctic corresponds to a simultaneous shrinking of ice cover on the seas of Siberia (Kara, Laptev, Eastern Siberian, and Chukchi). Ice in these seas decreased in area to 200 thousand km² in 2005, while in the «warm period» in the middle of the last century, surface area was never less than 500 thousand km².

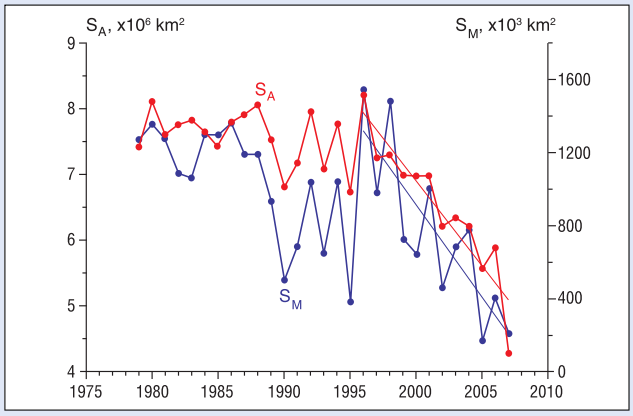
An even more **revealing sign of the loss of ice cover is the thinning of ice**, especially that of pack ice. In recent



Fluctuation of annual average air temperatures in the Arctic (top) and in the northern hemisphere (bottom)

Variations in temperature are calculated relative to the average values between 1961 and 1990

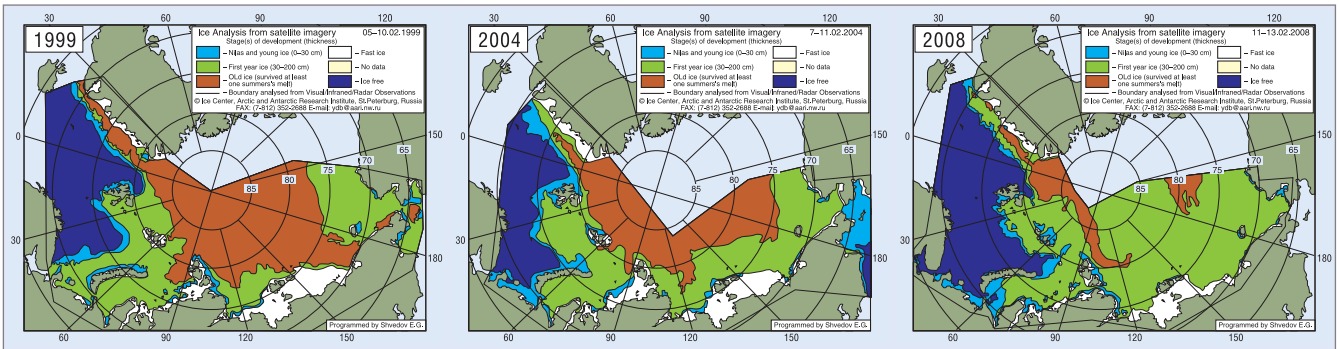
Source: «Report on the Specifics of Climate Conditions in the Territory of the Russian Federation», Russian Hydrometeorology and Environmental Monitoring Agency, Moscow, 2008, 35 pages (In Russian)



Variance in the area of ice in September in the Northern hemisphere (SA) and on the Siberian Arctic seas (SM)

The straight line shows the overall trend between 1979 and 2007. The line SA represents a 32.3% decrease in this period. During the same period, the area of ice cover on Siberian arctic seas (SM) decreased 79.4%.

Source: «Report on the Specifics of Climate Conditions in the Territory of the Russian Federation» Hydrometeorology and Environmental Monitoring Agency, Moscow, 2008, 35 pages (In Russian)



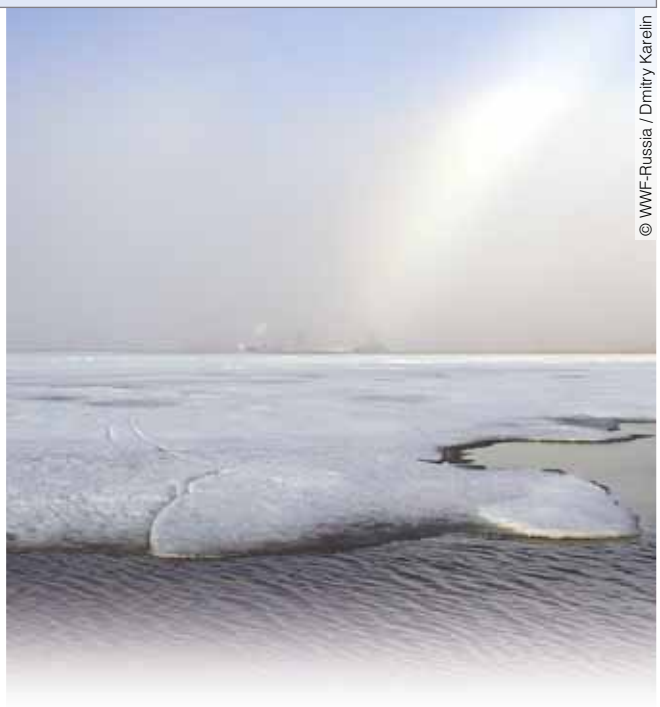
Ice cover on the Siberian arctic seas in February of 1999, 2004, and 2008.

Blue areas represent thin "young" ice in the given year (thickness of 0-30 cm), green areas are "young" ice of thickness from 30-200 cm, and brown areas are "old" ice of the previous year (having survived at least one summer). (Data from AANII[2])

years, multi-year, or "old" ice has thinned several times over. From the area of this ice in particular, we are able to examine long-term changes in winter ice cover.

The melting of the permafrost serves as another revealing indicator of climate change. Significant areas of the Russian permafrost zone, which covers 60% of the country (the largest such region in the world falling under a single nation's jurisdiction), clearly evidence a trend of temperature increase in the top layers of frozen ground from the 1970's to the 1990's, corresponding with the warming of the atmosphere. Although climate change in European Russia is less severe than in Siberia, the change in the condition of frozen terrain is no less substantial. In the last 20 to 30 years, temperatures in the frozen ground of Russia's European Arctic and Subarctic have increased between 0.22 and 1.56°C, matching increases in the number and thickness of taliks (thawed underground pockets). These observations speak to a progressive increase in seasonally thawing soil, as well as a 14-80% increase in thawed pockets of soil in individual regions of the Russian Arctic (The Kolyma lowlands, eastern Chukotka, Bol'shezemel'skaia Tundra). There has also been a noticeable northward shift of areas of seasonal frost, and a decrease in the area of isolated and sporadic pockets of frozen soil[3].

What are the ramifications of the thawing, or even just the increase of temperature of the permafrost? First and foremost, they increase the risk of dangerous cryogenic phenomena, such as soil creep, thermokarst, and land subsidence in northern regions. Degradation of the permafrost presents a danger to infrastructure in the far North (roads, oil and gas pipelines, storage tanks, oil fields, buildings, etc.) Over 30% of proven oil reserves and around 60% of Russia's natural gas are concentrated in the North, as well as an extensive infrastructure serving the oil and gas industry. Many structures are built on piled footing with the permafrost as their foundation, dependent on definite soil conditions and temperatures. In the last 30 years, over 300 buildings in Yakutsk have suffered serious damage due to ground subsidence. As early as 1992, 10% of all buildings in Norilsk were damaged, 22% in Tiksi, 35% in Dudinka, 50% in Pevek and Amderma, 55% in Magadan, 60% in Chita, and 80% in Vorkuta. Between 1990 to 1999, the number of structures suffering damage due to non-uniform land subsidence, compared to the number of such incidences in the previous decade, increased 42% in Norilsk, 61% in Yakutsk, and 90% in Amderma.[4].



1 «Report on the Specifics of Climate Conditions in the Territory of the Russian Federation», (Hydrometeorology and Environmental Monitoring Agency), Moscow, 2008. 35 pages. (In Russian)

2 Alekseev G.V., Ashik I.M., Danilov A.I., Dmitrev V.G., Radionov B.F., Frolov C.V. Arctic and Antarctic Research Institute. "The Impact of Climate Change on the Arctic Region. Results of the Scientific Program 'International Polar Year 2007-2008'. Report on the International Conference "Adaptation to Climate Change and its Role in Securing Sustainable Development of the Region." Murmansk, 13 May 2008. (In Russian)

3 Proceedings of Ninth International Conference on Permafrost, UAF, Fairbanks, June 29 – July 3, 2008. Eds. D.L. Kane, K.M.Hinkel.

4 Anisimov O.A., Belolutskaia M.A., 2002. Assessment of the impact of climate change and degradation of permafrost on infrastructure in Russia's northern regions. Meteorology and Hydrology (6): 15-22. (In Russian)

Anisimov O.A., Lavrov S.A. Global warming and melting of the permafrost: assessment of the risks to industrial structures TEK, 2004. Technology TEK (3): 78-83. (In Russian)

As expected, the thawing of soil is also leading to the generation of new sources of greenhouse gases (CO_2 and methane). These gases are released into the atmosphere as a result of 1) the thawing of Pleistocene organic matter preserved in the ground, and its subsequent consumption by microorganisms, 2) the activation of those very microorganisms, preserved in the frost, 3) the release of already formed greenhouse gases trapped in ice, and 4) an increase in microbial activity in seasonally-thawing soil. These additional sources can further accelerate warming by means of feedback loops.

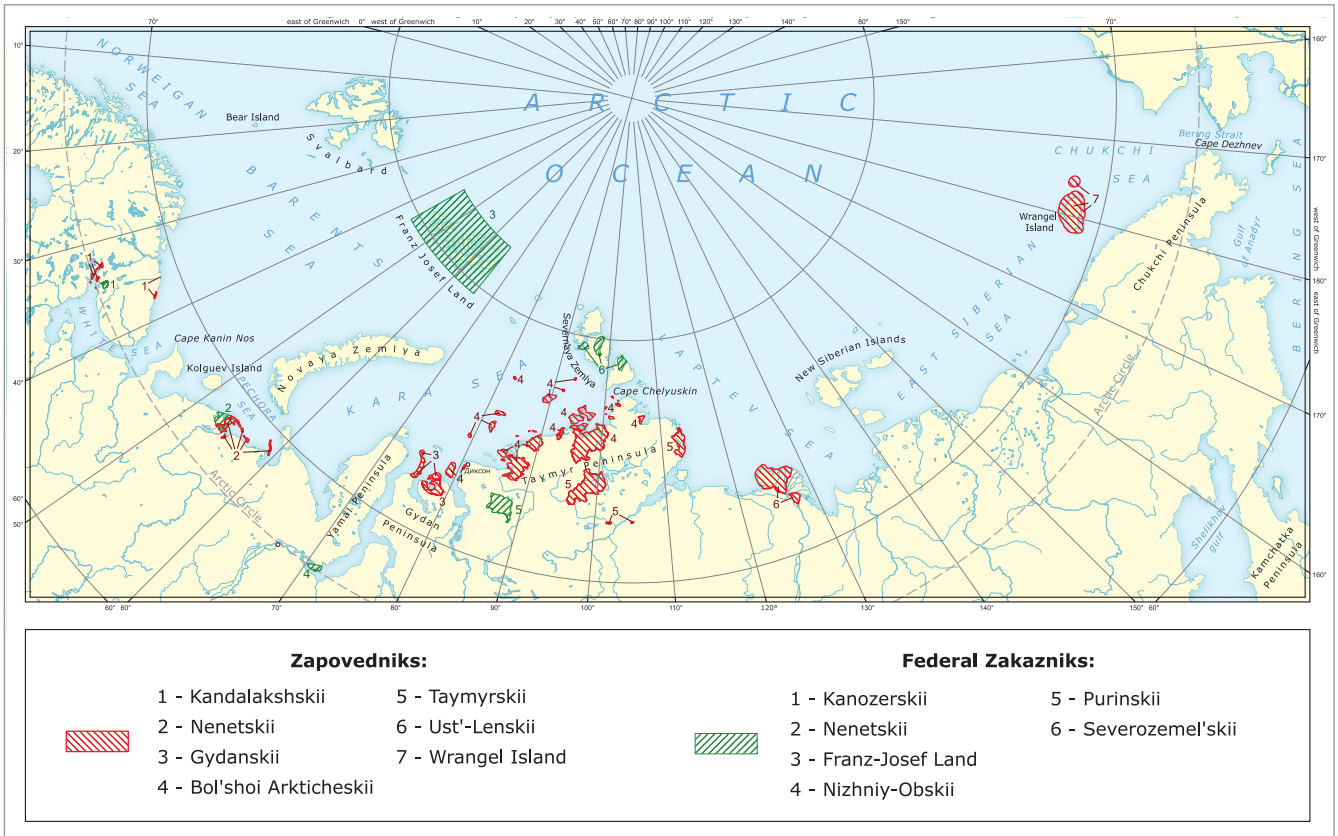
Although deeper layers of frozen soil are insulated against thawing by intermediate icy strata and a layer of organic soil and vegetation, models demonstrate that further deepening of seasonal thawing as a result of rising air temperatures may upset that balance. Should this happen, it will change (and this is already occurring) the composition of plant and animal communities, and existing natural complexes of the tundra may severely dwindle, or disappear entirely.

Aside from the impact of the climate on frozen soils, the last decade has seen **an increase in coastline erosion in the Arctic seas**, stemming from rising summer temperatures and the strengthening of ocean waves.

Climate change has always affected the inhabitants of our planet. Today, nobody can say whether the mammoth was doomed to extinction when the steppe turned to tundra and taiga, but most scientists agree that early man had a hand in the giants' disappearance. Imagine, for a moment, that 20-30 thousand years ago, agents of a highly developed civilization appeared on earth, and had created an expansive preserve for mammoths with a protected food supply and security against hunting and wildfires. Perhaps today, we could still see those enormous wooly creatures. This example may be fantastical, but it underscores one of the most important tasks of nature conservationists – **to create such places, where nature would be allowed to provide for itself, where living beings and their communities could thrive free of the negative influence, or even the aid, of man, and use their own means to adjust to changing conditions.**

Another important purpose of *zapovedniks* (strictly protected nature reserves), national parks and other such preserves is to alert us to changes taking place in nature. In Russia, zapovedniks have traditionally served as research stations, too, where "natural records" have been kept, chronicling data essential to the understanding of the effects of climate change on living systems.

The patchwork of protected areas in the Arctic coastal region was shaped by history. Long-term planning and analysis of the challenges of preserving biological diversity played no significant role in its formation. Rather, protected areas were



Zapovedniks:

1 - Kandalakshskii
2 - Nenetskii
3 - Gydanskii
4 - Bol'shoi Arkticheskii
5 - Taymyrskii
6 - Ust'-Lenskii
7 - Wrangel Island

Federal Zakazniks:

1 - Kanozerskii
2 - Nenetskii
3 - Franz-Josef Land
4 - Nizhniy-Obskii
5 - Purinskii
6 - Severozemel'skii

Federal protected areas in the Russian Arctic.

At the time of this publication, the formation of the "Russian Arctic" and "Onezhskoe Maritime Area" national parks is underway. Due to technical reasons some protected areas (Laplandskiy, Pasvik, Kurnovatskiy zapovedniks and Nadymskiy, Lebediniy, Murmanskiy Tundroviy zakazniks) which have no direct access to sea coast are not presented on this map

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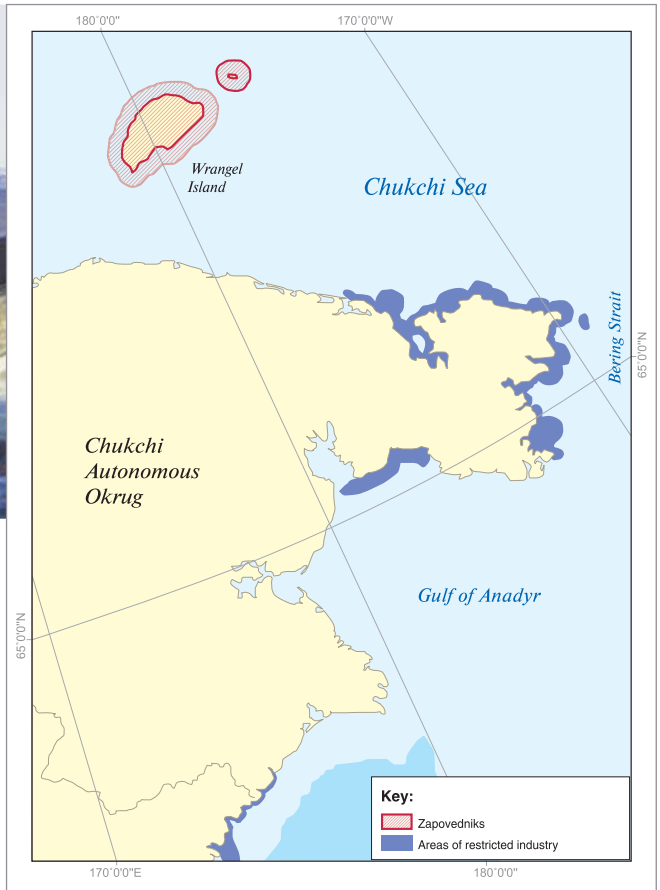

«Wrangel Island» Federal zapovednik and aquatic mammal protection areas in Chukotka

created on parcels where it was feasible, or where the administrator or the military was willing to hand over the land. Four of these preserves encompass marine compartments: Kadalakshckiy, Nenetskii, Bol'shoi Arkticheskii (with 7 maritime areas), "Wrangel Island", and 2 zapovedniks with protected maritime zones – Taymyrskii and Ust'-Lenskiy. Aside from these, there are 3 zakazniks (akin to Western national parks) with marine compartments – "Franz Josef Land", "Nizhny-Ob'", encompassing freshwater wetlands in the southern part of the Gulf of Ob, and "Severnaya Zemlya".

The cumulative area of all offshore compartments (including marine buffer zones) located within national parks and other nature preserves totals 95 583 km^2, which constitutes around 2% of Russian Arctic waters.

There is only one zapovednik in the Chukotka region – "Wrangel Island", which encompasses significant aquatic areas surrounding the island and includes a marine buffer zone. The island serves as a "nursery" for polar bears. The establishment of the zapovednik has had a very significant role in the protection and study of coastal ecosystems on the border of the Chukchi and East Siberian Seas, including the protection of several species in the Russian Federation's Red Book (endangered species list), among them the polar bear (Chukchi-Alaskan population), the Pacific subspecies of Walrus, and the White Goose. At present, the island's remoteness and inaccessibility provide natural protection, but a scarcity of material resources for the park presents a serious obstacle to conducting regular scientific research and monitoring.

Remaining protected areas include coastal natural monuments, which have no human monitoring, and the natural-ethnic reservation Beringia, which encompasses the northwest of the Chukchi Peninsula, but has no marine buffer zone.

In addition to the marine compartments of zapovedniks, zakazniks, and national parks, Russian has other forms of marine compartment protection. For instance, in the waters of the Far East, restricted fishing zones surrounding rookeries and other concentrations of aquatic mammals, most notably pinnipeds and sea otters, have been designated. Some of these zones are rather densely clustered along the coast of the Chukchi Peninsula, where they are comprised almost exclusively of walrus rookeries. The overall area of aquatic mammal protected areas totals 20968 km^2, or roughly 4% of Russian claims in the Chukchi Sea, the Bering Straight, and the Gulf of Anadyr.

These areas were designated as marine protected areas in accordance with the Economic Regulations and Protection of Aquatic Mammals legislation, enacted by the Soviet Ministry of Fisheries in 1986. Although these regulations are still in effect, many provisions are no longer enforceable, as they are voided by the Russian Federation's Fishing Industry and Protection of Marine Biological Resources laws in the new Russian legal code.

If in the past, visitation to rookeries in these marine animal protection zones was restricted, and low-altitude flights by airplanes and helicopters forbidden – **precisely the things that in today's conditions of climate change can cause the greatest harm to walruses - such restrictions no longer exist. If a helicopter were to fly too low over a rookery, provoking a panic and leading to the deaths of tens or hundred of animals in the ensuing stampede, it is likely that nobody would face any consequences.**

3. THE CLIMATE CHANGE FORECAST

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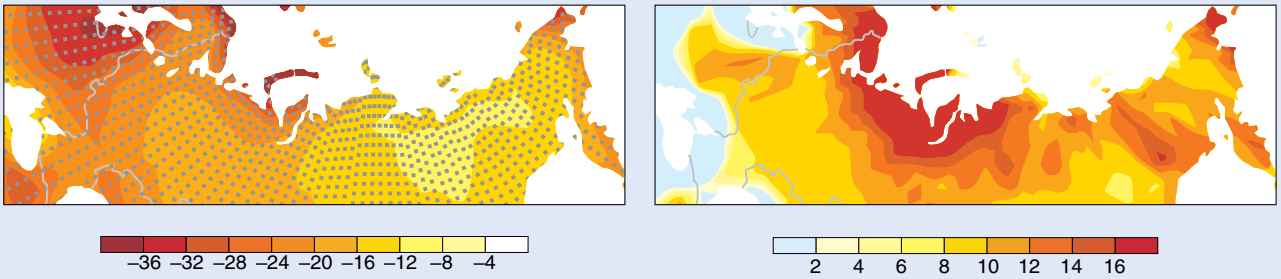
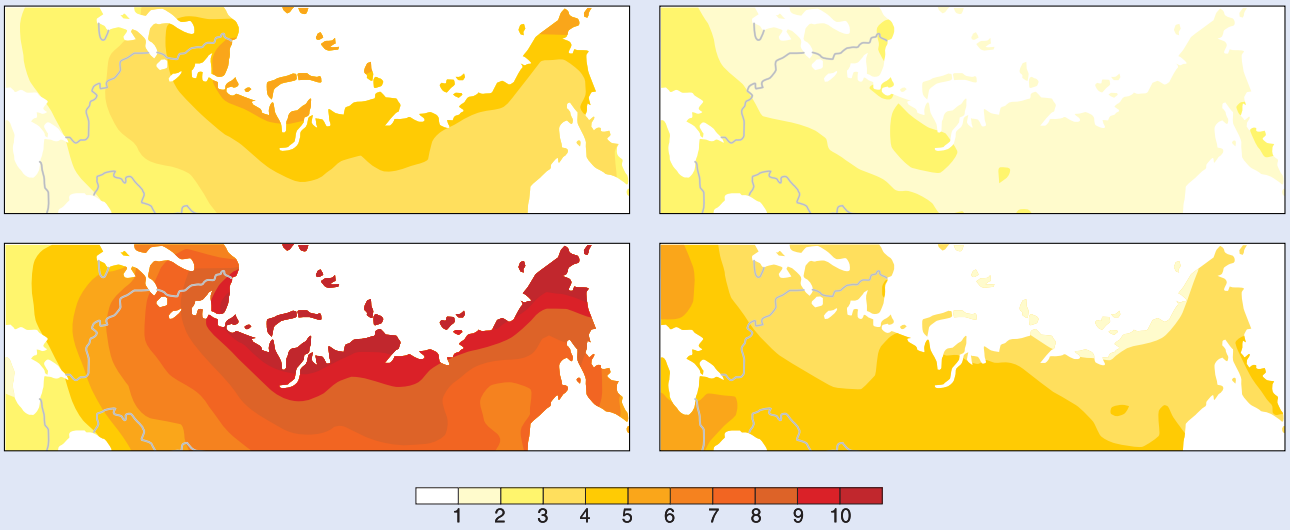
When discussing forecasts of climate change, we must acknowledge a few basic provisions.

- **First of all, general atmospheric circulation models are refined and dependable enough to forecast average seasonal conditions (temperature and precipitation). They have a spatial resolution of around 2° latitude by 2° longitude, focused enough to predict even local particularities in sections of larger regions like Chukotka.**
- **Secondly, the single biggest factor in any forecast is the volume of greenhouse gas emissions. The discrepancies between forecasts from different models are smaller than discrepancies due to different greenhouse gas emissions scenarios. This means that adaptation is merely a stopgap measure. Lowering of greenhouse emissions is the only strategy that can resolve the problem.**
- **Third, current models allow us to speak with a degree of certainty about the consequences of changing seasonal averages. The dwindling of sea ice, thawing of frozen soil, and in this connection, negative consequences for infrastructure, all stem from these changing averages. However, models still cannot predict changes in the strength and frequency of dangerous hydrometeorological phenomena. In this area, we are still limited to intuitive understanding and extrapolations of current trends.**

The Intergovernmental Panel on Climate Change (IPCC) constructed several scenarios of greenhouse gas emissions, three of which [(A2), (A1B) and (B1)] were analyzed in detail with the help of 15 models. In particular, this work has been carried out at A.I.Voeikov Main Geophysical Observatory (GGO). Scenario A2 simulates a refusal by the global community to take substantial steps towards lowering greenhouse emissions. A1B represents economic growth with an active implementation of new technologies with lower greenhouse emissions, as well as stabilization of the world population by the middle of the 21st century. B1 is the “greenest” scenario – it assumes that global warming is successfully limited to 2°C. This is the scenario advocated by WWF and



Decrease in the number of sub-zero days by the middle of the 21st century (left, in days), and the shift of the end of the frozen period towards the beginning of the year (right, in days). Data from GGO[5], 2008



The rise in average winter (left) and summer temperatures (right), in degrees Celsius, by the middle (top) and end (bottom) of the 21st century, according to the maximum greenhouse gas emissions scenario A2.
Data from GGO[6], 2008

the environmentalist community. But even that scenario constitutes a 4°C increase in autumn and winter average temperatures in the Arctic by the end of this century. Incidentally, the most pessimistic scenario foresees for Chukotka a rise in winter temperatures of more than 10°C, and 3-4°C in the summer, by the end of the 21st century.

When speaking of adaptation, **it is better to err on the side of caution and orient ourselves towards variant A2, especially given that the differences between scenarios through 2030 are marginal. Reducing greenhouse emissions will only begin to produce results towards the middle of the century (though by the end of the century, the difference between the variants is enormous).**

The decrease in the number of sub-zero days is one illustrative example of significant change. In the Arctic on the whole, by the middle of the century the period without sub-zero days will extend by a half of a month. However, in the northeast part of Chukotka, and in the northern Barents Sea region, the thawing period will lengthen by more than a month. This lengthening of the thawing period is generally marked by an earlier spring. Negative temperatures will come only 6-8 days later in Chukotka, 10-12 days later in the Barents Sea region, and no change is expected at all on the Taymyr Peninsula. On the other side of the equation, in the spring in the Barents Sea region and northwestern Siberia, as well as in the east of Chukotka, temperatures will exceed freezing 20 or more days earlier.

Conversely, large parts of the Arctic, and Chukotka in particular, will see uncharacteristic periods of very hot weather (so-called heat waves), from which Krasnodar Krai and many other regions of the world already suffer. Heat waves are expected mostly in the southern and central portions of western Siberia and, possibly, along the coast of the Kara Sea.

The problem of breakdown and melting of the permafrost is well-known and already evident. However, forecasts show that melting, or more precisely the breaking down of multi-year frozen soils (including the formation of thermokarst) is not progressing from south to north, but in a much more complicated pattern. The State Hydrological Institute (GGI) conducted specific studies and constructed risk maps (based on the level of geocryogenic danger)[7]. In many regions of the Arctic, and in particular in Chukotka, the risk to buildings and infrastructure is on the whole high, regardless of the relatively small increase in temperature in the summers, when the risk of structures sinking is greatest.

Generally speaking, there will be an increase in the depth of seasonal thawing in Arctic regions where permafrost covers more than 90% of the surface. Taliks will crop up and grow in these areas as well, for the most part under larger rives and lakes, due to the breakdown of permafrost near the surface and its preservation at greater depths. Nearly all of Chukotka (excepting the northeastern extremity of the peninsula) falls within the highest risk category on the geocryogenic risk index, including the Bilibino nuclear plant and associated power transmission lines between Chersk and Pevek settlements on the coast of the East Siberian Sea. Also in this risk category are the Yamal Peninsula and the Arctic coastlines of Yakutia and the Kola Peninsula.

5 Kattsov V., Govorkova V., Meleshko V., Pavlova T., Shkolnik I. Voeikov Main Geophysical Laboratory, Saint Petersburg. Climate change projections and impacts in Russian Federation and Central Asia countries. Report №1, World Bank, Moscow, 2008

6 Kattsov V., Govorkova V., Meleshko V., Pavlova T., Shkolnik I. Voeikov Main Geophysical Laboratory, Saint Petersburg. Climate change projections and impacts in Russian Federation and Central Asia countries. Report №1, World Bank, Moscow, 2008

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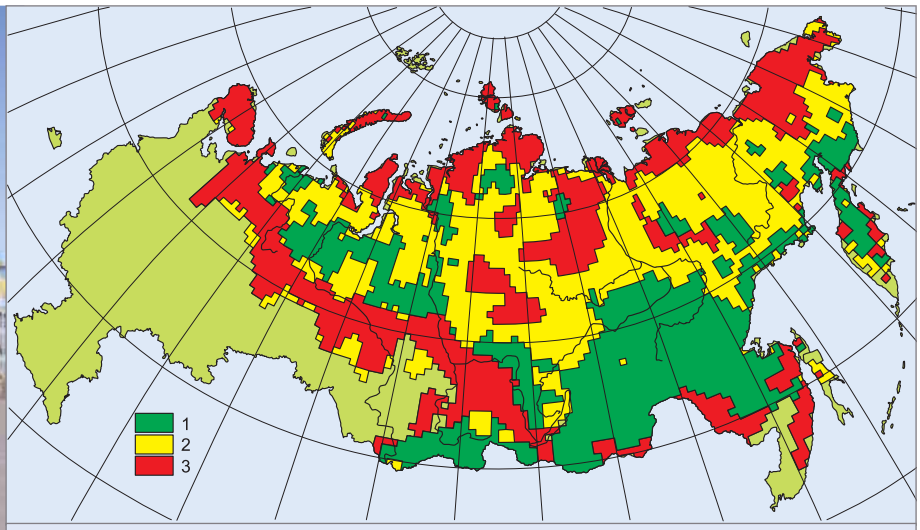
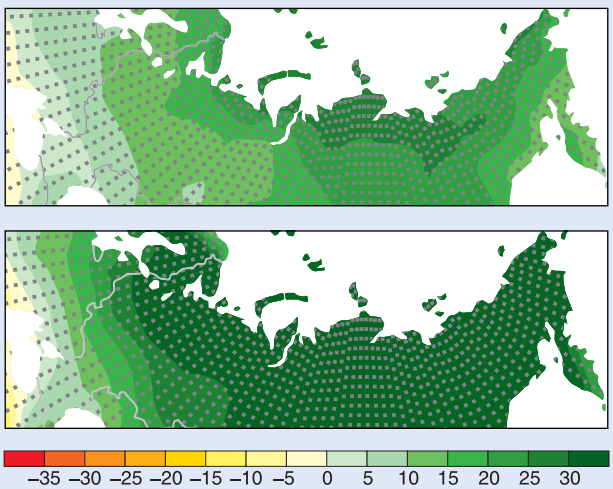
7 Anisimov O., Reneva S., Permafrost and Changing Climate: The Russian Perspective. Ambio Vol. 35, No. 4, June 2006 p. 169-175. Royal Swedish Academy of Sciences. 2006. http://www.ambio.kva.se



Map of the risk to buildings and structures in the permafrost zone. Data from GGI.
1 – low **2** – medium **3** – high risk

An increase in precipitation, to a certain extent, will also contribute to **the breakdown of frozen soils.** A significant increase in winter precipitation totals is expected by the middle of the century. Precipitation will increase on the Taymyr Peninsula by 30%, and by 15-20% in Chukotka and the Barents Sea region. This increase in precipitation will continue through the second half of the century. In the East of the Russian Arctic, precipitation totals will be more than double the present-day numbers. A deep layer of snow, as expected, will shorten the period of soil freeze in the winter.

Alternately, summer precipitation totals will increase only 5-10% by the middle of the century, and 10-20% by the end. This increase will be slightly larger in the eastern part of the Arctic. Also in this region, an increase in the number of torrential rains is forecasted, which could accelerate coastline erosion.



Increase in winter precipitation totals by the middle (top, in days) and the end (bottom, in days) of the 21st century. Data from GGO, 2008

Rainfall will exceed evaporation throughout the Arctic (despite an increase in evaporation due to warming), which leads to the formation of bogs. This effect might be most pronounced along the central and eastern Arctic coast.

Direct effects of rising sea levels will be relatively minor. Even a rise of up to 1m in the 21st century would likely not lead to flood damage to infrastructure. Gales and the effects of **coastal erosion present a much greater threat.**

In a number of places, thermokarst is already developing, and coastlines are eroding 10 or more meters per year. Erosion can represent a serious danger, and must be studied on the local level of individual inlets and settlements.

Generally speaking, the frequency of high winds and squalls contributes most to the overall number of dangerous hydrometeorological phenomena (DHP). On the whole, occurrences of such phenomena in Russia have increased from 150 per year in 1990 to 300-400. 2007 saw a record number of DHP's at 436, 20% of which were high winds. According to Hydrometeorology and Environmental Monitoring Agency forecasts, the number of DHP's will likely double between 2005 and 2015. When planning adaptive measures given these circumstances, **it is absolutely vital to anticipate a two or threefold increase in the strength and frequency of high winds, squalls, gales, etc.**

A sharp decline in the area of sea ice will, in all likelihood, be the most glaring consequence of climate change in the Arctic. As mentioned above, that process is progressing very rapidly. According to the latest estimates from GGO modeling, the total area of sea ice will dwindle in both the minimum (summer) and peak (winter) seasons (September and March, respectively)[8]. These calculations for the 21st century were conducted by 12 atmosphere-ocean general circulation model (AOGCM). The models used greenhouse emissions scenario A2, which allows for more certainty in planning adaptive measures.

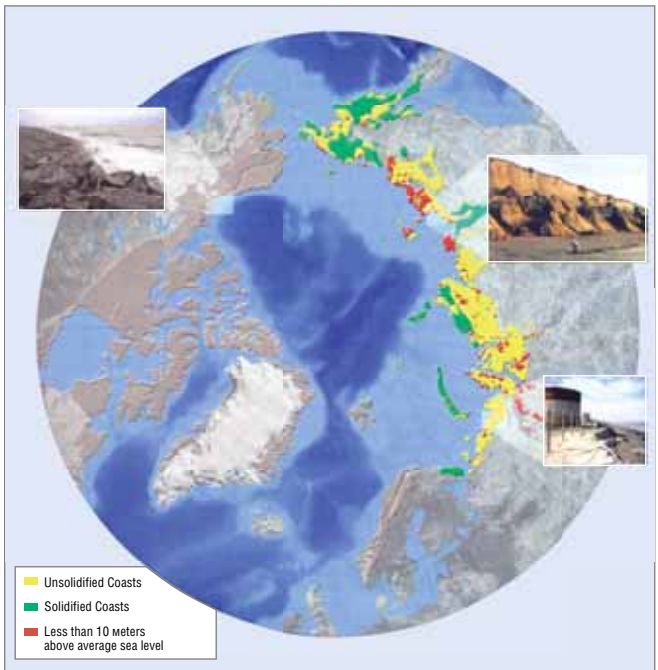
By the middle of the century, there may be a two or threefold decrease in the area of summer ice (in the graphic – the

difference between the gray region and the red line). By the end of the century, there will most likely be no summer ice cover at all. We acknowledge that a third of the models predict practically no change in ice cover, but these models also do not reproduce changes already observed at the beginning of the current century. To better plan adaptive measures, it follows to orient ourselves towards a more dramatic decline in Arctic sea ice.

In the winter, the Arctic will be covered in ice. Only the Atlantic sector of the Arctic Ocean will display by the changes in ice area. There will be far less ice in the Eastern portion of the Barents Sea. Outside the Arctic Ocean, changes in the winter ice cover will be very evident. By the middle of the century, the amount of ice on the Bering Sea and the Sea of Okhotsk will decline sharply. By the end of the century, these seas will likely have no ice at all (possibly excepting the northern part of the sea of Okhotsk).

However, there will be one significant change throughout the Arctic – the thickness of the ice. As demonstrated above, the thickness of ice and the amount of multi-year pack ice is already rapidly declining. Monitoring of this process is being conducted by the Arctic and Antarctic Research Institute[9], among other organizations. Most likely, pack ice in the Russian Arctic will disappear within ten years. It will remain only in the Canadian Arctic archipelago, where the inflow of warmer Atlantic waters is weaker.

The melting of sea ice will also alter navigation on the Arctic seas. By the end of the 21st century, the Vilkitsky Strait may be navigable for up to 120 days (compared to 20-30 days today). At the same time, due to the breakup of glaciers, the danger of collision with icebergs will increase. An increased mobility of pack ice may prove an even greater negative consequence. Sections of ice on the scale of tens of square kilometers may detach from larger masses on the Arctic Ocean and go adrift.



Map of coastal erosion risk. Source: ACIA 2004

Areas of greatest risk are highlighted in red, areas of medium risk are yellow.

The most significant erosion is expected in the Lena River delta, on the coast of the East Siberian Sea, on the Yamal Peninsula, and on the central Arctic coast of Chukotka.

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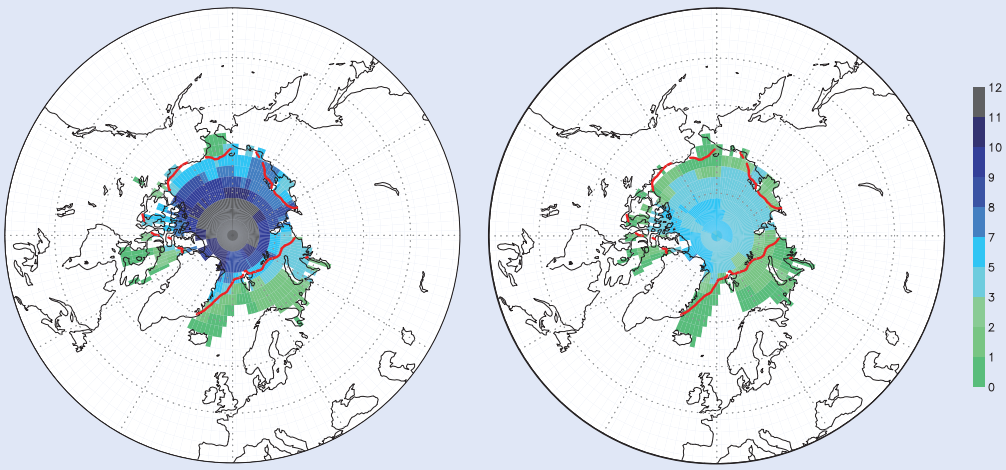
Minimum (September) area of Arctic sea ice by the middle (left) and the end (right) of the 21st century[5,8].

Gray areas show ice cover predicted by all 12 models. Dark blue shows ice predicted by 8-11 models, and light blue, by 3-7 models. The red line represents the limits of the area covered by ice in average between 1980 and 1999.



8 V.M. Kattsov, G.A. Alekseev, T.V. Pavlova, P.V. Sporyshev, R.V. Bekryaev, V.A. Govorkova, 2007b: Modeling the Evolution of the World Ocean ice cover in the 20th and 21st centuries. Izvestia of the Russian Academy of Sciences: Physics of the Atmosphere and Ocean, 43, 165-181. (In Russian)

9 Data on sea ice and hydrometeorological processes of the polar regions is posted on the AARI website, http://www.aari.nw.ru. (In Russian)

4. THE EXTRACTION OF OIL AND GAS

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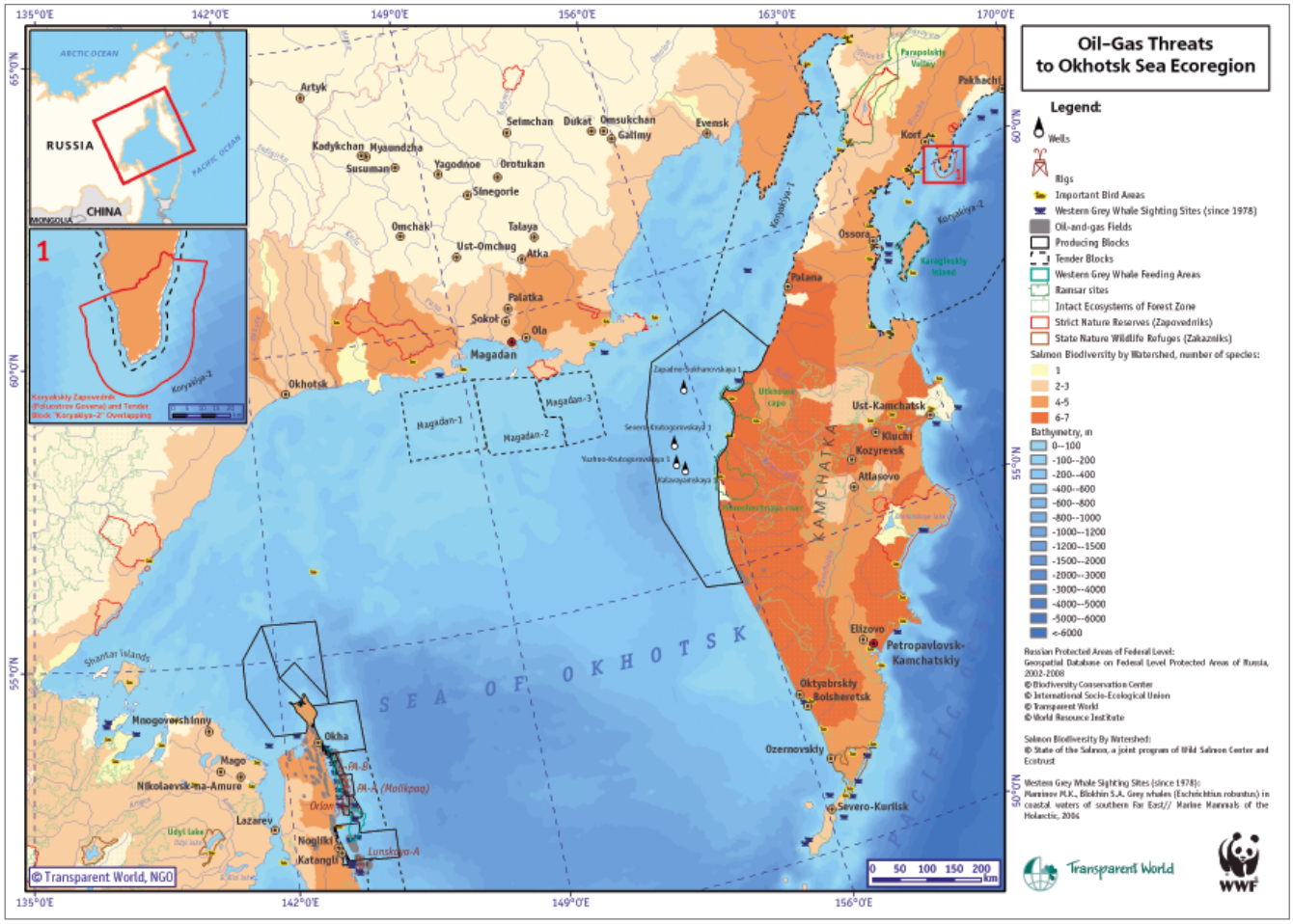
WWF-Russia views the Arctic and adjacent territories as a region whose ecosystems will endure the greatest human impact in the coming decades, as a result of global warming and the intensification of economic activity.

Environmental impact assessments (EIA) play a vital role in minimizing the impact of the extraction of resources (particularly oil and gas) on Arctic ecosystems and their ability to adapt to climate change. In keeping with the recommendations in the Guidelines for Environmental Impact Assessment in the Arctic (Helsinki, 1997), special attention must be paid to assessing the cumulative effect, and actively involving all interested parties.

Objective cartographical information for such an assessment is one of the goals of the new WWF project, which is being conducted together with “Transparent World” (Russian NGO focused at mapping for concentration purposes) and in conjunction with regional organizations. An interactive map of the Barents Sea region is already available (http://maps.transparentworld.ru/en/barents/viewer.htm), and similar maps are planned for other regions of the Russian Arctic.

A range of preventative measures, including EIA’s, can minimize the negative impact of oil and gas projects, but cannot negate them entirely. Not a single operator can fully guarantee oil field development free of spills. The Arctic



is an exceptionally vulnerable region, insofar as the climate and physical environment make spills more likely, and their consequences harder to remedy, than in other areas. This is attributable to the lack of natural light, low temperatures, ice drift, and strong winds, among other factors. A series of recent oil spills in a number of countries, including Russia, offer irrefutable proof that even in simpler climate conditions, response crews are still unable to effectively combat the effects of spills.

At present, new technologies for combating oil spills in Arctic conditions are in development, but research is ongoing, and such technologies have yet to be practically applied.

Off-road transport will be another substantial threat in particular to Chukotka. In 2001, the company Sibneft initiated prospective drilling on the territory of Tumanskii Zakaznik (which was closed the following year). In 2002, prospective drilling was conducted on the shelf of the Gulf of Anadyr. These explorations have yet to produce results, but clearly, the coastline of Chukotka will be an area of exploration and possibly drilling in the future. At present, it is difficult to evaluate all the threats to biodiversity that may result from this activity. The most obvious threat is that of acute impact on the local environment and the degradation of coastline, stemming from the use of heavy equipment while prospecting.

A WWF-Russia report is devoted to the problem of oil spills on the Arctic seas. The document was first presented in January 2008, at an international Arctic conference in Tromse, Norway. According to the report, the only way to avoid the destructive consequences of oil spills in the Arctic and minimize additional stresses on the ecosystem there **is to halt the development of new offshore fields, until effective means to clean up spills in Arctic conditions have been developed.**

5. VULNERABLE NATURAL BOUNDARY ZONES

Climate change, first and foremost, affects boundary zones, where interaction between contrasting physical elements is most pronounced.

We refer, first and foremost, to the boundary between dry land and the oceans. With the rhythm of the tides, the coastline of seas and oceans rise and fall twice daily. Marshes or Layds – expansive swampy meadows periodically flooded by the tide, and whose vegetation is well adapted to excesses of salt – are characteristic along the coasts of the northern seas. They are associated with built up, or as scientists say, accumulated, silty or sandy banks with extensive drainage, where a wide variety of conditions can be observed.

Coastal salt marshes (*layds*) are unique transitional zones between the sea and the coastal tundra, which serve as both buffers to lessen the impact of storms from the sea, and producers of organic material. Such buffer zones are widespread in the gulfs of the White Sea, the southeastern sector of the Barents Sea (The Pechora Sea), along the coasts of the Yamal and Gydan Peninsulas, in Chukotka, and in several other regions of the Russian Arctic coast. Staging areas form precisely in these marshy coastal areas, where sandpipers, Brent geese, and other goose species batten. 15 of around 130 species of waterfowl that inhabit the Arctic nest in narrow bands of coastline, predominantly in the coastal salt marsh zones.

The coast of the Chukchi Sea, unlike the majority of polar seas, is lined by chains of sand bars, which segregate the sea from various types of lagoons. Today's ocean dynamics on the Chukchi coast are characterized by the washout and reformation of these barriers, with a general shift to-

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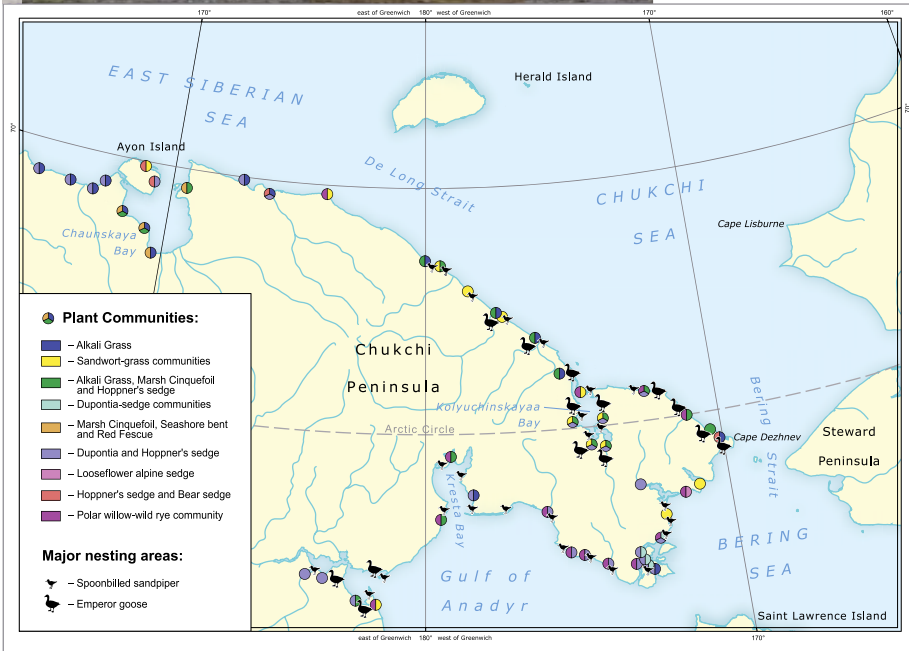
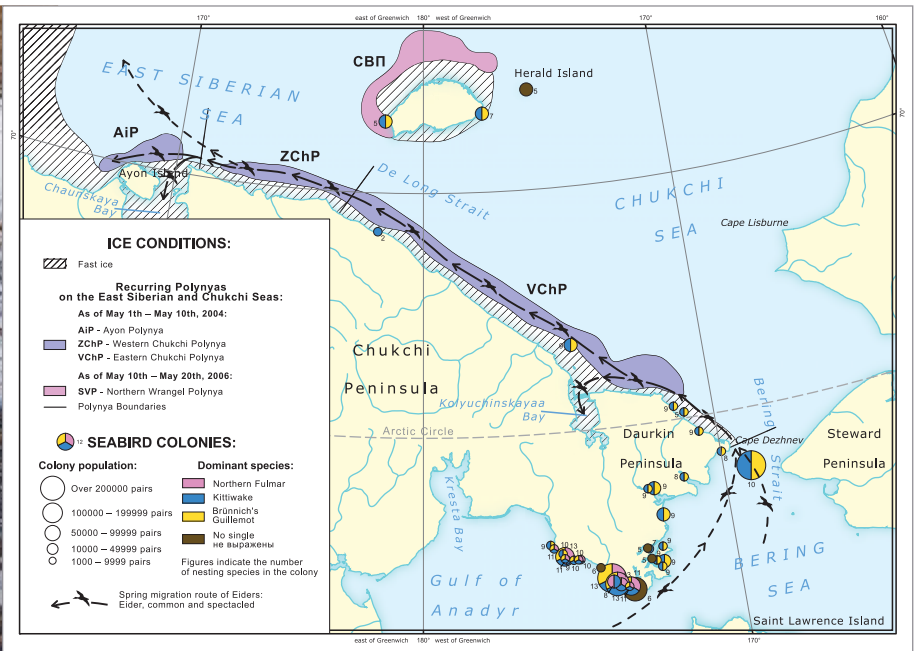


Coastal wetland communities and distribution of rare species of shorebirds, registered in the Russian Federation's Red Book

Map compiled by L.A. Sergienko and M.V. Gavrilo

© Rommel Zulueta



Ice conditions and the distribution of seabirds

Map compiled by A.V. Popov and M.V. Gavrilo

wards dry land. A significant rise in sea levels will accelerate that process, and may lead to the salinization of the lagoons, the destruction of some of the chains, which serve as important habitats for birds and marine mammals, and the eventual washout of the barriers. Thus, the formation of communities of coastal vegetation will regress to earlier stages, which may have far reaching and as yet vaguely predictable consequences for the entire ecosystem of the coastal zone. Ever expanding exploratory and extraction operations in Arctic coastal areas may yet inflict one more woe on the buffer zone between sea and land – the use of all-terrain equipment may leave open wounds on the layer of coastal vegetation. If oil is spilled at sea and washes onto the marshy coast, it may stay there for many years.

Another boundary biotope is the polyna, where the level of interaction between ocean and atmosphere is highest. Polynas are sustained areas of open water among or bordering stationary bodies of ice. They have unique features, and are of great significance to the biological and physical processes of the northern seas. Polynas form as a result of specific meteorological processes, most notably offshore winds and rip currents. The presence of open water and thin ice in polynas, when the surrounding sea is covered in thick ice and air temperatures are well below 0°C, leads to a concentrated transfer of energy, and the flow of heat and moisture to the atmosphere from the water surface. Additionally, continuously freezing water in the polyna contributes to the formation of substantial masses of ice, which then drift away, and to the release of brine into surrounding waters.

At the same time, these polynas themselves may influence climatic processes through feedback mechanisms, by regulating the flow of heat and moisture between atmosphere and ocean, and the formation and behavior of cyclones. Polynas can be used to gauge natural and climatic processes on the regional and global scale.

Based on their important biological role, polynas can be called «oases of life» in ice-covered seas. Unusually early and long-lasting Arctic growing seasons are contributing to an increased biological productivity in polynas and the ability to sustain communities with multi-layered trophic structures. Also, due to strengthened vertical convection currents and the inflow of organic materials, benthic communities of the polynas have unusually high biomass. It is these polynas that host the largest bird colonies in the high-latitude Arctic, and walruses, belugas and bowhead whales come to winter here. In the early spring, when the area is still confined in ice, sea birds migrate along the system of polynas to their nesting places.

For thousands of years, indigenous peoples of the Arctic, and much more recently, polar explorers, have identified two fundamental natural characteristics of stationary polynas – the presence of open water in the winter, and the abundance of birds and marine animals. The distribution of ancient and contemporary settlements of the indigenous peoples, as well as the routes of early research expeditions, closely correspond to the distribution of polynas.

In today's warming environment, more accessible ice conditions make marine polynas attractive for navigation and commercial development of the Arctic. As such, the highly vulnerable communities of the polynas are becoming areas of inevitable conflict in the current climate of industrial expansion in the polar shelf zone.

6.POLAR BEARS AND WALRUSES

The effect of warming on polar bears and walruses in Chukotka has already manifested itself so visibly and so menacingly, that their condition has come to exemplify the effects of climate change. These same problems, on the whole, affect other regions of the Arctic. The problem is variating from very pronounced on the island of Svalbard, to a lesser extent on the Taymyr Peninsula, but the mechanism and results of climate change, as they affect these animals, are similar.

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A sharp decline in sea ice has cut polar bears off from their traditional prey, seals. As a result, the bears have been forced not only to surmount greater distances of open water, which often leads to the animals' deaths, but also to move from their usual habitats. Additionally, in today's conditions, they have to seek alternative sources of food. Walruses in particular have become their new prey. However, the bears often take "the path of least resistance," and seek new food sources in villages and garbage dumps. The result is direct conflict with humans, not stemming from poaching or other negative actions on the part of man. For example, in the winters of 2006 and 2007, the settlements of Ryrkaypiy, Cape Schmidt and Vankarem in Chukotka were subjected to invasion by polar bears, and humans were among the victims.

Walruses are also suffering from the changing climate. Due to the dwindling of field-ice, the animals are weakened by lengthy swims, during which they cannot stop to rest on ice floes. The course of their annual migration and locations of rookeries are also changing. In a number of places, the rookeries end up in locations very close to human settlements. For example, next to the village of Ryrkaypiy, a new walrus rookery has emerged in the approach path of airplanes. The noise of the airplanes consistently incited panics among the walruses, resulting in the deaths of many young animals. Scientific data suggest that around 85% of walrus deaths in coastal rookeries are due to the trampling of primarily young animals, stemming from provoked panics (Stishov, 2004).

Around 7000 polar bears inhabit the Russian Arctic, or one third of the world's population. Therefore, work to save them is crucially important, especially in light of increased economic activity in the Arctic and the fundamental change in ice conditions in Chukotka and the eastern Siberian seas. Today, it is not enough that hunting of polar bears has been forbidden since 1956, and the species is registered in the Russian Red Book. It is not coincidental, that in May of 2008, the polar bear was acknowledged under the American Endangered Species Act (officially listed as a threatened species).

"Mother Earth" could, theoretically, gradually establish a new balance in the ecosystems of the Arctic without our help. Around 100 thousand years ago, in the warmest interglacial period, the Arctic was entirely free of ice in the summer. However, bears and walruses survived, although their numbers likely declined several times over. Alas, today's situation differs in two fundamental aspects. First of all, 100 thousand years ago, man had still not emerged as a signficant factor, there was no poaching or any other anthropogenic stresses. Polar bears and walruses had no chloroorganics in their bodies, and so forth.

"Bear patrol" locations
Red indicates active units
Blue - sites where information is being compiled
Green – prospective sites

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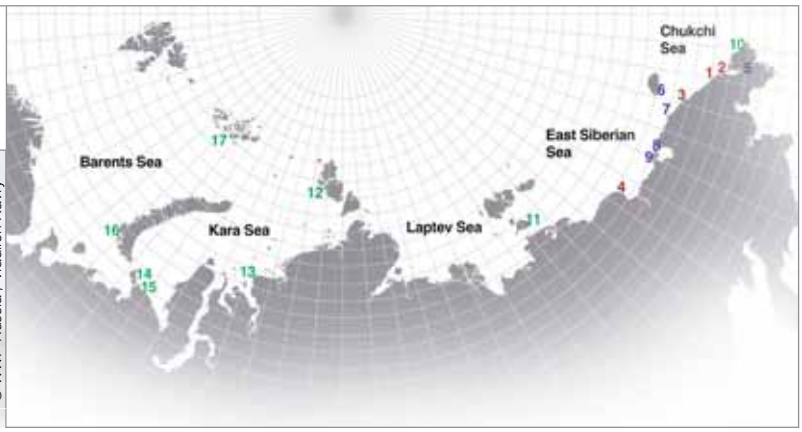
Dead walruses is a new food source for polar bears



Secondly, climate change today is progressing at an unprecedented rate, and animals simply don't have time to adapt.

Given these circumstances, it will be extremely difficult for the polar bear, walrus, and other inhabitants of the Arctic to survive without external help. The native population also needs help, as they live in close contact with nature. In a number of cases, we had to take urgent action.

According to initiatives of the local people and WWF "Bear Patrol" team has been created, which at first operated only in the village of Vankarem in Chukotka (number 1 on the map). Then, three additional units were formed in different parts of coastal Chukotka and Yakutia, in new areas of concentration of polar bears of the Chukchi-Alaskan population (2-4 on the map). Each unit monitors 100-150 km of Arctic coastline. There are around 15 permanent participants, but if a dangerous situation arises, their numbers may increase many times over.

The process of establishing "bear patrols" has already begun in 5 other locations. In these areas, there are still no organized groups, but there are supporters who understand the problem and are ready to actively resolve it in the event of conflict between polar bears and humans. These include three locations in Chukotka (points 5, 6 and 9 on the map) and two in the western Russian Arctic, areas where there are far fewer polar bears, but that fall within their expanding migration routes (points 14-15 on the map).

Additionally, prospective locations have been identified for organizing "bear patrols." They include the most remote regions and islands of the Russian Arctic, where practically no work with polar bears has ever been conducted.

Special monitoring procedures and data reporting forms (monitoring protocol) have been prepared and distributed to the patrols. Thus, **the patrols will serve both protective and monitoring functions, proactively tracking changes in the animals' migration routes.**

Drawing from the knowledge of the native population and the experience of such groups abroad, "bear patrols" have adopted a number of specific preventative measures. Specifically, in order to prevent an "autumn invasion" of bears, the patrol moved the remains of walruses, which died of natural causes at a rookery on the Vankarem Cape, to a location away from the village of Vankarem where the bears could find them. The set-up of such a "feeding spot" helped intercept the bears 10 km away from the village and lowered the likelihood of conflict between the predators and humans.

The largest walrus rookery in the world, numbering up to 50 thousand animals, in 2007 formed on the cape of Kozhevnikov near the village of Ryrkaypiy (point 3 on the map). Alas, this was not a result of population growth, but rather a side effect of changes in the climate and migration routes of Walruses.[10] With the help of the area's population and the support of local governments, round-the-clock monitoring of the new rookery has been organized. These measures, initiated by the "bear patrol," have significantly lowered the likelihood of panics and the deaths of animals resulting from tramplings.

The natural continuation of our work is to create protected areas in the most important and vulnerable habitats of polar bears, walruses, and other rare animal species. At the intiative of residents of the village of Vankarem in Chukotka, and with the support of WWF, in 2007 local powers created the new «Vankarem Cape» natural monument, placing a local walrus rookery and various native cultural heritage sites under protection. As of 2007, 30 thousand walruses inhabited the rookery (of the roughly 200 thousand that comprise the entire Pacific walrus population). Work has begun towards the creation of similar natural monuments on the island of Koliuchin and on the cape of Kozhevnikov. This will be carried out with the cooperation of the Russian Association of Indigenous Peoples of the North (RAIPON). As always, anti-poaching work remains critical. By WWF's estimates, poaching claims 150-200 bears annually, mostly in Chukotka**.**

Only by working together can we help the polar bear survive. The most optimistic figures predict that the polar bear will lose around 70% of its natural range by the middle of the 21st century. This confirms the gravity of the situation. If the dwindling of Arctic sea ice progresses even faster than predicted by models (as has been observed for the past three years), then within only several decades, the bears' traditional habitat will be gone. In order to survive, the bears will need to adapt to life on dry land within only 1-2 generations. The species' chances for survival largely depend on man. Thus, our immediate aid is essential.

10. Bolunov A, V.Nikiforov Pacific walrus uder the stress in the Chukchi Sea. Arctic Bulletin No 2, 2008

7. REINDEER

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The current conditions for populations of reindeer in the Russian Arctic are influenced by two major factors: global warming, and industrial expansion (particularly the expanding area of oil and gas development). Both of these factors, as a rule, contribute to the universal decrease in their numbers in Eurasia and North America. Industrial encroachment on their grazing land, though, is not as dangerous as progressive warming (see table). Specialists have proposed several means of correcting the situation. These include the use of satellites to constantly monitor herd movements and grazing conditions, the recruitment of hunters and reindeer herders from the native communities to help control and manage local reindeer populations, and finally, the development of governmental programs for the protection and management of reindeer in areas of industrial encroachment.

THE EFFECT OF GLOBAL WARMING ON REINDEER POPULATIONS

	Season and type of pressure	Effect on reindeer populations
	Fall	
1	Autumn rains, combining with frosts and the freezing of vegetation	Deer feed on frozen plants. Large amounts of ice in the stomach lead to quick cooling, slowed digestive processes and rapid deaths of animals
2	Late autumn frost without snow	Shortage of drinking water. The deer's bodies begin to use their fat stores to make up for the water loss, leading to malnutrition and subsequent low winter survival rates, as a result of low fat reserves
	Winter	
3	Frost immediately following winter thaws, the rapid development of an icy crust on top of snow cover	Hunger, malnutrition, migration in search of better grazing land
	Spring	
4	Frequent changes in weather during calving period, severe snow storms	High mortality rate among calves
5	Early and intensive snow melting	Migrating deer don't reach traditional calving grounds at the most favorable time, calving occurs in unsuitable habitats
6	Changing temperature gradient at high latitudes	Change in migrating behaviors. Slow recovery of fat stores, delayed molting, antler growth, and growth of calves, and decreased lactation among does. Possible disappearance of large migration groups, with simultaneous growth of small and scattered forest populations
	Summer	
7	Rapid onset of summer heat	Destruction of the so-called "green wave" (reindeer follow the line of melting snow northward, in order to graze on newly appearing green vegetation). Insufficient replenishing of fat stores in the summer. Disruption of the mating and rutting season, high death rates in winter, growth in the number of premature births, high mortality rates among calves due to low birth weight. Low milk production among lactating does
8	High summer temperatures	Disruption of temperature regulation (reindeer are poorly adapted to temperatures higher than +15°C), development of hoof problems (necrobacillosis)
	Shift in vegetation belts	
9	The boundary of forest is moving further to the north, and expanding higher in mountainous regions	Displacement of former calving and summering grounds especially on the Taymyr and Yamal peninsulas. Serious problems for reindeer herding in the traditional ranges of the Nenets people, due to disappearance of grazing land in the Bol'shezemel'skaia Tundra. Reindeer pastures in the alpine zones of the Siberian highlands may disappear and become forestland. Alpine grazing land in the Sayan and Altai mountains will be spared
10	Considerable temperature change on the Bering Sea may affect coastal reindeer grazing land. However, inland pastures in Kamchatka and Chukotka will most likely not change significantly	Curtailed reindeer herding in individual coastal regions of Kamchatka and Chukotka

Source: Leonid Baskin, Magnus Sylven, Hartmut Jungius, 2007

With regard to this, a system of measures designed to support reindeer populations in Yakutia may serve as a reference point (Workshop on Conservation and Management of Reindeer in Relation to Climate Change and Industrial Development. Yakutsk, Sakha Republic, Russia, August 2008). This report proposes the creation of a working group of specialists that would study the major threats to reindeer populations, and seek ways to protect them amidst growing industrial activity. The working group will recommend specific places where populations of wild or domesticated reindeer may come into conflict, or are already clashing, with industrial projects. Furthermore, special attention will be paid to the restoration and support of reindeer herding in these regions. Additionally, the workshop will develop recommendations for the protection and management of reindeer populations in the conditions of global warming, and coordinate them with local administration. The report also proposes the creation of a "coordinating committee for the monitoring of wild and domestic reindeer populations" for the region under the auspices of the Yakutia government.

This network of regional action seems sensible and transparent, and merits judicious adoption by others. It specifically provides an opening for international organizations, such as the WWF-Russia, to participate in all of the outlined areas of work

Against the backdrop of a universal trend of population decrease among reindeer, Chukotka has become the only region in the world where the stock of domestic reindeer is growing, thanks to appropriate policy from the local administration towards the restoration of reindeer herding. At the same time, from 1992 to 2001, stock of reindeer declined by 2% in Norway, 3% in Alaska, and 6% in Russia as a whole. From 2001 to 2003, the global population of the species, now estimated at 3.5 million individuals, decreased by 4% (http://www.chukotka.org/ru). Up until 2006, there had been a five-year moratorium on the slaughter of reindeer in Chukotka, but today, in view of the rapid population recovery, the ban has been lifted and commercial slaughter has begun (12 thousand individuals per year), as well as the export of meat to other regions. At present, the population has already recovered halfway to the 1990 maximum, and continues to grow rapidly. An integrated solution to the problem was initiated in 1998. At that time, naturalization of deer and decreasing numbers of domestic reindeer had led to a domestic stock equal to the wild, and the general population had fallen from an average of 500 thousand individuals to the lowest level since 1934 – a fivefold decrease. This was a result of the collapse of the Soviet reindeer herding system and uncontrolled hunting. After the introduction of reindeer from Yakutia in the beginning of the 2000's and the restoration of the system of reindeer herding brigades, the situation began to right itself.

A sharp decline in grazing pressure in the 1990's, brought on by the general economic recession in the country, acted favorably on vegetation conditions. At the same time, though, the collapse of reindeer herding as the main traditional economic activity of the North led to destabilization of the local natural "human-ecosystem" balance, which in turn led to increased pressure from man on other aspects of the ecosystem. Reindeer herding in the North, when administered properly, is tantamount to sustaining the traditional way of life for the native peoples, and securing their food supply.

8. COMMERCIAL FISHING

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The Russian Arctic, including the Barents and Bering Seas, is a region of utmost importance to domestic and worldwide commercial fishing. The area is inhabited by one of the last major stocks of Barents Sea cod still under protection, and the single largest gadoid species, the Alaska Pollock. Aside from the Alaska Pollock, there are other gadoid varieties well known to the fish consumer: Haddock, Coalfish, Navaga, Blue Whiting and Arctic cod.

During one of the warming periods in the Arctic, the common ancestors of Pacific and Atlantic cod may have inhabited the entire Arctic coastlines of North America and Siberia. Most likely, this single habitat was divided later in the glacial period, and the distinct Atlantic and Pacific groups began to take form.

The Pacific cod is slightly smaller than the Atlantic variety, and lays benthic eggs, as opposed to pelagic. It inhabits the space from the Bering Strait in the North, down to the coasts of Japan, Korea and California in the South, and does not embark on such lengthy migrations as the members of most Atlantic groups.

Apart from cyclical climate change, one of the major reasons for the decline in cod stocks, as well as those of other commercial fish, is illegal and uncontrolled fishing. For example, if we compare cod stock estimates in the North Sea 30 years ago with those of today, we see that in that period, the population has declined by 85%. In the Barents Sea, yields fell from 1.3 million tons in 1956 to 212 thousand tons in 1990. This problem was exposed, most notably, in a report by WWF-Russia [11].

Illegal fishing is not only a problem on the Barents Sea. The most valuable aquatic biological resources suffer from poaching. According to the expert analysis of WWF, the largest economic target is the Alaskan Pollock, which is overfished around 150% above the authorized obtainable yield.

In Chukotka, although the yield of fish and seafood is relatively small, amounting to only 20 thousand tons per year, highly commercially valuable species breed in the shelf zone, including Alaskan Pollock, cod, prawn, and crab. Pacific Salmon also spawn in the rivers of Chukotka. Additionally, due to global warming, many coldwater species are beginning to migrate north, which is leading to a northward shift of the fishing industry. Therefore, this region demands heightened attention as an aquatic area of valuable species' reproduction and growing commercial pressure.

Global fishing experts and the WWF contend that the root of the problem lies in excessive fishing capacity. First and foremost, we're speaking of commercial vessels. The more there are, and the more fuel they require per ton of fish, the more fish they need to catch to justify their presence. The capabilities of the Arctic commercial fleet, established over many decades of operation, significantly exceed the estab-

11 Economic effectiveness of the use of the commercial fleet on the Barents Sea. WWF Russia's Barents Sea project office. Series of technical reports "on sustainable commercial fishing". 2nd edition. Murmansk, 2007. (In Russian)

lished yield quotas. The pressure from excessive commercial output not only latently influences political decisions, but leads to two extremely negative phenomena – illegal fishing, and the throwing overboard of smaller fish. Catching poachers red-handed on the seas is difficult. Therefore, strategies and tactics for the fight against illegal fishing must be directed towards the exposure of excessive undocumented yields.

Global commercial fishing steadily removes from the oceans large and long-living fish, located in the upper tiers of the food pyramid in marine communities. That said, the removal of large predators doesn't entirely mean that more small fish, that the predators would feed upon, remain for commercial exploitation. The opposite is likely true. To understand that, imagine a simplified food chain, in which cod feeds on capelin and sand eel. Cod and capelin are commercial fish, while sand eel is not of interest to fisherman. In years when there are low numbers of capelin, cod switch to sand eel and, in doing so, give the capelin the chance to quickly recover their numbers. If cod stocks are cut, then the community loses an important regulator, and the capelin has to reckon with increased commercial fishing, as well as with its perpetual competitor, the sand eel. Declining stocks of capelin, by means of a feedback mechanism, leads to a decline in cod stocks, and so on. Of course, this explanation is greatly simplified, but it is derived from real life – this was roughly the case in the Barents Sea from 1970-1980, when commercial fishing of capelin endured a serious crisis.

Marine mammals, including seals, dolphins and other small cetaceans, play the same role in the oceans as predatory fish in regulating population numbers. Fisherman traditionally dislike these mammals, and admittedly, not without cause, as sea lions and killer whales steal fish from their nets. However, the conclusion that increased capture of seals and whales will lead to an increase in commercial fish is, to say the least, baseless. With rare exception, marine animals are not competitors of fisherman, but an essential element the community, ensuring regularity and balance.


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We must manage commercial fishing on the basis of understanding the processes of the ecosystem, as well as our influence, to a certain degree, on these processes, with the goal of conservation and sustainable use of the products of the marine ecosystem. This is the essence of the modern approach to fishing control, so-called "ecosystem based management." Ecosystem based management was recommended by the Biological Diversity Convention, to which Russia is a signatory. This approach was recommended by the Food and Agricultural Organization (FAO) of the U.N., which published a special report, "The Code of Conduct for Responsible Commercial Fishing," and by other international organizations.

Naturally, the current state of affairs, as yields of codfish decline, evoke serious unease among industry leaders about the future. One of the largest importers of whitefish in the world, Unilever, has begun an initiative to develop sustainable fisheries. The company introduced its own "ecological rating" system for each specific imported fish, and announced that they would only purchase fish produced in accordance with the requirements of responsible fishing, detailed in the Code of Conduct for Responsible Commercial Fishing by the FAO. Unilever, together with the WWF, established the Marine Stewardship Council (MSC). The MSC developed a program of ecological certification for commercial fishing. In return for a responsible approach to exploitation of marine biological resources, the Marine Stewardship Council gives producers the right to label their products with the MSC emblem, which testifies to the given product's accordance with ecological standards of fishing and processing. The seal gives consumers the ability to support sustainable commercial fishing, without detriment to the reproductive capacity of fish stocks, by means of choosing certified products in stores and restaurants. The MSC program is not a mandatory legislative measure enacted by governments, but rather works on a volunteer basis.

9. RECOMMENDATIONS

IN VIEW OF THE STRATEGIC IMPORTANCE OF THE ARCTIC TO THE STABLE DEVELOPMENT OF RUSSIA, INCLUDING ECONOMIC STABILITY AND ECOLOGICAL SECURITY, WE RECOMMEND:

☑ **That the federal agencies of the executive branch adopt additional measures regulating economic activity in the Arctic:**

- To adopt a new version of the Economic Regulations and Protection of Marine Mammals rules, which spells out clear rules for visiting rookeries, and restores the former restriction on aircraft flight over marine mammal rookeries.
- To create a system of fishing refuge zones (prohibiting other economic activities, apart from fishing).
- To create a system of commercial fishing in protected areas (prohibiting other economic activity, apart from fishing).
- To mandate the submission of detailed plans for prevention and clean-up of oil spills in particularly vulnerable areas of the Arctic (in regions of stationary polynas, seabird colonies, marine mammal rookeris, and coastal salt marshes) *before* the beginning of exploration, extraction, and large-scale transporation of hydrocarbons.
- To cease the development of new oil fields on the Arctic shelf, until technology to clean up emergency oil spills in ice conditions is fully developed.

☑ **That federal and regional branches of the Ministry of Natural Resources and Ecology, together with ecological organizations and local authorities:**

- Take climate change and its consequences into account when planning operations in existing protected areas, and while creating new ones. Develop preventative measures, with the aim of preserving species and ecosystems in the conditions of climate change.
- Produce an adaptation strategy for climate change in Arctic territories, based on global experience, and with consideration for local particularities and the needs of the native peoples of the North. The strategy must include a system of indicators of the condition of individual species and of the ecosystem on the whole, the creation of a united information network, and the publication of an atlas of key biotopes, requiring preservation for the support of biodiversity and functionality of marine and coastal ecosystems in the Arctic.
- Together with representatives from the business sphere and interested federal agencies from the executive branch, prepare:

  – *programs of action* to minimize the negative impact of oil and gas projects on biodiversity in particularly vulnerable areas of the Arctic (in areas of stationary polynas, seabird colonies, marine mammal rookeries and coastal salt marshes). The development of such programs must precede exploration, extraction, and large-scale transportation of hydrocarbons on the Arctic seas;

  – *effective legal and economic regulatory mechanisms* for commercial fishing in the Arctic. The capacity of the commercial fleet must be adjusted to correspond with the existing condition of marine bioresources. It is essential to restrict, or entirely halt exploration of new marine resources, until a comprehensive study of the resource base and the impact of commercial activity on marine ecosystems has been conducted;

☑ **That local authorities, together with agencies of the Ministry of Natural Resources and Ecology and other departments, as well as ecological organizations:**

- Amidst additional negative effects on species and ecosystems stemming from the climate, initiate and broaden the fight against poaching and strengthen security. They must also continue and expand "Bear patrol" activity. Concrete plans for this work are already outlined in our brochure.
- Rigorously observe rules and restrictions on the use of all-terrain equipment in the tundra zone during the snowless period; assist in the introduction of modern transporation that is not destructive to soil and plant cover, particularly equipment with large, low-pressure tires.

☑ **That the Government of the Russian Federation give its support (by including among its budgetary priorities), while the research institutes of the Russian Academy of Sciences, the Russian Hydrometeorology and Environmental Monitoring Agency, and the administrators of protected areas, with active involvement of the public:**

- In good time issue alerts of man-made violations and disasters in regions of industrial exploration, extraction, and transport of oil and gas.
- Conduct regular observations of

  – the condition of marine mammal and polar bear populations;

  – the migration routes and herd conditions of domestic and wild reindeer;

  – the migration routes and conditions of birds and other animals;

  – changes in stationary polynas;

  – changes in vegetation;

  – breakdown of permafrost and coastline erosion.

Adaptation to climate change is merely a temporary objective for the coming few decades. The problem of anthropogenic climate change can only be solved by radically reducing greenhouse gas emissions. Scientists maintain that, by the year 2050, global greenhouse gas emissions must be cut, at a minimum, to half the levels of 1990, and developed countries must decrease emissions 60-80% from the levels at the end of the 20th century. This is vital, in order to save the Arctic. It will require the participation and support of governments and businesses, as well as understanding and active contribution from every one of us.

Therefore, the informational campaign, our «Arctic voice» and a call to swift action is extremely important.

WE CALL UPON:

☑ **Federal, regional, and local authorities, to consider the data on the consequences of climate change when planning future activity.**

☑ **Environmental organizations and representatives of academic and field sciences, to conduct active expository work through the mass media.**

☑ **The mass media, to draw special attention to the problems of the Arctic, when addressing questions of climate change on the planet.**

Our views must be heard in the United Nations, during preparation of a new international agreement on the problem of climate change, which is suppose to be signed at the end of 2009.

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RECOMMENDED INTERNET SITES

www.wwf.ru
The official site of the Russian World Wildlife Fund (WWF – Russia).

www.ipcc.ch
The official site of the Intergovernmental Panel on Climate Change (IPCC). All the panel's reports with analysis of the current situation on the planet, forecasts of climate change, and recommendations. Many useful links to sites on the given issues. Also in this connection, it is worth looking at the following site of the U.N.: www.un.org/climatechange (Problems due to current climate change) and www.cbd.int (the problem of protecting biodiversity)

www.meteorf.ru
Official site of the Federal Service for Hydrometeorology and Environmental Monitoring of the Russian Federation.

www.mnr.gov.ru
Official site of the Ministry of Natural Resources and Ecology of the Russian Federation (MPR RF).

www.zapoved.ru
Official site of the MPR RF, with descriptions of every protected areas of the Russian Federation.

www.aari.nw.ru
Data on the hydrometeorological conditions in the polar region and on sea ice. Results of current research in the Arctic and Antarctica.

www.sevin.ru
The A.N. Severtsov Institute of Ecology and Evolution. Among other resources, this site has information on biological diversity and sustainable use of natural resources. Highlights issues of preserving living nature.

www.sevin.ru/fundecology
Scientific and educational portal to the fundamental ecology department of Lomonosov Moscow State University and the Severtsov Institute of Ecology and Evolution. The most current and topical scientific information in the sphere of ecology.

www.udel.edu/geography/calm
The program of circumpolar monitoring of changes in the active permafrost layer in all regions of the world. Detailed observational data and its analysis.

www.chukotka.org/ru
Official site of the Chukchi Autonomous Okrug. Information on the current condition of the economic sector and natural resources of the region.

www.beringiapark.ru
Official site of the Beringia Natural-Ethnic Reservation in Chukotka.

www.botsad.ru
Site of the botanical gardens of the Far East division of the Russian Academy of Sciences. Descriptions of all protected areas in Chukotka.

www.wri.org/climate
World Resource Institute. Information on the problem of climate change, and paths to its resolution. Analysis and reference materials.

www.metoffice.gov.uk/research/hadleycentre/models/modeldata.html
Website of the Met Office (meteorological service of Great Britain) and the leading international center for climate change forecasts, the Hadley Centre. Maps and forecasts of climate change.

www.climatenetwork.org, www.climnet.org
The site of the Climate Change Network, an international network of NGO's. Discussions, analysis, and reference materials on the politics of the climate, and on negotiations towards a new international accord on the problem of climate change.

www.realclimate.org
The world's leading site for scientific discussions of climate change (supported by NASA's Goddard Institute). News and discussions of all issues, excluding those political. Questions with full answers.

http://maps.transparentworld.ru/arctic.html
Threats to the Russian Arctic ecosystem from oil and gas.

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- ensuring that the use of renewable natural resources is sustainable;
- promoting the reduction of pollution and wasteful consumption.

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