CAFF Habitat Conservation Report No. 9

GAP ANALYSIS IN SUPPORT OF CPAN: THE RUSSIAN ARCTIC

CAFF
Conservation of Arctic Flora and Fauna

About CAFF

The program for the Conservation of Arctic Flora and Fauna (CAFF) of the Arctic Council was established to address the special needs of Arctic ecosystems, species and their habitats in the rapidly developing Arctic region. It was initiated as one of four programs of the Arctic Environmental Protection Strategy (AEPS) which was adopted by Canada, Denmark/Greenland, Finland, Iceland, Norway, Russia, Sweden and the United States through a Ministerial Declaration at Rovaniemi, Finland in 1991. Other programs initiated under the AEPS and overtaken by the Arctic Council are the Arctic Monitoring and Assessment Programme (AMAP), the program for Emergency Prevention, Preparedness and Response (EPPR) and the program for Protection of the Arctic Marine Environment (PAME).

Since its inaugural meeting in Ottawa, Canada in 1992, the CAFF program has provided scientists, conservation managers and groups, and indigenous people of the north with a distinct forum in which to tackle a wide range of Arctic conservation issues at the circumpolar level.

CAFF's main goals, which are achieved in keeping with the concepts of sustainable development and utilisation, are:

- to conserve Arctic flora and fauna, their diversity and their habitats;
- to protect the Arctic ecosystems from threats;
- to improve conservation management laws, regulations and practices for the Arctic;
- to integrate Arctic interests into global conservation fora.

CAFF operates through a system of Designated Agencies and National Representatives responsible for CAFF in their respective countries. CAFF also has an International Working Group which meets regularly to assess progress. CAFF is headed up by a chair and vice-chair which rotate among the Arctic countries and is supported by an International Secretariat.

The majority of CAFF's activities are directed at conserving Arctic biodiversity—the abundance and diversity of Arctic flora, fauna, and habitats—and at integrating indigenous people and their knowledge into CAFF. In recognition of this, the Arctic Ministers in 1998 endorsed CAFF's *Strategic Plan for Conservation of Arctic Biological Diversity* as a framework for future program activities. The Strategic Plan is built around five objectives addressing biodiversity monitoring, conservation of genetic resources, species and habitats, establishment of protected areas, conservation outside protected areas, and integration of biodiversity conservation objectives into economic plans and policies. Examples of major projects CAFF is currently working on are: a status report on Arctic biodiversity; development of a program to monitor Arctic biodiversity; assessment of climate change impacts on Arctic ecosystems in collaboration with AMAP and other Arctic organisations; assistance with implementation of circumpolar conservation strategies for murres (guillemots) and eiders and for a Circumpolar Protected Areas Network (CPAN); preparing a Circumpolar Arctic Vegetation Map and listing and mapping rare Arctic vascular plants. Whenever possible, CAFF works in co-operation with other international organisations and associations to achieve common conservation goals in the Arctic.

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by

Igor Lysenko and David Henry

CAFF INTERNATIONAL SECRETRARIAT 2000

PREFACE

This report, prepared by Igor Lysenko, World Conservation Monitoring Centre (WCMC) and David Henry, United Nations Environment Program (UNEP) Global Resource Information Database (GRID)-Arendal, is a technical account of a Gap Analysis Project conducted for the Russian Arctic in 1997-1999 in support of the Circumpolar Protected Areas Network (CPAN) of CAFF. It updates the status and spatial distribution of protected areas within the CAFF area of the Russian Federation and provides, in 22 GIS based maps and several data sets, a wealth of information relevant for present and future management decisions related to habitat conservation in the Russian Arctic.

EXECUTIVE SUMMARY

The present Gap Analysis for the Russian Arctic was undertaken in response to the *CPAN Strategy and Action Plan* requirement for countries to identify gaps in protected area coverage of ecosystems and species and to select sites for further action. Another important objective was to update the Russian data base.

The Analysis used a system of twelve landscape units instead of the previously used vegetation zone system as the basis to classify Russia's ecosystems. A comparison of the terrestrial landscape systems against protected area coverage indicates that 27% of the glacier ecosystem is protected, 9.3% of the tundra (treeless portion) and 4.7% of the forest systems within the Arctic boundaries are under protection, but the most important Arctic forested areas have only 0.1% protection. In general, the analysis indicates a negative relationship between ecosystem productivity and protection, which is consistent with findings in 1996.

Overall the Analysis points to an increase in protection of Russia's Arctic from 3.5% in 1996 to 7.5% in 1999. However, it does not answer a question posed by the *CPAN Strategy and Action Plan* of whether or not all of the Russian Arctic ecosystems are represented in the protected area system "as fully as possible".

Analysis of species protection shows *inter alia* that the habitat of Russia's endangered Arctic mammals, 16 of which are marine, are poorly protected. However, the correlation of protected areas to important bird areas is high in the north except for major gaps in the far eastern coastal areas. The analysis shows, in general, poor coincidence between high species diversity and habitat protection although where protected areas have been established, they appear strategically positioned to preserve key habitat. .

The Analysis maps wilderness areas that are remote from human activity and impacts and recommends that these be the priority for protection.

The Analysis is not sufficiently detailed or refined to determine habitat quality or to "select candidate sites for further action...." For this, other methods, such as applying the CPAN principles and guidelines for site selection, must be applied.

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INTRODUCTION

In 1994, a limited gap analysis was conducted in connection with the preparation of CAFF Habitat Conservation Report 1 - *The State of Protected Areas in the Circumpolar Arctic*. The Report concentrated on mapping existing and proposed protected areas rather than analysing gaps or standardising terminology. Based on the limited data available, gaps were identified in protection of marine and coastal areas, forested areas and wetlands as well as gaps in protection of caribou, seabirds, marine species, migratory species and waterfowl. Although limited, the 1994 Analysis marked the first attempt to identify gaps in protection of ecosystems, habitat and target species in the eight Arctic countries.

In 1996, CAFF conducted a more advanced circumpolar gap analysis in support of the *CPAN Strategy and Action Plan* which was published in the CAFF Habitat Conservation Report No. 5 - *Gaps in Habitat Protection in the Circumpolar Arctic – a Preliminary Analysis* (CAFF 1996, Lysenko *et al.*, 1996; see annex I). This study clarified the concept, purpose and application of gap analyses and applied a technical and more systematised approach to the process. It classified the entire Arctic region into seven vegetation zones - Permanent snow and ice, Arctic desert, Mountain tundra, Lowland tundra, Northern boreal, Middle boreal and marine/inshore waters. The Report pointed to a general weakness in Arctic data, especially for Russia but nevertheless, found that in the CAFF region, least protection is afforded to the northern boreal zone (2.6%) and inshore waters (2.1%). The northern boreal zone, which comprises 34% of the CAFF region, was identified as a high priority for further protection. The analysis also pointed out that nearly 70% of circumpolar mountain tundra occurs in Russia, very little of which is protected. Over 85% of the lowland tundra lies within Canada of which only 9.3% is protected. A preliminary assessment of gaps in the protection of critical habitat for the polar bear showed that while some polar bear breeding sites lie within protected areas, very little of the species' core range is protected.

Following recommendations from this initial work, an item was included in the CAFF Work Plan for 1997/98 for a limited gap analysis, in support of the Circumpolar Protected Areas Network (CPAN), focusing on the Russian Arctic, using integrated data on species, ecosystems and protection measures.

The Nordic Council of Ministers and the Norwegian Government through bilateral Norwegian/ Russian funds have provided support for this work. Russia was assigned to lead on this activity with assistance from UNEP/GRID-Arendal (GA) and The World Conservation Monitoring Centre (WCMC). The project has helped to mobilise data for the Russian Arctic, the largest national component of the terrestrial Arctic, and to secure Russian involvement in developing a methodology for identifying gaps in the protected area network at the circumpolar level. This project represents one step in the implementation of the CPAN Strategy and Action Plan, in particular calling for countries to "identify, in co-operation with competent Russian Authorities, potential joint projects in the Russian Arctic, and provide financial resources to facilitate the implementation of these projects as feasible and appropriate".

The original objectives of the project were to:

1. Identify and collect existing information, in the form of digital data sets, applicable for the evaluation of the ecological representation of protected areas in the Russian Arctic. The data sets should ideally be coherent and comparable with data sources from the rest of the circumpolar region.
2. Develop analytical approaches to measure the representation of flora and fauna within the existing protected areas network.
3. Analyse, using the best available information, the conservation situation in the Russian Arctic in respect to ecosystem, habitat and species conservation in order to identify gaps in CPAN.

CONCEPTUAL BACKGROUND

Conceptual assumptions for the analysis of protected areas in Russian Arctic.

The first general principle offered in the CPAN principles and guidelines, and repeated in the CPAN Strategy and Action Plan, states that CPAN will be predicated and based on national protected areas regimes (CAFF 1994, CAFF 1996). Therefore national approaches should be understood, recognised and respected. At the same time, the Strategy and Action Plan, assuming the necessary integration of conservation efforts and evaluation mechanisms at circumpolar level, proposed to "... incorporate different designation and uses and apply IUCN management categories where applicable". IUCN definition of protected area and categories are provided in Annex II.

The Russian Arctic has a rich natural heritage and a well-established system of protected areas - Zakazniks and Zapovedniks. The latter, has been an effective way of conserving a large number of valuable natural sites from potential industrial exploitation during the 20th century.

The existence of vast, relatively under developed territories preserving natural biological diversity are good prerequisites for a successful extension of CPAN in Russia which would protect whole ecosystems and the interconnection of biological systems.

Protected areas must be an organic part of a comprehensive nature management system, and they must continuously interact with the owners and users of exploited areas and be effectively protected from external anthropogenic influences. "Rationally" exploited areas and strictly protected areas should form a unified functional system.

Despite long-term pressure from ideological and economic threats, the reserves of Russia have maintained an appropriate level of preservation. In general they have avoided commercialisation and are managed according to an established regime. Today, however, they are under stress from the extreme circumstances caused by economical transition and related inconsistent changes in conservation approaches and policy.

These reserves have made a "golden contribution" to the protection of Arctic nature. In the 1970's they acquired a systematic basis founded on scientific principles put forth by the original founders of the reserve system, and improved through the addition of new scientific knowledge (Dezhkin and Lysenko, 1995). The characteristic features of the Russian national protected areas system include:

(a) a long-term (70 years in case of Lapland Zapovednik, currently a biosphere reserve) history of establishing and managing the reserves as nature-protection areas, as well and places for nature investigation and monitoring;

(b) a significant number of protected areas (within the Arctic - 210 existing protected area sites, including 12 – IUCN category I, 77 –IUCN category IV and 7 internationally designated RAMSAR sites), many of which are quite large;

(c) the existence of large areas of wilderness areas around many reserves and other protected areas, providing opportunities for further protection that helps to conserve larger ecosystems;

(d) protected areas of Arctic, like in Russia in general, include the existence of more than half of the populations of animal and plant species recorded in the Red Book of the Russian Federation;

(e) relatively broad regional ecosystem representation, reflecting specific zonal and geographic features of the largest ecosystems.

In order to analyse the ability of the Russian part of the CPAN system, we assume that in general the following conceptual statements on functioning and further development of Arctic protected areas are applicable. These are also the basis for the development of a protected areas network in Russia, presented within the framework of the GEF Biodiversity Conservation Program for the Russian Federation (after Lysenko *et al.*, 1995):

1. Protection of Arctic species, habitats and ecosystems, realised through different categories of protected natural areas, is a critical part of environmental protection and occupies an important and irreplaceable position.

2. The protected natural areas must be organically inscribed in the nature management system and should interact with territories under exploitation, implementing environmental protection and resource saving measures. The protected and rationally exploited natural areas form a unified functional system integrated with the habitats of indigenous peoples and their specific natural resource management practices.

3. Increasing anthropogenic influences on Arctic environment necessitate an increased diversity and enlarged proportion of protected natural areas and their improved management. The geographic distribution of protected areas is planned on the basis of the following principles:
    - representation of all large ecosystems;
    - protection of unique and vulnerable features (ecosystems, rare species and
    - populations);
    protection of ecological corridors

4. An optimal proportion of protected natural areas depends on the geographic region, the nature of landscapes, their anthropogenic vulnerability, degree of transformation, the existence of unique natural features, and those under the threat of extinction. This parameter, which can be theoretically very high, is restricted by

economic losses associated with the removal of natural resources from their traditional economic use and the costs of organisation and management of nature protection agencies. The minimum proportion of nature reserves and national nature parks is officially established in Russia (on average) at the level of 3 % of the whole area. This level must be much higher in Arctic and sub-arctic areas affected by extreme thermal characteristics of climate, limited vegetation period, and relatively low species diversity affecting the self-restoration potential of ecosystems.

5. As lands are designated as specially protected natural areas, conservation of their natural, ecological, ethnic and ethical functions should have priority over economic uses. The development plans of regional biodiversity protection are formulated and corrected on the basis of current operational efficiency estimates of the protected area system.

6. New protected natural areas are to be organised in the Russian Arctic using a system wide, theoretical basis, with the interests of all people taken into account. The existence of traditional forms of nature management must be considered in order to be effectively integrated into the protected areas system.

7. If most strictly protected, existing reserves (zapovedniks) are to be maintained as a network of research areas for long-term monitoring, it is necessary to institute cost effective organisational approaches that can remove lands from possible economic exploitation and ensure their conservation or "passive" reservation for future protective measures.

8. The great territories of the Russian Arctic and the diversity of natural conditions, anthropogenic influences and social demands of the population necessitate diverse forms of protected natural areas, tasks and functions. Such general forms include: state natural reserves, including: biosphere reserves and zapovedniks; natural parks, including national ones, those of republican significance; natural game reserves and other zakazniks; ethno-ecological zones; and natural monuments. A further differentiation of the status and management for each type is possible, depending on the nature of the protected features. Local authorities can organise still other forms of natural area protection.

9. The lands of state natural reserves and reserve zones of national parks are given to them freely on the terms of perpetual possession and are excluded from economic exploitation. The economic mechanism of protected area creation and efficient functioning must provide: free allotment of territories to be used as reserves and reserve zones of national parks; reduced land payments from land owners and users whose areas include other protected areas; reduced taxation on all kinds of activities within protected areas.

10. The CPAN elements across the circumpolar region are integrated to provide self-restoration of natural processes and ecological equilibrium at different levels (local, regional, circumpolar and global). This is achieved by goal-oriented planning, by combining regional and federal schemes, and through international co-ordination of national plans in the framework of CPAN co-operation within CAFF.

Principles for Establishing Protected Areas and Implementing CPAN in Russia are summarised in Annex III

Scientific principles of Protected Areas allocation and basic problems of justifying decisions on the spatial composition of the protected area network.

The basic scientific principles for the planning of a protected areas system, developed and used in Russia in recent decades, include:

- The reference reserves (zapovedniks) are seen as the cells of a continuous network of permanent ecosystem research centres, supplemented by sites with a lower or specific conservation status and complimentary to key (usually largest) protected areas for the additional conservation of particular species, habitats and ecosystems. Therefore, their allocation should be arranged in such a way as to represent all typical ecological features in those reserves.
- A network of permanent reserves, must not only represent each natural zone or sub-zone, but also their geographic subdivisions reflecting the variety of biota along broad vegetation zones.
- Sub-divisions having such properties must be natural physiographic zones and ecosystem units, able to be objectively determined both in the field and on a map.
- Natural zoning for the planning of reserves establishment should be both zonal and azonal (where the local combination of natural factors produce unique conditions and specific communities appear), therefore the biogeographical justification of natural boundaries should be considered as the main feature above the broad climatic or geographical parameters incorporated.

It was assumed that this approach to the construction of a protected area network makes it possible to take into account the entire diversity of ecosystems based on bioclimatic zonality (in the latitudinal, North-South direction) and the changes in the geographic and genetic structure of the flora and fauna. The latter is connected to the evolution of flora and fauna. Communities that are close in their basic structure characteristics are frequently formed from different species and even larger taxonomic groups of organisms. Accordingly, such communities should be treated as features for independent protection (for instance, the communities of European, West Siberian and Central Siberian forest-tundra, or marine complexes along with the East European, West Siberian and East Siberian taiga, etc.).

In practice, several methods of natural zoning evolved. Specially developed bioregion schemes were used as internationally funded aid projects were prepared. Fourteen regions were created in the WWF project (Krever *at al.* 1994), and up to 180 phisiographical units were applied by the Wildlife Management Laboratory of the Ministry of Agriculture of the Russian Federation, (Dezhkin et al., 1986). The Biodiversity Conservation Programme for the Russian Federation adopted a landscape hierarchy analysis, which considers protected areas within ranked natural complexes. Inherent populations were supplemented with isolated major river basins (Lysenko et al., 1995). There is also merit to the idea of relying on area zoning of the vegetative features used for drawing the boundaries of natural regions in the materials prepared within the CAFF programme (CAFF 1995).

Without detailing the advantages of every approach, each can be reasonably justified. Different versions of geographic zoning reflect real features of the natural environment generalised in different ways in the course of scientific analysis. The problems faced in this respect by managers are still very evident. When concrete decisions are to be taken, especially in disputable situations, a disagreement in approach can negatively affect the outcome of nature protection measures. The previously mentioned initiatives for evaluating the representativeness of a protected areas network, at circumpolar or country-wide scale, provide a good starting point for a more detailed analysis. This more detailed analysis requires the acquisition of more detailed data and a deeper consideration of Arctic ecosystems, habitats and species.

A further consideration is the conservation of vulnerable plant and animal species. These include: species with a limited range (sometimes relics), local endemics, sporadically spread species, naturally rare species and those under the threat of extirpation or extinction due to human development. The greatest contribution to rare species conservation in the Russian Arctic is from strictly protected reserves - zapovedniks. The federal game reserves also make an appreciable contribution to maintaining rare species. Local game reserves and sanctuaries aim to protect one or more vulnerable species. The creation of rare species protection areas should rest on detailed knowledge of their range and ecology. The problem of rare and vulnerable biotopes identification and protection is no less complicated.

Information Resources

Russia has extensive information resources covering, in particular, the Arctic region. This includes: reserve specific data, regional information on vegetation, wildlife and ecology, and topical investigations related to biodiversity conservation problems.

A unique feature of Russia is the existence of detailed documents describing the state of ecosystems and communities, and the abundance, condition and natural history of background and rare species (Fedotov *et al.* 1996). Frequently the amount of data exceeds the technical means for their effective use. This is related to the relatively late introduction of computer technology in conservation activities, and, ironically, with the exceedingly high level of professionalism and selflessness of many Russian natural scientists who have dedicated their lives to the study of nature. Under the socio-political system that existed for about 75 years, many outstanding scientists found their research as the only way for self-expression. Many investigations of Russian researchers, supported primarily by their own enthusiasm, could not be funded under current economic conditions. Cost estimates for such work would seem enormous by present-day standards and even the simple translation of existing environmental data into digital data sets far exceed resources available.

Nevertheless, a recent review of data on different aspects of the Russian Arctic environment identified 10 detailed digital maps (Denisov and Henry, 1995) and many new sources have appeared after this date. These data sources have incorporated information resources whose actual cost may be many times greater than the cost of their availability to the research process. In planning environmental protection activities, data integration over the entire Russian Arctic by means of Geographic Information Systems (GIS) is especially efficient and can help to optimise limited conservation resources and make real use of the enormous investments which were formerly spent collecting and publishing this data.

Reliable data and flexible means for analysing it can help to overcome the tendency of political, economic and organisational factors to dominate decisions on the formation of protected areas, at the expense of biological and geographic considerations.

METHODOLOGY

Data collection and preparation

Data used in the analysis was collected from resources available through the Internet and through co-operation with Russian partners from the All-Russia Institute for Nature Conservation, the Wildlife Management Laboratory, the Dokuchaev Soil Institute of the Russian Academy of Science, the Geography Institute of the Russian Academy of Science and from the extensive Arctic databases held at UNEP/GRID-Arendal, and the World Conservation Monitoring Centre. Annex IV provides a narrative description of the data sets used and Annex V provides tabular data.

The initial intention was to consider digital data sets only, due to the limitation of available resources. In some cases, existing databases required minimal editing. All available digital maps were assessed to see if they fulfilled the necessary technical GIS conditions, including:

a) should cover the full extent of the Russian Arctic (CAFF definition applied);
b) should be of an appropriate GIS quality and have a defined map projection;
c) should have a resolution between 1:1,000,000 to 1:4,000,000 to allow overlay analysis at a suitable resolution.

After preparatory GIS processing and re-projection considerable problems were found in many data sets rendering them useless for this analysis. Possible sources of error have been described in detail in the UNEP/GRD-Arendal report, "Circumpolar Arctic Eco-Regions" (Denisov and Henry, 1995).

Special efforts were undertaken to compile maps and data on the current status and boundaries of protected areas to improve pre-existing data on this topic. An accurate and up to date database of existing and proposed protected areas was crucial for identifying gaps in the network.

One of the key data sets identified was the digital map of Landscapes of the USSR (after Gudilin *et al.* 1980). This data set was used to delineate boundaries of landscape/ ecosystem zones, sub-zones, types and habitat units. The Dokuchaev Soil Institute of the Russian Academy of Science reprocessed this data set in the framework of this project. Further work was carried out at WCMC to ensure that this data set could overlay standard base maps generated from the Digital Chart of the World (ESRI, 1993).

The versions of raster maps (The Normalized Difference Vegetation Index, NDVI) and Apparent Naturalness map were processed at UNEP/GRID-Arendal.

A digital map of species diversity developed by the Lomonosov Moscow State University (Danilenko and Rumyantsev 1995) should be mentioned as one of the very few data sets that was perfectly compiled.

Spatial Indicators Representation

Modern technology actually removes much of the limitation on the volume of data that can be used for analysis of practical conservation problems. Meanwhile, due to the high complexity of biological systems and the novelty of approaches, the specialists use descriptive characteristics of ecosystem parameters for different functional features of the protected objects or for interaction types in the nature-society system.

The data used in this analysis included both quantitative (size of geographical units, protected areas, ration of its overlap or just number of species in particular geographical area) and qualitative where numbers describing some features do not have precious biological or conservation meaning (like apparent naturalness indexes or NDVI values).

Formulating conclusions and recommendations from such an analysis requires integral estimates of the whole complex of parameters at hand. Such a property can serve as a real basis for unifying the data of diverse nature. Further details of spatial indicator representation is covered in Annex VI.

The ultimate output form the analysis will be an index value that indicates the level of priority for protection. The index may vary between 0 and 1, where 0 means that an area does not need protection and 1 means that it is the highest priority for protection. Only highest values used as appropriate indication of major gaps and to be displayed at the map (see Figures 13 and 22).

RESULTS

CAFF Area in Russia

The total Russian land area within the CAFF boundary amounts to 5,475,534 km^2. There is a broad range of ecological conditions in this area ranging from arctic deserts and glaciers to island systems of the Arctic Ocean and from northern mountain ranges to middle and southern taiga in the southernmost parts of the Central Siberian Plateau. See Figure 1.

The area is divided into 14 major sub-national level administrative units (Oblast, Kray, National Okroug) where conservation measures are undertaken on a relatively independent basis according to regional specific traditions, with an overall coordination of efforts partly provided by the State Committee for the Environmental Protection. There are 73 lower level administrative districts (rayons) where practical management of protected areas occurs. Table 1 contains spatial and population statistics for each district (rayon) and province These administrative areas can be seen in Figures 2 and 3.

There are 265 protected areas including sites related to scientific monitoring, and flora and fauna data collection in the Russian part of CAFF's Protected Areas Network. Some of the protected areas have a cluster structure and some are a collection of separate sub-sites. These sub-sites might be separated at times by hundreds of kilometres. The use of spatial management tools, for example GIS is crucial in their successful management. In total 415 existing and proposed sites and sub-sites where digitised in this project. Thirty-nine of these new protected areas were found to be outside the limits used by CAFF as a definition of Arctic.

For the purpose of this analysis only existing protected areas of IUCN category I-VI were considered. This set includes Biosphere Reserve (Lapland – the only existing in Russian Arctic), Zapovedniks, National Parks, Zakazniks, Protected Landscapes, internationally designated Ramsar Sites and nature monuments. This report does not attempt to discuss the relative merits of these types of protected areas. However, there are only 87 nature monuments in the CAFF area with a total documented area of approximately 244 square kilometres (less than 0.005% of the total area). Therefore they could not be considered to be playing an important conservation role except as an educational function. It is assumed that each protected area contributes to the preservation of flora and fauna. Existing and Proposed Protected Areas in CAFF Area of Russia can be seen in Figure 4.

Analysis of gaps in ecosystem and habitat protection in the Russian Arctic

The challenge in analysing the effectiveness of the current system of protected areas is to identify a uniform data source that is suitable for dividing the territory into spatial units that are comparable in size with the protected areas. After much consideration and the evaluation of many sources the Landscape/ ecosystem map was chosen.

Landscape is defined as the relatively uniform part of the geographical surface that is distinctive of others by regular combination of components and phenomena and by typical interrelation of lower taxonomic territorial units.

The Landscape Map of the USSR (1980) at a scale of 1:2,500,000 was compiled at the Geological Association of the USSR, Ministry of Geology (editor - I.S.Gudilin) for the purpose of regional engineering-geological studies and mapping. The specific aim of the map has determined the peculiarities of its contents. The map shows the regularities of landscape distribution within the national territory stemming mainly from geological and geomorphological factors as well as bioclimatic features. At the same time the soil and vegetation cover is described in detail in a textual legend, where the particular lower level hierarchical landscape units are practically identical to habitats used in zoogeographical and botanical classifications. Each unit is coded with a number and a letter. There are CAFF area there are 856 unique habitat types for the CAFF area. The map was published using the conical equidistant projection of the USSR territory map at a scale of 1:2,500,000 and issued with the supplementary legend book by GUGK in 1987 (Gudilin *et al.* 1980, Anuchin *et al.* 1987).

The categories, classes and landscape genera according to geological and geomorphological features are systematised separately of belt-sectorial, altitudinal and latitudinal zonal landscape/vegetation types and subtypes. Cross-references of this multi-dimensional hierarchical classification provides opportunity to identify both ecosystem types and subtypes and split major ecosystems into particular groups with the characteristic features of elevation, climate, soils and hydrology.

Comparison of the 1:2,500,000 Landscape/ecosystem map against an available vegetation map (1:4,000,000) showed that this higher resolution source allows more detail to be identified in patterns of distinctive habitat differentiation and distribution, while still maintaining the overall structure of the vegetation classification.

The distribution of major ecosystem types can be seen in Figure 5. The level of protection in each ecosystem type can be seen in Table 3 and the preservation of major ecosystem types and the relationship to the current protected areas network can be seen in Figure 6.

Consideration at the level of ecosystem types or subtypes provides interesting opportunity for the analysis but not enough for the identification of particular regional variation along ecological zones that extend for thousands of kilometres. The landscape map by itself has at least three levels (ecosystem type, subtype and habitat unit) that are useful for dividing the territory in a east-west direction. Water catchment boundaries were used as an additional source to divide the area in a longitudinal direction.

The CAFF area is divided into 320 catchment units. These are organised in three hierarchical levels accordingly to the order of the river network. The first order units (145 in number) are listed in Table 4. The spatial relationship between major water catchment units and the protected areas network can be seen in Figure 7.

The representation of the protected areas system is further assessed at a small scale by overlaying first order river basins with ecosystem types. This enables a more detailed interpretation of the effectiveness of the current network of protected areas. Figure 8 shows the level (%) of protection of these spatial units. As the analysis becomes more involved it is important to understand the nature of the parameters chosen. The insert on Figure 8 provides a “Protection Index”, the result of averaging values between Figures 6 and 8.

Ecosystem subtypes, a second, more detailed level of ecosystem classification, are shown in Figure 9. This division divides the original 13 main types into 26 sub-types.

The level of protection in each ecosystem subtype can be seen in Table 5 and the preservation of major ecosystem subtypes and the relationship to the current protected areas network can be seen in Figure 10.

The main gap analysis was carried out using polygons that were created by intersecting the landscape/ecosystem map (incorporating all three levels: types, subtypes and habitat units) with the water catchment map (sliver polygons, less than 0.5 km^2 were not used). This intersection produced a map containing 13,063 unique polygons and these can be seen in Figure 11.

The effectiveness of the current system of protected areas in preserving unique habitat can be seen in Figure 12. Habitat is based on the third and lowest level of classification from the landscape map. This quick assessment does not help in estimating representation in a broad context nor does it allow comparisons to be made at a continental or circumpolar level.

Figure 13 shows the preservation of habitats within the protected areas network at the most detailed level. The analysis incorporates all three hierarchical levels of ecosystems and river basins units. The level of protection is presented as a percentage but is in fact a "protection index", that reflects the representation/protection of each habitat unit. The final protection index integrates the "level of protection" values calculated for each of 3 hierarchical levels of ecosystem and river basin spatial subdivisions. These values where weighted differently; the weight coefficients applied were: 1 for the upper, large units level, 2 for the middle size units like ecosystem subtypes or second order basins and 3 for the lowest level.

Analysis of Ecosystem Productivity and Human Impact on Habitats

The Normalised Difference Vegetation Index (NDVI) is widely accepted and has been used at a global scale by NOAA for the production of their Global Vegetation Index products since the inception of this service in the early 1980's (Tucker, 1979, Tucker *et al*, 1985). It's use at a continental scale was pioneered in Africa, where it was used to measure and monitor the effects of drought and the progress of desertification in the Sahel (Tucker *at al.* 1985 and Tucker, 1986). It is currently being used by the USGS to develop a land cover characteristics database for the USA based on phenological patterns (Loveland et al, 1991) and for mapping land cover in Canada (Cihlar et al, 1990). The USGS also now routinely produces national maps showing a variety of "greenness" characteristics, all based on AVHRR-derived NDVIs.

Thus, the AVHRR-derived NDVI has become the de facto global standard for mapping, measuring and monitoring plant cover distribution and growth at continental scales. Its relationships to other standard field measurements of plant cover and productivity such as biomass per unit area and Leaf Area Index, are difficult to determine. This is because it is practically impossible to obtain sufficiently large field samples to be representative of one pixel (about 1sq.km). At the same time a high correlation has generally been found between the NDVI and green cover or green biomass (e.g. Foran & Pearce, 1990; Filet et al, 1990 and Williamson et al, 1990, Bullen, 1993).

NDVI values theoretically range between one and zero but can also fall into negative values. Most calibrational relationships between NDVI and vegetation cover suggest that the NDVI range from 0.1-0.7 encompasses and measures the possible gross range in green vegetation cover (Loveland *et al.* 1991, Filet *et al.* 1990). NDVI values 0-0.1 can variously represent cloud, wet or damp soil as well as, or including, very sparse plant cover. These general findings were confirmed in this study with the lowest average NDVI values corresponding with arctic tundra and mountain tundra ecosystems and high values typical for southern-most taiga. The Normalised Difference Vegetation Index (NDVI) Yearly Average can be seen in Figure 14.

For practical reasons the interpretation of the distribution of NDVI values was limited to a qualitative analysis. At the same time the distribution of NDVI along the relatively uniform natural zones was reclassified for each major ecosystem based on the frequency of low, average and high values for each vegetation zone. Results are presented in Figure 15 and highlight important variations in conditions along continuous areas of major ecosystems. Within the same ecosystem relatively high NDVI values might be considered as a sign of a more productive and more diverse ecosystem.

Figure 16 shows pristine areas in the Russian north, as a factor of distance away from features of human impact. Apparent Naturalness indicates the possible direct and indirect impact on natural ecosystems and species communities (Husby and Henry 1995). This is especially important in the Arctic with its low self-restoration ability.

Direct natural habitat damage includes:
Land-take affecting originally natural habitats including:
- Designated protected areas.
- Known sites of special conservation concern.
- Other natural habitats of lesser known (but not necessary lower) value.
- Fragmentation of the above mentioned habitats.
- Rare species population damage, loss after land-take or fragmentation of above mentioned categories of habitats.
- Widespread changes in species populations as a result of land-take or fragmentation of the above mentioned categories of habitats.

Secondary (ecological effects):
- Virtual "space-take" effect on animals sensitive to disturbance and noise-pollution.
- Invasion of species typical of anthropomorphic landscapes.
- Change of species combination, food chains, ecological community structure (up to radical transformations in habitat type which is equivalent to loss of original areas).
- Hydrological impact (speeds up the habitat transformation).
- Geology and geomorphological impacts (speeds up the habitat transformation).

Secondary (socio-economic cumulative effects):
- Secondary urbanised development of areas where transport infrastructure is improved.
- Changes in land use as a result of transport infrastructure (agricultural or recreational pressure on remaining natural habitats etc).

Below is the function we used for the estimation of potential biodiversity value ($\mathbf{P_{bdv}}$) for the sites, located at some distance (**D**) from the nearest feature of anthropogenic impact:

$$\mathbf{P_{bdv} = \log (1 + D) / \log (M),}$$

*where **M** is the maximum distance and where human impact does not affect biodiversity.*

For the purpose of this study, we designated that **M** = 30 km, accepting the approach described in wilderness mapping studies, and assigned the $\mathbf{P_{bdv}}$ = 1 to all areas remote by more than 30 km from the transport infrastructure features.

The possible values of $\mathbf{P_{bdv}}$ may vary from 0 (at the asphalt surface, where little or no biodiversity exists) to 1 (in intact remote ecosystems). If you compare two sites of equal area, one within 500m of some anthropogenic feature, and the other in a remote intact region, the diversity of flora and fauna and chances to meet rare taxa or specimens would be roughly 10 times lower. In other words, the virtual or efficient space left for living nature is considered to be reduced by a factor of 10. Currently there is no common system for quantitative estimation of biodiversity or ecosystem complexity and probably in future the number mentioned might change considerably. However, the overall shape of the dependence between $\mathbf{P_{bdv}}$ and distance is unlikely to be very different. The "effective life space" or "**effective life area index**" defined as $\mathbf{P_{bdv} * 100\%}$ might be considered as reduced (against total area of habitat not affected by human activities) to the extent described by the function used for the $\mathbf{P_{bdv}}$ estimation and presented in the insert on Figure 17.

The next logical step in the analysis was to estimate the possible "effective life space" (as an index) against the total area of the particular habitat unit. The average value for the set of cells combining a habitat unit provides a reasonable estimation of possible impact to a particular habitat. The final picture of the estimated impact may vary considerably even for the habitats directly crossed by the road, depending on the shape, position and size of spatial units. For example, the equal size units having elongated shape might be almost destroyed (when the road comes along it) or hardly affected if the road crossed just one end of it and another one and most of it's area are located far away and at more than 30 kilometres from the road. The results of this interpretation of Apparent Naturalness can be seen in Figure 17.

Species Richness Analysis

A detailed analysis of species diversity would have far exceeded the resources available for this project and so efforts were concentrated on converting available data into a usable format and in incorporating general indicators into the framework of the current analysis. The total number of terrestrial species of mammals, birds, reptiles and amphibians in the Russian Arctic can be seen in Figure 18. This map of species richness where used as the basis for further interpretation while highlighting the most important gaps at the ecosystem level. Figure 19 shows the distribution of Red Data Book Mammals in the Russian Arctic. Rare species require more concern and higher resolution data in order to make particular recommendations on the necessary measures for their protection. We can conclude that the current availability of data on these species does not allow effective planning for their conservation.

Figure 20 shows the number of birds species in the Russian Arctic and includes important breeding sites of waterfowl in coastal areas (birds diversity data from Danilenko and Rumyantsev, 1995, birds colonies from Løvås and Brude 1999). Figure 21 shows the number of freshwater fish species in the Russian Arctic (Lysenko *et al.* 1998).

Integration of Ecosystem and Species Protection

Figure 22 shows gaps in species and habitat conservation by Protected Areas Network in the Russian Arctic. The northernmost ecosystems are well protected, however, more attention needs to be paid to sub-arctic and low arctic areas. There are considerable gaps in the protection of tundra and especially forest tundra.

The "gaps" mapped in these southern zones represent relatively broad areas. There is an absence of reserves in this area and therefore there exists a wide choice of sites to protect. If an ecosystem analysis helps to highlight these broad gaps, the particular sites chosen must also incorporate data on species, especially rare and endemic species.

The GIS database developed during this project contains a wealth of information. This database should be made available for future conservation efforts in the region. Expansion of CPAN and the creation of new protected areas in the Russian Arctic will provide more balanced protection of the arctic ecosystems if the process of priority setting for candidate site selection incorporates information on identified gaps in habitat conservation and addresses the Principles for Establishing Protected Areas and Implementing CPAN in Russia as summarised in Annex III

Recommendations

1. Provisional plans for CPAN expansion in the Russian Arctic should be considered in light of the gaps identified and mapped.
2. Special efforts must be made to develop comprehensive inventories of species (especially rare ones) including their distribution and status.
3. Results available from the current Gap Analysis project must be published on CD-ROM including source data, description of analytical approaches used and necessary for the future analysis background GIS maps and data collection forms.
4. A gap analysis should be conducted for the whole circumpolar Arctic utilising better resolution data and experience of national studies related to this type of analysis.
5. Hold a workshop to bring relevant expertise together in order to discuss how best to conduct a circumpolar gap analysis.

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Figures/maps

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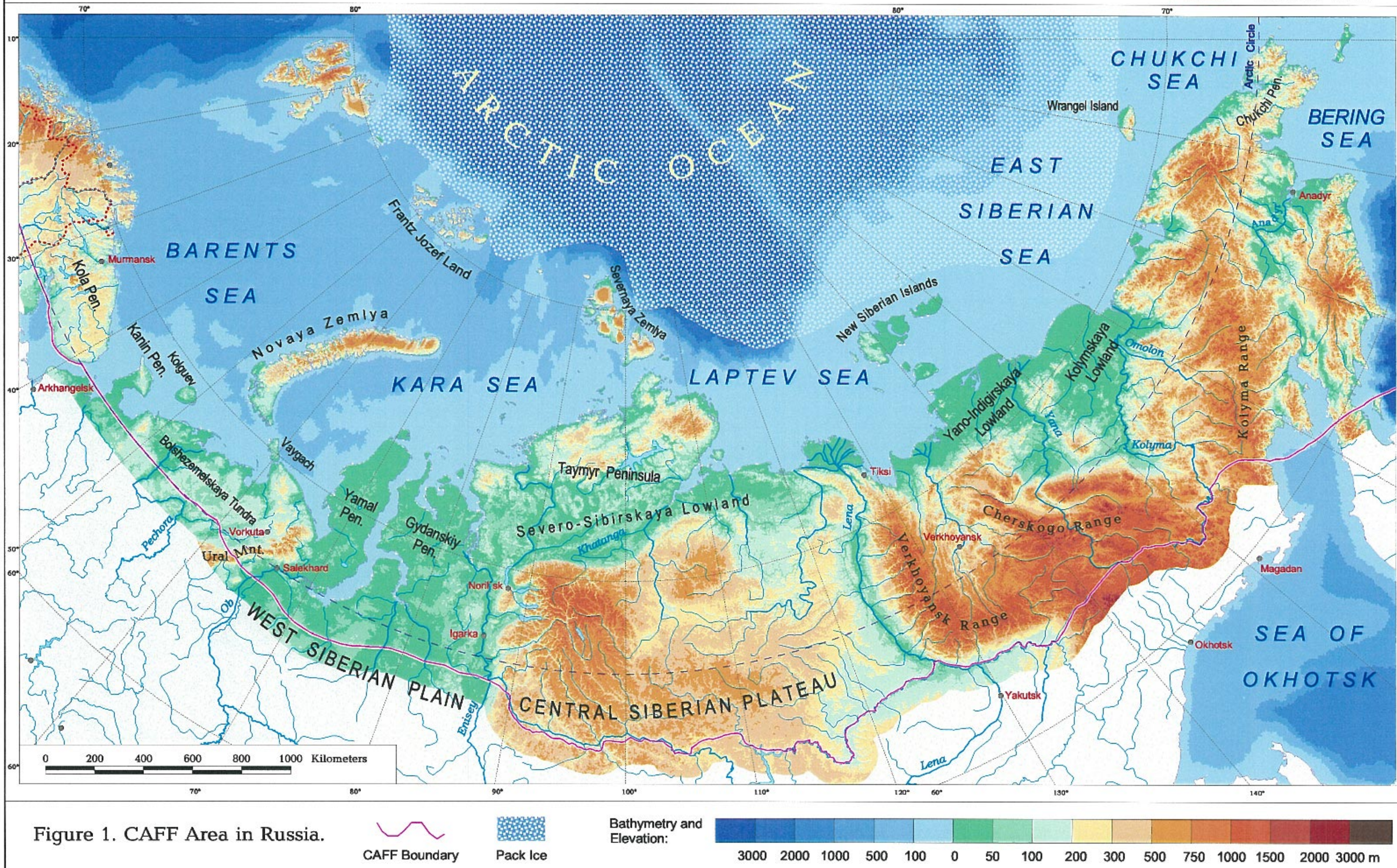

Figure 1. CAFF Area in Russia.

Map compiled by I Lysenko, D Henry: WCMC/GRID – Arendal, September 1999

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Figure 2. Administrative Provinces (Oblast' or Kray), Republics and Autonomous Districts (Okrug) in CAFF Area of Russia.

Map compiled by I Lysenko, D Henry: WCMC/GRID—Arendal, October 1999

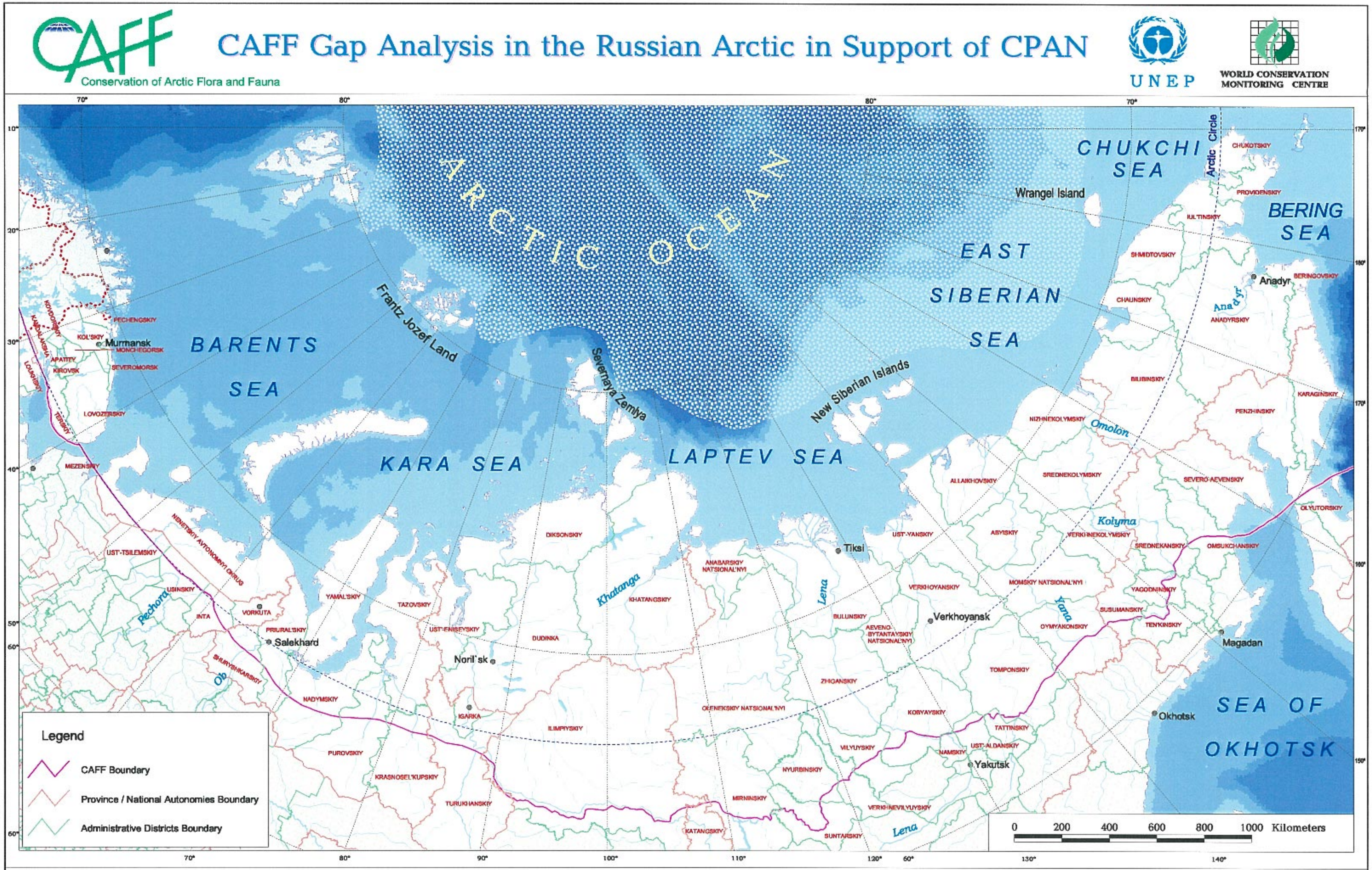

Figure 3. Administrative Districts (Rayon) in CAFF Area of Russia.

Map compiled by I Lysenko, D Henry; WCMC/GRID – Arendal, September 1999

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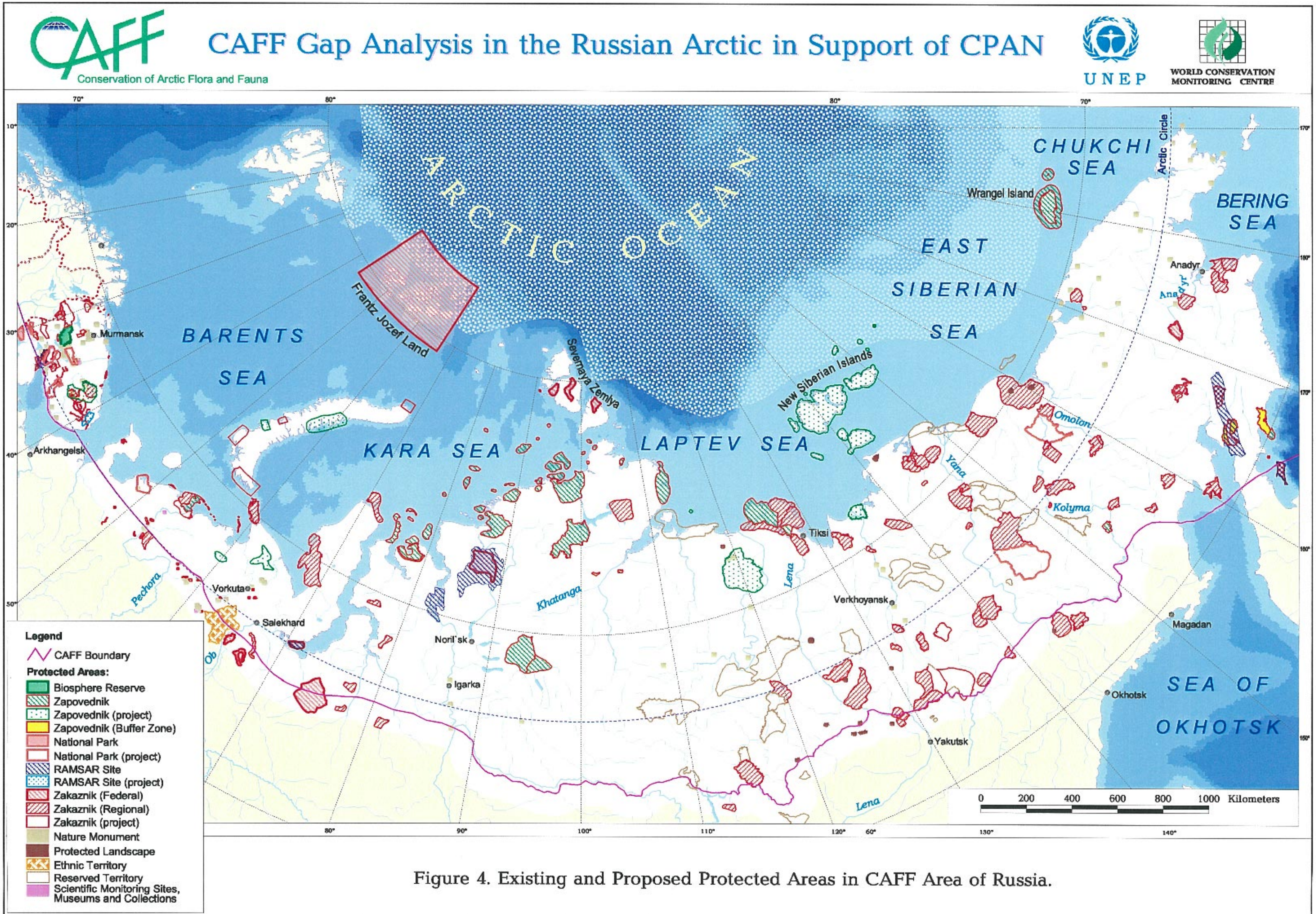

Figure 4. Existing and Proposed Protected Areas in CAFF Area of Russia.

Map compiled by I Lysenko, D Henry; WCMC/GRID – Arendal, October 1999

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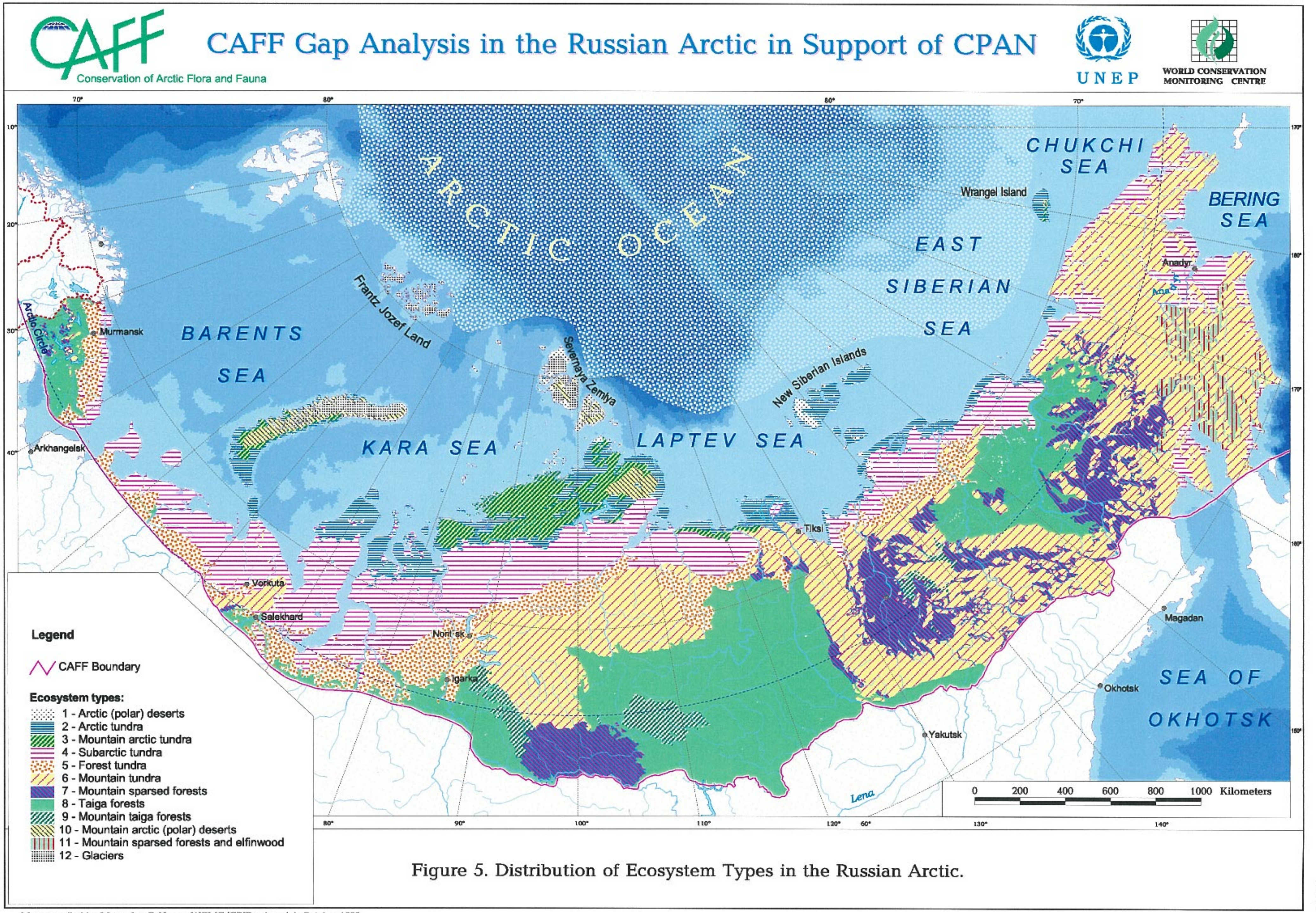

Figure 5. Distribution of Ecosystem Types in the Russian Arctic.

Map compiled by I Lysenko, D Henry: WCMC/GRID – Arendal, October 1999

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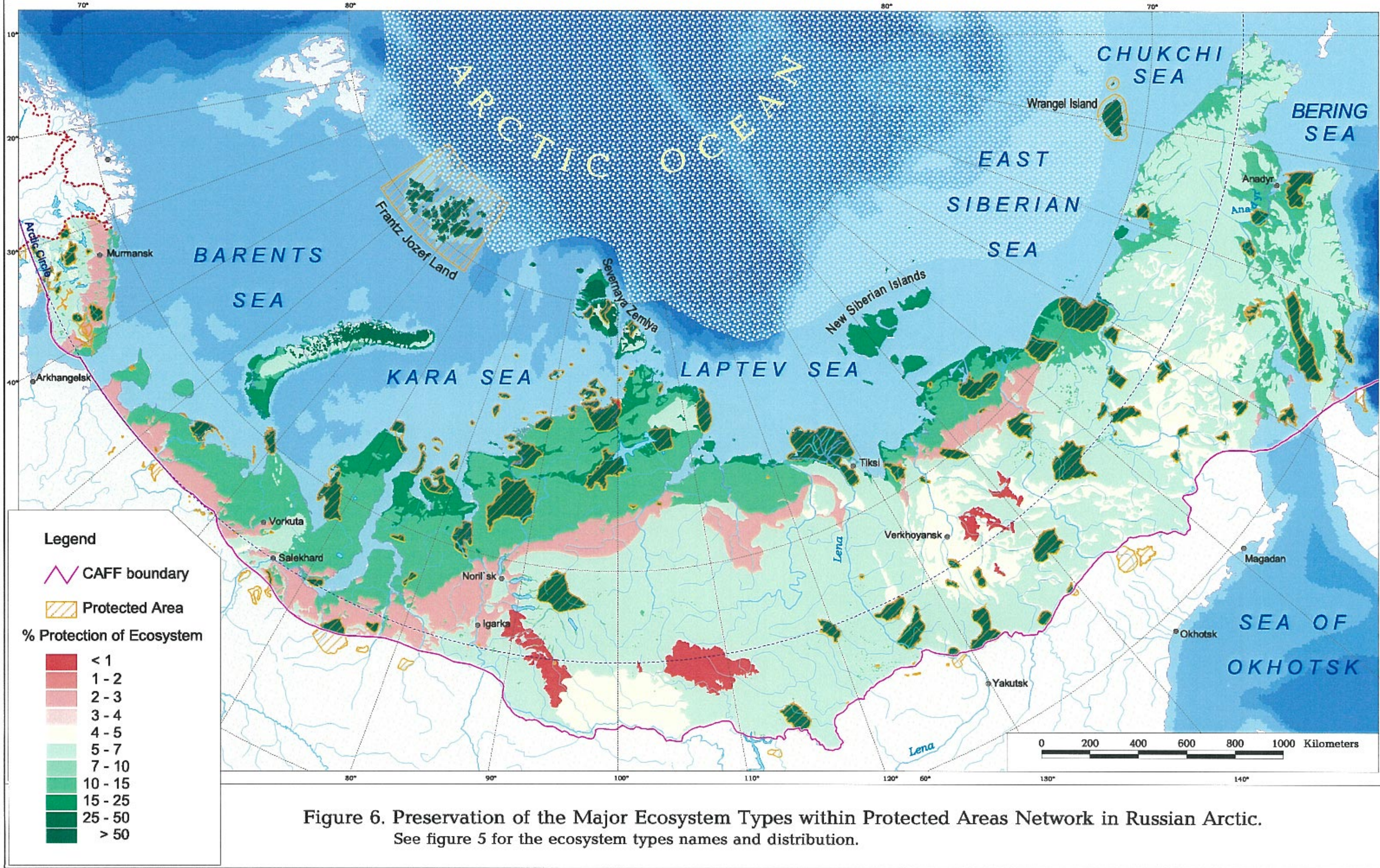

Figure 6. Preservation of the Major Ecosystem Types within Protected Areas Network in Russian Arctic.
See figure 5 for the ecosystem types names and distribution.

Map compiled by I Lysenko, D Henry: WCMC/GRID – Arendal, October 1999

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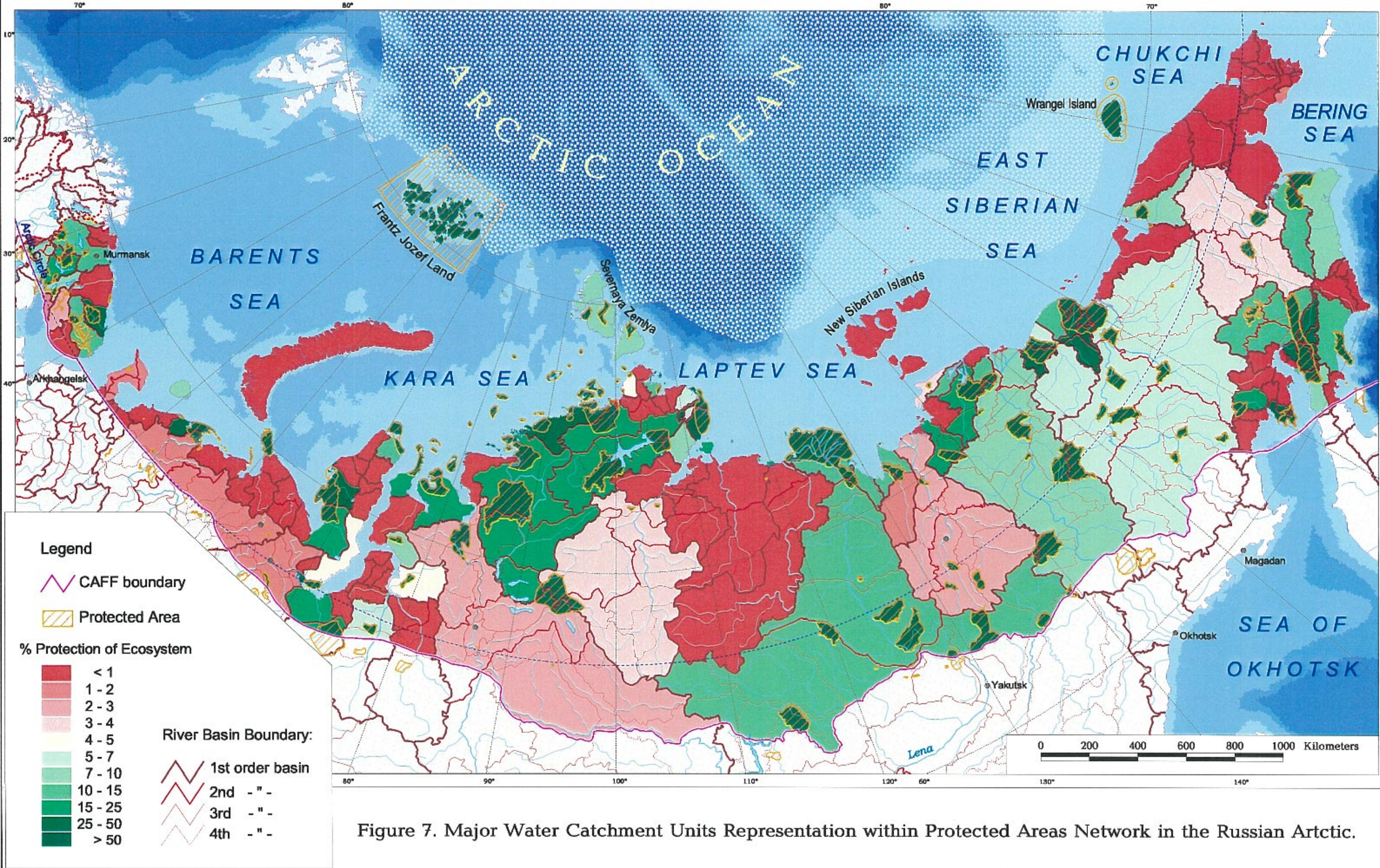

Figure 7. Major Water Catchment Units Representation within Protected Areas Network in the Russian Artctic.

Map compiled by I Lysenko, D Henry: WCMC/GRID – Arendal, October 1999

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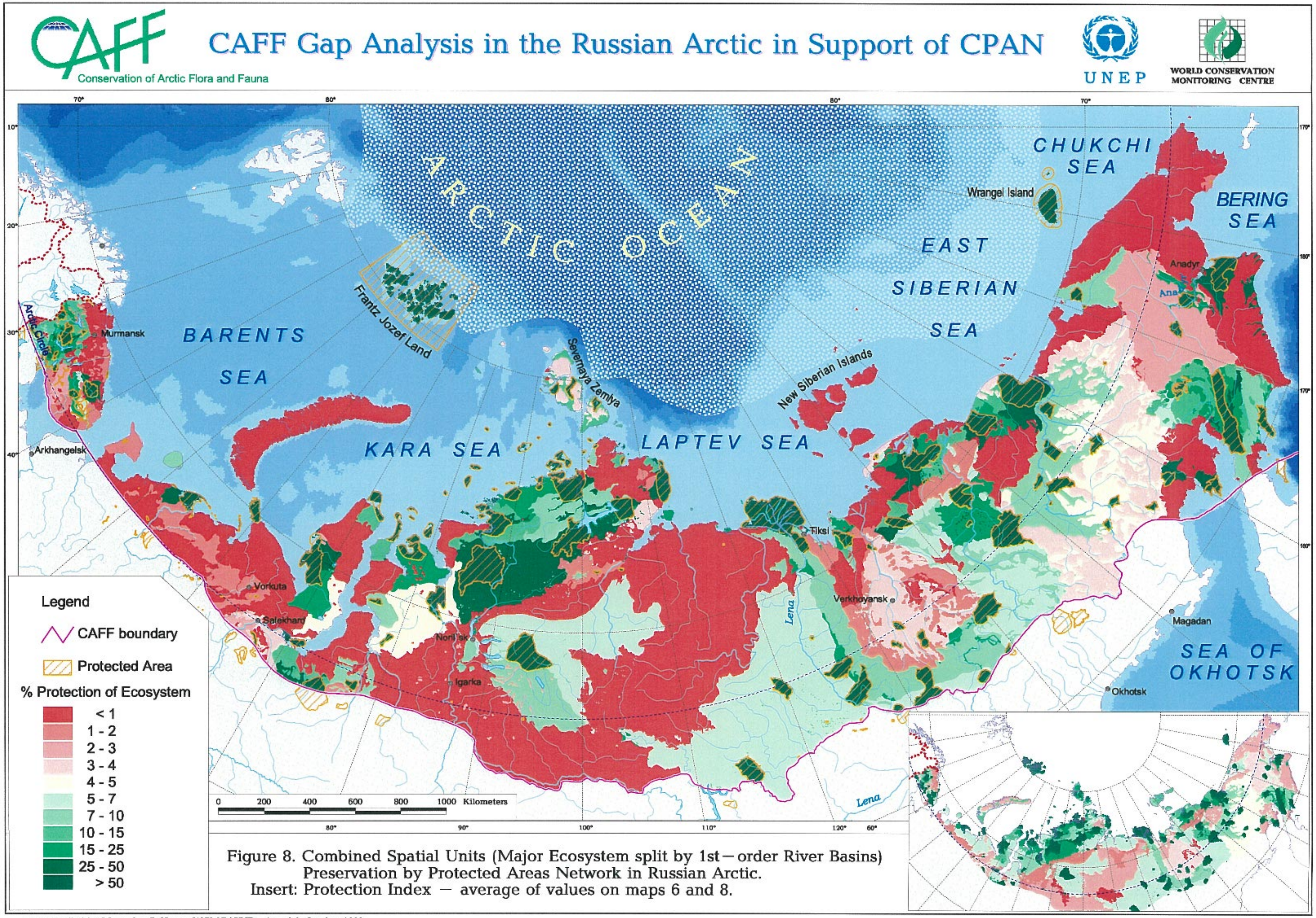

Figure 8. Combined Spatial Units (Major Ecosystem split by 1st – order River Basins) Preservation by Protected Areas Network in Russian Arctic.
Insert: Protection Index – average of values on maps 6 and 8.

Map compiled by I Lysenko, D Henry: WCMC/GRID – Arendal, October 1999

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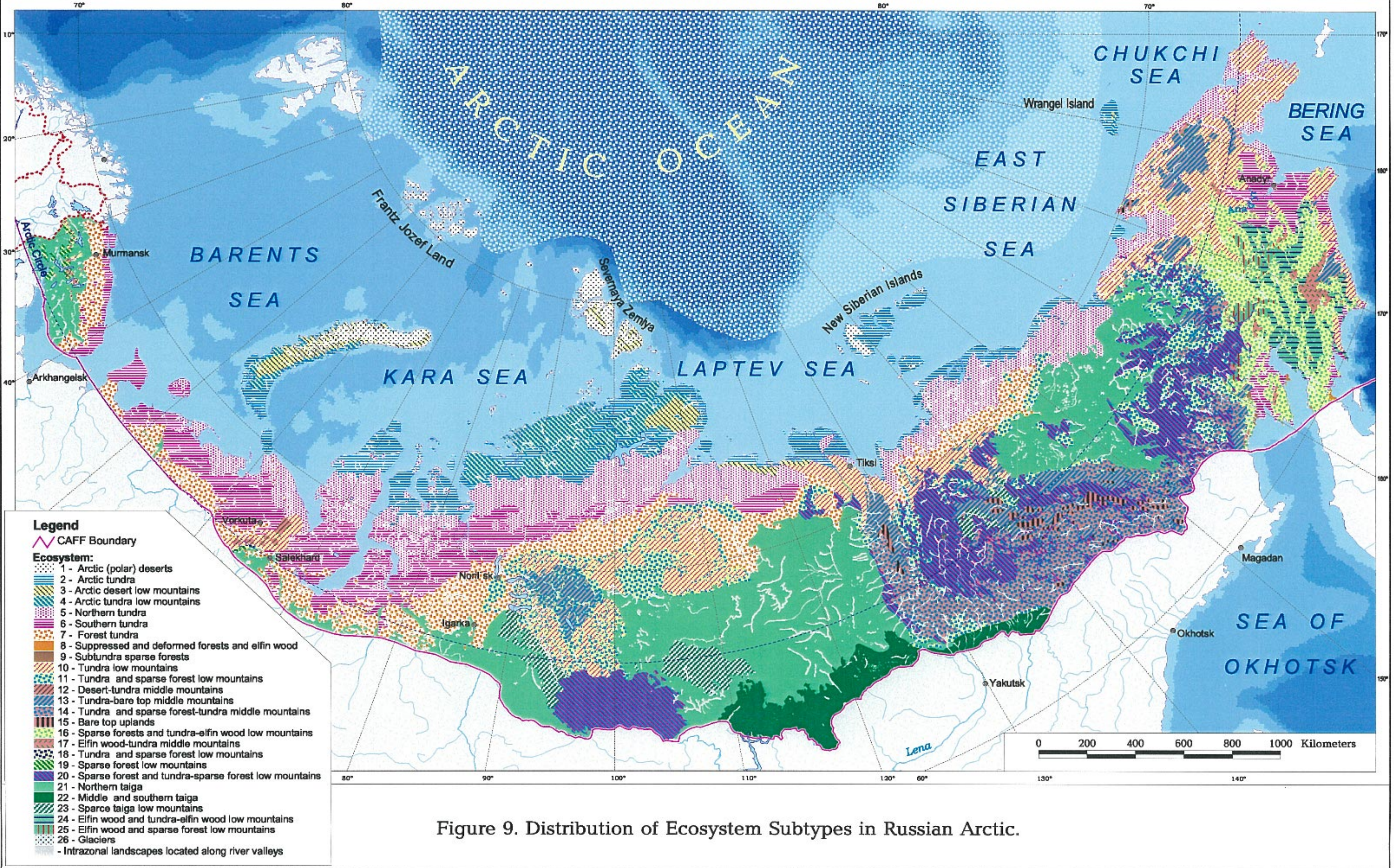

Figure 9. Distribution of Ecosystem Subtypes in Russian Arctic.

Map compiled by I Lysenko, D Henry: WCMC/GRID – Arendal, October 1999

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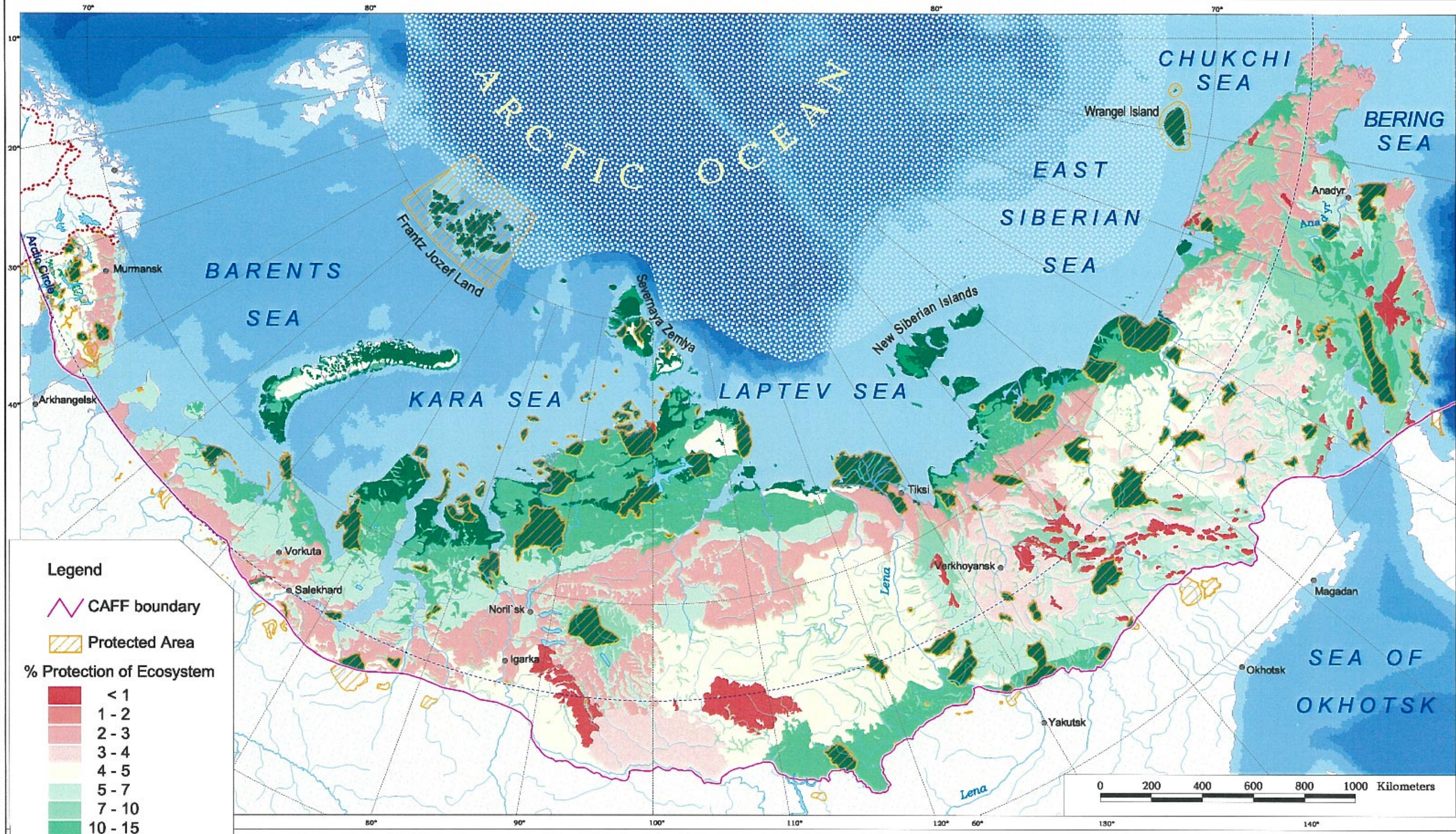

Figure 10. Preservation of the Ecosystem Subtypes within Protected Areas Network in Russian Arctic.
See figure 9 for the ecosystem subtypes names and distribution.

Map compiled by I Lysenko, D Henry: WCMC/GRID – Arendal, October 1999

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Figure 11. Overlay of Landscape Units and River Basin Units Used for Analysis of Ecosystem Preservation within Protected Areas Network.

Map compiled by I Lysenko, D Henry: WCMC/GRID—Arendal, October 1999

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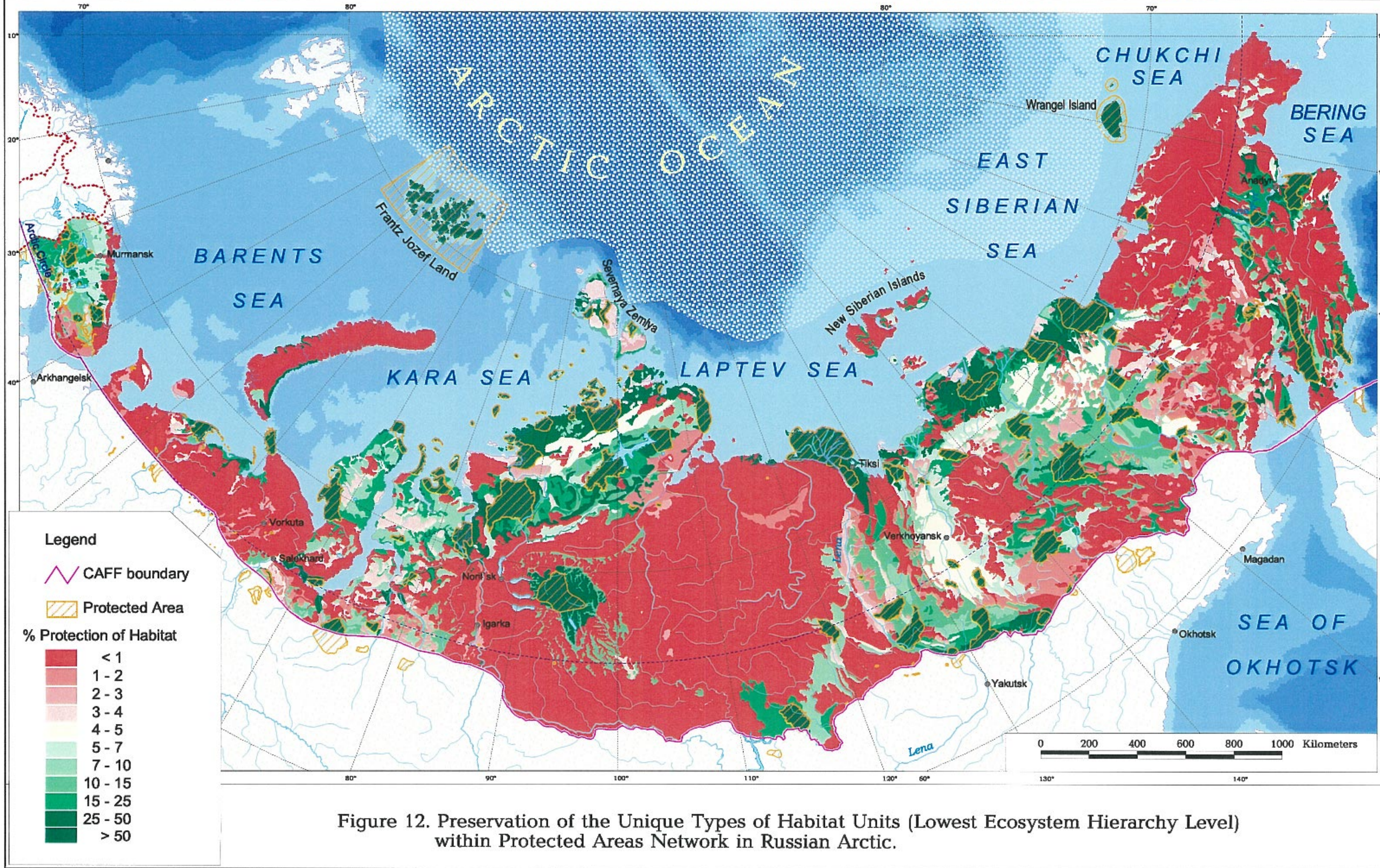

Figure 12. Preservation of the Unique Types of Habitat Units (Lowest Ecosystem Hierarchy Level) within Protected Areas Network in Russian Arctic.

Map compiled by I Lysenko, D Henry; WCMC/GRID – Arendal, October 1999

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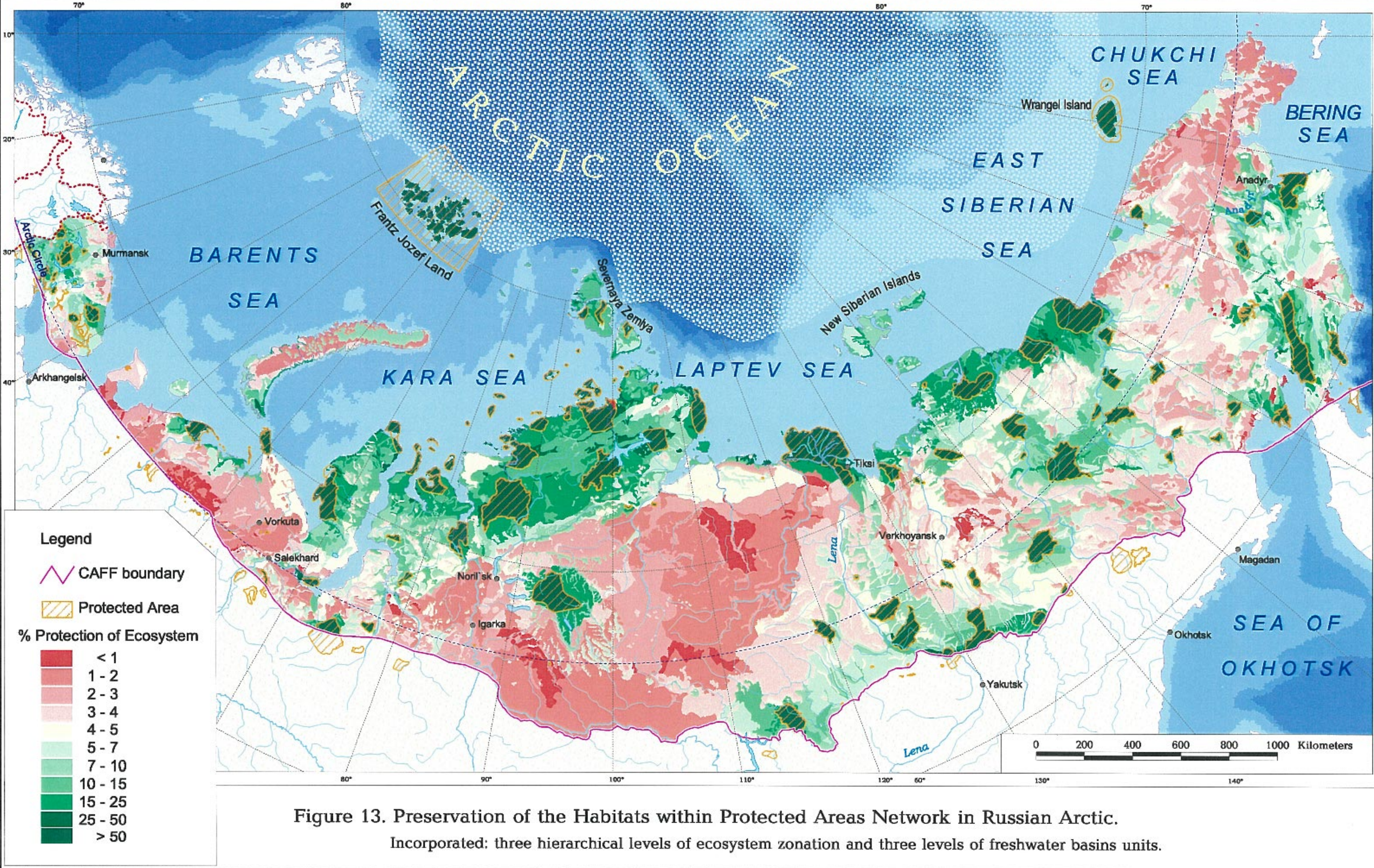

Figure 13. Preservation of the Habitats within Protected Areas Network in Russian Arctic.

Incorporated: three hierarchical levels of ecosystem zonation and three levels of freshwater basins units.

Map compiled by I Lysenko, D Henry; WCMC/GRID – Arendal, October 1999

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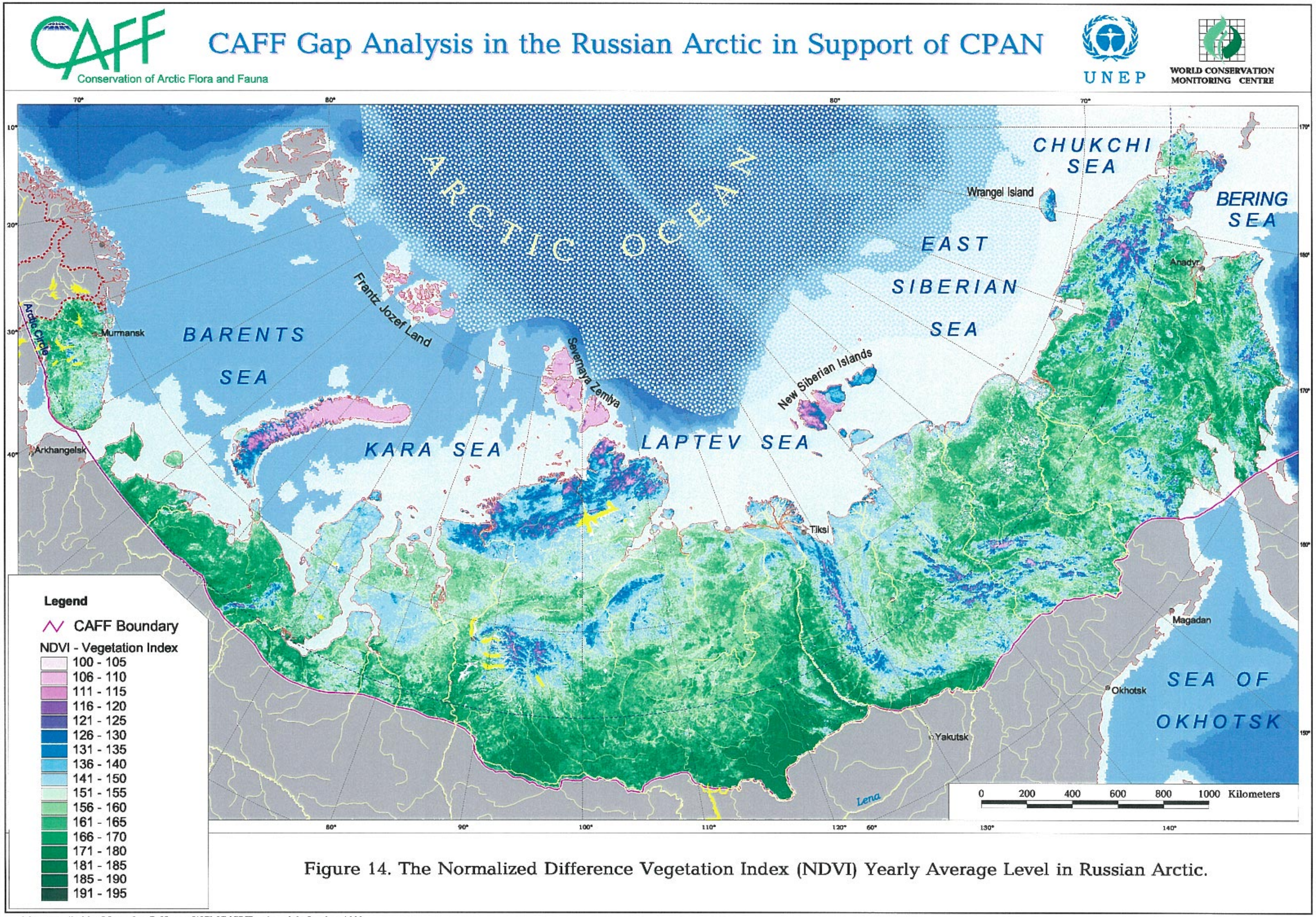

Figure 14. The Normalized Difference Vegetation Index (NDVI) Yearly Average Level in Russian Arctic.

Map compiled by I Lysenko, D Henry; WCMC/GRID – Arendal, October 1999

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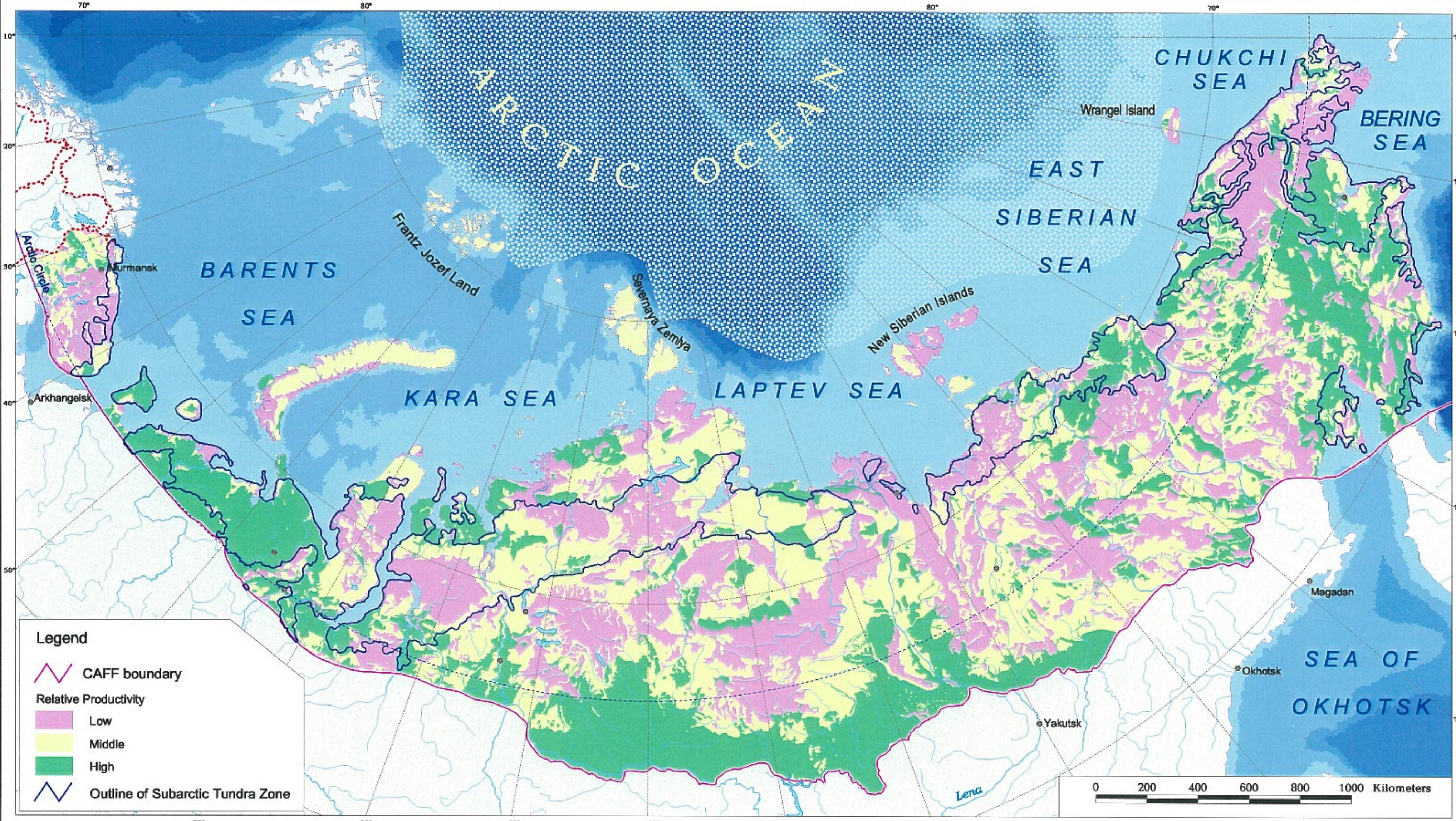

Figure 15. Relative Productivity within Major Ecosystems Estimated on the Basis of Distribution of the NDVI Index Values.
Average NDVI values of spatial units where compared inside each of 12 ecosystem types (see map 5, 11);
outline of Subarctic Tundra illustrates the extent of area where the NDVI variation compared for 2570 landscape/habitat units.

Map compiled by I Lysenko, D Henry: WCMC/GRID – Arendal, October 1999

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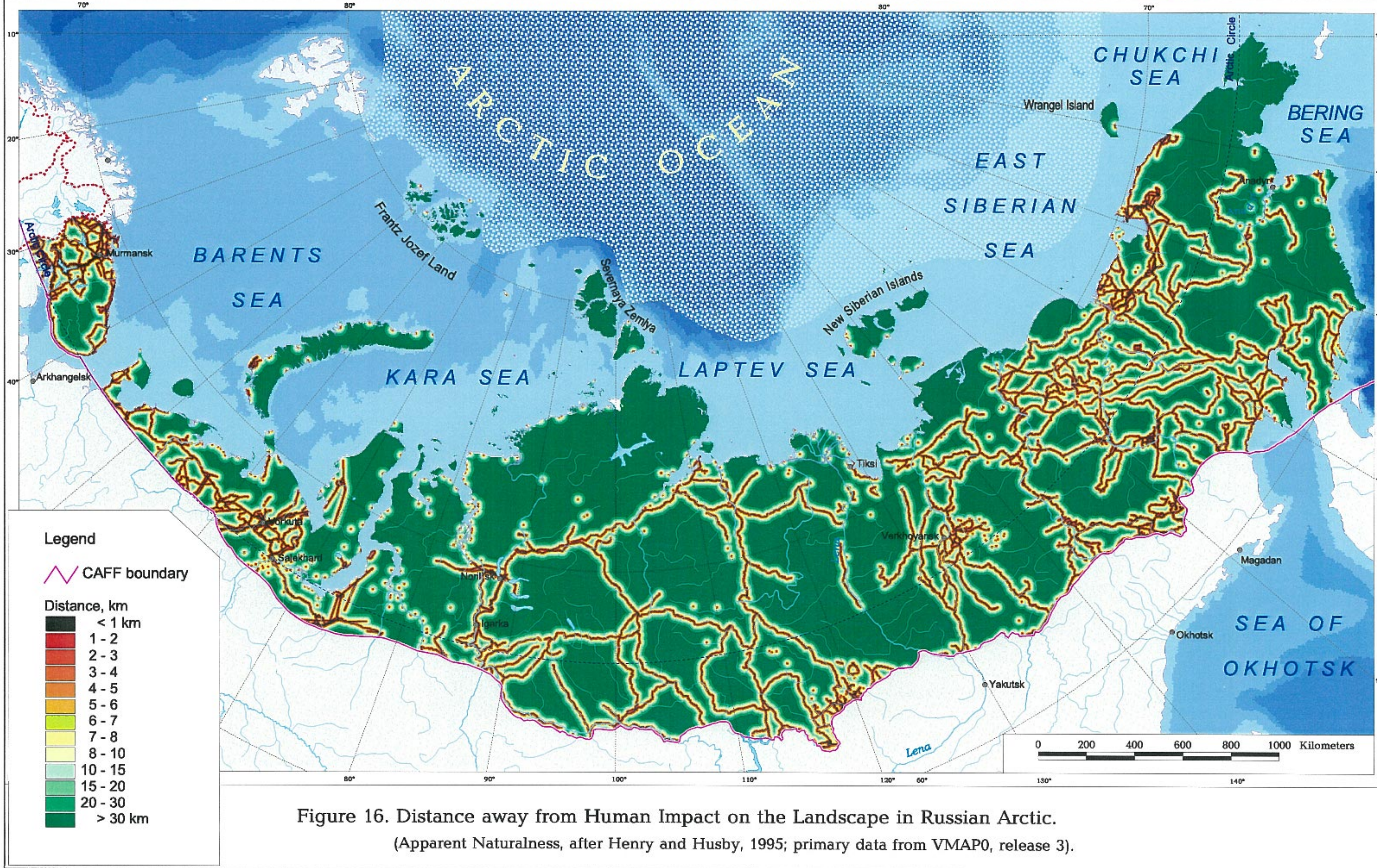

Figure 16. Distance away from Human Impact on the Landscape in Russian Arctic.

(Apparent Naturalness, after Henry and Husby, 1995; primary data from VMAP0, release 3).

Map compiled by I Lysenko, D Henry; WCMC/GRID—Arendal, October 1999

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Figure 17. Effective Life Area Index in Landscape Units — Interpretation of Apparent Naturalness Level for Particular Ecologically Uniform Continuous Habitats.

Map compiled by I Lysenko, D Henry; WCMC/GRID – Arendal, October 1999

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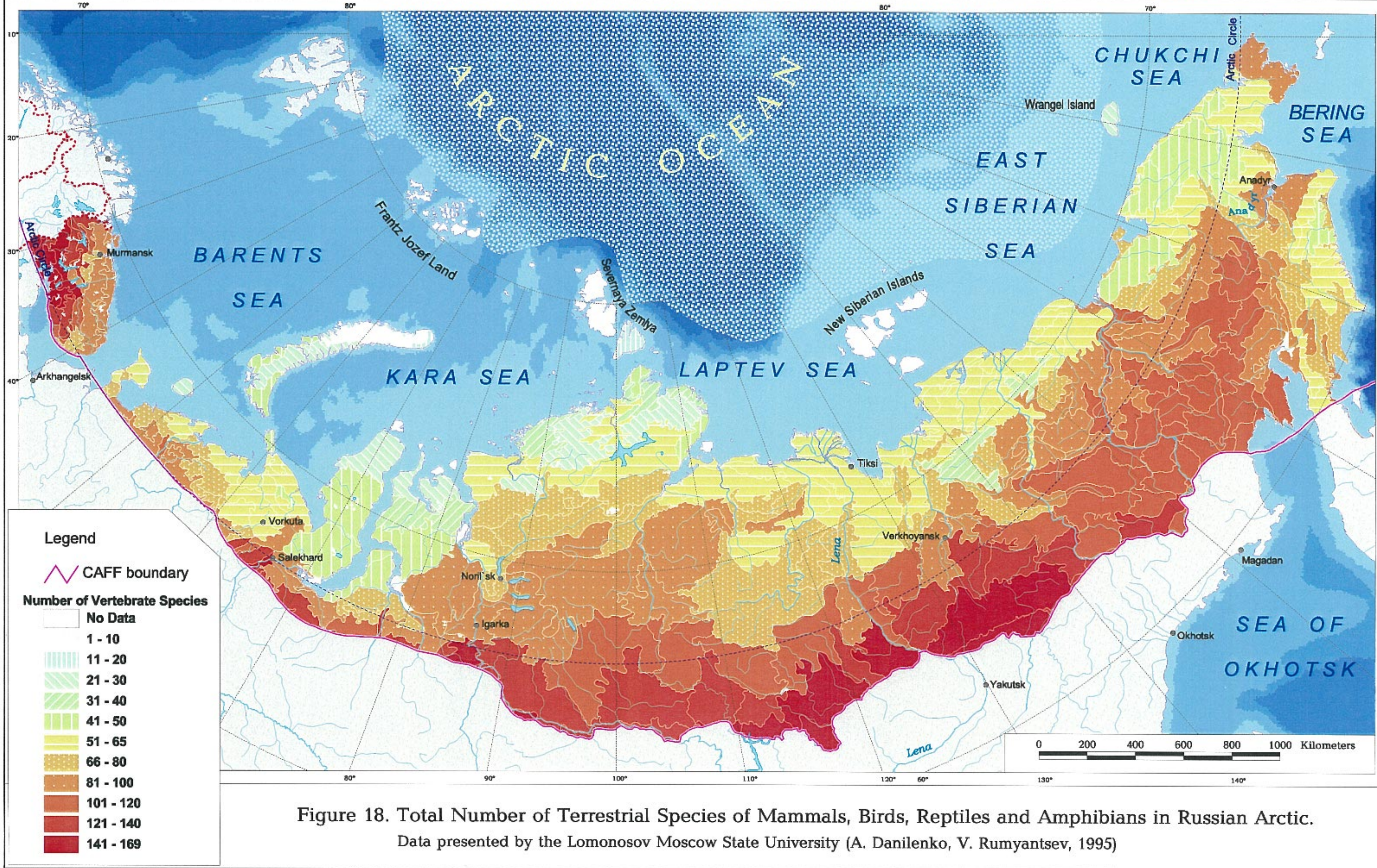

Figure 18. Total Number of Terrestrial Species of Mammals, Birds, Reptiles and Amphibians in Russian Arctic.

Data presented by the Lomonosov Moscow State University (A. Danilenko, V. Rumyantsev, 1995)

Map compiled by I Lysenko, D Henry; WCMC/GRID – Arendal, October 1999

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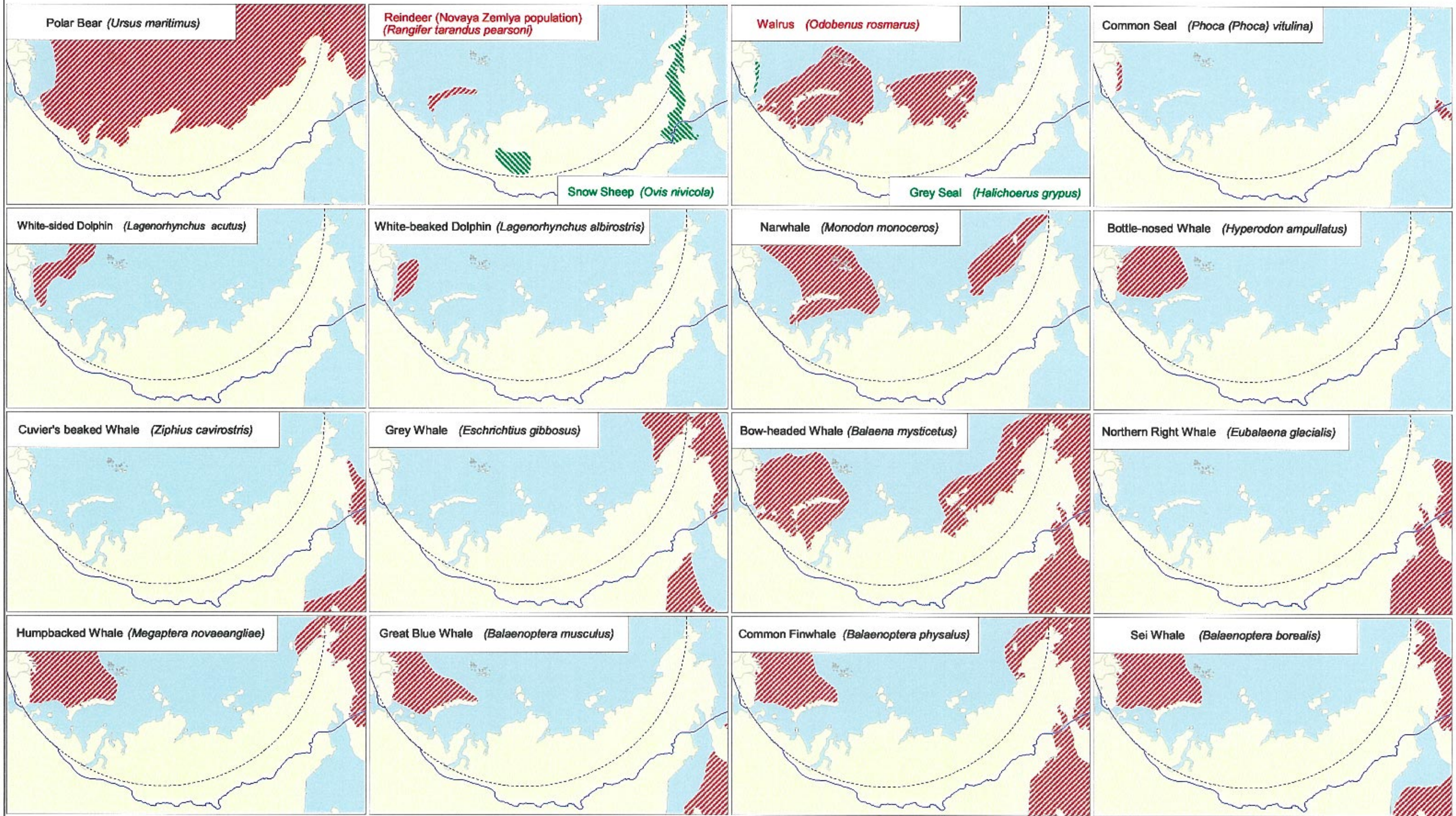

Figure 19. Distribution of Red Data Book Mammals in Russian Arctic.

Source: Red Data Book of the Russian Federation, Moscow, 1983

Map compiled by I Lysenko, D Henry: WCMC/GRID–Arendal, October 1999

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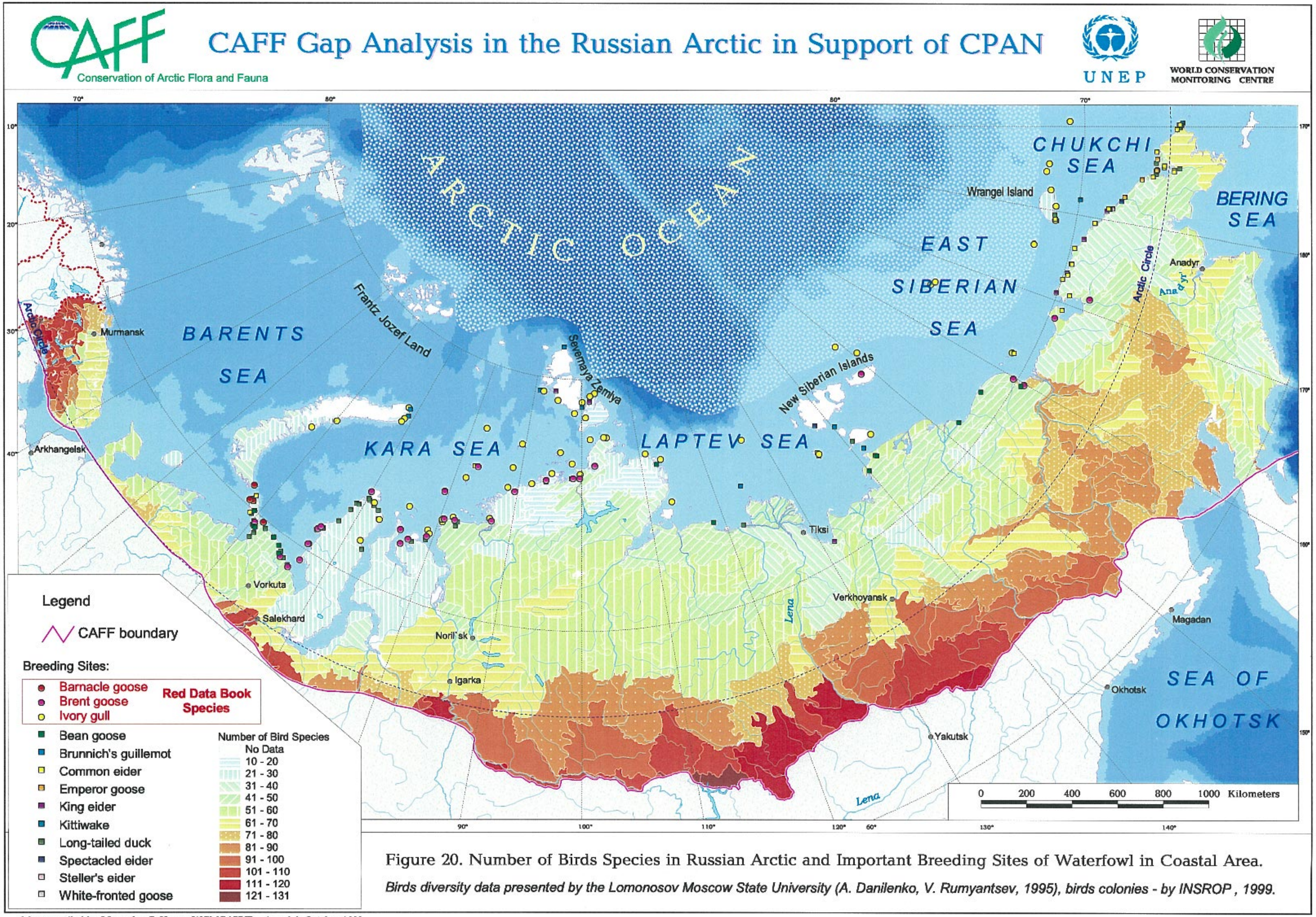

Figure 20. Number of Birds Species in Russian Arctic and Important Breeding Sites of Waterfowl in Coastal Area.

Birds diversity data presented by the Lomonosov Moscow State University (A. Danilenko, V. Rumyantsev, 1995), birds colonies - by INSROP , 1999.

Map compiled by I Lysenko, D Henry; WCMC/GRID – Arendal, October 1999

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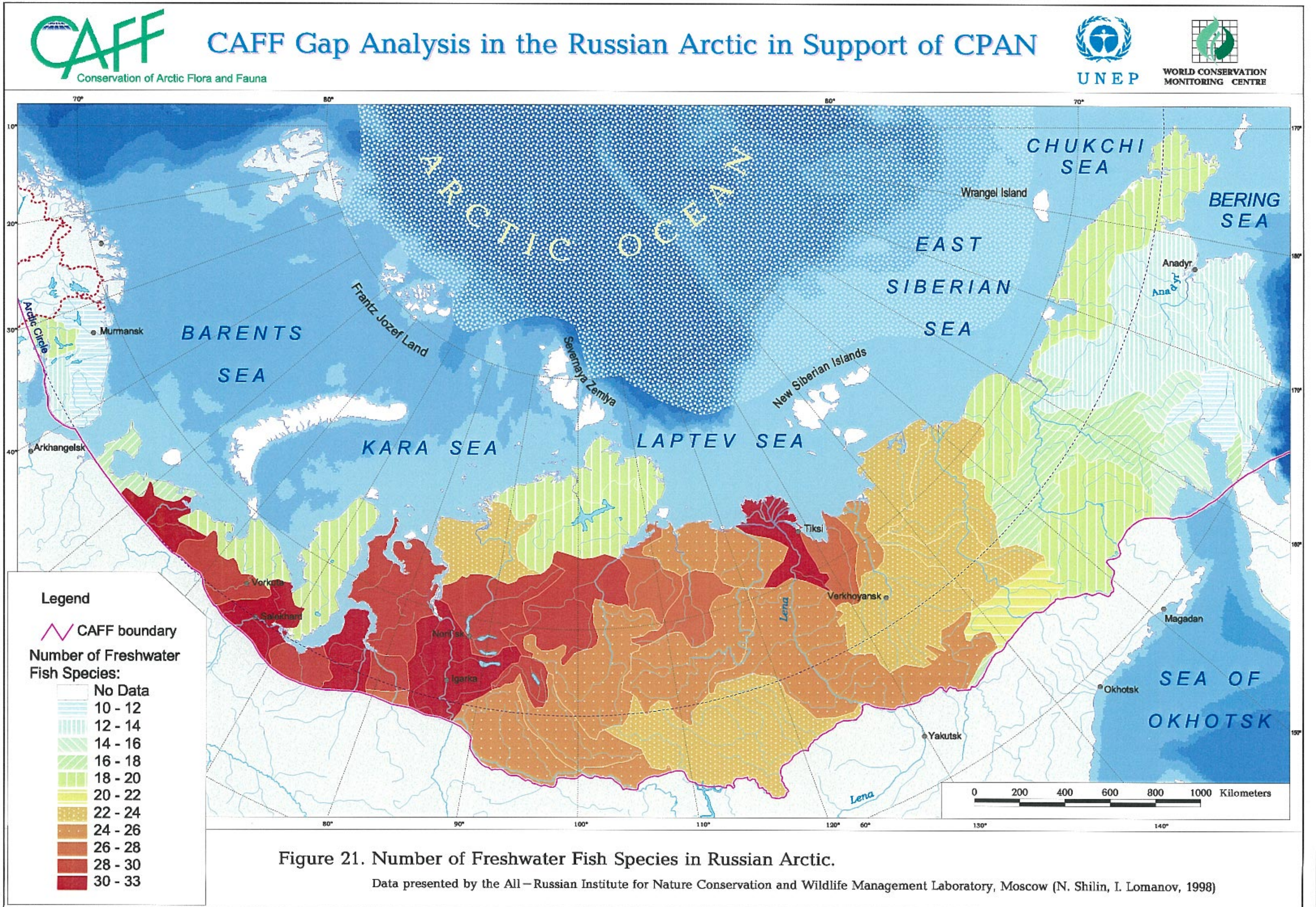

Figure 21. Number of Freshwater Fish Species in Russian Arctic.

Data presented by the All – Russian Institute for Nature Conservation and Wildlife Management Laboratory, Moscow (N. Shilin, I. Lomanov, 1998)

Map compiled by I Lysenko, D Henry; WCMC/GRID – Arendal, October 1999

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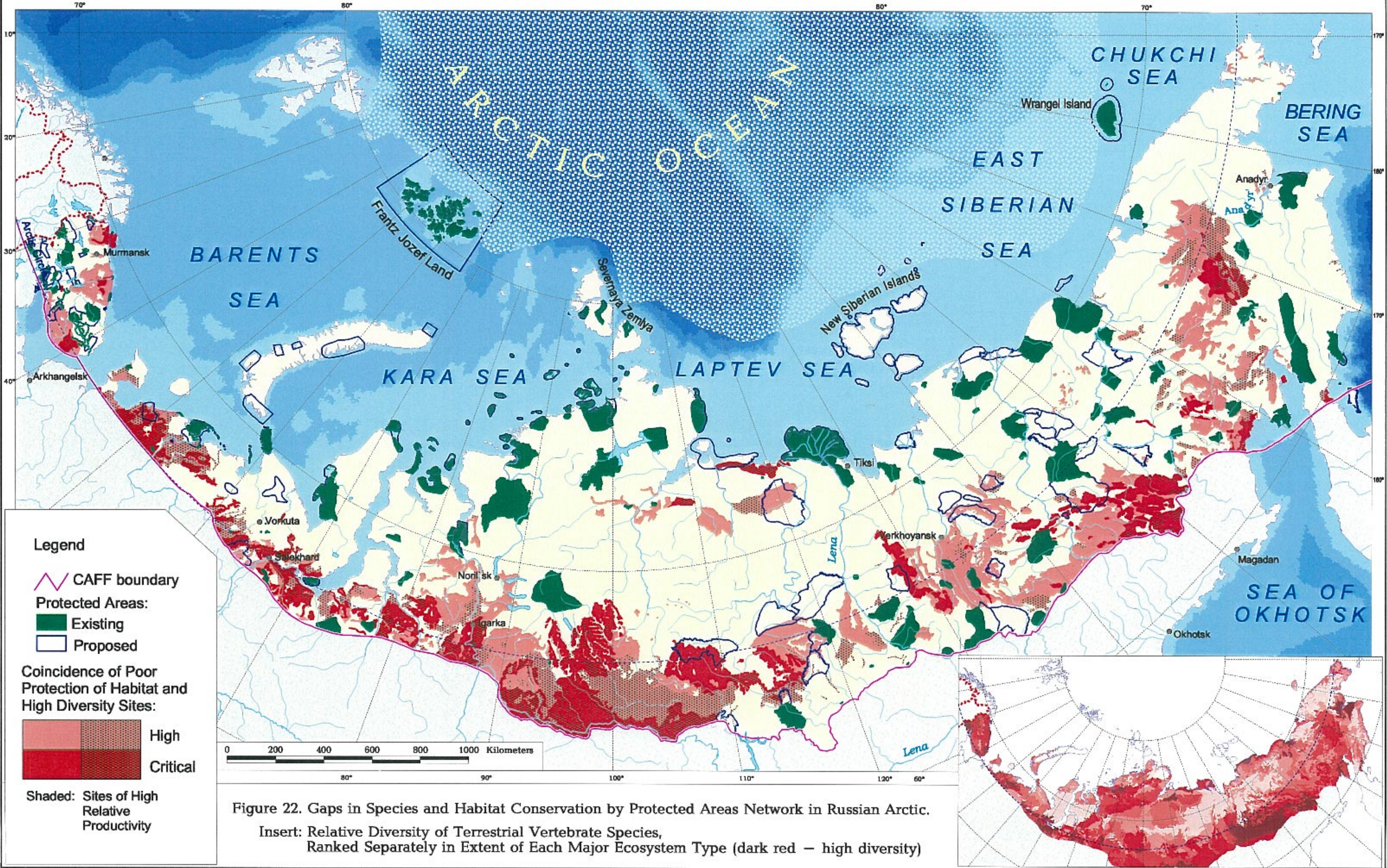

Figure 22. Gaps in Species and Habitat Conservation by Protected Areas Network in Russian Arctic.

Insert: Relative Diversity of Terrestrial Vertebrate Species, Ranked Separately in Extent of Each Major Ecosystem Type (dark red – high diversity)

Map compiled by I Lysenko, D Henry: WCMC/GRID–Arendal, October 1999

ANNEXES

Annex I

Summary of 1994 Gap Analysis Results

COUNTRY	GAPS IN OVERALL, ECOSYSTEM, AND HABITAT PROTECTION	GOAL	GAP IN SPECIES PROTECTION
CANADA	- % overall protection - Protection of important habitats - # of PA's - Tundra - Taiga - Marine - Wetlands	- Increase % protection from 3.7% to 12% - Increase # of protected habitats from 22 to 80 - Raise # of PA's by 37 - Increase # of protected wetlands from 6 to 47.	
FINLAND	- Old growth forests - Wetlands - Middle and Northern Boreal - Coastal		Waterfowl
GREENLAND	- Wetlands - Tundra - Scrubwoods - Seabird colonies - Caribou Grounds	- Increase no-hunting portion to 40%	
ICELAND	- Marine Areas - Volcanoes - Vegetation communities - Rivers/Watersheds - Increase # of PA's	- Increase PA's from 72 to 330	Waterfowl
NORWAY	- Jan-Mayen Island - Bear Island - Coastal Areas - Fjord systems - Northern/oceanic coniferous forest - Northern alpine areas - Wetlands - Seabird colonies - Deciduous forests - Coniferous forests - Overall PA coverage - # of PA's - National Park system	- Increase coverage by 690,650 ha - Increase # by 25 - Complete NP Plan by 2010	
RUSSIA	- PA network coverage - Major geophysical regions - Key habitat - Key vegetation zones - Overall coverage - Low-level tundra - Forested tundra - Taiga - Marine	- Complete PA network by 2005 - Increase coverage by 71,000 sq kms	
SWEDEN	- Wetlands - Forests - Overall coverage	- Complete protection by 1995 - Add 470,000 ha	
USA	- Marine and estuarine - No gaps in terrestrial coverage (57% already in PA's)	- No action required	

Annex II

IUCN Protected Area Management Categories

IUCN has defined a series of protected area management categories based on management objective. Definitions of these categories, and examples of each, are provided in *Guidelines for Protected Area Management Categories* (IUCN, 1994).
The six categories are:

Category Ia: STRICT NATURE RESERVE: protected area managed mainly for science

- **Definition:** Area of land and/or sea possessing some outstanding or representative ecosystems, geological or physiological features and/or species, available primarily for scientific research and/or environmental monitoring.

Category Ib : WILDERNESS AREA: protected area managed mainly for wilderness protection

- **Definition:** Large area of unmodified or slightly modified land, and/or sea, retaining its natural character and influence, without permanent or significant habitation, which is protected and managed so as to preserve its natural condition.

Category II : NATIONAL PARK: protected area managed mainly for ecosystem protection and recreation

- **Definition:** Natural area of land and/or sea, designated to (a) protect the ecological integrity of one or more ecosystems for present and future generations, (b) exclude exploitation or occupation inimical to the purposes of designation of the area and (c) provide a foundation for spiritual, scientific, educational, recreational and visitor opportunities, all of which must be environmentally and culturally compatible.

Category III : NATURAL MONUMENT: protected area managed mainly for conservation of specific natural features

- **Definition:** Area containing one, or more, specific natural or natural/cultural feature which is of outstanding or unique value because of its inherent rarity, representative or aesthetic qualities or cultural significance.

Category IV : HABITAT/SPECIES MANAGEMENT AREA: protected area managed mainly for conservation through management intervention

- **Definition:** Area of land and/or sea subject to active intervention for management purposes so as to ensure the maintenance of habitats and/or to meet the requirements of specific species.

Category V : PROTECTED LANDSCAPE/SEASCAPE: protected area managed mainly for landscape/seascape conservation and recreation

- **Definition:** Area of land, with coast and sea as appropriate, where the interaction of people and nature over time has produced an area of distinct character with significant aesthetic, ecological and/or cultural value, and often with high biological diversity. Safeguarding the integrity of this traditional interaction is vital to the protection, maintenance and evolution of such an area.

Category VI : MANAGED RESOURCE PROTECTED AREA: protected area managed mainly for the sustainable use of natural ecosystems

- **Definition:** Area containing predominantly unmodified natural systems, managed to ensure long term protection and maintenance of biological diversity, while providing at the same time a sustainable flow of natural products and services to meet community needs.

Where the site does not meet the internationally recognised definition of a protected area, application of a management category is not appropriate.

Annex III

Proposed Principles for Establishing Protected Areas and Implementing CPAN in Russia

- The use of various types of protected areas as a means of protecting Arctic species, habitats and ecosystems is a critical component of overall environmental protection
- Protected areas must be a component of a nature management system, be an integral component of a broader land-use system and interact with surrounding areas under exploitation.
- There needs to be an increase in the diversity and size of protected natural areas and better management to respond to increasing anthropogenic influences.
- Protected areas need to be geographically distributed to represent all large ecosystems, protect unique and vulnerable species and ecosystems, and to protect ecological corridors.
- The optimum number and distribution of protected areas is dependent on geographic location, landscape features, vulnerability, degree of human transformation, unique natural features
- In designated lands, conservation values shall be given preference over economic values.
- Protected areas will be established within and as part of a larger system of protected areas with all stakeholders interests taken into consideration.
- A variety of designations and protected area classifications will be applied (i.e. Biosphere Reserves, National Parks etc)
- Land for reserves and national parks shall be given freely and economic incentives will be used to promote area protection.
- CPAN will be implemented through goal-oriented planning, by combining central and regional efforts and through international co-ordination of national plans.

Annex IV

Description of data sets

A number of data sets were collected for this analysis. These data sets will be described briefly in this section. While these data have been important elements of the analysis their use will extends far beyond this work. It is believed that they will prove useful for both the CAFF and wider communities. It is anticipated that these data will be made available from the CAFF and UNEP/GRID-Arendal's web site.

Landscape Map

Full title:	Landscapes of the USSR
Scale:	1:2,500,000
Date of publication:	1980
Original production:	Ed.: Gudilin I.S.; Production: geological Association (Hydrospetsgeologia). Ministry of Geology of the USSR.
General description:	The map shows the regularities of landscape distribution within the former USSR, their bioclimatic, geological, geomorphological peculiarities and intra-landscape connections.
GIS data set name:	Landscape.e00
Format:	Arc/Info export format (.e00) – Polygon vector coverage

Wilderness Map: Apparent Naturalness Indicator: including VMAP0 release 3 data.

Full title:	Apparent Naturalness
Scale:	Approx. 1:1,000,000
Date of publication:	1999
Original production:	UNEP/GRID-Arendal, WCMC
General description:	The apparent naturalness indicator was used to provide an indication of the level of human impact on the landscape. It depicts distance measured away from features of human impact on the landscape. Human impact data includes roads, railroads, pipelines, settlement features, dams, power stations, airfields etc.
GIS data set name:	Appnat.e00
Format:	Arc/Info export format (.e00) – GRID raster format

Vertebrate communities of the Russian north (data on species types and species diversity)

Full title:	Vertebrate Animal Communities of the Russian North
Scale:	1:4,000,000
Date of publication:	Compiled 1995; no published
Original production:	Danilenko and Rumyantsev; MSU / Grid-Arendal /WCMC
General description:	Species by species information on the abundance of vertebrate animals. The abundance is estimated on a 5-grade scale and corresponds to the abundance of a species in a given habitat, compared with the known general variation of abundance.
GIS data set name:	VtbrCAFF
Format:	Arc/Info export format (.e00) – Polygon vector coverage

Fish species in the basins of the northern Russia

Full title:	Fish species in the basins of the northern Russia
Scale:	1:8,000,000
Date of publication:	Compiled 1998; not published
Source:	Lysenko I., Shilin N., Lomanov I; WCMC, All-Russian Institute for Nature Conservation, Wildlife Management Laboratory of the Ministry of Agriculture of the Russian Federation
General description:	Major river basins delineated for the CAFF area and related database listing all the freshwater fish species accordingly the presence in 60 catchment units
GIS data set name:	FishCAFF
Format:	Arc/Info export format (.e00) – Polygon vector coverage

Protected areas for the north of the Russian Federation

Full title:	Protected areas of the Russian Federation
Scale:	1:1,000,000
Date of publication:	1999
Source:	WCMC, GRID-Arendal, All-Russian Institute for Nature Conservation
General description:	Updated from CAFF 1996.
GIS data set name:	PA_CAFF
Format:	Arc/Info export format (.e00) – Polygon vector coverage

Red data book species

Full title:	Red Data Book of Russia, 1983, Mammals and Birds
Scale:	1:8,000,000
Date of publication:	1995
Original production:	WCMC
General description:	Species include: Mammals, Birds
GIS data set name:	REDSPCAFF
Format:	Arc/Info export format (.e00) – Polygon vector coverage

River basins

Full title:	The Northern Palaearctic Basins Digital Map
Scale:	1:1,000,000
Date of publication:	1999
Original production:	WCMC and WWF-Auen-Institute
General description:	Based on drainage data from DCW, 1571 catchment units.
GIS data set name:	BASS_PALE
Format:	Arc/Info export format (.e00) – Polygon vector coverage

Vegetation

Full title:	Vegetation Map of the USSR
Scale:	1:4,000,000
Date of publication:	1995
Original production:	1989
General description:	Contained information on vegetation at several levels of geobotanical classification
GIS data set name:	VEGET
Format:	Arc/Info export format (.e00) – Polygon vector coverage

ndvi

Full title:	Circumpolar Normalized Difference Vegetation Index (NDVI)
Scale:	1km * 1km resolution
Date of publication:	NDVI data taken from AVHRR 1992 data
Source :	NASA, NOAA, USGS. Data set downloaded from a USGS Alaska web site: (http://agdc.usgs.gov/data/projects/hlct/hlct.html)
General description:	The maximum NDVI reflects the maximum photosynthetic activity for the growing season.
GIS data set name:	ndvi_c.e00
Format:	Arc/Info export format (.e00) – GRID raster format

Productivity (bazil)

Full title:	Vegetation of the USSR
Scale:	1:8,000,000
Date of publication:	Updated in1990; not published version digitised in1995
Original production:	Original map – Lukicheva A., Sochava V.; update – Bazilevich N.
General description:	Descriptive information on vegetation formations and quantitative data on productivity and related parameters
GIS data set name:	BAZIL
Format:	Arc/Info export format (.e00) – Polygon vector coverage

Elevation

Full title:	Elevation map of CAFF Area in Russia
Scale:	1:1,000,000
Date of publication:	Recompiled in 1999 at WCMC, not published
Original production:	Source data - EROS Data Center, 1998
General description:	Simplified elevation model with the reduced umber of elevation classed and corrected coastline area data.
GIS data set name:	EleCAFF
Format:	Arc/Info export format (.e00) – GRID raster format

CAFF boundary:

Full title:	Limits of the Conservation of Arctic Flora and Fauna initiative consideration
Scale:	1:8,000,000
Date of publication:	1994
Original production:	1994 UNEP / GRID-Arendal
General description:	Digital boundary of CAFF
GIS data set name:	CAFF1994
Format:	Arc/Info export format (.e00) – Polygon vector coverage

Annex V

Data tables

Table 1. Administrative Provinces (Oblast', Kray, National Okrug) and Districts (Rayon) in CAFF extent in Russia.

N	ADMINISTRATIVE PROVINCE	DISTRICT	AREA, km^2	POPULATION Total	POPULATION Urban	POPULATION Farming	CAFF area, Km^2	CAFF area, Percent
1	Murmanskaya obl.	Apatity	3,417	84,500	84,300	200	3,417	100.0
2	Murmanskaya obl.	Kandalaksha	14,382	77,900	67,400	10,500	12,953	90.1
3	Murmanskaya obl.	Kirovsk	3,609	47,500	42,100	5,400	3,609	100.0
4	Murmanskaya obl.	Kol'skiy	28,328	72,900	46,800	26,100	28,328	100.0
5	Murmanskaya obl.	Kovdorskiy	4,066	35,800	30,000	5,800	4,066	100.0
6	Murmanskaya obl.	Lovozerskiy	53,376	17,800	13,200	4,600	53,376	100.0
7	Murmanskaya obl.	Monchegorsk	5,038	74,900	70,400	4,500	5,038	100.0
8	Murmanskaya obl.	Pechengskiy	9,031	58,000	48,200	9,800	9,031	100.0
9	Murmanskaya obl.	Severomorsk	4,343	96,300	89,000	7,300	4,343	100.0
10	Murmanskaya obl.	Terskiy	19,310	10,100	8,500	1,600	19,310	100.0
				Total Area in CAFF, Murmanskaya obl.			**143,471**	
11	Respublika Kareliya	Loukhskiy	22,542	24,900	14,300	10,600	1,277	5.7
				Total Area in CAFF, Respublika Kareliya			**1,277**	
12	Arkhangel'skaya obl.	Mezenskiy	34,410	17,900	10,300	7,600	80	0.2
				Total Area in CAFF, Arkhangel'skaya obl.			**80**	
13	Nenetskiy Autonomnyi Okrug	Nenetskiy a.o.	176,810	54,800	34,300	20,500	161,691	91.5
				Total Area in CAFF, Nenetskiy a.o.			**161,691**	
14	Respublika Komi	Inta	30,097	69,800	65,200	4,600	11,499	38.2
15	Respublika Komi	Usinskiy	30,564	17,800	5,900	11,900	11,707	38.3

16	Respublika Komi	Ust'-Tsilemskiy	42,511	17,200	-	17,200	5,812	13.7
17	Respublika Komi	Vorkuta	24,180	210,600	209,000	1,600	24,180	100.0
				Total Area in CAFF, Respublika Komi			**53,198**	
18	Yamalo-Nenetskiy a.o.	Krasnosel'kupskiy	106,759	8,500	-	8,500	14,626	13.7
19	Yamalo-Nenetskiy a.o.	Nadymskiy	137,190	26,500	16,700	9,800	60,513	44.1
20	Yamalo-Nenetskiy a.o.	Priural'skiy	65,991	6,800	-	6,800	54,315	82.3
21	Yamalo-Nenetskiy a.o.	Purovskiy	108,499	54,400	38,200	16,200	27,286	25.2
22	Yamalo-Nenetskiy a.o.	Shuryshkarskiy	61,774	9,300	-	9,300	12,352	20.0
23	Yamalo-Nenetskiy a.o.	Tazovskiy	174,344	17,000	5,900	11,100	174,344	100.0
24	Yamalo-Nenetskiy a.o.	Yamal'skiy	149,139	13,800	-	13,800	149,139	100.0
				Total Area in CAFF, Yamalo-Nenetskiy a.o.			**492,575**	
25	Taymyrskiy (Dolgano-Nenetskiy) a.o.	Diksonskiy	239,388	2,400	2,400	-	239,388	100.0
26	Taymyrskiy (Dolgano-Nenetskiy) a.o.	Dudinka	222,852	36,300	31,700	4,600	222,852	100.0
27	Taymyrskiy (Dolgano-Nenetskiy) a.o.	Khatangskiy	336,405	9,100	-	9,100	336,405	100.0
28	Taymyrskiy (Dolgano-Nenetskiy) a.o.	Ust'-Eniseyskiy	101,108	3,600	-	3,600	101,108	100.0
				Total Area in CAFF, Taymyrskiy (Dolgano-Nenetskiy) a.o.			**899,753**	
29	Aevenkiyskiy a.o.	Ilimpiyskiy	496,662	10,600	6,700	3,900	420,344	84.6
				Total Area in CAFF, Aevenkiyskiy a.o.			**420,344**	
30	Krasnoyarskiy kray	Igarka	17,990	20,900	20,500	400	17,990	100.0
31	Krasnoyarskiy kray	Turukhanskiy	164,830	17,900	-	17,900	47,691	28.9
				Total Area in CAFF, Krasnoyarskiy kray			**65,681**	
32	Irkutskaya obl.	Katangskiy	139,043	9,400	-	9,400	792	0.6
				Total Area in CAFF, Irkutskaya obl.			**792**	
33	Respublika Sakha (Yakutiya)	Abyiskiy	69,435	5,900	3,400	2,500	69,435	100.0

34	Respublika Sakha (Yakutiya)	Aeveno-Bytantayskiy Natsional'nyi	52,132	3,000	-	3,000	52,132	100.0
35	Respublika Sakha (Yakutiya)	Allaikhovskiy	107,338	5,200	3,900	1,300	107,338	100.0
36	Respublika Sakha (Yakutiya)	Anabarskiy Natsional'nyi	51,996	4,000	-	4,000	51,996	100.0
37	Respublika Sakha (Yakutiya)	Bulunskiy	223,583	14,600	9,700	4,900	223,583	100.0
38	Respublika Sakha (Yakutiya)	Kobyayskiy	107,789	19,000	8,400	10,600	87,496	81.2
39	Respublika Sakha (Yakutiya)	Mirninskiy	165,779	53,000	47,800	5,200	107,277	64.7
40	Respublika Sakha (Yakutiya)	Momskiy Natsional'nyi	104,627	5,800	-	5,800	104,627	100.0
41	Respublika Sakha (Yakutiya)	Namskiy	11,870	19,200	-	19,200	130	1.1
42	Respublika Sakha (Yakutiya)	Nizhnekolymskiy	87,118	11,700	9,200	2,500	87,118	100.0
43	Respublika Sakha (Yakutiya)	Nyurbinskiy	52,436	30,000	12,500	17,500	48,208	91.9
44	Respublika Sakha (Yakutiya)	Olenekskiy Natsional'nyi	321,539	4,300	-	4,300	321,539	100.0
45	Respublika Sakha (Yakutiya)	Oymyakonskiy	92,255	29,500	20,400	9,100	58,972	63.9
46	Respublika Sakha (Yakutiya)	Srednekolymskiy	125,161	10,000	4,800	5,200	125,161	100.0
47	Respublika Sakha (Yakutiya)	Suntarskiy	57,804	27,100	-	27,100	20,666	35.8
48	Respublika Sakha (Yakutiya)	Tattinskiy	18,984	17,200	-	17,200	1,150	6.1
49	Respublika Sakha (Yakutiya)	Tomponskiy	135,844	21,300	12,100	9,200	113,146	83.3
50	Respublika Sakha (Yakutiya)	Ust'-Aldanskiy	18,276	22,600	-	22,600	4,721	25.8
51	Respublika Sakha (Yakutiya)	Ust'-Yanskiy	120,278	31,100	25,600	5,500	120,278	100.0
52	Respublika Sakha (Yakutiya)	Verkhnekolymskiy	67,774	9,300	6,300	3,000	67,774	100.0
53	Respublika Sakha (Yakutiya)	Verkhnevilyuyskiy	42,050	21,600	-	21,600	17,630	41.9
54	Respublika Sakha (Yakutiya)	Verkhoyanskiy	189,726	20,400	11,900	8,500	189,726	100.0
55	Respublika Sakha (Yakutiya)	Vilyuyskiy	55,193	28,900	15,200	13,700	34,415	62.4
56	Respublika Sakha (Yakutiya)	Zhiganskiy	140,222	5,700	-	5,700	140,222	100.0
		Total Area in CAFF, Respublika Sakha (Yakutiya)					**2,154,740**	
57	Magadanskaya obl.	Omsukchanskiy	60,413	15,000	14,100	900	37,578	62.2
58	Magadanskaya obl.	Severo-Aevenskiy	102,022	7,400	3,900	3,500	102,022	100.0
59	Magadanskaya obl.	Srednekanskiy	91,818	13,100	7,800	5,300	82,439	89.8

60	Magadanskaya obl.	Susumanskiy	46,766	37,700	29,800	7,900	38,492	82.3
61	Magadanskaya obl.	Ten'kinskiy	35,578	20,000	9,200	10,800	4,864	13.7
62	Magadanskaya obl.	Yagodninskiy	29,557	41,700	30,600	11,100	21,234	71.8
				Total Area in CAFF, Magadanskaya obl.			**286,629**	
63	Koryakskiy a.o.	Karaginskiy	40,641	9,200	5,200	4,000	40,641	100.0
64	Koryakskiy a.o.	Olyutorskiy	72,352	12,000	4,700	7,300	13,805	19.1
65	Koryakskiy a.o.	Penzhinskiy	116,086	5,000	-	5,000	116,086	100.0
				Total Area in CAFF, Koryakskiy a.o.			**170,532**	
66	Chukotskiy a.o.	Anadyrskiy	246,375	14,200	5,500	-	246,375	100.0
67	Chukotskiy a.o.	Beringovskiy	37,520	7,500	5,900	1,600	37,520	100.0
68	Chukotskiy a.o.	Bilibinskiy	173,747	23,700	16,100	7,600	173,747	100.0
69	Chukotskiy a.o.	Chaunskiy	57,650	24,700	19,300	5,400	57,650	100.0
70	Chukotskiy a.o.	Chukotskiy	29,819	6,100	-	6,100	29,819	100.0
71	Chukotskiy a.o.	Iul'tinskiy	72,149	12,700	8,600	4,100	72,149	100.0
72	Chukotskiy a.o.	Providenskiy	27,093	8,400	4,300	4,100	27,093	100.0
73	Chukotskiy a.o.	Shmidtovskiy	70,328	12,700	10,400	2,300	70,328	100.0
				Total Area in CAFF, Chukotskiy a.o.			**714,681**	

Table 2. List of Existing and Proposed Protected Areas Mapped for the CAFF region in Russia (some PA mapped were found outside of CAFF extent).

	Protected Area	Category	Area, km^2	Number of sites mapped	Status	Located in CAFF area?	Creation status
Murmanskaya oblast							
1	Laplandsky	Biosphere Reserve	2784.360	1	International	Yes	
2	Kandalaksha Bay	RAMSAR Site	2080.000	1	International	Yes	
3	Lumbovskiy Bolotnyi Krai	RAMSAR Site (project)	3000.000	1	International	Yes	- project
4	Iolga	National Park (project)	3000.000	1	Federal	Yes	- project
5	Khibiny	National Park (project)	2000.000	1	Federal	Yes	- project
6	Kutsa	National Park (project)	700.000	1	Federal	Yes	- project
7	Terskiy Bereg	National Park (project)	2500.000	1	Federal	Yes	- project
8	Kandalakshskiy	Zapovednik	705.270	14	Federal	Yes	
9	Pasvik	Zapovednik	147.270	1	Federal	Yes	
10	Murmanskiy Tundrovyi	Zapovednik (project)	2950.000	1	Federal	Yes	- project
11	Girvasskiy	Zakaznik	1277.000	1	Regional	Yes	
12	Kanozerskiy	Zakaznik	656.000	1	Regional	Yes	
13	Kolvitskiy	Zakaznik	436.000	1	Regional	Yes	
14	Kutsa	Zakaznik	520.000	1	Regional	Yes	
15	Murmanskiy	Zakaznik	2950.000	1	Regional	Yes	
16	Na reke Nota	Zakaznik	158.000	1	Regional	Yes	
17	Na reke Ponoi	Zakaznik	986.000	1	Regional	Yes	
18	Na reke Varzuga	Zakaznik	386.800	1	Regional	Yes	
19	Oriyarvi	Zakaznik	794.300	1	Regional	Yes	
20	Pirengskiy	Zakaznik	456.000	1	Regional	Yes	
21	Ponoiskiy	Zakaznik	1500.000	1	Regional	Yes	
22	Saei`dozero	Zakaznik	174.000	1	Regional	Yes	
23	Tulomskiy	Zakaznik	337.000	1	Regional	Yes	
24	Vuvskiy	Zakaznik	172.500	1	Regional	Yes	
25	Alla-Akkayarvee	Zakaznik (project)	2200.000	1	Regional	Yes	- project

26	Kaito-Ensyi	Zakaznik (project)	2400.000	1	Regional	Yes	- project
27	Kandalakshskiy Bereg	Zakaznik (project)	2450.000	1	Regional	Yes	- project
28	Kano-Umbskiy	Zakaznik (project)	3500.000	1	Regional	Yes	- project
29	Kanozerskiy	Zakaznik (project)	900.000	1	Regional	Yes	- project
30	Laplandskiy Les	Zakaznik (project)	5500.000	1	Regional	Yes	- project
31	Tenniyokee	Zakaznik (project)	500.000	1	Regional	Yes	- project
32	Tulomskiy (Varzinskiy)	Zakaznik (project)	250.000	1	Regional	Yes	- project
33	Amazonity gory Parusnaya	Nature Monument	0.010	1	Regional	Yes	
34	Ametisty mysa Korabl`	Nature Monument	0.008	1	Regional	Yes	
35	Arniki u oz.Pal`ga	Nature Monument	0.010	1	Regional	Yes	
36	Astrofillity gory Eveslogchorr	Nature Monument	0.040	1	Regional	Yes	
37	Astry i myaty na gore Punkuruaei`v	Nature Monument	0.050	1	Regional	Yes	
38	Baraniy lob u oz.Semenovskoe	Nature Monument	0.005	1	Regional	Yes	
39	Bazal`tovidnye lavy u Rizsh guby	Nature Monument	0.090	1	Regional	Yes	
40	Biogruppa Elei na granice areala	Nature Monument	0.005	1	Regional	Yes	
41	Ekostrovskoe kintische	Nature Monument	1.000	1	Regional	Yes	
42	Enkalipty perevala Juksporlak	Nature Monument	0.030	1	Regional	Yes	
43	Epidozity mysa Verhniy navolok	Nature Monument	0.070	1	Regional	Yes	
44	Evtrofnoe boloto	Nature Monument	0.100	1	Regional	Yes	
45	Fljuority Elokorgovskogo navoloka	Nature Monument	0.020	1	Regional	Yes	
46	Gorechavka i tim`yan v doline r.Kitkuai	Nature Monument	0.030	1	Regional	Yes	
47	Granitoidy ostrova Mikkov	Nature Monument	0.100	1	Regional	Yes	
48	Grozdovniki p-ova Turiy	Nature Monument	0.010	1	Regional	Yes	
49	Kedr sibirskiy v Nikel`skom lesnichestve	Nature Monument	0.002	1	Regional	Yes	
50	Kedry i listvennicy vozle st.Hibiny	Nature Monument	0.020	1	Regional	Yes	
51	Kedry na r.Zapadnaya Lica	Nature Monument	0.000	1	Regional	Yes	
52	Kedry u lesnogo kordona Krivec	Nature Monument	0.020	1	Regional	Yes	
53	Kedry u oz.Nyamozero	Nature Monument	0.050	1	Regional	Yes	
54	Kedry urochischa Okunevoe	Nature Monument	0.200	1	Regional	Yes	
55	Kedry v Kovdskom lesnichestve	Nature Monument	0.020	1	Regional	Yes	
56	Kizil`niki gory Flora	Nature Monument	0.100	1	Regional	Yes	

57	Komsozero	Nature Monument	0.500	1	Regional	Yes
58	Kriptogrammovoe uschel`e	Nature Monument	0.010	1	Regional	Yes
59	Lechebnye gryazi Palkinskoi guby	Nature Monument	4.000	1	Regional	Yes
60	Lednikovy valun	Nature Monument	0.000	1	Regional	Yes
61	Listvennichnaya roscha Taei`boly	Nature Monument	0.020	1	Regional	Yes
62	Listvennicy sibirskie u pos.Revda	Nature Monument	0.120	1	Regional	Yes
63	Listvennicy sibirskie v Kovdskom lesnichestve	Nature Monument	0.020	1	Regional	Yes
64	Listvennicy u Nizshnetulomskogo vodohranilischa	Nature Monument	0.060	1	Regional	Yes
65	Maki uschel`ya Indichei`ok	Nature Monument	0.010	1	Regional	Yes
66	Mozshzshevel`niki vozvyshennosti Magazin-Musjur	Nature Monument	30.000	1	- Unknown	Yes
67	Naskal`nye risunki	Nature Monument	0.010	1	Regional	Yes
68	Osinovaya roscha	Nature Monument	0.020	1	Regional	Yes
69	Ozero Mogil`noe	Nature Monument	0.170	1	Regional	Yes
70	Pechenochniki v uschel`e Aei`kuaei`venchorr	Nature Monument	0.020	1	Regional	Yes
71	Pegmatity gory Maly Punkuruaei`v	Nature Monument	0.020	1	Regional	Yes
72	Roscha Eei`hfel`da	Nature Monument	0.003	1	Regional	Yes
73	Sosny dolgozshiteli	Nature Monument	0.020	1	Regional	Yes
74	Sosny na granice areala	Nature Monument	0.050	1	Regional	Yes
75	Uchastok kedra iskustvennogo proishozshdeniya	Nature Monument	0.005	1	Regional	Yes
76	Uchastok lesnyh kul`tur listvennicy sibirskoi	Nature Monument	0.056	1	Regional	Yes
77	Uchastok lesnyh kul`tur listvennicy sibirskoi iskustvennogo proishozshdeniya	Nature Monument	0.009	1	Regional	Yes
78	Vodopad na r.Chapoma	Nature Monument	0.500	1	Regional	Yes
79	Vodopad na r.Chavan`ga	Nature Monument	1.000	1	Regional	Yes
80	Vodopad na r.Shuoniei`oki	Nature Monument	0.010	1	Regional	Yes
81	Zalezsh Jubileei`naya	Nature Monument	0.005	1	Regional	Yes
82	Kandalakshskogo leshoza	Dendrological Park	0.019	1	- Unknown	Yes
83	Lovozero	Geophisical Station	0.040	1	- Unknown	Yes
84	Polyarno-al`piei`skiy sad-institut [illegible]	Botanical Garden	16.700	1	- Unknown	Yes

	Kol`skogo nauchnogo centra PAN						
85	Shuoni-Kuets	Geology-geophisical Polygon	3.000	1	- Unknown	Yes	
	Karelia Republic						
86	Paanayarvi	National Park	1033.000	1	Federal	No	
87	Keretskiy	Zakaznik	210.000	1	Regional	No	
88	Polyarny krug	Zakaznik	283.000	1	Regional	Yes	
89	Nyatyatunturee	Zakaznik (project)	84.000	1	Regional	Yes	- project
		Nenetskyi national okroug					
94	Novozemel'siy	Zapovednik (project)	5870.000	2	Federal	Yes	- project
95	Franz Josef Land	Federal Zakaznik	42000.000	1	Federal	Yes	
97	Shoinskiy	Zakaznik	164.000	1	Regional	Yes	
99	Gusinaya Zemlya	Zakaznik (project)	1820.000	1	- Unknown	Yes	- project
100	Karskiye Vorota	Zakaznik (project)	2400.000	1	- Unknown	Yes	- project
101	Lagernoye	Zakaznik (project)	40.000	1	- Unknown	Yes	- project
103	Oranskie Ostrova	Zakaznik (project)	110.000	1	Regional	Yes	- project
90	Indigirskiye Samotsvety	National Park (project)	5000.000	1	Federal	Yes	- project
91	Nenetsky	Zapovednik	3134.000	12	Federal	Yes	
92	Bolshezemel'skiy	Zapovednik (project)	6627.500	1	Federal	Yes	- project
93	Moree-U	Zapovednik (project)	1485.937	1	Federal	Yes	- project
96	Nenetsky	Zakaznik	4400.000	2	Regional	Yes	
98	Vaei`gachskiy	Zakaznik	3330.000	6	Regional	Yes	
102	Nizhnepechorskiy	Zakaznik (project)	346.000	1	- Unknown	Yes	- project
104	Canyon Bol`shie vorota	Nature Monument	2.120	1	Regional	Yes	
105	Pustozerskiy	Historical-Natural Museum	49.930	1	- Unknown	Yes	
	Komi Republic						
106	Adak	Zakaznik	30.000	1	Regional	No	
107	Boloto Hopkovskoe i Kletchatoe	Zakaznik	55.000	1	Regional	No	
108	Boloto bez nazvaniya v 46 km vyshe der.Kolva po r.Kolva	Zakaznik	3.000	1	Regional	No	
109	Chukchinskoe	Zakaznik	80.000	1	Regional	No	
110	Enganepe	Zakaznik	7.900	1	Regional	Yes	
111	Haiminskiy	Zakaznik	2.250	1	Regional	No	

112	Hrebtovy	Zakaznik	40.000	1	Regional	Yes
113	Kosminskiy	Zakaznik	25.000	1	Regional	No
114	Lar'kovskoe	Zakaznik	140.000	1	Regional	No
115	Nebesa-njur	Zakaznik	16.000	1	Regional	No
116	Novoborskiy	Zakaznik	0.000	3	Regional	Yes
117	Okean	Zakaznik	1789.750	1	Regional	Yes
118	Pon'ju-Zaostrennaya	Zakaznik	70.200	1	Regional	No
119	Putanye ozera	Zakaznik	10.000	1	Regional	Yes
120	Sula-Har'yaginskiy	Zakaznik	65.000	1	Regional	Yes
121	Usinskiy	Zakaznik	78.000	1	Regional	No
122	Usy i Un'-Yagi (Sistema bugristyh bolot mezshdurech'ya)	Zakaznik	30.000	1	Regional	Yes
123	Verhnetsilemskiy	Zakaznik	0.132	1	Regional	No
124	Adz'vinskiy	Nature Monument	0.000	1	Regional	No
125	Gora Olysya	Nature Monument	0.000	1	Regional	No
126	Junyahaty	Nature Monument	0.250	1	Regional	Yes
127	Kedr na ostrove Medvezshiy	Nature Monument	0.000	1	Regional	No
128	Lemvinskiy	Nature Monument	0.360	1	Regional	No
129	Listvennichnoe	Nature Monument	1.200	1	Regional	No
130	Parnoka-Ju	Nature Monument	0.150	1	Regional	No
131	Pemboi	Nature Monument	0.000	1	Regional	Yes
132	Sharjuskiy	Nature Monument	0.000	1	Regional	No
133	Skala Kol'cko	Nature Monument	0.000	1	Regional	No
134	Srednie vorota r.Sharju	Nature Monument	0.000	1	Regional	No
135	U fermy Un'-Yaga	Nature Monument	1.000	1	Regional	Yes
136	Vodopad na r.Hal'merju	Nature Monument	0.000	1	Regional	Yes
137	Vorkutinskiy	Nature Monument	0.200	1	Regional	Yes
138	Listvennicke sibirskoy	Genetical Preserve	0.000	1	- Unknown	No
		Yamalo-Nenetsky autonom okroug				
139	Islands in the Gulf of Ob	RAMSAR Site	1280.000	1	International	Yes
140	Gydanskiy	Zapovednik	8781.740	6	Federal	Yes
141	Gydanskiy (Buffer Zone)	Buffer Zone (Zapovednik)	1009.289	1	Federal	Yes

142	Kunovatskiy	Federal Zakaznik	2200.000	2	Federal	No	
143	Nadymskiy	Federal Zakaznik	5640.000	1	Federal	Yes	
144	Nizshne-Obskiy gosudarstvenny (respublikanskiy) zakaznik (VBUMZ) (Fed.)	Federal Zakaznik	1280.000	1	Federal	Yes	
145	Chasel'skiy	Zakaznik	920.000	1	Regional	No	
146	Evo-Yahinskiy	Zakaznik	1200.000	1	Regional	Yes	
147	Messo-Yahinskiy	Zakaznik	1035.000	1	Regional	Yes	
148	Sobty-Juganskiy	Zakaznik	1750.000	1	Regional	Yes	
149	Tydy-Ottinskiy	Zakaznik	400.000	1	Regional	No	
150	Yamal'skiy	Zakaznik	14020.000	3	Regional	Yes	
151	Synsko-Voikarskaya etnicheskaya territoriya	Ethnic Territory	14249.335	1	- Unknown	Yes	
	Taymyrsky national okroug						
152	Brekhovskiye Islands in the mouth of the Yenisei River	RAMSAR Site	7416.654	1	International	Yes	
153	Gorbita Delta	RAMSAR Site	0.000	1	International	Yes	
154	Watershed and Valleys of the Pura and Mokoritto Rivers	RAMSAR Site	25714.754	1	International	Yes	
155	Great Arctic	Zapovednik	41692.220	27	Federal	Yes	
156	Putoransky	Zapovednik	13633.210	1	Federal	Yes	
157	Taimyrsky	Zapovednik	17819.280	4	Federal	Yes	
158	Purinskiy	Federal Zakaznik	7875.000	1	Federal	Yes	
159	Severozemel`skiy	Federal Zakaznik	4217.010	4	Federal	Yes	
160	Bikada	Zakaznik	9377.600	1	Regional	Yes	
	Krasnoyarsky kray						
161	Ledyanaya Gora	Nature Monument	29.000	1	Regional	Yes	
162	Muzei vechnoi merzloty	Nature Monument	0.000	1	Regional	Yes	
163	Severozemel`skiy	Nature Monument	1.000	1	Regional	No	
		Aevenkiysky national okroug					
164	Putoransky	Zapovednik	5239.300	1	Federal	Yes	
165	Geographical Centre of the Russian Federation	Nature-historical Monument	118.590	1	Regional	Yes	
	Jakutia (Sakha) Republic						
166	Kolyma	Nature Park (project)	11868.870	1	Regional	Yes	- project

167	Momsky	Nature Park (project)	21750.000	1	Regional	Yes	- project
168	Ust'Lensky	Zapovednik	14330.000	2	Federal	Yes	
169	- Olenek-Anabar (unclear data)	Extension of zapovednik	22829.650	1	- Unknown	Yes	- project
170	Great Siberian Polynia	Extension of zapovednik	30684.168	11	- Unknown	Yes	- project
171	Peschany Island	Extension of zapovednik	160.397	1	- Unknown	Yes	- project
172	Yana Delta	Extension of zapovednik	3697.186	1	- Unknown	Yes	- project
173	- Unknown	Zakaznik	679.648	1	Regional	Yes	
174	Beloozersky	Zakaznik	632.000	1	Regional	No	
175	Belyanka	Zakaznik	1756.711	1	Regional	Yes	
176	Chaigurgino	Zakaznik	23756.000	1	Regional	Yes	
177	Djelinde	Zakaznik	3234.042	1	Regional	Yes	
178	Dzhunkun	Zakaznik	2000.000	1	Regional	No	
179	Echy	Zakaznik	951.971	1	Regional	Yes	
180	Eselyakh	Zakaznik	16445.722	1	Regional	Yes	
181	Gorny	Zakaznik	6893.652	1	Regional	Yes	
182	Kele	Resource Reservate	4500.000	1	Regional	Yes	
183	Khaltysy	Zakaznik	1223.414	1	Regional	Yes	
184	Kharbaiy	Resource Reservate	326.000	1	Regional	No	
185	Kolyma Delta	Zakaznik	19731.695	1	Regional	Yes	
186	Kresty	Zakaznik	3011.999	1	Regional	Yes	
187	Kuchus	Zakaznik	639.150	1	Regional	Yes	
188	Kytalyk	Resource Reservate	16070.000	6	Regional	Yes	
189	Lena Delta	Zakaznik	11568.216	3	Regional	Yes	
190	Nelgeze	Zakaznik	2363.210	1	Regional	Yes	
191	Ochuma	Zakaznik	6150.000	1	Regional	Yes	
192	Omoloy	Resource Reservate	3325.000	1	Regional	Yes	
193	Ozhogino	Resource Reservate	2412.500	1	Regional	Yes	
194	Prialdansky	Zakaznik	5477.174	1	Regional	Yes	
195	Saylyk	Zakaznik	246.000	1	Regional	Yes	
196	Sededema	Zakaznik	650.000	1	Regional	Yes	
197	Suntar-Khayata	Resource Reservate	631.000	1	Regional	Yes	

198	Suoturuokha	Resource Reservate	5000.000	1	Regional	Yes	
199	Sylgy-Ytar	Zakaznik	140.000	1	Regional	Yes	
200	Timirdiken	Zakaznik	5200.000	1	Regional	Yes	
201	Tomporuk	Zakaznik	2856.000	1	Regional	Yes	
202	Troitskoe	Zakaznik	50.800	1	Regional	Yes	
203	Uguannja	Zakaznik	1856.000	1	Regional	Yes	
204	Undulung	Zakaznik	7156.000	1	Regional	Yes	
205	Ust'-Vilyuisky	Zakaznik	10160.000	1	Regional	Yes	
206	Verkhne-Indigirsky	Zakaznik	7000.000	1	Regional	Yes	
207	Zhirkovo	Zakaznik	110.000	1	Regional	Yes	
208	- Unknown	Extension of zakaznik	12866.149	1	- Unknown	Yes	- project
209	Emandzha	Extension of zakaznik	3555.198	1	- Unknown	Yes	- project
210	Bolshoe Morskoe Lake	Protected Landscape	382.000	1	Regional	Yes	
211	Buranattalakh Lake	Protected Landscape	172.000	1	Regional	No	
212	Buustaakh Lake	Protected Landscape	1640.000	1	Regional	Yes	
213	Chukoche Lake	Protected Landscape	190.285	1	- Unknown	Yes	
214	Dzhengkude Lake	Protected Landscape	570.000	1	Regional	Yes	
215	Labuda Lake	Protected Landscape	94.900	1	Regional	No	
216	Labunkur Lake	Protected Landscape	943.000	1	Regional	No	
217	Mastah Lake	Protected Landscape	27.600	1	Regional	Yes	
218	Nidjili Lake	Protected Landscape	1010.000	1	Regional	No	
219	Sebian-Kue Lake	Protected Landscape	0.000	1	- Unknown	Yes	
220	Siegemde Lake	Protected Landscape	40.000	1	Regional	Yes	
221	Sualakh Lake	Protected Landscape	28.100	5	Regional	Yes	
222	Ulakhan-Kuel (1)	Protected Landscape	265.000	1	Regional	Yes	
223	Ulakhan-Kuel (2)	Protected Landscape	39.600	1	Regional	Yes	
224	Ebien Mas	Nature Monument	0.000	1	- Unknown	Yes	
225	Kikhi Taas	Nature Monument	0.000	1	- Unknown	Yes	
226	Kisilyakh	Nature Monument	0.000	1	- Unknown	Yes	
227	Mat Gora	Nature Monument	0.000	1	- Unknown	Yes	
228	Merchimden	Nature Monument	0.000	1	- Unknown	Yes	

229	Namy	Nature Monument	0.000	1	- Unknown	Yes	
230	Sengku	Nature Monument	0.000	1	- Unknown	Yes	
231	Seveke	Nature Monument	0.000	1	- Unknown	Yes	
232	Suruktakh	Nature Monument	0.000	1	- Unknown	Yes	
233	Tangalakh	Nature Monument	0.000	1	- Unknown	Yes	
234	Alakit	Local Nature Reserve	17359.414	1	- Unknown	Yes	- project
235	Alazea	Local Nature Reserve	8032.033	1	- Unknown	Yes	- project
236	Badiariha	Reserved Territory	3000.000	1	Regional	Yes	- project
237	Baraya	Reserved Territory	750.000	1	Regional	Yes	- project
238	Beke	Reserved Territory	16000.000	1	Regional	Yes	- project
239	Edgen	Reserved Territory	1650.000	1	Regional	No	- project
240	Ergedjey	Reserved Territory	2117.750	1	Regional	No	- project
241	Kytalyk	Resource Reservate (Reserved zone)	-1.000	2	Regional	Yes	- project
242	Medvezhie Ostrova	Reserved Territory	60.000	1	Regional	Yes	- project
243	Muna	Reserved Territory	25000.000	1	Regional	Yes	- project
244	Muru	Reserved Territory	348.440	1	Regional	No	- project
245	Nenneli	Local Nature Reserve	1142.946	1	- Unknown	Yes	- project
246	Oldjo	Local Nature Reserve	5254.300	1	- Unknown	Yes	- project
247	Oner	Reserved Territory	107.000	1	Local	No	- project
248	Orulgan-Sys	Reserved Territory	9217.000	1	Regional	Yes	- project
249	Ozhogino Basin	Reserved Territory	7704.000	1	Regional	Yes	- project
250	Shangina	Reserved Territory	2000.000	1	Regional	Yes	- project
251	Solokut	Local Nature Reserve	4069.917	1	- Unknown	Yes	- project
252	Sugzher	Reserved Territory	2500.000	1	Regional	Yes	- project
253	Tebulyakh	Local Nature Reserve	465.220	1	- Unknown	Yes	- project
254	Terpei-Tumus	Reserved Territory	11120.000	1	Regional	Yes	- project
255	Tommot	Reserved Territory	3429.760	1	Regional	Yes	- project
256	Tukulan	Local Nature Reserve	5594.928	1	- Unknown	Yes	- project
257	Tuostakh	Reserved Territory	5000.000	1	Regional	Yes	- project
258	Tyukyan	Reserved Territory	7400.000	1	Regional	Yes	- project
259	Vilyuisky	Reserved Territory	3000.000	1	Regional	Yes	- project

260	Yasachnaya	Reserved Territory	7704.000	1	Regional	Yes	- project
	Magadanskaya oblast						
261	Magadansky	Zapovednik	8838.050	1	Federal	Yes	
262	Burgali	Zakaznik	1045.000	1	Regional	Yes	
263	Hinike	Zakaznik	3700.000	1	Regional	No	
264	Kubaka	Zakaznik	2800.000	1	Regional	Yes	
265	Omolonskiy	Zakaznik	1597.000	1	Regional	Yes	
266	Sugoi	Zakaznik	1526.830	1	Regional	Yes	
267	Taeigonos	Zakaznik	3500.000	1	Regional	Yes	
	Koryaksky national okroug						
268	Karaginski Island	RAMSAR Site	1935.970	1	International	Yes	
269	Parapol Valley	RAMSAR Site	18900.000	1	International	Yes	
270	Koryaksky	Zapovednik	3271.560	3	Federal	Yes	
271	Koryaksky (Buffer Zone)	Buffer Zone (Zapovednik)	6326.000	4	Federal	Yes	
272	Ostrov Karaginskiy	Zakaznik	2000.000	1	Regional	Yes	
273	Ostrov Verhoturova	Zakaznik	8.000	1	Regional	Yes	
274	Reka Belaya	Zakaznik	900.000	1	Regional	Yes	
275	Severo- Ayankinskiy listvennichny	Zakaznik	620.000	1	Regional	Yes	
	Chukotsky national okroug						
276	Wrangel Island (Marine Part)	Zapovednik	14300.000	2	Federal	Yes	
277	Wrangel Island	Zapovednik	7956.500	9	Federal	Yes	
278	Lebediny	Federal Zakaznik	2605.600	1	Federal	Yes	
279	Avtotkuul'	Zakaznik	2500.000	1	Regional	Yes	
280	Chaunskaya Guba	Zakaznik	2105.000	2	Regional	Yes	
281	Omolonskiy	Zakaznik	320.000	1	Regional	Yes	
282	Tumanskiy	Zakaznik	3980.000	1	Regional	Yes	
283	Tundrovy	Zakaznik	5000.000	1	Regional	Yes	
284	Ust'-Tanjurerckiy	Zakaznik	4155.000	1	Regional	Yes	
285	Achchen	Nature Monument	35.000	1	Regional	Yes	
286	Aeionskiy	Nature Monument	0.130	1	Regional	Yes	
287	Amguemskiy	Nature Monument	0.270	1	Regional	Yes	

288	Anjueickiy	Nature Monument	125.000	1	Regional	Yes
289	Berezovskiy	Nature Monument	0.230	1	Regional	Yes
290	Chaplinskiy	Nature Monument	0.090	1	Regional	Yes
291	Chegitun'skiy	Nature Monument	0.200	1	Regional	Yes
292	Kljuchevoi	Nature Monument	0.210	1	Regional	Yes
293	Mechigmenskiy	Nature Monument	0.170	1	Regional	Yes
294	Ozero El'gygytgyn	Nature Monument	3.500	1	Regional	Yes
295	Palyavaamskiy	Nature Monument	0.190	1	Regional	Yes
296	Pegtymel'skiy	Nature Monument	0.110	1	Regional	Yes
297	Pekul'neeiskiy	Nature Monument	0.370	1	Regional	Yes
298	Pineeiveemskiy	Nature Monument	0.230	1	Regional	Yes
299	Rauchuagytgyn	Nature Monument	5.730	1	Regional	Yes
300	Routan	Nature Monument	0.190	1	Regional	Yes
301	Termal'ny	Nature Monument	0.310	1	Regional	Yes
302	Tnekveemskaya poscha	Nature Monument	0.370	1	Regional	Yes
303	Utiny	Nature Monument	0.700	1	Regional	Yes
304	Vostochny	Nature Monument	0.230	1	Regional	Yes

Table 3. Total Area of Major Ecosystem Types in Russian Arctic and Protection by Specially Designated Sites (IUCN Category I – VI).

N	Ecosystem Type	Area, km^2	Protected Areas, km^2	Protected, Percent
1	Arctic (polar) deserts	27,837	4,769	17.1
2	Arctic tundra	269,420	67,123	24.9
3	Mountain arctic tundra	137,094	15,332	10.6
4	Subarctic tundra	1,009,278	113,841	11.3
5	Forest tundra	411,026	10,268	2.5
6	Mountain tundra	1,594,391	83,298	5.2
7	Mountain sparsed forests	520,712	21,529	4.1
8	Taiga forests	1,181,579	66,233	5.6
9	Mountain taiga forests	92,912	75	0.1
10	Mountain arctic (polar) deserts	61,425	2,777	5.4
11	Mountain sparsed forests and elfinwood	79,982	8,698	10.9
12	Glaciers	56,412	15,062	26.7
	Total for terrestrial part of Arctic	**5,442,068**	**409,005**	**7.52**
	Major inland waters bodies in CAFF Area	33,466	4,665	13.9
	Marine part of Protected Areas		172,997	

Table 4. Total Area of River Basins in Russian Arctic and Protection by Specially Designated Sites (IUCN Category I – VI).

N	NAME (Indeces with numbers – no data on name)	Number of sub- units considered	Area, km^2 in CAFF region	Protected Area, km^2	Protected Area, %	Oceanic Basin	Basin Type
1	Lena	16	714965.2800	73982.5500	10.3500	Arctic (Asia)	Basin Unit
2	Kolyma	18	567477.2400	36141.3900	6.3700	Arctic (Asia)	Basin Unit
3	Yenisey	24	445521.3100	9262.0800	2.0800	Arctic (Asia)	Basin Unit
4	Indigirka	13	327494.6200	27652.9000	8.4400	Arctic (Asia)	Basin Unit
5	Khatanga	11	299247.8800	10823.6800	3.6200	Arctic (Asia)	Basin Unit
6	Yana	9	234157.3400	6271.5800	2.6800	Arctic (Asia)	Basin Unit
7	Olenek	4	218317.7000	3.5500	0.0000	Arctic (Asia)	Basin Unit
8	Anadyr'	9	186994.1400	6183.8600	3.3100	Pacific	Basin Unit
9	Pyasina	4	186534.9000	34459.2000	18.6148	Arctic (Asia)	Basin Unit
10	Anabar	3	127575.6900	36.2400	0.0300	Arctic (Asia)	Basin Unit
11	Taimyr Lake	7	126154.2900	26540.9400	20.9200	Arctic (Asia)	Lake
12	Petchora	14	104246.8100	1253.3000	1.2000	Arctic (Europe)	Basin Unit
13	Penzhina	6	73715.5700	10039.5000	13.6200	Pacific	Basin Unit
14	Alazeya	2	65405.7800	3458.9400	5.2900	Arctic (Asia)	Basin Unit
15	Ob	9	54834.5600	843.4600	1.5400	Arctic (Asia)	Basin Unit
16	Khatyrka	1	54502.8900	5147.6400	9.4400	Pacific	Group of small river basins
17	Peepeeguy	4	48147.6400	0.0000	0.0000	Arctic (Asia)	Basin Unit
18	Pegtymel'	1	45630.5600	0.1100	0.0000	Arctic (Asia)	Group of small river basins
19	Rauchua	1	40382.1500	121.2300	0.3000	Arctic (Asia)	Group of small river basins
20	Taz	3	39374.2900	0.0000	0.0000	Arctic (Asia)	Basin Unit
21	Kanchalan	1	38965.2400	0.3700	0.0000	Pacific	Basin Unit
22	Velikaya	1	38226.9300	4966.8600	12.9900	Pacific	Basin Unit
23	Amguaema	1	33282.2800	0.5000	0.0000	Arctic (Asia)	Basin Unit
24	Omoloi	1	33205.3600	521.1300	1.5700	Arctic (Asia)	Basin Unit
25	Pakhacha	1	33177.0400	3746.2600	11.2900	Pacific	Group of small river basins
26	Khroma	2	31704.1800	6498.2300	20.5000	Arctic (Asia)	Basin Unit
27	Palyavaam	1	30868.1700	2266.7300	7.3400	Arctic (Asia)	Basin Unit
28	Nadym	2	29815.3700	4481.7300	15.0300	Arctic (Asia)	Basin Unit
29	Mamonta peninsula	1	29807.9200	4804.1600	16.1200	Arctic (Asia)	Group of small river basins
30	Messoyakha	1	29255.5500	1319.1300	4.5100	Arctic (Asia)	Basin Unit
31	Bolshaya Balakhnya	1	28958.0000	142.8100	0.4900	Arctic (Asia)	Basin Unit
32	Pur	2	28536.1000	1587.8900	5.5600	Arctic (Asia)	Basin Unit
33	Tuloma	2	26626.0100	2775.9400	10.4300	Arctic (Europe)	Basin Unit
34	Leneevaya	1	24784.3400	6202.6500	25.0300	Arctic (Asia)	Group of small river basins

35 Uereebei (located in Yamal)	1	24752.2200	4087.8300	16.5200	Arctic (Asia)	Basin Unit
36 Kuolai	1	24129.9200	3122.3500	12.9400	Arctic (Asia)	Basin Unit
37 Talovka	6	23504.8600	8303.9800	35.3300	Pacific	Basin Unit
38 Uereebei (located in Gydan)	1	23021.7200	0.0000	0.0000	Arctic (Asia)	Basin Unit
39 Yadayakhodyyakha	1	22560.0800	1008.5800	4.4700	Arctic (Asia)	Basin Unit
40 Vael'mai	1	21928.3200	0.0000	0.0000	Arctic (Asia)	Group of small river basins
41 Chondon	3	20940.6800	3247.3200	15.5100	Arctic (Asia)	Basin Unit
42 Voron'ya	1	19771.8600	114.6300	0.5800	Arctic (Europe)	Basin Unit
43 Ponoi	1	19500.9900	2024.9000	10.3800	Arctic (Europe)	Basin Unit
44 Kara	3	18839.0100	0.0600	0.0000	Arctic (Europe)	Basin Unit
45 Bolshaya Chukoch'ya	2	18193.7100	4773.1700	26.2400	Arctic (Asia)	Basin Unit
46 Chernaya	1	15895.6800	59.8100	0.3800	Arctic (Europe)	Basin Unit
47 Sanga-Ueryakh	1	15857.1200	1858.7800	11.7200	Arctic (Asia)	Basin Unit
48 Mordyyakha	1	15424.9300	6432.4500	41.7000	Arctic (Asia)	Basin Unit
49 Taimyr west coast	1	15161.8900	0.0000	0.0000	Arctic (Asia)	Group of small river basins
50 Korotaeekha	1	14747.9200	0.0000	0.0000	Arctic (Europe)	Basin Unit
51 Kanin peninsula	4	14468.7700	154.2400	1.0700	Arctic (Europe)	Group of small river basins
52 Apuka	1	13827.8900	0.0000	0.0000	Pacific	Basin Unit
53 Konaenmyveem	1	13141.2200	0.0000	0.0000	Pacific	Group of small river basins
54 Neeva	2	13095.4100	2853.6700	21.7900	Arctic (Europe)	Basin Unit
55 Anteepaetayakha	1	12659.1300	996.9600	7.8800	Arctic (Asia)	Basin Unit
56 Podkamennaya	1	12653.5000	1236.4800	9.7700	Arctic (Asia)	Group of small river basins
57 Paren'	1	12341.5600	0.0000	0.0000	Pacific	Basin Unit
58 Bolshaya Kuropatoch'ya	1	12217.2300	1330.9400	10.8900	Arctic (Asia)	Basin Unit
59 Geezheega	1	12211.3100	2474.2200	20.2600	Pacific	Basin Unit
60 Kovdozero	3	11743.6100	1112.7400	9.4800	Arctic (Europe)	Basin Unit
61 Pustaya	1	11525.9100	889.9500	7.7200	Pacific	Group of small river basins
62 Leneengradskaya	3	11448.1800	0.0000	0.0000	Arctic (Asia)	Basin Unit
63 Sueroktyakh	1	11280.3600	0.0000	0.0000	Arctic (Asia)	Basin Unit
64 Sundrun	1	10748.9500	5265.9200	48.9900	Arctic (Asia)	Basin Unit
65 Varzuga	1	10625.6300	280.3900	2.6400	Arctic (Europe)	Basin Unit
66 Eeoneeveem	1	10609.4100	0.0000	0.0000	Arctic (Asia)	Basin Unit
67 Eendeega	1	10531.0800	2.1200	0.0200	Arctic (Europe)	Basin Unit
68 Strel'na	1	10136.5700	96.0400	0.9500	Arctic (Europe)	Basin Unit
69 More-Ue	1	9821.6100	0.0000	0.0000	Arctic (Europe)	Basin Unit
70 Khaduttae	1	9441.1200	0.0000	0.0000	Arctic (Asia)	Basin Unit
71 Eeokanga	1	9421.8000	3013.1600	31.9800	Arctic (Europe)	Basin Unit
72 Seyakha	1	9396.5300	0.0000	0.0000	Arctic (Asia)	Basin Unit
73 - N_0034_0	1	9387.9200	0.0000	0.0000	Pacific	Basin Unit
74 Yavai Peninsula	1	8700.0200	1726.0000	19.8400	Arctic (Asia)	Group of small river basins
75 Nyda	1	8544.5300	0.0000	0.0000	Arctic (Asia)	Basin Unit

76 Aerguveem	1	8371.9900	0.0000	0.0000	Pacific	Basin Unit
77 Tylkhoi	1	8350.4600	0.0000	0.0000	Pacific	Basin Unit
78 Tambei	1	8014.1400	0.0000	0.0000	Arctic (Asia)	Basin Unit
79 Chegeetun	1	7896.0400	0.4300	0.0100	Arctic (Asia)	Group of small river basins
80 Yakhadyyakha	1	7893.5300	920.6200	11.6600	Arctic (Asia)	Basin Unit
81 Baidarata	1	7815.1400	0.0000	0.0000	Arctic (Europe)	Basin Unit
82 Umba	1	7728.6700	746.8000	9.6600	Arctic (Europe)	Basin Unit
83 Tchernokhrebetnaya	1	7725.3800	3932.9500	50.9100	Arctic (Asia)	Group of small river basins
84 Khatangskiy Gulf coast	1	7578.3700	0.0000	0.0000	Arctic (Asia)	Group of small river basins
85 Rybnaya	1	7552.2700	378.7200	5.0100	Arctic (Asia)	Basin Unit
86 Bolshoy Oue	1	7541.0600	0.0000	0.0000	Arctic (Europe)	Basin Unit
87 Neruta	1	7403.4700	2364.7200	31.9400	Arctic (Europe)	Basin Unit
88 Bustakh Lake	1	7200.8200	248.2800	3.4500	Arctic (Asia)	Basin Unit
89 Kon'kovaya	2	7155.9000	4733.8900	66.1500	Arctic (Asia)	Basin Unit
90 Kharasavaei	1	7152.6300	0.3000	0.0000	Arctic (Asia)	Basin Unit
91 - N_0033_0	1	6399.3800	0.0000	0.0000	Arctic (Asia)	Basin Unit
92 Lainadoyakha	1	6312.0300	0.0000	0.0000	Arctic (Asia)	Basin Unit
93 Malaya Itkana coast	1	6236.6300	0.0000	0.0000	Pacific	Group of small river basins
94 Cape Olyutorskiy coast	1	5537.6300	0.0000	0.0000	Pacific	Group of small river basins
95 Anapka coast	1	5467.3000	0.0000	0.0000	Pacific	Group of small river basins
96 Poilovayakha	1	5212.9700	0.0000	0.0000	Arctic (Asia)	Basin Unit
97 Pechenga	1	5100.4300	0.0000	0.0000	Arctic (Europe)	Basin Unit
98 Cape Taigonos coast	1	4877.7100	2507.6100	51.4100	Pacific	Group of small river basins
99 Bolshaya Garmanda	1	4778.2400	4.1100	0.0900	Pacific	Basin Unit
100 - N_0031_0	1	4728.5200	236.2300	5.0000	Arctic (Asia)	Basin Unit
101 Bogdashkeena	1	4633.2700	0.0000	0.0000	Arctic (Asia)	Basin Unit
102 Avekova	1	4458.0900	0.0000	0.0000	Pacific	Basin Unit
103 Eegael'veem	1	4408.2400	0.3100	0.0100	Pacific	Basin Unit
104 Klueevka	1	4253.8300	0.0000	0.0000	Arctic (Asia)	Basin Unit
105 Loiyakha	1	4229.6500	0.0000	0.0000	Arctic (Asia)	Group of small river basins
106 - N_0030_0	1	4138.6900	0.1700	0.0000	Pacific	Basin Unit
107 Khadytayakha	1	3959.0800	0.0000	0.0000	Arctic (Asia)	Basin Unit
108 Venuieuo	1	3958.7900	0.0000	0.0000	Arctic (Asia)	Basin Unit
109 Aderpajota	1	3906.6000	0.0000	0.0000	Arctic (Asia)	Group of small river basins
110 Bludnaya	1	3895.8700	0.0000	0.0000	Arctic (Asia)	Basin Unit
111 - N_0027_0	1	3365.5200	0.0000	0.0000	Arctic (Asia)	Basin Unit
112 Pyyakolyakha	1	3355.5200	0.0000	0.0000	Arctic (Asia)	Basin Unit
113 Mongojureviy	1	3351.5900	0.0000	0.0000	Arctic (Asia)	Basin Unit
114 Pesha	1	3285.3200	0.0000	0.0000	Arctic (Europe)	Basin Unit
115 Vezdekhodnaya	1	3228.9600	1375.0700	42.5900	Arctic (Asia)	Basin Unit
116 Gol'tcovaya	1	3146.4200	0.0000	0.0000	Arctic (Asia)	Basin Unit

117 - N_0025_0	1	3131.5300	0.8100	0.0300	Arctic (Asia)	Basin Unit
118 - N_0022_0	1	3007.4900	310.7600	10.3300	Arctic (Asia)	Basin Unit
119 Eelirgytgyn Lake	1	2898.1700	2894.2300	99.8600	Arctic (Asia)	Group of small river basins
120 Kurupkan	1	2794.2800	0.0000	0.0000	Pacific	Basin Unit
121 Ach'chen Lake	1	2673.7400	35.0000	1.3100	Pacific	Basin Unit
122 - N_0020_0	1	2629.5200	2146.0400	81.6100	Pacific	Basin Unit
123 Rasvikelvapatsoyoki	1	2624.6000	193.4300	7.3700	Arctic (Europe)	Basin Unit
124 Vatyna	1	2506.7500	0.0000	0.0000	Pacific	Basin Unit
125 - N_0018_0	1	2130.8400	23.5200	1.1000	Arctic (Europe)	Basin Unit
126 Zapadnaya Litsa	1	2118.5200	0.2300	0.0100	Arctic (Europe)	Basin Unit
127 Kengeveem	1	1996.7400	643.2500	32.2200	Pacific	Basin Unit
128 - N_0016_0	1	1859.6400	0.0700	0.0000	Pacific	Basin Unit
129 Eel'peeveem	1	1846.4000	0.0000	0.0000	Pacific	Basin Unit
130 Kemijoki	1	1756.1800	0.0000	0.0000	Baltic Sea	Basin Unit
131 Gaetlyangaen	1	1224.8500	0.0000	0.0000	Pacific	Basin Unit
132 Oma	1	1149.3800	0.0000	0.0000	Arctic (Europe)	Basin Unit
133 - N_0014_0	1	1021.3100	0.0000	0.0000	Pacific	Basin Unit
134 - N_0013_0	1	1011.6900	0.0000	0.0000	Pacific	Basin Unit
135 Nes'	1	999.1500	0.0000	0.0000	Arctic (Europe)	Basin Unit
136 - N_0012_0	1	976.9300	3.7200	0.3800	Pacific	Basin Unit
137 - N_0011_0	1	840.4000	0.0000	0.0000	Pacific	Basin Unit
138 Veeleecha	1	794.7000	0.0000	0.0000	Pacific	Basin Unit
139 - N_0009_0	1	713.1300	0.0000	0.0000	Pacific	Basin Unit
140 - N_0006_0	1	546.7100	0.0000	0.0000	Pacific	Basin Unit
141 - N_0003_0	1	474.4500	52.0300	10.9700	Pacific	Basin Unit
142 Veezhas	1	434.0100	0.0000	0.0000	Arctic (Europe)	Basin Unit
143 Pon'goma	2	281.3400	0.0000	0.0000	Arctic (Europe)	Basin Unit
144 Karacha	1	33.6500	0.0000	0.0000	Pacific	Basin Unit
145 Island Systems of Arctic Ocean	13	207349.1300	41914.2400	46.2777	Arctic Ocean	Islands

Table 5. Total Area of major Ecosystem Types in Russian Arctic and Protection by Specially Designated Sites (IUCN Category I – VI).

N	Ecosystem Subtype	Number of mapped polygons	Belongs to Ecosystem type (table3)	Area, km^2	Protected area, km2	Percent
1	Arctic (polar) deserts	336	1	27,837	4,769	17.13
2	Arctic tundra	1078	2	269,420	67,123	24.91
3	Arctic desert low mountains	140	10	61,425	2,777	4.52
4	Arctic tundra low mountains	252	3	137,094	15,332	11.18
5	Northern tundra	1137	4	583,216	85,141	14.60
6	Southern tundra	1081	4	426,061	28,700	6.74
7	Forest tundra	803	5	408,959	10,268	2.51
8	Suppressed and deformed forests and elfin wood	11	5	994	-	0.00
9	Sub-tundra sparse forests	6	5	1,073	-	0.00
10	Tundra low mountains	811	6	479,127	12,935	2.70
11	Tundra and sparse forest low mountains	482	6	332,723	18,490	5.56
12	Desert-tundra middle mountains	37	6	6,614	340	5.14
13	Tundra-bare top middle mountains	272	6	194,370	15,549	8.00
14	Tundra and sparse forest-tundra middle mountains	421	6	286,034	15,328	5.36
15	Bare top uplands	87	6	29,409	117	0.40
16	Sparse forests and tundra-elfin wood low mountains	649	6	241,173	20,412	8.46
17	Elfin wood-tundra middle mountains	61	6	24,940	128	0.51
18	Tundra and sparse forest low mountains	5	7	1,085	-	0.00
19	Sparse forest low mountains	53	7	6,468	1,212	18.74
20	Sparse forest and tundra-sparse forest low mountains	663	7	513,159	20,317	3.96
21	Northern taiga	1347	8	1,016,221	45,692	4.50
22	Middle and southern taiga	199	8	165,358	20,541	12.42
23	Sparse taiga low mountains	110	9	92,912	75	0.08
24	Elfin wood and tundra-elfin wood low mountains	224	11	62,897	6,502	10.34
25	Elfin wood and sparse forest low mountains	50	11	17,085	2,196	12.85
	Glaciers	122	12	56,412	15,062	26.7
	Inland waters			33,466	4,665	13.9
	Total			**5,475,535**	**413,671**	**7.60**

Annex VI

Spatial Indicator Representation; further discussion

In many cases, in spatially distributed data analysis with the aid of cartographic representation of the result, the materials are displayed most clearly when the data sets are partitioned into quantiles. Quantiles are **n** classes of approximately equal volumes $(n > 1)$ into which the sample to be studied is partitioned, with consecutively increasing values of the parameter to be analysed. Presentation of cartograms with parameters ranged and coloured using the method of quantiles, is especially clear since the whole range of parameter values is displayed, thus providing the inclusion of sufficiently representative groups of territories with parameter values close to extreme ones. A shortcoming of this method is the dependence of class selections on a particular sample and the consequent impossibility of a comparison between different samples, territories and temporal sequences. A partition into classes provides the possibility of many comparisons but necessitates a thorough preliminary analysis of both each sample and the whole data set. An unlucky choice of boundaries between the classes can harden the analysis, for example, in the simplest case most of the data might be placed in a single class and a cartographic presentation prepared by GIS tools would turn out to be monotonic.

The quantile method could simply be used as a supportive tool, to help identify the appropriate class breaks for the presentation of spatial distribution. For example, mapping the percentage of ecosystem protection.

When the properties of natural systems are considered form the standpoint of diversity, quantitative estimates are sometimes used simultaneously with qualitative expert estimates of the structure complexity, stability, uniqueness and other system features.

Any combination of these two useful approaches (quantitative and qualitative) requires very careful manipulation to be sure that the combination of diversified estimations still have a common basis and make real practical sense. The spatial frequencies and spatial coincidence of values belonging to particular quantile classes provides a reasonable basis for operation using these diversified parameters, until we have at least an indication where the positive or negative directions are in the trends of the parameters incorporated.

To combine the advantages of both methods indicated, the following procedure, consisting of two stages, is suggested:

1. The concrete parameter values $\mathbf{X_1, X_2, ..., X_i}$ of each of the samples considered are reduced to the dimensionless standard deviations $\mathbf{K_1, K_2, ..., K_i}$ by comparing them with the average value for the sample, in the standard deviation units:

$$\mathbf{K_i = (X_i - X) / \square, \quad where \square = [\square(X_i - X)^2 / (i-1)]^{1/2}} \qquad \{1\}$$

The probable variability range of **K** is between -3.1 and +3.1 provided the distribution law of **X** is similar to the normal distribution. In most specific examples this is the case. In some cases when the distribution strongly differs from the normal one, it is possible to use one of the standard statistical techniques for introducing a factor compensating this difference.

2. With the aid of the well-known function $\mathbf{\square(p) = u\ (\Phi)}$, the inverse function of the probability integral for the normal distribution curve, all the values K may be attributed in an unambiguous way to, or replaced by, the corresponding values $\mathbf{P_1, P_2, ..., P_i}$. The latter parameter is very convenient since, on the one hand, it reduces a distribution of any parameter

to the easily observed range between 0 and 1 (or 0 to 100%) and, on the other hand, the **P** scale is practically the linear probability scale. The values **K** may be transferred to **P** both by a direct calculation with the function □**(p)**, or by simply using standard functions incorporated into Excel spreadsheets.

An important property of the parameter **P** is the possibility of a uniform scale partition into a desired number of intervals for which a fairly homogeneous distribution of values over all classes could be expected. As the dimensionality of the initial parameters is in principle insignificant for the P factor, reflecting the frequency characteristics of a distribution rather than its absolute values, the above form may be applied to both quantitative data and factors estimated in conditional units. Even scores or points might be analysed in combination with other numeric parameters and used for representation on coincidence in spatial units (e.g. "high" productivity and number of species).

Reduced factor sequences for a set of parameters **A, B, ..., N**, designated by $\mathbf{P_a}$, $\mathbf{P_b}$, $\mathbf{P_n}$, open the possibility of confronting factors of absolutely different origin on the basis of frequency (probability) characteristics of occurrence of particular values. The only condition for conducting a correct confrontation of different factors is the choice of a unified scale direction for the initial factors. This means that if, for instance, the value of an ecosystem is estimated, the factors (expressed in numbers) which characterise the community positively (the diversity, stability, uniqueness, etc.) should increase along with the growing value estimate, while the negative ones should decrease as their role in the ecosystem estimate grows. Thus, for example, if the rarity of ecosystems is estimated in percent of the whole territory, then it is reasonable to replace the estimates 20%, 5%, 1% by the reciprocal values 5, 20, 100, and to take the contaminating factor concentrations with the inverse sign. However, this condition is quite common and is taken into account using common sense when the analysis is carried out.

The obtained reduced parameter sequences, characterising, for instance, different divisions of a certain area, open the possibility of their combined processing and integration in a single generalised indicator. The latter can be obtained by determining an average value (geometric mean is often the most convenient way of averaging) for the whole set P and each division. The resulting average estimates can be reduced to the P scale again, taking into account the particular values and the dispersion for the whole sequence, which makes clearer the graphic representation of the results, or maybe a further confrontation with other factors. In this paper this method was applied for the interpretation of the apparent naturalness map, for relative productivity consideration and presentation of coincidence of habitat types poorly represented in protected areas and for comprising the high number of species at the same type.

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No.2 Proposed Protected Areas in the Circumpolar Arctic (1996)

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Circumpolar Seabird Working Group Bulletin, Vol 1-2, (1995-1996)

CAFF Newsletter Vol 1-2 (1995-1996)

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ISBN NUMER: 9979-9476-3-2

Prentstofan Stell ehf.