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**Dr. Henry P. Huntington** (A.B. Princeton University, M.Phil. and Ph.D. University of Cambridge) is an independent researcher in Eagle River, Alaska. His research has documented traditional ecological knowledge of beluga whales in Alaska and Russia, examined Inupiat Eskimo knowledge and use of sea ice in Alaska, evaluated U.S. involvement in the Arctic Council, analyzed the co-management practices of the Alaska Beluga Whale Committee, studied the adaptation of wildlife management to incorporate subsistence hunting practices, and assessed the interactions of humans and forest fires in interior Alaska. This work has been funded by the National Science Foundation (NSF), the Trust for Mutual Understanding, the Exxon Valdez Oil Spill Trustee Council, the National Marine Fisheries Service, the Alaska Beluga Whale Committee, the Marine Mammal Commission, and other agencies and organizations. Dr. Huntington has also been involved as a researcher and writer in a number of international research programs, such as the Arctic Monitoring and Assessment Programme and the Program for the Conservation of Arctic Flora and Fauna. He was a member of the U.S. Polar Research Board from 1999 to 2005 and president of the Arctic Research Consortium of the United States from 2001 to 2003.

**Dr. Arne Instanes** (M.Sc. and Ph.D. Norwegian Institute of Technology, University of Trondheim) has worked with cold regions engineering for the last 15 years. He has work experience from research institutes and universities in Norway (SINTEF Geotechnical Engineering, Trondheim; Norwegian Geotechnical Institute, Oslo; University Centre in Svalbard, Longyearbyen) and Canada (University of Alberta, Edmonton). Dr. Instanes is currently vice-president of OPTICONSULT consulting engineers in Bergen, and director of Instanes Svalbard AS in Longyearbyen. His research on cold regions engineering includes work on stress-strain relationships in frozen soil, snow, and ice, thermal analysis of engineering structures, and the effect of pollution on the physical and mechanical properties of frozen soils. Dr. Instanes is co-chairman of the International Permafrost Association's Working Group on Permafrost Engineering and is a member of the International Society of Soil Mechanics and Geotechnical Engineering Technical Committee No. 8 on Frost.

**Dr. Glenn Patrick Juday** (B.S. Purdue University, Ph.D. Oregon State University) is currently Professor of Forest Ecology and Director of the Tree-Ring Laboratory in the Forest Sciences Department of the School of Natural Resources and Agricultural Sciences at the University of Alaska Fairbanks, where he has worked since 1981. His research specialties include climate change, tree-ring studies, biodiversity and forest management, and forest development following fire. He is currently a co-principal investigator in the NSF-supported Bonanza Creek Long-Term Ecological Research site, and has been on the science steering board of the Center for Global Change at the University of Alaska since its founding. Dr. Juday contributed to the U.S. National Climate Change regional assessment regional reports for Alaska and elsewhere. Dr. Juday teaches conservation biology and wilderness ecosystem management. He has served as science advisor for several television programs and in-depth news articles on climate warming in the United States, Europe, and Japan. He conducted research in the office of the vice president for science of The Nature Conservancy in 1988, and served as president of the Natural Areas Association for four years. Dr. Juday was recognized for outstanding accomplishments as the Chair of the Society of American Foresters Forest Ecology Working Group in 2000.

**Professor Erland Källén** (B.Sc. and Ph.D. Stockholm University, Sweden) is a professor of dynamic meteorology at the Department of Meteorology, Stockholm University and is presently head of department. His research areas are numerical weather prediction and climate modeling. He has contributed to the understanding of long wave

dynamics in the atmosphere as well as methods for data assimilation in the field of numerical weather prediction. Dr. Källén contributed to the 2001 IPCC assessment of climate change, both as reviewer and participant in workshops and meetings. Dr. Källén was the first director of the Swedish Regional Climate Modelling Programme (SWE-CLIM) and his present activities include research on climate processes relevant to the Arctic. His positions on scientific bodies include: president of the Swedish Geophysical Society, chairman of the scientific advisory committee of the European Centre for Medium-Range Weather Forecasts, chairman of the Swedish committee to the World Climate Research Programme/ International Geosphere–Biosphere Programme, editorial board member of the journal *Tellus*, board member of the Swedish Meteorological and Hydrological Institute, member of a mission advisory group for the European Space Agency's Earth Explorer Atmospheric Dynamics mission. His main research interest is the large scale dynamics of the atmosphere and its applications to climate dynamics and weather prediction.

**Dr. Vladimir M. Kattsov** (M.Sc. Leningrad Hydrometeorological Institute; M.Sc. St. Petersburg State University; M.A. Kalinin State University, Ph.D. Leningrad Hydrometeorological Institute) is in his 17th year as a research scientist at the Voeikov Main Geophysical Observatory of the Russian Federal Service for Hydrometeorology and Environmental Monitoring, St. Petersburg. Since 2000, he has been head of the Department of Dynamic Meteorology. Dr. Kattsov's research includes global climate 3D modeling with a focus on polar climate dynamics. He was a lead author for the 2001 IPCC Working Group I report, and is currently a lead author for the chapter on model evaluation in the fourth IPCC assessment of climate change. Since 2000, Dr. Kattsov has been a member of the World Climate Research Programme's Working Group on Numerical Experimentation. He is a member of the Climate Commission of the Russian National Geophysical Committee, and a member of the Russian National Council on the WCRP project "Climate and Cryosphere".

**Dr. David R. Klein** (B.S. University of Connecticut, M.S. University of Alaska, Ph.D. University of British Columbia) was employed by the U.S. Fish and Wildlife Service prior to Alaskan statehood, and by the Alaska Department of Fish and Game immediately after statehood. He was leader of the Alaska Cooperative Wildlife Research Unit at the University of Alaska from 1962 to 1992 when he was appointed senior scientist with the Alaska Cooperative Fish and Wildlife Research Unit until his retirement in 1997. Dr. Klein spent sabbatical-type leaves undertaking research on roe deer in Denmark, wild reindeer in Norway (via a Fulbright Grant), and impala and blesbok in South Africa, and has been involved in other collaborative research in Canada, Greenland, Scandinavia, Siberia, and Portugal. Dr. Klein's research interests have focused on arctic and alpine ecology and habitat relationships of caribou, muskoxen, and other herbivores, assessment of impacts of northern development, and sustainability of arctic ecosystems. He serves on the Board of the Arctic Research Consortium of the United States and is currently Professor Emeritus with the Institute of Arctic Biology and the Department of Biology and Wildlife at the University of Alaska Fairbanks.

**Professor Harald Loeng** is head of the research group Oceanography and Climate at the Institute of Marine Research in Bergen and is adjunct professor at the University of Tromsø, Norway. He was responsible for the research program on Fish and Climate at IMR and has been head of the Norwegian Marine Data Centre. His main research interest has been climate change and variability and its impact on the marine ecosystem. His positions on scientific bodies include: chair of the Hydrography Committee, the Oceanography Committee, and the Consultative Committee of the International Council for the Exploration of the Sea (ICES); chair of the Norwegian National Committee on Polar Research under the Research Council of Norway; and vice-chair of the Arctic Ocean Science Board. Dr. Loeng has been the Norwegian member of the ICES Advisory Committee of Marine Environment. He was a lead author for the chapter on marine pathways in the 1998 assessment on Arctic Pollution Issues by the Arctic Monitoring and Assessment Programme. He has been an editorial board member for the Journal of Fisheries Oceanography since its beginning.

**Dr. Marybeth Long Martello** (B.S. and B.A. University of Connecticut, M.S. and Ph.D. Massachusetts Institute of Technology) is a research fellow in Harvard University's Science, Technology, and Society Program. Her research examines global change science and governance, and includes projects on scientific and political dimensions of vulnerability analysis, framing, analysis and representation of climate change impacts, scientific and inter-governmental efforts to address dryland degradation, local knowledge and traditional knowledge in the context of environmental science and policymaking, and corporate approaches to sustainability. She was formerly a research associate with the Kennedy School's Sustainability Systems Project, a policy fellow with the American Meteorological Society, a fellow with the Global Environmental

Assessment Project, and a fellow with an NSF-funded project on Sustainable Knowledge for the Global Environment. Dr. Martello is a contributor to the United Nations Environment Programme's fourth Global Environmental Outlook Report, and has worked as an environmental consultant. She has authored a number of journal articles and book chapters and is co-editor of *Earthly Politics: Local and Global in Environmental Governance*.

**Professor Gordon McBean** (M.Sc., McGill University; Ph.D., University of British Columbia) has been active in studies of the atmosphere and weather and climate systems for over 35 years. Dr. McBean was a scientist in Environment Canada and then moved to the Institute of Ocean Sciences. In 1988, he became Professor of Atmospheric and Oceanic Sciences at the University of British Columbia and chair of the WMO-IOC-ICSU Joint Scientific Committee for the World Climate Research Program. As chair, he initiated the Arctic Climate System Study (ACSyS), and other major programs. In 1994, he was appointed Assistant Deputy Minister for the Meteorological Service of Environment Canada, with overall responsibility for weather, climate, sea ice, and water sciences and services in the Canadian government. Since leaving government in 2000, he has been appointed professor in the Institute for Catastrophic Loss Reduction at the University of Western Ontario and Chair of the Board of Trustees for the Canadian Foundation for Climate and Atmospheric Sciences. Dr. McBean is theme leader for the Canadian ArcticNet research program, an integrated study of the coastal Canadian Arctic in the context of climate change. He has been elected a Fellow of the Royal Society of Canada, the American Meteorological Society, and the Canadian Meteorological and Oceanographic Society.

**Dr. James J. McCarthy** (B.S. Gonzaga University, Ph.D. Scripps Institution of Oceanography) is Alexander Agassiz Professor of Biological Oceanography and Head Tutor for degrees in Environmental Science and Public Policy at Harvard University. He recently completed a two-decade term as Director of Harvard University's Museum of Comparative Zoology. His research interests concern the regulation of marine plankton productivity, and in recent years have focused on regions that are strongly affected by seasonal and interannual variation in climate. He has written many scientific papers, and currently teaches courses on biological oceanography, biogeochemical cycles, marine ecosystems, and global change and human health. Dr. McCarthy has served on many national and international planning committees, advisory panels, and commissions relating to oceanography, polar science, and the study of climate and global change. From 1986 to 1993, he chaired the International Geosphere–Biosphere Program. He was the founding editor for the American Geophysical Union's *Global Biogeochemical Cycles*. He was a convening lead author for the 1990 IPCC Working Group I report, and was co-chair of the 2001 IPCC Working Group II. He has been elected a Fellow of the American Association for the Advancement of Science, a Fellow of the American Academy of Arts and Sciences, and a Foreign Member of the Royal Swedish Academy of Sciences.

**Professor Mark Nuttall** (MA University of Aberdeen, Ph.D. University of Cambridge) holds the Henry Marshall Tory Chair of Anthropology at the University of Alberta and is Honorary Professor of Sociology at the University of Aberdeen. His work in the Arctic and North Atlantic is mainly concerned with environmental change and resource use issues in rural and coastal communities, depopulation and migration, climate change impacts on indigenous peoples and their livelihoods, the human dimensions of global environmental and sustainability issues, and historical ecology. He has worked extensively in Greenland, Alaska, Canada, and Scotland. Dr. Nuttall is author of *Arctic Homeland: Kinship, community and development in northwest Greenland* (University of Toronto Press, 1992), *White Settlers: The impact of rural repopulation in Scotland* (Routledge, 1996), and *Protecting the Arctic: Indigenous peoples and cultural survival* (Routledge, 1998); editor of the three-volume *Encyclopedia of the Arctic* (Routledge, 2005); and co-editor of *The Arctic: Environment, people, policy* (Taylor and Francis, 2000), *Cultivating Arctic Landscapes: Knowing and managing animals in the circumpolar North* (Berghahn, 2004), and *The Russian North in Circumpolar Context* (2003).

**Dr. Terry D. Prowse** (B.E.S. University of Waterloo, M.Sc. Trent University, Ph.D. University of Canterbury) holds an Environment Canada Research Chair and Professorship in Geography at the Water and Climate Impacts Research Centre, University of Victoria, investigating the impacts of climate on water resources. As a senior scientist with Environment Canada, he also heads a research program for the National Water Research Institute investigating the impacts of climate on hydrology and aquatic ecosystems. He was a lead author (chapters on the cryosphere, ecosystems, and polar regions) for the 1995 and 2001 IPCC assessments of climate change, and has a similar position for the 2007 IPCC assessment of the Arctic and Antarctic. His positions on scientific bodies include: President of the Canadian Geophysical Union, including the Hydrology Section; Canadian government representative

for the UNESCO International Hydrologic Programme; Canadian Member of the International Association for Hydraulic Research-Ice; editorial board member for the journal *Hydrological Processes*, and associate editor for the *Journal of Cold Regions Engineering*. His main research interest is the impact of climate change on water resources and freshwater ecosystems, particularly in cold regions.

**Dr. James (Jim) D. Reist** (B.Sc. University of Calgary, M.Sc. University of Alberta, Ph.D. University of Toronto) is in his 22nd year as a research scientist in the Arctic Research Division at Fisheries and Oceans Canada, Central and Arctic Region, Winnipeg, where he has led the Arctic Fish Ecology and Assessment Research Section since 1989. His research addresses biodiversity of northern Canadian fishes using genetic, morphological, and ecological approaches with particular emphasis on charrs and whitefishes. In addition to documenting fish diversity, biogeography, and understanding their roles in the structure and function of both arctic freshwater and marine ecosystems, his research addresses effects of anthropogenic activities such as exploitation, industrial development, and climate change. Dr. Reist has been active in the Conservation of Arctic Flora and Fauna working group of the Arctic Council, as well as in national and international programs to assess human impacts on fish in the Arctic. He has had adjunct status at several Canadian universities where he has supervised or co-supervised a number of graduate students researching northern fish biology and ecology. He has authored or co-authored over 80 scientific publications in both the primary literature and government publication series.

**Amy J. Stevermer** (M.S. Oregon State University) has been involved in research related to the transfer of radiation in the earth's atmosphere for more than a decade. Throughout her employment as an associate scientist at the University of Colorado at Boulder, she has contributed to projects focused on understanding the various parameters, including stratospheric aerosol and ozone, that affect UV radiation reaching the earth's surface. She has worked on data analysis and public outreach issues for the U.S. Environmental Protection Agency's Ultraviolet Radiation Monitoring Network and has given talks on UV monitoring and effects studies at faculty workshops and national conferences.

**Aapo Tanskanen** (M.Sc. Lic. Tech. Helsinki University of Technology) is the head of the UV radiation research group at the Finnish Meteorological Institute. His research includes work on UV measurement techniques, radiative transfer modeling and development of methods for estimating surface UV irradiance using satellite data. He is a member of the Ozone Monitoring Instrument science team.

**Professor Michael B Usher** (B.Sc. and Ph.D. Edinburgh University, Honorary Doctorate University of Stirling) began his career at the University of York, with teaching and research interests in soil biodiversity and nature conservation. He undertook sabbatical periods to establish a termite research group in Ghana and to work on the soil mites and springtails in Antarctica. From 1991 until he retired he was chief scientist at Scottish Natural Heritage, the government's countryside and conservation agency in Scotland. In this role, as well as leading a large team of scientists, he was actively involved with advice to government ministers. Dr. Usher is a chartered biologist, a Fellow of the Institute of Biology, a Fellow of the Royal Entomological Society, and was elected a Fellow of the Royal Society of Edinburgh (Scotland's National Academy of Science & Letters) in 1999. Dr. Usher was awarded an OBE in the 2001 New Year Honour's List. Over the last few years he has chaired the U.K.'s Soil Biodiversity Research Programme, and has been active in the Scottish Biodiversity Forum and the Council of Europe; he is also a Trustee of the Royal Botanic Garden Edinburgh and the Woodland Trust, and continues to teach aspects of biodiversity conservation.

**Dr. Hjálmar Vilhjálmsson** (B.Sc. University of Glasgow, Ph.D. University of Bergen) has spent much of his career based at the Marine Research Institute in Reykjavik, initially working on operational fisheries research, namely the design and execution of surveys of pelagic fish migrations, abundance, and catchability, and on the environmental variables that affect them. The purpose of this work was to locate areas rich in target species, to predict future migrations and catchability, and to keep the fishing fleet informed. By necessity, the nature of his work changed to abundance assessments of these stocks and advising on their sustainable exploitation. He has been the senior pelagic fisheries biologist at the Marine Research Institute since 1990. Dr. Vilhjálmsson has been a member and vice-chairman of the board of the Icelandic Fisheries Fund, a long-term member of the ICES Northern Pelagic and Blue Whiting Working Group, and was appointed to serve on a special committee, organized by the National Research Council of Iceland, for evaluating existing fisheries science activities in Iceland and advising on research priorities. He is a member of the Icelandic Science Academy.

**Dr. John Walsh** (B.A. Dartmouth College, Ph.D. Massachusetts Institute of Technology) is a President's Professor of Global Change at the University of Alaska Fairbanks. He is also the Director of the Coopera-

tive Institute for Arctic Research and the Center for Global Change at the University of Alaska. His research has addressed arctic climate weather variability, with an emphasis on sea ice variability and the role of sea ice and snow cover in weather and climate. His work has also included evaluations of global climate model simulations of the Arctic. Dr. Walsh is a lead author for the polar regions in the fourth IPCC assessment. He is a member of the Polar Research Board and a panel chair for the Study of Environmental Arctic Change (SEARCH). Before joining the University of Alaska, he spent 30 years on the faculty of the University of Illinois, where he taught courses on weather and climate. He co-authored the textbook, *Severe and Hazardous Weather*, and is an associate editor of the *Journal of Climate*.

**Professor Gunter Weller** (Ph.D. University of Melbourne) is Professor of Geophysics Emeritus of the University of Alaska Fairbanks. His early research concerned climate change and its impacts in both the Arctic and the Antarctic. He has been program manager of the NSF's polar programs in meteorology, project manager of the NOAA-BLM Outer Continental Shelf Environmental Assessment Program in the Arctic, project director of the NASA-University of Alaska SAR Facility, and deputy director of the UAF Geophysical Institute. Among many scientific committee assignments he was the president of ICSU's International Commission on Polar Meteorology and chaired the U.S. National Research Council's Polar Research Board. He recently retired as the director of the Center for Global Change and Arctic System Research and director of the NOAA-UAF Cooperative Institute for Arctic Research and now lives in Australia. Dr. Weller was Executive Director of the ACIA for the last four years.

**Dr. Frederick Wrona** (B.Sc. and Ph.D. University of Calgary) is currently the Director of the Aquatic Ecosystems Impacts Research Branch, National Water Research Institute (Environment Canada) and is a professor in the Department of Geography, University of Victoria. Dr. Wrona has conducted and managed interdisciplinary aquatic ecosystem research for over 23 years, focusing on the ecology and eco-hydrology of cold-regions aquatic ecosystems. His research interests include understanding and predicting the impacts of climate variability/change on the structure and function of cold-regions aquatic ecosystems, identifying mechanisms responsible for the observed patterns of dynamics in aquatic predator-prey systems, assessing the ecotoxicology of aquatic organisms to contaminant stressors, and assessing the impacts of human developments on the health and sustainability of northern aquatic systems. He has served as the Science Director for the Northern River Basins Study and is currently involved with numerous national and international scientific and advisory committees related to the development and implementation of northern hydrological and ecological research programs (e.g., contributing author to the 2007 IPCC Working Group II assessment of the polar regions and the 2nd International Conference on Arctic Research Planning, Environment Canada's Northern Working Group). Dr. Wrona has a strong interest in science-policy linkages and is currently the Head and Chief Delegate for the Canadian National Committee for the UNESCO International Hydrological Programme.

## Additional Members of the ACIA Implementation Team<sup>5</sup>

**Dr. Robert W. Corell** (B.S., M.S., Ph.D., Case Western Reserve University and MIT) joined the National Science Foundation (NSF) in 1987 as Assistant Director for Geosciences where for over 12 years he oversaw the Atmospheric, Earth, and Ocean Sciences and the global change programs of the NSF. While there, Dr. Corell chaired the National Science and Technology Council's committee that oversees the U.S. Global Change Research Program, and the international committee of government agencies funding global change research. He was also chair and principal U.S. delegate to many international bodies with interests in and responsibilities for climate and global change research programs. Dr. Corell is currently a Senior Fellow at the Policy Program of the American Meteorological Society and is actively engaged in research concerned both with the science of global change and with the interface between science and public policy, particularly research activities focused on global and regional climate change and related environmental issues, and science to facilitate understanding of vulnerability and sustainable development. He co-chairs an international strategic planning group on harnessing science, technology, and innovation for sustainable development, and is the lead for an international partnership to better understand and plan for a transition to hydrogen for several nations, currently focused on Iceland, India, and the eight Arctic nations. He is leading a research project to explore methods, models, and conceptual frameworks for vulnerability research, analysis, and assessment – the current focus of which is on vulnerabilities of indigenous communities in the Arctic. Dr. Corell was recently invited to join the Washington Advisory Group, LLC to work on the industry dimension of the climate issue.

<sup>5</sup>Entries for Terry Callaghan, Gordon McBean, and Gunter Weller may be found under "Lead authors"



**Dr. Pål Prestrud** (Master degree and Ph.D. University of Oslo) has been involved for the last 25 years in environmental research and management in the Arctic, with a special research interest in population dynamics of polar mammals and their physiological adaptation to the harsh polar conditions. Dr. Prestrud is currently Director of the Centre for Climate Research at the University of Oslo. He has been Director of Research for a number of years at the Norwegian Polar Institute, and has served as deputy director general in the Norwegian Ministry of Environment where he headed the Section on Polar Affairs and Cooperation with Russia. Dr. Prestrud has been involved in several environmental impact assessments conducted in the Norwegian Arctic over the last 20 years.

**Lars-Otto Reiersen** graduated in marine biology from the University of Oslo, Norway. He then worked at the University of Oslo for several years conducting research on basic processes in marine fish and the effects of oil and other contaminants. He later worked for the Norwegian State Pollution Control Authority dealing with the environmental regulation of shipping and oil and gas activities (exploration and exploitation) in the seas around Norway and at Svalbard. He was involved in the work of the Oslo and Paris Commissions and the London Dumping Commission, especially in relation to the testing of chemicals to be used offshore and chemical and biological monitoring of the marine environment. He chaired the group that made the assessment of the Pollution of the North Sea under the North Sea Task Force and was involved in the establishment and implementation of the Arctic Environmental Protection Strategy and the Arctic Council. Since 1992, he has been the Executive Secretary for the Arctic Monitoring and Assessment Programme.

**Jan Idar Solbakken** (M.Sc. University of Tromsø) has worked at Saami University College, Norway for the last 13 years as an assistant professor in biology. From 2000 to 2003 he was Dean at Saami University College. He has represented the Saami Council, one of the Permanent Participants in the Arctic Council, within AMAP working groups since 1994. He also represented the Saami Council within the AMAP Assessment Steering Group during the first AMAP assessment of Arctic Pollution Issues.

**Dr. Patricia A. Anderson** (B.Sc. University of Iowa, M.A. Dalhousie University, Ph.D. New York University) has 18 years experience researching polar issues and managing polar science programs at the NSF and the University of Alaska Fairbanks. She was Executive Director of the U.S. Antarctic Program Safety Review Panel, an NSF activity that involved researching the history of U.S. exploration and science in Antarctica and the safety of these operations, and co-authoring the panel's report. She spent four years coordinating federal interagency programs on global climate change. Dr. Anderson's 12 years of experience at the University of Alaska Fairbanks involved the management of several arctic research and education activities, including the establishing of a competitive student research grant program, expanding participation of a wide range of stakeholder groups in assessing the impacts of climate change on Alaska, and facilitating interdisciplinary arctic system research through science management of the NSF Arctic System Science Land-Atmosphere-Ice Interactions program. In her capacity as Deputy Executive Director of the ACIA Secretariat, she has been responsible for coordinating all ACIA activities.

**Elizabeth Bush** (M.Sc. and M.A. University of Toronto) is a member of the Science Assessment and Integration Branch of Environment Canada, whose mandate it is to provide science advice and to coordinate science assessment activities on atmospheric issues. She has been involved in science assessment activities for many years, working first as an air quality advisor during which time she participated in Canadian national assessments of particulate matter and ground-level ozone. She currently works as a climate change science advisor and was the focal point in Canada for Canadian participation in the ACIA.

**Paul Grabhorn** is a communications consultant and photographer with 22 years of experience producing publications and campaigns on the subjects of global change, humanitarian action, and environmental research. A particular area of expertise is in the visual communication of complex subjects. His background in human ecology provides his work with a systems view and a synthesis perspective. Some of Grabhorn Studio's productions include: The U.S. National Assessment – Climate Change Impacts on the United States, Global Energy Technology Strategy: Addressing Climate Change, White House Conference on Science and Economics related to Global Change, National Energy Strategy, National Space Council Annual Reports, Coastal America campaign materials, Global Stewardship Brochure (White House), Army Corps of Engineers Environmental Stewardship Campaign, Defense and the Environment Initiative (US Army), GLOBE - Global Learning and Observations to Benefit the Environment (White House) – US Global Change Research Program – annual reports: Our Changing Planet, CIESIN; Understanding the Human Dimensions of Global Change, US Army Corps of Engineers recruitment and outreach materials, Government Buy Recycled Initiative, Technology for a Sustainable Future (White House), Bridge

to a Sustainable Future: National Environmental Technology Strategy (White House), Sustainable America: A New Consensus, Picturing Climate's Complexity, People on War campaign (International Committee of the Red Cross), So Why! Music goes to war campaign (ICRC). Paul Grabhorn has also undertaken photographic documentary missions for the International Committee of the Red Cross in many locations: Somalia, Bosnia, Rwanda, Azerbaijan, Georgia, Abkhazia, Armenia, Ngorn Kharabakh, Chechnya, Cambodia, Colombia, Philippines, Croatia, Nepal, Burundi, Guatemala, Mali, Angola, South Africa, Kenya, and Liberia among others.

**Susan Joy Hassol** is a researcher and writer with 20 years experience in global change science. Known for her ability to translate science into English, she synthesizes information from across the spectrum of scientific disciplines, and makes complex issues accessible to policymakers and the public. She was a lead author of Climate Change Impacts on the United States, the synthesis report of the U.S.

National Assessment of the Consequences of Climate Change. Susan authored a chapter on energy efficiency in a book entitled *Innovative Energy Strategies for CO<sub>2</sub> Stabilization* (Cambridge University Press, 2002). She wrote a feature article entitled "A Change of Climate," in *Issues in Science and Technology*, a journal of the National Academy of Sciences, focusing on the actions of U.S. states, localities, and corporations in mitigating climate change. She has also written and edited numerous articles, papers, and books for organizations including the United Nations Environment Programme, the Scientific Committee on Problems of the Environment, and the Inter-American Institute for Global Change Research. She has served as Environment Fellow for the Aspen Institute and as Research Associate and Director of Communications for the Aspen Global Change Institute.

**Dr. Michael C. MacCracken** (B.S.E. Princeton University; Ph.D. University of California Davis) is Senior Scientist for Climate Change with the Climate Institute in Washington, DC. For 34 years, he was employed by the Lawrence Livermore National Laboratory, where his research included numerical modeling of various natural and anthropogenic causes of climate change and of factors affecting air quality in the Bay Area and northeastern United States. For the latter part of this period, Dr. MacCracken was on assignment with the interagency Office of the U.S. Global Change Research Program, serving for different periods as executive director of the Office and of its National Assessment Coordination Office. He also coordinated the U.S. Government technical review of the IPCC assessments. Dr. MacCracken is currently president of the International Association of Meteorology and Atmospheric Sciences and serves on the executive committees of the International Union of Geodesy and Geophysics and the Scientific Committee for Oceanic Research.

## ACIA Science Editors

**Lelani Arris** (B.Sc. University of Vermont, M.Sc. Massachusetts Institute of Technology) has more than 14 years experience writing and editing technical and popular publications about climate change, ozone depletion, and other environmental science topics. She was editor of the bi-weekly newsletter *Global Environmental Change Report* for five years, senior editor of the quarterly magazine *Global Change* for three years, and has also written or edited publications for the Canadian Climate Impacts and Adaptation Research Network, the U.S. Global Change Research Program, and the British Columbia Ministry of Forests, among others.

**Dr. Carolyn Symon** (B.Sc. Loughborough University, M.Sc. Kings College London, Ph.D. Lancaster University and Proudman Oceanographic Laboratory) is a science editor specializing in multi-authored environmental assessments prepared by intergovernmental bodies. For the last ten years most of her work has focused on marine-related and polar-related issues. Dr. Symon has undertaken work for the OSPAR Commission, the British Antarctic Survey, the Secretariat for the Fifth North Sea Conference, ICES, CCAMLR, and AMAP.

**Professor Bill (O.W.) Heal** (BSc., Ph.D. Durham University, Honorary Professor Edinburgh University, Fellow Hatfield College, Durham) is now retired. His early research on protozoa expanded into soil biology and decomposition then into ecosystems. In the 1970s he led the UK International Biological Programme at the Moor House upland site. This linked naturally into the IBP Tundra Biome through its sub-Arctic climate and to his involvement in international co-ordination and synthesis. As Director of the Institute of Terrestrial Ecology he was responsible for a wide range of pure and applied national and international research. He led the EU Arctic Terrestrial Ecosystem Research project which helped to integrate arctic research and spawned a series of new Arctic-Alpine projects. He subsequently chaired the Polar Sciences Committee of the Natural Environment Research Council, helped to initiate the University of the Arctic, and participated in CAFF and AMAP and in the US NSF and LTER programs.



## Reviewers

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This appendix lists those international experts selected by ACIA that were willing to review one or more chapters of this assessment. Most of the experts listed below reviewed at least two related chapters and a few reviewed several chapters. Many additional reviewers, not listed here, were selected through national reviews conducted by the arctic countries. Reviews were received from about 200 individuals in total.

Hans Alexandersson, Swedish Meteorological and Hydrological Institute  
Leif Anderson, Göteborg University, Sweden  
Robert Barbault, Institut d'Ecologie Fondamentale et Appliquée, France  
Roger Barry, National Snow and Ice Data Center, USA  
Esfir G. Bogdanova, Voeikov Main Geophysical Observatory, Russia  
Jerry Brown, International Permafrost Association, USA  
Margo Burgess, Geological Survey of Canada  
John Calder, National Oceanic and Atmospheric Administration, USA  
JoLynn Carroll, Akvaplan-niva AS, Norway  
Tim Carter, Finnish Environment Institute  
Richard Caulfield, University of Alaska Fairbanks  
Nataly Ye. Chubarova, Moscow State University, Russia  
Stewart Cohen, University of British Columbia, Canada  
Andre Corriveau, Government of the Northwest Territories, Dept. of Health and Social Services, Canada  
Robert Crawford, University of St. Andrews (Emeritus), UK  
Yvon Csonka, University of Greenland  
Jens Dahl, International Work Group for Indigenous Affairs, Denmark  
Klaus Dethloff, Alfred Wegener Institute for Polar and Marine Research, Germany  
Mark Dyurgerov, University of Colorado at Boulder, USA  
Michael A.D. Ferguson, Dept. of Sustainable Development, Government of Nunavut, Canada  
Craig Fleener, Gwich'in Council International, USA  
Sven Haakanson, Jr., Alutiiq Museum, Kodiak, Alaska, USA  
Don Hayley, EBA Engineering Consultants Ltd., Canada  
Bill Heal, University of Durham, UK  
Raino Heino, Finnish Meteorological Institute  
Annika Hofgaard, Norwegian Institute for Nature Research, Norway  
Ad H.L. Huijskes, Netherlands Institute of Ecology  
George Hunt, University of California, Irvine, USA  
Ingvar Jarle Huse, Institute of Marine Research, Norway  
Satu Huttunen, University of Oulu, Finland  
Trond Iversen, University of Oslo, Norway  
Robert Jefferies, University of Toronto, Canada  
Peter Jones, Bedford Institute of Oceanography, Canada  
Eigil Kaas, Danish Meteorological Institute  
Anders Karlqvist, Swedish Polar Research Secretariat  
Roy Koerner, Geological Survey of Canada  
Pirkko Kortelainen, Finnish Environment Institute  
Eduard Koster, Utrecht University, Netherlands  
Peter Kuhry, Stockholm University, Sweden  
Manfred Lange, University of Muenster, Germany  
Donald S. Lemmen, Natural Resources Canada  
Pentti Mälkki, Finnish Institute of Marine Research  
Svend Aage Malmberg, Marine Research Institute, Iceland  
Michael McGeehin, Centers for Disease Control, USA  
Richard McKenzie, National Institute of Water and Atmospheric Research, New Zealand  
Mark Meier, University of Colorado at Boulder, USA  
Jamie Morison, University of Washington, USA  
Lars Moscholm, National Environmental Research Institute, Denmark  
Ted Munn, University of Toronto, Canada  
Aynslie Ogden, Northern Climate Exchange, Canada  
Erling Ögren, Swedish University of Agricultural Sciences  
Mats Olsson, Swedish University of Agricultural Sciences  
Olav Orheim, Norsk Polarinstitutt, Norway  
Jim Overland, Pacific Marine Environmental Laboratory/NOAA, USA  
Chris Paci, Dene Nation, Canada  
Gisli Pálsson, University of Iceland  
Walter Parker, Circumpolar Infrastructure Task Force of the Arctic Council; the Northern Forum, USA  
Geoff Petts, University of Birmingham, UK  
Henning Rodhe, Stockholm University, Sweden  
Odd Rogne, International Arctic Science Committee, Norway  
Ursula Schauer, Alfred Wegener Institute for Polar and Marine Research, Germany  
Frank Sejersen, University of Copenhagen, Denmark  
Stepan G. Shiyatov, Institute of Plant and Animal Ecology, Russian Academy of Sciences  
Oddvar Skre, Norwegian Forest Research Institute  
Kimberly Strong, University of Toronto, Canada  
Thora E. Thorhallsdottir, University of Iceland  
Darin Toohey, University of Colorado at Boulder, USA  
Reidar Toresen, Institute of Marine Research, Norway  
Adrian Tuck, NOAA Aeronomy Laboratory, USA  
Jay Van Oostdam, Health Canada  
Patrick J. Webber, Michigan State University, USA  
Martin Weinstein, 'Namgis First Nation, Canada  
Jan Weslawski, Institute of Oceanology, Polish Academy of Sciences  
Ed Wiken, Wildlife Habitat Canada  
Ming-Ko Woo, McMaster University, Canada  
Oran Young, University of California, Santa Barbara, USA  
T. Kue Young, University of Toronto, Faculty of Medicine, Canada  
Alexander Zhulidov, South Russian Regional Centre for Preparation and Implementation of International Projects  
Francis Zwiers, Meteorological Service of Canada



## Appendix D

# Species Names

### Latin name

### Common name/descriptor

#### Birds

<i>Aethia cristatella</i>	crested auklet	<i>Fulmaris glacialis</i>	northern fulmar
<i>Aethia psittacula</i>	parakeet auklet	<i>Gallinago gallinago</i>	common snipe
<i>Aethia pusilla</i>	least auklet	<i>Gavia adamsii</i>	yellow-billed loon
<i>Alca torda</i>	razorbill	<i>Gavia arctica</i>	Arctic loon
<i>Alle alle</i>	little auk	<i>Gavia immer</i>	common loon/ great northern diver
<i>Anas acuta</i>	pintail	<i>Gavia pacifica</i>	Pacific loon
<i>Anas americana</i>	widgeon	<i>Gavia stellata</i>	red-throated loon
<i>Anas crecca</i>	common teal	<i>Grus americana</i>	whooping crane
<i>Anas penelope</i>	Eurasian wigeon	<i>Haematopus ostralegus</i>	Eurasian oystercatcher
<i>Anas platyrhynchos</i>	mallard	<i>Hydrobates pelagicus</i>	European storm petrel
<i>Anser albifrons</i>	white-fronted goose or "yellow legs"	<i>Lagopus lagopus</i>	willow grouse
<i>A. a. flavirostris</i>	Greenland white-fronted goose	<i>Lagopus mutus</i>	ptarmigan
<i>Anser anser</i>	greylag goose	<i>L. m. hyperboreus</i>	Svalbard ptarmigan
<i>Anser brachyrhynchus</i>	pink-footed goose	<i>Larus argentatus</i>	herring gull
<i>Anser caerulescens</i>	snow goose	<i>Larus canus</i>	mew gull
<i>A. c. caerulescens</i>	lesser snow goose	<i>Larus fuscus</i>	lesser black-backed gull
<i>Anser canagicus</i>	emperor goose	<i>Larus glaucescens</i>	glaucous-winged gull
<i>Anser erythropus</i>	lesser white-fronted goose	<i>Larus hyperboreus</i>	glaucous gull
<i>Anser fabalis</i>	bean goose	<i>Larus marinus</i>	great black-backed gull
<i>A. f. fabialis</i>	taiga bean goose	<i>Larus ridibundus</i>	black-headed gull
<i>A. f. rossicus</i>	tundra bean goose	<i>Limnodromus scolopaceus</i>	Long-billed dowitcher
<i>Arenaria interpres</i>	ruddy turnstone	<i>Limosa lapponica</i>	bar-tailed godwit
<i>Asio flammeus</i>	short-eared owl	<i>Limosa limosa</i>	black-tailed godwit
<i>Aythya affinis</i>	lesser scaup	<i>Loxia</i> spp.	crossbills
<i>Aythya collaris</i>	ring-necked duck	<i>Melanitta fusca</i>	white-winged scoter/ velvet scoter
<i>Aythya marila</i>	greater scaup	<i>Melanitta nigra</i>	black scoter
<i>Aythya valisineria</i>	canvasback duck	<i>Mergus merganser</i>	common merganser
<i>Branta bernicla</i>	Brent goose/ black brent	<i>Mergus serrator</i>	red-breasted merganser
<i>B. b. bernicla</i>	dark-bellied brent goose	<i>Morus bassanus</i>	northern gannet
<i>B. b. hrota</i>	light-bellied brent goose	<i>Motacilla alba</i>	white wagtail
<i>Branta canadensis</i>	Canada goose	<i>Numenius borealis</i>	Eskimo curlew
<i>Branta leucopsis</i>	barnacle goose	<i>Nyctea scandiaca</i>	snowy owl
<i>Branta ruficollis</i>	red-breasted goose	<i>Oceanodroma leucorhoa</i>	Leach's storm-petrel
<i>Buteo</i> spp.	raptors	<i>Oenanthe oenanthe</i>	northern wheatear
<i>Buteo lagopus</i>	rough-legged buzzard	<i>Pagophila eburnea</i>	ivory gull
<i>Calcarius lapponicus</i>	Lapland longspur	<i>Parus caeruleus</i>	blue tit
<i>Calidris acuminata</i>	sharp-tailed sandpiper	<i>Phalacrocorax aristotelis</i>	European shag
<i>Calidris alba</i>	sanderling	<i>Phalacrocorax carbo</i>	great cormorant
<i>Calidris alpina</i>	dunlin	<i>Phalacrocorax pelagicus</i>	pelagic cormorant
<i>Calidris canutus</i>	red knot	<i>Phalacrocorax perspicillatus</i>	Pallas's cormorant
<i>C. c. canutus</i>	red knot (Taymir population)	<i>Phalaropus fulicarius</i>	red phalarope/ grey phalarope
<i>C. c. islandica</i>	red knot (Nearctic population)	<i>Phalaropus lobatus</i>	northern phalarope/ red-necked phalarope
<i>Calidris ferruginea</i>	curlew sandpiper	<i>Philomachus pugnax</i>	ruff
<i>Calidris fuscicollis</i>	white-rumped sandpiper	<i>Phylloscopus borealis</i>	Arctic warbler
<i>Calidris maritima</i>	purple sandpiper	<i>Phylloscopus inornatus</i>	yellow-browed warbler
<i>Calidris mauri</i>	western sandpiper	<i>Pinguinus impennis</i>	great auk
<i>Calidris melanotos</i>	pectoral sandpiper	<i>Plectrophenax nivalis</i>	snow bunting
<i>Calidris minuta</i>	little stint	<i>Pluvialis dominica</i>	lesser golden plover
<i>Calidris ruficollis</i>	red-necked stint	<i>Pluvialis fulva</i>	Pacific golden plover
<i>Calidris tenuirostris</i>	great knot	<i>Pluvialis squatarola</i>	black-bellied plover
<i>Carduelis chloris</i>	greenfinch	<i>Polysticta stelleri</i>	Steller's eider
<i>Carduelis hornemanni</i>	Arctic redpoll	<i>Puffinus gravis</i>	greater shearwater
<i>Catharacta skua</i>	great skua	<i>Puffinus griseus</i>	sooty shearwater
<i>Cephus columba</i>	pigeon guillemot	<i>Rhodostethia rosea</i>	Ross' gull
<i>Cephus grylle</i>	black guillemot	<i>Rissa brevirostris</i>	red-legged kittiwake
<i>Charadrius semipalmatus</i>	semipalmated plover	<i>Rissa tridactyla</i>	black-legged kittiwake
<i>Chen caerulescens</i>	lesser snow goose	<i>Somateria fisheri</i>	spectacled eider
<i>Clangula hyemalis</i>	long-tailed duck/ oldsquaw	<i>Somateria mollissima</i>	common eider
<i>Corvus corax</i>	raven/ common raven	<i>Somateria spectabilis</i>	king eider
<i>Cygnus columbianus</i>	tundra swan/ whistling swan	<i>Stercorarius longicaudus</i>	long-tailed jaeger
<i>Emberiza pusilla</i>	little bunting	<i>Stercorarius parasiticus</i>	Arctic skua/ parasitic jaeger
<i>Eremophila alpestris</i>	shore lark	<i>Sterna hirundo</i>	common tern
<i>Eurynorhynchus pygmaeus</i>	spoon-billed sandpiper	<i>Sterna paradisaea</i>	Arctic tern
<i>Falco peregrinus</i>	peregrine falcon	<i>Sula bassanus</i>	northern gannet
<i>Falco rusticolus</i>	gyrfalcon	<i>Synthliboramphus antiquus</i>	ancient murrelet
<i>Fratercula arctica</i>	Atlantic puffin	<i>Tetrao urogallus</i>	wood grouse
<i>Fratercula cirrhata</i>	tufted puffin	<i>Tetrastes bonasia</i>	hazel grouse
<i>Fratercula corniculata</i>	horned puffin	<i>Tringa erythropus</i>	spotted redshank

<i>Tryngites subruficollis</i>	buff-breasted sandpiper
<i>Turdus iliacus</i>	redwing
<i>Turdus migratorius</i>	American robin
<i>Turdus pilaris</i>	fieldfare
<i>Uria aalge</i>	common murre
<i>Uria lomvia</i>	Brünnich's guillemot/ thick billed murre
<i>Vanellus vanellus</i>	northern lapwing
<i>Xema sabini</i>	Sabine's gull

## Fish

<i>Abramis brama</i>	carp bream
<i>Alosa</i> spp.	alewives
<i>Ammodytes americanus</i>	sand lance
<i>Ammodytes dubius</i>	sand lance
<i>Anarhichas lupus lupus</i>	wolffish
<i>Anguilla anguilla</i>	eel
<i>Arctogadus glacialis</i>	Arctic cod
<i>Atheresthes stomias</i>	arrowtooth flounder
<i>Berryteuthis magister magister</i>	commander squid
<i>Boreogadus saida</i>	Arctic cod/ polar cod
<i>Brosme brosme</i>	tusk
<i>Catostomus</i> spp.	suckers
<i>Cetorhinus maximus</i>	basking shark
<i>Chrosomus eos</i>	northern redbelly dace
<i>Clupea harengus</i>	Atlantic herring
<i>Clupea pallasii</i>	Pacific herring
<i>Coregonus albula</i>	vendace
<i>Coregonus artedi</i>	lake cisco
<i>Coregonus autumnalis</i>	Arctic cisco
<i>Coregonus clupeaformis</i>	lake whitefish
<i>Coregonus lavaretus</i>	whitefish/ powan
<i>Coregonus nasus</i>	broad whitefish
<i>Coregonus pidschian</i>	Siberian whitefish
<i>Coregonus sardinella</i>	least cisco
<i>Cottus</i> spp.	sculpins
<i>Cottus cognatus</i>	slimy sculpin
<i>Couesius plumbeus</i>	lake chub
<i>Dallia</i> spp.	blackfishes
<i>Dicentrarchus labrax</i>	sea bass
<i>Eleginus gracilis</i>	saffron cod
<i>Engraulis mordax</i>	northern anchovy
<i>Esox lucius</i>	northern pike
<i>Gadus macrocephalus</i>	Pacific cod
<i>Gadus morhua</i>	Atlantic cod
<i>Gadus ogac</i>	Greenland cod
<i>Gasterosteus aculeatus</i>	threespine stickleback
<i>Glyptocephalus cynoglossus</i>	witch
<i>Gymnocephalus cernuus</i>	ruffe
<i>Haliotis rufescens</i>	abalone
<i>Hemilepidotus jordani</i>	yellow Irish lord
<i>Hiodon alosoides</i>	goldeye
<i>Hippoglossoides elassodon</i>	flathead sole
<i>Hippoglossoides platessoides</i>	long rough dab/ American plaice
<i>Hippoglossoides robustus</i>	northern flathead sole
<i>Hippoglossus hippoglossus</i>	halibut
<i>Hippoglossus stenolepis</i>	Pacific halibut
<i>Hypomesus olidus</i>	pond smelt
<i>Icelus spiniger</i>	thorny sculpin
<i>Illex illecebrosus</i>	squid
<i>Lamna ditropis</i>	salmon shark
<i>Lepidopsetta bilineata</i>	rock sole
<i>Lepomis macrochirus</i>	bluegill
<i>Leuciscus idus</i>	ide
<i>Leuciscus leuciscus baicalensis</i>	common dace
<i>Limanda aspera</i>	yellowfin sole
<i>Lota lota</i>	burbot
<i>Mallotus villosus</i>	capelin
<i>Melanogrammus aeglefinus</i>	haddock
<i>Microgadus proximus</i>	Pacific tomcod
<i>Micromesistius poutassou</i>	blue whiting
<i>Micropterus dolomieu</i>	smallmouth bass
<i>Mola mola</i>	ocean sunfish
<i>Molva molva</i>	ling
<i>Myoxocephalus quadricornis</i>	fourhorn sculpin
<i>Noemacheilus barbatulus</i>	stone loach
<i>Notidanus griseus</i>	bluntnose sixgill shark
<i>Notropis atherinoides</i>	emerald shiner
<i>Oncorhynchus gorbuscha</i>	pink salmon
<i>Oncorhynchus keta</i>	chum salmon
<i>Oncorhynchus kisutch</i>	coho salmon

<i>Oncorhynchus mykiss</i>	rainbow trout
<i>Oncorhynchus nerka</i>	sockeye salmon
<i>Oncorhynchus tshawytscha</i>	chinook salmon
<i>Osmerus mordax</i>	smelt/ rainbow smelt
<i>Perca flavescens</i>	yellow perch
<i>Perca fluviatilis</i>	European perch
<i>Percopsis omiscomaycus</i>	trout perch
<i>Petromyzon marinus</i>	lamprey
<i>Pleurogrammus monopterygius</i>	Atka mackerel
<i>Pleuronectes asper</i>	yellowfin sole
<i>Pleuronectes bilineatus</i>	rock sole
<i>Pleuronectes ferrugineus</i>	flounder
<i>Pleuronectes glacialis</i>	Arctic flounder
<i>Pleuronectes platessa</i>	plaice
<i>Pleuronectes quadrituberculatus</i>	Alaska plaice
<i>Pollachius virens</i>	coal fish/ saithe
<i>Prosopium cylindraceum</i>	round whitefish
<i>Psetta maxima</i>	turbot
<i>Pungitius pungitius</i>	ninespine stickleback
<i>Reinhardtius hippoglossoides</i>	Greenland halibut
<i>Rutilus rutilus</i>	roach
<i>Salmo gairdneri</i>	rainbow trout
<i>Salmo salar</i>	Atlantic salmon
<i>Salmo trutta</i>	brown trout
<i>Salvelinus alpinus</i>	Arctic char
<i>Salvelinus confluentus</i>	bull trout
<i>Salvelinus fontinalis</i>	brook trout
<i>Salvelinus malma</i>	Char/ Dolly Varden
<i>Salvelinus namaycush</i>	lake trout
<i>Sander lucioperca</i>	zander
<i>Sander vitreus</i>	walleye
<i>Scomber japonicus</i>	Pacific mackerel
<i>Scomber scombrus</i>	Atlantic mackerel
<i>Scomberesox saurus</i>	Atlantic saury
<i>Sebastes marinus</i>	redfish
<i>Sebastes mentella</i>	redfish
<i>Sebastes viviparus</i>	redfish
<i>Squalus acanthias</i>	spurdog
<i>Stenodus leucichthys</i>	inconnu
<i>Thaleichthys pacificus</i>	eulachon
<i>Theragra chalcogramma</i>	pollock
<i>Thunnus thynnus</i>	northern bluefin tuna
<i>Thymallus arcticus</i>	Arctic grayling
<i>Trachurus trachurus</i>	horse mackerel
<i>Xiphias gladius</i>	swordfish

## Marine mammals

<i>Balaena mysticetus</i>	Greenland right whale/ bowhead whale
<i>Balaenoptera acutorostrata</i>	minke whale
<i>Balaenoptera borealis</i>	sei whale
<i>Balaenoptera musculus</i>	blue whale
<i>Balaenoptera physalus</i>	fin whale
<i>Callorhinus ursinus</i>	northern fur seal
<i>Cystophora cristata</i>	hooded seal
<i>Delphinapterus leucas</i>	beluga whale/ white whale
<i>Enhydra lutris</i>	sea otter
<i>Erignathus barbatus</i>	bearded seal
<i>Eschrichtius robustus</i>	grey whale
<i>Eubalaena glacialis</i>	right whales
<i>Eubalaena japonica</i>	North Pacific right whale
<i>Eumetopias jubatus</i>	Steller sea lion
<i>Globicephala melaena</i>	pilot whale
<i>Halichoerus grypus</i>	grey seal
<i>Hydrodamalis gigas</i>	Steller sea cow
<i>Lagenorhynchus acutus</i>	white-sided dolphin
<i>Lagenorhynchus albirostris</i>	white-beaked dolphin
<i>Megaptera novaeangliae</i>	humpback whale
<i>Monodon monoceros</i>	narwhal
<i>Odobenus rosmarus</i>	walrus
<i>O. r. divergens</i>	Pacific walrus
<i>O. r. rosmarus</i>	Atlantic walrus
<i>Orcinus orca</i>	killer whale
<i>Phoca fasciata</i>	ribbon seal
<i>Phoca groenlandica</i>	harp seal
<i>Phoca hispida</i>	ringed seal
<i>Phoca largha</i>	spotted seal
<i>Phoca vitulina</i>	harbour seal
<i>Phocoena phocoena</i>	harbour porpoise
<i>Phocoenoides dalli</i>	Dahl's porpoise
<i>Physeter catodon</i>	sperm whale



<i>Tursiops truncatus</i>	bottlenose dolphin
<i>Ursus maritimus</i>	polar bear
<b>Terrestrial mammals</b>	
<i>Alces alces</i>	moose
<i>Alopex lagopus</i>	Arctic fox
<i>Bison bison</i>	buffalo
<i>Canis lupus</i>	wolf
<i>Castor canadensis</i>	beaver
<i>Cervus elaphus</i>	red deer
<i>Cervus nippon</i>	Sika deer
<i>Clethrionomys rufocanus</i>	grey-sided vole
<i>Clethrionomys rutilus</i>	red-backed vole
<i>Coelodonta antiquitatis</i>	woolly rhinoceros
<i>Dicrostonyx groenlandicus</i>	collared lemming
<i>Dicrostonyx torquatus</i>	Arctic lemming
<i>Erethizon dorsatum</i>	porcupine
<i>Gulo gulo</i>	wolverine
<i>Lemmus lemmus</i>	Norway lemming
<i>Lemmus sibiricus</i>	brown lemming
<i>Lepus americanus</i>	snowshoe hare
<i>Lepus arcticus</i>	Arctic hare
<i>Lepus timidus</i>	hare/ mountain hare
<i>Lynx lynx</i>	lynx
<i>Mammuthis primigenius</i>	mammoth
<i>Martes zibellina</i>	sable
<i>Megaloceros giganteus</i>	giant deer/ Irish elk
<i>Microtus abbreviatus</i>	insular vole
<i>Microtus gregalis</i>	narrow-headed vole
<i>Microtus middendorffi</i>	Middendorf's vole
<i>Microtus oeconomus</i>	tundra vole
<i>Microtus rossiaemeridionalis</i>	sibling vole
<i>Moschus moschiferus</i>	musk deer
<i>Mus musculus</i>	house mouse
<i>Mustela erminea</i>	ermine
<i>Mustela vison</i>	mink
<i>Mustela nivalis</i>	least weasel
<i>Odocoileus hemionus</i>	mule deer
<i>Ondatra zibethicus</i>	muskrat
<i>Ovibos moschatus</i>	muskox
<i>Ovis canadensis dalli</i>	Dall sheep
<i>Puma concolor</i>	cougar
<i>Rangifer tarandus</i>	caribou/ reindeer
<i>R. t. pearyi</i>	Peary caribou
<i>Rattus norvegicus</i>	Norway rat
<i>Sorex spp.</i>	shrews
<i>Spermophilus parryii</i>	ground squirrel
<i>Tamiasciurus hudsonicus</i>	red squirrel
<i>Ursus arctos</i>	grizzly bear/ brown bear
<i>Ursus major</i>	brown bear
<i>Vulpes vulpes</i>	red fox

**Lower Animals**

<i>Acyrtosiphon spp.</i>	aphids
<i>Agrilus anxius</i>	bronze birch borer
<i>Alopecosa hirtipes</i>	[spider]
<i>Alvania</i>	[gastropod]
<i>Apherusa glacialis</i>	[amphipod]
<i>Asplanchna priodonta</i>	[zooplankton]
<i>Balanus balanoides</i>	[barnacle]
<i>Balanus balanus</i>	[barnacle]
<i>Bombus balteatus</i>	[bumblebee]
<i>Bombus cingulatus</i>	[bumblebee]
<i>Bombus hyperboreus</i>	[bumblebee]
<i>Bombus polaris</i>	[bumblebee]
<i>Bosmina longirostris</i>	[zooplankton]
<i>Calanus finmarchicus</i>	[zooplankton]
<i>Calanus hyperboreus</i>	[zooplankton]
<i>Calanus glacialis</i>	[zooplankton]
<i>Calanus marshallae</i>	[zooplankton]
<i>Calliopidae</i>	[amphipod]
<i>Cancer magister</i>	Dungeness crab
<i>Carabus truncaticollis</i>	[ground beetle]
<i>Ceriodaphnia quadrangula</i>	[water flea]
<i>Chaetozone setosa</i>	[polychaete]
<i>Chiloxanthus pilosus</i>	[mite]
<i>Chionoecetes bairdi</i>	Tanner crab
<i>Chionoecetes opilio</i>	snow crab
<i>Chlamys islandica</i>	Iceland scallop

<i>Chone paucibranchiata</i>	[polychaete]
<i>Choristoneura fumiferana</i>	eastern spruce budworm
<i>Choristoneura pinus pinus</i>	jack pine budworm
<i>Chrysaora melamaster</i>	[jellyfish]
<i>Clossiana sp.</i>	fritillary butterfly
<i>Cotesia jucunda</i>	[parasitic wasp]
<i>Curtonotus alpinus</i>	[ground beetle]
<i>Cyclops scutifer</i>	[cladoceran]
<i>Danaus plexippus</i>	milkweed butterfly
<i>Daphnia longiremis</i>	[cladoceran]
<i>Daphnia middendorffiana</i>	[cladoceran]
<i>Daphnia pulex</i>	[cladoceran]
<i>Daphnia pulicaria</i>	[cladoceran]
<i>Daphnia umbra</i>	[cladoceran]
<i>Dendroctonus rufipennis</i>	spruce bark beetle
<i>Dendrolimus sibiricus</i>	Siberian silkworm
<i>Dioryctria reniculelloides</i>	spruce coneworm
<i>Dreissena polymorpha</i>	zebra mussel
<i>Epirrita autumnata</i>	autumnal moth
<i>Eucalanus bungii</i>	[zooplankton]
<i>Euphausia pacifica</i>	[krill]
<i>Folsomia quadrioculata</i>	[collembolan]
<i>Folsomia regularis</i>	[collembolan]
<i>Folsomia sexoculata</i>	[collembolan]
<i>Gammarus lacustris</i>	freshwater shrimp
<i>Gammarus oceanicus</i>	[amphipod]
<i>Gammarus setosus</i>	[amphipod]
<i>Gammarus wilkitzkii</i>	[amphipod]
<i>Gorgonocephalus caputmedusae</i>	[brittle star]
<i>Gynaephora groenlandica</i>	[moth]
<i>Harpinia spp.</i>	amphipods
<i>Heterocope spp.</i>	copepods
<i>Hiattella arctica</i>	[bivalve]
<i>Hormathia nodosa</i>	[actinarian]
<i>Hypogastrura tullbergi</i>	[collembolan]
<i>Hypogastrura viatica</i>	[collembolan]
<i>Ips typographus</i>	spruce engraver beetle
<i>Janira maculosa</i>	[isopod]
<i>Lepidurus</i>	[benthic invertebrate]
<i>Limacina helicina</i>	[pteropod]
<i>Lithodes aequispina</i>	[crab]
<i>Littorina saxatilis</i>	[gastropod]
<i>Lymantria dispar</i>	gypsy moth
<i>Lymnaea elodes</i>	[snail]
<i>Macoma spp.</i>	clams
<i>Malacosoma disstria</i>	forest tent caterpillar
<i>Maldane sarsi</i>	[polychaete]
<i>Metridia longa</i>	[zooplankton]
<i>Metridia pacifica</i>	[zooplankton]
<i>Munna</i>	[isopod]
<i>Mya arenaria</i>	[clam]
<i>Mya truncata</i>	[clam]
<i>Mysis relicta</i>	opossum shrimp
<i>Mytilus edulis</i>	blue mussel
<i>Neocalanus spp.</i>	zooplankton
<i>Neodiprion sertifer</i>	European pine sawfly
<i>Onisimus spp.</i>	amphipods
<i>Onychiurus arcticus</i>	[collembolan]
<i>Onychiurus groenlandicus</i>	[collembolan]
<i>Operophtera brumata</i>	winter moth
<i>Ophiopholis aculeata</i>	[isopod]
<i>Pandalopsis dispar</i>	deepwater prawn
<i>Pandalus borealis</i>	deepwater prawn/ deepwater shrimp/ northern shrimp
<i>Pandalus goniurus</i>	humpy shrimp
<i>Pandalus jordani</i>	pandalid shrimp
<i>Paragorgia arborea</i>	red gorgonian
<i>Paralithodes camtschatica</i>	red king crab
<i>Paralithodes camtschaticus</i>	king crab
<i>Parasyrphus tarsatus</i>	[flower-fly]
<i>Phyllocnistis populiella</i>	aspen leaf miner
<i>Pristiphora erichsonii</i>	larch sawfly
<i>Pterostichus costatus</i>	[ground beetle]
<i>Rana sylvatica</i>	wood frog
<i>Rana temporaria</i>	common frog
<i>Scoloplos armiger</i>	[polychaete]
<i>Spio filicornis</i>	[polychaete]
<i>Spiochaetopterus typicus</i>	[polychaete]
<i>Themisto libellula</i>	[amphipod]
<i>Thyasira</i>	[bivalve]
<i>Thysanoessa inermis</i>	[krill]

<i>Thysanoessa longicauda</i>	[krill]
<i>Thysanoessa longipes</i>	[krill]
<i>Thysanoessa raschii</i>	[krill]
<i>Tipula carinifrons</i>	[crane fly]
<i>Tonicella</i>	[barnacle]
<i>Umingmakstrongylus pallikuukensis</i>	muskox lungworm
<i>Urticina eques</i>	[actinarian]
<i>Vertagopus brevicaudus</i>	[collembolan]

### Higher plants

<i>Abies</i> spp.	firs
<i>Abies sibirica</i>	Siberian fir
<i>Allium schoenoprasum</i>	wild chive
<i>Alnus</i> spp.	alders
<i>Alnus fruticosa</i>	alder
<i>Alopecurus alpinus</i>	alpine foxtail
<i>Andromeda polifolia</i>	bog rosemary
<i>Arctophila fulva</i>	pendant grass
<i>Artemisia</i> spp.	sagebrushes
<i>Betula ermanii</i>	gold birch
<i>Betula exilis</i>	dwarf birch
<i>Betula nana</i>	dwarf birch
<i>Betula papyrifera</i>	paper birch
<i>Betula pendula</i>	silver birch
<i>Betula pubescens</i>	downy birch
<i>B. p. czerepanovii</i>	mountain birch
<i>Calamagrostis lapponica</i>	Lapland reedgrass
<i>Calluna vulgaris</i>	heather
<i>Cardamine pratensis</i>	cuckoo flower
<i>Carex aquatilis</i>	water sedge
<i>Carex bigelowii</i>	Bigelow's sedge
<i>Carex bigelowii / arctisibirica</i>	[sedge]
<i>Carex chordorrhiza</i>	creeping sedge
<i>Carex duriuscula</i>	needleleaf sedge
<i>Carex ensifolia</i>	[sedge]
<i>Carex lugens</i>	[sedge]
<i>Carex stans</i>	water sedge
<i>Carex subspathacea</i>	Hoppner's sedge
<i>Carpinus</i> spp.	hornbeams
<i>Cassiope tetragona</i>	white arctic mountain heather
<i>Cerastium beeringianum</i>	Bering chickweed
<i>Cerastium regelii</i>	Regel's chickweed
<i>Chrysosplenium alternifolium</i>	alternate-leaved golden-saxifrage
<i>Corallorrhiza</i> spp.	coralroots
<i>Cortusa matthioli</i>	bear's ear sanicle
<i>Draba oblongata</i>	Canadian arctic draba
<i>Draba subcapitata</i>	Ellesmereland whitlowgrass
<i>Dryas integrifolia</i>	Arctic dryad
<i>Dryas octopetala / punctata</i>	mountain avens
<i>Dupontia fisheri</i>	Fisher's tundra grass
<i>Dupontia psilosantha</i>	Fisher's tundra grass
<i>Empetrum hermaphroditum</i>	mountain crowberry
<i>Empetrum nigrum</i>	crowberry
<i>Equisetum</i> spp.	horsetails
<i>Eriophorum angustifolium</i>	tall cottongrass
<i>Eriophorum scheuchzeri</i>	white cottongrass
<i>Eriophorum vaginatum</i>	cottongrass
<i>Eritrichium nanum</i>	alpine cushion plant
<i>Euphrasia frigida</i>	cold eyebright
<i>Fagus sylvatica</i>	beech
<i>Galium densiflorum</i>	[herb]
<i>Gentiana nivalis</i>	snow gentian
<i>Geum</i> spp.	avens
<i>Helictotrichon krylovii</i>	[herb]
<i>Juniperus communis</i>	creeping juniper
<i>Kobresia</i> spp.	bog sedges
<i>Koenigia islandica</i>	Iceland purslane
<i>Lagotis minor</i>	little weaselnout
<i>Larix cajanderi</i>	Cajander larch
<i>Larix dahurica</i>	Dahurian larch
<i>Larix gmelinii</i>	Gmelin larch
<i>Larix laricina</i>	tamarack
<i>Larix sibirica</i>	Siberian larch
<i>Larix sukaczewii</i>	Sukachev larch
<i>Ledum</i> spp.	Labrador teas
<i>Lemna</i> spp.	duckweeds
<i>Lupinus</i> spp.	lupines
<i>Luzula confusa</i>	northern woodrush
<i>Menyanthes</i> spp.	bogbeans
<i>Oxycoccus</i> spp.	cranberries

<i>Oxyria digyna</i>	Arctic sorrel
<i>Papaver polare</i>	Arctic poppy
<i>Pedicularis hirsuta</i>	hairy lousewort
<i>Phippsia algida</i>	ice grass
<i>Phleum alpinum</i>	alpine timothy
<i>Picea abies</i>	Norway spruce
<i>Picea glauca</i>	white spruce
<i>Picea mariana</i>	black spruce
<i>Picea obovata</i>	Siberian spruce
<i>Picea sitchensis</i>	Sitka spruce
<i>Pinus contorta</i>	lodgepole pine
<i>Pinus pumila</i>	Dwarf Siberian pine
<i>Pinus sibirica</i>	Siberian stone pine
<i>Pinus sylvestris</i>	Scots pine
<i>Poa abbreviata</i>	northern bluegrass
<i>Polygonum amphibium</i>	water smartweed
<i>Polygonum viviparum</i>	alpine bistort
<i>Populus balsamifera</i>	balsam poplar
<i>Populus tremula</i>	European aspen
<i>Populus tremuloides</i>	aspen
<i>Populus trichocarpa</i>	black cottonwood
<i>Potamogeton</i> spp.	pondweeds
<i>Puccinellia phryganodes</i>	creeping alkaligrass
<i>Quercus</i> spp.	oaks
<i>Ranunculus glacialis</i>	glacier buttercup
<i>Ranunculus sabinei</i>	Sardinian buttercup
<i>Rhododendron</i> spp.	rhododendrons
<i>Rubus chamaemorus</i>	cloudberry
<i>Salix arctica</i>	arctic willow
<i>Salix glauca</i>	glaucous willow
<i>Salix herbacea</i>	dwarf willow
<i>Salix lanata</i>	hairy willow
<i>Salix myrsinifolia</i>	dark-leaved willow
<i>Salix myrsinites</i>	whortle-leaved willow
<i>Salix myrtilloides</i>	[willow]
<i>Salix phylicifolia</i>	tea-leaved willow
<i>Salix polaris</i>	polar willow
<i>Salix pulchra</i>	tealeaf willow
<i>Salix reptans</i>	[willow]
<i>Sanguisorba officinalis</i>	official burnet
<i>Saxifraga caespitosa</i>	tufted alpine saxifrage
<i>Saxifraga cernua</i>	nodding saxifrage
<i>Saxifraga hyperborea</i>	pygmy saxifrage
<i>Saxifraga nivalis</i>	alpine saxifrage
<i>Saxifraga oppositifolia</i>	purple saxifrage
<i>Silene acaulis</i>	moss campion
<i>Sorbus aucuparia</i>	rowan
<i>Taraxacum officinale</i>	dandelion
<i>Tilia</i> spp.	lindens
<i>Vaccinium myrtillus</i>	blueberry/ bilberry
<i>Vaccinium uliginosum</i>	bog blueberry/ bog whortleberry/ bog bilberry
<i>Vaccinium vitis-idaea</i>	lingonberry

### Lower plants

<i>Achnanthes</i>	[diatom]
<i>Ahnfeltia plicata</i>	[red algae]
<i>Alaria esculenta</i>	[kelp]
<i>Arctocetraria nigricascens</i>	[lichen]
<i>Aulacomnium turgidum</i>	[moss]
<i>Bryum cyclophyllum</i>	[moss]
<i>Cetraria islandica</i>	[lichen]
<i>Cetrariella delisei</i>	[lichen]
<i>Cinclidium arcticum</i>	[moss]
<i>Cladina</i>	[lichen]
<i>Cladina rangiferina</i>	[lichen]
<i>Cladonia</i>	[lichen]
<i>Cladonia arbuscula</i>	[lichen]
<i>C. a. mitis</i>	[lichen]
<i>Cladonia pyxidata</i>	[lichen]
<i>Cladonia uncialis</i>	[lichen]
<i>Climacium dendroides</i>	[forest moss]
<i>Cyclotella</i>	[diatom]
<i>Dactylina madreporiformis</i>	[lichen]
<i>Dactylina ramulosa</i>	[lichen]
<i>Dicranoweisia crispula</i>	[moss]
<i>Drepanocladus intermedius</i>	[moss]
<i>Fragilaria</i>	[diatom]
<i>Fucus distichus</i>	sea-tangle (seaweed)
<i>Hylocomium splendens</i>	[moss]

<i>Laminaria digitata</i>	[kelp]
<i>Laminaria saccharina</i>	[kelp]
<i>Laminaria solidungula</i>	[kelp]
<i>Orthothecium chryseon</i>	[moss]
<i>Phaeocystis pouchetii</i>	[flagellate]
<i>Pleurozium shreberi</i>	[forest moss]
<i>Pogonatum alpinum</i>	[bryophyte]
<i>Polytrichum commune</i>	[moss]
<i>Polytrichum juniperinum</i>	[moss]
<i>Psora decipiens</i>	[lichen]
<i>Ptilidium ciliare</i>	[liverwort]
<i>Racomitrium lanuginosum</i>	[moss]
<i>Rhizoplaca melanophthalma</i>	[lichen]
<i>Rhytidiadelphus triquetrus</i>	[forest moss]
<i>Seligeria polaris</i>	[moss]
<i>Sphagnum fuscum</i>	[moss]
<i>Stereocaulon paschale</i>	[lichen]
<i>Thamnomia subuliformis</i>	[lichen]
<i>Tomentypnum nitens</i>	[moss]
<i>Tortula ruralis</i>	[moss]
<i>Xanthoria candelaria</i>	[lichen]
<i>Xanthoria parietina</i>	[lichen]

**Misc. fungi/bacteria etc.**

<i>Alternaria</i>	[fungus]
<i>Archaeoglobus</i>	[bacterium]
<i>Archaeoglobus fulgidus</i>	[bacterium]
<i>Arthro bacter</i>	[bacterium]
<i>Aspergillus</i>	[fungus]
<i>Azotobacter</i>	[bacterium]
<i>Bacillus</i>	[bacterium]
<i>Beijerinckia indica</i>	[bacterium]
<i>Botrytis</i>	[fungus]
<i>Clostridium</i>	[bacterium]
<i>Cortinarius</i>	[fungus]
<i>Cryptococcus laurentii</i>	[yeast]
<i>Exobasidium</i>	[fungus]
<i>Fusarium</i>	[fungus]
<i>Inocybe</i>	[fungus]
<i>Metarhizium</i>	[fungus]
<i>Metarhizium anisopliae</i>	[fungus]
<i>Methylocapsa</i>	[bacterium]
<i>Methylocella</i>	[bacterium]
<i>Microcoleus chthonoplastes</i>	[cyanobacteria]
<i>Mucor hiemalis</i>	[fungus]
<i>Nostoc spp.</i>	[cyanobacteria]
<i>Penicillium</i>	[fungus]
<i>Pseudomonas</i>	[bacterium]
<i>Pyrococcus</i>	[bacterium]
<i>Rhizopus</i>	[fungus]
<i>Thermococcus</i>	[bacterium]
<i>Truncatella truncata</i>	[fungus]





# Acronyms

ABL	Atmospheric boundary layer	H <sub>2</sub> S	Hydrogen sulfide
ACIA	Arctic Climate Impact Assessment	ha	Hectare
ACD	Arctic Coastal Dynamics project	HadCM3	An AOGCM developed by the Hadley Centre for Climate Prediction and Research (UK)
AEPS	Arctic Environmental Protection Strategy	HCB	Hexachlorobenzene
AFI	Air freezing index	HCH	Hexachlorocyclohexane
AGCM	Atmospheric general circulation model	Hg	Mercury
AMAP	Arctic Monitoring and Assessment Programme	Hg <sup>0</sup>	Elemental mercury
AO	Arctic Oscillation	Hg <sup>2+</sup>	Divalent mercury
AO <sup>-</sup>	Low AO index	IABP	International Arctic Buoy Programme
AO <sup>+</sup>	High AO index	IASC	International Arctic Science Committee
AOGCM	Atmosphere–ocean general circulation model	IBA	Important Bird Area
ARCMIP	Arctic Regional Climate Model Intercomparison Project	IBP	International Biological Programme
ATI	Air thawing index	ICC	Inuit Circumpolar Conference
AVHRR	Advanced Very High Resolution Radiometer	ICES	International Council for the Exploration of the Sea
β-HCH	beta-Hexachlorocyclohexane	IGBP	International Geosphere–Biosphere Programme
BOREAS	Boreal Ecosystem–Atmosphere Study	IPA	International Permafrost Association
BP	Before present	IPCC	Intergovernmental Panel on Climate Change
C	Carbon	ITEX	International Tundra Experiment
CAFF	Conservation of Arctic Flora and Fauna	ITQ	Individual Transferable Quota system
CCSR	Center for Climate System Research (Japan)	IUCN	World Conservation Union
Cd	Cadmium	IWC	International Whaling Commission
CDOM	Colored dissolved organic matter	J	Joule
CDQ	Community Development Quota program (Alaska)	K	Potassium
CFC	Chlorofluorocarbon	Kg	Kilogram (10 <sup>3</sup> grams)
CGCM2	An AOGCM developed by the Canadian Centre for Climate Modelling and Analysis	LGM	Last glacial maximum
CH <sub>4</sub>	Methane	LIA	Little Ice Age
Chl-a	Chlorophyll-a	LPJ	Lund-Potsdam-Jena dynamic global vegetation model
CMIP	Coupled Model Intercomparison Project	MDE	Mercury depletion event
CO	Carbon monoxide	MeHg	Methyl mercury
CO <sub>2</sub>	Carbon dioxide	MIP	Model intercomparison project
CPAN	Circumpolar Protected Area Network	MPI	Max Planck Institute for Meteorology (Germany)
CPUE	Catch-Per-Unit-Effort	mwe	Meter water equivalent
CRU	Climatic Research Unit (University of East Anglia, UK)	MWP	Medieval Warm Period
CSM_1.4	An AOGCM developed by the National Center for Atmospheric Research (USA)	My	Million years
CTM	Chemical transport model	N	Nitrogen
D-O	Dansgaard-Oeschger	N <sub>2</sub> O	Nitrous oxide
DDT	Dichlorodiphenyltrichloroethane	NADW	North Atlantic Deep Water
DEWG	Denendeh Environmental Working Group	NAFO	Northwest Atlantic Fisheries Organization
DIC	Dissolved inorganic carbon	NAMMCO	North Atlantic Marine Mammal Commission
DMS	Dimethyl sulfide	NAO	North Atlantic Oscillation
DO	Dissolved oxygen	NASA	National Aeronautics and Space Administration (US)
DOC	Dissolved organic carbon	NCAR	National Center for Atmospheric Research (US)
DU	Dobson unit	NCARP	Northern Cod Adjustment and Recovery Program (Canada)
E	Evapotranspiration	NCEP	National Centers for Environmental Prediction of NOAA
ECHAM4/OPYC3	An AOGCM developed by the Max Planck Institute for Meteorology (Germany)	NDVI	Normalized Difference Vegetation Index
ECMWF	European Centre for Medium-range Weather Forecasts	NEAFC	North East Atlantic Fisheries Commission
EEZ	Exclusive economic zone	NEP	Net ecosystem production
ENSO	El Niño–Southern Oscillation	NH <sub>3</sub>	Ammonia
FAO	United Nations Food and Agriculture Organization	NH <sub>4</sub>	Ammonium
fCO <sub>2</sub>	Fugacity of CO <sub>2</sub>	NIES	National Institute for Environmental Studies (Japan)
GCM	General circulation model	nm	Nautical mile
GDD	Growing degree-day	NO <sub>3</sub>	Nitrate
GDP	Gross domestic product	NOAA	National Oceanic and Atmospheric Administration (US)
GEP	Gross ecosystem production	NPP	Net primary production
GFDL-R30_c	An AOGCM developed by the Geophysical Fluid Dynamics Laboratory (USA)	NRL	Sámi Reindeer Herders Association of Norway
Gg	Gigagram (10 <sup>9</sup> grams)	NSF	National Science Foundation (US)
GHCN	Global Historical Climatology Network	NWT	Northwest Territories (Canada)
GHG	Greenhouse gas	O	Oxygen
GPS	Global Positioning System	OUML	Ocean upper mixed layer
GWP	Global warming potential	P	Phosphorus
H	Hydrogen	P	Precipitation
H <sub>2</sub>	Molecular hydrogen	PAH	Polycyclic aromatic hydrocarbon
		PAR	Photosynthetically active radiation

Pb	Lead
PBDE	Polybrominated diphenyl ether
PCB	Polychlorinated biphenyl
PCN	Polychlorinated naphthalene
$p\text{CO}_2$	Difference in partial pressure of $\text{CO}_2$ (e.g., across the air–sea interface)
PDO	Pacific Decadal Oscillation
P-E	Precipitation minus evapotranspiration
Pg	Petagrams ( $10^{15}$ grams)
POC	Particulate organic carbon
POP	Persistent organic pollutant
ppmv	Parts per million by volume
PSC	Polar stratospheric cloud
PUFA	Polyunsaturated fatty acid
R	Runoff
$R_A$	Respiration, autotrophic
$R_E$	Respiration, ecosystem
$R_H$	Respiration, heterotrophic
RAF	Radiation amplification factor
RAIPON	Russian Association of Indigenous Peoples of the North
RCM	Regional climate model
RCS	Regional (age) curve standardization
RIMS	Rapid Integrated Monitoring System
RIVM	National Institute for Public Health and the Environment model
RUV	Remote underwater vehicle
S	Salinity
SBUV	Solar backscatter ultraviolet
SHEBA	Surface Heat Budget of the Arctic Ocean
SLP	Sea-level pressure
SO	Sulfur monoxide
$\text{SO}_2$	Sulfur dioxide
$\text{SO}_x$	Sulfur oxide
SRÉS	Special Report on Emissions Scenarios (by the IPCC)
SST	Sea surface temperature
Sv	Sverdrup (unit = $10^6 \text{ m}^3/\text{s}$ )
SZA	Solar zenith angle
T	Tonne
TAC	Total allowable catch
TEK	Traditional ecological knowledge
Tg	Teragrams ( $10^{12}$ grams)
THC	Thermohaline circulation
TOMS	Total Ozone Mapping Spectrometer
TOPEX/ POSEIDON	joint French/US altimeter satellite
UIUC	University of Illinois at Urbana-Champaign (US)
ULAQ	Università degli studi dell'Aquila (Italy)
UNCED	United Nations Conference on Environment and Development
UNEP	United Nations Environment Programme
UV	Ultraviolet
UV-A	Ultraviolet-A radiation (315–400 nm)
UV-B	Ultraviolet-B radiation (280–315 nm)
W	Watt
WMO	World Meteorological Organization
WWF	World Wide Fund for Nature
Zn	Zinc
$\Sigma\text{DDT}$	Sum of DDT, DDD, and DDE (concentrations)
$\Sigma\text{PCBs}$	Sum of a number of individual polychlorinated (PCB) congeners

# Glossary

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## **Actinic flux**

Radiation incident at a point, determined by integrating the spectral irradiance over all directions of incident light (units =  $W/m^2/nm$ ).

## **Action spectrum**

A sensitivity function that describes the relative effectiveness of energy at different wavelengths in determining a biological response.

## **Active layer**

The layer of ground that is subject to annual thawing and freezing in areas underlain by permafrost.

## **Adaptive ability or capacity**

The ability of an organism, an ecosystem, or a human system (community, culture, enterprise) to adapt to environmental change.

## **Albedo**

The fraction of solar radiation reflected by a surface or object, often expressed as a percentage. Snow covered surfaces have a high albedo; the albedo of soils ranges from high to low; vegetation covered surfaces and oceans have a low albedo. The earth's albedo varies mainly through varying cloudiness, snow, ice, leaf area, and land cover changes.

## **Allochthonous**

Exogenous; originating outside and transported into a given system or area.

## **Anadromous**

An adjective describing fish that exhibit migratory behavior between fresh and marine waters characterized by spawning (and in ice-covered arctic seas also by overwintering) in freshwater and summer feeding in marine water.

## **Aquaculture**

Breeding and rearing fish and shellfish, etc.

## **Aquifer**

A stratum of permeable rock that bears water. An unconfined aquifer is recharged directly by local rainfall, rivers, and lakes, and the rate of recharge will be influenced by the permeability of the overlying rocks and soils. A confined aquifer is characterized by an overlying bed that is impermeable and the local rainfall does not influence the aquifer.

## **Arctic**

[See chapter 1, section 1.1, paragraph 4]

## **Athalassic**

Used of waters or water bodies that have not had any connection to the sea in geologically recent times, all ions in solution are thus derived from the substratum or atmosphere.

## **Atmospheric boundary layer**

The bottom layer of the troposphere that is in contact with the surface of the earth. It is often turbulent and is capped by a statically stable layer of air or temperature inversion. The atmospheric boundary layer depth (i.e., the inversion height) is variable in time and space, ranging from tens of meters in strongly statically stable situations, to several kilometers in convective conditions over deserts.

## **Benthic**

Pertaining to the sea bed, river bed, or lake floor.

## **Biodiversity**

The numbers and relative abundances of different genes (genetic diversity), species, and ecosystems (communities) in a particular area.

## **Biogeochemical cycle**

The cyclical system through which a given chemical element is transferred between biotic and abiotic parts of the biosphere.

## **Biota**

All living organisms of an area; the flora and fauna considered as a unit.

## **Bloom**

A reproductive explosion of microscopic organisms in a lake, river, or ocean.

## **Catadromous**

An adjective describing fish which exhibit migratory behavior between fresh and marine waters that is characterized by spawning in marine waters and feeding and early rearing in freshwaters.

## **Climate**

Climate in a narrow sense is usually defined as the "average weather"

or more rigorously as the statistical description in terms of the mean and variability of relevant quantities over a period of time ranging from months to thousands or millions of years. The classical period is 30 years as defined by the WMO. These relevant quantities are most often surface variables such as temperature, precipitation and wind. Climate in a wider sense is the state, including a statistical description, of the climate system.

## **Climate change**

Climate change refers to a statistically significant variation in either the mean state of the climate, or in its variability, persisting for an extended period (typically decades or longer).

## **Climate feedback**

An interaction between processes in the climate system, where the result of an initial process triggers a second process that in turn influences the initial one. A positive feedback intensifies the original process, and a negative feedback reduces it.

## **Climatological baseline**

A period of years representing the current climate, the latter being understood as a statistical description in terms of the mean and variability over the period. A baseline period should: be representative of the present-day or recent average climate in the region considered; be of sufficient duration to encompass a range of climatic variations; cover a period for which data on all major climatological variables are abundant, adequately distributed in space, and readily available; include data of sufficiently high quality for use in evaluating impacts; and be consistent or readily comparable with baseline climatologies used in other impact assessments.

## **Co-management**

A system for management of wildlife populations in which responsibility is shared between the users of the resource and government entities with legal authority for management of wildlife.

## **Conservation**

The protection of environmental values associated with natural systems through planned management of natural resources to assure their continued viability and availability for human appreciation and use by preventing overexploitation, and protection from destruction or neglect.

## **Conspecific**

Belonging to the same species.

## **Contaminant**

A substance that is not naturally present in the environment or is present in unnatural concentrations that can, in sufficient concentration, result in potential negative effects on the health of humans, other organisms, and ecosystems.

## **Continental shelf**

A shallow submarine plain of varying width forming a border to a continent and typically ending in a steep slope to the ocean abyss.

## **Cryosphere**

The component of the climate system consisting of all snow, ice, and permafrost on and beneath the surface of the earth and ocean.

## **Demersal**

Living at or near the bottom of a sea or lake but having the capacity for active swimming.

## **Diadromous**

Migrating between fresh water and seawater.

## **Dose**

Dose rate integrated over a time period of exposure (units =  $J/m^2$  (effective)).

## **Dose rate**

Spectral irradiance weighted by a biological action spectrum (units =  $W/m^2$  (effective)).

## **Ecosystem**

A system of interacting living organisms together with their physical environment. The boundaries of what could be called an ecosystem are somewhat arbitrary, depending on the focus of interest or study. Thus the extent of an ecosystem could range from very small spatial scales to, ultimately, the entire earth.

## **Ecosystem function**

Ecosystem function includes carbon and nutrient cycling, soil processes, controls of trace gas exchange processes, primary and secondary productivity, and water and energy balance.

**Ecosystem services**

Ecological processes or functions that have value to individuals or society.

**Ecosystem structure**

The spatial structure of an ecosystem, trophic interactions, and community composition in terms of biodiversity.

**Ecotone**

A zone of transition from one major plant community to another. For example, the forest–tundra ecotone in high northern latitudes is a zone of patchy and often stunted tree growth intermixed with areas of tundra.

**Emissions scenario**

A plausible representation of the future development of emissions of substances that are potentially radiatively active (e.g., greenhouse gases and aerosols), based on a coherent and internally consistent set of assumptions about driving forces (such as demographic and socio-economic development, technological change) and their key relationships.

**ENSO**

El Niño in its original sense is a warm water current that periodically flows along the coast of Ecuador and Peru, disrupting the local fishery. This oceanic event is associated with a fluctuation in the intertropical surface pressure pattern and circulation in the Indian and Pacific Oceans, called the Southern Oscillation. This coupled atmospheric–oceanic phenomenon is collectively known as El Niño–Southern Oscillation, or ENSO.

**Environment**

The complex of climatic, edaphic, and biotic factors that act upon an organism or an ecological community and ultimately determine its form and survival. From the human perspective, also inclusive of the aggregate of social and cultural conditions that influence the life of an individual or community.

**Erythema**

Reddening of the skin. Commonly called sunburn, it is most effectively caused by UV-B radiation.

**Evapotranspiration**

The combined process of evaporation (the process by which a liquid becomes a gas) and transpiration (loss of water vapor from an organism through a membrane or through pores).

**Extant**

Existing or living at the present time.

**Extinction**

The complete disappearance of an entire species.

**Extirpation**

The disappearance of a species from part of its range; local extinction.

**Fast ice (or land-fast ice)**

Fast ice (or land-fast ice) is immobilized for up to 10 months each year by coastal geometry or by grounded ice ridges (stamukhi).

**Finite-difference model**

A model based on finite-difference approximations – the differences between the values of a function at two discrete points are used to approximate the derivatives of the function. Same as grid-point model.

**Flux adjustment**

To avoid the problem of coupled atmosphere–ocean general circulation models drifting into some unrealistic climate state, adjustment terms can be applied to the atmosphere–ocean fluxes of heat and moisture (and sometimes the surface stresses resulting from the effect of the wind on the ocean surface) before these fluxes are imposed on the model ocean and atmosphere.

**Food chain**

A sequence of organisms on successive trophic levels within a community, through which energy is transferred by feeding; energy enters the food chain during fixation by primary producers (mainly green plants) and passes to herbivores (primary consumers) and then to carnivores (secondary and tertiary consumers).

**Food web**

The network of interconnected food chains of a community.

**Freshet**

A rush of freshwater from rain or melted snow.

**Gas hydrates or methane hydrates**

In the presence of high concentrations of certain gases in the water, at low temperatures and high pressures, gas hydrates can form (i.e., open-structured water ice hosting gases such as methane, carbon dioxide or hydrogen sulphide). When the gas trapped in the icy compound is methane, this is known as methane hydrate. Methane hydrate is by far the most common naturally occurring gas hydrate. Other gases, including larger hydrocarbons and carbon dioxide, also form hydrate compounds.

**Giardiasis**

An infection caused by the parasite *Giardia lamblia*.

**Greenhouse gases**

Greenhouse gases are those gaseous constituents of the atmosphere, both natural and anthropogenic, that absorb and emit radiation at specific wavelengths within the spectrum of infrared radiation emitted by the earth's surface, atmosphere, and clouds. This property causes the greenhouse effect. Water vapor, carbon dioxide, nitrous oxide, methane, and ozone are the primary greenhouse gases in the earth's atmosphere. A major proportion of these gases derive from past and present life processes on the earth, including decomposition of organic matter, respiration of plants and animals, burning of forests and other plant material, and burning of coal, oil, and other fossil fuels.

**Halocline**

A zone of marked salinity gradient.

**Indigenous people**

People whose ancestors inhabited a place or a country when persons from another culture or ethnic background arrived on the scene and dominated them through conquest, settlement, or other means and who today live in more conformity with their own social, economic, and cultural customs and traditions than those of the country of which they now form a part. Such people are often referred to in the Arctic as “aboriginal”, “Native”, “first nations”, or “tribal”.

**Irradiance**

Radiant power per unit area (units = W/m<sup>2</sup>).

**Native**

Official legal term used in Alaska for indigenous people as a result of wording in the Alaska Native Claims Settlement Act of 1971.

**Net ecosystem production**

Net gain or loss of carbon from an ecosystem. Net ecosystem production is equal to the gross primary production (carbon fixed by plants through the process of photosynthesis) minus the carbon lost through heterotrophic respiration.

**Net primary production**

The increase in plant biomass or carbon of a unit of a landscape. Net primary production is equal to the gross primary production (carbon fixed by plants through the process of photosynthesis) minus carbon lost through autotrophic respiration.

**Nival**

Pertaining to snow.

**North Atlantic Oscillation**

The North Atlantic Oscillation consists of opposing variations of barometric pressure near Iceland and near the Azores. On average, a westerly current between the Icelandic low pressure area and the Azores high pressure area carries cyclones and their associated frontal systems towards Europe. However, the pressure difference between Iceland and the Azores fluctuates on timescales of days to decades, and can be reversed at times. It is the dominant mode of winter climate variability in the North Atlantic region, ranging from central North America to Europe.

**Northeast Passage (Northern Sea Route)**

The route of potential ship transit through the Arctic Ocean north of Eurasia between the Barents and Bering Seas.

**Northwest Passage**

The route of potential ship transit north of North America between the Labrador and Bering Seas.

**Nunatak**

A mountain peak or rocky outcrop projecting above an ice cap.

**Ocean outfall**

A discharge pipe used for the final disposal of wastewater extending from a wastewater treatment works to the point of discharge in marine waters.

**Ontogenetic migration**

The occupation by an animal of different habitats at different stages of development.

**Ozone layer**

The stratosphere contains a layer in which the concentration of ozone is greatest, the so-called ozone layer. The layer extends from about 12 to 40 km. The ozone concentration reaches a maximum between 20 and 25 km. This layer is being depleted by human emissions of chlorine and bromine compounds. These compounds interact photochemically with the ozone to allow increased ultraviolet-B radiation to reach the earth's surface.

**Pack ice**

Ice formed on oceanic surfaces in polar regions, often encompassing ice bergs derived from calving of glaciers as glaciers enter the sea from land.

**Paludification**

The process of bog expansion.

**Parameterization**

In climate models, this term refers to the technique of representing processes that cannot be explicitly resolved at the spatial or temporal resolution of the model (sub-grid scale processes) by relation-



ships between the area- or time-averaged effect of such sub-grid-scale processes and the larger scale flow.

**Pathogen**

A microbiological agent capable of causing disease.

**Pelagic**

Pertaining to the water column of the sea or lake; used of organisms inhabiting the open waters of an ocean or lake.

**Permafrost**

Ground (soil or rock and included ice and organic material) that remains at or below 0 °C for at least two consecutive years.

**Phenology**

The study of seasonal changes in plant and animal life and the relationships of these changes to weather and climate.

**Phenotypic responses**

Changes in the physical expression of a characteristic of an organism when experiencing a change in the environment and without genetic change.

**Photokeratitis**

Sunburn of the cornea resulting from overexposure to UV-B radiation that is usually reversible. It can occur after long periods on the snow, especially on bright, clear, sunny days, without adequate eye protection. It can be very painful for a couple of days and can result in transitory loss of vision.

**Photoperiod**

The relative lengths of seasonally alternating periods of lightness and darkness in the 24 hour day that affect the growth, activity, and reproductive timing in organisms.

**Phytoplankton**

The plant forms of plankton. Phytoplankton are the dominant plants in the sea, and are the basis of the entire marine food web. These single-celled organisms are the principal agents for photosynthetic carbon fixation in the ocean.

**Piscivorous**

Feeding on fish.

**Pit privy (outhouse)**

A structure that receives urine and excrement that is not water-borne; and is the final disposal site and not a temporary storage facility.

**Planktivorous**

Feeding on planktonic organisms.

**Polar stratospheric clouds**

Clouds that form at extremely low temperatures (below 195 K) in the stratosphere, mostly in the polar regions, and play a role in ozone depletion chemistry.

**Polynya**

A Russian term meaning an area of open water, possibly containing some thin ice, within the ice pack. A polynya is distinguished from a lead by being a broad opening rather than a long, narrow fracture.

**Post and pad foundation**

A building foundation system constructed with posts for vertical support and pads on the ground to distribute the load of each vertical support.

**Prognostic variable**

A variable that is described by an equation that contains a time derivative of this variable (a differential equation), and therefore its value can be determined at a later time when the other terms in the equation are known.

**Proxy climate data**

A proxy climate indicator is a local record that is interpreted, using physical and biophysical principles, to represent some combination of climate-related variations back in time. Climate-related data derived in this way are referred to as proxy data. Examples of proxies are tree ring records and various data derived from ice cores.

**Quasi-biennial oscillation**

An oscillation in the zonal winds of the equatorial stratosphere having a period that fluctuates between about 24 and 30 months. This oscillation is a manifestation of a downward propagation of winds with alternating sign. This phenomenon is sometimes referred to as the stratospheric quasi-biennial oscillation to distinguish it from other atmospheric features that also have spectral peaks near two years.

**Refugium**

An area that has escaped major climatic changes typical of a region as a whole and acts as a refuge for biota previously more widely distributed; an isolated habitat that retains the environmental conditions that were once widespread.

**Regime shift**

A rapid change in regional climate.

**Resilience**

Synonymous with "adaptive ability", or the ability of a system to undergo change without changing its state or identity.

**Ruderal**

Inhabiting disturbed sites.

**Runoff**

The water from rain or melted snow that travels over the ground surface.

**Saline wedge**

A salt-water layer flowing below a lower density freshwater layer that tends to form the shape of a wedge as it intrudes into a river system.

**Species adaptation**

Characteristics of an organism that have been selected by specific selection pressures exerted by other organisms or the physical environment and that have led to a new genetic constitution.

**Spectral irradiance**

Radiant power per unit area (units = W/m<sup>2</sup>/nm).

**Spectral model**

A model in which the prognostic field variables are represented as sums of a finite set of spectral modes rather than being given at grid points. The spectral modes may be Fourier modes in the one-dimensional case or double Fourier modes or spherical harmonics in the two-dimensional case. One advantage of a spectral model is that horizontal derivatives can be calculated exactly for the spectral modes represented in the model. Spectral models are, in general, computationally more efficient than a grid-point model with an equivalent resolution.

**Stamukhi zone**

The zone of heavily broken ice which marks the contact between land-fast ice and the moving pack-ice zones.

**Stenothermal**

A tolerance of a narrow range of environmental temperatures.

**Storm surge**

A temporary increase, at a particular locality, in the height of the sea due to extreme meteorological conditions (low atmospheric pressure and/or strong winds). The storm surge is defined as being the excess above the level expected from the tidal variation alone at that time and place.

**Subpermafrost**

Located beneath the permafrost.

**Subsistence activity**

An aspect of human existence involving derivation of food and other needs directly from the locally available natural resources.

**Sustainability**

The ability of a natural system (e.g., ecosystem, plant community, population of organisms) or a human-generated system (e.g., community, economy, culture) to maintain itself over time. Often used in reference to the ability of a renewable natural resource to yield a stable annual harvest over time.

**Taiga**

Russian term for the boreal or northern coniferous forest biome; the ecosystem adjacent to the arctic tundra.

**Talik**

A layer or body of unfrozen ground occurring in a permafrost area due to a local anomaly in thermal, hydrological, hydrogeological, or hydrochemical conditions.

**Thermocline**

A boundary region in water bodies (lakes or oceans) between two layers of water of different temperature, in which temperature changes sharply with depth.

**Thermohaline circulation**

Large-scale density-driven circulation in the ocean, caused by differences in temperature and salinity. In the north Atlantic, the thermohaline circulation consists of warm surface water flowing northward and cold deepwater flowing southward, resulting in a net poleward transport of heat. The surface water sinks in highly restricted sinking regions located in high latitudes.

**Thermokarst**

Irregular, hummocky topography in frozen ground caused by melting of ice.

**Traditional knowledge**

The accumulated knowledge of indigenous peoples about the environment in which they live that has been passed on via the elders of a community.

**Trophic levels**

The sequence of steps in a food chain; from producer to primary, secondary, or tertiary consumer.

**Tundra**

A type of ecosystem dominated by lichens, mosses, grasses, and dwarf woody plants. Tundra is found at high latitudes (arctic tundra) and high altitudes (alpine tundra). Arctic tundra is underlain by permafrost and is usually saturated.

**Urocanic acid**

A photoreceptor for the induction of UV immune suppression.

**UV-A**

The longest UV wavelengths (315–400 nm). Atmospheric gases absorb little UV-A radiation, so most reaches the earth's surface.

**UV-B**

Solar radiation within a wavelength range of 280–315 nm, the greater part of which is absorbed by stratospheric ozone. Enhanced UV-B radiation suppresses the immune system and can have other adverse effects on living organisms.

**UV-C**

The shortest UV wavelengths (100–280 nm). UV-C radiation is almost entirely absorbed by atmospheric oxygen and ozone.

**UV index**

A number reflecting the daily risk of overexposure (sunburning) to sunlight. Measured on a scale of 0 to >10, where 0 indicates minimal exposure and >10 indicates high to very high risk.

**UV-induced immune suppression**

A change in cell-mediated immunity induced by UV-B radiation. The result of UV-induced immune suppression is the production of regulatory T-cells (suppressor cells) as opposed to effector (antigen-attacking) T-cells.

**Varve**

A layer of sediment deposited in a lake during the course of a single year.

**Vernal**

Pertaining to the spring.

**Wastewater**

Waterborne human wastes or graywater derived from dwellings, commercial buildings, institutions, or similar structures; "wastewater" includes the contents of individual removable containers used to collect and temporarily store human wastes.

**Weather**

State of the atmosphere with regard to temperature, precipitation, wind, and degree of cloud cover.

**Zooplankton**

The animal forms of plankton. They consume phytoplankton or other zooplankton.

 **$\delta^{18}\text{O}$** 

An expression for the ratio of the  $^{18}\text{O}$  to  $^{16}\text{O}$  atoms (stable isotopes of oxygen) in a sample relative to a standard, used as an indicator of temperature change over time, and defined as:  $\delta^{18}\text{O} = ((^{18}\text{O}/^{16}\text{O})_{\text{sample}} - ^{18}\text{O}/^{18}\text{O}_{\text{standard}}) / (^{18}\text{O}/^{16}\text{O}_{\text{standard}})$ .