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One Arctic - One Health

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One Arctic – One Health (Grant No. HEL7M0674-65)

Project team

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Abstract

One Health takes a multidisciplinary approach to health risks and risk mitigation for humans, animals, plants and the environment, with the understanding that human health welfare is dependent on ecosystem health. The U.S. and Canada started the One Health project under the Sustainable Development Working Group (SDWG) of the Arctic Council in 2015, Finland joined the project as a co-lead in 2017. This report is a summary of the Finnish activities and achievements in the One Arctic - One Health project during the Finnish Chairmanship of the Arctic Council. The main actions included the One Arctic - One Health conference in Oulu, establishment of the TremArctic network, and two published Systematic Review papers and two manuscripts. There were also joint sessions and presentations in scientific conferences, seminars and workshops, and joint meetings and collaboration with the other Arctic Council Working Groups, the University of the Arctic, other organisations, and scientific projects. The report concludes with some updated proposals for further work, based on previous works and reflecting progress over the past two years. The Finnish One Arctic - One Health team consisted of scientists from the University of Oulu, National Institute for Health and Welfare (THL), University of Helsinki and the Finnish Food Authority. This work was supported by the grant of the Ministry for Foreign Affairs of Finland.

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Tiivistelmä

Yhteisen terveyden (One Health) perusajatus on, että ihmisten, eläinten, kasvien ja ympäristön terveys on toisistaan riippuvaista, ainakin niin, että sairaassa ympäristössä ei ihminenkään voi olla hyvinvoiva. Yhdysvaltain johtaessa puhetta Arktisessa neuvostossa, USA ja Kanada aloittivat kestävän kehityksen työryhmän (SDWG) alaisuudessa One Health -hankkeen, jonka johtoon Suomi liittyi toimiessaan Arktisen neuvoston puheenjohtajana 2017-2019. Tämä raportti on yhteenveto Suomen toimista ja saavutuksista puheenjohtajakaudellaan. Tärkeimmät toimet olivat One Arctic - One Health -konferenssi Oulussa, TremArctic-verkoston toiminnan aloittaminen, kaksi julkaistua laajaa systemaattista katsausta ja kaksi käsikirjoitusta. Lisäksi Suomen työryhmä osallistui tieteellisiin konferensseihin, seminaareihin ja työpajoihin, sekä yhteisiin kokouksiin ja muuhun yhteistyöhön Arktisen neuvoston muiden työryhmien kanssa. Raportti sisältää myös päivitettyjä jatkotoimenpide-ehdotuksia, jotka perustuvat aikaisempaan työhön ja viimeisten kahden vuoden aikana tapahtuneeseen kehitykseen. Suomen Yksi Arktis – yhteinen terveys -työryhmä koostui asiantuntijoista Oulun yliopistosta, Terveyden ja hyvinvoinnin laitoksesta, Helsingin yliopistosta ja Ruokavirastosta. Hanketta rahoitti Suomen ulkoministeriö.

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Grundprincipen till One Health -tänkandet är att människohälsa, djurhälsa, planthälsa och ekosystemhälsa är nära besläktade. I alla fall så att människans välfärd kräver frisk natur. Under det amerikanska ordförandeskapet i Arktiska rådet inledde USA och Kanada One Health -projektet i regi av arbetsgruppen för hållbar utveckling (Sustainable Development Working Group, SDWG). Finland gick med i ledningen av projektet under Finland ordförandeskap 2017-2019. Denna rapport är en sammanfattning av finska åtgärder och resultat under Finlands ordförandeskap. De mest viktiga handlingarna var arrangerandet av One Arctic - One Health – konferensen i Uleåborg, startandet av TremArctic-nätverket, publiceringen av två systematiska litteraturöversikter och produceringen av två vetenskapliga manuskript. I tillägg deltog den finska arbetsgruppen i vetenskapliga konferenser, seminar och verkstäder med gemensamma sessioner och presentationer. Vidare hade man gemensamma möter samt annat samarbete med andra arbetsgrupper under Arktiska rådet. Rapporten innehåller också uppdaterade förslag till för ytterligare åtgärder baserade på tidigare arbeten och utvecklingen under Finland ordförandeskap. Finlands One Arctic – One Health - arbetsgrupp bestod av forskare från Uleåborgs universitet, Institutet för hälsa och välfärd, Helsingfors universitet, samt Livsmedelsverket. Projektet fick finansiering från det finska utrikesministeriet.

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1 Introduction and background

The One Health process advances a multidisciplinary approach to health risks and risk mitigation for humans, animals, plants and the environment. During the U.S. Chairmanship (2015–17) of the Arctic Council, the U.S. and Canada introduced to the Sustainable Development Working Group (SDWG) a One Health project designed to strengthen regional knowledge sharing and coordination regarding a variety of Arctic One Health concerns, such as infectious and vector- borne diseases, water and food safety, environmental contamination, and changes in animal species distribution. The project advances operational One Health networks in the Arctic region by promoting knowledge sharing, exercises, and collaborative investigations of One Health phenomena.

In fall 2017, Finland joined the project as a co-lead. This report is a summary of the Finnish activities and achievements in the One Arctic - One Health project during the Finnish Chairmanship of the Arctic Council. The main actions included the One Health conference in Oulu, set up of the TremArctic network, and two published papers and two manuscripts. There were also joint sessions and presentations in scientific conferences, seminars and workshops, and joint meetings and collaboration with the other Arctic Council Working Groups, the University of the Arctic, other organisations, and scientific projects. The report concludes with some updated proposals for further work, based on previous works and reflecting progress over the past two years.

The team members of the One Arctic - One Health consisted of University of Oulu, National Institute for Health and Welfare (THL), University of Helsinki and the Finnish Food Authority. This work was supported by a grant of the Ministry for Foreign Affairs of Finland. Ministry of Agriculture and Forestry as well as Ministry of Social Affairs and Health of Finland gave practical and mental support. Here are short summaries of the published papers and manuscripts, water security in the Arctic region, TremArctic networking, conference, and other activities during the project.

Published scientific papers:

Abass K., Emelyanova A., Rautio A., Temporal trends of contaminants in Arctic human populations. Environmental Science and Pollution Research (2018) 25: 28834. https://doi.org/10.1007/s11356-018-2936-8.

Waits A, Emelyanova A., Oksanen A., Abass K., Rautio A., Human Infectious Diseases and the Changing Climate in the Arctic. Environmental International, 121 (2018) 703–713.

2 Current trends of contaminants and their health effects in Arctic human populations

(based on the article of Abass et al., 2018)

Humans are exposed to environmental contaminants through ingestion, inhalation and dermal absorption. In the Arctic, consuming a traditional diet is one of the main sources of exposure to persistent organic pollutants (POPs) and toxic metals. These contaminants have the potential to be transported and accumulated in wildlife and humans from other parts of the globe. Recent reviews of contaminant trends showed that Arctic environment and ecosystem changes are expected to impact directly or indirectly the distribution profiles of environmental contaminants in the Arctic.

Although use of POPs has been either phased-out or limited, POPs still exist in humans and biota. Levels and existence of POPs vary considerably between geographical areas and between species. Data presented by Arctic Monitoring and Assessment Programme (AMAP) depends on each of the Arctic countries' National Implementation Plans in order to produce relevant information needed for Arctic monitoring research. The aim of this report was to provide a firm basis for future levels and effects of pollutants in humans of the Arctic under climate and environmental changes (see Abass et al., 2018 for more details and references).

2.1 Temporal trends and geographical differences of contaminants in humans of the Arctic

The short summary of trends of POPs and toxic metals in the blood of children, in breast milk, in maternal blood and trends of perfluorinated compounds (PFCs) in human blood and serum is shown in (Figure 1). There has been a gradual decrease in the concentration of contaminants, with the exception of oxychlordane, hexachlorobenzene (HCB), 2,2',4,4',5,5'-Hexabromodiphenyl ether (PBDE153) and PFCs, measured in the Arctic and the reduction varied between different populations. Fluctuating, stable, or increasing levels have been found in the concentrations of HCB and PBDE153, especially in Yup'ik and Nunavik. Legacy POPs in the Arctic have shown declining trends in human biological matrices due to strict international regulations and many new ones are under discussion by the POPs Review Committee. Elevated perfluorohexane sulfonic acid (PFHxS) levels were identified in serum samples of nursing Swedish first-time mothers and men in Northern Norway. PFHxS could show a decreasing trend after the international regulation of production and usage. Legislation and long-term monitoring are vital for limiting the levels and health-related risks/effects from exposure to environmental contaminants. On the other hand, PFOS, which is among the 16 new POPs under the Stockholm Convention, showed a decreasing trend but is still higher than the starting biomonitoring point in Northern Norway men, while PFOS is steadily increasing in the serum samples of nursing Swedish first-time mothers. PFOA, PFNA and PFOS showed increasing trends in blood samples of

Yup'ik mothers, but data is only available for two time points. Despite the phase-out of listed POPs production and usage, contaminants circulation in the environment through their environmental fate will remain. Environmental factors and the impact of climate change on temperature will affect the volatilization and distribution of POPs. For instance, despite the general declining trend of PCBs levels in human biological matrices and biota, modelling of the atmospheric PCB composition and behavior showed some increase in environmental concentrations in a warmer climate (Carlsson et al., 2018).

The geographical differences in the concentrations and trends of several contaminants reflect the distinct cultures, traditional lifestyles and dietary habits. The availability of commercial food has reduced the consumption of traditional foods in the Arctic. The elevated levels of PFOS, PFNA and PFDA were correlated with the consumption of marine mammals and fish, while a high concentration of PFOA was correlated with beef consumption. Increased levels of PFHxS and PFNA were significantly correlated with the consumption of game. High POPs concentrations have been accumulating in lipid tissues of Arctic marine mammals over the last several decades. Key findings of the comprehensive Arctic research project ArcRisk (https://cordis.europa.eu/result/rcn/161281_en.html) showed that species of marine mammals contain a variety of legacy POPs that have been included in the Stockholm Convention for over a decade as well as PFAS (Carlsson et al., 2018). The highest mean concentrations of most POPs, metals and PFCs are connected to high consumption of marine mammals, game and fish (Berg et al., 2014; Weihe and Joensen, 2012).

During the years 2003–2004 and later, some mitigation actions were attempted based on recommendations by the international AMAP expert panel, including the disposition and detoxing activities on local sources of persistent contaminants and thus reducing the risk of related harmful impact on health. However, there was no effect found in the contaminant levels of the populations in Chukotka and Nenets areas.

2.2 Health outcomes associated with contaminant levels in humans of the Arctic

Several cohort studies were established in the circumpolar area to examine the association between exposure to contaminants and health outcomes. Findings from Arctic cohort studies have reported link between exposure to contaminants and human health outcomes (Table 1) (see Abass et al., 2018 for details and references).

Table 1. Health outcomes reported in published Arctic cohort studies associated with exposure to contaminants.

Health endpoint	Findings	Cohort
Skeletal system effects	PCB105 and PCB118 inversely associated with the bone stiffness index in Cree women	Eastern James Bay (Canada)
Cardiovascular system effects	High Hg concentration in cord blood was reported to be associated with decreased heart rate variability in children at ages 7 and 14 years old	Faroe Islands
	Child blood Hg levels were correlated with reduction of overall heart rate variability parameters	Nunavik
	Hg was associated with elevated blood pressure among adults, decreased heart rate variability in adults from Nunavik	Faroe Islands and Nunavik
Endocrine system effects	Prenatal exposure to high levels of PCBs was associated with lower serum luteinizing hormone and testosterone in boys	Faroe Islands
	Exposure to PCBs interferes with thyroid hormone homeostasis in adults, while a significant correlation between POPs and thyroid hormones was also reported in ageing residents	Hudson River communities (USA)
	The serum POPs have hormone disruptive potentials to ER, AR, and Ah-receptors	Greenland
Immune system effects	Serum PCB concentrations at 7 years of age were positively associated with total IgE concentrations	Faroe Islands
	Parental exposure to organochlorines increases the susceptibility to infectious diseases, particularly otitis media among Inuit children	Nunavik
	OCs strongly, negatively affected serum antibody concentrations during developmental and perinatal exposure	Faroe Islands
Nervous system effects	Postnatal PCB exposure appears to affect processes associated with error monitoring and information processing at later stages	Arctic Québec
	Parental MeHg exposure has been linked to, up to the age of 22, decreased motor function, attention span, verbal ability, memory, and defects in general mental ability	Faroe Islands
	Parental exposure to Hg linked to, up to the age of 11 years, developed poorer early processing of visual information, lower estimated IQ, poorer comprehension and perceptual reasoning, poorer memory functions, and increased risk of attention problems and ADHD behaviour	Nunavik
Reproductive effects	A strong relationship between the PCB-153 and the level of sex hormone binding globulin	Norway
	High PCB levels associated with low semen quality in men	Faroe Islands
	High levels of PFCs in blood were adversely associated with longer menstrual cycles in women	Greenland, Poland, Ukraine
	Organochlorine exposure was significantly associated with EROD activity and DNA adducts levels when stratifying for smoking (placental toxicity)	Quebec, Canada
	Prenatal exposure to organochlorines was associated with reduced gestation duration	Arctic Quebec
	Serum PFC levels were associated significantly with breast cancer risk	Greenlandic Inuit
DNA methylation	Global methylation levels were inversely associated with blood plasma levels for several POPs and merit further investigation	Greenland

ADHD – attention deficit hyperactivity disorder
Ah receptor – Aryl hydrocarbon receptor
AMAP – Arctic Monitoring and Assessment Program
DNA – deoxyribonucleic acid
ER, AR – Estrogen receptor, Androgen receptor
HCB – hexachlorobenzene
Hg – mercury
IgE – immunoglobin E
MeHg – methylmercury
PBDE – polybrominated diphenyl ethers
PCB – polychlorinated biphenyl
PFAS – polyfluoroalkyl substances
PFCs – perfluorinated compounds
PFDA – perfluorodecanoic acid
PFHxS – perfluorohexane sulfonic acid
PFNA – perfluorononanoic acid
PFOA – perfluorooctanoic acid
PFOS – perfluorooctane sulfonate
POP – persistent organic pollutant

Adverse effects on human health due to exposure to harmful substances found in the Russian Arctic have been largely focused on the studies in the Chukotka (coastal and inland) and Nenets autonomous areas (a.a.) from 2000 to 2010.

Special attention was paid to reproductive health, and in its coastal part of Chukotka, the ratio of the analyzed PCB congeners in the blood samples remained unchanged five years after the first survey, and it differs from that of the continental population.

Conclusions

There are several time series of 31 different contaminants in human cohorts in the Arctic, see the review of Abass et al., 2018. International restrictions have decreased the levels of most persistent organic pollutants in humans and food webs. Percentage changes for contaminants in human biological matrices (blood samples from children, mothers, males, and breast milk samples) for the period of sampling showed declining trends in most of the monitored Arctic locations, with the exception of oxychlordane, HCB, PBDE153 and PFCs. On the other hand, broad ranges of new chemicals of emerging Arctic concern have been identified (AMAP 2017). It is essential that more data are collected on levels and temporal trends of chemicals of emerging Arctic concern in different environmental mediums as well as in human biological matrices over wider geographical areas. Studies on the impact of pollutants on human health are challenging to undertake with many other confounding factors influencing health at the same time. There have been several EU projects to investigate the link between exposure to environmental contaminants and their risks for human health. Human health risk assessment from exposure to contaminants could be evaluated through several approaches, i.e. long-term retrospective epidemiological studies, modelling, systematic review, and toxicological cutoff reference values. Epidemiological studies established in the circumpolar area to investigate the link between exposure to contaminants and health outcomes showed links between exposure to contaminants and neurobehavioral, reproductive, cardiovascular, endocrine, and carcinogenic effects. Future research should focus on new emerging contaminants as well as establishing toxicological cut-off points to evaluate the health consequences for humans. Furthermore, new approaches need to be developed to estimate the magnitudes of health effects of exposed populations as well as determine the effects of mixtures.

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Weihe P, Joensen HD (2012) Dietary recommendations regarding pilot whale meat and blubber in the Faroe Islands. International Journal of Circumpolar Health 71:18594.

3 Current trends in human infectious diseases in the Arctic

(based on the article of Waits et al., 2018)

Infectious disease rates across the Arctic are highly variable, depending on country, disease, age, sex, and location. Overall, improved sanitation, medical treatment, vaccination, and education has resulted in decreased infectious disease rates and decreased health disparities between indigenous and non-indigenous populations across the Arctic. In 1950, for example, infectious diseases accounted for 47% of deaths among Alaskan Natives, but only 3% of deaths among non-Native Alaskans. By 1990 though, only 1.2% of deaths among Alaska Natives were due to infections, and 1% of deaths among non-Native Alaskans (Arctic Council Ministerial 2009). However, significant disparities in the Arctic still exist. For example, disease rates for tularemia in the Arkhangelsk region and Khanty-Mansi autonomous area (a.a.), are several times higher than averages registered for the Russian Federation in total. From 2005 to 2015, the Russian male population suffered more deaths from infectious and parasitic diseases than females in every region. Current trends in infectious diseases in the Arctic include the reemergence of tuberculosis, high prevalence of sexually transmitted diseases, introduction of new pathogens, changes in the emergence of food- and waterborne diseases, and spread of vector-borne and zoonotic diseases further north as a result of climate changes. See Waits et al., 2018 for more details and references.

Tuberculosis (TB) and sexually transmitted infections (STIs) constitute a significant public health burden in the Arctic. General trends in for TB and STI incidence include higher incidence rates in Arctic communities (compared to the country as a whole) and higher incidences in indigenous populations, compared to non-indigenous population. In a study investigating TB in the Arctic from 2006–2012, TB incidence was found to be variable among Arctic countries and higher in males than females (Bourgeois et al., 2018). Another study, investigating STI incidence rates from 2006 in the Arctic found that incidence rates were higher in Arctic communities compared to the country as a whole, and higher in indigenous populations (Gesink Law et al., 2008). Specific incidence rates are shown in the Table 2.

Table 2. Tuberculosis and sexually transmitted infections incidence rates

Tuberculosis (2006–2012) (incidence rate per 100,000 people); both sexes (♂ males, ♀ females)	
Annual incidence rate (Bourgeois et al., 2018)	Northwest Territories, CA: 25.4 (♂: 33.9; ♀: 16.4) Nunavik, CA: 199.5 (♂: 215.3; ♀: 182.9) Nunavut, CA: 194.3 (♂: 236.0; ♀: 149.6) Yukon, CA: 12.1 (♂: 16.3; ♀: 7.7) Northern Finland: 5.1 (♂/♀ information not available) Greenland: 144.9 (♂: 163.0; ♀: 124.6) Northern Norway: 6.9 (♂/♀ information not available) Northern Sweden: 4.3 (♂: 215.3; ♀: 182.9) Arkhangelsk, Russian Federation: 65.1 (♂: 215.3; ♀: 182.9) Alaska, USA: 8.1 (♂: 9.5; ♀: 6.6)

Sexually Transmitted Infections (2006) (incidence rates per 100,000)		
	Chlamydia	Gonorrhea
Average annual incidence rates	Alaska: 715/ US: 470.9 Northern Canada: 1693/ CA: 205 Greenland: 5543/ Denmark: 681	Alaska: 101/ US: 164.4 Northern Canada: 247/ CA: 33 Greenland: 1738/ Denmark: 6.5
Indigenous status and gender (only for Alaska)	Indigenous ♀: 3012/ White ♀: 389 Indigenous ♂: 927/ White ♂: 235	Indigenous ♀: 344/ White ♀: 41 Indigenous ♂: 153/ White ♂: 28
		Source: (Gesink Law et al., 2008)

Abbreviations: US – United States as a whole; CA – Canada as a whole; Indigenous – Alaska Native/ American Indian

3.1 Globalization and climate change

In addition to complex health issues in the Arctic (health disparities, high concentrations of environmental contaminants, rising chronic disease rates), the Arctic is undergoing rapid change, bringing new health challenges to the Arctic as well (Waits et al., 2018). Climate change and unprecedented globalization are occurring concurrently in the Arctic. Greater accessibility to remote locations, increases in tourism and industry, and social change provide new opportunities for novel and exotic pathogens and disease-vectors to infect naïve populations.

Climate change has been predicted to be the most influential factor in the emergence of infectious diseases. The changes in the Arctic climate will have both direct and indirect impacts on the health of Arctic residents, especially in relation to infectious diseases. Directly, warmer temperatures can accelerate growth rates of pathogens and animals, including insect vectors. Extreme precipitation may result in flooding and disruption of water/ sanitation infrastructure, elevating the risk for waterborne outbreaks. Indirectly, climatic factors affect infectious disease transmission by altering human behavior. For example, warmer temperatures lead to more people using public bathing waters, providing more opportunities for a waterborne outbreak to start. Similarly, people spend more time outside (i.e. in forests and public places for picnics and other free time activities), increasing the likelihood of contracting a tick-borne disease, Additionally, changes in climatic factors can expand a disease-vector's geographic range, or enlarge its population, for example more vector species and individuals survive though the winter. Increases in public and health personnel education, vaccination programs, and hygiene, however, help combat the spread of disease, potentially reducing infections even though opportunities for infection may increase as a consequence of climate change.

3.2 Vector-borne diseases and zoonosis

Temperature and precipitation significantly influence the life cycle and range of ticks. Consequently, the spread of **tick-borne diseases** like tick-borne encephalitis (TBE) and tick-borne borreliosis (TBE). Warmer temperatures improve the ticks' habitat and can accelerate the ticks' reproduction and development. A study investigating the range expansion of the *Ixodes ricinus* tick in Sweden found that the range expanded by 10%, with most of the expansion occurring about 60°N, where the range doubled from 12.5% in the early 1990s to 26.8% in 2008. The European part of the Russian Arctic (Arkhangelsk, Komi regions) is currently exposed to the increasing TBE and TBB incidence, the northern range expansion of associated ticks, and better survival for tick vectors. The annual TBE incidence rates from 2005 to 2015 per 100,000 people were 2-5.4 times higher than compared to the respective rates nation-wide.

In the Russian Arctic, melting permafrost is exposing buried carcasses of animals infected with **anthrax**, increasing the risk that humans can become infected. Humans are mainly infected by coming into contact with infected animals, animal products or spores. An outbreak in 2016 corresponded with an abnormally warm summer, resulting in 30 people infected from a population of 266. The majority of infected individuals were unvaccinated, residing in rural areas (97.5%), males of working age (77.5%) and infected during slaughtering (90.5%) with meat as the main transmission factor (96.4%).

Warmer temperatures and milder winters result in higher populations of disease vectors. About 70% of **tularemia** cases in Russia occur in the Northwest (Arkhangelsk region) and Siberian federal districts (Khanty-Mansi a.a.). In the Khanty-Mansi area, the last significant outbreak occurred in 2013, when there were 1 005 cases recorded. A likely contributor was the expansion of the agent reservoir: northern red-backed voles and common red-toothed shrews to carry the disease in addition to the water vole and blood-sucking insects.

3.3 Food- and waterborne disease

Food- and waterborne diseases can be affected by increased temperature and extreme precipitation. Increased temperature leads to increased pathogen growth and better pathogen survival. Extreme precipitation can result in flooding, which can disrupt and contaminate water and waste treatment facilities. In a study of waterborne diseases in the Russian Arctic, incidence of bacterial and parasitic food and water-borne diseases were found to be "alarmingly high" (Dudarev et al., 2013). The rapidly warming Arctic and predictions of increased precipitation suggest food- and waterborne diseases will be significantly impacted directly.

In the Arctic, heat waves correlate with more outbreaks of **vibriosis**, particularly when sea surface temperature is increased. Heat waves in Finland and Sweden in July 2014 were associated with abnormal sea surface temperatures and an increase in reported cases of vibriosis. Changes in human behavior, (i.e. spending more time outside and swimming in the sea), resulting from the warm weather could also be a contributing factor.

Gastroenteritis can be caused by viruses, bacteria, and parasites. Common causes of viral gastroenteritis include norovirus and rotavirus. Transmission can occur in food- and waterborne outbreaks, through person-to-person contact, and from fecal contamination. An outbreak of gastroenteritis occurred in Finland during July and August 2014. The exceptionally warm temperatures and long duration of the heat wave are thought to have resulted in more people visiting beaches and possibly more exposure to the infectious viral particles in the water.

Botulism also disproportionately affects Arctic coastal communities, particularly in Alaska, northern Canada, and Greenland. In Nunavik, Canada, for example, the incidence rate was 50.5/100,000 (>1,600 times higher than the rate for the rest of Canada, 0.03/100,000). Outbreaks of botulism associated with traditional foods account for 83.5% of all the botulism outbreaks in Canada. The increased rate of botulism among Arctic coastal communities is associated with contaminated food preparation and storage.

Conclusions

Tuberculosis, sexually transmitted infections, zoonotic and vector-borne diseases, and food- and waterborne diseases are significant burdens of Arctic resident health. Changes in the Arctic, especially climate change and globalization, add additional challenges for infectious diseases.

Climatic factors and climate change are causing environmental changes, significantly impacting zoonotic and vector-borne diseases, and food- and water-borne diseases. The growing number of tourists and immigrants adds additional risk for the introduction of pathogens. Increased prevention, vaccination, and education will be important in mitigating the effects of climate change on infectious disease rates in the Arctic, even if opportunities for infection may increase because of climate change. Additionally, monitoring and data compilation across the Arctic will help to predict and reduce economic and human costs across the Arctic.

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4 Current trends in wildlife infectious diseases in the Arctic

(based on the manuscript of Waits et al., 2019)

Globally, different parasites constitute a major part of biodiversity (Dobson et al., 2008). These are commonly referred to as pathogens (Dobson et al., 2008). Despite being a region characterized by a harsh climate, the Arctic contains a wealth of biodiversity. Between wildlife that permanently inhabits the Arctic to migratory species that occupy the Arctic seasonally, the Arctic is populated by over 200 species of birds, 100 species of mammals, 300 species of fish, and thousands of species of invertebrates and microorganisms (CAFF, 2013). However, climate change and increasing anthropogenic activity threaten the current health of the Arctic wildlife. As the Arctic warms, rapid changes are occurring in the environment. For wildlife, this changes habitat, foraging grounds, breeding areas, and migration routes. Additionally, the environmental changes are altering disease-vector populations, ranges, and life cycles. Increased human interest in the Arctic is occurring simultaneously, bringing additional challenges that impact infectious diseases among wildlife. The rapid influx of people (and their pets) has the potential to introduce new pathogens, establish new hosts, and alter the wildlife's environment through industry, construction, and pollution. Resulting change can stress animals, potentially making them more vulnerable to infectious diseases (Bradley et al., 2005). All of these factors contribute to increasing infectious disease threats to Arctic wildlife. Current trends in Arctic wildlife are shifts in disease emergence, rising potential for new pathogens, and increased infections.

4.1 New threats for Arctic wildlife

Increased interest in the Arctic and growing economic industries are bringing more people, and their pets, into the Arctic. These domestic pets, mainly cats and dogs, bring their diseases, pathogens, and parasites, potentially introducing new diseases to Arctic wildlife. A study in northwest Canada and Alaska (1993–2001) showed that lynx (*Lynx canadensis*) had been exposed to feline parvovirus, feline infectious peritonitis virus/ feline enteric corona virus, and canine distemper virus (Bradley et al., 2005). The majority of infections occurred in more southern populations. While environmental factors could play a role in the difference, the high incidence of infection could indicate more exposure to domestic pets, because the southern regions of Canada are more densely populated (Bradley et al., 2005). Additionally, these domestic animals could become part of the life cycle of existing parasites, amplifying the number of parasites. For example, foxes and lemmings are host to the parasite *Echinococcus multilocularis*, but domestic dogs can also carry and spread the parasite (Bradley et al., 2005). Additionally, as animal husbandry expands into the Arctic, there are greater risks for diseases to spread from livestock to wild animals. In 1977, examined Alaskan bison (*Bison bison*) did not have any antibodies for parainfluenza 3 virus. However in 1984, after a cattle industry came to the region, another study was conducted, which found antibodies in the bison (Bradley et al., 2005). Toxoplasmosis, which is transmitted by domestic cats, has been found in a spinner dolphin and Beluga whales (Daszak et al., 2001). Additionally, influenza B, which was previously only found in humans, has been detected in a harbor seal (Daszak et al., 2001). Increased human activity in the Arctic could also be a source of new infections for wildlife. Pollution, soil runoff, and sewage all provide opportunities for human and domestic animal pathogens to enter the environment, where wildlife could encounter them.

4.2 Climate change

Warmer temperatures in the Arctic are causing changes in surface temperature, sea ice, snow coverage, permafrost, ocean warming, and precipitation. The resultant changes to the food cycle may result in wildlife adapting their diet or hunger, reducing their immune system. The environmental changes also have significant effects on pathogens and the host-pathogen relationship. For pathogens favoring warmer temperatures and milder winters, climate change could improve their survival and development. Additionally, warmer weather allows for temperature limited vectors to expand their range, potentially infecting more or new animals. For immunologically naive populations, this expansion could have detrimental effects.

Warmer water temperatures will likely allow pathogens to expand their range, moving further north. For example, the bird intestinal trematode parasite *Cryptocotyle lingua* is an infective parasite that causes "black spot" disease in intermediate fish hosts. In mariculture, particularly for cod, this is a particularly detrimental disease, resulting in spoilage and unsellable fish. *Cryptocotyle lingua* can only emerge from its mollusk host when water temperatures are above 10°C (Tryland et al., 2009). As water temperatures rise, conditions improve for the infective parasite to emerge and have greater opportunities for its range to expand northward. Additionally, the salmonid parasite, *Tetracapsuloides bryosalmonae* is currently limited by temperature. While widespread in freshwater invertebrate Bryozoans and salmonids, *T. bryosalmonae* only causes proliferative kidney disease when water temperatures remain above 14°C for long periods of time. *Tetracapsuloides bryosalmonae* is responsible for severe disease and population decline in parr in at least two Norwegian rivers (Tryland et al., 2009). Warmer waters are also a factor in increasing rates of bacterial furunculosis as well as protozoan-caused *Ichthyophonus* and whirling diseases, supporting the free-living stages of fish pathogens and possibly stressing the fish, leaving them more susceptible to diseases (Bradley et al., 2005).

Temperature and moisture strongly influence development and survival in parasites. Warmer soil temperatures, milder winters, and wetter summers provide favorable conditions for parasitic eggs and larvae to survive. But increased frequency of freeze-thaw cycles or flooding/drought could decrease parasitic survival and transmission (Bradley et al., 2005). Increasing temperatures are predicted to expand the range and abundance of parasites. For example, U*mingmakstrongylus pallikuukensis*, *Parelaphostrongylus odocoilei*, and *Elaphostrongylus rangiferi* larvae are shed by ungulate hosts and enter gastropod intermediate hosts. Development in the intermediate host does not occur at temperatures lower than 8–10°C (Bradley et al., 2005). Zoonotic fish parasites *Diphyllobothrium* spp., *Anisakis simplex*, and *Pseudoterranova decipiens* are likely to have faster hatching and development of larvae and increased abundance in intermediate and definitive hosts as a result of climate change. *Trichinella* spp. (bears and walruses), *Toxoplasma gondii* (marine mammals, birds, and ungulates), *Echinococcus multilocularis* (red fox and raccoon dogs), and *Echinococcus granulosus* (dogs) have been considered likely to have better opportunities for completing their life cycle and to be spread to more hosts as a result of climate change (Davidson et al., 2011).

Arctic birds may be particularly affected by climate effects for habitat, migratory timing, and breeding, but the effect on avian diseases is difficult to predict (Bradley et al., 2005). Migratory birds are particularly susceptible to poultry pathogens like Newcastle disease (paramyxo), and avian influenza viruses (Bradley et al., 2005). As such, they have the potential to spread these diseases to endemic Arctic species or, to even spread diseases like H5N1, a highly infectious influenza strain, to humans (Bradley et al., 2005).

4.3 Zoonotic diseases

As the Arctic changes, there is also a greater risk for zoonotic infections. Zoonotic infections (infections spread from animals to humans) in the Arctic of great concern include brucellosis, toxoplasmosis, trichinellosis, giardiasis, cryptosporidiosis, echinococcosis, rabies, tularemia, tick-borne encephalitis, leptospirosis, and anthrax (Hueffer et al., 2013; Revich et al., 2012). Monitoring and surveillance in wildlife, especially for these diseases holds a significant impact for humans.

4.4 Limitations and knowledge gaps

Assessing wildlife infectious disease trends poses many challenges. Wildlife in the Arctic is marine, terrestrial, and aerial, spanning across eight countries or more, if the species is migratory. Limited surveillance systems, veterinary care, and animal behavior also pose challenges for assessing wildlife diseases. However, indigenous populations, citizen scientists, hunters, and governmental agencies provide valuable data. Wildlife surveillance is important for detecting new diseases and forming risk assessments, vital to both human and wildlife populations (Yon et al., 2019). As the Arctic continues to change at a rapid pace, detecting changes in wildlife is paramount.

Conclusions

Food sources, habitat, migratory timing, distribution patterns, and reproductive success are changing with globalization and climate changes. As a result, changes in wildlife infectious diseases are occurring. As the environment warms, becoming more favorable for development and reproduction for certain pathogens and insect vectors, there is a greater risk for wildlife infections. New disease exposures and stresses put additional risk for wildlife. Surveillance, vaccination, and education for people interacting with wildlife and living in the Arctic will be crucial for mitigating the changes in wildlife infectious diseases associated with globalization and climate change.

Table 3. Arctic changes and wildlife infectious diseases

Threat	Consequences	Example
More people (and pets) coming into the Arctic	Pets introduce new diseases	Toxoplasmosis (transmitted by domestic cats) found in a spinner dolphin (Daszek et al., 2001)
	Pets become hosts for wildlife parasites	Domestic dogs carry and spread *Echinococcus multilocularis*, in addition to wild hosts, foxes and lemmings (Bradley et al., 2005)
Climate change	Habitat changes stress wildlife	Warmer water temperatures may stress fish, leaving them more susceptible to bacterial and protozoan infective diseases (Bradley et al., 2005)
	Pathogen range exposure	Northern expansion of fish parasite *Cryptocotyle lingua*, (causative agent for "black spot" disease) resulting from increasing areas with suitable warm water (Tryland et al., 2009)
	More favorable conditions for parasite development	Warmer temperatures and milder winters result in better condition for parasites' development, survival of larvae, and opportunities to spread to hosts (Davidson et al., 2011)
Increasing industry	Animal husbandry introduces new diseases	Bison exposed to parainfluenza 3 virus from cattle industry (Bradley et al., 2005)

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5 One Arctic - One Health - Water security in circumpolar region

Ilkka T. Miettinen

Clean, safe, fresh water is one of the most important natural resources for human kind. Safe drinking water and adequate sanitation are corner stones for human life. Thus safely managed drinking water services are included as one the main WHO´s Sustainable Development Goals (SDG target 6.1). However, a challenge with water resources is that water is not evenly available for all the human settlements. The state of water services in the Arctic was studied using interviews of water hygiene experts and reviewing the literature. The study showed that Arctic climate conditions affect strongly the water services in the circumpolar nations. Some of the challenges concerning water services are similar while some are more nation-related.

In **Alaska**, as in many Arctic regions, permafrost is restricting the usage of ground water. Thus, Alaska´s public water systems use often surface water supplies in drinking water (DW) production. A large portion (60%) of Alaska Native people live in villages. Nearly 30% of these villages (3,200 households) do not have running piped water or sanitation. Streams, ponds, snowmelt, ice melt, precipitation are used as water sources (ADEC, 2018). Lack of in-home water means that most of the water has to be dedicated for making food instead of personal hygiene (hand washing and bathing) (Hennessy et al., 2008). In **Canada**, DW supplies are generally of excellent quality. Problems are related to the indigenous communities which have difficulties to have access to safe DW. In many indigenous communities a boil water advisory is the only available action to ensure safe quality of DW (Black and McBean, 2017). Availability of water resources is a challenge in northern Canada where permafrost prevents the usage of ground water. Pipelines installed above ground are used in some communities, while in many villages DW is delivered with trucks (NCCEH, 2014). This means that amount of in-home water at territories like Nunavat can be limited (M.LeBlanc-Havard, personal communication, 5/2018). Scarcity of water can affect capability to maintain good personal hygiene (Daley et al., 2014).

In **Finland**, as in many Nordic countries, approx. 500,000 inhabitants living in rural areas use private wells. Major challenges related to ground water supplies concerns the geography. The aquifers are unconfined and shallow which cause vulnerability for pollution (Klöve et al., 2017). During the past twenty years, there have been 95 waterborne outbreaks, which have mainly occurred in small groundwater suppliers. The majority of the drinking water produced in **Norway** is safe and complies with the hygienic requirements. Major challenges in DW quality are related to small water works, usage of untreated surface water and deterioration of pipelines (NIPH, 2016). There have been 41 waterborne outbreaks causing 8,308 illness cases in Norway during 2003–2015. The national legislation requires that public water works need to have “a sufficient number of hygienic barriers so that the water is free of viruses, bacteria, parasites, other microorganisms or substances” (Mattilsynet, 2018). In **Sweden**, the water treatment in ground water works is simple or no treatment is used (Swedish Water, 2018). About 1 million inhabitants use a private well in their house-holds (Guzman-Herrador et al., 2016). Chemical contamination and overexploitation is threatening ground water sources (Swedish Water, 2018). There have been 59 waterborne outbreaks in Sweden which have affected 52,258 persons during 1998–2012 (Guzman-Herrador et al., 2016). As in all Nordic countries most of the Swedish waterborne outbreaks have occurred in small water works (<5 000 customers) (Gunnarsdottir et al., 2017).

In **Greenland**, the ice sheet covers majority of the surface area of Greenland forming the largest fresh water source on earth. Surface waters (lakes and rivers) are used as major sources for drinking water. Permafrost mainly prevents the usage of ground water. Centralized DW production system consists of 74 water works resulting in 100% coverage of population (Government of Greenland, 2018). In **Iceland**, the vast majority (95%) of drinking water (DW) originates from ground water. The rest of DW is produced from surface waters using UV disinfection and some also use filtration treatment. Usually the quality of ground water is good and complies with the requirements of safe DW. Major challenges in DW production are related to small, rural water supplies. Some of these rural communities use unconsolidated gravel deposits potentially affected by surface waters (Gunnarsdottir et al., 2016). During 2010–2014 there have been six waterborne outbreaks which were all related to small water suppliers (<5 000 customers) (Gunnarsdottir et al., 2017).

There are significant challenges related to drinking water (DW) quality in the Arctic regions of **Russia** (Dudarev et al., 2013a). “The water supply and sanitation situation in the Russian Arctic Yakutia and Chukotka is remarkable for the very limited access to running in-home service. Additionally, the combination of a lack of water pretreatment, common use of raw surface water, and direct sewage discharge into the environment all pose real and ongoing threats to public health. Many of the systems are old and subject to deterioration.” (Dudarev, 2018). The problems in general water hygiene have major impact of the health status in the Arctic regions of Russia (Dudarev et al., 2013a). “Both the incidence of infectious and parasitic food- and waterborne diseases among the general population of selected regions of Russian Arctic, Siberia and the Far East (in 2000–2011) is alarming, often exceeding the national incidences.” (Dudarev et al., 2013b).

Conclusions

In principle, the existing legislation in the Arctic nations should ensure equal rights to safe drinking water and sanitation. Still, centralized DW and sanitation systems are not yet available for all people in the Arctic region. The cold climate reduces the dispensing time of fresh surface waters and permafrost may prevent the usage of ground waters. Also, running water systems will freeze if the pipelines are not properly insulated. Alternative drinking water sources and transport options including usage of self-hauling water sources and DW tanks need to be applied. Arctic conditions often reduce the amount of usable household water jeopardizing every-day hygiene to prevent water-washed diseases. Difficulties in maintaining sufficient amounts of safe DW may also result waterborne outbreaks. The lack of running water also influences the cost of water which can be a remarkable economic burden.

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6 TremArctic Networking

Antti Oksanen and Antti Lavikainen

The primary aim of the TremArctic Network is to foster collaboration within zoonotic fish-borne trematode infection research in the circumpolar North. The secondary aim is to promote collaboration in cestode parasite research. Even though there is no indication that the North American liver fluke *Metorchis conjunctus* would be disappearing from the wildlife cycle, human cases have become rare, possibly mostly due to change in diet with less consumption of raw sucker fish (Catostomidae). This may, however, change, if the increasing interest in eating raw fish will also cover sucker fish and/or invasive cyprinid species potentially spreading in northern North America. In this case, fish-borne liver flukes could rapidly re-emerge in North America.

In Russia, especially in Siberia, *Metorchis bilis* and *Opistorchis felineus* liver flukes are important zoonotic agents. The recent discovery of the former species in the Gulf of Finland has caused concern both in Russia and in Finland, and has led to research collaboration. Common interest in Taeniidae tapeworms has initiated Russian-Finnish genetic research of *Echinococcus* spp. and *Taenia* spp. from the Siberian (Nenets Autonomous Region) and Northwest-Russian (Nenets Autonomous Region and Murmansk Oblast) reindeer herding areas, as well as from Finland. The counterparts signed formal collaboration agreements. As the rodent-borne zoonotic *Echinococcus multilocularis* is emerging in Canada, and the moose- and caribou-borne *Echinococcus canadensis* is prevalent in wolves and hunting dogs in Canada, and apparently also in Alaska, mutual interest has been expressed to identify parasite isolates in the circumpolar Arctic.

7 One Arctic - One Health conference

The conference (https://www.oulu.fi/thule/onehealth) was held in Oulu February 7–9, 2019, drawing nearly 100 registered participants (from 16 countries), and 24 of those were early career researchers and Indigenous participants who received travel grants from the U.S. NSF. The conference served as an integral part of Finland's Arctic Council Chairmanship program and was open to scientists, students, policy makers, businesses and all other interested stakeholders. Science sections focused on all the multidisciplinary themes of One Health approach - health of environment, wildlife, semi-domestic animals and humans - from social aspects to technological solutions (see conference program, Annex 3 and abstracts, Annex 4). One Health enhances participatory community-based approaches for identifying and responding to health and well-being issues in communities, which take into account traditional and local knowledge. In the first day there were keynote sessions, the second day was for oral and poster presentations and the third day allowed for planning joint activities and next steps in One Health actions. Key areas for further exploration and work (identified on day 3) included:

- The need for more exchange and educational programs to learn about best practices and how they can be adapted to other Arctic communities
- The need for better communication, data management and data sharing practices
- The need for inclusion of non-traditional stakeholders (such as social science and the private sector) in One Health activities, as well as women, youth, and indigenous communities
- The need for greater collaboration and coordination between Arctic and sub-Arctic projects and communities, since many One Health phenomena extend beyond the Arctic region
- The importance of addressing new phenomena (such as vectors carrying emerging diseases, marine debris, etc.) and applying new technologies (such as improved diagnostics) to address One Health issues
- The difficulty and importance of building networks with common language and shared goals across complex and different systems and sectors
- The importance of demonstrating impact
- The continuation of One Health conferences

The next conference of One Health will be in Fairbanks, March 11–14, 2020. The One Health project will continue during the Icelandic Chairmanship, and collaboration between different societies, projects and networks will produce a lot of scientific and practical information to be shared locally, nationally, circumpolarly and globally.

8 Collaboration and future plans

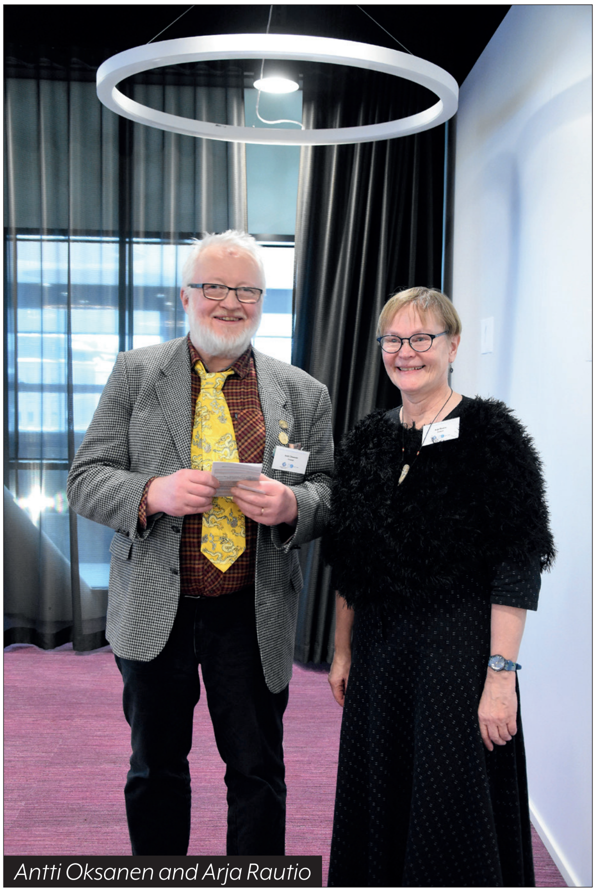
There are human health expert groups under the Arctic Council SDWG (AHHEG) and AMAP (HHAG) Working Groups (WGs). During the last two years there have been two joint meetings (Inari 2017 and Copenhagen 2018) focusing on identifying potential areas of closer collaboration. One important common topic has been One Health. It is important to continue and strengthen collaboration with AMAP, but also to inform other WGs about the actions and projects on One Health under SDWG and AMAP.

The University of Alaska (Fairbanks) has joined the UArctic Thematic Network on Health and Well-being in the Arctic, which enhances the collaboration and improves the visibility of the education and research of One Health (e.g. Master's program on One Health). Collaboration with INTERACT (https://eu-interact.org/, EU funded project, monitoring of possible vectors for zoonotic diseases), Nunataryuk (https://nunataryuk.org, Horizon project, modelling and risk assessment of anthrax and contaminants), and CLINF (https://clinf.org, Nordic Centre of Excellence, climate change effects on infectious diseases) will give opportunities to share knowledge, which is needed when planning next steps of the One Health approach.

Proposed action items for further work in the Arctic Council:

1. The Arctic Council and SDWG should continue to promote One Health as a key strategy for regional resilience.
2. The Arctic Council and SDWG should continue to play a valuable role by forming a platform for knowledge sharing, simulated exercises, and collaborative investigations of One Health phenomena, and by creating avenues for the inclusion of Traditional and Local Knowledge as a key aspect of One Health understanding and practice in the Arctic region.
3. The Arctic Council, SDWG, Member States, Permanent Participants, Accredited Observers, and Arctic communities should promote regular and recurring Table Top Exercises, exchange and educational programs as a tool for continued capacity building and relationship strengthening.
4. The Arctic Council, SDWG, Member States, Permanent Participants, Accredited Observers, and Arctic communities should continue promote opportunities for increased international collaborative investigations of One Health phenomena in the circumpolar region; results of these investigations should be shared with affected communities
5. The Arctic Council and SDWG should continue to engage nongovernmental groups in future One Health projects and activities.
6. Arctic Council member states, Permanent Participants, and Accredited Observers should identify and empower One Health Hubs/Points of Contact.

Photos from the One Arctic - One Health conference, February 7–9, 2019, Oulu, Finland

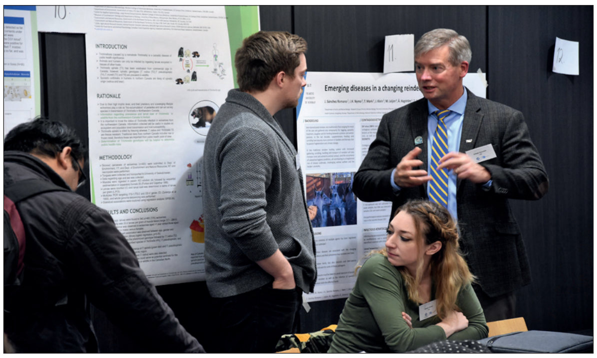


Antti Oksanen and Arja Rautio

Khaled Abass and Tomas Thierfelder

Ilkka T Miettinen

Audrey Waits



Photos: Seija Leskelä Kulmakuvaamo

9 List of Annexes

Annex 1:

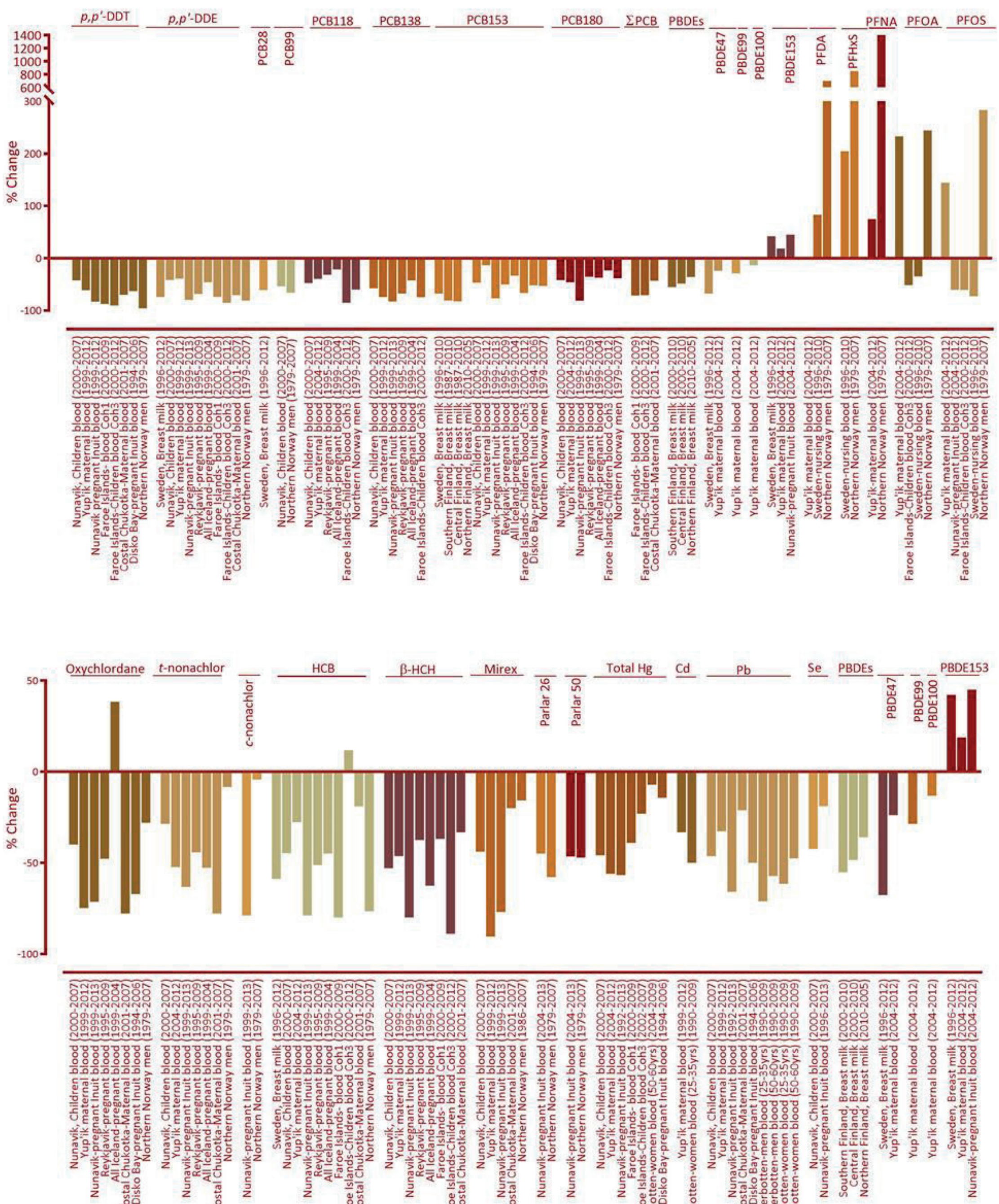


Figure 1. *Percentage changes for contaminant monitoring trends in human biological matrices for the specific location and period of sampling*

Annex 2:

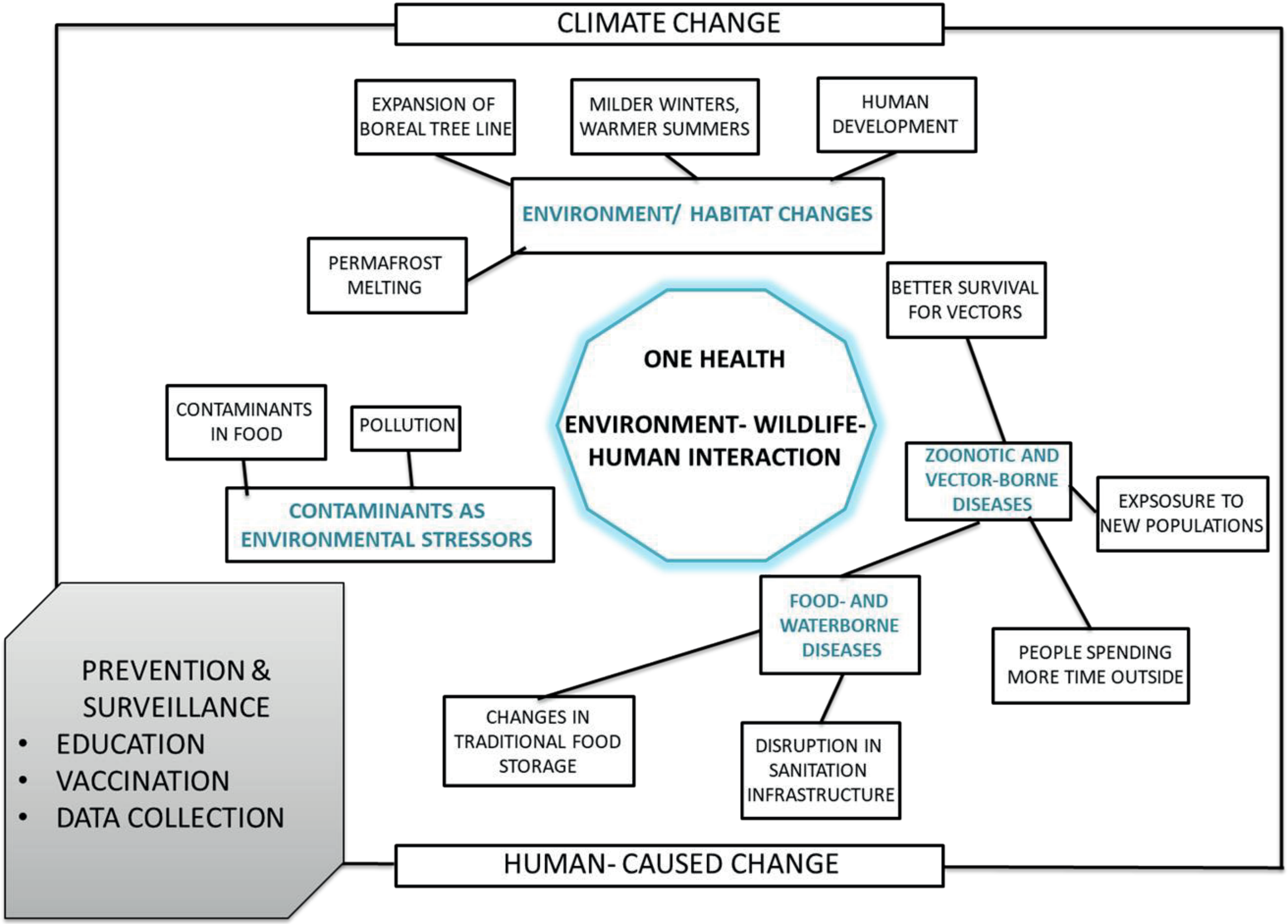


Figure 2. *Effects of climate and human-caused change on the Arctic*

Annex 3: One Arctic - One Health conference program

Thursday, February 7, 2019

8:30–13:00	**AHHEG meeting**
10:00	Registration
13:00–14:00	Lunch
14:00–15:00	**Opening session**
Welcome words	René Söderman, Senior Arctic Official for Finland, Ministry of Foreign Affairs, Finland Joshua Glasser, Foreign Affairs Officer, U.S. Department of State, USA Jyoti Bhargava, Policy Lead, Crown-Indigenous and Northern Affairs Canada, Government of Canada
Keynote speech	Heikki Henttonen, Finland: Biome specific zoonotic epidemiologies
15:00–15:30	Coffee break
15:30–17:00	**Opening session**
Keynote speeches	Khaled Abass, Finland: Contaminants in Arctic human populations Arleigh Reynolds, University of Alaska Fairbanks: Sled dog husbandry as approach to supporting transfer of traditional knowledge and resilience to at risk youth in rural Alaska. Emily Jenkins, Canada: Emerging infectious disease issues at the One Health interface in the northern North America
17:00–18:00	Icebreaker event

Friday, February 8, 2019

8:30	**Registration**
9:00–10:15	**Session 1**
9:00–9:15	Audrey Waits, Finland: Human infectious diseases.
9:15–9:30	Douglas Causey, USA: Local Partnerships in the Detection, Identification, Surveillance, and Public Health Aspects of Viral Zoonotic Pathogens in the Bering Sea Region.
9:30–9:45	Postoev V.A., Russia: Using medical birth registry for birth defects surveillance: Russian experience.
9:45–10:00	Tomas Thierfelder, Sweden: Climate-change Effects on the Epidemiology of Infectious Diseases in the Arctic. Linking landscape effects of climate change to the geographic spread of zoonotic infectious diseases.
10:00–10:15	Q&A
10:15–10:35	Coffee break + posters
10:35–12:00	**Session 2**
10:35–10:50	Kriya Dunlap, USA: Sled dogs as a model for human health in the circumpolar north.
10:50–11:05	Sanna Malkamäki, Finland: *Echinococcus canadensis* in reindeer in Northern Europe and Northwestern Siberia.
11:05–11:15	Anna Nikanorov, Russia: Ticks (Acari: Ixodidae) are bloodsuckers and vectors of dangerous pathogens and diseases. Ticks genera of Dermacentoz and Ixodes the most adapted in the Central and North-Western latitudes of Russia. Short presentation + poster
11:15–11:30	Ann Albihn, Sweden: Ticks on the move to the north – increased risk for new zoonotic infections?

11:30–11:35	Elisa Stella, Italy: On the transmission of anthrax disease in the Arctic region. Short presentation + poster
11:35–11:40	Anton N. Tokarev,Russia: Muscle parasites in reindeer: differential diagnostics and Russian food safety legislation. Short presentation + poster
11:40–11:45	Audrey Waits, Finland: Wildlife infections. Short presentation + poster
11:45–12:00	Q&A
12:00–13:00	Lunch
13:00–14:20	**Session 3**
13:00–13:15	Morten Tryland, Norway: Arctic hosts and pathogens on the move
13:15–13:20	Muhammad Asaduzzaman, Bangladesh: Environmental dimension of Antimicrobial Resistance (AMR); Occurrence and Spatial diversity of airborne resistomes in the poultry and household environment in Bangladesh. Short presentation + poster
13:20–13:35	Anita L. Moore-Nall, Lisa L. Schwarzburg, USA: A Legacy of Contaminated Sites and Possible Links to Health and Lifestyles in Alaska Native Communities.
13:35–13:50	Åsa Engström, Päivi Juuso, Sweden: Births before arrival to hospital – specialist ambulance nurses experiences.
13:50–13:55	Ilia Avrusin, Russia: Do we really need to use special charts to assess physical development of indigenous children of the North? Short presentation + poster
13:55–14:10	Heidi Aklaseaq Senungetuk, USA: *Inuit sayakturut, aġiruat*: The people are healthy, they are dancing.
14:10–14:20	Q&A
14:20–14:50	Coffee break + posters
14:50–17:00	**Session 4**
14:50–15:05	Jenifer Huang McBeath, USA: Strategies for developing an environmentally-responsible plant production system in Alaska.
15:05–15:10	Hannele Savela, Finland: INTERACT –building capacity for terrestrial research and monitoring in the Arctic and beyond. Short presentation + poster
15:10–15:25	Alex Bernardova, Czech Republic: Rapid response to environmental emergency alerts. An INTERACT initiative.
15:25–15:40	Joshua Glasser, USA: Applying a Diplomatic Toolkit to Advance One Health: The Case of the Arctic Council
15:40–15:55	Erica Lujan: Environmental observation, social media, and One Health action: A description of the Local Environmental Observer (LEO) Network
15:55–16:10	Sappho Z. Gilbert and Nora D. Moraga-Lewy, USA: “All of the Above” to “American Energy Dominance”: a One Health-based analysis comparing US energy policy impacts in Alaska
16:10–16:25	Rada Bulgakova, Russia; Marija Launonen, Finland: View of Western Siberian Indigenous peoples on Opisthorchiasis
16:25–16:30	Kayla Buhler, Canada: Role of a nest flea as a potential bridge vector for *Bartonella henselae* transmission between nesting geese and Arctic foxes, Vulpes lagopus, in Nunavut, Canada. Short presentation + poster
16:30–16:35	Émilie Bouchard, Canada: *Toxoplasma gondii* and other zoonotic endoparasites in foxes and lynx in Arctic and Subarctic Québec, Canada. Short presentation + poster
16:35–16:40	Elena Benusova, Russia: Interaction of Authorities and NGO in Social Health Issues of Children at Crime Risk. Short presentation + poster
16:40–16:45	Rajnish Sharma, Canada: Trichinella in wolverines of northwestern Canada, Sentinel Species and One Health. Short presentation + poster

16:45–16:50	Javier Sanchez Romano, Norway: Emerging diseases in a changing reindeer herding system. Short presentation + poster
16:50–16:55	Ekaterina Bubnova, Russia: The traditional livelihood of indigenous populations and the climatological conditions of the circumpolar world. Short presentation + poster
16:55–17:00	Natalia Petrova, Russia: Strongyle invasion at kulans in Kazakhstan during winter 2017–2018
16:55–17:15	Q&A
18:30	Dinner *Restaurant Vanha Paloasema* (Kauppurienkatu 24A)

Saturday, February 9, 2019

9:00–10:30	**Session 5**
9:00–9:15	Ilkka T. Miettinen, Finland: Water safety in the Arctic region
9:15–9:30	Sarah Yoder, USA: The public health response to arsenic contamination of drinking water wells in Alaska
9:30–9:45	Veronica M. Padula, USA: Plastics in the Bering Sea: Marine Debris and Associated Contaminant Exposure in Subsistence Species
9:45–9:50	Evgenia Tsupadina, Russia: Association between polymorphisms of NAT2 gene and lung cancer susceptibility in Yakut population. Short presentation + poster
9:50–9:55	Nathaniel Hansen, USA: Mental healthcare performance measurement in circumpolar regions. Short presentation + poster
9:55–10:00	Kennedy Jensen, USA: Multidisciplinary Collaborations for Community Wellness within Circumpolar Regions. Short presentation + poster
10:00–10:05	Samantha Salter, Canada: A One Health approach to emergency preparedness in health and social services: Incorporating animal care into emergency social services planning. Short presentation + poster
10:05–10:10	Lidia Rakhmanova, Russia: "We live like on a boiling pot": parallels between climate change, ecology and health in local community members' interpretation. Short presentation + poster
10:10–10:30	Q&A
10:30–10:50	Coffee break + posters
11:05–12:00	**Closing discussion**
12:00–13:00	Lunch

Annex 4: One Arctic - One Health conference abstracts

Contaminants in Arctic human populations

Khaled Abass[1], Anastasia Emelyanova[2], Arja Rautio[1,2]
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The focus area of the Arctic Monitoring and Assessment Programme reports was to monitor levels of environmental contaminants in the Arctic and to assess the health effects connected with detected levels in Arctic countries. This review gives an overview of temporal trends of contaminants and their health effects in humans of the Arctic based on data published by AMAP, as well as Russian scientific literature. Several time series of 31 contaminants in humans of the Arctic from different cohorts are reported. The lengths of time series and periods covered differ from each other. International restrictions have decreased the levels of most persistent organic pollutants in humans and food webs. Percentage changes for contaminants in human biological matrices (blood samples from children, mothers and males and breast milk samples) for the period of sampling showed declining trends in most of the monitored Arctic locations, with the exception of oxychlordane, hexachlorobenzene (HCB), 2,2´,4,4´,5,5´-hexabromodiphenyl ether (PBDE153) and perfluorinated compounds (PFCs).

Sled dog husbandry as approach to supporting transfer of traditional knowledge and resilience to at risk youth in rural Alaska

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University of Alaska Fairbanks, USA

Sled dogs have long been integral to the identities of the indigenous societies of the arctic, where for millennia they have been used for transportation, hunting, recreation, and protection. The sudden plunge of these societies into the modern world, with its notions of individualism versus collectivism and materialism versus spiritualism, has resulted in a difficult cultural transition, creating dramatic social and economic upheaval. In the final years of his life, Athabaskan elder and world champion sled dog racer, George Attla, conceived of a program that engaged youth in learning sled dog husbandry as a means of transferring traditional cultural knowledge from elders, provided a sense of self-identity, and improved the mental, behavioral, and physical resiliency of young people and their communities. Using elders to teach mushing related traditional skills such as hunting and fishing, and food preparation, as well as fire-building and arctic survival, students in the FAYSDP program spend time in working kennels, where they gained a sense of cultural history and self-esteem. Improvements in student behavior, and student outcomes have been observed, resulting in a positive transformation for the entire community. The work that Attla started in his home village of Huslia has grown, and is now being used as the model for an expanded A-CHILL project that serves nine other schools in Alaska's Interior, with high school students learning traditional skills while taking University courses and preparing for village based careers in the fast growing healthcare fields.

Human infectious diseases

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[2]Thule Institute & University of the Arctic, University of Oulu, Finland
[3]Finnish Food Safety Authority Evira (FINPAR), Oulu, Finland

Climatic factors, especially temperature, precipitation, and humidity play an important role in disease transmission. As the Arctic changes at an unprecedented rate due to climate change, understanding how climatic factors and climate change affect infectious disease rates is important for minimizing human and economic costs. The purpose of this systematic review was to compile recent studies in the field and compare the results to a previously published review. English language searches were conducted in PubMed, ScienceDirect, Scopus, and PLOS One. Russian language searches were conducted in the Scientific Electronic Library "eLibrary.ru". This systematic review yielded 22 articles (51%) published in English and 21 articles (49%) published in Russian since 2012. Articles about zoonotic and vector-borne diseases accounted for 67% (n=29) of the review. Tick-borne diseases, tularemia, anthrax, and vibriosis were the most researched diseases likely to be impacted by climatic factors in the Arctic. Increased temperature and precipitation are predicted to have the greatest impact on infectious diseases in the Arctic.

Local partnerships in the detection, identification, surveillance, and public health aspects of viral zoonotic pathogens in the Bering Sea region

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Recent advances in molecular virology have led to the identification of many different human or related viruses in diverse species of birds, marine mammals, and bat species. Even apparently healthy animals are now known to carry pathogens that are virulent in humans ("zoonotic disease"). The high potential for wide-spread dispersal of influenza, rabies, and other pathogenic viruses by bird and bat populations is high due to their unusual immune system that allows persistent infection and shedding of viral pathogens for months, their ability to fly and migrate, their gregarious social structure (which contributes to the amplification of viruses in breeding colonies), and the close association of arctic human communities with hosts through locality and subsistence. We discuss our use of single sample pan-viral assays for the detection of RNA viruses of wildlife and human concern: Orthomyoxoviruses (Influenza A), Coronaviruses, Orthoreoviruses, Paramyxoviruses, and Lyssaviruses (Rabies). Emerging viruses including avian influenza viruses (AIV) can cross species barriers to spread into new ecological niches, hosts, and infection locality foci. A systematic data analysis of viral genotypes, virus infections in animal models, and host factors governing species specificity, replication potential, transmission and pathogenicity may contribute to understanding zoonotic and epidemiological patterns of infection. We are now focusing study on the community-wide assembly of likely zoonotic pathogens in selected localities in the Bering Sea region, the changes through time associated with breeding cycles, and how LEK, TEK, and local subsistence activities can engage and be informed in the survey activities.

Using medical birth registry for birth defects surveillance: Russian experience

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Introduction: An ongoing epidemiological surveillance is a core issue in a primary prevention of birth defects (BD). The aim of the study was to assess the prevalence of BD based on population-based birth registry data and to compare the completeness of registration with data of Federal BD monitoring system.

Materials and methods: The Arkhangelsk County Birth Registry (ACBR) and Federal BD monitoring system data were used in this retrospective cohort study. The ACBR includes information on all 57 944 live- and stillbirths at gestational age 22 and more weeks registered in Arkhangelsk County, Northwestern Russia, in 2012–2015. Totally, 57 449 newborns without missing information on BD were included in the study.

Results: In 2012–2015, 2 841 various BD in 2 274 newborns were registered in Arkhangelsk County according to the ACBR. The total prevalence of BD in the ACBR was 39,6 per 1 000 newborns (95% CI: 39.6–41.2), the total prevalence in the Federal monitoring system was 16.2 per 1 000 newborns (95% CI: 15.2–16.2) The completeness of registration varied across groups of BD and their severity: the accuracy and completeness of information on neural tube defects and chromosomal abnormalities were higher in Federal BD monitoring system, while registration of cardiovascular and genital-urinary malformation was more complete in the ACBR.

Conclusion: The total prevalence of BD in the ACBR was higher compared to that reported by the Federal BD monitoring system. Population-based registries can supplement the current system of BD surveillance to make an estimation of prevalence more precise.

Climate-change effects on the epidemiology of infectious diseases in the Arctic
Linking landscape effects of climate change to the geographic spread of zoonotic infectious diseases

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Introduction: Climate change is considered to have a significant impact on the epidemiology of Arctic infectious diseases, that threatens Arctic societies by terms of socio-economy, culture, health, welfare, security, animal husbandry, and food supply (etc.). With arctic societies being generally dependent on husbandry animals, the erosion of animal welfare introduced with emerging zoonotic diseases adds to the effects of human exposure, where the resulting dynamic scenario requires a holistic OneHealth study-approach. The OneHealth approach requires interdisciplinary collaboration across disciplines such as ecology, veterinary and human medicine, earth sciences, and mathematical statistics, in order to address the processes and effects of potentially spreading infectious diseases.

Methods: The authorities that administer national programs of infectious diseases control have been engaged in the acquirement of diseases data covering Denmark/Greenland, Iceland, Norway, Sweden, Finland, and Russia through the past 30-year climate reference period, regarding incidences of anthrax, borreliosis, brucellosis, cryptosporidiosis, leptospirosis, hantavirus infection, Q-fever, tick born encephalitis, and tularaemia. These data were supplemented with satellite-sensed climate data covering the same reference period of time with approximately 35 standard variables ranging from different temperature cumulations, via snow-cover duration, to chlorophyll density. The selection of diseases and climate variables was made via a process of expert review. When combined, a geographic information system was used to down-scale climate data into the climate-characteristics of individual administrative diseases report districts (basically at county-level). The resulting dataset was statistically inferred regarding the orthogonal linear combinations of climate data that best explain the observed variation of diseases incidences across report districts.

Results: Preliminary studies indicate strong climate sensitivity regarding some diseases, and lesser sensitivity regarding others. This conforms well with empirical observations, where climate sensitivity indicates a potential of diseases to migrate with climate change, and where this potential is much regulated by the ecological characteristics of the vector and reservoir organisms that carry diseases pathogens through the landscape.

Discussion: By determining statistical relations across the geographic spread of climate and diseases through the 30-year climate reference period, future diseases scenarios may be predicted in accordance with the standard IPCC climate scenarios. Such projections of future diseases scenarios constitute invaluable decision support in the process of strengthening the climate resilience of Arctic societies and cultures.

Sled dogs as a model for human health in the circumpolar north

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Dogs are an important biomedical research model whose relationship and parallel evolution with man embodies the essence of One Health. In the circumpolar north, sled dogs were historically part of the traditional subsistence lifestyle; used for trapping, packing and transportation. In rural Alaska, sled dogs eat many of the same foods and are exposed to many of the same environmental stressors as their human counterparts, making them a unique model for studying the impact of diet and environmental contamination on disease. Their robust energy expenditure makes them an ideal model for studying metabolism and exercise research. The extreme environment in which these animals thrive allows for the study of cold adaptation and thermoregulation. I will present the highlights from nearly two decades of research in which sled dogs were used as a sentinel for human health. Example studies that will be discussed include diet and exercise in insulin signaling, the influence of season and activity on vitamin D levels, mercury exposure in fish fed population, and seasonal adaptations and diurnal variations in northern latitudes. Several sled dog studies have paved the way and refined techniques that were employed in follow up human studies in populations living in the circumpolar north.

Echinococcus canadensis in reindeer in Northern Europe and Northwestern Siberia

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Tapeworm *Echinococcus canadensis* is one of the causative species of cystic echinococcosis, a significant zoonotic disease. Dogs and wolves are definitive hosts for *E. canadensis*, and in Northern regions cervids act as intermediate hosts. Two mitochondrial genotypes, G6 and G10, have been reported in reindeer. The parasite has disappeared from reindeer population in Norway and Sweden. In Finland, only one or a few cases are found annually in meat inspection. Endemic human cases have not been reported from reindeer husbandry area of these countries for 40 years. The parasite is maintained only in wildlife cycle (wolves and wild cervids) in backwoods of Eastern Finland. In Murmansk region, prevalence of reindeer echinococcosis is ca 2%. Two human cases were reported during the past 10 years, but their origin is unknown. In Yamalo-Nenets Autonomous Okrug (YaNAO), Northwestern Siberia, prevalence of echinococcosis in reindeer is ca 4%. The number of human cases in YaNAO was halved over the past 15 years, but still 16 cases were diagnosed in 2017. The patients were reindeer herders or their family members. Survival of traditional nomadic reindeer herding culture in YaNAO, with an extensive use of dogs, can explain the foothold of echinococcosis. Despite significance of reindeer echinococcosis in Northern Russia, knowledge on parasite genotypes is based only on very limited data from Sakha Republic. In this winter, as a joint research between Finland and Russia, One Arctic – One Health project is aiming to clarify genetic diversity, phylogeography and epidemiology of *E. canadensis* in reindeer in Northern Russia from Murmansk region to YaNAO. Specimens will be collected for sequence analyses in reindeer slaughterhouses during routine meat inspection.

Ticks (Acari: Ixodidae) are bloodsuckers and vectors of dangerous pathogens and diseases Ticks of the genera Dermacentor and Ixodes the most adapted in the Central and North-Western latitudes of Russia

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Objective: to study the fauna and ecology of cold-resistant ticks in the Kaluga region.

Results and discussion: For determining the tick fauna, tick specimens were collected from large mammals, small vertebrates and free from the environment plants. Altogether 1 256 ticks were collected, 685 adults from large animals and 245 from plants, and also 218 larvae and 108 nymphs from small mammals. We found ticks of the species *Ixodes ricinus* and *Dermacentor reticulatus*. The identified hosts of the larvae and nymphs in the Kaluga region are *Myodes glareolus*, *Apodemus agraris*, *Apodemus uralensis*, *Rattus norvegicus*, and *Mus musculus*.

We found the number of ixodid larvae and nymphs depending on the activity of the hosts. The parasitic activity of larvae and nymphs in small and big mammals begins in the second week of April with parasite number increasing till the maximal number between May 10th and 20th. The larval abundance of *I. ricinus* and *D. reticulatus* is reduced deeply in mid-June and mid-August, respectively. The low temperature threshold for larva and nymph evolution was determined as 9 ˚C ± 1.5 ˚C, although some individual specimens were discovered at 6–7 ˚C.

Imagoes of *I. ricinus* are active in the end of March. The first activity peak is in May, the second is in the second half of August and September. *Dermacentor reticulatus* reproduces every year if larvae and nymphs find their hosts. The temperature threshold of larva, nymph and imago evolution was determined as 10 ˚C ± 1.5. ˚C. *Dermacentor reticulatus* ticks are mobile in late March and early April with a peak of activity in mid-May-June, the second peak of activity in ticks of this species is less pronounced and falls on the second and third week of September. Both well-fed and hungry *D. reticulatus* spend winter in imago stage. In the Kaluga region, *I. ricinus* mites belong to forest biotopes and in turn *D. reticulatus* ticks belong to agriculture and suburban biotypes.

Ticks on the move to the north – increased risk for new zoonotic infections?

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Introduction: Climate change expands the geographical distribution of ticks to higher latitudes and altitudes. Ticks are vectors for several zoonotic diseases e.g. granulocytic anaplasmosis and babesiosis. The role of ticks bringing tick-borne pathogens into the north is unclear. Globally anaplasmosis and babesiosis cause relevant diseases in several species including humans and in the southern half of Sweden they infect especially ruminants. The present study aims to investigate the northern expansion of ticks and tick-borne pathogens in Sweden.

Methods: Through a citizen science study 2018, SVA received around 4 500 ticks found on animals or humans in the northern half of Sweden. Morphological species identification and microbiological analysis with FLUIDIGM, a microfluidic PCR-based technique for an array of pathogens will be performed.

Results: Preliminary results concerning the tick species identification and expanded geographical distribution will be presented. Retrospective collection of Swedish official animal disease data revealed 24 cases of babesiosis year 2005–2016. For anaplasmosis there were no cases officially reported but 310 cases were diagnosed on ruminants year 2008–2018 at SVA.

Conclusion: When diseases show up in new areas, the unawareness may compromise protection of a population and the recognition of clinical symptoms. In addition, in an immunologically unprotected population, a new infection may give higher mortality rate or more severe clinical pictures. With new knowledge regarding the northern distribution of ticks and tick-borne pathogens, we may be able to identify new risk areas and suggest measures to minimize diseases.

On the transmission of anthrax disease in the Arctic region

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Recent cases of anthrax disease have severely affected reindeer herds in Siberia. Experts believe that these outbreaks have been caused by the presence of infected carcasses emerged from the thawing permafrost, underlying therefore the emerging character of such disease in the Arctic region due to climate change. Anthrax occurs in nature as a global zoonotic and epizootic disease caused by the sporulating bacterium *Bacillus anthracis*. It principally affects herbivores and causes high animal mortality. Its transmission occurs mainly via environmental contamination through spores which can remain viable in permafrost for more than 100 years.

We propose and analyze a novel epidemiological model for anthrax transmission that is specifically tailored for the Arctic region. In particular, the model investigates the transmission of disease between susceptible and infected animals in the presence of environmental contamination, including also herding practices (e.g. seasonal grazing) and a seasonal environmental forcing caused by the thawing permafrost. We show how the temporal variability of these factors influences the transmission of anthrax disease and how pathogen invasion may be favored as the endemic state of the infection changes. On the basis of our results, further analyses, which may also include spatial dynamics, can establish optimal procedures to prevent uncontrolled diffusion of anthrax infection in herding areas in the Arctic.

Muscle parasites in reindeer: differential diagnostics and Russian food safety legislation

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Reindeer muscles and therefore meat can be affected by Protozoa, Arthropods or Helminthes. In October 2018, heard of reindeer of the Nenets breed of various sex-age groups (from 6 months to 7 years) was slaughtered in the Zapolyarny region of the Nenets Autonomous District. During the veterinary and sanitary examination in several carcasses (obtained from adult males and females), elongated whitish objects, not characteristic for deer the muscle tissue, were found. They were delivered to the Department of Parasitology SPbSAVM and studied macroscopically and microscopically in its native form and with lactic acid clearing. It was found that objects were of different lengths (ranging from 1 to 3 mm) with a width of up to 0.03 mm; they were motionless and had a cavity divided into chambers. Objects were assumedly identified as cysts of *Sarcocystis rangi*. To clarify the diagnosis, it is advisable to conduct a genetic and histological examination. According to the current "Rules of veterinary inspection of slaughter animals and veterinary and sanitary examination of meat and meat products" (approved by the General Directorate of Veterinary Medicine of the USSR Ministry of Agriculture on December 27, 1983), the meat invaded by *Sarcocystis* if not damaged can be sold without restrictions. The proposed by the Ministry of Agriculture, but not yet in force "Rules in the field of veterinary and sanitary examination of meat and other products of slaughter" (March 22, 2017), demand the use of such meat for the manufacture of canned food or cooked sausages.

Wildlife infections

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The relationship between humans and wildlife in the Arctic is uniquely intertwined. For indigenous populations, wildlife plays a significant role in culture, traditional food, and livelihoods. For Arctic industry, wildlife provides food, sport, recreation, and are a valuable contributor for tourism. Because of the close connection and recurrent interaction between wildlife and humans, understanding wildlife infections is important for animal, human, and environmental health. In this review, we are investigating the literature that has been published about infections in a few key Arctic species: gulls, geese, grouse, ducks, salmon, pike, cod, reindeer/ caribou, moose, hares, foxes, bears, wolves, and sled-dogs. We are using PubMed, Scopus, and the Russian database, Scientific Electronic Library eLibrary.ru. Using a "One Health" approach, our aim is to establish a baseline review of what research is being conducted on infections in wildlife and explore what infections are emerging and important for human health, and what are the ramifications to wildlife, human, and environmental health. Our results are still in progress but we anticipate new insights into the current status of wildlife infections by using both English and Russian language databases.

Environmental dimension of Antimicrobial Resistance (AMR). Occurrence and Spatial diversity of airborne resistomes in the poultry and household environment in Bangladesh

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[2]School of Public Health, University of California, Berkeley, USA
[3]Department of Biotechnology and Bioinformatics, Pathogen Biology Laboratory, School of Life Sciences, University of Hyderabad, India

Background: Antimicrobial resistance (AMR) is an alarming issue with environmental evolution and transmission to a larger extent. We studied whether the outdoor environment (air) in Bangladesh acts as a reservoir for bacteria that can confer resistance to antibiotics with spatial diversity.

Methods: We collected air samples during January to July 2018 from both urban and rural settings in four distinct outdoor environments- i) Urban live bird markets(LBM) ii) Urban residential area(URA) iii) Commercial poultry farms (CPF) and iv) Rural households (RHH). We used standard plates and media supplemented with 3rd generation cephalosporin (3GC),carbapenem, oxacillin and vancomycin to obtain the gram negative resistant organisms, both 3GC resistant (3GCr) and carbapenem resistant Enterobacteriaceae (CRE) as well as gram positive resistant organisms like Methicillin (Oxacillin) resistant Staphylococci (MRS) and Vancomycin resistant Enterococci (VRE) respectively.

Results: All types of resistant organisms were present in each of the study sites. We found the presence of 3GCr, CRE, MRS and VRE in 85%, 60%, 100% and 80% air samples respectively. Considering sampling sites, 3GCr, CRE and MRS were found highest in the air samples obtained from the environment of commercial poultry farms and VRE was present higher in the live bird markets. The alarming finding is the presence of resistant organisms like MRS, VRE and 3GCr in urban residential area with high frequency (>90%) whereas the rural household were heavily burdened with 3GCr and MRS (60–100%).

Conclusion: The presence of airborne resistomes highlights the importance of intervention in outdoor environments which act as both reservoir and medium of spread of resistance.

A legacy of contaminated sites and possible links to health and lifestyles in Alaska native communities

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Introduction: Contaminated sites exist across Alaska, many within or proximal to Alaska Native villages. Available literature shows the incidence and mortality rates of different cancers, Parkinsonism, Lupus, fetal and neonatal birth defects vary throughout Alaska, most are much higher among Alaska Native populations when compared to non-Alaska Natives. Some communities experiencing higher and multiple disease rates have concerns about environmental contamination and request health assessments. Due to such small populations, national public health reports typically aggregate data of Alaska Natives with all American Indians to establish sample sizes large enough for robust findings, sometimes masking findings.

Methods: Authors used GIS to look at potential associations between known contamination sites and health disorders experienced in Alaska.

Results: In December 2018, authors presented preliminary findings, including maps at the Alaska Tribal Conference on Environmental Management in Anchorage Alaska. Cards were dispersed with a simple questionnaire to gain feedback on communities' concerns and interest in developing participatory community-based studies. Four different community representatives completed cards.

Conclusions: Environmental contamination is a concern in many Alaska Native communities. Authors are developing an approach utilizing a Tribal Participatory Research (TPR) framework coupled with participatory community-based studies for better understanding of environmental health in several communities. We plan to use TPR to identify the appropriate criteria for aggregating health data on small populations. Combining data from several communities with similar concerns can help create a more statistically, culturally significant, and representative dataset. Outreach to interested communities to address concerns with qualitative participatory knowledge and input is planned.

Births before arrival to hospital – specialist ambulance nurses experiences

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Introduction: To work as ambulance, nurse means to interact with and care patients in need of different emergency medical- and other conditions, such as births before arrival to the hospital. Even though most deliveries are uneventful, they are a clinical challenge in the pre-hospital setting. They are rare but increasing due to the centralization of maternity wards, especially among women living in remote areas.

Aim: The aim was to describe specialist ambulance nurses experiences of assisting birth before arrival to hospital.

Method: We conducted a qualitative approach and interviewed nine specialist ambulance nurses who had assisted with one or more prehospital births. Data were analysed with thematic content analysis.

Findings: The analysis revealed a theme; Feeling fright and exhilaration and three categories. The findings showed that births before arrival to hospital causes feelings of anxiety and stress. The experience is also associated with joy and relief when the baby is born. Childbirth is a situation for which specialist ambulance nurses feel less prepared. They experience a lack of knowledge, and wish for more education.

Conclusion: Specialist ambulance nurses face challenges in the pre-hospital care environment during births before arrival to hospital, with long distances, a lack of equipment aboard the ambulance, and no assistance from midwives. To feel secure in the complex role that is required when assisting mothers during delivery, specialist ambulance nurses should have opportunity to receive scenario training.

Do we really need to use special charts to assess physical development of indigenous children of the North?

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Introduction: Factors that affect physical growth of a child are numerous, ethnic origin being one of them. Using existing growth charts to assess physical development of indigenous children of the North leads to ambiguity: pediatricians must change the diet in boarding schools because children have low weight and/or short stature, but to change the diet means to face many associated health issues. The aim of this study is to assess the appropriateness and feasibility of establishing the regulatory frameworks to monitor the growth of indigenous children from birth to young adulthood.

Methods: We have analyzed data collected in the years 1996–2017 in the Yamal-Nenets Autonomous region (total number of Nenets, Khanty and Slavic children 5 940, age 3–17 years) and in Yakutia (total number of Sakha, 5 ethnic groups of indigenous and Slavic children 27 8793, age 0–17 years). We used standard methods of parametric statistics.

Results: We confirmed that in most indigenous peoples the body length and mass, being at birth the same or even higher than in non-indigenous folks, after the age of 3 years became significantly lower. Arterial pressure in Nenets children becomes lower than in non-original settlers beginning from the age of 10 years although the arterial pressure in indigenous children of Yakutia is higher than in non-original settlers. There are also differences in normal sonographic liver and aorta sizes, salt taste sensitivity in some ethnic groups.

Conclusions: Our data support the appropriateness and feasibility of establishing the regulatory frameworks for studied indigenous populations.

Inuit sayakturut, aġiruat: The people are healthy, they are dancing

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Alaskan Indigenous peoples have known music and dance as playing a role in healing processes for millennia. Group singing, drumming and dancing is recognized in a one-health Indigenous view regarding ways of negotiating and alleviating individual health issues as well as promoting community health. The *Kingikmiut Dancers and Singers of Anchorage*, an urban Inupiaq dance group with ancestral ties to the Native Village of Wales, began dancing and singing as a way of claiming a healthy lifestyle for Inupiaq people living in Anchorage, Alaska's largest urban center. As an Indigenous participant-observer in the Kingikmiut Dancers and Singers of Anchorage, the author experienced the benefits of singing and dancing with the group. She also observed elders as they navigated their age-related health conditions through participation in regular dance practices and performances, and also witnessed social cohesion of the group as they continue to practice and perform their cultural heritage. This paper also provides evidence from scientists and musicologists that corroborate with ancient methods of maintaining health and promoting community healing. Inupiaq dancing and singing not only provides individual practitioners with health benefits such as increased aerobic exercise, but also strengthens communities as a cohesion-building activity. Recent scientific studies confirm what Indigenous peoples had already long established: that group singing and dancing is healthy for people.

Strategies for developing an environmentally-responsible plant production system in Alaska

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Food security is one of the most serious problems affecting Alaska. Food acquisition and production are closely associated with ecosystems and climate. In the Arctic, changes in climate make harvesting and gathering of wild foods more difficult and costlier. Transition to store-bought foods subjects households to the vagaries and vulnerabilities of the global food system and to unintended health consequences. Food produced in the subarctic region provides an attractive alternative. As climate in the Arctic becomes warmer and wetter, and growing seasons longer, it is also increasingly more hospitable to migrant insect pests and pathogens, especially as they survive and become established in the environment. Conventional agricultural practices which rely heavily on the use of chemicals could have especially serious consequences in the far North because of the long persistence of pesticides in the still cold soils. Chemical pesticides taking days to degrade were found persisting for years in the soils in Alaska. The subsequent bioaccumulation of chemical pesticides in plant tissues also endangers the health of residents. To minimize the need for chemical pesticides, promote environmental sustainability and food safety, a system which involves exclusion, surveys, detection and biological control was developed. Plant Helper, a cold-tolerant, beneficial mycoparasite, discovered and developed in Alaska, provides a powerful tool in the protection of agricultural, horticultural and economically important crops against a wide range of diseases. The resulting environmentally-responsible plant production system will support the policies of governments of Alaska, and circumpolar regions in producing fresh, wholesome, nutritional foods for their people.

Rapid response to environmental emergency alerts. An INTERACT initiative

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INTERACT - International Network for Terrestrial Research and Monitoring in the Arctic is an infrastructure project funded by the EU. Its main objective is to build capacity for identifying, understanding, predicting and responding to diverse environmental changes throughout the Arctic.

The “Rapid Response” work package within INTERACT has a main goal to help protect Arctic and global residents from potential environmental emergencies or hazards. The work package is focused on identifying, observing and documenting potential risks and hazards and working with relevant agencies and organisations to help response actions. The Rapid Response work package’s main output will be the development of protocols for monitoring of potential environmental risks and hazards and a subsequent set up of an alert system for Arctic research stations and adjoining territories.

Climate sensitive infections were identified as one of the important group of hazards. As a trial, we cooperate with the Laboratory of Arbovirology of the Czech Academy of Sciences, on the determination of the prevalence of selected tick – and mosquito-borne diseases in the Arctic (such as influenza). The data obtained will serve as a baseline for the monitoring of future shifts in the distribution of selected diseases.

The whole project is dependent on efficient networking throughout the Arctic, for which INTERACT provides a great platform with its comprehensive net of more than 80 research stations where sampling and observations can be carried out simultaneously and in the same way across a wide range of territories and often in remote regions.

Applying a diplomatic toolkit to advance One Health: The case of the Arctic Council

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Since 2015, the Arctic Council Sustainable Development Working Group has supported *Operationalizing One Health*, a project to strengthen human-animal-environmental health collaboration in the circumpolar region. Because the Arctic Council is a diplomatic forum rather than a technical body, it is an unorthodox One Health stakeholder. Nonetheless, the project has drawn from a unique array of diplomatic tools to advance One Health. Specifically, the project has created avenues for information sharing and exercises among Arctic Council member states and Permanent Participant organizations, while also identifying areas for collaborative investigations. This presentation will explain the origins of the project, delineate the methods used to implement it, and specify results to date. It will conclude by elucidating lessons learned for operationalizing One Health in the Arctic region, and lessons for other diplomatic fora seeking to advance One Health.

Environmental observation, social media, and One Health action: A description of the Local Environmental Observer (LEO) Network

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As a result of the close relationships between Arctic residents and the environment, climate change has a disproportionate impact on Arctic communities. Despite the need for One Health responses to climate change, environmental monitoring is difficult to conduct in Arctic regions. The Local Environmental Observer (LEO) Network is a global social media network that recruits citizen scientists to collect environmental observations on social media. We examined the processes of the LEO Network, numbers of members and observations, and three case studies that depict One Health action enabled by the system. From February 2012 to July 2017, the LEO Network gained 1870 members in 35 countries. In this time period, 670 environmental observations were posted. Examples that resulted in One Health action include those involving food sources, wild fire smoke, and thawing permafrost. The LEO network is an example of a One Health resource that stimulates action to protect the health of communities around the world.

"All of the Above" to "American Energy Dominance": a One Health-based analysis comparing US energy policy impacts in Alaska

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Introduction: The Obama administration's energy strategy, dubbed "all of the above" (AOTA), aimed to pursue "every source of American-made energy." Although the Trump campaign and administration previously borrowed the Obama-era phrase, they now call for "American energy dominance" (AED), particularly in fossil fuels and notably in Alaska.

Methods: Using a One Health-based approach, we analyzed the benefits and impacts of these two federal executive energy policy approaches in the Alaskan context. We systematically identified and mapped the effects of AOTA and AED on human, wildlife, environmental, and planetary health.

Results: The implications and benefits of the two strategies spanned multiple geographic and temporal scales. Additionally, human, wildlife, environmental, and planetary health opportunities and impacts were found to be manifested through several intersectional pathways, including climate change, pollution, infrastructural investments, and social and economic development. Gaps in both AOTA and AED were also identified that must be addressed in pursuit of a more sustainable, community-engaged US energy policy approach.

Conclusion: Given the geographic and temporal distribution of the two strategies' implications, policymakers at all levels must seek to realign incentives and structures such that local, immediate human livelihoods are not sacrificed at the expense of mid- and long-term benefits. In order to achieve a more sustainable energy policy approach, a better understanding of the magnitude and immediacy of these considerations is needed. Affected communities' perceptions of these costs and benefits must be centrally integrated into energy policy- and decision-making processes to ensure a just transition to our collective energy future.

Toxoplasma gondii and other zoonotic endoparasites in foxes and lynx in Arctic and Subarctic Québec, Canada

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The Canadian North is undergoing unprecedented climate and landscape change, which may alter distribution and prevalence of parasites. Understanding current trophic relationships and parasite ecology is key to predicting the potential for altered zoonotic risks for northern human populations. We are establishing baseline host and geographic distributions for zoonotic endoparasites of wild carnivores in Nunavik and subarctic regions in Québec, including helminths such as tapeworms (*Echinococcus multilocularis* and *E. granulosus/E. canadensis*), roundworms (*Trichinella* and *Toxocara* spp.), and protozoans (*Toxoplasma gondii*, *Giardia*, and *Cryptosporidium* spp.). Carcasses of red

and arctic foxes (*Vulpes vulpes*, *V. lagopus*; n=227), and lynx (*Lynx canadensis*, n=81) were collected by trappers during the winter of 2016/2017. We used morphological, molecular, and immunological methods to detect zoonotic parasites. Fecal samples were analyzed by sugar flotation to detect parasitic eggs. Real-time PCR and melting curve analysis were used to detect and identify DNA from coccidian species in feces. Adult worms were collected from the small intestines by the scraping, counting, and filtration method. We detected DNA of *T. gondii* in foxes and lynx using a magnetic capture technique on brain and heart tissues. Lynx are the proposed definitive host of *T. gondii* in subarctic regions, but intestinal infection has not been definitively demonstrated. As high trophic level carnivores, fox and lynx provide a better idea of distribution and transmission of zoonotic parasites, especially foodborne parasites, in northern ecosystems. This work generates significant information on status of zoonotic parasites in wildlife of Québec, which will inform future predictive models.

Interaction of authorities and NGO in social health issues of children at crime risk

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The article discusses ways of interaction between authorities and NGOs in order to raise the level of social health of children who have conflict with the law. Examples of joint activities of government agencies and NGOs are given. The author relies on the system of development of child-friendly justice in the sphere of criminal proceedings in Arkhangelsk region. The author investigates the peculiarity and role of non-profit organizations in rendering assistance on social adaptation of children at crime risk on the example of Arkhangelsk region. The place of NGOs in the system of social services of population is revealed. In conclusion we analyze problems and prospects of development of the NGOs as a providers of social services, representing a resource for effective solution of social health issues of adolescent offenders.

Trichinella in wolverines of northwestern Canada, Sentinel Species and One Health

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Trichinellosis, an important parasitic zoonosis is caused by nematodes of *Trichinella* spp. Wolverines (*Gulo gulo*) are an economically important species across much of its Holarctic range because of their valuable fur. Due to their position in northern food webs as a high-level predator and scavenger, wolverines could play role as "bioaccumulators" and indicators of foodborne parasites such as *Trichinella* spp. Our study was designed to explore the utility of apex carnivores as sentinels for occurrence and circulation of *Trichinella* spp. in northwestern Canada. Muscle samples (tongue and diaphragms) were collected from 465 wolverine carcasses submitted by licensed fur trappers. Muscles were artificially digested using pepsin-HCl digestion method to detect and recover *Trichinella* spp. larvae. Larvae were identified to species level using Multiplex Polymerase Chain Reaction (PCR). Overall, 340 wolverines were found positive for *Trichinella* spp. larva indicating a prevalence of 73%. *Trichinella* T6 was the predominant genotype followed by: *T. nativa* (T2); a previously undescribed species of *Trichinella*; *T. pseudospiralis*; and *T. spiralis*. This is the first recorded occurrence of *T. spiralis* and *T. pseudospiralis* in the Canadian sub-arctic region. Mixed infections (both T6 and *T. nativa*) were also detected. Our findings suggest a wider diversity of species of *Trichinella* in wolverines in northwestern Canada as compared to previous reports. We validate molecular methodologies for broad scale survey of zoonotic parasites and concurrently reveal the power of wolverines as sentinels in building a One-Health infrastructure to explore the pathways and circulation of parasitic diseases in northwestern Canada because samples are readily available, protocols are well-tested, and prevalence, intensity, and genetic diversity are relatively high compared to other wildlife.

Emerging diseases in a changing reindeer herding system

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Supplementary feeding and corralling have become more common in Sweden and Norway due to pasture fragmentation and climate change. A less traditional reindeer herding system with increased gathering, corralling, handling and transport of reindeer will also increase stress and animal-to-animal contact, and the occurrence of suboptimal hygienic conditions, all contributing to a heightened risk of disease outbreaks, challenging animal welfare and the herder`s economy. Disease outbreaks of oral necrobacillosis, contagious ecthyma and eye infections in semi-domesticated reindeer have been investigated clinically and with serological (ELISA) and molecular (PCR) assays. Results indicated that infections with *Fusobacterium* spp. (necrobacillosis), Orf virus (ORFV, contagious ecthyma), and cervid herpesvirus 2 (CvHV2) and *Chlamydia* spp. (eye infections) are present in the Fennoscandian reindeer herds, causing disease outbreaks. While, simultaneous presence of multiple agents has been registered. There are clear indications that these and other emerging and re-emerging infectious diseases are associated with the changing herding conditions and their prevalence may hence increase over time, with the subsequent risks for reindeer herds and herders. Furthermore, the risk of zoonotic and inter-species transmission of some of these pathogens exist. Preventive measures must be taken while working with affected animals to avoid exposure of herders, veterinarians and other people, as well as the infection of other susceptible species in contact with the affected herds, such as other cervid species or domestic animals.

Water safety in the Arctic region

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Background: Clean, safe fresh water is one of the most important natural resources. Thus, safely managed drinking water (DW) services are one the WHO´s Sustainable Development Goals (SDG 6.1). Water is not, however, evenly available for all human settlements. The aim of the study was to collect and assess information about water services in the Arctic region.

Methods: The survey study included interviews of water hygiene experts and review of the literature available.

Results: The existing legislation in the Arctic nations should in principle ensure equal rights to safe DW and sanitation. However, national statistics about the access to improved DW and sanitation are dominated by the results of the large settlements. Centralized DW and sanitation systems are not yet available for all people in the Arctic region. Cold climate reduces the disposable time of fresh surface waters and permafrost may prevent the usage of ground waters. Furthermore, running water systems will get frozen if the pipelines are not properly insulated. Alternative drinking water sources and transport options including usage of self-hauling water sources and DW tanks need to be applied.

Conclusions: Hard climate conditions in the Arctic region may reduce the amount of usable household water jeopardizing every-day hygiene to prevent water-washed diseases. Difficulties in maintaining sufficient amount of safe DW may also result waterborne outbreaks. At Arctic the cost of household water can also be a remarkable economic burden.

The public health response to arsenic contamination of drinking water wells in Alaska

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Introduction: Chronic oral exposure to inorganic arsenic (Asi) is associated with a number of adverse health effects. The most characteristic symptoms of prolonged Asi exposure include skin changes, although it is also neurotoxic and carcinogenic. In August 2018, the Alaska Environmental Public Health Program (EPHP) learned that elevated concentrations of Asi had been measured in two groundwater wells that served a public building near Fairbanks, Alaska, USA. Due to the public health risk posed by elevated Asi in drinking water, EPHP conducted an environmental investigation.

Methods: EPHP administered a survey to assess potential exposure and the occurrence of symptoms commonly associated with acute and chronic Asi poisoning. EPHP also collected hair samples and conducted an education campaign to increase awareness among residents.

Results: Concentration of Asi in the wells were above 9,000 μg/L, exceeding drinking water standards (10 μg/L) by several orders of magnitude. Of the hair samples received, 88% exceeded the reference value (0.9 μg/g). Survey results indicated some individuals were experiencing symptoms consistent with acute or chronic arsenic poisoning, including severe abdominal pain, hypertension, and peripheral neuropathy.

Conclusions: The large deposits of Asi in this region are well known to academic researchers, regulators, and public health officials. Despite repeated historical attempts to notify residents of the potential for elevated Asi in drinking water, many residents remained uninformed. The findings of our environmental investigation indicate that Asi exposure is ongoing, and further underscore the importance of interdisciplinary cooperation to inform residents of the risk and to get their well water tested.

Plastics in the Bering Sea: Marine debris and associated contaminant exposure in subsistence species

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The island and coastal communities in the Bering Sea region are intimately connected to the marine environment through their subsistence and cultural resources. Plastic debris pollution can disrupt those connections. For example, local subsistence species are susceptible to entanglement in debris, or they may mistake debris for prey and will consequently ingest it. As plastics are known to be coated in and absorb harmful chemicals, marine organisms risk exposure to these chemicals upon ingestion. Humans are potentially at risk of exposure through consumption of subsistence resources. One prominent group of plastic-associated chemicals is phthalates, which are widely used in plastic manufacture and endocrine disruptors. Therefore, with increasing amounts of plastic entering marine ecosystems, it is imperative to track chemicals like phthalates in the environment. Seabirds are model organisms for studying such contaminants, as they sample from many parts of the food web in marine ecosystems. They are also highly susceptible to plastic ingestion and consequent contaminant exposure. In this study, we build a foundation of knowledge of phthalate exposure in Bering Sea seabirds that leads to better understanding their correlative effects on ecosystem health. We analyzed six phthalate congeners in the muscle tissue of 111 individuals, representing nine seabird species that breed in the Bering Sea, many of which showed evidence of exposure to at least one congener. These results suggest seabirds are broadly exposed. Furthermore humans are at risk of exposure through consumption of seabirds and their eggs, raising questions about threshold levels of exposure both in wildlife and humans.

Association between polymorphisms of NAT2 gene and lung cancer susceptibility in Yakut population

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Markers of increased risk of lung cancer in Yakuts are the NAT2*857A allele and NAT2*857G/A genotype, the reduced risk is the NAT2*857G allele, NAT2*857G/G genotype.

Introduction: In the structure of cancer incidence among the indigenous people - Yakuts, lung cancer occupies a leading position. Some authors have shown that polymorphic variants of the NAT2 gene contribute to the development of lung cancer.

Methods: A case-control study involving 60 patients (17 women and 43 men) histopathologically diagnosed for lung cancer and cancer-free controls 60 people. For release of DNA was used the phenol–chloroform extraction.

The analysis of polymorphic options 481C>T, 590>T; 857G>A; was carried out by PCR method on the thermocycler T100 (Bio-Rad). RFLP was carried out by KpnI, BamHI, TaqI.

Results: We have not found statistically significant differences in the frequency distribution of alleles and genotypes of the 481C>T, 590G>A polymorphism of the NAT2 gene between the control group and the group of patients with lung cancer.

Significant differences in the frequencies of alleles and genotypes were observed for the polymorphic variant 857G>A. Compared with healthy patients, there was a decrease in the frequency of mutant NAT2*857G allele - 64.2% and 78.3% (χ^2=42.52; p=0.000…) and an increase in the frequency of wild NAT2*857A allele 35.8% , 21.7% (χ^2=42.52; p=0.000…). In the group of patients, the frequency of the NAT2*857A allele (35.8%; χ^2=42.52; p=0.000…) and the heterozygous genotype NAT2*857G/A (71.6%; χ^2=13.43; p=0.0002) and the frequency of the homozygous genotype decreased NAT2*857G/G (28.4%; χ^2=10.95; p=0.0009) compared to the control 21.7%, 36.6% and 60.1%.

Conclusion: Thus, markers of increased risk of lung cancer in Yakuts are the NAT2*857A allele and NAT2*857G/A genotype, the reduced risk is the NAT2*857G allele, NAT2*857G/G genotype.

Mental healthcare performance measurement in circumpolar regions

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Introduction: The sparse population distribution, environmental hazards, conflicting government health mandates, and history of the Arctic's indigenous peoples make measuring the performance of mental health systems in the circumpolar context uniquely challenging. The objective of this study was to identify performance indicators that apply to mental healthcare systems in circumpolar regions and to explore alignment with indigenous models of health and wellness.

Methods: We searched Pubmed, Scopus, High North Research Documents, grey literature and key reference lists. Articles were included if they presented a compendium of mental healthcare indicators or described the indicator development process, and the population of interest included indigenous people, or people receiving mental healthcare in circumpolar, rural or remote regions.

Results: Six articles were included. Three were research articles describing community health interventions, two were literature reviews, and one was a review describing a government-funded indicator development process. We extracted 179 individual health measures and characterized each as either a 'domain', 'indicator', or 'determinant' of mental health status. Many articles described strength-based measures and assessment of a patient's relationship to their community/environment, though usage of these measures across health systems was limited.

Conclusions: This preliminary scoping study indicates that indigenous values are not widely integrated into evaluation criteria for health systems in circumpolar regions, despite previous implementation at the local level. One Health models that explore human and environmental interactions could provide a framework for a health systems performance measurement lens more in accordance with indigenous models of mental health.

Multidisciplinary collaborations for community wellness within circumpolar regions

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Introduction: Within circumpolar regions, the state of community wellness can be impacted by an overlapping, and often compounding, myriad of factors including rapidly changing climates, remote populations, large inequities, and distinct cultures. These multidimensional determinants of community wellbeing require creative intersectoral collaborations. This scoping review seeks to characterize the range of existing cooperative approaches for addressing these complex challenges, particularly those that have spanned traditional divisions between academic disciplines.

Methods: We searched the Cochrane Library, JSTOR, Medline, Scopus, Ebscohost, CINAHL, Global Health Database, High North Research Documents, and online grey literature. Articles were included if they involved multidisciplinary research within Arctic regions of circumpolar nations and addressed community wellness. Throughout this analysis, 'indigenous knowledge' was defined as a discrete discipline different from conventional fields of study.

Results: Though extraction and analysis are ongoing, initial results drawn from the first stage of review offer preliminary insights. Of the 409 articles identified, most focus on community wellness with regards to physical environment; other common areas of focus included mining, engineering solutions, food and nutrition, physical illness, education, socioeconomic status, community resiliency and social determinants of health.

Conclusions: This scoping review reveals both the subject matter areas and circumpolar regions where valuable multidisciplinary work has already been implemented, as well as existing gaps for further research. Many of the creative collaborations included could guide work moving forward. Among the most vital disciplines, Traditional Knowledge is emerging as a field of scientific expertise and has much to offer future collaborative efforts.

A One Health approach to emergency preparedness in health and social services: Incorporating animal care into emergency social services planning

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Northern communities are disproportionately vulnerable to climate change given the elevated exposure to Arctic environmental change and high sensitivity of social systems. Climate change effects on Yukoners' health will include direct impacts, environmental system mediated impacts, and social mediated effects. Extreme weather events are anticipated to increase in Yukon over coming decades, potentially resulting in an increased need for emergency health and social service response. While work in Yukon on climate change adaptation is not new, actions to improve adaptive capacity in the health sector have been limited. Additionally, under the recent Joint External Evaluation for International Health Regulations, challenges were identified for Canada around sustaining response and recovery from a large-scale health disaster, and embracing the One Health triad. Yukon is no different in experiencing these challenges. Response to wildfire evacuations in Yukon during the summer of 2018 exposed vulnerabilities in current Yukon emergency social services plans related to animal care, which can act as a barrier to evacuation and place emergency response workers at risk. Yukon faces several challenges in planning for animal care during an emergency social services response, including a large and diverse animal population (such as sled dogs and pack horses), limited capacity of local veterinarians and animal shelters, paucity of data related to domestic animals in the territory, and large geographic distances between communities. This poster will provide an overview of an approach to incorporating animal care into disaster preparedness, that addresses the challenges posed by living in a remote northern jurisdiction.

”We live like on a boiling pot”: parallels between climate change, ecology and health in local community members’ interpretation

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Interdisciplinary research at the interface of climatology, ecology, medicine and anthropology, focused on the process of climate change, can be a challenge when the need to bring together statistical data and series of local observations arises while assembling a project. It’s not only the task of translating everyday impressions into the academic language but the task of operationalizing concepts and triangulating data.

Thus we faced the inconsistency of judgments not only residents of different villages, but also with the internal inconsistency of the informants’ responses. If initially the focus of anthropologists were local interpretations and views, observations, feelings of local residents of the Northern regions of Siberia on climate change – the way they are perceived at the local level - then by the end of the expedition it became obvious that it is impossible to obtain accurate data without involving related factors, refracting the perception of climate change in a certain way.

This contextual expansion was inspired by the locals themselves. Speaking about climate change, they moved to the category of weather conditions, environmental conditions, clean water and air, and linked these phenomena with high mortality, the frequency of cancer and cardiovascular diseases. The climate conversation shifted to the proximity of death and the passing away of working-age men, who are the backbone of the community. One interviewee said about sudden deaths and the weakening of community vital resources: ”we live like on a boiling pot and never know when we will lose the next of our men.”

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