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Review article

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The Role of Conservation Biology in Understanding the Importance of Arctic Sea Ice

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Abstract
The transdisciplinary nature of conservation biology is pivotal to understanding the concept of near-term human extinction. The rate of environmental change impacts the habitat of all organisms, and loss of habitat underlies extinction. These concepts apply to all species, including Homo sapiens. *The ongoing and expected rates of environmental change indicate human extinction in the near term, with loss of Arctic sea ice an important driving force.*

Keywords: Albedo, Conservation Biology, Cryosphere, Human Extinction, Nuclear Power

Introduction

On 28 August 2017, President Niinistö of Finland said during a meeting with President Trump of the United States, "if we lose the Arctic, we lose the globe. That is reality." President Niinistö apparently was referring to the loss of habitat for human animals shortly after the remaining ice on the Arctic Ocean melts. It seems unlikely he knew that such an event would lead to the loss of all life on Earth. Information published after the meeting between Presidents Niinistö and Trump indicates the likelihood of such a situation within a relatively short period after the first ice-free Arctic Ocean experienced by *Homo sapiens*.

The Arctic region, with a particular focus on Arctic ice, has been called the "planetary air conditioner" for Earth [1]. The rapid rate of environmental change virtually certain to occur in the wake of an ice-free Arctic Ocean will outstrip the ability of all, or nearly all, life on Earth to keep pace with the rapid rate of change. Specifically, the rapidity of environmental change associated with the loss of albedo indicates industrial civilization will fail shortly after the Arctic Ocean becomes ice-free [2]. Catastrophic loss of all life on Earth is certain to follow, for two reasons: (1) the rapidity of environmental change as a result of loss of aerosol masking [3] and (2) cessation of industrial civilization causing the meltdown of hundreds of nuclear power plants, therefore leading to the near-term death of the plants that form the base of the food web for humans and other animals [4].

The Importance of Conservation Biology

The multidisciplinary enterprise of conservation biology is helpful in attempting to understand the concept of near-term human extinction. The pillars of conservation biology — speciation, extinction, and habitat — are poorly understood by most scientists, yet they are crucial to understanding and predicting the demise of organisms, including *Homo sapiens*. Conservation biologists are reluctant to apply words such as "field" or "discipline" to their collective endeavor because these words are deemed too narrow to be accurate. Conservation biology draws from several subjects to tackle complex topics such as guild, niche, functional extinction, and species diversity. It is difficult to think of an endeavor that requires broader understanding than conservation biology. A mix of theory and its application makes conservation biology simultaneously difficult to categorize — much less understand, by those unfamiliar with the relevant vocabulary — and crucial to preservation of life on Earth.

Conservation biologists readily understand the fragile nature of life. Conservation biology is the scientific study of the intricate, interconnected web comprising life on Earth and is therefore the science of connecting seemingly disparate information into a clear, compelling story. Conservation biologists reasonably conclude that humans can go extinct quickly after losing habitat. Disappearing birds, linked to disappearing insects, is a contemporary story that conservation biologists see as relevant to our own extinction. That humans could be next on the list of extinct species is an obvious conclusion to every conservation biologist and stunningly few other people. After all, conservation biologists know the importance of soil, wind, fire, precipitation, temperature, bacteria, fungi, and myriad other factors on the continued persistence of every life form. In studying the importance of interspecific competition, mutualism, and evolution by natural selection, they are aware that every species continually dances on the edge of extinction, constantly hovering on the brink.

Extinction occurs when the last individual of a species dies. Most species are driven to extinction as a result of habitat loss. It seems likely the final human will follow this path, not long after habitat is destroyed by ongoing, abrupt climate change. Already, vertebrates and mammals, respectively, cannot adapt to the ongoing and projected rates of environmental change [5, 6].

Counting the loss of biological diversity is the saddest of jobs. As pointed out by American conservationist Aldo Leopold in his posthumously published 1949 book, *A Sand County Almanac*: "One of the penalties of an ecological education is that one lives alone in a world of wounds." Few within civilization are aware of the horrors of civilization. They do not feel the wounds about which they are ignorant.

Ice-Free Arctic Leads to Rapid Planetary Heating

The primary contributors to planetary heating after loss of Arctic ice come from three sources: (1) loss of albedo, (2) loss of aerosol masking, and (3) release of methane from the relatively shallow continental shelves surrounding the Arctic Ocean. Each of these factors is considered in the following paragraphs.

Loss of albedo, or reflectance, is already occurring as the Arctic ice melts. Arctic sea ice cover has been in decline since the 1950s, and probably before [7]. In addition, melting of the Arctic ice during the early melt season "triggers large-scale feedback which subsequently amplifies summer sea ice anomalies," and this process has doubled since 2000 [8]. Decreasing sea ice cover, not changes in terrestrial snow cover, has been the dominant radiative feedback mechanism during the last few decades [9]. Furthermore, a 2020 simulation result "provides support for a fast retreat of Arctic summer sea ice in the future" [10].

The decline in Arctic sea ice has accelerated during the few decades of measurement (1979-present). For example, one-third of the ice cover within the Arctic Ocean was comprised of very old ice (>4 years old) at the end-of-winter maximum extent in March of 1985 [11]. In contrast, old ice constituted only 1.2% of the ice extent in March of 2019, and first-year ice now dominates the sea ice cover. In summary, "the Arctic sea ice cover has transformed from an older, thicker, and stronger ice mass in the 1980s to a younger, thinner, more fragile ice mass in recent years" [11].

Even assuming constant cloudiness, a global radiative heating of 0.71 W/m^2 relative to the 1979 baseline results from an ice-free Arctic Ocean. This is equivalent to the effect of one trillion tons of CO_2 emissions, suggesting that the additional heating due to complete Arctic sea ice loss would hasten global warming by an estimated 25 years [12].

To summarize the information and evidence presented in the preceding four paragraphs: It seems likely that the ice-free Arctic incorrectly projected to occur in 2016 plus or minus 3 years, based on data through 2007 [13], lies in the near future. The resulting loss of albedo indicates a very rapid rise in global-average temperature shortly after this defining event. Scientific study of the aerosol masking effect dates to at least 1929 [14]. A 1 C rise in global-average temperature is expected to occur following as little as a 20% reduction in industrial activity [3]. Such a reduction in industrial activity may have already occurred as a result of SARS-CoV-2, with the biological, ecological, and societal responses expected in the near future [3, 15]. The expected continued decline in industrial activity as this self-reinforcing feedback loop continues will doubtless lead to the 5-6 C global-average temperature rise that causes the annihilation of "all life on earth" [16]: "in a simplified view, the idea of co-extinctions reduces to the obvious conclusion that a consumer cannot survive without its resources." Finally, the ongoing release of methane from the relatively shallow seafloor of the Arctic Ocean is expected to accelerate when the ice disappears. Atmospheric methane began to rise exponentially in 2007 after a 7-year period of near-zero growth [17]. By 2013, it became clear that "significant quantities of methane are escaping the East Siberian Shelf as a result of the degradation of submarine permafrost over thousands of years" [18].

Conclusion

The evidence presented in this paper indicates the strong likelihood of extinction of all life on Earth in the near future. This conclusion, based on the ongoing rapid rate of environmental change and the consequent meltdown of the world's nuclear power stations, invokes obvious questions, some of which I have mentioned in my earlier writing [2]: How do we minimize suffering? Is such a quest restricted to humans, or are other organisms included? What is the temporal frame of the quest? Does it extend beyond the moment, perhaps to months or years? Does it extend beyond the personal to include other individuals? What intellectual and emotional responses are expected in light of this knowledge? Which of these responses are acceptable? How shall I respond? How shall we respond, as individuals within communities and society?

These are the questions on which I have chosen to focus. I encourage others to join me in my quest to understand and alleviate suffering. I can imagine worse pursuits than the final individuals of our species exhibiting ethical, responsible behavior.

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