My name is Frank Lance Craighead. I received a Ph.D. in Biological Sciences from Montana State University in 1994, an M.Sc. in Wildlife Ecology from the University of Wisconsin-Madison in 1976, and a B.A. in Biology from Carleton College, Minnesota, in 1969. I believe that my education in ecology, however, has been greatly augmented by travel; working in different cultures around the world on different animal species with different colleagues. The greatest lesson I have learned is that natural ecosystems have evolved over millennia to work efficiently to support and maintain biodiversity: the plants and animals and other species that comprise the ecosystem. We need healthy ecosystems in order to exist. Human population growth and habitat alteration has fragmented and damaged those ecosystems to the point where we have altered the world climate and produced a new wave of extinctions.

Intact ecosystems which are not fragmented by human developments or degraded by human activities are important for many reasons. These include the provision of ecosystems services such as clean air and clean water, climate regulation, soil formation, nutrient cycling, and harvesting of food, fuel, fibers, and pharmaceuticals. Ecosystems also provide spiritual and psychological benefits. These benefits, like many others derived from wild places, cannot be exactly measured in traditional economic terms. We need to think about more than just dollars. We need to think about ecosystems.

To ensure that wildlife have sufficient habitat for population persistence into the future, and to confer resilience in the face of climate change and land use change, there must be an adequate amount of protected habitat available among the spectrum of lands that are accessible to those wildlife. The more permanent that protected habitat is, and the larger the area is, the more certainty there is that wildlife populations can persist. Fragmenting of natural areas into smaller pieces of protected habitat has greatly diminished its value for wildlife habitat and the provision of ecosystems services, and severely reduced its ability to function as a refuge from climate change.

The inevitable question about habitat protection is always; “How much is enough?”. Before humans appeared on the scene in large enough numbers to disrupt ecosystems, we could say that 100% in ‘natural’ conditions appeared to be enough. Now that we’ve messed things up, E.O. Wilson estimates that we need at least 50% to maintain biodiversity and functioning ecosystems (Wilson 2016). Another way to figure out how much is enough is to see how much we need to maintain a wide-ranging, vulnerable, species like the grizzly bear. If we have healthy grizzly populations (and perhaps a few other ‘umbrella’ species), then we have a healthy ecosystem. This begs the question; what is a healthy grizzly population?

Another way to phrase this, is what is a viable grizzly population? Mark Shaffer developed the overall systems concept of population viability in 1978 and explained that for a population to persist it needed to be large enough and diverse enough to survive random changes in genetics (genetic stochasticity), demographics (demographic stochasticity), environmental variables (environmental stochasticity), and wide-ranging catastrophic events. It also needed security from deterministic changes such as a continued loss of habitat (Shaffer 1981).

Shaffer originally suggested that a minimum viable population for Yellowstone grizzlies was

35-70 and revised that estimate to 70-100 grizzlies needed to have a 95% probability of surviving for 100 years (Shaffer 1978, Shaffer 1980). These were early estimates using simple models and no serious biologist today would agree that 70-100 grizzlies are sufficient to maintain a population in isolation, or that 100 years is a reasonable time-frame for a keystone species like the grizzly to be allowed to exist. I include these early estimates to help illustrate how far the science has progressed since then. Gilpin and Soule (1981) refined Shaffer's approach and introduced the concept of extinction vertices resulting from feedback loops among the fields such that any decrease in one area such as population size also reduces genetic variability and so on (Gilpin and Soule, 1986), and our understanding of extinction has increased steadily since then.

In this series of statements, Dr. Fred Allendorf explains our current understanding of the genetic diversity, and the demographic security, needed for grizzlies to persist for several hundred years, and has estimated that up to 5,000 grizzly bears may be necessary (Allendorf and Ryman, 2002). Dr. Lee Metzger also emphasizes the large numbers and large areas needed to consider the grizzly population recovered. Dr. Brain Horesji further addresses the inadequacy of government agency practices and regulations, in Canada, to ensure that these large numbers of grizzlies, and large areas of habitat will persist. Dr. David Mattson provides a comprehensive review of the history of grizzly bear declines and the threats to their continued existence. He provides a blueprint for meaningful recovery under the existing legal framework. We all agree that the current situation does not provide enough habitat or large enough populations.

Two items of consensus among most conservation biologists are that 1) existing protected areas within the Greater Yellowstone, Northern Continental Divide, Central Idaho (Selway-Bitterroot), and other US Grizzly Bear Recovery Areas are too small individually to support a viable population over a long time frame (say 500-1000 years), and 2) the only feasible way to provide enough habitat is to connect these recovery areas with protected habitat corridors so the animals can move between them and thus provide demographic and genetic connectivity. Connectivity is therefore the main focus of habitat and population conservation efforts. Providing policy and regulatory frameworks to ensure this is also necessary. And none of this can happen without the understanding and support of local citizens in our United States and Canadian democracies.

Ensuring the survival of grizzly bears requires habitat; but habitat is disappearing as human populations expand, as humans alter the habitat, and as humans alter the climate which changes the habitat. In fact, humans are changing the environment so greatly, on a global scale, that many scientists are now referring to this era in time as the Anthropocene, as summarized by Biello (2016). Whether you subscribe to the label of Anthropocene or not, human activities are now a part of the geologic record and sediments contain radiation that began with atomic bomb testing and intensified when Chernobyl melted down. That signal will last for perhaps 100,000 years. More recently, humans have blanketed the waters of the earth with microplastics that are also part of the sediment layer and may last indefinitely. The point I am trying to make is that humans are the cause of most of our environmental problems, including the current mass extinction event. Humans can also provide solutions, but in many places it is already too late. Here in the Rocky Mountain West we can still slow down our destruction of the environment

and keep these critical ecosystems intact. We can start by continuing to protect the grizzly bear.

Literature Cited

Allendorf, F.W. and N. Ryman. 2002. The role of genetics in population viability analysis. In: Population Viability Analysis, S.R. Beissinger and D.R. McCullough (eds.) University of Chicago Press.

Biello, D. 2016. Humans Leave a Telltale Residue on Earth. Scientific American, Jan 7, 2016.

Gilpin, M. E., and M. E. and Soule. 1981. Minimum Viable Populations: Processes of Species Extinctions. In: Conservation Biology – The Science of Scarcity and Diversity. Sinauer and Associates, Sunderland Mass. 19-34.

Shaffer, M,. L. 1978. Determining minimum viable population sizes: A case study of the grizzly bear (Ursus arctos L.). Ph.D. Thesis. Duke Univ., Durham, N.C. 190pp.

Shaffer, M,. L. 1980. Determining minimum viable population sizes for the grizzly bear. In: Bears: Their Biology and Management. Vol. 5, A Selection of Papers from the Fifth International Conference on Bear Research and Management, Madison, Wisconsin, USA, February 1980 (1983), pp. 133-139 Int. Conf. Bear Res. And Manage. 5:133-139.

Shaffer, M.L. 1981. Minimum population sizes for species conservation. Bio-Science 31: 131-134.

Wilson, E.O. 2016. Half-Earth: Our Planet's Fight for Life. W.W. Norton and Company Ltd. London. 259 pp.