The Chernobyl + Fukushima Research Initiative

SUMMARY OF THE INITIATIVE AND ITS RESEARCH

The Chernobyl Research Initiative began formal research activities in Ukraine in 2000, Belarus in 2005, and Fukushima, Japan, in July, 2011. To date, the group has conducted more than 30 research expeditions to Chernobyl and 10 expeditions to Fukushima.

USC's Chernobyl Research Initiative was the first and currently is the only research group to utilize a multidisciplinary approach to address the health and environmental outcomes of radiation effects in free-living natural populations. This has permitted the investigation of both acute (short term) and chronic (long term and multi-generational) exposures.

The Chernobyl Research Initiative is also currently the only research team working in both Chernobyl and Fukushima.

Key funding sources have included the Samuel Freeman Charitable Trust, the CNRS (France), the National Science Foundation, and the National Geographic Society. Subsequently, additional funding sources have included NATO, the Civilian Research Development Foundation (CRDF), the National Institutes of Health (NIH), Qiagen GmbH, the Fulbright Foundation, the University of South Carolina Office of Research and the College of Arts and Sciences, the Academy of Finland, and gifts from private citizens.

To date, more than 60 scientific publications have resulted from this initiative, most in the past seven years (see link above for publications). This research has been highlighted in many newspaper reports and television programs including the New York Times, The Economist, Harpers, the BBC, CNN and Miles O'Brian of PBS News Hour (see links above for media coverage).

The team has pioneered the use of ecological, genetic and dosimetric technologies in order to unravel the health and environmental consequences of chronic low-dose exposure resulting from the Chernobyl and Fukushima disasters. These have included massively replicated ecological censuses of natural populations of birds, mammals and insects to investigate population and demographic effects; DNA sequencing and genotoxicity testing to assess short and long term genetic damage to individuals living in the wild; and the use of miniature dosimeters attached to wild animals and field measurements of whole body burdens of radioisotopes in birds and mammals to obtain accurate estimates of realized external and internal radiation doses to animals living under natural conditions. Recently, the group has expanded to include epidemiological and genetic studies of human populations (especially children) living in Chernobyl-affected regions of Ukraine.

Key results published in 2013 include the discovery of tumors, cataracts and damaged sperm in birds from high radiation areas of Chernobyl, and impacts on biodiversity in Fukushima. Exciting as yet unpublished results include the discovery that some species

of birds may have developed resistance to the effects of radiation and effects on neurological development in small mammals in both Chernobyl and Fukushima.

These two disasters differ in the time since the events, and the amount and diversity of radionuclides that were released, although the predominant source of radiation is cesium-137 in both locations.

Goals for 2014-15

We are seeking funding to support the following ongoing and planned future research activities of the Chernobyl + Fukushima Research Initiative:

1) Continued monitoring of Fukushima populations of birds, small mammals, and insects in order to test for changes in population sizes (abundances) and numbers of species (biodiversity) through time.

2) Continued monitoring of barn swallows and rodents (mice and voles) populations for cancers, survival, reproduction, and genetic damage in Fukushima and Chernobyl (in collaboration with the CNRS, France, Rikkyo University, Tokyo, the Wild Bird Society of Japan, the National Institute of Forestry, Japan, and the University of Jyvaskyla, Finland).

3) Initiate a new project to study effects of radiation on tree growth and soil microbial activity in Fukushima (in collaboration with Chubu University, Nagoya, Japan).

4) Initiate a new project to investigate effects of radiation growth, fertility, and genetic damage in cows living in highly radioactive regions of Fukushima (in collaboration with the Fukushima Cattle Ranchers Association).

5) Initiate a new project to examine mutation rates in humans using whole genome DNA sequencing. Initially this project will focus on families living in contaminated regions of Ukraine. The project is in collaboration with the Montreal Neurological Institute and Hospital at McGill University, the Center of Radiological Research at Columbia University, and the Institute for Radiation Medicine in Kiev, Ukraine.

6) Continued development of new methods for measurement of dose and genetic damage in wild populations of animals.

7) Coordination of an international consortium of independent scientists to provide unbiased evidenced-based information concerning the health and environmental risks related to nuclear accidents. This group will compile, evaluate, and interpret the current scientific and medical literature and develop a literature suitable for public distribution via the print and internet media, as well as public presentations in Japan and internationally.

Highlights from research published by the Chernobyl Research Initiative include the following:

- Population sizes and numbers of species (i.e. biodiversity) of birds, mammals, insects, and spiders are significantly lower in areas of high contamination in Chernobyl.
- For many birds and small mammals, life spans are shorter and fertility is depressed, in areas of high contamination.
- In Fukushima, only birds, butterflies, and cicadas showed significant declines during the first summer following the accident. Other groups were not negatively affected.
- There is considerable variability among species in their sensitivity to radionuclides. Many species are not affected, and a few species even appear to increase in numbers in areas of high contamination in both Chernobyl and Fukushima, presumably in response to competitive release (i.e. more available food and shelter) and fewer predators.
- Many species show evidence of genetic damage stemming from acute exposures and the differences observed between Fukushima and Chernobyl suggests some species may show the consequences of mutation accumulation over multiple generations.
- Some individuals and species show no evidence of genetic damage in relation to radiation exposure and some even show evidence of evolutionary adaptation to the effects of radiation through increased antioxidant activity, which may provide protection against ionizing radiation.
- The bird species that are most likely to show declines in numbers in response to radiation are those that historically have shown increased mutation rates for other reasons possibly related to DNA repair ability or reduced defenses against oxidative stress.
- Deleterious effects of radiation exposure seen in natural populations in Chernobyl include increased rates of cataracts, tumors, growth abnormalities, deformed sperm, and albinism.
- Neurological development is impacted as evidenced by depressed brain size in both birds and rodents and consequent effects on cognitive ability and survival have been demonstrated in birds.
- Tree growth and microbial decomposition in the soil are also depressed in areas of high radiation.

- In Fukushima, the first signs of developmental abnormalities have been observed in birds in 2013, although significant genetic damage has not yet been documented for birds or rodents.

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