



THE CASE AGAINST NUCLEAR POWER

Nuclear power and harm to animals, wild and domestic

A PUBLICATION OF BEYOND NUCLEAR

Cover image: Gray Wolf, by Gunnar Ries, Creative Commons/Flickr

Acknowledgements

This booklet would not have been possible without all the incredible work that has already been done on this subject by our colleagues around the world.

Many of our sources are acknowledged in the endnotes, but we would like to give special thanks to two scientists in particular.

Dr. Timothy Mousseau and his colleagues have worked extensively in the radioactively contaminated zones around both the Chernobyl nuclear disaster site in Ukraine, and the stricken Fukushima reactors in Japan. Far from finding animals “thriving” in the absence of humans, Mousseau and his colleagues discovered birds suffering sterility and cataracts, small mammals with tumors, and generally reduced life expectancies.

Dr. Bruno Chareyron, and his France-based laboratory, CRIIRAD, have sampled and analyzed wild habitats in Europe, North America, Siberia and Africa with alarming results. Dr. Chareyron found high levels of radioactive contamination in lakes, rivers, aquatic plants, desert sands and rocks and in the air. His conclusions about the negative impacts to human health apply to animals as well.

In 2001, two of us now at Beyond Nuclear, but then at other organizations, published an in-depth study about the impact on marine animals from the routine operation of coastal US nuclear power plants. We have quoted our report — *Licensed to Kill*—extensively because sadly, since then, almost nothing has changed for the better.

Licensed to Kill can be found on the page of that name on the Beyond Nuclear website — www.BeyondNuclear.org. Updates arising from this booklet will be posted on the Animals page on our website. You can select the Animals tab from the sidebar menu on our site. Much is still happening. We encourage you to check there regularly.

— Linda Pentz Gunter, *Beyond Nuclear*. January 2020


Introduction

"The time for using world oceans as a dump is over," wrote a coalition of sea turtle and marine protection groups in 2017, protesting a Japanese government proposal to dump at least 770,000 tons of radioactive water from the stricken Fukushima Daiichi nuclear power plant in Japan into the Pacific Ocean.¹

But oceans, rivers, lakes and other waterways have long served as dump-sites for the nuclear power industry, and continue to do so, whether due to a disaster, such as Fukushima, or as part of everyday operations, including uranium mining, electricity production, reprocessing and nuclear waste (mis)management.

All commercial nuclear power plants are located on major bodies of water. This is because vast quantities of water are needed to cool the reactors. The water is drawn in from a lake, river, reservoir or ocean and used to keep the reactor cool while it is fissioning. Then, depending on the design of the reactor cooling system, the water is either discharged through an evaporative process into the atmosphere through cooling towers; or it is released as super-heated water through a discharge pipe directly into the body of water from which it came.

Creatures living in these water bodies are inevitably affected, whether by being drawn into the reactor ("entrainment") or confronting the suddenly artificially warm water the plant discharges.



In 2001, Linda Pentz Gunter and Paul Gunter, now with Beyond Nuclear, investigated the impact of routine nuclear reactor operation on marine life. The groundbreaking report – *Licensed to Kill: How the nuclear power industry destroys endangered marine wildlife and ocean habitat to save money*² – found harm to almost every kind of marine creature and their habitats. It also found a woefully delinquent regulatory environment that allowed this wanton destruction to continue with little to no penalty to nuclear plant operators.

Terrestrial wildlife, pets and livestock living downwind or downstream of an accident, or even within range of routine radioactive releases from nuclear power facilities and uranium mines, are affected as well.

Some studies have looked at the impact on terrestrial animals who drink contaminated water released by nuclear plants or uranium mines. However, far more research has looked at wildlife in the aftermath of the major nuclear disasters at Chernobyl and Fukushima. The findings are increasingly alarming.

Whether radioactive releases are due to a serious accident or are part of routine operation; and whether radionuclides are released into the air or into waterways; their impact on animals is both far-reaching and long-lasting. These global pathways of radiological contamination mean that animals living far from a nuclear facility can be as seriously affected as those living close by.



Uranium Mining

Much of what we know about the impacts to wildlife from uranium mining comes from indigenous people whose traditions are threatened when a uranium mine opens on their land.

Consequently, indigenous people around the world have been on the front lines in opposing new uranium mines or getting the old ones closed. This is in part because native peoples often still rely on hunting and fishing to sustain themselves and their families. They also, by tradition, adhere strongly to a sustainable way of life that does not wantonly destroy animals for the sake of industry and corporate profit. “In a Diné creation story”, writes Winona LaDuke, “the people were given a choice of two yellow powders. They chose the yellow dust of corn pollen, and were instructed to leave the other yellow powder—uranium—in the soil and never to dig it up.”³

The Grand Canyon

Its geology can be traced back beyond two billion years and it is considered the most spectacular gorge in the world. Yet the Grand Canyon, a World Heritage site, has remained under the threat of uranium mining for decades. It is home to 447 species of birds, 91 species of mammals, 48 species of reptiles, 10 species of amphibians, and countless insects, spiders and other creatures. And yet, despite a 20-year ban on uranium mining imposed in 2012, these animals – along with the human inhabitants – remain at risk of being poisoned by the arsenic and lead, as well as the uranium and other radioactive isotopes, that a mine would release.

Photo opposite: Mike Bradley, Shutterstock

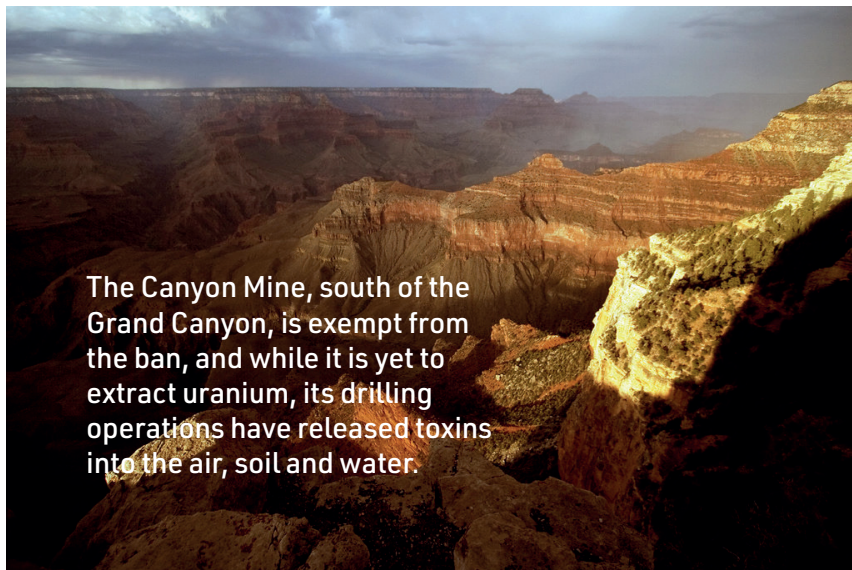


Photo: Grand Canyon by britsinvaide, Creative Commons/Flickr

The Canyon Mine, south of the Grand Canyon, is exempt from the ban, and while it is yet to extract uranium, its drilling operations have released toxins into the air, soil and water. Scientists “found toxic levels of arsenic and selenium in Western spadefoot tadpoles, which were significantly higher than levels they found in the same type of tadpoles from a nearby water source.”⁴

According to members of the Havasupai tribe, who live deep in the Canyon, and who have been challenging the mine in court, Canyon Mill “will contaminate the food chain and ultimately poison wildlife they hunt for food. The pond is one of the area’s only water sources, so animals will gravitate to it,” they say.⁵

As the struggle to stop the mine continues, Carletta Tilousi, a Havasupai council member, said her tribe will “Keep speaking for the animals. Keep speaking for the land. Keep speaking for our sacred places. Because that’s what Native Americans do. That’s all we have left.”

Wildlife and Nature in France

There were once more than 200 active uranium mines across France. The last one closed in 2001. These activities left behind more than 180 million metric tons of radioactive rocks and detritus, known as “tailings.” Tailings contain high amounts of radioactivity, as about 85 percent of the total radioactivity in the excavated ore is never used but remains in the tailings.



The Grand Canyon is home to 447 species of birds, 91 species of mammals, 48 species of reptiles, 10 species of amphibians, and countless insects, spiders and other creatures. All would be at risk of poisoning from uranium, arsenic and lead released by uranium mining.

The process of mining uranium releases radioactive dust into the air. This happens not only during uranium extraction but also during the crushing of ore, milling, and management of the waste rocks or tailings. Decay products of uranium released in this way, such as thorium, are highly radiotoxic when inhaled.

Radon gas, relatively harmless when trapped inside soil, is also released into the atmosphere through mine vents and diffusion from tailings.⁶

Uranium mining also uses water, especially during the in-situ leach method, when enormous quantities of water are “injected” into the mine site to flush out the uranium. Uranium mining contaminates groundwater, and consequently drinking water, especially for wild animals and livestock. When an accident occurs, radioactively and chemically contaminated water is released into the environment.

In France, radioactive tailings were used to construct buildings and pave parking lots, transferring their radioactivity into human-inhabited environments. This exposed people and animals to unnecessary doses of radiation, largely without their knowledge.⁷

Even after uranium mining production ceases, the radioactive contamination continues, given that the half-lives of uranium and its decay products are very long (uranium 238 is 4.5 billion years; thorium 230 75,000 years; radium 226 1,600 years, for example.)

Former mine sites have also led to the accumulation of radioactive materials in sediments of plants found in rivers, ponds and lakes, according to research by the Commission for Independent Research and Information on Radioactivity (CRIIRAD) an independent French laboratory and NGO that specializes in the analysis of radioactivity in the environment.

“The CRIIRAD laboratory discovered that sediments, aquatic plants and soil from river banks downstream from former uranium mines have such a contamination that they deserve in many cases the terminology ‘radioactive waste’ (238U activity or the activity of some of its by-products were exceeding 10,000 Bq/kg),” CRIIRAD reported in its paper, *Radiological Hazards from Uranium Mining*.⁸

CRIIRAD found high contamination of aquatic plants leading to high bioaccumulation of radioactive metals in biota. At the abandoned Les Bois Noirs uranium mine, for example, uranium accumulation in sediments was found to be 54 times above background even 12 kilometers downstream from the mine. “The contamination of aquatic flora will indeed contaminate the animals that consume such plants,” CRIIRAD’s laboratory director, Dr. Bruno Chareyron, wrote in a 2014 report on the impacts of uranium mining.⁹

Caribou in Nunavut

As snow begins to melt in June, thousands of Caribou gather in Nunavut, the autonomous Inuit region in northern Canada, having made the arduous journey across Canada from Saskatchewan. They are there to give birth. The attrition rate among calves is high, as predators such as wolves and bears move in for the kill. But there is another predator lurking. Uranium. Beneath the herd lies the 100 million-pound Kiggavik-Sissons uranium deposit, harmless as long as it stays buried.

But, as Mark Dowie wrote in the February 2009 edition of *Orion* magazine, the prospect of uranium being mined there would mean a virtual death sentence for the already vulnerable caribou herd.¹⁰

“Toxic radionuclides will find their way into the flesh of every animal that eats the vegetation and drinks the water. As it moves up the food chain, radioactivity will concentrate, threatening the food security of the



Photo: Caribou, by LS Photography, Creative Commons/Flickr

inland ‘Caribou Inuit,’ a people for whom the caribou are still, in this modern time, a vital source of food, clothing, and shelter.”

By the mid-2000s, as uranium prices suddenly soared, there were 28 uranium prospectors drilling at Baker Lake in Nunavut, even though the region’s people had voted to ban uranium mining in 1990. Eventually, it was the French company Areva (now renamed Orano) that actively pursued the mine. “Areva’s plans would empty part of a lake, build a road through the habitat of a declining caribou herd and stretch a bridge across a Canadian heritage river,” said a 2012 *Globe and Mail* article.¹¹ There were no protective measures in place for the caribou.

But by 2017 the caribou – and the Inuit – won a reprieve when Areva pulled out of the mine project.¹² Should uranium once again become profitable, however, the caribou could face a renewed threat.

Niger and its Herders

Niger, a sub-Saharan nation, is considered one of the poorest countries in the world. The nomadic Touareg tribespeople of Niger are already struggling against expanding desertification and water depletion due to the climate crisis. They depend on herding and grazing animals, and on their camels for transport. But they also face a longterm health threat from on-going radiation exposures due to uranium mining. Since their animals drink the same water and breathe the same air, their fate is equally uncertain.

Uranium mining began in the region in the 1960s and ‘70s, conducted by two French companies as well as the Chinese. Before that, “It was a pastoral region on the edge of a desert, where wild animals such as ostriches and gazelles lived and camels and other domestic animals grazed in a pasture environment rich in firewood,” writes former Arlit uranium miner and activist, Almoustapha Alhacen. “In those years, no artificial mountains were visible in a radius of 50km.”¹³ Those ‘artificial mountains’ are in fact the piles of radioactive mine tailings, stored in the open air.

The mining companies, virtually unregulated, have paid scant attention to health risks and environmental damage. According to the French laboratory, CRIIRAD, “In Niger, more than 20 million tons of radioactive tailings are stored in the open air, near SOMAÏR and COMINAK mills, a few kilometers away from the cities of Arlit and Akokan (about 70,000 inhabitants). Radon gas and radioactive dust can be scattered away by the powerful winds of the desert.”¹⁴

CRIIRAD has found radiological contamination of water supplies in the Niger mining communities.¹⁵ They looked at the deaths of camels and livestock who drank contaminated effluents from uranium mines in the region – including water released after a tailings dam break that



Niger herdsman, by Catay/Shutterstock

spilled 50 million liters of slurry contaminated with radioactive substances (uranium concentration of 180 mg/l) and chemicals (including nitrates) into the environment.¹⁶ The BBC reported that hundreds of animals died. However, the CRIIRAD analyses did not deliver any definitive conclusions. “That distresses me,” says lab director Chareyron, “because I believe that there is a serious impact.”

Now the wild animals are gone, and the domestic ones, along with their human owners, endure prolonged exposure to radioactive air, dust and drinking water. It is important to note that the uranium mining process also releases heavy metals into water supplies, which can be equally – and in some cases even more – damaging to health.

Operating reactors and nuclear facilities

Aquatic Animals

Sea Turtles

Sea turtles are the most numerically affected of all larger marine species around coastal nuclear power plants. Sea turtles mainly fall into the categories of “endangered” or “threatened” and the industries that harm them, such as shrimp fishing, have been regulated and mandated to use a “turtle excluder device” or TED, to allow sea turtles trapped by fishing nets to escape.

But nuclear power plants capture, harm and kill sea turtles, and plant owners are bound by extremely inadequate and arbitrary regulation. At the St. Lucie nuclear power plant in Florida, USA, for example, sea turtles have been caught in large numbers – 933 in one particular year – and yet federal authorities have failed to enforce regulations that curb these “takings.”¹⁷

Sea turtles are “entrained” at coastal nuclear power plants that use what is called the “once-through cooling system.” This involves the drawing in of up to three billion gallons of water a day to cool the plant, then discharging the now artificially warmed water into the same body of water from which it is drawn. As much as a million gallons of water a minute can be drawn in through intake pipes, traveling at high velocity. This creates a suction force and sea life is drawn in with the water, including sea turtles.

At St. Lucie, which was sited on a major sea turtle nesting beach, animals drawn in through the intake system endure a turbulent ride through what can be a barnacle-encrusted concrete intake pipe. Some are injured or even killed en route. Sea turtles at the end of a breath cycle can suffocate during transit through the intake pipe.¹⁸ Those animals that survive, emerge into a plant cooling pond where they continue to be drawn toward the plant. Nets erected to prevent further entrainment sometimes serve instead as death



Sea turtle, istock photo

traps as turtles become impinged on the nets. If not removed promptly, they drown (technically, they suffocate.) Yet, Florida Power and Light, the plant owner, describes St. Lucie as a “Sea Turtle Sanctuary.”

Sea turtles are injured during this transit, sometimes badly enough that they cannot survive. And yet, at St. Lucie and elsewhere, federal regulators typically just increase the “take quotas” for sea turtles, rather than enforce measures such as excluder devices that would increase their chances of escape and survival. The reason for this is simple: Fixes and retrofits such as excluders, barriers and nets, are expensive, particularly to maintain as debris collects, impeding their efficacy. An industry already itself drowning financially, has no interest in investing in such measures if not required.

Another member of the reptile family, the rare American crocodile, has also been affected negatively by nuclear power plant operations at Turkey Point in Florida, even though the plant owners try to claim that the artificially warmed waters around the plant have improved the habitat for the animals. But our research found that four American crocodiles had died at the plant between August 1998 and July 2000 with scant explanation as to what caused their fate, although at least one had been impinged in the suction of one of the cooling canal skimmer pumps.¹⁹

Marine Mammals

Seals and manatees have, like sea turtles, been entrained at US coastal nuclear power plants. Young seals were routinely sucked into the intake system at the Seabrook nuclear power plant in New Hampshire, at a rate of about one seal a month between January 1994 and December 1998.²⁰ But after a public outcry, preventive measures were installed to end this capture.

The Seabrook owners took their lead from similar measures installed at Dungeness nuclear power plant on the Kent coast in England.²¹ Despite this, on the same day that the Seabrook owners announced they would install seal deterrent bars, the US National Marine Fisheries Service opted to accommodate even higher seal kill rates. The agency raised Seabrook's take allowance to 24 seals a year, more than double the average number of seals Seabrook had been killing at the time.²²

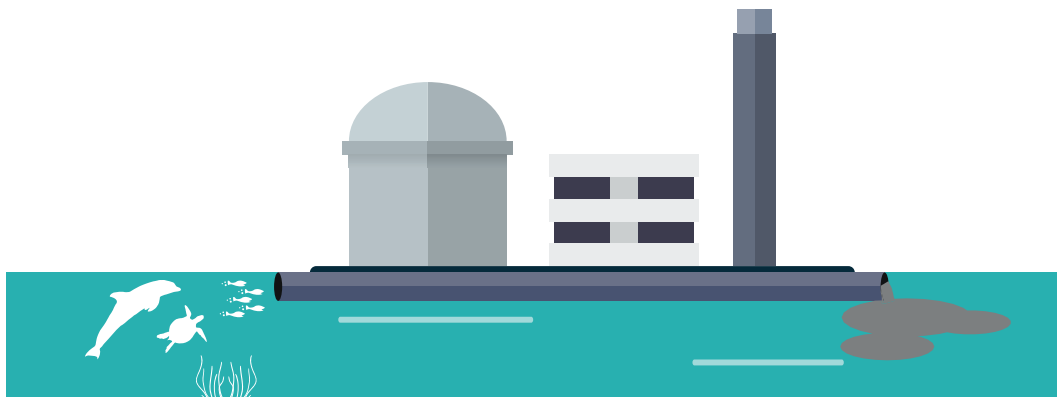
This practice – of simply raising take allowances to accommodate higher kill and capture rates of marine and aquatic animals rather than enforce prevention – continues to be the “go to” practice among federal regulatory agencies.

Before they closed, the San Onofre reactors near San Diego, California, routinely violated the Marine Mammal Protection Act. Between 1983 and 2001, when we wrote our *Licensed to Kill* report, at least 187 harbor seals and sea lions were found dead at the plant. Between January and July 2000, ten sea lions were entrained at the plant, five of which died.²³

Manatees have been entrained at St. Lucie,²⁴ while those congregating around the now closed Crystal River nuclear power plant on Florida's west coast, manifested mysterious lesions potentially related to bovine papilloma virus, likely connected to contamination in the water.²⁵ But no studies were conducted to establish any connection to discharges from the nuclear plant.



Photo left: Manatee, by By Tomas Kotouc/Shutterstock; Photo right: Seals, stock photo pixabay



In January 2018, FPL reported capturing 41 loggerhead, 142 green, and nine Kemp's ridley sea turtles in the intake canal of the St. Lucie power plant on Hutchinson Island.

As with other marine animals, manatees become habituated – and even attracted – to the artificially warmed waters around nuclear power plants. When the plant must abruptly shut down for refueling, or because of technical problems or dangerous weather patterns such as hurricanes, the surrounding water temperature abruptly drops, subjecting the animals to thermal shock. But plant owners are on record as stating that, for economical reasons, they cannot keep plants running just to save manatees.²⁶

Manatees lingering in the artificially warmed discharge waters around power plants have also failed to migrate in time, not realizing that ambient water temperatures beyond the plant have seasonally dropped. When they do finally set off, the now too low water temperatures subject them to cold stunning.

Fish and Lobsters

Fishing and the harvesting of lobsters is very strictly regulated in the US and requires a license. For example, lobstermen are not permitted to harvest undersized or egg-bearing female lobsters and fishing fleets must stick to quotas. But US coastal nuclear power plants are bound by no such limitations. This is despite the fact that US nuclear power plants are expected to comply with the Clean Water Act, which states that nuclear reactors are required to use water intake systems that “reflect the best technology available for minimizing adverse environmental impacts.” Clearly, the once-through cooling system used by nuclear plants that have not installed cooling towers instead, falls far below this standard.



Coastal once-through nuclear plants suck in billions of fish, fingerlings and spawn, as well as lobsters, every year, and without discrimination regarding age, gender, condition or species. Far from having a fishing license, reactor owners have a license to kill, indiscriminately and with impunity. With fish stocks depleted and over-fishing already a worldwide problem, the cumulative effect is worsened by adding this latest marine predator to the crisis.

At the other end of the process, fish are harmed again by the discharge of hotter water into the local aquatic environment. At the Diablo Canyon nuclear power plant in California, hot water discharges into Diablo Cove resulted in “loss and degradation of habitat, decreases in several species’ diversity and density, and loss of entire species,” according to a memo from the California Fish and Game department. “It has been shown that the effects continue to expand beyond Diablo Cove and are greater than predicted. The discharge does not provide for the protection of propagation of species and does not provide habitat suitable for indigenous species.”²⁷ The hot water was found to cause “withering syndrome” in the local black abalone population, putting it into steep decline.

Fish, like other sea creatures, have also been killed by thermal shock (cold stunning), when the nuclear plant goes into sudden shutdown, the hot water discharges abruptly cease, and the ambient water temperature drops. Many such incidents are well documented.²⁸

Indigenous Species

The effect of hot water discharges from nuclear power plants changes the marine or aquatic environment around the plant. This has a damaging effect on the indigenous species that live around the plant’s discharge pipes. The warmer water creates an unnatural environment, and drives away the indigenous species living there, instead inviting in invasive warmer water species.

Because the water is discharged at speed, it kicks up sediment, scouring the sea floor or river, reservoir or lake bed and clouding the water, blocking out sunlight. This kills aquatic plant life on which the indigenous species depend, further impacting their survival.

Activists around the now closed Pilgrim nuclear power plant on the Massachusetts coast noted in a 2014 study that there was “a 15,000-square-foot dead zone around the end of the discharge canal. Essentially, nothing can live there. Surrounding that is an even larger area of stunted marine life.”²⁹

What still needs to be studied is the radioactive content of the discharge water, and how this likely affects the species living in the immediate vicinity of the discharge pipes or even further out.

Terrestrial Animals

The Hanford Rabbits

Far less is known about the impact on terrestrial animals living around routinely operating nuclear facilities (those living in nuclear disaster zones *have* been studied – see the Reactor Accidents section.) But when a radioactive rabbit was captured on the Hanford Nuclear Reservation in 2010, it was a fair assumption, given the animals' breeding power, that where there was one radioactive rabbit, there were countless more. Shortly afterward, radioactive mouse droppings were also found around Hanford.

Hanford produced much of the plutonium used for the US atomic bomb program during the Cold War. Located in Washington State, it sprawls across 586 square miles and is considered the most radioactively contaminated nuclear site in the United States.

Early on, according to news reports, a badger burrowed into one of the site's waste pits, and rabbits followed, attracted to —and licking — radioactive



Jack Rabbit spotted at Hanford, by US Department of Energy

salts that had been discharged on site into the ground. The result was that the Hanford rabbit population “scattered 200 curies of radioactive droppings over 2,500 acres of the Hanford Reserve.”³⁰ By 1969, a perimeter fence had been constructed, ostensibly to keep animals out but which apparently did not factor in creatures that fly or burrow.

The rabbit captured in 2010 was found to be so highly contaminated with cesium it had to be disposed of “as radioactive waste.”³¹ Around the same time, numerous radioactive wasp nests were discovered, spreading across six acres and necessitating the removal of a foot of soil to get rid of them.³²

Them! Radioactive Ants

Beyond radioactive rabbits, mice and wasps, it was the appearance in 1999 of radioactive ants, flies and gnats that prompted satirical columnist, Dave Barry, to recall the 1954 science fiction feature film, *Them!* in which “marauding ants are spawned by nuclear experiments in the desert,” then mutate and head to Los Angeles.³³

“If, as now seems likely, the radioactive insects at the Hanford complex mutate and start marauding, they will almost certainly head for Los Angeles,” Barry joked in the column. “This is a terrifying prospect. Imagine how you would feel if you tuned in to the evening news and learned that, for example, Fran Drescher had been sucked dry by a gnat the size of a water buffalo. You’d feel pretty excited. You’d hope there was video.”

Like the heroes of *Them!*, Hanford authorities attempted to “solve” the problem by killing off the ants, in their case by poisoning rather than burning them, hardly an ecologically friendly measure and, like the fence, unlikely to have been a comprehensive preventive.³⁴

Dairy Cows and Farm Cats

As we will see in the nuclear accident section, a nuclear disaster can have a devastating effect on farmers and their ability to make a living. Not only can this affect local farms as it did around the Fukushima nuclear power plant, but also those located many thousands of miles away, such as the sheep farms in North Wales, where fallout from the 1986 Chernobyl nuclear accident in Ukraine caused animals to be unmarketable as meat for decades. As a BBC News story recalled in April 2016, “In total, 344 Welsh farms were put under restrictions, with animals’ radiation levels monitored before they were allowed to be sold at market. The number of failing animals peaked in 1992, but some still recorded higher levels of caesium as recently as 2011.”³⁵ Monitoring stopped in 2012, but farmers continued to notice abnormal lambs and the BBC story concluded that “the disaster’s legacy may be felt for generations to come.”

But what of farms close to operational nuclear power plants? As always, these farmers live in the shadow of potential bankruptcy. A single accident could destroy their livelihood overnight. But does it even take an accident? In 1982, New England activist, Chris Nord, began an investigation of dairy farming downwind of the then operational Vermont Yankee nuclear power plant located in Vernon, Vermont, in the USA, situated close to the New Hampshire and Massachusetts borders.³⁶



Farm cats by David Maitland, Creative Commons/Flickr

Nord interviewed two sisters, Mildred Zywna and Annie Fostyck, both of whom had farmed milking cows for a time across the Connecticut River in Hinsdale, New Hampshire, about two miles from Vermont Yankee. The sisters had first noticed higher rates of leukemias and cancers among the local human population, then also among pets such as dogs and cats, and eventually their own herds.

“Cattle were aborting, and later on it got to the point that a lot of calves were being born deformed,” Mildred Zywna reported. This had been something very rare before the nuclear plant was built, the sisters said, but gradually more frequent once it went into operation. At Annie’s place, Mildred said, “they had a lot of barn cats that were dying all over the place. Now a lot of them are born one-eyed.” Most of the calves there “were born dead and deformed.” And there were cases of cancers among cows, unheard of before in the dairy farming community.

“It kept getting worse,” Fostyck said. Vets treating her cows found “deformities, miscarriages, tumors, twisted stomachs, hoof rot, lethargy, poor milk production, and breeding problems.” The barn cats exhibited similar symptoms to the cows.

Anecdotal? Certainly. Too many cases to be just a coincidence? Probably. Efforts to get studies done or support from the state were met with threats of farm closures or dismissal by authorities. But one veterinarian, Dr. Fred Hess, who treated the Fostyck animals, told Nord: “Scientifically, of course, I couldn’t prove it, but there’s enough of a question in my mind concerning Vermont Yankee’s role in the Fostyck’s troubles, that I think the matter should definitely be investigated.” It never was.

344 Welsh farms were put under restrictions due to Chernobyl fallout.



Proposed new reactors

Fermi's Snake

The fate and wellbeing of nature and wildlife must also be taken into account when new nuclear sites are proposed. Fortunately, nature sometimes holds sway over such plans. A proposed uranium mine in South Africa was defeated when a rare succulent was discovered on the targeted land. But the American Eastern Fox Snake has not been so lucky.

A proposed new nuclear reactor in Michigan, US, – Fermi 3 – is still on the books and would be built at the existing Fermi 2 nuclear site by the shores of Lake Erie, one of the Great Lakes. The new nuclear plant construction site poses a specific danger to the threatened Eastern Fox Snake, an indigenous constrictor, which makes its home on coastal wetland habitat at the Fermi 3 site – only one of four such habitats that still exist. Should the Fermi 3 reactor be built, a new transmission corridor would also need to be connected to the new reactor. That transmission line corridor would destroy critical habitat, including forested wetlands, where Eastern Fox Snakes also live, along with many other important species.

Detroit Edison (DTE), the site owner, suggested it would create an “alternative habitat” for the snake, as if species can simply be picked up and moved to an environment chosen by humans.³⁷ (This is a familiar “out.” See Welsh Terns and Yucca Mountain sections). DTE’s plan for replacement habitat for the snakes is a former farm field immediately under the chimneys of its 3,000 megawatt coal-burning Monroe Power Plant. The



Photo above: Eastern Fox Snake by Anthony Cannizzaro, Wikimedia/Creative Commons/Flickr



Cemlyn Bay tern colony, by Julian Wynne

land there is already likely contaminated with acids, radioactivity, mercury, and other toxic chemicals fallout.³⁸

The State of Michigan has acknowledged that the impact of Fermi 3 on Great Lakes shoreline wetlands would be the largest in the history of Michigan's wetlands protection law. The Michigan Department of Natural Resources also admitted that Fermi 3 construction "would not only kill snakes but destroy the habitat in which they live and possibly exterminate the species from the area".³⁹ But all of these concerns have been ignored by the US Nuclear Regulatory Commission which has issued DTE a construction license despite protracted legal challenges, including from Beyond Nuclear.⁴⁰ The exorbitant cost of the project may yet stall it, but the law failed to protect the snakes and their fragile habitat.

Welsh Terns

Had not the Japanese firm Hitachi essentially pulled the plug on its proposed new Wylfa Newydd (Wylfa B) two-reactor site on the north Wales Yns Môn (Anglesey) coast in January 2019, it might have been killed by a bunch of birds. Within sight of the closed Wylfa A reactor and the area proposed for nuclear expansion, sits Cemlyn Bay, home to a unique breeding colony of Sandwich terns. This fragile population stood to be destroyed by the disruptive nuclear site construction nearby. A proposed 500m breakwater needed for the nuclear site posed an added threat, as it might have pushed storm water over the fragile ridge where the colony sits, washing it away. A protected wetland, home to myriad and important animal and plant species, was also threatened.⁴¹ All of this spurred the North Wales Wildlife Trust to take a stand against Wylfa Newydd.⁴²

Horizon, the Hitachi subsidiary in charge of the project, had suggested that in the case of terrestrial animals disrupted by the construction, it would simply relocate them. “Clearing of the 738-acre site would see buildings demolished and the relocation of wildlife, some of which, such as barn owls, bats and great crested newts, is endangered.”⁴³ If the project was subsequently canceled, it would move them back again, the company said, even though by then the landscape – which would have seen entire hillsides leveled – would have been radically and irrevocably transformed.⁴⁴

Hinkley Point Fish

The proposed Hinkley Point C two reactor site on the UK coast in Somerset, scored a dramatic headline in the conservative British newspaper, *The Times*, in July 2019, when it blared: “Nuclear plant will suck fish to their deaths.”

As with all “once-through” nuclear power plant systems, Hinkley C, if it ever opens, will draw in huge volumes of water and, with it, countless fish and other small sea life. With two inlet tunnels, Hinkley C is expected to draw in at least 130,000 liters of water a second. According to the *Times* article, “conservation groups say it will kill up to 250,000 fish a day,” making it a veritable slaughterhouse and further depleting already

dwindling fish stocks. EDF, owner of the plant, admits it will kill fish, but claims the tally would be 650,000 fish a year, a gross under-estimation according to the conservation groups.

Fish caught on the debris screens, which will only deter larger species and could kill them anyway through entrapment on the

mesh, will be returned to the sea, dead or alive, meaning the plant owners will have no accountability for the level of marine life destruction Hinkley C would cause. James Robinson of Wildfowl & Wetlands Trust, one of the groups protesting the potential fish kills, called the system “a giant plughole” that would “suck millions of sea animals to their deaths, in one of our most important protected marine areas, in order to produce electricity.”



Photo above: Hinkley C construction site, by Nick Chipchase, Wikimedia Commons



Minsmere is one of the most important wildlife sites in Europe, and also one of the most wildlife-rich nature reserves in the UK

Minsmere Birds

The Minsmere Nature Reserve, on Britain's Suffolk Coast, is owned by the Royal Society for the Protection of Birds, and is home to more than 5,500 species of animals and plants. It is responsible for the revival of the near extinct marsh harrier and welcomes the unusual avocet to its wetlands.⁴⁵ The RSPB says Minsmere is "one of the most important wildlife sites in Europe," and also "one of the most wildlife-rich nature reserves in the UK."

But French nuclear company, EDF, wants to expand its existing Sizewell nuclear site to accommodate its proposed Sizewell C EPR reactor. Construction would begin adjacent to the reserve. This will impose on the precious refuge "an industrialized site for more than ten years with pollution from light, noise, dust," said nearby resident, actress and activist, Diana Quick.⁴⁶ The construction site could also cause coastal erosion, potentially inundating the nature reserve. An ancient forest – Coronation Wood – would need to be razed, creating further noise and eliminating yet more important wildlife habitat.

The fate of Minsmere wildlife lies in the hands of a classically undemocratic process, typical of the conduct of nuclear corporations everywhere. In one example, while EDF claims to conduct public engagement, the company allowed "126 objectors just three minutes collectively in which to publicly state their case," reported Together Against Sizewell C's Pete Wilkinson about a November 2019 public meeting.⁴⁷

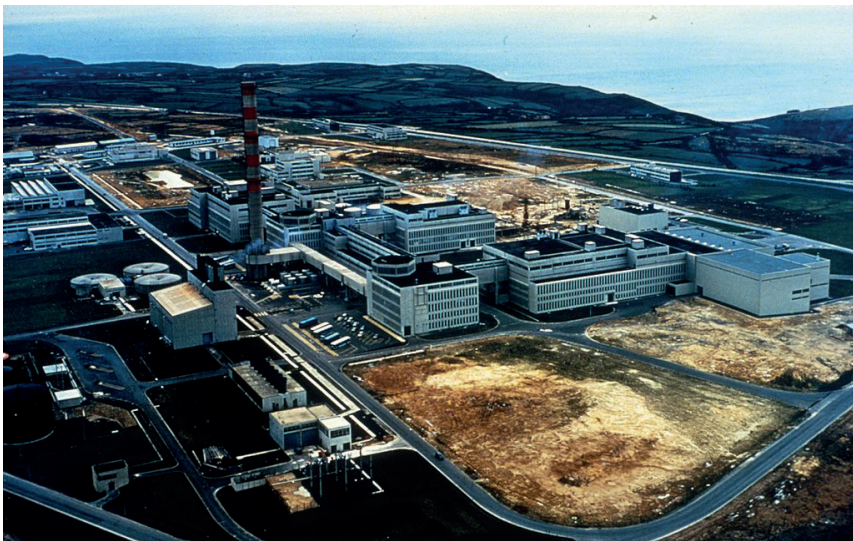
Furthermore, permission to bulldoze the area was narrowly granted by the local council even as uncertainty still hangs over whether the Sizewell C reactor will even go ahead. What BBC television presenter, Bill Turnbull, described as "a treasure chest of wildlife" could be swept aside in favor of a nuclear construction site that would eventually house a legacy of radioactive waste deadly for at least tens of thousands of years.

Photo above: Minsmere nature reserve, Suffolk, by Royal Society for the Protection of Birds

Reprocessing

The two major nuclear reprocessing centers in Europe are on the west coast of the UK at Sellafield, and on the northern Cherbourg Peninsula in France at La Hague. Both have contributed to aerial and marine contamination through the routine release of radioactive gases and liquids. Radioactive gases from La Hague, such as krypton and xenon, have been traced as far as the Arctic. Sellafield (originally Windscale) has made the Irish Sea, into which it discharges, the most radioactively contaminated sea in the world.⁴⁸

Around the La Hague site, local people are constantly exposed to releases of carbon-14 from the plant, one of the most carcinogenic radioactive gases for human beings. Inevitably, wildlife, livestock, pets and marine life are also affected.



La Hague reprocessing site, by US Department of Energy

Sea life

Lobsters, mussels and shrimp harvested off the coasts of Ireland and Scandinavia were found to have high levels of cesium and technetium during the height of the Sellafield nuclear reprocessing operations. Ireland, as well as Norway and Sweden,⁴⁹ protested this radioactive contamination of their food source.

In addition to the flow of radionuclides discharged into the sea by Sellafield, it was found through studies that remobilization from sediments of historic discharges was also contributing to radioactivity in the seawater of the western Irish Sea, in particular cesium-137.⁵⁰

A 1999 study found radioactive cesium and plutonium concentrations in seals and porpoises swimming in the Irish Sea and observed that “the radiocaesium contamination in seals and porpoises decreased with distance from Sellafield indicating that the BNF plc processing plant was the major source of the contamination.”⁵¹

When in 1987 Greenpeace tested the discharge pipes at the La Hague reprocessing plant on France’s Normandy coast, the radioactivity levels contained in the liquid waste were 3,900 times higher than background levels, qualifying the discharge to be classified as radioactive waste.⁵² Had that waste been put into tanks or barrels and dumped at sea, it would have violated the 1970 London Dumping Convention. But because it is released as effluent, no action can be taken. However, the Greenpeace readings were high enough to alarm government officials at the time, and an “indefinite ban” was placed on swimming and fishing near the site by the environment minister.⁵³



Sellafield, by Simon Ledingham, Wikimedia/Creative Commons

Radioactivity levels contained in liquid waste discharged from La Hague tested at **3,900 times higher** than background.



Despite the fact that the ocean is expected to serve as a massive diluter, “Studies from previous releases of nuclear material in the Irish, Kara and Barents Seas, as well as in the Pacific Ocean, show that such radioactive material does travel with ocean currents, is deposited in marine sediment, and does climb the marine food web,” a Yale study found.⁵⁴

The Sellafield pigeons

Once upon a time, there lived middle-aged twin sisters in the tiny town of Seascale, just down the coast from Sellafield. The sisters loved birds, and cared for a flock of around 700 pigeons in their garden, which they dubbed the “Singing Surf” sanctuary. But this is not a fairy story. These same pigeons also roosted on the roofs at Sellafield. After a while, the guest house next door got tired of all the pigeon droppings on their own building and called the authorities. After a cull of around 150 birds, it was found that the pigeons and their droppings had effectively turned the sisters’ garden into a radioactive waste dump site.⁵⁵ At least 2,000 radioactive pigeons were eventually killed, while the entire garden, as well as the tarmac drive, was dug up and had to be disposed of as nuclear waste, along with all of the garden furniture.⁵⁶ Eventually the UK government was forced to issue a ban on handling or eating pigeons within a 10-mile radius of Sellafield.

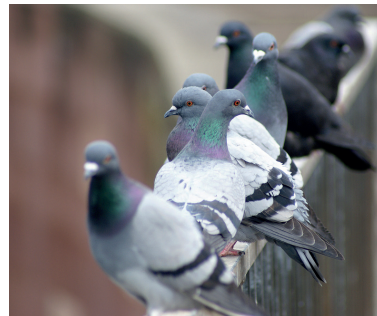


Photo above: Pigeons roosting, by Neil Kulp, Shutterstock

However, Sellafield continues to discharge its radioactive waste into the sea and air and will continue to do so even during cleanup, due to begin after all of the reprocessing activities finally cease in 2022.



Blighted bees

Since 2009 when honey was first tested, the UK government, in its annual report, *Radioactivity in Food and the Environment*, revealed the presence of various radioactive isotopes in honey local to nuclear installations, including plutonium-241, carbon-14 and cesium-137. These rates were generally higher than samples of honey from elsewhere in the UK. While the government

insisted this still fell within so-called allowable levels for consumption, as the late nuclear consultant, John Large, pointed out, “cesium-137 should not be turning up in honey at all.”⁵⁷

Radioactive milk

Although there appear to have been no studies of milk produced by cows grazing near La Hague, an accidental discharge of radioactive iodine in 1969, after the plant had been operating just one year, forced then owner Cogema to buy part of the local milk production which had been contaminated.⁵⁸

However, subsequent analysis by CRIIRAD during La Hague’s operational years, found evidence of iodine-129 in 12 of 15 samples of moss taken at seven kilometers distance from the plant, with noticeably higher levels north of the facility. “Before it is deposited in soil, this radionuclide can be inhaled by the population or can contaminate the food chain through transfers such as grass → cow → milk,” the lab said.⁵⁹ Iodine-129 is especially radiotoxic, with a half-life of 15.7 million years.

In the UK, the government report referenced in the bee section also tested milk and, over the years, sometimes found carbon-14 present in milk at levels higher than background.

Photo above: Honey bee, by MattX27, Creative Commons

Reactor accidents

Three Mile Island

Most reporting on the health impacts of the March 28, 1979 Three Mile Island (TMI) nuclear power plant accident, including to animals, tends to whitewash the real effects. Why was this? Due to a gag order from a federal district court, researchers studying the human health impact of TMI radiation emissions were prohibited from assessing “worst case estimates” of radiation releases unless such estimates would lead to a conclusion of insignificant amount of harm.⁶⁰ If a researcher wanted to claim more harm or investigate a worst-case scenario, an expert selected by nuclear industry insurers would have to “concur on the nature and scope of the [dosimetry] projects,” according to the court order.

Consequently, the much higher radiation doses than publicly admitted at the time were covered up for years, cementing a false narrative about TMI that “no one died” and no real harm was done by the accident.

However, thanks to a multitude of interviews with locals, done at the time and shortly afterwards, there is plenty of evidence, from the owners of pets

and livestock as well as veterinarians, to show that significant harm was also done to the animal population.

Dr. Robert Weber, working as a veterinarian at the time of the March 1979 accident, reported a 10% increase in stillbirths and a sharp increase in the need for Caesarian sections among sheep, goats and pigs in 1979, 1980 and 1981 in a 15-mile area around TMI. He also observed a significant



Middletown, Pennsylvania marker describing the Three Mile Island accident, by Z22, Wikimedia Commons

increase in the cancer rate among the animals he treated, as well as shorter life spans among dogs and cats.⁶¹

Individual pet owners also reported instant harm to their animals from the accident. From 1979 to 1988, Green Action's Aileen Mioko Smith and Katagiri Mitsuru recorded testimonials from 250 TMI eyewitnesses. Bill Peters, an auto mechanic, told how he and his family left for seven days, providing 50 gallons of water and 200 pounds of dog food for their German Shepherd dog. "When we came back, he was laying on his mattress dead," Peters recalled. "And both eyes burnt white."⁶²

A good compilation of the impacts from TMI on pets and livestock can be found in chapter 13 – *Animals died at Three Mile Island* – in the 1982 book, *Killing Our Own*.⁶³

Chernobyl

Chernobyl is probably the most studied of all nuclear sites in relation to health impacts on local animal populations and on animals living far away. The accident took place on April 26, 1986 but its harmful repercussions persist today.

More than 110 peer-reviewed studies, conducted over a period of more than 18 years, have already been published, clearly showing a negative impact to local wildlife and habitat due to the large amounts of radiation released during the Chernobyl disaster.⁶⁴

These extensive and detailed studies reveal a number of common phenomena: mammals and birds have shortened lifespans; low to zero sperm counts; suffer from tumors and cataracts; and bear young with reduced brain sizes. Scientists found that the higher the radiation levels in the area, the greater frequency of tumors in the birds and mice they studied. Up to 39% of male birds in the radiologically hottest areas were sterile in some years.

The notion that animals do better in the absence of human predators is negated around Chernobyl because of the high radiation levels. Instead,



More than 110 studies over 18 years show shortened life-spans, low to zero sperm counts, tumors, cataracts and reduced brain sizes among exposed wildlife populations.

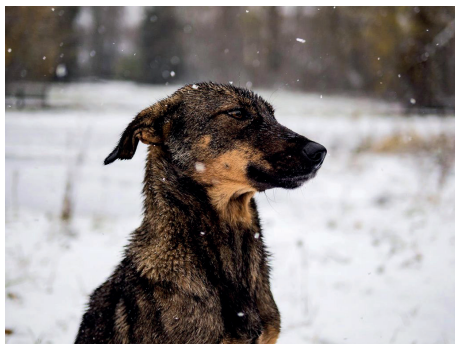


Photo: Chernobyl stray, courtesy Dogs of Chernobyl, Clean Futures Fund; Illustration: Deformed leaf bugs, by Cornelia Hesse-Honegger

researchers found populations in decline. A study looking at bank voles found that the probability of a bank vole being pregnant decreased significantly with increasing radiation levels.⁶⁵ As an important source of prey to other species such as owls, hawks, weasels and foxes, the voles' decline has a ripple effect throughout the food chain.

Even the tiniest of creatures have taken a hit at Chernobyl. In a May 2014 study, Mousseau et al. concluded that "radioactive contamination has reduced the rate of litter mass loss, increased accumulation of litter, and affected growth conditions for plants."⁶⁶ The cause was the reduced abundance of organisms such as microbes, fungi and various insects usually responsible for recycling organic matter back into the soil.⁶⁷ All of this could have serious implications for the entire ecosystem.

Someone else who had paid attention to the tiniest of creatures was Swiss biological illustrator, Cornelia Hesse-Honegger, who, one year after the Chernobyl disaster, came across deformed leaf bugs in areas of Sweden that had been hit hard by radioactive fallout.⁶⁸ She began to illustrate these, and others near a German nuclear power plant and the French reprocessing facility at La Hague. After collecting 18,000 bugs, cicadas and ladybirds, Hesse-Honegger could not escape the conclusion that their similar mutations and deformities were due to radiation exposure.

Mammals living further away, but still under the plume pathway of Chernobyl, carry high enough loads of cesium even today to render them unfit for human consumption. This is true of reindeer⁶⁹ in Scandinavia, wild boar in Germany⁷⁰ and, until recently, sheep in Wales. In the case of reindeer and boar, the cause is primarily the animals' consumption of lichen and fungi which bioaccumulate radioactive cesium. For sheep, it is due to pasturing on grass in radioactive hot spots caused by Chernobyl fallout. In the UK, this is potentially compounded by radiological discharges from the Sellafield reprocessing site and from nuclear power plants.

When residents evacuated Pripjat a few days after the Chernobyl disaster began, no one knew how long they would be gone or how serious the Chernobyl accident really was. Consequently, many left their pets – mainly cats and dogs – behind. As was portrayed in the HBO/Sky television series, **Chernobyl**, some of the liquidators sent in to deal with the disaster were tasked with exterminating these pets, through fear they would contaminate other animals and people. But many of course survived, and their descendants live there to this day. More recently, a project called *The Dogs of Chernobyl*, has been established to spay, neuter, vaccinate, and in some cases adopt out, the stray dogs, many of whom are routinely fed by workers at the Chernobyl site.⁷¹ The program now also includes cats.

Fukushima

Unfortunately for macaque monkeys, they can't read evacuation notices. Consequently, after the March 11, 2011 Fukushima Daiichi nuclear disaster began to unfold, the monkeys remained in the prefecture, enduring daily exposure to radiation. Now, those monkeys have been found with compromised bone marrows, which are less capable of producing white blood cells. Their bone marrow has instead turned into a white, fatty-like substance. This has been directly attributed to “disturbingly high” levels of cesium in the monkeys' muscle tissue.⁷² The monkeys are also giving birth to young with smaller brain sizes. The monkey findings issue a stark warning to humans, as our DNA differs from theirs by only 7%.



Macaque monkey, Japan, by Yblich, Wikimedia Commons



Dr. Timothy Mousseau and his colleagues, authors of many of the studies we cite in the Chernobyl section, have also conducted extensive research around Fukushima. “Although it’s too early to assess the long-term impact on abundance and diversity around Fukushima, there are very few butterflies and many birds have declined in the more contaminated areas,” Mousseau and his co-authors reported. “If abundance is

compressed, biodiversity will follow.”⁷³

The images – and sounds – of starving cows, abandoned by Fukushima farmers forced to evacuate, remain seared in the memory of many. So traumatic was this abandonment for some, that there was a rise in suicide among farmers as a result. News reports showed photos of gnawed wooden posts in cowsheds where the desperate animals had tried to feed.

Other reports showed dogs and cats running wild through abandoned towns and countryside. Although Japanese evacuees were allowed to bring their pets to shelters, many evacuated without their animals, believing their exodus would last only a few days.

For some people, the suffering of these animals was too much, and they returned to the zone, despite the prohibitions, to feed and care for the animals who had survived. This was captured most vividly in the documentary *Alone in the Zone*, about Naoto Matsumura, who lives in Tomioka looking after pets and livestock, from kittens to cows and even ostriches.⁷⁴

Image above: Where are the birds? Fukushima collection, painting by Mary Lou Dauray



Radioactive waste drums, by Zoltan Acs/Shutterstock

Radioactive Waste Dumps

What to do with the main product of nuclear energy – high-level radioactive waste – remains perhaps the most fraught, and hitherto also unsolved, problem of the entire uranium fuel chain. A deep geological repository has been a favored option by governments, but largely because no better one has been found. Any site identified to date – including Onkalo, in Finland, the only such repository seriously underway – remains plagued with questions and doubts about what will happen far into the future, given the very long half-lives of some of the intended inventory. In the United States, only Yucca Mountain, Nevada, has so far been targeted for such a repository.

Yucca Mountain

The proposed Yucca Mountain high-level nuclear waste repository – the project that refuses to die despite being canceled under the Obama administration – sits on land belonging to the Western Shoshone Native American tribe. Although the Yucca Mountain site is routinely described by the media as “barren,” “desolate,” “arid” and “remote”, given its location in America’s Nevada desert, the Western Shoshone argue that Yucca Mountain’s deadly radioactive cargo will eventually leak into aquifers. This would have harmful consequences for animals and plants as well as people.⁷⁵ Yucca Mountain would theoretically play host to the country’s irradiated commercial reactor fuel, all of which currently sits either in fuel pools or storage casks at the sites where it was generated, given no safe, secure, long-term storage option has yet been discovered. But Yucca Mountain has been opposed from the start by the State of Nevada, the Western Shoshone, scientists, and scores of citizen, anti-nuclear and environmental groups across the country.

Patrick Donnelly, the Nevada state director for the Center for Biological Diversity, told the *Reno Gazette Journal* in May 2019, that “Contamination from Yucca Mountain could very easily contaminate the aquifer, and thus contaminate all sorts of springs that harbor some kind of endemic life.”⁷⁶ The same article stated that “Yucca’s aquifer drains to the Amargosa Valley – home to more than 1,400 people and several endangered species.”

Far from being barren, the Yucca Mountain area is home to the desert tortoise, lizards, kangaroo rats, pocket mice and other animals. Indeed, there was great enough concern about the potential impact on the desert tortoise to prompt several studies on the animal, its abundance and habitat, with the view to “minimizing” impacts on the species once the Yucca project got underway and for when it would eventually open. Once again, one of the conclusions was that these animals would need to be moved. “More than 180 ha of desert tortoise habitat may be disturbed during SCA [site characterization activities]. Desert tortoises found in those areas may have to be moved to other areas within their home range or relocated to areas outside of their home range.”⁷⁷ This idea that animals can simply be shifted about to suit the extractive and invasive excesses of human beings, does not hold up well under scientific or biological scrutiny.



Yucca Mountain site, Nevada, by U.S. Department of Energy

The next accident

Until they are all closed down, another accident at a nuclear power plant is a tragic inevitability. When this next nuclear disaster comes, what happens to the animals over whom we theoretically have ownership and control—our pets and livestock? Many remember the tragedy of Hurricane Katrina, the devastating storm that struck Louisiana in 2005, when countless pets were left behind, some stranded on the rooftops of flooded homes, struggling to fend for themselves. Those who took their pets with them were denied entry into shelters where animals were not permitted.

Since then, two laws have been passed in the US – the Pets Evacuation and Transportation Standards Act⁷⁸ and the AKC Pet Disaster Relief law⁷⁹ – that direct federal services such as the Federal Emergency Management Agency to create and implement preparedness and management plans for pets in the event of a disaster that requires evacuation.

Today, people are urged to take their pets with them in an emergency, and are encouraged to have a pre-planned destination with friends, relatives or pet-friendly hotels, since many public shelters still do not allow animals.⁸⁰

During natural disasters such as hurricanes, fires and floods, rescue groups like the ASPCA and the Humane Society of the United States work frantically on the ground rescuing pets. Concerned citizens have also tried to save wild animals, rescuing bats, deer, possums and others. Livestock, given their numbers and size, pose far greater challenges.

All of these efforts become complicated, if not impossible, during a manmade disaster like a nuclear accident when radioactive contamination is added to the mix. When a nuclear accident happens, emergency personnel and animal welfare charities may not be able to enter the stricken area if radiation levels are too high. Those not at home at the time may not be permitted to return there to retrieve their pets for the



same reason. Livestock may be left to starve, as many were during the Fukushima disaster. And wild animals, as with Chernobyl and Fukushima, will once again continue to live, unawares, in the front line of harm, suffering persistent, daily exposure to radiation.

Conclusion

Whether wild or domestic, animals and their wellbeing have become our responsibility. Our impact on Earth is having a drastic effect on their ability to survive. And on their survival also depends ours. In the nuclear sector, as elsewhere, humans have exposed animals to dangerous toxins and have destroyed precious habitat.

From uranium mining to power generation to the production of radioactive waste, nuclear power acts as a predator on the welfare of animals. A nuclear accident permanently contaminates wild lands and seas and the animals who live there; in a disaster, domestic animals may simply be abandoned.

The climate crisis has made the plight of animals infinitely worse. It is up to us to eliminate any added burdens that may hasten their demise or extinction. That means ending our use of nuclear power, an industry that poisons our environment and needlessly injures and kills animals of every species, including the human kind.

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