

# A Tale of Two Urban Forests - Horsechestnuts in Kiev and Chernobyl

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[Welcome music playing in the background]

**Tom Smiley:** Welcome to the ISA Science of Arboriculture podcast series. This is Dr. Tom Smiley at the Bartlett Tree Research Laboratory host of this podcast series, which is brought to you by the International Society of Arboriculture and the Bartlett Tree Expert Company.

Today's podcast is by Dr. Jim Downer. He's from the University of California division of Agriculture and Natural Resources, where he serves as a cooperative extension, a horticulture advisor in Ventura County. He will be speaking on A Tale of Two Urban Forests Horsechestnuts in Kiev and Chernobyl. This presentation examines, the post-apocalyptic zone in Pripyat Ukraine with a similar population of trees in Kiev Ukraine.

**Jim Downer:** [00:01:09] Hi, this is Jim Downer and I'm here today remotely in Portal Arizona to give you a lecture on my adventures in Ukraine. And I want to also note that my co-author here, John Carlick is also an extension agent in California. So as we go through the presentation I'll give you a little bit more background on how we came to go to Chernobyl and why we went there.



The Third Angel, a sculpture at the Wormwood Star Memorial in Chernobyl, Ukraine (Revelation 8:10-11)

But one of the most iconic pieces of art in the town of Chernobyl is the statue here that appears to be made of fuel rods from the exploded reactor, or at least that's the impression you get. It's called the Third Angel and it's at the Wormwood Star [00:02:00] Memorial and the town of Chernobyl that is an actual museum to the disaster and everything that had happened.

The whole concept of the statute comes from scripture from Revelation. And you can go look up that passage and read about some of the things from scripture that sort of resonate very well with what happened in Ukraine. So as an overview, we're going to talk a little bit about radioactivity because it's so important in understanding this. A little bit about the incident, and then our recent travels from 2012 to 2018. And finally the comparisons that we make between the forest, urban forests of Kiev and Pripyat.

So first off, there are three kinds of radiation. There's, and these all result from the decay of radioactive elements and these may be naturally occurring or not, but in this case naturally occurring and some that occurred in the explosion not naturally occurring, but the most innocuous and, and harmless of these would be alpha decay.

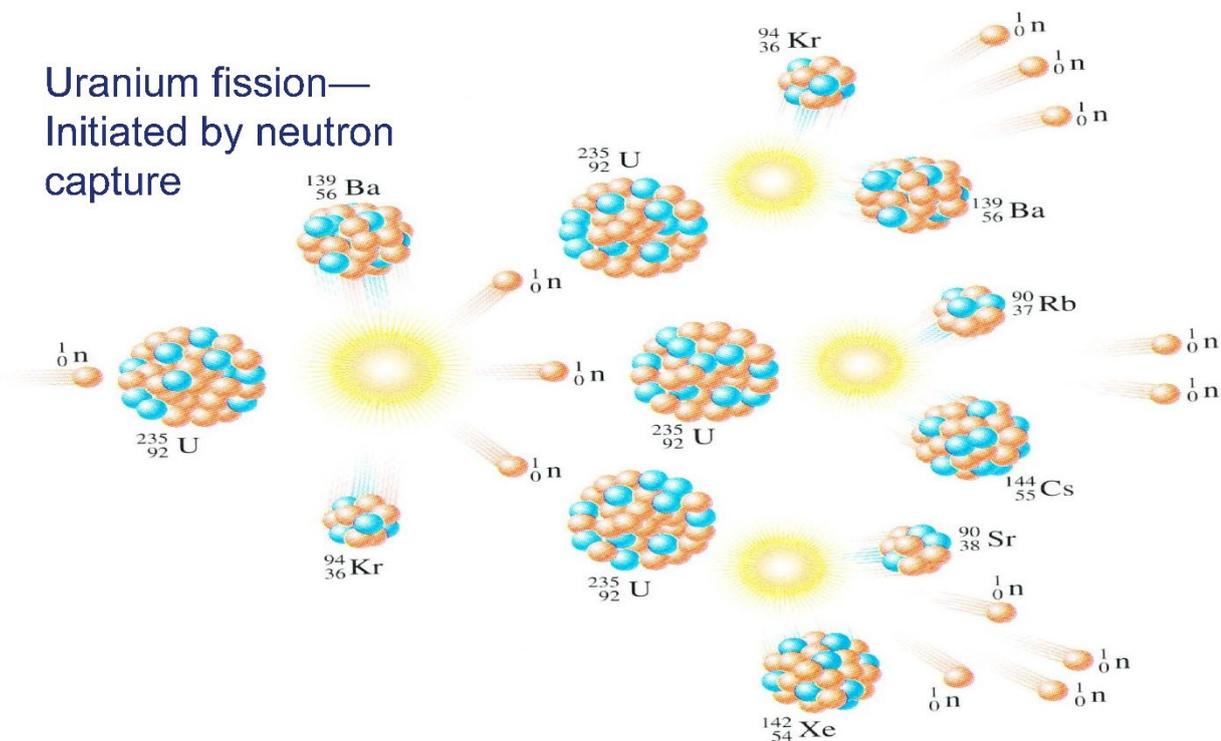
And this is where a nucleus ejects an alpha particle. This sort of radioactive decay barely has the power to go through a sheet of paper. And it doesn't have much impact on biology. A beta decay is where a nucleus emits an electron or a positron, and a type of neutrino. Protons can become neutrons and vice versa and the elements transmute.

So they change from one element to another. And the atomic number changes. This sort of decay is also less powerful than gamma radiation, but because some of the elements actually bond biologically with animals, it can be quite destructive. If it's incorporated into animal [00:04:00] tissues.

Gamma radiation is the most severe form of radiation. And it's the one we all worry about. We are bombarded by gamma radiation every day. Gamma rays enter our atmosphere and some of them make it all the way to the, to the earth. And so gamma rays are high energy photons that are emitted from a nucleus and they're involved in the transmutation of elements and also in causing biological defects, such as cancer.

So to understand nuclear physics and nuclear reactors, we have to understand what's actually going on with, inside of a nuclear reactor. And usually the, the fuel is uranium. And in this diagram, we're showing uranium 235 and we see a neutron hits this uranium uh, nucleus and the neutrons and protons are smashed apart.

## Uranium fission— Initiated by neutron capture



And when the nucleus breaks apart, different elements are formed. And so we see a barium and a krypton form. And as a result of this fission three more neutrons are released and they're able to hit three more uranium atoms and create more krypton and barium and sometimes some rubidium and some strontium or some cesium or some xenon.

And then all of these interactions reduce or produce many more neutrons which are the able to hit many more uranium atoms. And so you can see that if this reaction is uncontrolled, it would, it would lead to massive destruction. And that's what happens in nuclear bombs. And occasionally has happened in nuclear reactors.

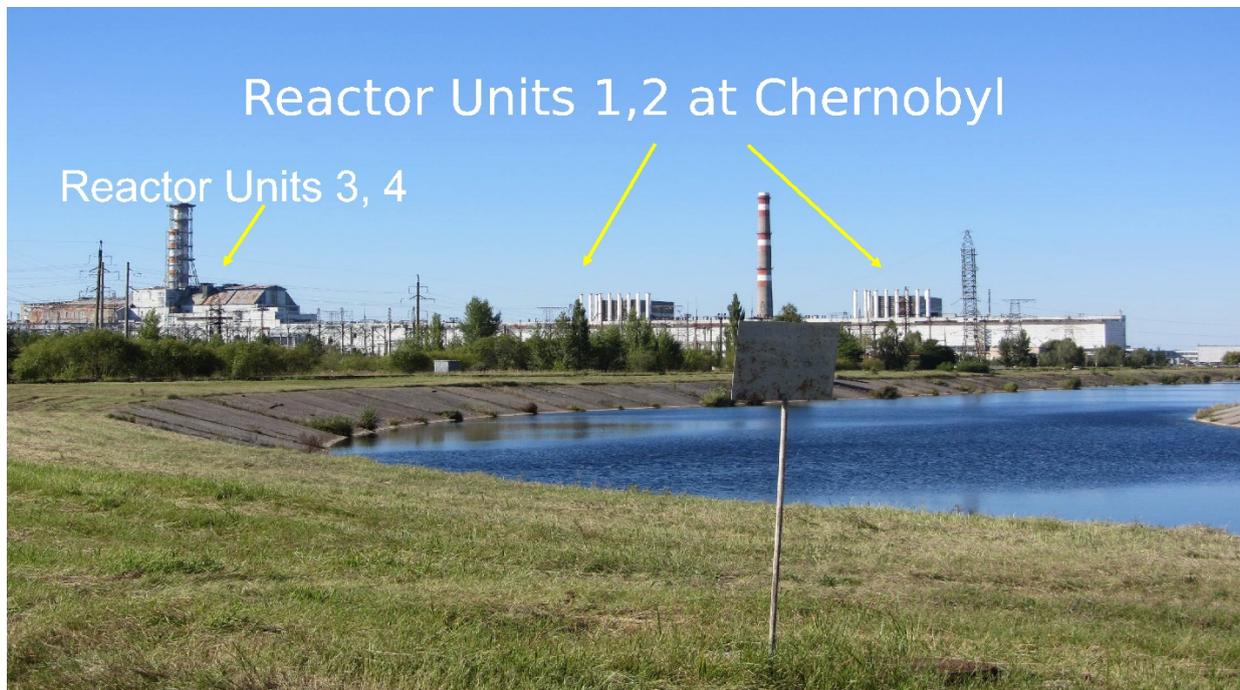


[00:06:00] So in this case in Ukraine, this is an image from right after the explosion of reactor number four. This occurred in April of 1986, over 35 years ago now. And it was the worst nuclear power plant disaster in the history of mankind and still remains so. Even worse than Fukushima, even though Fukushima continues to evolve.

The containment of this disaster required 500,000 workers at 18 billion rubles in that day of Russian money. But the expense has gone way beyond that into modern times as the cleanup continues. Even at this time. The disaster occurred due to design and human error during a test of cooling pumps and backup power systems and ultimately resulted in a steam explosion

that sent the core of the reactor through the roof of the reactor building. And then back down again.

And here you can see a landscape view. Recently, this was from 2012 or so of the remaining power stations one, and two, and three, is three is right about here. And four is here with this building that's been put over it. And so this is the so-called sarcophagus that contains the exploded reactor number four in Ukraine.

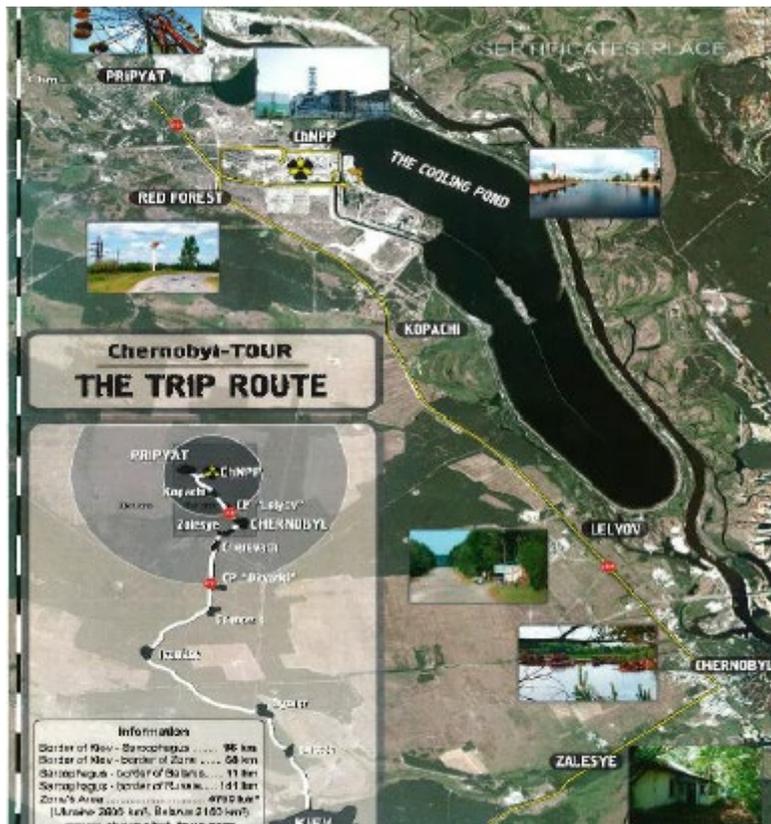


There was an enormous release of radiation, radiation, and radioactive particles or radionuclides. If you will. About 200 times that of the Hiroshima and Nagasaki atomic bombs combined. 10 times that of the Fukushima accident.

And many, many different nuclides were released initially. Some of them being iodine, strontium, cesium, et cetera. [00:08:00] I'm not going to go into the nuclear physics of, of decay, but some, some of you may know that some elements decay very rapidly, like iodine on amount of matter of days, radioactive iodine goes away.

But other elements like plutonium are around for approximately 20,000 years, is their half-life. So initially, there was enough radiation released and a lot of it in forms of gas, such as xenon and iodine and others, to increase the background radiation of the planet by 2%. And that is a huge amount of radiation.

Now, a bunch of that has deteriorated because the half-life was days. And so what we're left with then are the longer lived radionuclides like strontium and cesium and plutonium that are still around in the area today. So namely strontium and cesium high amounts of them were released and their half-life is 30 years. So half of their radioactivity is gone.



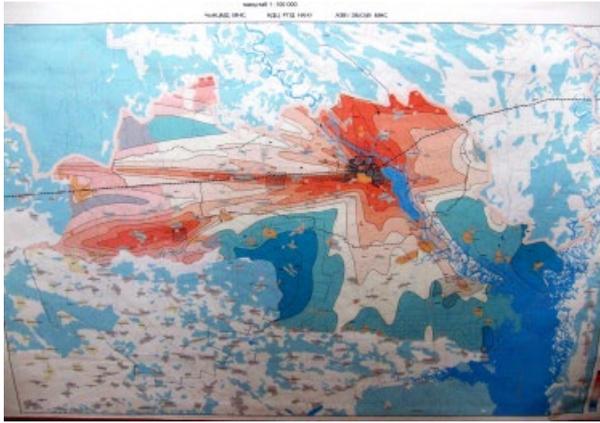
So this is a little map that the tour company we use gives to their participants to show where they've been. And it's kind of nice because it puts it in perspective for audiences here. So we're going to talk about the town of Pripyat, which was the place where workers live that were maintaining the nuclear power plant system.

And it's good to see what the relative distances are. So here's Pripyat town and here's the Chernobyl nuclear power plant. And the actual town of Chernobyl is way down here. It's several kilometers away. The Chernobyl town is actually very old. It's about a thousand years old. And it's [00:10:00] also abandoned because

of its proximity to the, to the reactor.

The thing to know though, is that back in the day in Pripyat, in 1985 or so was considered the premier town to live in if you were a good, comrade of the Soviet Union. It was modern. It was new. They had a [mumble], a performing arts center. They had huge public pool. They had movies, they had everything and there were roughly 50,000 people there.

After the explosion, of course the radiation was spread on the wind. And very typically for that time, the wind was blowing from the east to the west. And so what developed in Ukraine was a radiation trace. And this is called the western radiation trace because it spreads again from east to west and the darker colors indicate increased radiation. Both diagrams, basically showing you the same thing. And as you go north into Belarus, you also see it was heavily contaminated. And this area of Belarus is off limits even today. It's just a wild forest.



But the disaster at the Chernobyl Complex, our first are very unique study opportunity. I think. What Dr. Carlick and I have tried to do. This is from our recent visit, last visit in 2018, we were going to go again in 2020, but the pandemic kind of stopped us. And so we were not able to go in 2020. But by 2018, you see this gigantic arch has been placed over the reactor.

And this is the largest freestanding man-made arch in the world. And it provides a platform for deconstruction of the reactor as [00:12:00] well as protection of the reactor from elements. And so this is a distance of many kilometers from, or about a kilometer from Pripyat here to, to the reactor.

So the new urban forest to Pripyat was just like the town. It was well done. Planted consistently all through the town. It was young and it was abandoned and suddenly and abruptly in 1986, when all 50,000 inhabitants of Pripyat were bused out within one to two days. And so people at that time were told that they, it was just a temporary thing. They would all be back, but of course, we know that the town was permanently abandoned and 30 to 35 years of abandonment ensued, depending upon what year we talk about us being there, the resident trees and the urban forest were then invaded by the encroaching species from the surrounding forest. And you can see many different kinds of trees here, but most of these were not planted. They've just grown up in the city.



So we're going to bounce back to Kiev now and talk a little bit about the capital city of Ukraine. And it really is a gorgeous city and has an amazing culture. And uh, it's, it's a wonderful place to visit once the pandemic is over. I would encourage anybody who has this interest to go there and see Ukraine cause it's, it's incredible.



But unfortunately it has some of the things we don't admire in an urban forest. It's very low diversity. We basically have poplars in the center of streets and horsechestnuts on the sides of streets. And this brown tree over here is a horsechestnut tree and it's brown [00:14:00] because they suffer from a leafminer disease that's pretty much epidemic in Europe.

Trees tend to be not well-maintained. And in the streets they tend to be attacked quite a bit by maintenance workers. And then the larger parks that are there more let go. So here we see a park in Kiev, and it's a spectacular image of, of a park with trees that are just left to grow.



And these were Magnolias blooming in the spring, really a stunning scene. And in these larger urban areas where there was no risk of anything falling on a person the trees don't get pruned, they're left to attend their mature and natural form. And they can be, as I say, quite stunning.

So the pruning practices in Ukraine are really quite draconian, in my opinion. The urban forest is pruned aggressively and the equipment is neither high tech nor modern, and

the approaches are the same. And so we see in the city incredible damage to trees and it struck me that this would be interesting to compare these two forests.

How have the trees in Pripyat fared in absence of these rather draconian tree maintenance practices compared to those in the capital of Kiev?

And what we see really is the effect of stress in this urban life. Trees that are in a park or an open area. This is a park tree. This is a horsechestnut in a park, doing fairly well. And on the very same day, this tree in a street planting pit, struggling mightily from a leaf minor damage and a chestnut, a kind of European Chestnut blight [00:16:00] that affects horsechestnuts there.



So the urban stresses are difficult. They're compounded by the various maintenance practices and lack of space I think to really do well in the city. Infrastructure is harsh compaction, lack of rooting space. Lack of irrigation, deicing salts, all of these things weigh heavily on urban trees. Restriction of root volume.

And of course no mulch and no litter fall. So litter fall in Kiev matters not because there's no where for it to accumulate and nobody's going to let it accumulate. So there's no natural organic matter system inputs to these trees. And we see workers and kids are very diligent about sweeping. They're always sweeping and removing the leaves and on the street tree scenes, there's nowhere for mulch to be anyway. So these trees cannot derive the benefit of mulch.

And tree car conflicts in Ukraine are incredible. I'd never seen a city where cars are allowed to do whatever they want. They park right on the sidewalks and they drive over the tree wells compacting the soil. So this again is just another insult and another pressure that are placed on the urban lives of trees in this capital city.

Okay. So as we go to the Chernobyl zone, we noticed that time has changed the look of things there. In 1986, or shortly after 1986, the sarcophagus was completed with the efforts of 500,000 red army soldiers that donated their lifetime exposure to radiation to, [00:18:00] to create that thing.



And then in 2012 was our first visit. Dr. Carla, Karen Red you can see there's still work going on with the sarcophagus cause its roof was leaking by then. And so there's work to try to repair this. And even as you stand here at this memorial and the statue, the radiation levels in this place are, are way above normal compared to if you were a mile away or something.

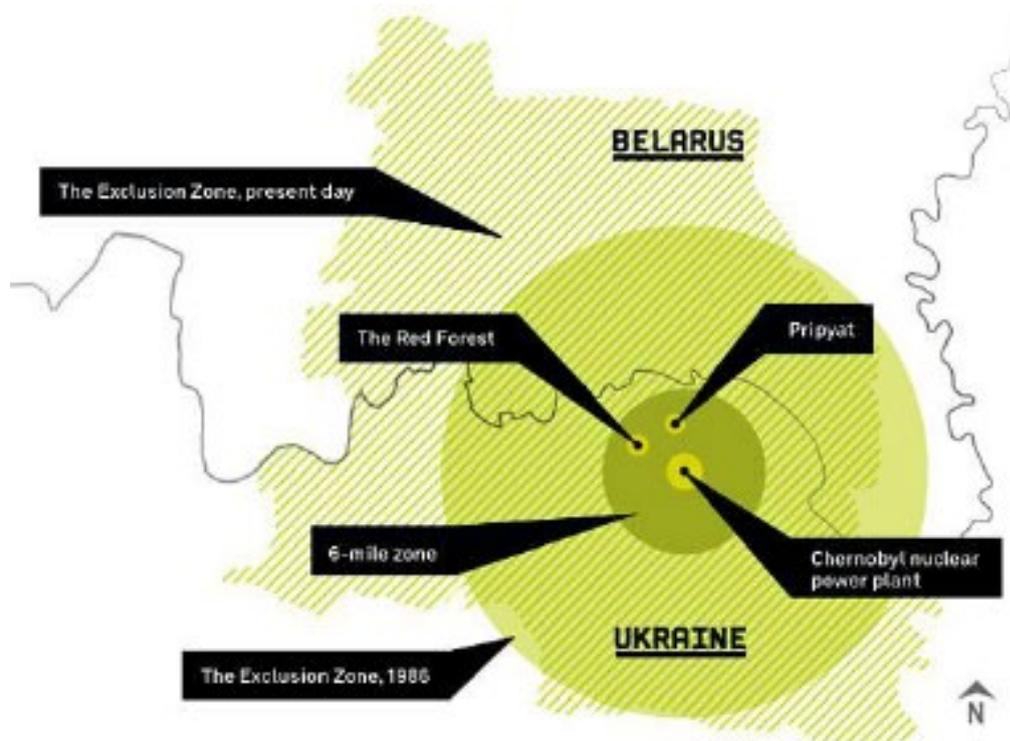
So it's still very contaminated and very radioactive. And here we are in 2018

and the modern arch structure has been put over, has I put over the sarcophagus. And this is rated for a hundred years and it's made of stainless steel and there is a hope that within a hundred years, somebody is going to figureout how to take this all apart safely and prevent further contamination.

The river, which is nearby. And this happened in 1986 the then Soviet Union created two exclusion zones, one at 10 kilometers, which we see in the darker green color and one at 30 kilometers and, or, or20? Yeah, 30 kilometers about 30 kilometers. And this zone has checkpoints. So all the roads going in are military checkpoints, which are maintained even today.



You have to have your paperwork in order to go there, even if you're visiting the zone as a tourist. And in 2011 Ukraine opened the sealed zone around Chernobyl [00:20:00] to anyone who wished to visit it and see the landscape there. By 2012, my colleague and I had scheduled our first visit. And this was an initial visit to see what's going on.



And later on, we, we got ideas about how, how we might study things there. So we returned in 2015, 2016, and 2018. And during those years we made some measurements of, of horsechestnuts. So just taking a look, look at the forest from inside of buildings, these are abandoned buildings and Pripyat the workers town.

You can see the impact the forest has had. It has grown up. It has invaded. It has taken over every space between every building in the city. And the forest is vital and vigorous. It continues to grow. With some species growing faster than others, but invading every aspect of Pripyat. And it's, we know from images that we have from 1986, that it's it's dramatically changed, and this has become an emblematic place to understand how nature can overcome man's disasters.



And so we have the worst nuclear accident in the history of mankind, but the forest has the ability to deal with this and grow very well. So the forest in Pripyat is now 34 or 35 years old. And so all these trees you see are, are relatively new, and this is the result. Maybe well, closer to 36 years of, of growth now this forest. And it's lush, vigorous doing very [00:22:00] well. And as the forest encroaches, trees invade the buildings, causing their ruin. And we see this all through the workers town, and indeed buildings that I visited in 2012, such as this one on the far right, which is a high school. I walked through

these rooms up here in 2012.



And now today, this is condemned to the point where visitors can't go in this building. And what has happened is the tree roots have grown on the roof. And between the walls and separated the walls and the, from the floor and just cause these massive cave ins. And so within 30 years, these buildings, these kinds, concrete bunker, like Soviet era buildings have been destroyed by the encroaching forest, which to me is really quite astounding.

The fact that nature can take back the city so fast. And so what seems to be surviving best there in Pripjat are the 16 floor apartment buildings. They're just really solid. And so far that none of those have been taken down by the forest.

So this is some art that I saw in Pripjat that was tiled on the side of a small building and it, it so struck me because birches are common a species in Europe and were used ornamental only there in Pripjat and the stick figure would imply, you know, topping cuts here like that one. And, you know, it's interesting because the forest in Pripjat did not get to grow far enough to need any of this kind of pruning.



And so none of it was ever done. We have a forest that [00:24:00] grew in 30 well it's they planted it somewhat in the seventies. So the forest is maybe 45 years old or somewhere in that range of 40 to 45 years old. And it never was at a point when people were occupying the city, the management through pruning was much of an issue.

So again, looking out of an abandoned building into the environment around Pripjat, we see that the forest has become the dominant feature and more recently people have come into the zoning and the graffiti is interesting. One image here celebrating the return of nature. To two main themes here. The other images portraying the, the fear of radiation. And in Ukraine, if you go talk to somebody in Kiev or, or anybody in Ukrainian, you ask them, have they been to the Chernobyl? They look at you with a weird look and go, "no, it's too frightening. We wouldn't ever want to go there." And so most people in Ukraine are definitely afraid of this experience.

They don't want to go to Chernobyl. But adventurous Ukrainians have gone there. They largely looted the city and stole anything of value. And then artists have come in to do these kinds of graffiti, which are, are really quite a statement actually of the two basic effects of the Chernobyl disaster. One to frighten everybody with radiation and the other, the nature is coming back in this area and has become such an ecological preserve.



And indeed there is an ecological preserve there and it is managed by scientists.

[00:26:00] So, in our little study mainly observational because we're not allowed to really take samples away. We did things we could look, look at or measure directly like the size of trees and this and that. But these are the two study sites. This is Lenin Boulevard in Pripjat. And this is Peremohy Avenue and Kiev. And they both have horsechestnut trees of the same age.



Lenin Blvd, Pripjat



Peremohy Ave, Kiev

And there's a poplar trees on, this is the center of this large street. And the horsechestnuts are along the edge. And this case, this is a linear, medium, or a linear park in the middle of a large split street with a horsechestnut trees. And we're able to do some increment boring and verify that both populations are of a similar age.

And so one thing we could easily do is measure heights of trees and diameters and their diameters. Now we found out that the population in Pripjat was much smaller. And over a period of three years in making these measurements were able to also find out that the population in Pripjat is growing much slower.

So the trees in Kiev grow faster and the trees in Pripjat grows slower. There is some information in the literature about the effects of gamma radiation on tree growth. Not a lot, but we do have some studies from the zone, particularly Scotts pine, which is cultivated there. And Scott's pine is not a natural forest

but is planted extensively in Ukraine. And we know from these studies in the zone, that gamma radiation from the Chernobyl explosion, stunted the growth of Scott's pine significantly in the zone. And [00:28:00] wherever there is more gamma radiation, there's less growth. And indeed, you may have heard of a term called the "red forest" or the red forest was an area of Scott's pine where the western radiation trace cut across it and ended up killing a number of trees along the western radiation trace. So these trees received a dose of about 20 grays, which is a lot of radiation and that's a kind of level you would need to kill trees. And then, and so a whole swath of trees died from that, that impact.

The western radiation trace is still detectable today. When you drive over it, your dosimeter will sound an alert as you get closer to it, and then it goes away once you passed. So we think it's very likely that horsechestnut trees in Pripyat probably were slowed in their growth. And even today are slower in their growth than they are in Kiev.

Now we also measured, in our recent trips about a 10 time, 10 fold increase of gamma radiation, still in Pripyat compared to Kiev. Now, when we look at some of these things that we're interested in, the architectural quality rating, the overall form of the tree was high, was actually a little bit higher in Pripyat.

And the total number of branch defects of course, was significantly greater in Kiev because nobody was there to damage branches in Pripyat. And of course, the number of codominant stems that results from some poor pruning was also significantly greater in Kiev than in Pripyat. Now we present these results [00:30:00] in the *Open Journal of Forestry*, and anybody can go look at it in 2019.

## Tree defects

Tree population	Architectural Quality Rating	Total Branch defects	Codominant Stems
Kiev	3.2a	1.68a	1.21a
Pripyat	3.7b	0.68b	0.56b
t-value; P value	2.1; 0.04	3.4; 0.002	-3.1; 0.003

From Downer, and Karlik, 2019. *Open Journal of Forestry* 9:1-10

And so trees in Kiev, were, are have been, still are being heavily pruned. And there is, I think, poor understanding that this is bad for trees. The huge wound, not well angled, more or less flush cuts, lead to cavities and consequent decay organisms like this pleuritis, coming in here and fruiting. And of course, those are very edible.



But in our comparison between these Kiev trees and Pripjat trees, we found that in Kiev of there were 173 large branches removed from the study population. We're looking out of 25 trees. On the study population in Pripjat had zero pruning wounds. So these kinds of impacts are, are horrible on trees.

And what we've seen in the most recent years is more and more removals. So these trees get further decayed. You see a number of areas where large cuts have been made to raise them up and eventually. Somebody decides that a tree is just too dangerous and they take it out. So you see a space here and there's a young tree planted there.

And of course, here in Pripjat, nobody is removing anything. Nobody is pruning anything, it's all just staying there. And we see the incursion of all these other weeds, species, and vines, and a huge mulch layer on the ground. But more than anything, we see a beautifully articulated, natural structure for horsechestnut that we don't see in the city of Kiev.

Another view, a nice open face or upright structure [00:32:00] of a horsechestnut, beautifully structured, compared to the trees, compared to the trees and Kiev that have been pruned so many times, so many large branches removed, branch faults created, multiple branches from one point codominance stems, such as here. And, and so the comparison really shows how, when arboriculture practice is not top of the notch, is not state-of-the-art, the population of trees will suffer.



Pripjat



Kiev

We have a few other observations that were very interesting. And we're hoping to really look at this in 2020, but we're having to wait now until the pandemic settles down. Hopefully we can go in 2021. But one of the things you notice is that in Pripjat the trees are covered in lichen. And here you see good evidence of lichen. And Kiev there's very little lichen to be found. Of course, lichen seems to tolerate radionuclides well, but not, not poor quality air.

And so the, the amount of vehicular traffic and in Pripjat is almost zero. And except for a few tour vans that go around, probably more in recent years. Lichen is very common in the nuclear exclusions zone, but not so much in the urban city of Kiev.



Another thing that's really amazing is that pruning paints are still a thing. And people paint, wounds all over Ukraine. On farm trees or urban trees, everywhere. And so here's a great example how this was painted for many years and the paint is solidified into a sheet. [00:34:00] It's removed and we have some wood decay organisms, probably again, aderma or formatopsis in here or something. Ganoderma most likely, that has farmed inside and underneath the pruning paint.



So pruning paints as we know don't retard the development of decay and they certainly don't protect a large wound like this from entrance of these organisms. So it's not really been figured out yet and Ukraine that this is the case, I guess. And so they continue to assiduously paint, large wounds.

So in conclusion abandonment has served the trees of Pripjat well. In terms of their structure and freedom of defect, they are better off than their urban counterparts in the capital city. What can be done about this? Well, my colleagues and I held the first, arboriculture summit in 2015. I have some good friends who are practicing arborists and Kiev and the areas around a Kiev, and they have come together and I've joined them three times to go to their annual meetings and speak there.

Or two times at least. And that has continued even in the years, I haven't been able to go. And so there's a growing educational group. They have a Facebook page called Ukraine Arborists. And if anybody's interested, I can give you the link to that. If you're interested in Facebook and it's a fairly vital group of interested arborists that are trying to learn.

They're particularly interested in climbing techniques, but also trying to learn more about biology and good practice. So it's our hope that this progress toward arboricultural [00:36:00] education is now well underway in Ukraine, and that some of the less appropriate pruning work will occur. And perhaps the urban forest will improve over time.

I am available at my email [ajdowner@UCDavis.edu](mailto:ajdowner@UCDavis.edu), and I appreciate any comments you have for me. Thank you very much.

**Tom Smiley:** [00:36:24] This concludes Dr. Jim Downer's talk: A Tale of Two Urban Forests Horsechestnuts in Kiev and Chernobyl. This talk was originally presented at the 2020 ISA Virtual Conference. The views and information expressed are those of the presenter.

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