Science Studio Vol 019 (Guest: Stephen Pyne)

Biology on Fire (Part I)

Regents' Professor, Mac Arthur Fellow, author and a world's expert on fire and fire ecology Stephen Pyne talks about how fire, its use, misuse, and its biological nature have shaped our world, before and because of man, and learn how policies of the past still reverberate in our present, in Arizona and globally.

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Peggy Coulombe: Hi. This is Peggy Coulombe, and welcome to Science Studio. Today, we're going to talk to Regents' professor and MacArthur fellow Stephen Pyne, who's been, at different times in his life, a firefighter, a professor, and an author. Stephen is the world's expert on flames and an environmental historian. He's written more than 20 books. His latest is called "Awful Splendour: The Fire History of Canada," a comprehensive fire history of Canada, some of which he's going to read for us today. Welcome, Stephen.

Stephen Pyne: Well, thank you.

Peggy: The ancient Greek tale of Prometheus is an old one, of how man stole fire from the gods. Does anyone know when fire was first taken up as a tool by people?

Stephen: Well, we really don't. The current thinking is that *Homo erectus* could manipulate fire. So there are hearths, what appear to be permanently maintained fires in caves and other settings that date back a million and a half years or so ago. So, probably, most of the existence of *Homo erectus*, we could manipulate it, but it doesn't seem likely that early hominids could start fire until *Homo sapiens*.

So all of the tools that we have--striking, drilling, rubbing, abrading--all of these kinds of things really are associated with the toolkits of *Homo sapiens*. And it's also important that we captured fire from nature. We didn't invent fire; we found a way to domesticate it. It really may be our first domestication, literally.

Peggy: So it was a literal stealing of...

Stephen: That's right. I mean, there are many variants of the Promethean story. And almost all societies have fire myths, and I can't think of any where fire is freely given. It is always something that is extremely powerful. It is something that has to be stolen or beguiled away, or in some ways taken. And the person or culture hero or animal who does the stealing is usually killed, or in some ways punished for the theft, because that really changes the power structure of the biota.

And there's a great emblem of this at Cave Swartkrans in South Africa that was excavated. And you could see that the cave was used by various predators from time to time, and there were early hominid bones among the prey. And then there's a layer of charcoal, and above that, the relationship has changed, and suddenly the other creatures have become the prey. And in a sense, that acquisition of fire did really change the dynamics of that.

And that's what most fire myths tell us, is that people were not especially endowed. When they got fire, they became powerful; they became important.

Peggy: How has fire changed earth's landscapes?

Stephen: Well, first of all, fire has been around for a long time. We have fossil evidence of fire back to the early Devonian, essentially at the time of the earliest colonization by plants on land. So it's also important to remember that fire is really biologically constructed. By that, I mean that it's life that created the oxygen that fire needs, and it's life that creates the fuels that feed fire. And so, as long as that combination was present, for a very long period time, fire has been on the planet.

What life could not control was ignition, the third part. So you're mostly dependent on lightning, which means that fire occurs in very lumpy occasions. Some eras have a lot; some not very much. Some places have a lot; some very little. Where life completes the cycle of fire, in a sense, is when these early hominids acquire the ability to start fire. And now, overwhelmingly, like nine to one as much as 20 to one in many places, or at some places exclusively, people are responsible for starting fires. So in some ways that might be seen as sort of a violation of the natural order, that somehow we're perverting it, we're injuring it. But in another interpretation, you can see it as life taking fuller and fuller control over fire and all of its components.

Let me back up just a second...

Peggy Coulombe: OK.

Stephen: ...on the other thing - what does fire do? I mean, basically, fire takes apart what photosynthesis puts together. It's very much about fundamental biochemical reaction. I mean, when it occurs in cells, we call it respiration. When it occurs out in the wide world, we call it fire.

So it's a very, very elemental process, and what it does is break apart. It recycles chemicals and nutrients, it recycles organisms, it recycles whole ecosystems, at a point. And without fire, many systems, particularly in the Southwest, just begin to choke on their own accumulated debris. There's nothing really to break it down, particularly in drier climates. So it competes with biological decomposition, but also complements it.

Peggy: So in some parts it's part of a healthy ecosystem that fire exists.

Stephen: That's right. Fire exists, and in fact because it exists, many things have adapted to it. There seem to be very few unique adaptations to fire. In other words, the thing that adapts an organism to fire may also adapt it to drought, it may also adapt it to heavy browsing or grazing or some other kind of damage. And fire sort of gets caught up with that suite of stressors, and so it's part of a suite of adaptations, if you will.

What's really interesting, though, we think of fire in those terms, we think of it as adapting to protect itself, but there's another sense in which many plants adapt to the persistence of fire, by seizing the opportunities that fire presents. So they can re-seed

earlier, or they re-sprout earlier, or they can occupy ground earlier, and it gives them, in some ways, a competitive advantage. They can move in and take these.

Then the trick becomes do these species, these plants, say, also have particularly high flammability? In which case their enhanced flammability then feeds in to their ability to recover after a fire preferentially. So, this is a topic that gets very tricky.

But apart from that, simply the fact that fire is there. I mean, in the same way that rain is there in particular patterns. And we're talking about patterns of fire, not just whether fire happens or not. The fact that it is there, things come into accommodation with that pattern. And if you change it, then they're no longer adapted. So removing fire can be just as powerful ecologically as putting it in.

Peggy: So I understand that there's this term "firestick forestry" that you, in fact, invented. Can you tell me something about that?

Stephen: Well, firestick forestry was an adaptation of a wonderful term an Australian anthropologist used. He coined the expression "firestick farming" and he was talking about Aboriginal uses of fire and the intensive way in which fire, simply by manipulating a firestick, or what we would call a torch, could shape landscapes. By the patterns of burning, the timing of burning, the frequency of burning, the seasonality of the burning and so forth. And he likened this to a form of cultivation and called it firestick farming.

What I was interested in in Australia is the way that practice gets handed down through successive colonizers of Australia. Certainly rural Australians from European colonization, but then eventually, they hand it on to foresters. And foresters in Australia adapted controlled burning as a basic strategy for bushfire protection. So they really took the other side of this classic debate which we have in the United States as well. They were the road not taken. They were the only group of colonial foresters who seized upon fire and made it the foundation of fire control.

Peggy: How do you balance the needs of those systems that utilize fire or have adapted to fire with the needs of people or organisms that are sensitive to fire?

Stephen: Well, that is the question. Ever since humanity acquired fire, or fire power, if you will, that has carried with it an obligation, not only to make the world habitable for us, but to make sure that the right patterns of fire get distributed for all the other creatures that depend upon it. And there's one sense of human fire power which is limited to ignition.

We can start fire. But that doesn't mean it carries. So fire is only as powerful as its ability to propagate. And that's pretty much set by environmental conditions. But when we also begin controlling fuels, that is to say we change landscapes: we cut, we dry, we drain, things mostly associated with agriculture or land-clearing, then suddenly we make available stuff that otherwise couldn't burn.

So we change the patterns of fire. We change the extents of fire. Areas that wouldn't have burned now can. Areas that would have burned in one way now burn a different way. This is an enormous power.

And more recently as we've industrialized, we're changing this in an enormous way, in ways that we have not really studied systematically. We are routing our fire power no longer by burning open, living biomass surface fuels in that way, but by burning fossil biomass. We're burning landscapes, really, from the geologic past. And that is altering things enormously.

We think of global warming. But we haven't begun to look at the way this cascades through whole ecosystems, because we are no longer burning in ways that we did before. So we're back to this question of removing fire. And it's not just a case of humans using industrial machinery to attack fires that nature set, that's somehow unnatural and inappropriate. But many of these landscapes for hundreds if not thousands, and in some cases tens of thousands of years, have been subjected to patterns of human burning.

And we are changing those. And so the combination of these changes is simply up-ending the whole fire ecology of the planet at local and global scales.

Peggy: In your books, "The Burning Bush" and "The Still Burning Bush" you talk about the fire ecology of Australia and America. And you referenced that a little bit here. And they are two countries whose philosophies diverged on fire control, one being more toward fire suppression, and the other toward controlled light burns. Tell me something about each country's approach and why neither has proven ideal.

Stephen: Well, that's a great question. The modern era of fire management really begins with a couple of things. One is industrialization. But the other is this wave of imperial and colonial expansion in the 18th and particularly the 19th centuries, which created large expanses of uninhabited lands, which were then put aside as public domains.

So if we think about countries that share similar fire problems to ours, they are places like Australia, Canada, Russia, all of whom had this similar history of colonization. Interestingly enough, however, the colonial forestry institutions were created first for places that did have people, particularly the British in India. And they were debating the question in the early 1870s as they were setting up their apparatus.

The first question asked at the first national conference was whether fire control was possible, and if it was possible, whether it was desirable. And so right at the beginning the whole foundation of the enterprise depends on fire. And there is a split. And basically the people who were in the field said that you cannot eliminate fire, and if you did, the consequences would be horrific.

You would have larger fires, subsequently you would have an unbalanced forest, you would get diseases, you'll have animals that don't know where to go any more wandering around, you'll have all kinds of problems, and this is a crazy idea. Even the attempt would unsettle the systems.

But the officials and the intellectuals, the academics, the professors, the people responsible for administering the colonies in the bureaus, said no, we have to control fire. This is an emblem of our administration. I mean this shows that we are in fact in charge. And by controlling fire you control the local populations and you make the landscape into

a pattern you want.

So that became official doctrine. And that was official doctrine for both the U.S. and Australia. The early U.S. foresters went through the British system. They looked to British India, interestingly enough, for inspiration. But both communities eventually took different choices.

The U.S. decided that fire suppression, the exclusion of fire ultimately from these reserve lands, would be essential. And it would be a political test, that in fact the control of fire was an argument for setting the reserves aside initially. After 1910 this trauma of the great 1910 fires, which really became a kind of long march for the U.S. Forest Service, fire suppression became an unquestioned dogma. And they would apply whatever was necessary to make it happen.

That rule continued for almost 60 years. Eventually the consequences of having made those choices became overwhelming: the economic cost of trying to control fire, the ecological damage, the cost in fire-fighter lives, all the other stuff that goes on.

Australia initially took the same approach, but was unable to enforce it given the conditions in Australia. You had a very small population in a very large area. Eventually it began experimenting with controlled burning. This, again, was a handed-down tradition actually going back to the Aborigines, passed through rural Australia, picked up by Australian foresters, adapted to forestry, given some rigor of science, given some rigor of bureaucratic order, and then made a way of keeping bush fires in a form that they could contain them.

And that really takes its full form after World War II, this very nationalist expression for Australia. They were very pleased with themselves. They thought that they had done something that was different from the Americans; that they weren't simply Brits off down-under and they weren't going to be clones of Americans. They had developed their own system, building out of their own understanding of indigenous ecology and their own history, etc. And they were very pleased with it.

So they took the other approach. And you would think, well, based on what we've learned, they must be doing very well. Well, both groups have been slammed by basically urban-based environmental groups, who only see controlled burning as another form of human intervention. It's no different than poisoning animals and slaughtering indigenous creatures and clear-felling clipped forests for wood chips and whatever else.

So it got caught up with the whole revulsion against the history of rural colonial occupation of Australia and is seen as a part of forestry that people would like to go away. So the Australians are very busy trying to reintroduce fire suppression. The Americans have been desperately trying to reintroduce controlled burning.

And I think what it suggests is that the choice was framed wrong initially: that it's not one or the other, it's mixtures of them adjusted to particular times and places, and adjusted not only to environmental conditions but to political and cultural conditions. What do people

value, how do they see the land, how do they see their relationship to that land, and how does fire fit into that?

Peggy: You briefly mentioned the great fires of 1910. Can you tell us what some of those fires were and who they impacted?

Stephen: Sure. Well, the fires of 1910 are one of the really defining events in American fire history and for that matter I would say global fire history. There were large fires. Probably five million acres or so burned on the national forests at the time, but nobody knows for sure.

Probably three and a quarter million acres burned in the Northern Rockies. These were huge fires at the time. But they were very damaging fires. Perhaps two-thirds of the burning, maybe more, occurred in one 36-hour period, what became known as the "big blow-up" on August 19 and 20.

The U.S. Forest Service was barely five years old at this time. Their charismatic founder, Gifford Pinchot, had been fired for insubordination by President Taft earlier in the year, so there's a great political context around this. They were being criticized by the Secretary of the Interior, they were being criticized by lots of people, and they saw fire-fighting as simply one of the things they did and had to do as a test that they knew what they were doing.

They had probably nine thousand or so fire-fighters out on the fire lines at the time of the big blow-up, almost the entire standing army of the U.S., which was not very large in 1910, but for the Northwest was also brought in to fight fires. They were all out there. 78 fire-fighters were killed in one afternoon, basically at six different episodes.

So this is the great founding trauma. The agency spent almost a million dollars over budget fighting the fires. That was real money in 1910, and it could have meant the end of the agency. This was the first great challenge for the new chief of the Forest Service. And the next three chiefs, all the way through 1939, were all personally on the fire lines.

So they individually, personally weathered this, suffered through the trauma. And that entire generation could think of nothing but preventing this from happening again. And so that deeply impressed itself on the agency, and in some ways we're still dealing with the effects of that.

Basically the whole system we have for fire-fighting, all the issues, everything, boiled over in 1910. And in fact at the same time as the big blow-up, what became known as the “light burning controversy” surfaced. It went into national and especially regional newspapers and magazines. Sunset Magazine, for heaven's sake, was running articles that the Forest Service was wrong.

Here they are, out fighting this war on fire, and the whole thing is misguided. And all of the things that the critics predicted, all the things that we've discovered, that fire exclusion or the attempt at fire exclusion brings, happened exactly as they predicted.

Peggy: What is the present policy in Arizona? Is it still fire suppression?

Stephen: Well, the policy in Arizona depends on land owners. And whoever controls the land really more or less can decide the policy, within limits. The federal agencies have a common policy as of 1995. And it's based on something called appropriate response, which really doesn't commit them to do anything.

Which is wonderful in the sense that it doesn't force them to do bad things, but it's also difficult in that it doesn't tell them what they should do. It doesn't say what you need to do to make the outcome you want happen. So it's a very mixed policy, and it's still in flux. So there are successes and failures.

But I also think it's important to recognize that this debate has been going on for a long time now, almost as long as the suppression period. The National Parks Service changed its policy in '67. The Forest Service converted about 10 years later. So this is not a new policy. This has been around for a good while.

And the question might be: why haven't we more to show for it? Why, after 35 or 40 years, are we still seeming to fumble?

Well, it's turned out that it was not just a case of policy. It was a case of being able to make it happen. And it's also a case of being able to make it happen after 60, 80 or 100 years of disturbed forests. And in the Southwest that really begins with overgrazing in the late 19th century. That's what shocked the system. That's what struck fire out.

You stripped away the grasses that had carried fire, that had defined the earlier fire regime. Then you took away many of the native burners, who had been instrumental in keeping fire in a particular pattern. And then, after that, you begin setting this land aside as protected public domain, and active fire-fighting, and you add all that together and you've got a real mess.

So putting fire back into that system now is not the same as having fire in the system in 1780.

Peggy: It also sounds like, from a lot of the things you've said, that the policies almost have to be tailored very specifically for area. So you can't create one that's going to address everybody in the United States or every forest even in the same state.

Stephen: I think that's exactly where we go. The difficulty is finding the right mix. The difficulty is that fire turns out to be a lot trickier to deal with in this way. And in many ways we don't really know what we're doing. And I don't say that in a snide way. It's just that we really don't know what is happening.

And to the extent that global change is making itself felt, particularly climate, then we don't know. The past may not be an adequate guide either. So we don't know. It may be that this wave of fire that we've been seeing associated with the long drought in the West is going to be a process of simply overturning the whole biota.

I mean I'm being a little dramatic here. But the whole thing may be burned off in significant ways, and what comes back will be very different than what was there before. I don't think anyone knows. But we may be in the process of watching that happen.

Peggy: Do you miss anything about that time when you were in the fire crews in the Grand Canyon, on the rim?

Stephen: Well, sure, I miss being 20.

[laughter]

Stephen: I mean you're young, you're immortal. You're on the rim of the Grand Canyon, for heaven's sake. You're fighting fires. It's exciting work, it's interesting, great camaraderie. It was a wonderful time. I enjoyed every minute of it.

That got me interested in fire, and after I finished my doctorate I was wondering, why hasn't somebody written about fire in the same way I've been trained to write about all these other subjects? So that was a niche. And it's turned out to be a global niche.

That's actually what I went to graduate school for: history, history of science. I did a biography of a geologist, exploring geologist, that kind of thing.

And so I continued to work in that, but the fire stuff is really mostly what I've written on. But that's not what I went to school for, and didn't really study it until after I already had my doctorate; alternative careers.

Peggy: Stephen, I want to thank you so much for sitting down with us and sharing your thoughts about exploration. You're an explorer yourself, I'd like to add. I haven't been to the Antarctic, and I've certainly never been in a fire line on the Grand Canyon. But you can get a sense of what those things are through Stephen's books.

Stephen: You're welcome. Always happy to talk about fire.

[laughter]

Peggy: This is Peggy Coulombe and you've been listening to School of Life Sciences' podcast Science Studio. Our theme music is by Yongen from the collection "Moonrise" and provided by Magnatunes. The School of Life Sciences is from the College of Liberal Arts and Sciences on the Tempe campus of Arizona State University.

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