Conservation and Restoration Ecology: Crash Course Ecology #12

Crash Course: Ecology
https://youtube.com/watch?v=Kaeyr5-O2eU
https://nerdfighteria.info/v/Kaeyr5-O2eU

For the past 12 weeks, we've been investigating our living planet together and learning how it works on many levels, how populations of organisms interact, how communities thrive and ecosystems change, and how humans are wrecking the nice, perfectly functioning systems Earth has been using for hundreds of thousands of years. And now it's graduation day! This here is like the commencement speech, where I talk to you about the future and our role in it, and how what we're doing to the planet is totally awful, but we're taking steps to undo some of the damage that we've done. So what better way to wrap up our series on ecology than by taking a look at the growing fields of conservation biology and restoration ecology. These disciplines use all the kung fu moves that we've learned about in the past 11 weeks and apply them to protecting ecosystems and cleaning up the messes that we've already made. And one of the main things they teach us is that doing these things is difficult, like, in the way that uncooking bacon is difficult. So let's look at what we're doing, and try to uncook this unbelievably large pile of bacon we've made!

(Intro)

Just outside of Missoula, Montana, where I live, we've got a Superfund site. Not Superfun... Superfund. A hazardous waste site that the government is in charge of cleaning up. The mess here was made more than a hundred years ago, when there was a dam in the Clark Fork River behind me called the Milltown Dam. This part of Montana has a long history of copper mining, and back in 1908, there was a humongous flood that washed about 4.5 million cubic meters of mine tailings chock full of arsenic and toxic heavy metals into the Clark Fork River. And most of it washed into the reservoir created by the Milltown dam. I mean, actually it was lucky that the dam was there, it had only been completed six months before, or the whole river system, all the way to the Pacific Ocean, would have been a toxic mess. As it happened, though, only about 160 kilometers of the river was all toxic-messed-up. A lot of it recuperated over time, but all that nasty hazardous waste was still sitting behind Milltown Dam, and some of it leached into the groundwater that started polluting nearby resident's wells. So scientists spent decades studying the extent of the damage caused by the waste and coming up with ways to fix it. And from 2006 to 2010, engineers carefully removed all the toxic sediment as well as the dam itself. Now, this stretch of the Clark Fork River runs unimpeded for the first time in over a century, and the restored area where the dam used to be is being turned into a state park. Efforts like this show us conservation biology and restoration ecology in action. Conservation biology involves measuring the biodiversity of an ecosystem and determining how to protect it. In this case, it was used to size up the health of fish populations in the Clark Fork River, which were severely affected by the waste behind the dam, and the dam blocking their access to spawning grounds upstream, and figuring out how to protect them during the dams removal. Restoration ecology, meanwhile, is the science of restoring broken ecosystems, like taking an interrupted, polluted river and turning it into what you see taking shape here.

Types of Diversity

(3:00) These do-gooder, fix-it-up sciences are practical rather than theoretical, by which I mean, in order to fix something that's broken, you've got to have a good idea of what's making it work to begin with. If something was wrong with the expansion of the Universe, we wouldn't be able to fix it because we have no idea, at all, what's making all that happen. So in order to fix a failing ecosystem, you have to figure out what was holding it together in the first place. And the glue that holds every ecosystem together is biodiversity. But then of course, biodiversity can mean many different things. So far we've generally used it to mean species diversity, or the variety of species in an ecosystem. But there are also other ways of thinking about biodiversity that help conservation biologists and restoration ecologists figure out how to save species and repair ecosystems. In addition to the diversity of species, ecologists look at genetic diversity within a species as a whole and between populations. Genetic diversity is important because it makes evolution possible by allowing a species to adapt to new situations like disease and climate change. And then another level of biodiversity has to do with ecosystem diversity, or the variety of different ecosystems within an area. A big ol' forest, for example, can host several kinds of ecosystems, like wetland, alpine, and aquatic ones. Just like we talked about when we covered ecological succession, the more little pockets you've got performing different functions, the more resilient the region will be as a whole.

Conservation Biology

(4:12) So, yeah, understanding all of this is really important to figuring out how to repair an ecosystem that is in shambles. But how do conservation biologists take the information about what makes an ecosystem tick and use it to save the place from going under?

Small Population Conservation

(4:26) Well, there's more than one way to approach this problem. One way is called small-population conservation. This approach focuses on identifying species and populations that are really small, and tries to help boost their numbers and genetic diversity. Low population and low genetic diversity are kind of the death knell for a species. They actually feed off each other, one problem making the other problem worse, ultimately causing a species to spiral into extinction. See, when a tiny little population suffers from inbreeding or genetic drift, that is, a shift in its overall genetic makeup, this leads to even less diversity, which in turn causes lower reproduction rates and higher mortality rates, which makes the population smaller still. This terrible little dynamic is known by the awesome term extinction vortex. The next step is to figure out how small a population is too small. Ecologists do this by calculating what's called the minimum viable population, which is the smallest size at which a population can survive and sustain itself. To get at this number, you have to know the real breeding population of, say, grizzly bears in Yellowstone National Park, and then you figure out everything you can about a grizzly's life history: how long they live, who gets to breed the most, how often they can have babies, that kind of thing. After all that information is collected, ecologists can run the numbers and figure out that for the grizzlies in Yellowstone, a population of, say hypothetically, 90 bears would have about a 95% chance of surviving for 100 years, but if there were a population of 100 bears, the population would likely be able to survive for 200 years. Something to note: ecology involves a lot of math so if you're interested in this, that's just the way it is.

Declining Population Conservation

(5:50) So, that's the small-population approach to conservation. Another way of preserving biodiversity focuses on populations whose numbers are in decline, no matter how large the original population was. This is known as declining population conservation, and it involves answering a series of related questions that get at the root of what's causing an organism's numbers to nosedive. First, you have to determine whether the population's actually declining. Then, you have to figure out how big the population historically was and what its requirements were. And finally, you have to get at what's causing the decline and figure out how to address it. Milltown Dam actually gives us a good example of this process. In the winter of 1996, authorities had to release some of the water behind the dam as an emergency measure, because of a big ice flow in the river that was threatening to break the dam. But when they released the water, a bunch of toxic sediment went with it, which raised the copper concentrations downriver to almost 43 times what state standards allowed. As a result, it's estimated about half of the fish downstream died. Half the fish! Dead! And researchers have been monitoring the decline in populations ever since. This information was really helpful in determining what to do with the dam. Because we knew what the fish population was like before and after the release of the sediment, it was decided that it would be best to get the dam out as soon as possible, rather than risk another 1996 scenario.

Restoration Ecology
(7:06) Which brings me to the place where conservation biology and restoration ecology intersect. Restoration ecology is kind of where the rubber meets the road in conservation biology. It comes up with possible solutions for ecological problems. Now, short of a time machine, which I'm working on, you can't really get a natural environment exactly the way that it used to be. But you can at least get rid of whatever is causing the problem and help re-create some of the elements that the ecosystem needs to function properly.

Structural Restoration
(7:30) All this involves a whole suite of strategies. For instance, what's happening in Milltown is an example of structural restoration, basically the removal and cleanup of whatever human impact was causing the problem. In this case, the dam and the toxic sediments behind it. And then the rebuilding of the historical natural structure, here the meanders of the river channel and the vegetation.

Bioremediation
(7:48) Another strategy is bioremediation, which recruits organisms temporarily to help remove toxins, like bacteria that eat wastes or plants that leach out metals from tainted soils. Some kinds of fungi and bacteria are even being explored as ways to bio-remediate oil spills.

Biological Augmentation
(8:03) Yet another, somewhat more invasive restoration method is biological augmentation. Rather than removing harmful substances, this involves adding organisms to the ecosystem to restore materials that are gone. Plants that help fix nitrogen like beans, acacia trees and lupine are often used to replenish nitrogen in soils that have been damaged by things like mining or overfarming. And ecologists sometimes add mycorrhizal fungi to help new plantings like native grass take hold. But of course, we're just humans, and we're not as smart as millions of years of evolution. Sometimes we get things wrong. For example, when you bring an invasive species into a place to eradicate another invasive species, sometimes you just end up with two invasive species on your hands, which collapses the ecosystem even more rapidly. The introduction of cane toads to Australia in the 1930s to control beetles is a particularly infamous example. Not only are they everywhere now but because they're toxic they're poisoning native species like dingos that try to eat them. Nice.

So you know what? I have an idea. After spending the past couple of weeks talking about ecological problems, I've come to the conclusion that it's just easier to protect ecosystems rather than trying to fix them. Because we know a lot about what makes ecosystems tick, so if we spend more time trying to save them from us and our stuff, we'll spend less time cleaning up after ourselves and running the risks of getting it wrong. Because as we all know, the sad fact is: uncooking bacon is impossible. But we can eat it.

Thank you for joining me on this quick three-month jaunt through the natural world, I hope it made you smarter not just in terms of passing your exams but also in terms of being a Homo sapien that inhabits this planet more wisely. And thank you to everyone who helped us put these episodes together: our technical director Nick Jenkins, our editor Caitlin Hofmeister, our writers Blake de Pastino, Jesslyn Shields and myself, our sound designer Michael Aranda, and our animators and designers Peter Winkler and Amber Bushnell. And the good news is: there's more Crash Course coming at you soon. If you have any questions or comments or ideas, we're on Facebook and Twitter, and of course, down in the comments below. We'll see you next time.