The Nature of Scientific Evidence

Treating a sick forest: evidence-based medicine?

Prof. Paweł Koteja

Jagiellonian University

Prof. Paweł Koteja works at the Institute of Environmental Sciences, Jagiellonian University. He studies the ecological and evolutionary physiology of animals.

pawel.koteja@uj.edu.pl

Should the Białowieża Primeval Forest be protected actively or passively? This is a question I will not answer, because it pertains to the sphere of values, not to science. Is sanitary cutting an effective way of protecting forests against bark beetle outbreaks? Although this is a question that is scientific in its nature, I will likewise not answer it, because I am not a specialist in this field. However, as someone interested in the scientific method, I can consider a different question, namely: "Is the claim that sanitary cutting is an effective tool for controlling the bark beetle supported by scientific evidence?" Despite how it may seem, this is by no means a trivial question. Let us therefore consider three main scenarios.

If a forest is free from human intervention, the bark beetle will attack its trees one by one, causing the outbreak to spread. Ultimately, most of the trees will become infested –only some 10–20% will survive. Such trees will be the beginnings of a new forest that will grow after some time, even though it will not be the same forest as before. Importantly, the forest will include trees that survived the beetle attack, which may contribute to an increased resistance of the forest in the future.

Active protection requires efforts to remove the infested trees. In the optimistic scenario, we cut down all the infested trees so that the remaining trees can grow safely. However, there is also a pessimistic scenario: we cut down the infested trees, but it turns out that we have missed one, from which the bark beetle can spread further and infect other trees. In addition, if many trees are infected, we need to use heavy machinery to remove them. When the outbreak subsides, we may think that we have achieved success. However, the heavy machinery has destroyed the forest floor, and the remaining trees may be damaged and therefore vulnerable to future infestation by the bark beetle, to wind damage, and so on.

These three scenarios are obviously exaggerated, but they illustrate an important issue, one that is analogous to the introduction of new cancer drugs. More often than not, such drugs are essentially poisons that kill cells – the purpose is to kill all the cancer cells and as few healthy cells as possible. The first step is a controlled experiment conducted to compare the survival of the cells targeted by the drug and the control cells. However, that is not enough for the drug to be approved. We need another step, namely animal studies. Here, it often turns out that the tested substance does not bring the expected results. But if it does, this step is followed by a clinical trial. Phase one is about safety – the substance is tested to see if it is safe for humans before its efficacy can be assessed.

Clinical trials are subject to strict regulations. An adequate test group needs to be chosen, consisting of individuals who suffer from the disease that the tested substance is expected to treat. Achieving the relevant statistical significance requires many independent replications. Randomization is recommended, which means the random allocation of subjects to the treatment group or control group. Ideally, the experiment should be designed as a double-blind trial. Finally, it is necessary to avoid a conflict of interest – decisions about accepting a drug for regular medical practice cannot be made based on results of research conducted by the manufacturer of the tested drug. Similarly, if people who earn their living by working in the logging industry claim that logging is the best remedy for the bark beetle, we can have reasonable grounds to doubt their objectivity.

Let us now apply these guidelines to the question about the effectiveness of sanitary cutting. First, we need independent replications, which means research performed in several distantly spaced places. Moreover, if the issue concerns specifically the Białowieża Primeval Forest, an adequate design should include localities representing similar type of forest, rather than, for example, forests in the Tatra or Beskidy Mountains. Randomization means that

once an outbreak occurs, we should randomly select the forests subjected to sanitary cutting and the ones where there will be no cutting. For obvious reasons, it is impossible to design this study as a double-blind experiment. Nonetheless, a certain type of blinding is possible in the data analysis – it is important that the individuals who perform such analyses have no preconceived opinions on the issue. We could say that such a study is impossible in practice, and that is true. However, we cannot use this to argue that if we cannot provide evidence-based arguments for the effectiveness of sanitary cutting, we simply need to declare the existence of evidence based on the reasoning that such evidence cannot be obtained.

What more can we do? We can use data collected in the course of other studies. In order to do so, I searched the Scopus database using the keywords "bark beetle" and "outbreak." Two hundred and fifty-nine results pertained to mountainous terrain, and only seven to lowland tree stands, which demonstrates that most of our knowledge about bark beetle outbreaks comes from areas not directly relevant to the question of the rationale behind measures taken in the Białowieża Forest. Likewise, I found no meta-analysis, which seems surprising in light of the amount of time devoted to discussions on the problem posed by the bark beetle. Indeed, as it turns out, little is known about this issue.

I also checked what is known about the effectiveness of sanitary cutting against bark beetle outbreaks. I found only 39 results, 18 of which described outbreaks of *Ips typographus* (the species currently infesting the Białowieża Forest), mostly in mountainous terrain. None of them posited the unambiguous conclusion that such measures are effective. However, all of them showed that abstaining from intervention had a positive impact on biodiversity.

I would like illustrate the problem under discussion by referring to one paper, namely Mezei et al. (2018 – "Testing the salvage-logging treatment: a case study". *Ann Forest Sci* 74). It is based on a study of 417 areas in the Tatra Mountains, and one might think that these areas represented 417 independent observations differing in terms of sanitary cutting and other factors. In fact, however, all these areas were located in the same region, where a mixed strategy was used. Although this study is very informative, it provides only *one* point of data.

Consequently, the answer to the question whether sanitary cutting is "an evidence-based treatment" is "no." This is not because existing studies have contained methodological errors, but because of the high degree of complexity of the problem. However, the absence of good scientific grounds to draw conclusions as to the effectiveness of interventions does not permit the arbitrary conclusion that logging is effective. ■

JAKUB OSTAŁOWSKI

This is a summary of a presentation given by Prof. Koteja at the international conference "Managing the Bark Beetle Outbreak in the Białowieża Primeval Forest" organized by the Polish Academy of Sciences on 4 December 2017 (preceded by a study visit to Białowieża).