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The Australian Environment Foundation (AEF) welcomes the opportunity to make this submission to the Independent Inquiry into 2019-20 Victorian Fire Season

Preface

The Australian Environment Foundation (AEF) is a non-profit, membership-based organisation that has no political affiliations. It is dedicated to informing and educating Australians about environmental issues and advocating solutions to environmental problems that enhance the well-being of all Australians, and preserve the rule of law, property rights, and the freedom of the individual.

While it may be true that "We are all environmentalists now", the great majority of Australians have little or no say in the environmental policies being put to governments – federal, state or local. These policies are almost exclusively the domain of a tight network of ideologically driven environmental groups ensuring one view, and one view only, is put forward.

The AEF is a different kind of environment group, taking a non-ideological, evidence-based and solution-focussed approach to supposed environmental problems, recognising that human beings are part of the environment, and that human prosperity is necessary to preserve and enhance the environment.

Constitutional background

Prevention and mitigation of bushfires is essentially a matter of land management which, under the constitution is generally a matter reserved to the States, although the Commonwealth has a seat at the table by virtue of its ultimate power over the ACT and the NT, who are by no means immune from bushfires, under s. 122 Constitution. Preponderantly, however, land management and bushfire prevention and suppression are State matters. They are very expensive to carry out adequately and vital measures to reduce the frequency and intensity of bushfires are opposed, particularly by ideologically-driven environmental bodies and their followers. In short, State governments garner votes by creating the National and State parks, but find that there are no votes in incurring the substantial cost of those vital measures, making those parks wombes, as it were, for catastrophic bushfires because of inadequate implementation of those vital measures.

The 2019-20 bushfires in SE Australia showed that assistance by the Commonwealth, in particular through the ADF, can be valuable, if not essential, in the face of catastrophic bushfires; but it must be kept in mind that bushfires become catastrophic only if a State fails to carry out tried and tested bushfire prevention and suppression measures, and that the cost of the ADF's assistance is met by the Commonwealth and Australian taxpayers generally, which can be seen as a form of cost shifting by the relevant State. Commonwealth assistance can thus create moral hazard.

What should be done?

AEF can do no better than to quote the concluding section of the article in the April 2020 issue of *Quadrant* by the retired forester, Mark Poynter, who has written extensively on forestry and bushfire prevention and suppression as follows:

Drawing upon the successes of the past, the royal commission into the 2019-20 bushfires should be asking just how committed today's state governments are to dealing with the bushfire threat when:

they elevate advice from eco-activist groups and academic ecologists—neither group with any practical fire management experience—above the advice of forest fire management practitioners and bushfire science specialists?

they consequently lack enthusiasm for fuel reduction burning and are prone to using national park declarations as a political mechanism to close timber industries that have always been integral to ground-based forest fire-fighting through provision of equipment and experienced bush operators?

they do not adequately resource land management agencies to maintain numbers of field officers engaged in forest management?

their land management agencies have centralised organisational structures that micro-manage fire from cities or large regional centres remote from the field, thereby fostering a decline of local bush and fire knowledge and informed on-the-spot decision making?

their land management agencies no longer insist on fire-fighting as a condition of employment and there are no restrictions on key personnel taking annual leave during the fire season?

thereby counter-productively allowing more fires to grow larger with exponentially increased risks to firefighters and the broader community?

While there is a real danger that the royal commission will be overwhelmed by climate change concerns, the past shows that the answers to the bushfire problem are primarily rooted in human factors that determine the effectiveness of land and fire management in enabling quick control of fires while they are small. Unless we learn from the past when fire-fighting was primarily ground-based, more initially

aggressive, and consequently more effective; the Australian landscape will be doomed to regular repeats of what has occurred this season.

AEF submits that Mark Poynter's questions should be central to the Independent Inquiry.

The sentence following Mark Poynter's questions is an oblique reference to the increasing use of aircraft in attempting to control bushfires. Politically, the attraction of aerial water bombing of bushfires is that it provides an outward and visible sign the relevant government is *doing something* about them. It could also be seen as an application of what one can call the Humphrey Appleby syllogism directing political action: *something must be done; this is something; therefore, this must be done.*

Mark Poynter in the same article quotes with agreement the internationally acclaimed US wildfire analyst Stephen Pyne as arguing that *the domination of this aircraft-based emergency response had arisen because of a need to protect burgeoning US suburbs, towns and other assets that were increasingly abutting flammable forests. But while this justified the approach, he contended that it was failing to improve wildfire outcomes because: (1) it is focused on treating the symptoms rather than addressing the factors that underpin fire risk; (2) massive expenditure on aircraft reduces the budgetary resources for off-season fire mitigation activities such as fuel hazard reduction and maintaining forest access that is integral to containing fires while they are small; (3) aerial water-bombing, while effective at saving houses and other community assets, is relatively ineffective in controlling most forest fires; and (4) an over-reliance on aerial water-bombing was partly displacing ground-based fire-fighting which, although carrying a higher degree of firefighter risk, is integral to containing wildfires.*

Mark Poynter goes on to say:

According to Pyne, these consequences of a dominant focus on an aircraft-based emergency response foster a self-sustaining cycle of massive wildfires which is regularly reinforced as each big fire increases community and political demands to further expand the fleet of fire-fighting aircraft. Recent research in Mediterranean countries refers to this phenomenon as the "fire-fighting trap" because nowhere in the world has increasing the numbers of fire-fighting aircraft ever reduced the incidence and extent of large forest fires.

In AEF's view, Stephen Pyne's observations apply as much to Australia as to the US and elsewhere, particularly countries who have established large eucalyptus forest imported originally from Australia. Eucalypts are inherently highly incendiary, as is the detritus which they shed incessantly to the forest floor, summer, autumn, winter and spring, providing the fuel that generates the ferocity of eucalypt forest fires.

Climate change

The Independent Inquiry can expect to be inundated by submissions to the effect that the severity and extent of the 2019-20 bushfires were caused by anthropogenic global warming. Bearing in mind that Australia's average temperature has increased by at most 1deg.C over the last 100 years, common sense suggests that is a stretch. Victoria has seen even more extensive and calamitous bushfires in January 1939 and even more so in 1851. Mark Poynter's article includes a comparison of the comparable East Gippsland fires in 1983 and those in 2019-20, which shows that fire fighting was more effective then than now.

In June 2019, Professor Andrew Pitman, Director, ARC Centre of Excellence for Climate Extremes, was quoted by the Sydney Environment Institute at the University of Sydney as saying:

“...this may not be what you expect to hear, but as far as the climate scientists know there is no link between climate change and drought.

That may not be what you read in the newspapers and sometimes hear commented, but there is no reason a priori why climate change should [have] made the landscape more arid.

If you look at the Bureau of Meteorology data over the whole of the last one hundred years there's no trend in data. There is no drying trend. There's been a trend in the last twenty years, but there's been no trend in the last hundred years, and that's an expression on how variable Australian rainfall climate is.

Moreover, Australia's Chief Scientist, Dr. Alan Finkel AO, acknowledged in 2018 that no amount of reduction of CO₂ emissions by Australia, which accounts for a mere 1.5% of anthropogenic emissions of CO₂ would have any effect on the world's, and Australia's, climate.

Nevertheless, the States and the ideological environmental bodies may be expected to raise this furphy, the former to extract more from the Commonwealth or to justify inadequate fire prevention and control measures, and the latter to continue their long-maintained resistance to such measures, no matter how much destruction unconstrained bushfires bring to the fauna and flora that those bodies purport to protect.

Commonwealth-State collaboration on natural disasters

AEF notes that the Commonwealth, presumably at the request of the NSW and Victorian State governments, contributed very usefully through the ADF to mitigating the damage caused by the bushfires. The Commonwealth seems to have established its Royal Commission to investigate, among other things, formalising arrangements between the Commonwealth and the States for dealing with national disasters, rather than leaving them to be worked out *ad hoc*, as with the recent fires. AEF sees the very disparate issues which arise with all the possible kinds of natural disasters contemplated by the terms of reference for the Commonwealth Royal Commission present a formidable obstacle to finding a workable formulation covering all, and recommends that, as and when natural disasters occur, the Commonwealth and the relevant State(s) work out between themselves as sovereign governments their respective roles in the light of the nature of the relevant natural disaster and the circumstances surrounding it.

The Replication Crisis in Science

Success in designing and implementing measures to address the management of bushfires and other natural disasters and of the consequences of such disasters when they occur critically depends on the quality and quantity of the formalised body of knowledge that they are able to draw upon for this purpose.

With the advancement of science, much of this knowledge is now routinely provided by researchers in the environmental sciences.

One aim of this submission is to draw the Independent Inquiry's attention to the fact that it is by no means clear that the research findings upon which much environmental policy in Australia have relied upon to date are rigorous, transparent, and reproducible.

These shortcomings are a direct consequence of the replication crisis that has engulfed scientific disciplines around the world, including the environmental sciences.

One of the key consequences of this crisis is that Australian Governments need to take concrete steps to ensure that:

- the research methods used in such research have been independently and professionally checked and verified as rigorous and transparent; and
- the research results obtained with those methods have been replicated to an acceptable standard.

The crisis refers to the persistent failure of independent attempts to replicate the results of previous scientific research, including that published in peer-reviewed journals.

As replication is considered to be the gold standard for measuring scientific progress, the number and the source of the failures that have accumulated across the scientific literature suggest the crisis is serious and no scientific discipline is immune to the crisis, including the environmental sciences.

As it is very likely that the Independent Inquiry will be referred to scientific papers, studies and other material, AEF accompanies this submission with a submission on AEF's behalf on the replication crisis by one of its Directors, Jeffrey Rae.



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The Replication Crisis in Science

Jeffrey Rae – Director, Australian Environment Foundation

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While it may be true that "we are all environmentalists now", the great majority of Australians have little or no say in the environmental policy measures that are pressed on Commonwealth, State and local governments. They almost exclusively emerge from a tight network of ideologically driven environmental activists that aims to ensure that one view, and one view only, is put forward on any issue.

AEF is a completely different kind of environment group. It takes a non-ideological, evidence-based and solution-focussed approach to environmental problems. It recognises that human beings are a part of the environment, and human prosperity is necessary to preserve and enhance it.

Introduction

Success in designing and implementing measures to address the management of bushfires and other natural disasters and of the consequences of such disasters when they occur critically depends on the quality and quantity of the formalised body of knowledge that they are able to draw upon for this purpose.

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In 2005 Professor John Ioannidis — then Head of the Medical School at the University of Ioannina in Greece — sounded the alarm (Freedman 2010 & Bailey 2016).

Ioannidis was extremely well-qualified to do so. He holds chairs in medicine, statistics and biomedical statistics at Stanford University and is a Co-Director of Stanford's Meta-Research Innovation Centre, which undertakes scientific research into how scientific research is carried out and interpreted.

Ioannidis published one of these articles in *PLoS Medicine* and the other in the *Journal of the American Medical Association*. Both journals are highly regarded by researchers.

His first paper demonstrated mathematically that researchers will come up with wrong findings most of the time, assuming modest levels of researcher bias, typically imperfect research techniques, and the well-known tendency to focus on exciting rather than highly plausible theories. Moreover, in many research fields, the claimed findings may simply reflect the extent of the prevailing bias, rather than the weight of the supporting evidence.

His second paper examined the intellectual history of 49 of the most highly regarded research findings in medicine over the preceding 13 years. They had been published in the most widely cited articles in the most widely cited journals.

Forty-five of the articles in question claimed to have found an effective medical treatment. After 34 of these claims were retested, 41 per cent were found to be wrong or significantly exaggerated.

The two papers caused a sensation.

Initially, some researchers claimed Ioannidis had exaggerated the extent of non-replication. As researchers continued to examine the issue, however, they continued to find replication failures wherever they looked.

In 2011 researchers at Bayer Healthcare reported that they had been able to replicate in-house the results of only 24 — or 36 per cent — of 67 preclinical studies they had tested, from those published in the peer-reviewed literature (Prinz et al 2011). The company had planned to use the original results to develop new medical treatments and diagnostic products.

In 2012 researchers from the Amgen pharmaceutical company reported that they had been able to replicate the findings of only six out of 53 — or 11 percent — landmark preclinical cancer studies that had been previously published in the peer-reviewed literature (Begley & Ellis 2012). A preclinical study tests the safety and potential efficacy of a prospective medical treatment on animals before it can be trialled on people.

In 2015 a group of researchers attempted to replicate a hundred studies that had been published in three high ranking psychology journals (Open Science Collaboration 2015). They found that two-thirds of their attempts could not reproduce the ‘statistically significant’ effects estimated by the original studies.

Ioannidis has subsequently estimated that, in the biomedical sciences, non-replication rates range from more than 90 percent for observational studies to between 70 and 90 percent for preclinical research (Bailey 2016).

Before investing in a biomedical start-up, Venture capital firms typically hedge against "academic risk" by hiring contract research organizations to vet the science on which a prospective investment is based. The journal, *Science-Business eXchange*, has reported that 50 percent of published academic studies have been unable to be replicated by prospective venture capitalists (Bailey 2016).

In 2015 a symposium was held in the UK on the state of reproducibility and reliability in biomedical research. The discussion was off-the-record as it was conducted under Chatham House rules. The editor of the journal, *The Lancet*, was in attendance and publicly summarised the results of the symposium in the following terms:

“The case against science is straightforward: much of the scientific literature, perhaps half, may simply be untrue. Afflicted by studies with small sample sizes, tiny effects, invalid exploratory analyses, and flagrant conflicts of interest, together with an obsession for pursuing fashionable trends of dubious importance, science has taken a turn towards darkness.” (Horton 2015)

The headlines of the media coverage of this issue leave little doubt about the nature and scale of the crisis: “Scientific regress” (*First Things*); “Academic publishing is broken” (*The Scientist*); “Science’s big scandal” (*Slate*); “Lies, damned lies, and medical science” (*The Atlantic*); “Broken science” (*Reason*); “Science has lost its way” (*Los Angeles Times*); and “How science goes wrong” (*The Economist*).

Views of Researchers

In 2016 *Nature* — one of the world's leading scientific journals — conducted an online survey to gauge the views of research scientists around the world on the 'reproducibility crisis' (Baker 2016).

The *Nature* survey received a total of 1,576 responses. They were drawn from all the major scientific disciplines, including biology (703 respondents), and the earth and environmental sciences (95 respondents).

Over 70 per cent of the survey respondents had tried but failed to reproduce another scientist's experiments, while more than half of the respondents had failed to reproduce their own work.

Some 52 per cent of survey respondents agreed there is a significant reproducibility crisis in their field.

By this measure, the survey respondents from biology, and the earth and environmental sciences did not rate replicability in their discipline as highly as those from physics and chemistry had.

In what was a major surprise for *Nature*, less than 31 per cent of respondents agreed with the idea that irreproducibility means the published result is probably wrong. Given the weight of the empirical evidence, this is almost certainly a case of wishful thinking.

The Editor commented that empirical data on how much of the scientific literature is reproducible are "rare and generally bleak"; the best-known examples being psychology and cancer biology with reproducibility rates of only 40 per cent and 10 percent respectively.

The *Nature* survey respondents were more optimistic. Some 73 per cent thought at least half of the papers in their field could be trusted; with the physicists and chemists generally having the greatest confidence.

Nature asked their respondents about what contributed to reproducibility problems. Over 60 per cent said a combination of pressure to publish and selective reporting were always or often involved. More than half also pointed to insufficient replication in the laboratory, poor oversight, or low statistical power of the research methodology.

As the survey respondents were self-selected, their views are not necessarily representative of all the scientists in their field. Nevertheless, the survey suggests that scientists would be prepared to cooperate with journals, research funders, and research institutions in addressing reproducibility; about 80 per cent of respondents believed funders and publishers should do more to improve reproducibility.

Poor Statistics: A Key Contributor to the Crisis

Poor statistical analysis is a key contributor to the number of research findings that cannot be reproduced. Statistical analysis is extensively used in the biological and environmental sciences due to the dynamic and stochastic nature of ecosystems and the animal and plant populations that live within them.

The Nobel-winning economist, Ronald Coase, once quipped: "If you torture the data long enough, nature will confess to anything." The torture can take several forms. They include p-hacking, HARKing, and choosing research methods that are lacking in statistical power.

P-hacking abuses the statistical test — called the p-value — that is used to determine whether an experiment's results were due to chance. The chosen p-value — the p stands for probability — can range from 0 to 1. In the environmental sciences, researchers generally test to see if there is a 20 per cent chance — a p-value of 0.05 — that their results could have occurred by accident. (This is also known as testing for statistical significance.)

P-hacking involves running multiple tests on a dataset, looking for a result that exceeds the threshold chosen for statistical significance, and reporting only that result.

The American Statistical Association (ASA) has warned about the misuse of the p-value (Wasserstein & Lazar 2016). For example, it has confirmed that the test cannot determine whether a hypothesis is true or whether the results obtained are important. The group has taken the unusual step of issuing principles to guide use of the p-value.

HARKing — "hypothesizing after the results are known" — is a fall-back strategy that is often used when the original hypothesis fails the statistical tests set for it. The researchers then hunt through the data looking for the "best" result they can extract, which they present as the original research aim.

Unfortunately, HARKing increases the risk of finding false positives and makes the results seem stronger than they really are.

Many published studies use research methods that are lacking in statistically power. Statistical power may be thought of as the likelihood a study will detect an effect when there is one there to be found. detected. Other things being equal, the bigger the effect, the easier it is to find; and the larger the sample size used in the analysis, the easier it is to detect a more subtle effect.

Many studies use sample sizes that are too small to accurately detect the effects they are looking for. In large part this reflects the fact that larger sample sizes are more expensive and take longer for researchers to collect.

How Should Governments Respond to Crisis

In 2018 the National Association of Scholars (NAS) in the US published a report entitled *The Irreproducibility Crisis of Modern Science: Causes, Consequences, and the Road to Reform* (Randall & Welser 2018).

The NAS is a network of scholars and citizens who promote academic freedom, disinterested scholarship, and excellence in US higher education.

The NAS report concludes that many factors have contributed to the replication crisis. The include:

- the improper use of statistics;
- the arbitrary choice of research techniques;
- a lack of accountability by researchers;
- political groupthink among researchers; and
- a scientific culture that is biased towards the production of positive and eye-catching results.

The consequences of the crisis have been profound and far-reaching.

Non-reproducible research is also distorting public policy and public expenditure in many areas including public health, climate science, and the environment. The US alone is spending about \$28 billion a year on irreproducible preclinical research into new drug treatments.

Perhaps the gravest consequence is that science and scientific experts are losing the authority they once held in the eyes of the public, both in the US and Australia.

The good news is that individual scientists, journal editors and publishers, foundations, and governments around the world have begun to take concrete steps to address the crisis. However, there is still much more to be done.

An effective and durable long-term solution will need to address each and every aspect of the replication crisis — the technical competence of scientific researchers, the institutional practices of scientific research organizations, and their professional culture. The NAS report proposes 40 reforms that systematically address each of these contributors.

Most importantly, the NAS report includes recommendations for fundamental reforms to public policy. In particular, it proposes that governments should:

- fund public efforts to replicate previous research;
- require all new regulations to be based on research that meets strict reproducibility standards;
- review all existing regulations to ensure they are based on reproducible research and repeal those that do not; and
- require all government agencies to adopt strict reproducibility standards.

While these recommendations have been specifically directed at governments in the US, they are equally applicable to governments outside the US.

With this in mind, the AEF urges the Independent Inquiry to commend each of the recommendations to the Victorian Government in its Reports.

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