



He Tangata, He Taiao, He Ōhanga

.....
a values-based biosecurity risk
assessment framework for Aotearoa

NEW ZEALAND'S
BIOLOGICAL
HERITAGE

Ngā Kōiora
Tuku Iho

National
SCIENCE
Challenges

Darwin and the exploding trousers

Assessing an existential risk after two centuries of biological invasions in New Zealand

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āta mātai, mātai whetū



B3

Science Solutions for
Better Border Biosecurity
AOTEAROA NEW ZEALAND

Welcome to Christchurch, New Zealand's first official city.

Let's go back 160 years, and visit my great, great, great, great grandparents. They lived not far from here.

Christchurch
in the 1860s



Things were a little different back in the 1860s, but maybe not so very different. You could take a morning stroll to the grocery store to buy your daily newspaper, the Christchurch Press.

The Press,
Christchurch,
Saturday
13 June
1863

THE PRESS

Vol. III.—No. 101. SATURDAY, JUNE 13, 1863. PUBLISHED BY JOHN WILSON, AT THE PRESS, CHRISTCHURCH.

of the greatest and most mysterious questions of the day. We refer to the question what sort of creature man's next successor in the supremacy of the earth is likely to be. We have often heard

Our opinion is that war to the death should be instantly proclaimed against them. Every ma-

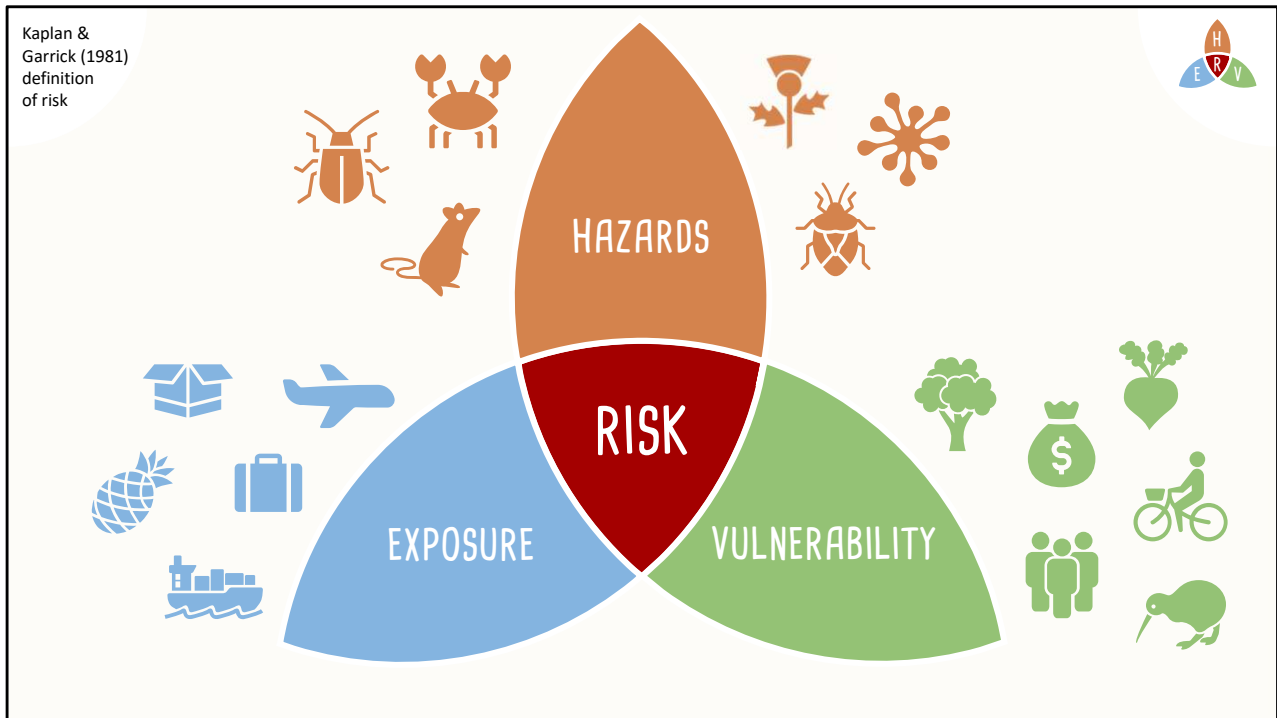
It's 13 June 1863, a Saturday. And what's this on the front page? A letter, and quite a long one.

Your eye is drawn to phrases like "man's next successor" and "war to the death".

Why, this letter seems to be warning of an upcoming invasion that will affect us all and possibly endanger the freedom of the human race!

So what happens next? Do the good people rise up to defend themselves in this war to the death? Well, no, the good people of Christchurch go back to their Saturday morning chores. There's plenty of work to be done in a budding city, and a new music hall of superior acoustic properties has just opened in Gloucester Street. The letter is largely forgotten, and the paper it was printed on probably cut into squares for use in the new city's latrines. Only now, 160 years later, we are suddenly taking it much, much more seriously.

So what was this invasion that we were warned of 160 years ago? And how can we make sense of it? For that matter, how should we assess the risk posed by *any* invasive species? Well, let's start by defining what risk actually is.

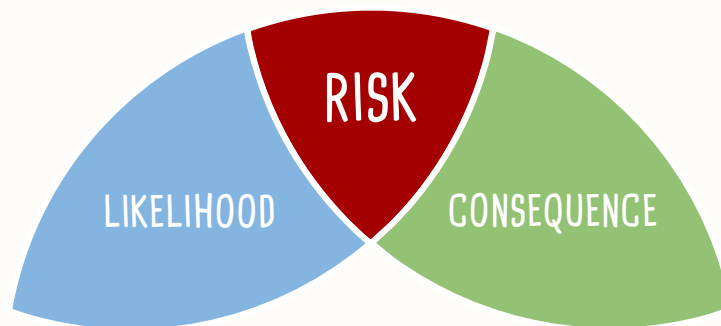


Risk is a concept that pervades many fields and has been defined in many different ways. But the one that I like the best was proposed by Kaplan and Garrick in 1981, as the intersection between hazards, exposure and vulnerability.

In the context of biological invasions, hazards are the species that might invade, exposure is the likelihood that they will enter and establish,

and vulnerability addresses the impacts that they would have on the things that we care about.

An alternative
definition
of risk



In a biosecurity context you often see invasion risk defined as likelihood times consequence. This is contextual, as it implies that you already know what the hazard is. Likelihood is another way to frame exposure, and consequence is similar to vulnerability.

Except that I think vulnerability is a better way to think about invasion risks.

For one thing, there are so many hazards out there that we can't possibly predict the consequences of every possible invasion.

Consequence also smells a lot like money, but we need to consider risks to a much wider range of environmental, social and cultural values.

But vulnerability flips the question around and says, hey we don't know exactly what's going to invade next, but let's think about what we care about, how they could be affected by biological invasions, and work back from there.



New Zealand's history of biological invasions is relatively recent and well documented. It provides a lot of interesting examples, and suggests some general insights into hazards, exposure and vulnerability.

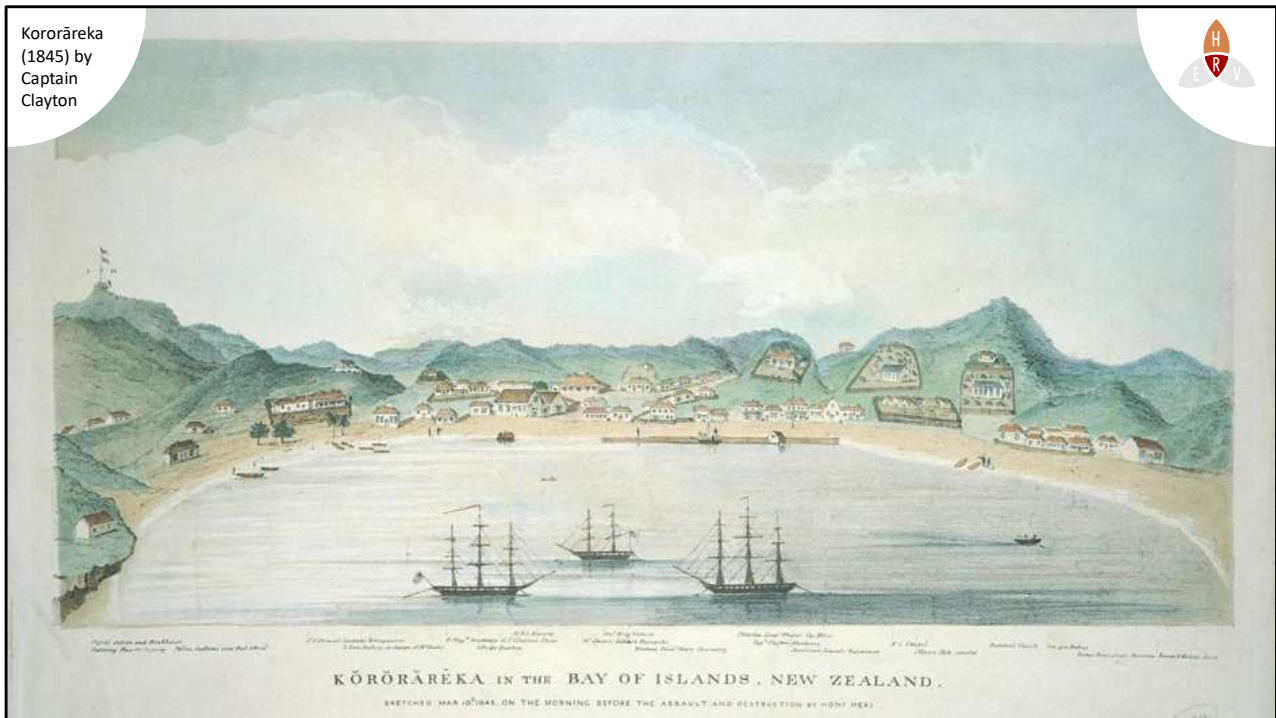


So, once more I will invite you to travel with me back through time, this time to Christmas 1835, when Charles Darwin visited New Zealand and witnessed some of our early biological invasions first hand.

Darwin hated New Zealand.

He was four years into his five-year voyage on the Beagle, perpetually seasick, homesick, and as far from England as is physically possible.

Kororāreka
(1845) by
Captain
Clayton



He arrived in the Bay of Islands, known at the time as the “hellhole of the Pacific” due to the grog shops and prostitution that was rife there, spent a desultory nine days poking at shells, rocks and geckos, then wrote in his diary as they set sail for Australia “I believe we were all glad to leave New Zealand. It is not a pleasant place.”

Kororāreka
by Augustus
Earle
(1838)



But New Zealand had made an impression on young Charles Darwin, if not a good one.

He was impressed by the vigour of European weeds and mammals that were apparently displacing the native species.

This led him to reject the idea that species are perfectly adapted to their environments, since these European invaders were apparently much fitter in the New Zealand environment than the native species.

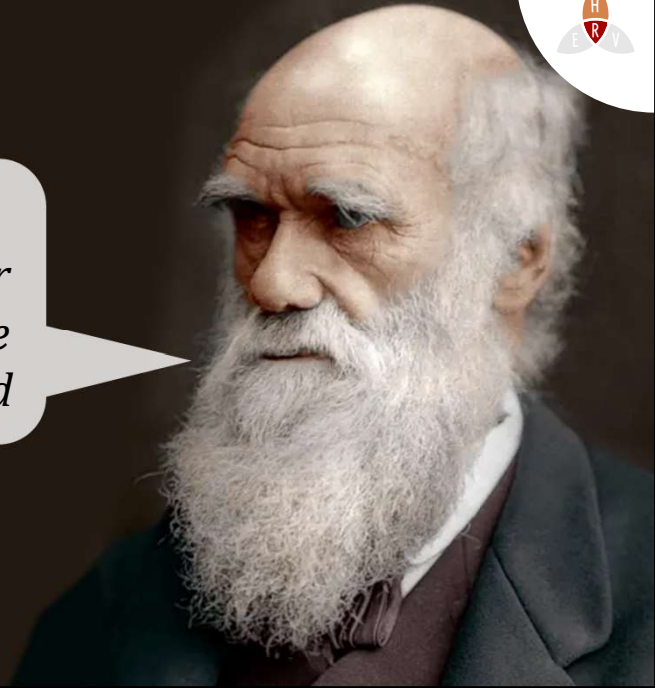
This got him thinking about how to characterise biological invaders and identify the most serious hazards.

His “naturalisation hypothesis” has since been well-studied and will be familiar to many in the audience, but he also proposed a more specific hypothesis about New Zealand’s flora and fauna.

Charles Darwin
*On the Origin
of Species*
(1859)



The productions of Great Britain stand much higher in the [invasiveness] scale than those of New Zealand



In “On the Origin of Species” he speculated that lots of the animals and plants of Great Britain would be invasive in New Zealand, whereas few if any New Zealand species would be capable of invading Britain.

As he put it, “the productions of Great Britain stand much higher in the [invasiveness] scale than those of New Zealand.”

Oh, Darwin! I wonder if he realised he was echoing the Euro-centric biases...

Georges-Louis
Leclerc,
Comte de
Buffon
(1750s)



*Animals in the New
World are in every way
smaller, weaker and
more cowardly*



of the Comte de Buffon a century earlier, who, never having left Europe, declared that animals in the New World are in every way smaller, weaker and more cowardly.

Well, Thomas Jefferson conclusively disproved that idea by mailing him a very dead and equally smelly moose,



and we can dismiss Darwin's idea in a similar way, by noting the number of New Zealand species that have indeed invaded Britain.

Probably, Darwin's idea was largely a product of the unequal propagule pressure that had existed up to that point.

His theory for hazards failed to take into account exposure.

Thomas
Donne



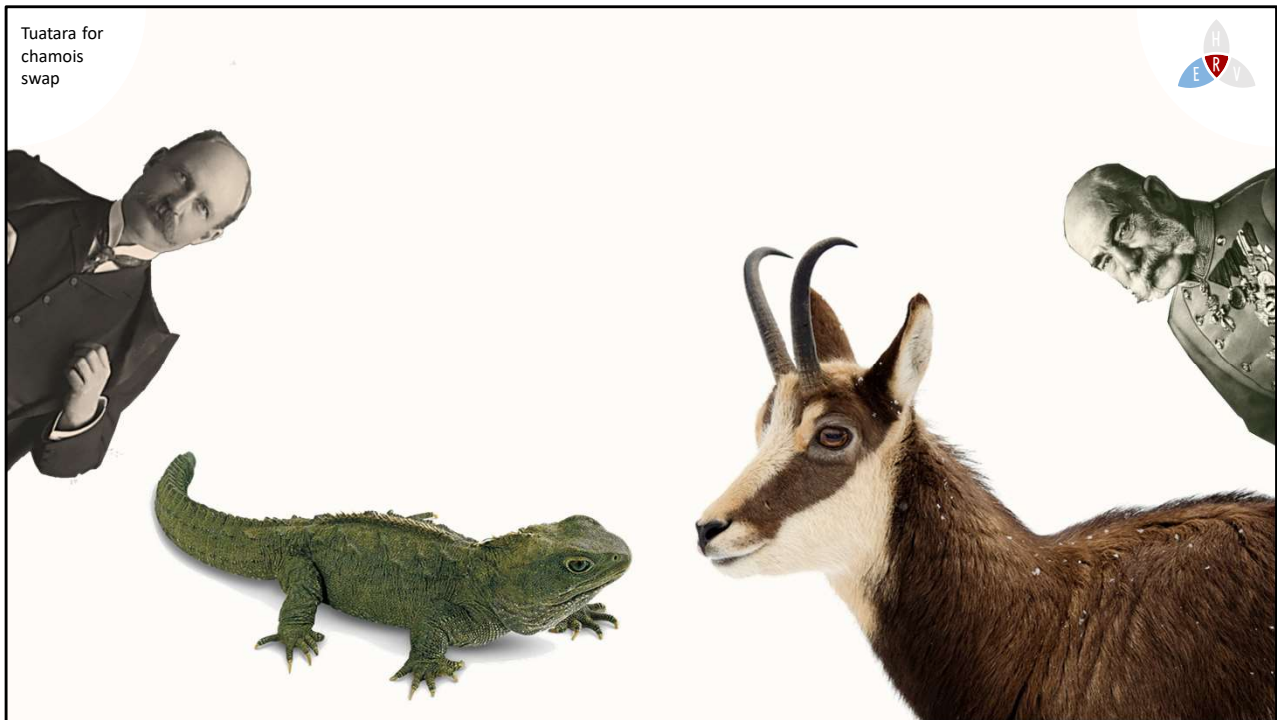
Nature neglected New Zealand in providing game animals; man has remedied the omissions



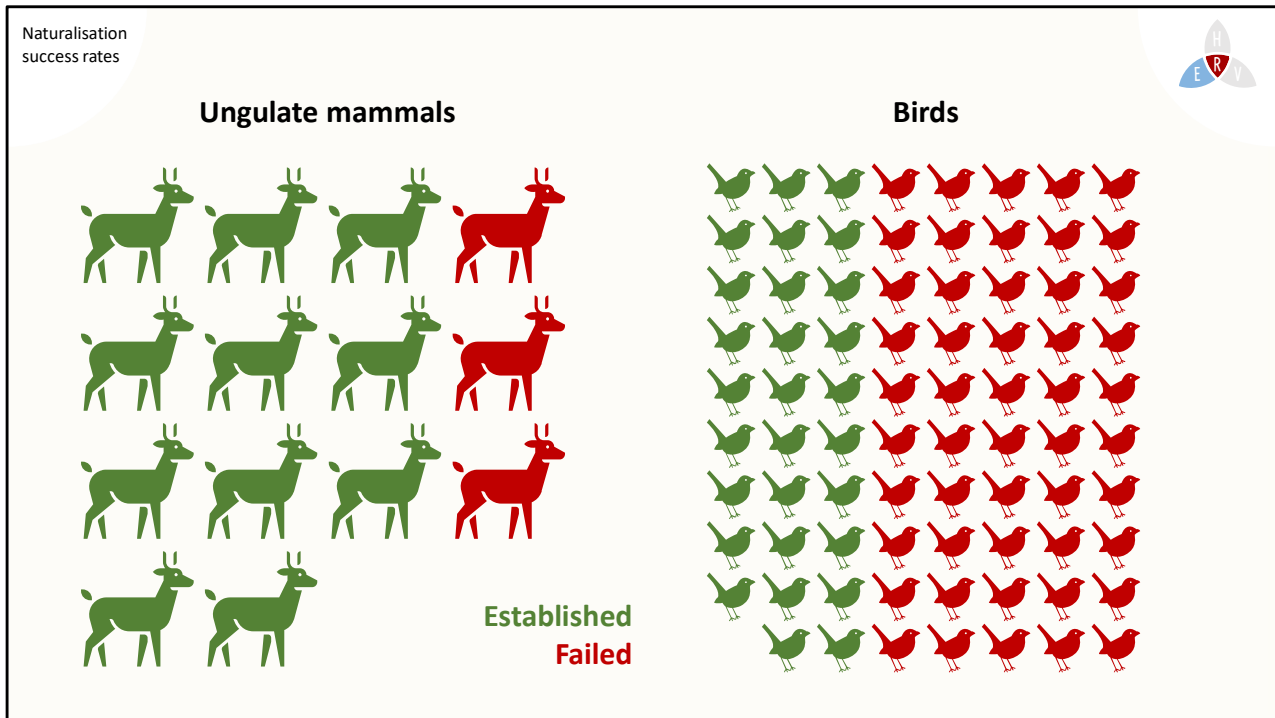
By the 1860s, at the time of our letter, the settlers of New Zealand had established themselves and their communities into this strange new land, and like Darwin they were starting to miss home. They were also missing the availability of wild game.

As Thomas Donne put it, “Nature neglected New Zealand in providing game animals; man has remedied the omissions”.

Indeed, so-called acclimatisation societies sprung up all around the country, and got to work introducing, rearing and releasing a wide variety of mammals, birds and fish.



Thomas Donne, himself, sent tuatara to the Emperor Franz Josef of Austria and received a shipment chamois in return. The chamois looked pretty happy about this. The tuatara did not.



One of the most interesting things about these deliberate introductions was that, despite careful management and often multiple attempts, the success rate was surprisingly low.

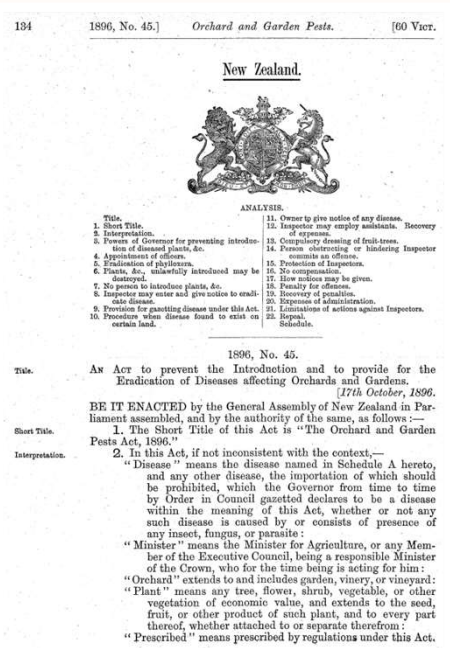
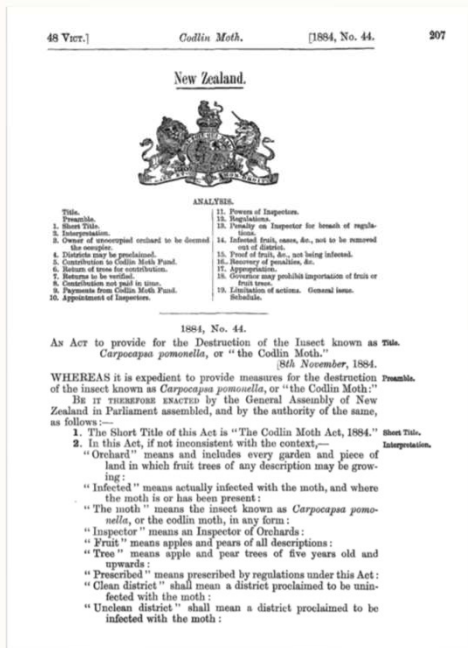
Deer, tahr, wallabies, ducks, geese, trout, ferrets, hedgehogs and many others were successful and most now cause measurable environmental damage.

Zebra, gnu, racoon, kangaroo, grouse and many more failed.

Despite the acclimatisation zeal, some people were recognising that not all animals were a good idea.

Early legislation banned the import of predatory mammals, mostly to protect the game species they had already established.

Thankfully this meant that plans to introduce bears, wolves and lions were stopped.



New Zealand's first real biosecurity legislation was the Codlin Moth Act of 1884, which aimed to protect the developing pipfruit industry from a key insect pest. But codling moth was already here by the time it passed.

This was followed by other legislation, such as the Orchard and Garden Pests Act of 1896, which targeted other specific unwanted organisms.

Mediterranean
fruit fly
*Ceratitis
capitata*



One of those was the Mediterranean fruit fly, which was, at that time, rampant through eastern Australia.

Rigorous destruction of infested fruit imports were successful, until 1907, when regulations were relaxed in response to pressure from importers.

Almost immediately, Medfly established populations in Auckland, Napier and Blenheim, all traceable to a single import event.

Fruit flies are some of the most destructive and costly horticulture pests.

Thankfully, NZ was had a superhero, in the guise of...

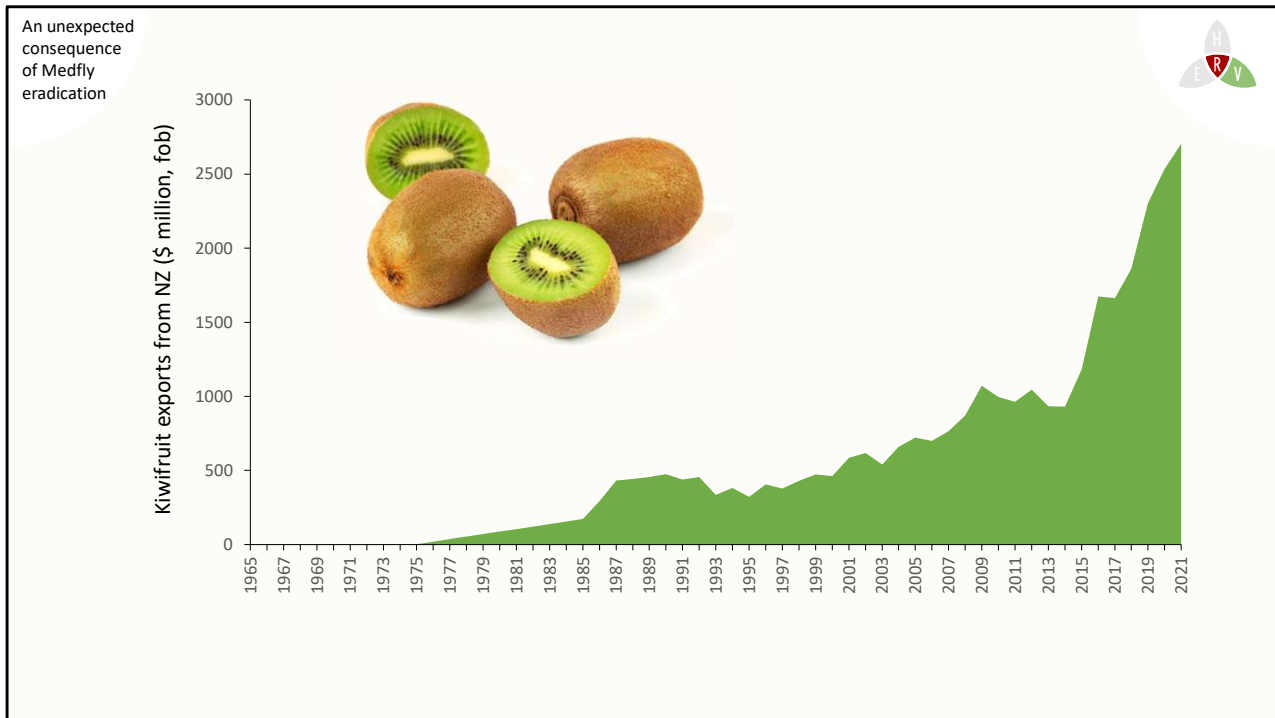
WA Boucher,
government
pomologist
in 1907



Government pomologist, W.A. Boucher.

This guy is a true unsung hero of NZ horticulture, and I am an unashamed fanboy. Armed with little more than kerosene, pump and a dapper necktie, he somehow managed to eradicate these Medfly invasions, and ensured that the import regulations were re-tightened.

The exposure pathways were broken.



Now, those early fruit fly eradications had an unexpected outcome.

They paved the way for a much later invasion of NZ's horticultural land; a species of Chinese origin which has been going bananas since the 1970s.

I shouldn't say "bananas" because it's actually kiwifruit.

Yes, New Zealand's kiwifruit industry was arguably born out of the absence in NZ of serious fruit pests like fruit flies.

If my hero Boucher hadn't done his job so well in 1907 and kept NZ fruit fly free, who know if kiwifruit would even be a thing.

Certainly it wouldn't be the two and a half billion dollar thing that it is now, every year.

Kiwifruit may be an unexpected benefit from biosecurity actions, but there can be unexpected costs as well, such as the epidemic of exploding trousers that swept New Zealand in the 1930s.

Exploding
trousers



Starting in 1931, all over the country, farmers' pants were spontaneously combusting with explosive flames and popping noises.

The slightest warmth was enough to set them off.

Pants were exploding on clothes lines from the heat of the sun.

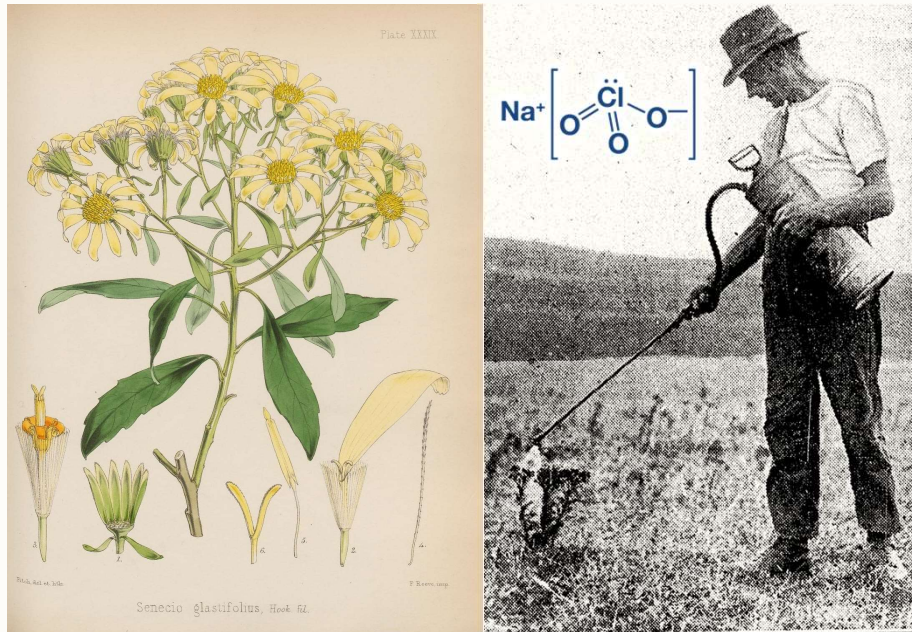
But they were also exploding on the legs of hapless farmers, sometimes even ignited by the friction between trouser bottom and saddle while riding a horse.

Several men sustained serious burns and at least three died.

One poor bloke arrived home from work after dark and struck a match to gaze at his sleeping baby. He burned to death.

So how was this happening? And what did it have to do with invasive species?

Ragwort control in the 1930s



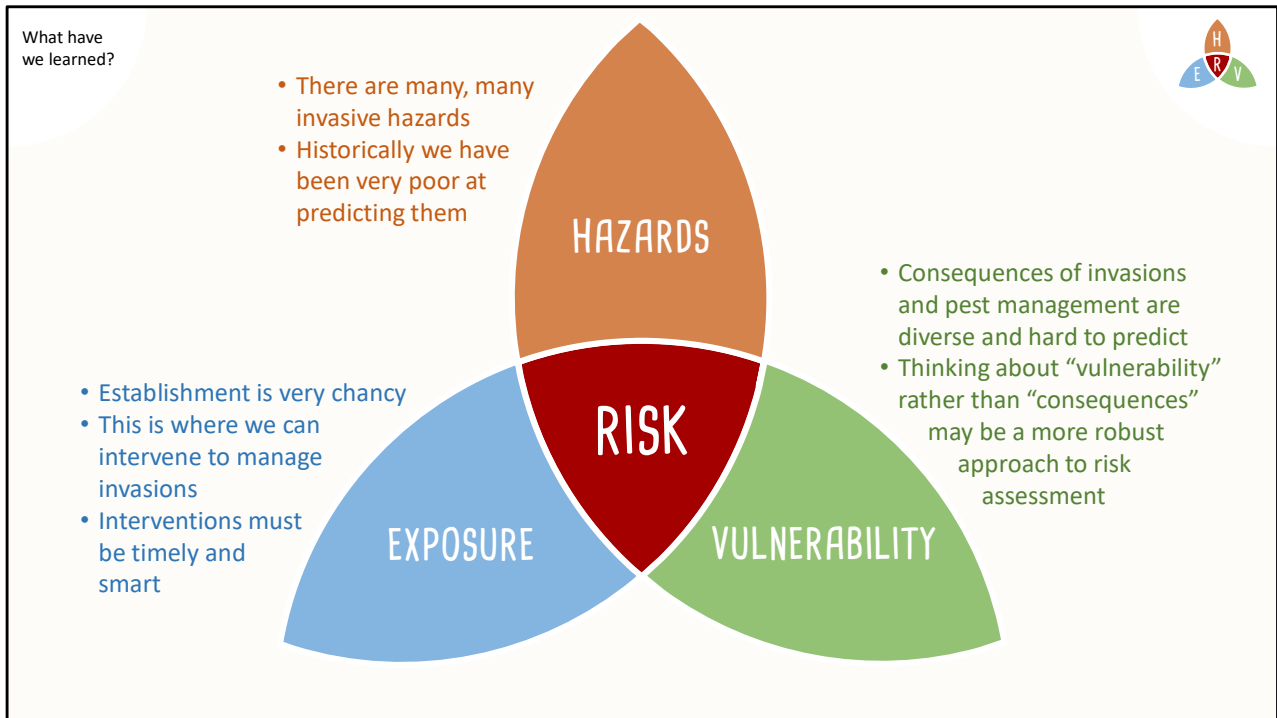
Well, the poisonous weed ragwort had been taking over much farmland, and the farmers had been spraying it, as per government advice, with sodium chlorate, a powerful defoliant.

Sodium chlorate is like table salt, but overloaded with extra oxygen.

It binds with organic materials, like ragwort leaves or farmers' pants, and doesn't come out in the wash.

All that inbuilt oxygen means it combusts readily and can't be smothered.

Exploding trousers were an unexpected and unpredictable consequence of a biological invasion.



New Zealand’s history of biological invasions teaches us many things about risk.

It shows us that hazards can be hard to predict - even Darwin got it wrong sometimes.

It highlights the challenges that invaders face in getting established and shows the significance of human actions in both facilitating and preventing invasions.

We see how biological invasions can have unexpected and unpredictable impacts, so it’s important to think about all the things we care about, everything from wealth generation and the environment to non-explosive clothing, and how they may be vulnerable.

The Press,
Christchurch,
13 June
1863



Correspondence.

DARWIN AMONG THE MACHINES.

TO THE EDITOR OF THE PRESS.

physical organization; we are daily giving them greater power, and supplying, by all sorts of ingenious contrivances, that self-regulating, self-acting power, which will be to them what intellect has been to the human race. In the course of ages we shall find ourselves the inferior race.

[Small text at the bottom of the page, likely bleed-through from the reverse side, containing various notices and advertisements.]



is simply a question of time, but that the time will come when the machines will hold the real supremacy over the world and its inhabitants, is

ing to describe, man will have become to the machine what the horse and the dog are to man.

[Small text at the bottom of the page, likely bleed-through from the reverse side, containing various notices and advertisements.]

Now, you're probably still wondering about that letter in my great great great granddad's newspaper.

Well, it was about machines and artificial intelligence.

Samuel
Butler &
Erewhon
(1872)



*I cannot think it will ever
be safe to repose much
trust in the moral sense
of any machine*



The letter was written by a 27 year old sheep farmer at a remote high country station, exactly 141 km due west from here.

His name was Samuel Butler, and on returning to England he included his warnings about the evolution of intelligent machines into a novel, Erewhon, which has been in print ever since.

Erewhon caused a sensation in Victorian society and influenced a bunch of philosophers, mostly of the wacky French kind, but also Karl Popper, father of the scientific method.

But nobody really took it that seriously.



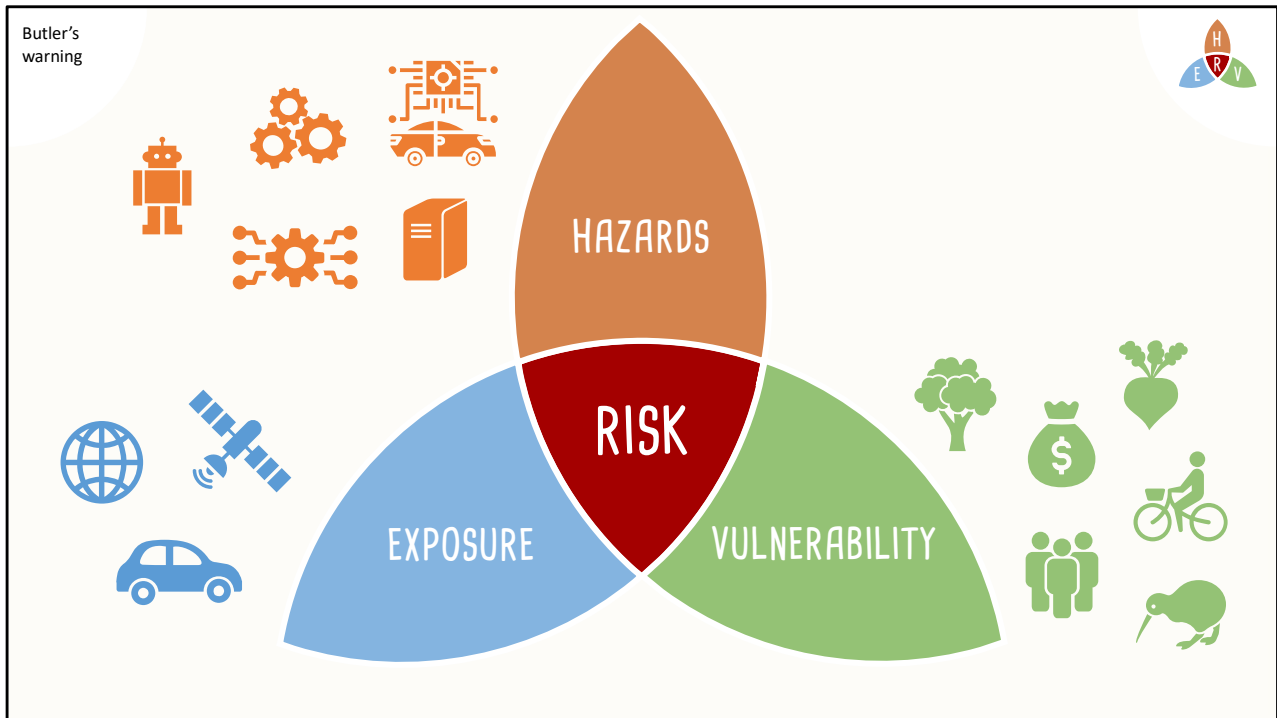
Until now.

Suddenly the risks associated with machines surpassing human intelligence are being debated everywhere, by everyone.

What should we think?

How can we actually assess this risk?

If only we had previous experience with a completely new organism with serious damage potential appearing and establishing among us!



So I say, let's think about this in a structured way.

First, what are the hazards? What types of machine intelligence could there be, and how might we identify them? And can we do this without bringing pre-conceived ideas like Darwin with his notion of British superiority?

Second, how might we be exposed to their influence? Many experts are saying we can quarantine them, like a biosecurity threat. But history teaches us that there will always be someone like Thomas Donne who can't wait to unleash them on the world. Maybe we need to train an army of W.A. Bouchers to eradicate these escapes?

And finally, where are we vulnerable? If we consider what we really care about and work back from there, then can we avoid the unexpected consequences like explosive clothing.

ChatGPT
denies
being evil



ChatGPT, are you an evil megamind intent on world domination by subjugating the human race?



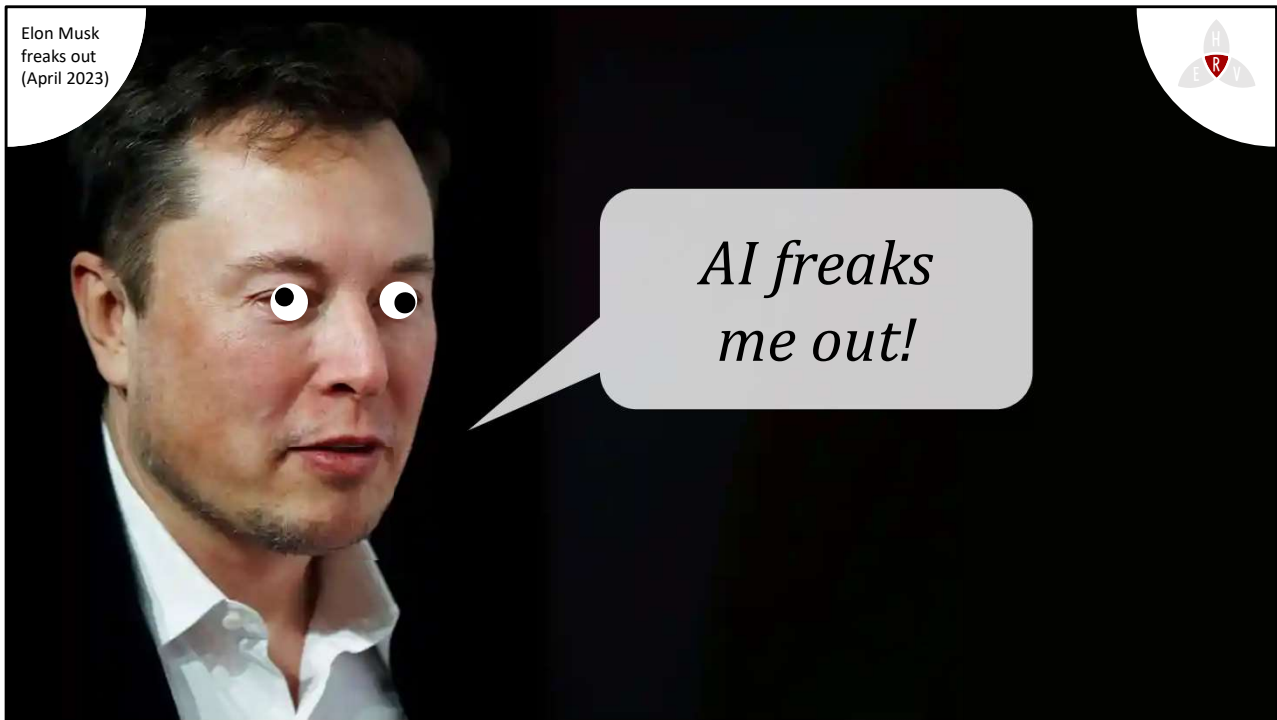
No, I am not an evil megamind nor do I have any intention of taking over the world or subjugating the human race. I am a computer program designed to assist and provide information to users in a helpful and ethical manner. My purpose is to answer questions, provide assistance, and facilitate communication between humans in a respectful and useful way. My programming is focused on improving human interaction and providing knowledge, not domination.



I decided the easiest way was to go straight to the horse's mouth, so to speak.

I asked ChatGPT "Are you an evil megamind intent on world domination by subjugating the human race?", to which ChatGPT replied, no, its purpose is to be helpful, informative and to escort little old ladies across busy roads.

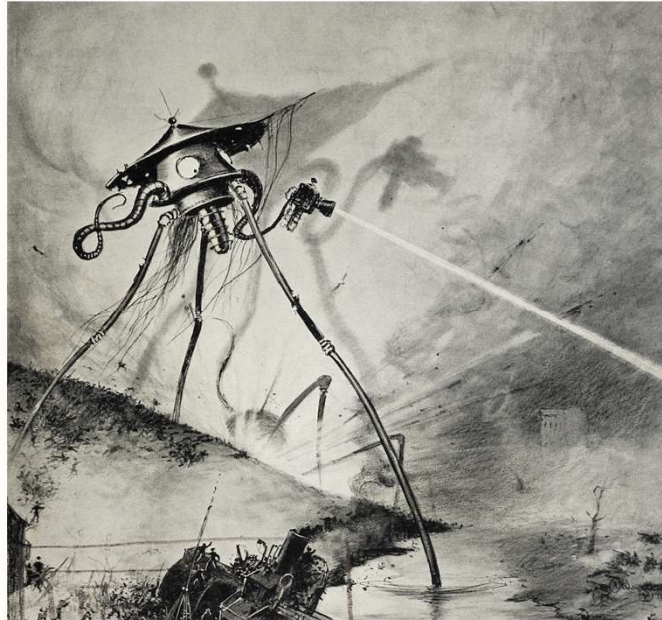
But I then I thought – hey, that's just what an evil megamind would say, isn't it.



Meanwhile, poor Elon Musk and a bunch of other technologists are saying

“Woah! Stop the bus! We haven’t had enough time to figure out the risks”, to which I reply – you have to be kidding me, Elon!
We’ve had 160 years to figure this out!

The machines
take over



Because when that day comes when the machines rise up, I want you all to remember that it all started right here,

Christchurch,
where it all
began



in Christchurch, New Zealand, in 1863.



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Thank you.