



<http://youtu.be/W7DUaxCPMt8>

## **Week 9: If we can construct a genome then why can't we build an organism?**

<b>Day</b>	<b>Location</b>	<b>Title</b>
Mon 27 May	No class	Memorial Day
Wed 29 May	320-105	How to parse a research paper on the frontiers of bioengineering.
Fri 31 May	320-105	Why is humpty dumpty more than just a nursery rhyme? <b>(PSET 9)</b>

**Lead Instructor:** Jan and Drew

## **Week 10: Natural Flourishing**

<b>Day</b>	<b>Location</b>	<b>Title</b>
Mon 3 June	320-105	Why engineer biology? & How much can we make with biology?
Wed 5 June	320-105	Summary and sendoff

## Week 9:

### Natural Flourishing

Day	Location	Title	
Mon 27 May	No class	Memorial Day	
Wed 29 May	320-105	What is the relationship between bioengineering & biodiversity?	
Fri 31 May	320-105	How to parse a research paper	No PSET9

**Lead Instructor:** Jan and Drew

### Preparing to Launch

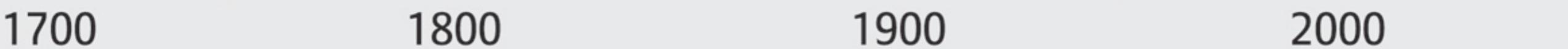
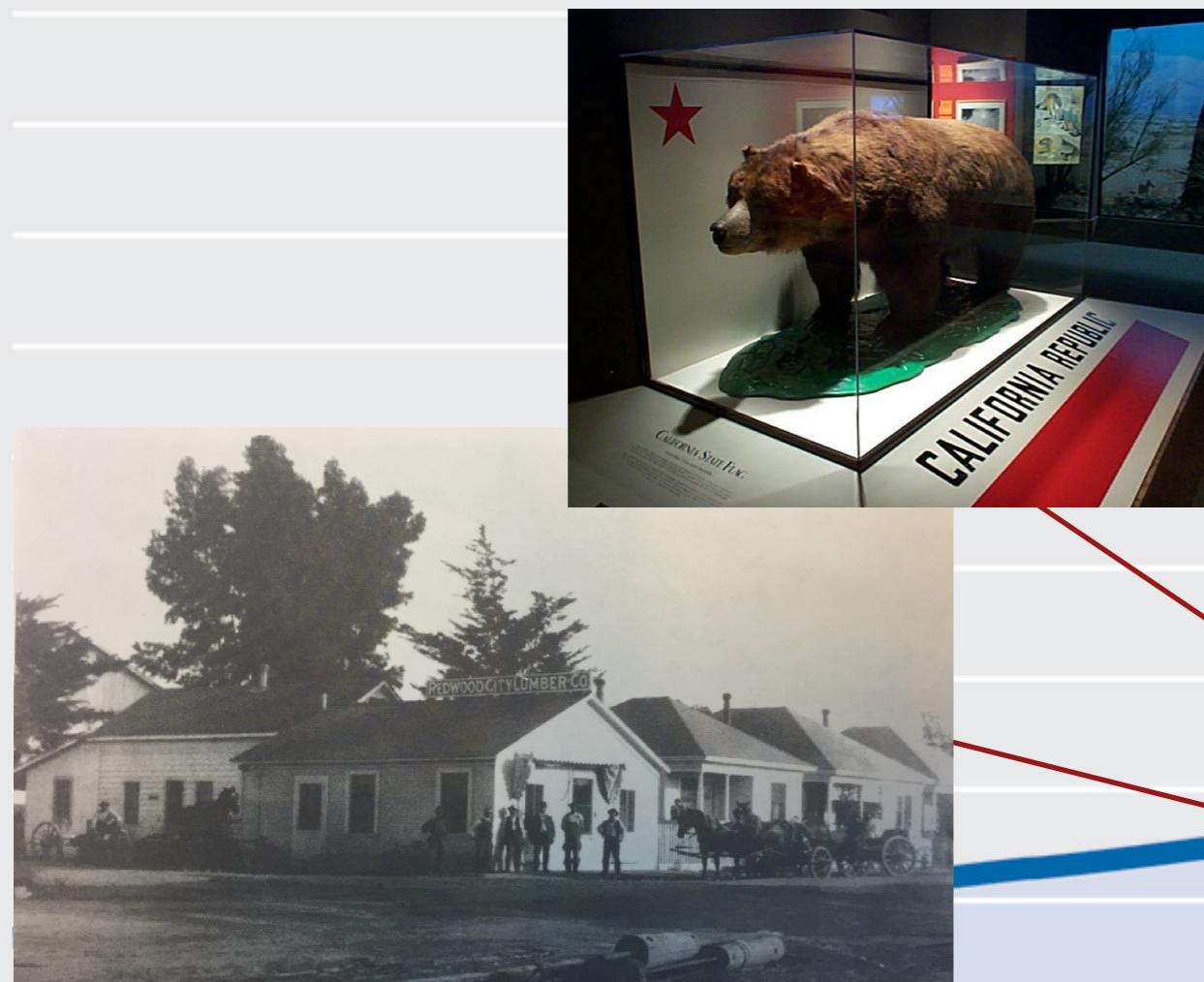
## Week 10:

Day	Location	Title
Mon 3 June	320-105	Introduction to Bioengineers (Other People)
Wed 5 June	320-105	Introduction to Bioengineering (You & What's Ahead)
Projects Due — 5p June 6 (Thursday)		

# POPULATION OF THE EARTH

Allianz 

Number of people living worldwide since 1700 in billions



Source: United Nations World Population Prospects, Deutsche Stiftung Weltbevölkerung

For further information please visit: [www.knowledge.allianz.com](http://www.knowledge.allianz.com)

# *George the Snail, Believed to Be the Last of His Species, Dies at 14 in Hawaii*



This snail, named George, died on Jan. 1. Scientists believe he was the last of his species, which was native to the Hawaiian island of Oahu.

Hawaii Department of Land and Natural Resources

By **Julia Jacobs**

Jan. 10, 2019

# Accelerated modern human-induced species losses: Entering the sixth mass extinction

Gerardo Ceballos,<sup>1\*</sup> Paul R. Ehrlich,<sup>2</sup> Anthony D. Barnosky,<sup>3</sup> Andrés García,<sup>4</sup> Robert M. Pringle,<sup>5</sup> Todd M. Palmer<sup>6</sup>

The oft-repeated claim that Earth's biota is entering a sixth "mass extinction" depends on clearly demonstrating that current extinction rates are far above the "background" rates prevailing between the five previous mass extinctions. Earlier estimates of extinction rates have been criticized for using assumptions that might overestimate the severity of the extinction crisis. We assess, using extremely conservative assumptions, whether human activities are causing a mass extinction. First, we use a recent estimate of a background rate of 2 mammal extinctions per 10,000 species per 100 years (that is, 2 E/MSY), which is twice as high as widely used previous estimates. We then compare this rate with the

species as evidence of gone extin years to indicating subsequen of opportu

Since 1900 alone, 69 mammal species are believed to have gone extinct, along with about 400 other types of vertebrates. Evidence for species lost among nonvertebrate animals and other kinds of living things is much more difficult to come by, the researchers say, but there's little reason to believe that the rest of life on Earth is faring any better.

- Land clearing for farming, logging and settlement
- Introduction of invasive species
- Carbon emissions that drive climate change and ocean acidification
- Toxins that alter and poison ecosystems



<http://thebreakthrough.org/index.php/programs/conservation-and-development/can-palm-oil-deforestation-be-stopped>



# Study: Over 90% of Great Barrier Reef suffering from coral bleaching



By **Euan McKirdy**, CNN

⌚ Updated 8:47 AM ET, Wed April 20, 2016

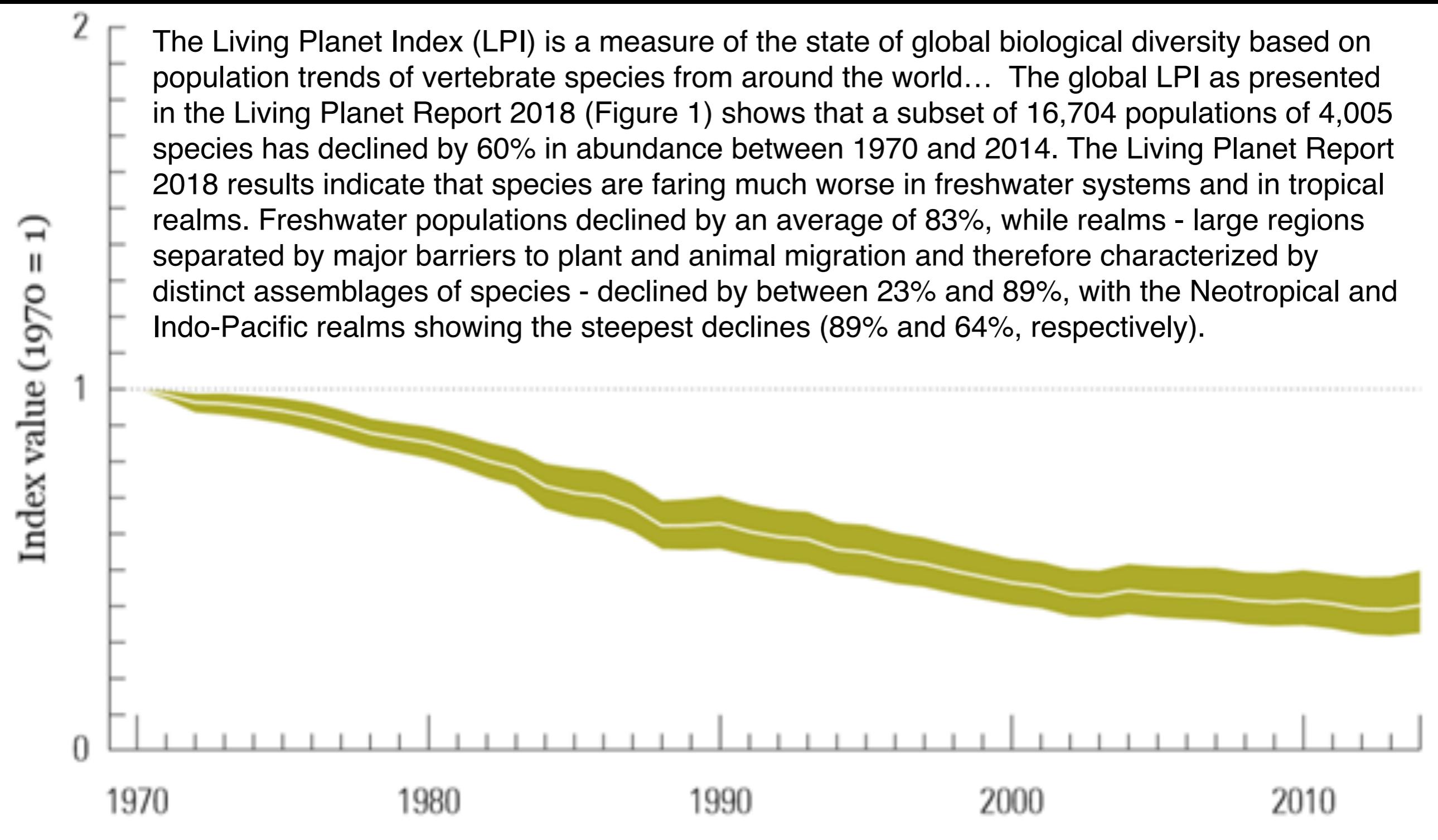


**9 photos:** Australia's Great Barrier Reef suffers 'extreme' coral bleaching

Some of the bleaching of reefs in the northern section has been described as "extreme."

# Past ~45 years, humans x 2, animals / 2

The Living Planet Index (LPI) is a measure of the state of global biological diversity based on population trends of vertebrate species from around the world... The global LPI as presented in the Living Planet Report 2018 (Figure 1) shows that a subset of 16,704 populations of 4,005 species has declined by 60% in abundance between 1970 and 2014. The Living Planet Report 2018 results indicate that species are faring much worse in freshwater systems and in tropical realms. Freshwater populations declined by an average of 83%, while realms - large regions separated by major barriers to plant and animal migration and therefore characterized by distinct assemblages of species - declined by between 23% and 89%, with the Neotropical and Indo-Pacific realms showing the steepest declines (89% and 64%, respectively).



What do you think?

Is species extinction good or bad (or other)?

Should bioengineers care  
about natural biodiversity? Why?



## Molecule of the Month

[By Category](#)[By Date](#)[By Title](#)

# Antifreeze Proteins

*Small antifreeze proteins protect cells from damage by ice*

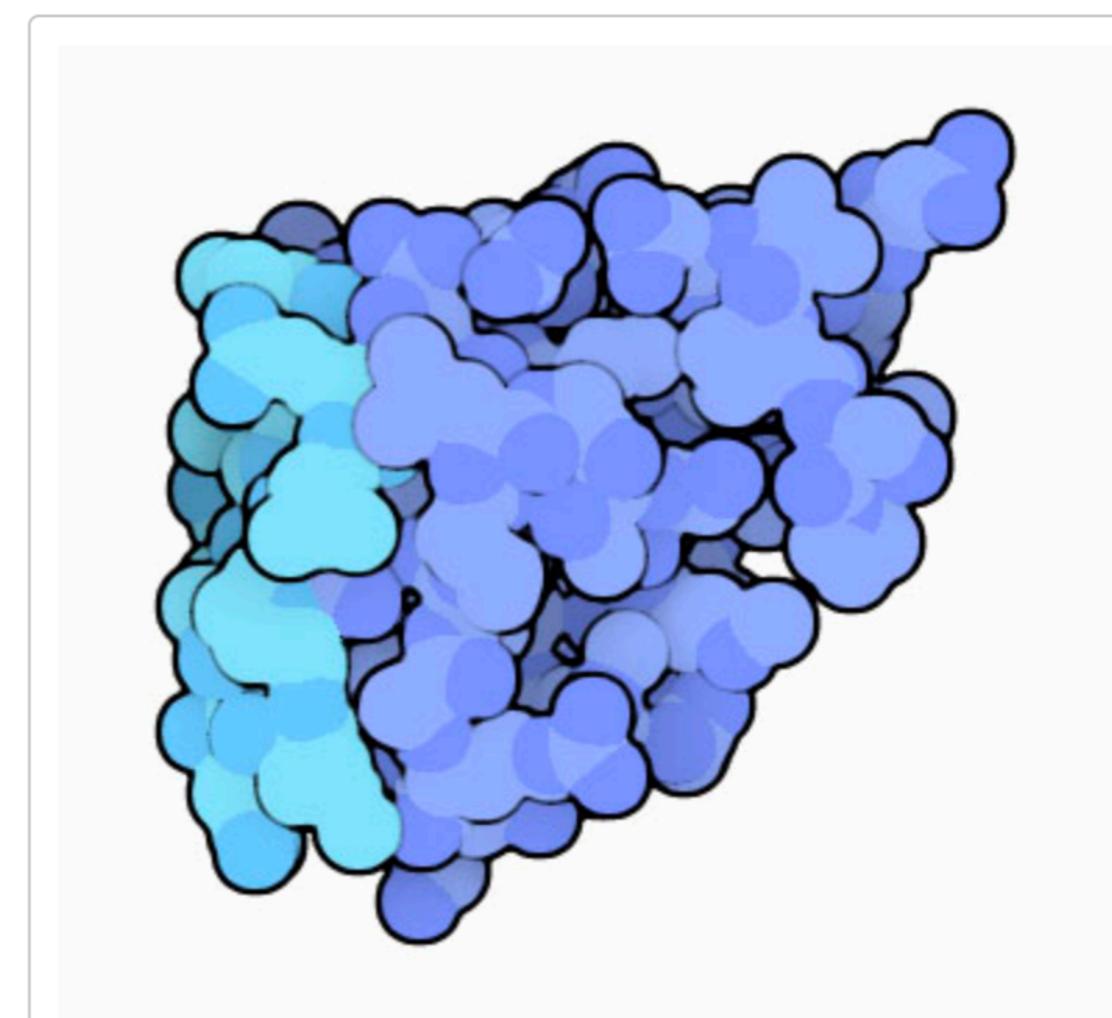
Ice is a big problem for organisms that live in cold climates. Once the temperature dips below freezing, ice crystals steadily grow and burst cells. This danger, however, has not limited the spread of life on Earth to temperate regions. Organisms of all types--plants, animals, fungi and bacteria--have developed ways to combat the deadly growth of ice crystals. In some cases, they pack their cells with small antifreeze compounds like sugars or glycerol. But in cases where extra help is needed, cells make specialized antifreeze proteins to protect themselves as the temperature drops.

### Nice Ice

Antifreeze proteins don't stop the growth of ice crystals, but they limit the growth to manageable sizes. For this reason, they are also known as ice-restructuring proteins. This is necessary because of an unusual property of ice called recrystallization. When water begins to freeze, many small crystals form, but then a few small crystals dominate and grow larger and larger, stealing water molecules from the surrounding small crystals. Antifreeze proteins counteract this recrystallization effect. They bind to the surface of the small ice crystals and slow or prevent the growth into larger dangerous crystals.

### Supercooling

Antifreeze proteins lower the freezing point of water by a few degrees, but surprisingly, they don't change the melting point. This process of depressing the freezing point while not effecting the melting point is termed *thermal hysteresis*. The most effective antifreeze proteins are made by insects, which lower the freezing point by about 6 degrees. However, antifreeze proteins, even the ones from plants and bacteria that have smaller effects on freezing point, are useful in another way. They are placed outside cells where they control the size of ice crystals and prevent catastrophic ice crystal formation when the temperature drops below the (lowered) freezing point.



*Antifreeze protein from the cold-water ocean pout, with the ice-binding portion in lighter blue.*

[Download high quality TIFF image](#)

# Creamy, Healthier Ice Cream? What's the Catch?

By JULIA MOSKIN JULY 26, 2006



IN its quest to create ice cream as voluptuous as broccoli, the ice cream industry has probed the depths of nature. Scientists have studied the intimate structures of algae and fungi to create ice creams that taste like fruit without the American public.

"I have tried them all as they came down the pike: sugar-free; with tofu, yogurt, rice, whatever," says Karen S. Johnson, 47, who lives near Flagstaff, Ariz., cataloguing the ice creams she has tasted over the years. "They always make me sick."

For Americans who spend each summer wrestling with the question of what to eat for dessert, there is fresh hope in the freezer case. New industrial processes for creating supercreamy ice cream involve a protein cloned from the blood of an Arctic fish. This allows manufacturers to produce very creamy ice creams with fewer additives. The new product has acquired a taste for superpremium high-fat ice cream, though, and it may be losing its fat content.

But using new technologies can be risky for manufacturers. The other new method for making supercreamy ice cream was caught up last month in the global debate over genetically modified foods. In June, Unilever, the Anglo-Dutch conglomerate, applied to Britain's Food Standards Agency for permission to use a new ingredient in its frozen desserts — a protein cloned from the blood of an eel-like Arctic Ocean fish, the ocean pout.

Instead of extracting the protein from the fish, which Unilever describes as "not sustainable or economically feasible" in its application, the company developed a process for making it, by altering the genetic structure of a strain of baker's yeast so that it produces the protein during fermentation.

This ingredient, called an ice-structuring protein, has been approved by the Food and Drug Administration and is used by Unilever to make some products in the United States, like some Popsicles and a new line of Breyers Light Double Churned ice cream bars.

"Ice-structuring proteins protect the fish, which would otherwise die in freezing temperatures," said H. Douglas Goff, professor of dairy sciences at the University of Guelph in Ontario. "They also make ice cream creamier, by preventing ice crystals from growing."



## mor·al com·pass

*noun*

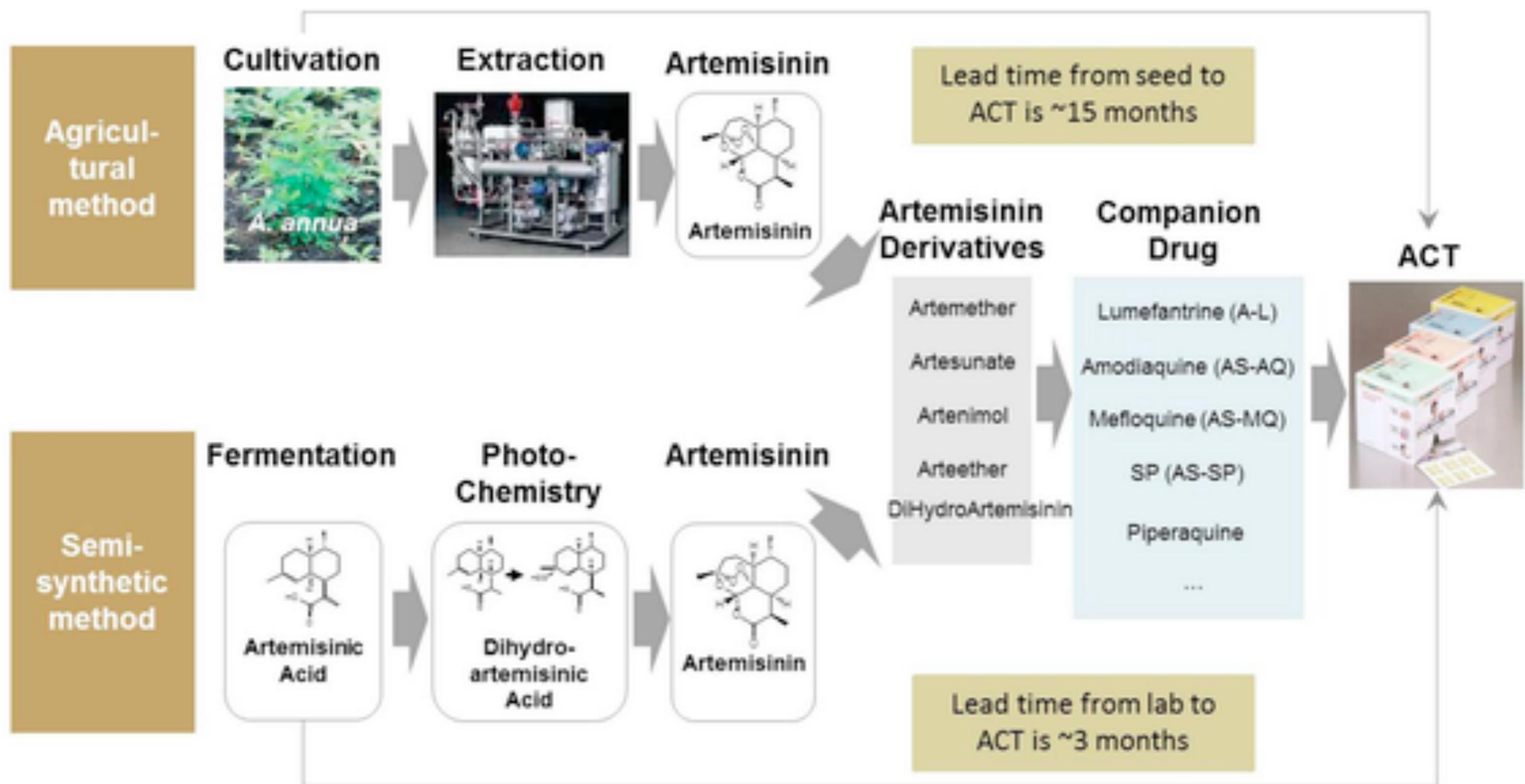
used in reference to a person's ability to judge what is right and wrong and act accordingly.  
"he is by no means the only senior politician who has mislaid his moral compass"

Any bioengineering opportunities?

Respond to causes (landuse, climate, invasion)

Act to repair (revive, restore, ...)

# What if we make medicines via fermentation of engineered yeast versus growing & harvesting plants?



Source: MMV Artemisinin Conference 2010

<http://patentsforhumanity.devpost.com/submissions/10871-semi-synthetic-artemisinin-for-treating-malaria>

"Glucose can be produced in various ways: maize, sugar cane, potatoes..

“It seems that two average size potato farms in Idaho (supporting say 100 seasonal workers between them with only very part-time employment) could theoretically replace approximately 100,000 growers in the global artemisinin trade.”

For natural artemisinin:

2 MT per ha dry leaf with lets say 1% content and 75% industrial efficiency yields a number of 15 kg of artemisinin. For one MT this means close to 67 hectares per MT of artemisinin.

so for the whole 200 MT artemisinin market around 13 000 ha for Natural artemisinin closer to 25 000 in actual Chinese conditions.

**There is 35 times more land use with natural compared to SSA**

It would be too simple and naive to consider that the issue is a debate of land use for food crop versus a cash crop such as artemisia annua. Most often this is not the case."

*unpublished personal communication, Jim Thomas, ETC Group*



<https://youtu.be/ZZfBqdaafjA>



# Extinction looms for native bird species on the Hawaiian island of Kauai



The i'iwi, a species of Hawaiian honeycreeper, on Kauai. Six out of seven of the studied species on the forested island could face extinction in the coming decades. (Jim Denny)

By **Sean Greene**

SEPTEMBER 16, 2016, 3:00 AM

**H**awaiian honeycreepers have lived in the islands' tropical forests for millennia, but the colorful finch-like birds are facing "imminent collapse" on Kauai, experts say.



ADVERTISEMENT

## In Case You Missed It



A GOP governor already is thinking of killing protection for preexisting conditions in his state

2 hours ago @ 10:05 am



Obama warned Trump not to hire Flynn two days after the election

2 hours ago @ 10:05 am



France's election proves it — America is now an example of



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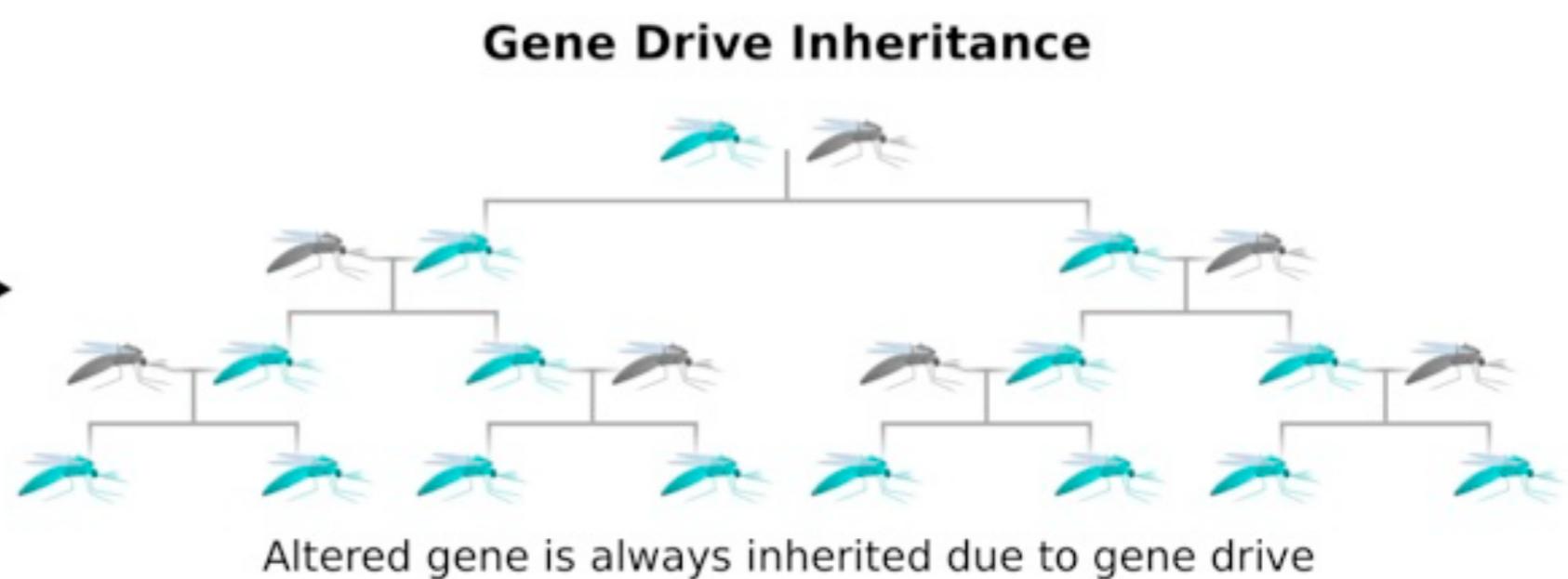
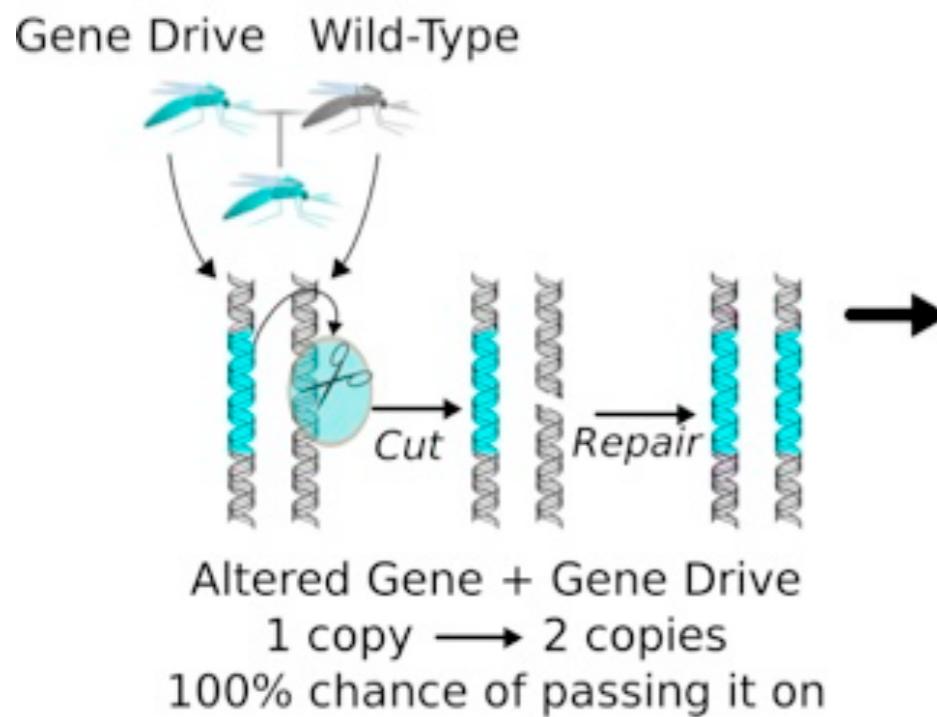
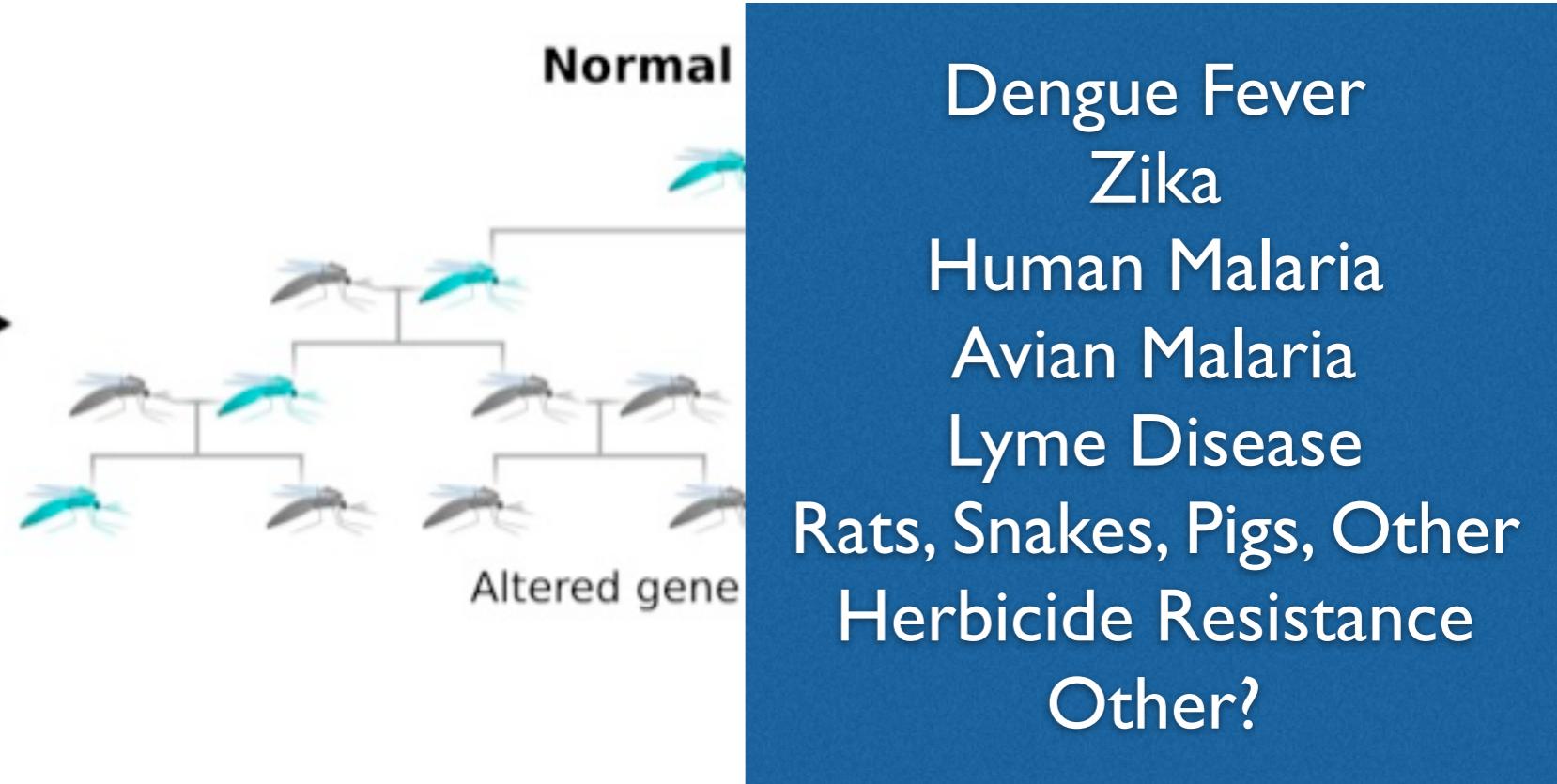
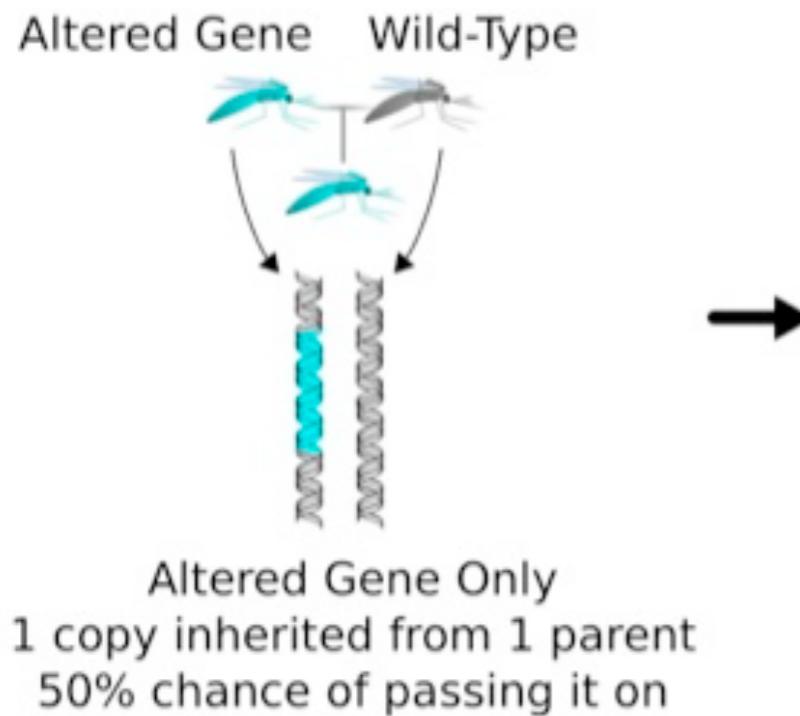
**OUR MISSION** is to prevent extinctions  
by removing invasive species from islands.



# What are our options?

Methods	Toxicants	Mechanical Methods	Biological Controls	Genetic Engineering*	No Methods Applied
Points of Comparison					* Speculative, as technology is not yet developed
Past attempts	Many. More successful for rats than mice	Not many for full eradication	Few	None	Yes
Monetary Costs	Millions of dollars and fixed	Thousands of dollars and fixed	Variable depending on invasive organism and treatment	Millions of dollars and likely decreasing over time	None
Social Acceptability	Controversial	Controversial	Controversial	Controversial	Controversial
Any current regulations?	Yes	Yes	Yes	Unclear	N/A
Species specific	No	No	Sometimes	Yes	N/A
Effective for eradication?	Yes, though more effective for rats than mice	No	No	Unknown	No

# “Drive” genes into wild populations





# revive&restore

genetic rescue for endangered and extinct species

Thanks to the rapid advance of genomic technology, new tools are emerging for conservation. Endangered species that have lost their crucial genetic diversity may be restored to reproductive health. Those threatened by invasive diseases may be able to acquire genetic disease-resistance.

It may even be possible to bring some extinct species back to life. The DNA of many extinct creatures is well preserved in museum specimens and some fossils. Their full genomes can now be read and analyzed. That data may be transferable as working genes into their closest living relatives, effectively bringing the extinct species back to life. The ultimate aim is to restore them to their former home in the wild.

Molecular biologists and conservation biologists all over the world are working on these techniques. The role of Revive & Restore is to help coordinate their efforts so that genomic conservation can move ahead with the best current science, plenty of public transparency, and the overall goal of enhancing biodiversity and ecological health worldwide.

"Gone"— Isabella Kirkland's painting of 63 species that have gone extinct since the 1700s.





<http://reviverestore.org/about-the-passenger-pigeon/>

<http://reviverestore.org/passenger-pigeon-de-extinction-roadmap/>

# Woolly Mammoth Revival



## Project goals

The ultimate goal of woolly mammoth revival is to produce new mammoths that are capable of repopulating the vast tracts of tundra and boreal forest in Eurasia and North America. The goal is not to make perfect copies of extinct woolly mammoths, but to focus on the mammoth adaptations needed for Asian elephants to live in the cold climate of the tundra. The milestones along the way range from developing elephant tissue cultures to genome editing and cloning.

The Harvard Woolly Mammoth Revival team has been working closely with Revive & Restore to study allele replacement (CRISPR genome editing) within elephant cells. We are interested in using genes from ancient mammoths to research evolutionary and ecological forces that impact speciation and extinction. Recent advances in DNA sequencing and genome editing are allowing functional experiments to test the links between genes and adaptations that may illuminate these areas of research, while simultaneously forming the groundwork for the de-extinction of mammoths.

[Woolly Mammoth Revival](#)      [Woolly Mammoth Revivalists](#)  
[Work in Progress](#)      [Sergey Zimov's Manifesto](#)  
[About the Woolly Mammoth](#)      [News & Media](#)  
[How to Clone a Mammoth](#)

“Not all mammoths were woolly”-  
Hendrik Poinar at TEDxDeExtinction



We're just a biological speculation  
Sittin' here, vibratin'  
And we don't know what we're vibratin' about

And the animal instinct in me  
Makes me wanna defend me  
It makes me want to live when it's time to die

Y'all, see my point  
I don't mean to come on strong but I am concerned

I believe in God  
Though I know that law and order must prevail  
Oh, if and when the laws of man  
Is not just equal and fair  
Then the laws of nature will come and do her thing

Oh, she does not think  
She just rectifies  
She comes and balances the book  
Y'all see my point?

