

AAAS AMA: Hi, we're Maria Elena Bottazzi, Marcia Castro, Kacey Ernst, and Anthony Wilson and we study vector-borne diseases. Ask us anything!

AAAS-AMA¹ and r/Science AMAs¹

¹Affiliation not available

April 17, 2023

Abstract

Vector-borne diseases – infectious diseases that are carried between humans or from animals to humans by organisms such as mosquitoes and ticks – infect over 1 billion people and cause more than 1 million deaths every year (World Health Organization, <http://www.who.int/mediacentre/factsheets/fs387/en/>). What makes someone susceptible to vector-borne disease? What do globalization, climate change, and human behavior have to do with where these diseases are found? What vaccines are in development? We're a diverse group of infectious disease researchers – ask us anything! Maria Elena Bottazzi, Associate Dean, National School of Tropical Medicine, Baylor College of Medicine. I lead the research, education and administration efforts of my school, as a Professor of Pediatric Tropical Medicine and the Deputy Director for the Sabin Vaccine Institute and Texas Children's Hospital Center for Vaccine Development. An internationally-recognized scientist with more than 16 years of experience in translational immunoparasitology research and vaccine development for neglected tropical diseases, my major interest lies in the role of vaccines as control tools integrated into international public and global health programs and initiatives. I earned her PhD in 1995 from the University of Florida. Marcia Castro, Associate Professor of Demography, Harvard T.H. Chan School of Public Health. My research focuses on infectious diseases (particularly mosquito borne), environmental change and health, environmental management for vector control, spatial patterns of disease transmission, and infant & child mortality. More specifically, I focus on the development and use of multidisciplinary approaches, combining data from different sources, to identify the determinants of disease transmission in different ecological settings, providing evidence for the improvement of current control policies, as well as the development of new ones. I earned my PhD in Demography from Princeton University in 2002. Anthony Wilson, Integrative Entomology Group Leader, The Pirbright Institute. I lead the Integrative Entomology group at The Pirbright Institute in the UK, studying the ability of insects (particularly mosquitoes) and ticks to transmit viruses and how this is affected by the environment. I have contributed opinions as an expert on vector-borne disease emergence for the European Food Safety Authority and the Global Strategic Alliances for the Coordination of Research on the Major Infectious Diseases of Animals and Zoonoses (STAR-IDAZ); I'm a member of the MACSUR European network on the impacts of climate change on food production via disease ecology; and I'm a Fellow of the Royal Entomological Society. Additionally, I am a core member of Pirbright's Equality, Diversity and Inclusion committee, a site union representative and sits on the national panel for the Athena SWAN Charter awards, which recognize employer commitments to gender equality. I earned my PhD from the University of Oxford in 2008. Kacey Ernst, Associate Professor of Epidemiology, University of Arizona College of Public Health. My primary research interests are in determining how human-environment interactions alter risk of vector-borne disease transmission. I focus specifically on questions surrounding the emergence of Aedes-borne viruses such as dengue and Zika in the U.S.-Mexico border region and the development and uptake of sustainable control strategies for malaria in western Kenya. Recently, I partnered with the Centers for Disease Control to develop Kidenga, a community-based surveillance mobile application that is intended to educate communities and provide early warning of pathogen emergence. I have presented to the public in a wide range of forums on her research and the impact of climate change on human health, and earned my PhD in Epidemiology from the University of Michigan in 2006. [edit] Okay guys, I'm afraid we're heading off now. Thank you very much for joining us, and hope we were able to give you some useful answers!

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AAAS-AMA [R/SCIENCE](#)

Vector-borne diseases – infectious diseases that are carried between humans or from animals to humans by organisms such as mosquitoes and ticks – infect over 1 billion people and cause more than 1 million deaths every year (World Health Organization, <http://www.who.int/mediacentre/factsheets/fs387/en/>). What makes someone susceptible to vector-borne disease? What do globalization, climate change, and human behavior have to do with where these diseases are found? What vaccines are in development? We're a diverse group of infectious disease researchers – ask us anything!

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CORRESPONDENCE:

DATE RECEIVED:

June 16, 2017

DOI:

10.15200/winn.149752.23848

ARCHIVED:

June 15, 2017

CITATION:

AAAS-AMA , r/Science , AAAS
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The Winnower
4:e149752.23848 , 2017 , DOI:
[10.15200/winn.149752.23848](https://doi.org/10.15200/winn.149752.23848)

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I have two questions concerning ticks as vectors. 1) How long does the tick need to be attached for it to transmit the disease? 2) In the veterinary world there is a simple antibody screening tests for 3 main tick borne diseases. It seems like on the human side, tick borne disease often goes undiagnosed for long periods of time. What contributes to this?

[greyhoundknight](#)

MEB: I am not an expert on this topic but if you are interested you could reach out to one of our experts in the Leshner Fellows Cohort in Infectious Diseases. [See link and look at Dr. Danielle Buttke](#)

A lot of work on this front seems to be eradication / sterilisation of mosquitoes in malaria ridden parts of the world. How much thought is given to the potential effect of this on an eco system, and what measures are you aware of to counteract this?

[Lavidius](#)

Anthony Wilson (AW): Hi there, and thanks for a great question! Nowadays this is a given a lot of thought; [this](#) was a nice discussion of the key issues by the BBC. In most cases control will only ever affect *local* populations rather than completely wiping out the species, but with some new GM technologies like gene drive it could theoretically be possible. From an ecological point of view most species that eat mosquitoes have quite broad diets so losing access to one species wouldn't be a disaster. And in most places where mosquito-borne viruses occur, the main vectors are actually ecological invaders themselves (the yellow fever mosquito *Aedes aegypti* was restricted to Africa until a few hundred years ago) which means they're unlikely to play an essential ecological role. If you're using chemical control then you're probably going to affect lots of other species too though.

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[Lavidius](#)

[AW] Because of environmental concerns most modern approaches to the control of mosquitoes and other disease-spreading insects either use chemicals in ways which reduce its impact on other species (like insecticide-treated bednets for malaria) or use technologies that are highly specific to the mosquitoes: biological control such as [Bti](#), genetic modification, etc.

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[Lavidius](#)

[AW] The first round of approaches using genetic modification were all based around population suppression, but nowadays some groups are attempting to develop population *replacement* strategies, where you modify the mosquito population to resist the thing it's transmitting; one advantage of this is that the mosquitoes are still there, they just can't spread disease any more.

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measures are you aware of to counteract this?

[Lavidius](#)

MC: mosquito eradication has happened in the past. An invasive anopheles was eradicated from Brazil in the 40s; aedes mosquitoes were eradicated from most of the south and central America in the 50-60s (at the time as an effort to control yellow fever) - and they were also invasive species in the Americas. This cause no problems in ecosystem sustainability.

Thanks so much for doing this! Are there multiple strains of common vector-borne diseases (l.e. Lyme or malaria) like the flu?

[sargon36](#)

MC: Malaria has different five different parasites, dengue has four different virus.

Thanks so much for doing this! Are there multiple strains of common vector-borne diseases (l.e. Lyme or malaria) like the flu?

[sargon36](#)

Anthony Wilson (AW): Dengue is actually particularly interesting for this: dengue is usually pretty mild the first time you get it. It seems though that when you have had any one of the types (imaginatively called dengue 1, dengue 2...) you are more likely to get severe disease the next time you get infected. There's a spectrum of clinical disease ranging from completely asymptomatic infection through dengue fever and dengue haemorrhagic fever to dengue shock syndrome. You really don't want to get dengue shock syndrome.

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[sargon36](#)

(AW): I'd also mention that we know that very minor genetic differences between strains of some viruses can have massive effects on their epidemic potential. Check out [this paper](#) for a great example.

Thank you for taking the time to do this AMA.

Are we looking at infectious diseases as the major concern for the medical field in the near future?

With the resistant bacterium developing at a faster rate than we can produce new antibiotics should we start thinking on how to prevent the spreading of these "super bugs" or are we still stuck with traditional PPI and wash your hands?

[ekuskrash](#)

MC: IDs will remain a concern in the medical field. But there are concurrent problems: the obesity epidemic, cardiovascular diseases, etc. Pathogens can emerge, re-emerge, and create outbreaks. This is unlikely to go away considering how connected the world is, and also how environmental changes can trigger the appearance of zoonotic diseases.

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[ekuskrash](#)

Anthony Wilson (AW): Personally I would say yes, but this isn't my area of expertise - happily it is for another one of this year's Leshner Fellows, so I'll ask her after the session and see if I can get her to chip in later.

How do you go about developing a vaccine? There must be so many different factors to consider, how do you ever hit upon a recipe that works? Do some (chemicals? Ingredients?) have well documented effects in vaccines such that you can experiment with combinations and have an idea of what the outcome will be, or are there other ways of finding a vaccine? Sorry for the long question, thanks for the AMA!

[emma4eyes](#)

Maria Elena Bottazzi (MEB) The process of developing vaccine is indeed very complex and s you say many factors to consider. There is a good paper that helps with rationalizing the intellectual process [Here is the link to the paper](#)

Do you anticipate surprises coming from global climate change, e.g., corpses buried in permafrost thawing out?

[exgiexpcv](#)

Anthony Wilson (AW): Nice question! I think we'll see plenty of nasty surprises from climate change. Mosquitoes breed rapidly and are cold-blooded, so populations often respond strongly and rapidly to changes in the environment - both short-term extreme weather events and gradual trends over time. Most vector-borne viruses are pretty fragile though, so wouldn't survive in frozen bodies etc; DNA viruses like poxviruses are much more environmentally resistant. Some bacteria like anthrax are incredibly good at surviving in the environment for long periods, but mosquito-borne viruses are mostly adapted to survive inside mosquitoes.

I used to work with *Glossina mortisans* (tsetse flies) and their mating/reproductive habits as a way to possibly lower populations (I am not for eradication) and lower instances of transmission of the trypanosome responsible for Human Sleeping Sickness. I was interested in the use of *wolbachia* to lower populations. How effective is *wolbachia* at causing sterilization/interrupting reproduction in vectors such as mosquitos?

Thank you, and would love to talk more! My favorite insect in my collection is my tsetse fly :D

[gingy_nin jy](#)

(AW) *Wolbachia* is an incredibly exciting technology with a lot of potential. Currently, the main direction of research into *Wolbachia* for the control of vector-borne diseases was triggered by the observation that infection with some strains appears to "block" the mosquito's ability to transmit viruses like dengue - more information [here](#).

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[gingy_ninji](#)

(AW) I'd love to hear more about your work, by the way - my doctoral supervisor was a tsetse & trypanosomiasis researcher first. He was actually one of the first to use satellite imagery to predict the distribution of tsetse because there were hardly any weather stations in the areas where he worked so he couldn't get 'conventional' data.

How does one get into the public health/ epidemiology field?

I've always wondered, if the flu shots are produced before flu season starts. How do the scientists know which strain to make the vaccine with?

What are the chances of a zombie type parasite / virus / bacterium wiping out the human race?

Thanks!

[actioncrip](#)

(MC) You can enter in public health from different fields. Since all the work is multidisciplinary, public health needs physicians, epidemiologists, economists, demographers, lawyers, nutritionists, etc. All you need is a passion for public health, and the desire to help those in need.

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[actioncrip](#)

MC: The WHO determines which should be the composition of the flu vaccine. It is not an easy task. But it has to be done ahead of time, or vaccine production would not keep up with demand.

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MC: it is unlikely that a pathogen would wipe out the human race. A severe strain of flu could kill many people (as it did in 1918-19), but with the knowledge and technology we now have, the human race would not be wiped out that way.

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Thanks!

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Check this: [report](#)

What do you think about Dengue Vaccine? Do you think it still needs improvement or clinical trials before being released to public?

[unknown_knight](#)

(MC) There are other vaccines currently being tested, and they might be better choices than the current one. The main problem is what we call ADE or the fact that once people get infected with one dengue type, another infection with a different dengue type may make the infection worse. Giving the vaccine to people that never had a infection before, and considering that the effectiveness of the vaccine is not 100% for all dengue types, then people could get a serious dengue infection later in life. It is a concern, and some groups are not recommending the use of the vaccine without a test to detect previous infections.

I was wondering what your opinions were on the best way to reduce the prevalence of malaria (and mosquito borne viruses in general)? Is it more effective to create a vaccine for malaria (like the Gates Foundation) or to implement mosquito bite prevention such as bed nets/draining stagnant water/ etc. ?

[lilsleepy1](#)

Kacey Ernst: KE It is my opinion that there is not one strategy that will eliminate/ eradicate malaria. This is particularly true given the incomplete protection that is provided by the current malaria vaccine.

We need to have multi-pronged efforts. Efforts to improve the efficacy of the vaccine as well as better and more widely implemented established control measures are needed. Yet even these have some difficulties. One of the biggest concerns with strategies such as bed nets and IRS is the increasing development of resistance as well as changes in behavior of the mosquito feeding patterns. Investments in alternative and new insecticides will also be needed.

There are also promising new vector control strategies that may provide additional inroads in reduction; toxic-sugar baits, genetically modified mosquitoes, etc.

Whatever investments are made in disease reduction strategies must also be supplemented with data collection strategies. It is very difficult to fight malaria if you are unaware of the current disease transmission status. Investment in infrastructure for surveillance of malaria cases and disease are also

needed. It will require continued investment from donors and governments to succeed.

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[lilsleepy1](#)

(MC) We need a combination of strategies to address malaria. Vector control is important, and should combine strategies that target the adult mosquito, the larval stage, but also that modifies the environment to reduce breeding habitats. Rapid treatment is also important, and good drugs are crucial here. But we also need to look at social and behavioral aspects. Behavior is an important component, since it can impact the uptake of all other interventions. No single strategy will solve the malaria problem. But a combination of interventions, addressing that many different factors that affect malaria transmission, is our best bet.

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Anthony Wilson (AW): There is sometimes a risk that low-tech solutions are ignored as not 'sexy' enough. Funders like the Gates Foundation has achieved some amazing results by focusing on improving access to insecticide-treated bednets, for example. Often the problem is *sustaining* investment in control - once a disease or vector species starts to decline, funders lose interest and it bounces back. So the best way to reduce prevalence is probably more down to the funding strategy than the specific technology used.

How worried of the mosquitoes in my backyard should I be? Living on the east coast of the USA.

[LOB-Silvertone](#)

(MC) Not all mosquitoes transmit diseases. Make sure you don't have ideal breeding habitats in your backyard, don't leave pots with standing water without a cover, etc. And if you do observe lots of mosquitoes, contact the local health agency and have them examined, so you can know for sure their species, and thus the risk they could pose.

Is the Powassan virus projected to be as widespread as Lyme's? Do you know anything about it?

[skipperdog](#)

Anthony Wilson (AW): That's another great question! I don't know much about Powassan specifically but it is a member of the tick-borne encephalitis 'family' which I do know a bit more about. There's a lot of research on TBE and its environmental requirements and it's a bit of a 'Goldilocks' virus - conditions have to be just right for it to sustain transmission. It is affected by climate, but in a pretty complex way, and also affected by factors like deer density. Like most tick pathogens, the amount of human exposure also strongly depends on human activity; ticks don't move around much!

If I have had malaria in the past will it always stay dormant? I was also told I cannot give blood is this true?

[Send me armpits](#)

KE: What species of malaria did you have?

Plasmodium falciparum does not generally recur if you have received proper treatment but you can get reinfected. P. vivax can recur.

As far as blood donation - if you have traveled to a malaria endemic area, it is recommended that you do not donate blood for a year and if you have been diagnosed you must wait three years after treatment AND be symptom free during that time.

[CDC guidance](#)

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[Send me armpits](#)

(MC) If you had Vivax malaria, it stays dormant in your liver and you can have a relapse, and thus present symptoms of malaria again (without having been bitten by a mosquito). Countries have different recommendations regarding how many years you have to wait to donate blood after a malaria infection.

Welcome,

What are cities, townships, and localities doing well with regard to integrated pest management to prevent vector-borne disease spread and what do you think they, as a whole, need to improve upon?

And, are mosquito control districts sufficient or could more be done from a policy standpoint?

[adenovato](#)

KE: This is an excellent question and one without a straight-forward answer. There is incredible variability in the resources that are dedicated towards vector control within municipalities, counties, and states. Not all regions actually even have mosquito control districts and the level of funding is highly variable. Some jurisdictions have only enough resources to conduct basic mosquito surveillance (some have no mosquito surveillance at all) and respond to public complaints about mosquito activity, while others have very extensive monitoring and control programs. One county that I work with, Maricopa County, has arguably one of the best programs in the country. They have extensive weekly monitoring and combine that with adulticiding and larviciding activities based on trap counts. This is combined with public outreach and education to ensure that residents also take action.

I think there is a need for: 1. Standardized surveillance methods across jurisdictions 2. Better community education and outreach to enhance engagement in mosquito control activities 3. Stronger partnerships with private industry partners that are administering mosquito control, both for better knowledge of what is happening in the community and coordination of efforts. 4. Additional tailoring of surveillance and outreach activities for the specific mosquito vectors that are in an area. While many jurisdictions do an excellent job with West Nile Virus monitoring, fewer have been able to increase the *Ae. aegypti* and *Ae. albopictus* monitoring. These exploit different habitats and *Ae. aegypti* in particular can reside in people's homes. This means we need to shift the public's perception to include vases, containers, and tires as mosquito habitat in addition to ponds and swampy areas.

I see Dr. Bottazzi must have spent time in Houston. I believe we have Zika and a whole host of other tropical diseases confirmed here. I get bitten by mosquitos all the time in Houston. We have the same species of mosquito as the kind that spreads disease in the Caribbean and I would think we are getting bitten at a similar rate (though honestly I tend to get eaten alive in my own backyard and when I've visited the Caribbean/central America haven't gotten one bite that I could tell).

So given these factors, why don't places like Texas and Florida seem to have as much of an issue with Tropical diseases carried by mosquito as, say Mexico or central America? Or is it that we have similar instances, just no travel advisories despite it?

[AuditoryMeltdown](#)

MEB: Indeed you are right that Texas, Houston and the gulf coast has all the right forces and factors for disease transmission especially for those transmitted by mosquitos or other vectors. The challenge is that in the US we may have the perception that they don't exist so we don't look for them. Fortunately now with the right awareness public health officials and researchers are doing more work in the area of epidemiology and surveillance. So we are starting to identifying these local transmissions and help communities with prevention methods We are fortunate that we may have the possibility of better control methods and our PH systems are rapid to respond, but we still have much work to be done to improve our communities especially in poor areas of our cities

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[AuditoryMeltdown](#)

KE: I agree with MEB that we need to do a better job conducting surveillance for these diseases as local transmission can sometimes go undetected. But you are right, we have not had outbreaks of the magnitude that are experienced in Latin America and the Caribbean. This is likely due to a combination of factors. 1) The US is at the cooler margins of *Ae. aegypti* habitat which means they may have lower survival rates and viral replication may be slower, 2) infrastructure in many cases is better (i.e. weekly trash collections, piped water access, better housing quality), and 3) human behaviors may differ with more indoor activity in the US as compared to other countries. Risk of transmission is dictated by local conditions and one of these factors may play a bigger role in limiting transmission in one area than it does in another geographic area.

Simple question: Are we going to get rid of malaria finally, according to your opinion?

Thanx before hand.

[truth_alternative](#)

MC: Significant declines have been achieved recently, and with proper funding and commitment, they should continue. There are challenges, however. Not all country leaders have the same commitment,

there are biological and medical challenges (parasite resistance, diagnostic methods, managing asymptomatic infections, etc), and funding for control programs is not increasing. How those challenges will be dealt with in the near future will influence the trajectory of malaria decline.

What upcoming or already published papers have excited you?

What advances in your field aren't getting attention that we should know about?

Are there any concerns that the greater public should be aware of that they aren't paying attention to?

[Sbrii](#)

MEB: This year we celebrated the 5th anniversary of the World Health Organization's roadmap and the activities spearheaded by the coalition Uniting to Combat Neglected Tropical Diseases for the control and elimination by the year 2020 of these diseases. It also marks a decade of integrated scaled-up mass drug administration efforts supported by the US Agency for International Development. [See link to WHO](#) The lancet also has a great series of papers talking about the wins and challenges in global health and the global burden of infectious and tropical diseases. I think you would enjoy reading those. My paper in Curr Treat Options Infect Dis DOI 10.1007/s40506-017-0126-8 entitled Human Hookworm Disease: Alternative Strategies to Achieve the Global Health Agenda for Elimination summarizes a few of these advances and challenges.

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[Sbrii](#)

Anthony Wilson (AW) the level of coverage a virus outbreak gets often surprises me - for example, Zika gets a lot more attention than chikungunya (probably because it's easier to spell!) or dengue. In my experience hardly anyone in the UK has heard of dengue, even though it's the most important insect-borne virus of humans. And people forget how important yellow fever used to be in the US - if you want to be truly terrified, read about the [1793 yellow fever epidemic in Philadelphia](#).

What are your opinions on the possibility of chikungunya spreading to the US and really taking hold? Have Zika-prevention initiatives largely prevented it, or is it still a real possibility? Obviously this is all speculative, but if it were to come to the US do you think it's likely that some areas would have infection rates as high as we've seen in places like La Reunion?

[rslake](#)

Marcia Castro (MC): Since the Aedes mosquito is in the US, the key issue is to intensify vector control measures to keep mosquito density low. Failure to control the mosquito opens the possibility for all diseases transmitted by Aedes to be introduced.

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[rslake](#)

Anthony Wilson (AW): Thankfully dengue, Zika and chikungunya (and yellow fever) are spread by the same mosquitoes, so control effects that target the vectors help reduce the transmission potential of all of them. As I just mentioned in another answer though, mosquito-borne outbreaks used to get pretty bad in the US - take a look at the [1793 Philadelphia yellow fever epidemic](#), for example. The potential for transmission depends a lot on the density of mosquito populations though, which in turn depends on the environment.

I was wondering if you knew if there would actually be any significant downsides, ecologically or otherwise, from permanently eradicating the species of mosquitoes that act as vectors. (Through something like oxitec's tech or similar)

[moewolf](#)

There are 3500 species of mosquitoes only a small fraction transmit disease. Eliminating these few mosquito species that transmit infections would be unlikely to make a significant impact on the ecosystem, particularly given the broader range of food that higher level organisms consume. Asynchronous elimination, however, may reduce the effectiveness of control efforts. For example, if you are able to eliminate one species of malaria vector but that elimination provides a competitive advantage for another malaria vector that may even be a more efficient vector, you may tip the scales towards increasing transmission inadvertently. Fortunately, scientists are considering these unintended consequences more and more and can use computer simulations to better explore the potential impacts of new technologies on transmission ecology.

As a side note, the Oxitec mosquito does not persist in a population and thus the impact on mosquito populations is temporary; thus the need for re-release.

I was wondering if you knew if there would actually be any significant downsides, ecologically or otherwise, from permanently eradicating the species of mosquitoes that act as vectors. (Through something like oxitec's tech or similar)

[moewolf](#)

Anthony Wilson (AW): I've given some thoughts on this in response to an earlier question that you might find useful [link](#). Basically, it always has to be evaluated on a case-by-case basis but because a lot of the species that are important for spreading viral diseases like Zika or chikungunya have only arrived recently, are mainly found in urban environments and don't really have 'specialist' predators, the ecological impact of eradication is likely to be relatively low. This obviously depends on the methods; if you tried to eradicate by extensively modifying the habitat or spraying a ton of chemicals, that would have knock-on effects.

Interestingly, I have heard it claimed that the nuisance activity of the Scottish highlands biting midge (*Culicoides impunctatus*) has played in major role in how the highlands look today, so if you eradicated it you might encourage extensive development or changes to farming practice which would have massive effects on the entire ecosystem.

Hello! How timely this is. I was wondering if you could give a scientist's view on the prevalence of hantavirus in deer mice in the US. I read a lot of conflicting information about how probable it actually is that a human could contract this by handling deer mice. Thanks for reading and the ama!

[yerFACE](#)

We'll ask our fellow AAAS Leshner Fellow Danielle Buttke if she can weigh in on this later today. Here's [a story](#) from a few years ago in which she talks about a hantavirus outbreak in Yosemite.