PLOS Science Wednesday: Hi Reddit, we're Colin Carlson and Eric Dougherty, and we developed an ecological model using historical data to map Zika transmission patterns – Ask Us Anything!

PLOSScienceWednesday [1] and r/Science AMAs[1]

[1]Affiliation not available

April 17, 2023

the WINNOWER

REDDIT

PLOS Science Wednesday: Hi Reddit, we're Colin Carlson and Eric Dougherty, and we developed an ecological model using historical data to map Zika transmission patterns -- Ask Us Anything!

PLOSSCIENCEWEDNESDAY R/SCIENCE

[removed]

CORRESPONDENCE:

DATE RECEIVED:
November 03, 2016

DOI:
10.15200/winn.147809.91041

ARCHIVED:
November 02, 2016

CITATION:
PLOSScienceWednesday , r/Science , PLOS Science Wednesday: Hi Reddit, we're Colin Carlson and Eric Dougherty, and we developed an ecological model using historical data to map Zika transmission patterns -- Ask Us Anything!, *The Winnower* 3:e147809.91041 , 2016 , DOI: 10.15200/winn.147809.91041

I just looked at your paper and something concerns me standing out. Niche theory already has issues because many tests of niche theory tend to fail when stacked against null distributions. In other words, what you observe with Niche models is not necessarily different than what you would see by random chance (see Tilman 2004 and Rosindell et al. 2013). Granted these sources refer to community models, but presence absence of particular populations (or strains) may be stochastically structured depending solely on dispersal factors and random differentiation, not on any Grinellian niche factors. Hence, it may not be that there are any relevant ecological factors other than dispersal distance (as you already mention). Consequently, the phylogeographic spread of the disease and its strains may not be predictable along any environmental gradient and thus hinder forecasting.

These factors should be partialed out from each other and analyzed seperately and not assumed to be solely niche process a priori. Not everything is solely niche determined. What tests did you perform to do so if you did any? Did you run any variance partitioning (Legendre and Legendre 2012) to determine the contribution of broad scale environmental factors compared with spatial distances and other spatial factors?

feedmahfish

Colin: Oh man, this is such a good question and it's very deep in the nitty gritty of this. A few things: (1) There's really no connection in the literature between niche theory and broad-scale community assembly patterns. I wish there were, but there's a massive disconnect. (By training I'm actually a community ecologist who got lost!) I know the papers you're talking about very well and even if there's not evidence that niche patterns are the strongest force structuring communities, niche models are still the premier and most well-validated method in spatial ecology for mapping species distributions, and there's no real evidence that they don't work. In fact, some great recent papers going back to basics have come out that validate these things. I'd point you to this really great study: http://www.journals.uchicago.edu/doi/abs/10.1086/685387 (2) Variance partitioning! Yeah, there's a bunch of very complicated methods for evaluation that are being developed in this kind of work right now but they all require sample sizes that are way beyond what we currently have for Zika. Down the road someday!

Which serious diseases are likely to gain significant new ranges as a result of current development/climate change?

And does climate change significantly influence the number of potential vectors for any given vector-borne disease?

hapaxlegomenonically

Colin: Good morning from sunny Berkeley CA, where it's a lovely crisp 51 degrees! Thanks for having us today. We wanted to start with this one not just because it's the top question but because it's the cornerstone of what we want to talk about today. Starting from basics, we can only talk about infectious diseases (you're gonna need a public health person for the noninfectious ones!): a lot of diseases will get worse with climate change not just because of direct effects (i.e. gaining suitable habitat) but also because climate change exacerbates socioeconomic disparities, limits access to clean drinking water,

and challenges our infrastructure. Vector-borne diseases will definitely expand a bit out of the tropics - many were cut back to tropical areas, like malaria (which used to actually get as far north as Norway, according to some folks), that are probably going to have the chance to spread a bit. Increased temperatures/precipitation can also definitely increase vector density and in some cases vector competence (how good is a vector at picking up, carrying, and transmitting a virus?), which has big ramifications for how VBDs - including Zika, dengue and others - will go.

Direct-contact diseases will also get worse just because of some of those infrastructure problems, and shifting wildlife ranges will mean new patterns of human-wildlife contact that could mean new pathways for viral spillover into humans. But these things are overarching principles, and it's sort of like weather and climate; just because Climate Change Exacerbates Infectious Disease, doesn't mean every disease will benefit. Actually, angiostrongyliasis is probably going to lose some suitable habitat in the next few years.

Can you tell us a little about what kinds of mosquitos carry zika? Are parasite extinction plans able to specifically target mosquitos capable of carrying zika? Can a lay person tell visually if a mosquito is a kind capable of carrying zika?

p1percub

Colin: Great answer from s00permouse that covers most of the bases! As for parasite extinction and PEARL: in our other life, Eric and I are part of a team that measured the extinction rate parasites will experience in a changing climate, and we also published some of the most formal guidelines for how to actually conserve parasites (http://onlinelibrary.wiley.com/doi/10.1111/cobi.12634/abstract). So actually, we spend a fair amount of time playing team #SaveTheParasites. But in this case, I think that the idea of eradicating mosquitoes globally that transmit human infectious diseases is a great but complicated idea. It's a lot like geoengineering - lots of promise, lots of margin for error, potentially impossible.

This is awesome. I'm actually writing a research paper right now on Methods in Disease mapping. I just have a couple questions.

1. What program did you use to compile your data/build your model, I didn't see it in the paper?
2. Did you take into account mutations of the virus and what factors/vectors could lead to these mutations?
3. Did you use multiple iterations/how many iterations did you run of the model to predict the likelihood of the disease spreading?
4. What modifications could and would you make to the model if you were researching a different virus, or even bacterial disease?

These questions may seem really simple but I don't have time to read the entire paper before 1 oclock, and I'm really into the topic of this AMA. I know I said a couple, but it turned out to be a couple couple, thanks for doing this!

deadliestwarrior

Colin: Great questions! Very detailed. All this is in our methods section, but we georeferenced the data in GeoLocate, an online web app for georeferencing; and we run all our models in the R package BIOMOD2. The details on all the iterations are in the methods section of the paper - we did run some models with more iterations to check they converged though, and that's not in the paper. I'm writing a massive review on a similar topic right now (what are the actual best practices in disease niche modeling, and do we actually follow them?) and to be honest I'd love to do some more complicated statistics and more complicated comparison of Brazil data with the rest of the world (which we didn't have when we wrote the paper - actually, there weren't even cases in Florida yet when we made our first models). Bacterial diseases are a big mess. In my other life I map out anthrax and we need a whole other host of things to do that - more vegetation data, elevation, water flow data, LOTS of soil data. I'm learning a lot of things about soil I never knew before. Did you ever hear about the soil scientist with dating problems? He kept getting into humultuous relationships.

What is probability of getting Zika if you travel to a country and stick to urban and beach areas? Is the same likelihood of catching yellow/dengue fever? It has never been full reported how contagious and widespread Zika is effected territories. I have flight tickets to the Carribean for the beginning of next year, (specifically Barbados), but we have not booked a place to stay because we are debating whether to go at all.

salkhan

Colin: This is really complicated, because 80% of cases are asymptomatic in Zika; and the diseases you chose to compare it to are also complicated! Dengue has a lot of asymptomatic cases but is also complicated by the four types that circulate and interact in weird ways. I would say check out CDC's guidelines on Barbados, which definitely has cases and is at risk: http://wwwnc.cdc.gov/travel/notices/alert/zika-virus-barbados.

What is probability of getting Zika if you travel to a country and stick to urban and beach areas? Is the same likelihood of catching yellow/dengue fever? It has never been full reported how contagious and widespread Zika is effected territories. I have flight tickets to the Carribean for the beginning of next year, (specifically Barbados), but we have not booked a place to stay because we are debating whether to go at all.

salkhan

Colin: To be honest, a virologist would have a better answer to the urban/beach part, but the probability is pretty complicated to measure overall, because 80% of cases are asymptomatic in Zika; and the diseases you chose to compare it to are also complicated! Dengue has a lot of asymptomatic cases but is also complicated by the four types that circulate and interact in weird ways. I would say check out CDC's guidelines on Barbados, which definitely has cases and is at risk: http://wwwnc.cdc.gov/travel/notices/alert/zika-virus-barbados

What is the likelihood of the Zika virus becoming as prevalent as it currently is in South and Central America, in the southern United States and Gulf Coast within the next 2-5 years? Would you recommend that women who live in this area not actively try to conceive a child in this time frame if the Zika Virus is expected to spread to the gulf coast? And if it is probable to spread to the souther US, would that put the rest of the country and Canada at risk for virus growth as well? Thank you so much for this AMA!

ieatbugsandstuff

Colin: Thank you for this question! I would bet you what's in my pocket, which is $4 and a stick of gum, that we will never see anything quite like how bad things got in Bahia or in Colombia, anywhere in North America. We just don't have the vector density - and even in places we do, there's reason to think the kind of invasion epidemic we saw with Zika could be pretty out of the ordinary. That said, Zika will definitely be endemic in parts of the United States. In Florida we have a consensus; the Gulf, our models disagree slightly with others. As for the rest of the U.S., it's very unlikely except in the very, very rare circumstances that the virus does much better in a vector we don't know about (like a Culex mosquito), and there's some work doing predictions on that front, but I wouldn't panic about Canada right now certainly.

As for medical recommendations, those are obviously banned in an AMA, but here's some vaguer musings: There's an obvious tradeoff between policy that is precautionary ("don't have children in affected areas"), which is becoming par for the course, and the basic social and bias-related problems inherent in that. Because I'm not a government funded researcher, I can also say that abortion restrictions are a really big deal in Brazil right now because of this, and this sort of issue figures into the Gulf Coast certainly where some of the laws may be a bit tighter, and personally I'm really worried about women having access to safe and legal abortions depending on how things go. If you live in the Gulf Coast and are thinking about getting pregnant, I would say (1) we don't have a scientific consensus whether Zika will be in the Gulf, big names and smart folks like Peter Hotez think it will, and I'm not willing to bet any child's life on my model being more predictive than others, so don't make life decisions based on that; (2) an OBGYN is a better person to talk to.

What is the likelihood that Zika will become endemic to the United States?

vilnius2013

Eric: According to our assessment, there are a few small portions of the United States with the appropriate climatic conditions to support sustained (autochthonous) transmission of the virus. The major area of concern would be the southern tip of Florida where we have already witnessed a series of (non-traveller) cases. Our model, however, is not the only one out there, and each has a number of assumptions that others may overcome (while adding a few of their own). For this reason, we are currently working on a paper that considers the level of agreement we see between alternative models. The next step would be to develop a method for combining the results of different models, each associated with some ‘degree of belief’ in their results, much like what Nate Silver and his group at fivethirtyeight.com do with polls during election season. Thus, the answer to you question is: the

likelihood of endemicity within the US is relatively high because of the suitability of some places like southern Florida, yet the likelihood of endemicity throughout the entire US is extremely small.

What are your thoughts on the new Nature study that shows Zika damages the testes of mice? http://www.nature.com/nature/journal/vaap/ncurrent/full/nature20556.html

vilnius2013

Colin: To be honest it's definitely not good. Zika's doing so many things we had no idea it could do, and it raises a lot of pretty scary questions about sexual transmission. The good news is the papers that are out so far modeling the vector/sexual components point to pretty minimal impacts from the sexual side - check out this paper: http://link.springer.com/article/10.1007/s11538-016-0219-4

What are common misconceptions about this current outbreak of Zika in the general public? Can you explain why using dengue fever as an analog is a good/bad idea?

divvyflax

Colin: Oh boy okay. As of a couple weeks ago when I was working on a talk, there had been a single death in the U.S. (not sure if there had been another since then) but a lot of media coverage calls Zika a "deadly virus". (http://www.dailymail.co.uk/health/article-3562270/Mosquitoes-carrying-deadly-Zika-virus-reach-far-north-NEW-YORK-Nasa-risk-map-reveals.html) It's not. 80% of cases are asymptomatic. The reason we're really worried about Zika is microcephaly, and a little less so, potential neurological impacts to adults. (The jury still seems to be out on that). Also, big misconception: viruses can go anywhere their mosquitoes can go. They can't! Viruses have their own niche determined by a bunch of interactions in the "golden triangle" (host-pathogen-environment), that are pretty complicated but that we kind of summarize in a black box fashion with our models. If you want proof that viruses have their own niche, look at dengue - it certainly hasn't filled the full range of Aedes aegypti (that's why we put so much effort into mapping diseases!). So, if you live in upstate New York and in your travels you meet an Aedes aegypti, don't panic too much. As for dengue fever, that difference comes down to the fact that dengue and Zika are related but not the same. Their pathogenesis is different, Zika doesn't have the same big patterns (like dengue haemorrhagic fever and its four serotypes), and altogether what our paper shows is that if the data we have now is correct, Zika should have a much more limited niche than dengue. It was okay to use dengue as a proxy when we knew very little, but now that we have three different niche models in the literature for Zika (ours is only one third of the picture! but we love it like a favorite child), there's really no reason to use dengue models anymore, at least as far as niche models go. It's still sometimes helpful to borrow parameters from dengue for more complicated models in epidemiology though - there's an art to this as well as a science.

A lot of biosecurity is looking at controlling incidental exotic mosquito transportation from a tropical area to a non-tropical area, such as a plane returning on an international flight or ships. Given your modelling what is the estimated risk of a single or small amount of aegypti either causing an outbreak or establishing zika in an area?

Have you been able to track zika through wildlife populations as the zika virus has spread? How is it creating new reservoirs?

Is there evidence of other Aedes becoming vectors as it spreads?

How will the different transmission mechanisms, mozzie vs sti, affect the zika virus itself?

TRexhatesyoga

Eric: These are all good questions. As for the risk of an outbreak based on the transportation of a single mosquito, it is possible, though extremely difficult for us to prove. The large jumps we see between Southeast Asia and French Polynesia, and from there to South America suggest that transported mosquitoes or infected travelers are responsible. Differentiating between the two alternatives is tough. If the mosquito or traveller ends up in a climatically suitable location according to our model, it is certainly possible that it could become established.

Concerning tracking Zika through wildlife, there have not been a lot of concerted efforts to do this just yet. Since we are in the midst of an outbreak right now, the emphasis has not been on finding additional reservoirs. Humans (particularly asymptomatic ones) are the most populous affected species, and are therefore the most likely to serve as reservoirs for subsequent transmission.

At the time of our writing of this paper, there were twelve different species of mosquitoes that had been

implicated as vectors of Zika. These included several Aedes species as well as some in other mosquito genera. Thus, it is not at outside the realm of possibility for other Aedes to serve as vectors. However, it is important to consider that Zika will not necessarily be transmitted throughout the entirely of a mosquito species's range, as their niches may differ.

Finally, it is unclear exactly what the relative roles of the two known transmission modes are at this point, but the fact that both exist suggest the the virus might have some evolutionary potential that we haven't seen yet (i.e., instead of occasional sexual transmission being a byproduct of immune evasion, it could become an actual transmission route that's part of Zika's evolutionary strategy). This early in the outbreak, we're still figuring a lot of this out.

What's your stance on the genetic engineering of special mosquitoes that are to reproduce with the wild mosquitoes and cause their offspring to shortly die after birth?

Exnoxide

Eric: Thanks for your question! My answer here is directly related to a question below from u/briannasaurusrex concerning the impacts of spraying chemicals to combat mosquitoes in high-risk areas. The fact of the matter is that targeted interventions are exceedingly expensive, both in terms of time and money. Rather than using these targeted methods, we tend to spray pesticides relatively indiscriminately and we end up killing a lot of things that we don't intend to kill, like honey bees (http://www.cnn.com/2016/09/01/health/zika-spraying-honeybees/). One way to avoid these sorts of unanticipated impacts on ecosystems containing mosquito species that host Zika would be genetically modified mosquitoes. Of course, there are a lot of problems associated with the release of GM mosquitoes, though the advent of gene drive technology may represent one solution to some of these issues. A very interesting report from the National Academies (http://nas-sites.org/gene-drives/) on the use of gene drives says that we may not be at a point in its development that we can fight Zika, but there is still the potential to combat future vector-borne disease epidemics.

For a little more information about the impacts of completely eradicating the mosquito, this op-ed from the New York Times in 2003 offers a thought-provoking view (http://www.nytimes.com/2003/09/25/opinion/a-bug-s-death.html)

Are you aware of any environmental impact of GM mosquitos used to reduce/eliminate vectors for malaria or Zika?

PLOSReddit

Eric: I am not aware of any environmental impacts of GM mosquitoes at this point, but this may be because there are few real-world tests. Brazil has approved their use and I do not know of any complications thus far. The FDA has also released a statement for public comment that predicted "no environmental impacts" of GM mosquitoes (http://www.fda.gov/downloads/AnimalVeterinary/DevelopmentApprovalProcess/GeneticEngineering/GeneticallyEngineeredAnimals/UCM48

Are any other animals susceptible to the Zika virus?

graven29

Eric: There are, indeed, a number of other animals that are susceptible to the Zika virus. The virus was actually first discovered in 1947 in the Zika forest in Uganda (hence the name) in a rhesus monkey that had been placed in a cage in the forest to see what kind of diseases it would contract (cruel, I know, but the rules were a bit more lenient back then). The rhesus monkey is actually not native to Africa, so its infection is especially interesting. There are also reports of a number of other species exhibiting serological evidence of infection with Zika, from rodents and livestock to orangutans, zebra, and elephants! The potential for transmission to other species appears to be quite high, but little effort has been made to explicitly determine which species serve as the primary reservoirs of the disease.

How likely is cross-contamination? For example, someone from the US Midwest (relatively cool climate) vacations in a known Zika country or region. That person encounters a Zika carrying mosquito and contracts the virus. That person travels home. A non-infected, "home grown" mosquito bites the infected person. Does that homegrown mosquito now carry the virus? Can it then spread Zika or pass it to its offspring?

Also, what can you tell me about non-sexual transmission as reported here: www.mdedge.com/emed-journal/article/114657/emerging-infections/nonsexual-secondary-zika-virus-case-confirmed-utah?

utm_source=News_EM_eNL_100516&utm_medium=email&utm_content=Nonsexual%20secondary%20Zika%20transmission%20confirme

PinkRN

Colin: Hey this is a great question. What you're talking about are secondary cases that are in a couple models of human movement right now: https://www.researchgate.net/profile/Abdallah_Samy/publication/301512671_Supplementary_materials_041420161/links/5716fb2708aeefel http://biorxiv.org/content/biorxiv/early/2016/07/29/066456.full.pdf Our paper suggests that the risk in the Midwest is fairly limited, but then again other folks disagree. We're working on building a consensus right now; but I would say that while a single case might crop up here or there, if you don't have Aedes aegypti or Aedes albopictus locally you're probably going to be fine. As for the non-sexual transmission, that was an interesting case of potential contact transmission. Sexual cases are just one form of contact, and blood transfusions etc. can definitely transmit Zika. But as far as we know mosquitoes in Utah still aren't spreading Zika!

In what regions of the US is zika most prominent and what are the current treatments/vaccines to this virus?

shutyourface123

Colin: There's no vaccine yet but I'm hearing some positive things about trials. But vaccinations for flaviviruses are complicated - there's some really big questions about the dengue vaccine that folks are pushing right now (in terms of potentially making antibody dependent enhancement worse, maybe exacerbating dengue hemorrhagic fever), and the vaccine for Japanese encephalitis used to be much, much worse in terms of bad accidental symptoms (it's gotten a lot better). Vaccines aren't the answer to everything, also, because they're usually costly and sometimes inefficient.

For a while, Zika is all the US news stations talked about. Now, they don't mention it. Has the outbreak started to subside, or have the news stations lost interest?

kfc469

Colin: To be honest, I think (a) the presidential election is drowning it out and (b) the lack of a Bahia-scale microcephaly outbreak in the U.S. calmed down a lot of people who were previously very afraid. But that doesn't mean it's gone - there's still new cases of Zika accumulating in Florida even though the epidemic is slowing down in a bunch of places.

Who is most at risk for Zika? What can those of us who are not at risk do to help them?

SacredWeapon

Eric: I would start off by saying that approximately 80% of Zika cases are completely asymptomatic. After the first human case was reported, an investigation of the members of that patient's community revealed that a high proportion of them exhibited evidence of Zika infection, but without any meaningful symptoms to report. So when we talk about risk, we can talk about risk of infection or risk of health impacts. Right now, the main group that should be concerned about health impacts is pregnant women, as microcephaly represents the primary threat that Zika poses. While there have been some suggested links between Zika and Guillain-Barré syndrome (from which both males and females of all ages could potentially suffer), this link remains somewhat tenuous in the literature and the risk remains much lower than that of microcephaly.

As for what those who are 'not at risk' can do, there isn't much except to advise pregnant women in affected areas to protect themselves against mosquitoes. Here are the CDC's recommendations: http://www.cdc.gov/zika/prevention/prevent-mosquito-bites.html

Why is zika getting so much more attention than West Nile Virus when West Nile Virus is fatal?

LuiMCLXVI

Colin: The answer is, in this case, babies. Microcephaly has been honestly devastating from a public health perspective. I was at a workshop this weekend where another scientist said something to the effect of "when I was in Brazil and spent time watching mothers interact with microcephalic babies, it reminded me how it felt thirty years ago the first time I got to meet an AIDS patient" and my heart kind of stopped. What we saw in Brazil this year was devastating, it's not over, and we still don't fully understand if other factors made microcephaly vary the way it did between different regions of the

epidemic.

Related to your fields, is there a specific most frustrating misrepresentation of a piece of data or fact in popular media?

differencemachine

Colin: It drives me absolutely crazy when people call it a "deadly virus" like the Daily Mail did recently. Also, this is more of a personal pet peeve, but I can't stand when articles use maps of mosquitoes as the only graphic to explain where Zika might go, now that there are three different maps specifically for Zika that are published and available for use - that kind of thing can make a lot of the inland eastern U.S. more at risk than most scientists agree it is.

What was your experience with gathering and working with historical data? Were you happy with going back to 1950, or would you have gone further if the data cooperated?

orangecamo

Colin: I had SO much fun working on this paper. Digging through historical data on Zika was definitely an interesting experience though it's not my first rodeo - in another project from another life, I've been working on a project that maps the extinct Carolina Parakeet from records like Lewis and Clark's, and it goes as far back as the 1500s. We'd definitely love to have a better dataset so we can understand whether Zika was actually spreading in the 1940s and 1950s or whether it's been around for a while, asymptomatic and undetected.

What was your experience with gathering and working with historical data? Were you happy with going back to 1950, or would you have gone further if the data cooperated?

orangecamo

Eric: In this case, it was not really data limitations, but limitations in human knowledge, that prevented us from going back beyond 1950. The Zika virus was first discovered/named in 1947, so there were no human cases recorded before then. Of course, the more historical data, the better, but it also certainly complicates analyses in a lot of ways because the availability of one type of data (say, case reports) will not always be accompanied by other forms of data we need to perform the analysis (like climatic data). We felt pretty comfortable with the data available to us because we were confident that we had amassed a larger dataset than had ever been compiled for Zika and because our data was sufficient to use the methods we intended to use (namely, MaxEnt).

Every year we hear of genetic methods to make mosquitos extinct. Yet it never seems to come to fruition. Why not?

StoleThisFromYou

Eric: This is a very interesting question, and I think you could find a lot of different people with a lot of different answers, but what it seems to come down to is the public perception of risk surrounding GM… anything. There are a number of very interesting articles in the popular press (http://www.theatlantic.com/technology/archive/2016/04/genetically-modified-mosquitoes-zika/479793/; http://fivethirtyeight.com/features/zika-mosquito-florida-vote/) and more academic forums (http://currents.plos.org/outbreaks/article/genetically-modified-mosquito-use-to-reduce-mosquito-transmitted-disease-in-the-us-opinion-survey/; https://research.ncsu.edu/ges/files/2015/08/Public-Attitudes_Delborne.pdf) that touch on some of these ideas.

How do you see the potential reach of Zika in Florida over the next year?

PLOSReddit

Eric: There is certainty the potential for Zika to spread in Florida. When we initially drafted this paper, there were not cases in Florida, at the time of publication, cases were confined to Miami-Dade and its surrounding counties. Since then, we have witnessed transmission outside of these areas, and it is definitely possible that it will continue spreading over the course of the year. It is also possible that the winter months in Florida will be cold enough to reduce mosquito activity. With increasingly warm winters as a result of climate change and the ongoing effects of the current El Niño event, we may not see the expected decline in mosquito activity. So the answer is really the unsatisfactory “it depends.”

As someone who studies our environmental impact, I'm curious to know how you feel about the chemicals that are being sprayed to kill Zika infected mosquitos/ prevent the mosquitoes in high risk areas. I've noticed the chemicals aren't just killing mosquitoes but other very important bugs like bees and the loss of bees can have a devastating impact on our environment.

briannasaurusrex

Colin: GREAT question. I'm writing a paper right now that measures the actual threat Zika-related pesticide spraying poses to bees; what I can tell you right now is, it looks pretty bad as far as the honeybee industry might be concerned. Pesticides are important if Zika is actually around, because human health takes priority, but we need to strike a good balance between precautionary spraying and staying safe in areas where pesticides could ultimately have more human health impacts than Zika. (Maybe I'll be back when we finish that paper! That'd be fun!). But this is one of the reasons the maps we make are so important - they let us answer questions like that.

As someone who studies our environmental impact, I'm curious to know how you feel about the chemicals that are being sprayed to kill Zika infected mosquitos/ prevent the mosquitoes in high risk areas. I've noticed the chemicals aren't just killing mosquitoes but other very important bugs like bees and the loss of bees can have a devastating impact on our environment.

briannasaurusrex

Eric: I would also direct you to the question above from u/Exnoxide concerning GM mosquitoes

How are the winter months expected to effect the spread of Zika? Are there ways we could introduce a new predator early in spring that could really hurt mosquito populations?

Diltron24

Eric: Winter months tend to decrease the activity of mosquitoes such that we would normally expect the spread of Zika to slow during winter. However, with a changing climate, we have seen increasing winter temperatures, so our predictions on this matter may not hold. We are also amidst a pretty severe El Niño event that may further complicate our predictions of mosquito activity during winter.

As for introducing a new predator, most biologists would shy away from this type of biocontrol method, as we have seen time and time again that introductions of non-native predators often lead to unexpected outcomes (see the invasion of the introduced cane toad in Australia for just one of many possible examples). GM mosquitoes represent an alternative, targeted approach that would have a similar impact, but even this has been difficult to implement because of public concern.

Is there anything to the argument that we should consider bringing back DDT to fight mosquitoes that carry Zika, or is that just scaremongering?

Empigee

Eric: Bringing back DDT does not seem to be the answer as the negative impacts of DDT on ecosystems are well-established. I have not seen this recommended, but there are alternatives that would serve as more targeted strategies to combat mosquitoes carrying Zika; the most popular of these would be GM mosquitoes.

Have the Amazonian native tribes been effected by Zika in any way?

age_of_rationalism

Colin: This is a super cool question but unfortunately I have no idea! I'd also love to know that though.

Could you explain what you mean by an "evolution in the virus" and how, exactly, it could alter the dynamics? What factors play a roll in the virus evolving? Is an evolution in the virus something that can be predicted/forecasted and then safeguarded against?

SweetCheeks843

Colin: When we talk about viral evolution in this paper and the other work we're doing, what we're really

worried about is the idea that the "fundamental niche" (also called the "transmission niche" or the "Hutchinsonian niche" or the ... there's a lot of names) is sort of a black box that contains a bunch of different things - viral replication rates, transmission vector to human and human to vector, virulence, immune evasion strategies, vector specificity - that all mesh together into one overall geographic pattern. But viruses evolve faster than any other part of the system, and faster than most species we build niche models for. If there's strong selective pressure for viruses to push their thermal limits, the boundaries that keep transmission in the tropics might not be constant over the next 10-20 years. Those selective pressures are complicated and could be affected even by things like vaccination or vector switching.

Can we forecast evolution? We can anticipate some broad patterns. (Here's a great place to start from one of my advisors: http://journals.plos.org/plosbiology/article?id=10.1371/journal.pbio.1002236) But it's kind of hard to know exactly how evolvable a virus is without more molecular and empirical data. One thing we do know is that there's two explanations for Zika either spreading through Asia-Pacific regions to the Americas OR having been around in the Old World for a while, island-hopping and suddenly experiencing some sort of evolutionary or epidemiological release in Brazil. Whichever one of those ultimately proves to be true might give us some insight into whether rapid evolutionary changes (or even some simple mutations) are playing into how bad things got in Brazil (and why microcephaly showed up so seriously in Brazil).

What is the biggest misconception about these kind of diseases?

MarsNirgal

Colin: I honestly think the biggest misconception is that traveler cases aren't the same thing as local cases. A lot of graphics are misleading. Compare this one from Popular Science, in which Aedes looks a lot like actual cases and the number of cases aren't broken down by imported vs. autochthonous (local):

http://www.popsci.com/here-are-all-cases-zika-virus-in-world

To this much clearer graphic for the United States from the Washington Post, which actually breaks it down (and shows how severe things are in Puerto Rico):

https://www.washingtonpost.com/graphics/national/us-zika-cases/

What is the CDC (or WHO) doing right and doing wrong in regard to stopping the spread of Zika?

vilnius2013

Colin: This is a really important question and also one we are severely unqualified to answer, in the sense that our job in this paper, and as its communicators, is to tell you: this is one potential pandemic trajectory; there are other predictions; consensus exists in much of the tropics and controversy exists in most of the U.S. We can't directly advise interventions based on this type of model - that's the job of more epidemiologically minded folks. All those things said, broad strokes observations: pesticide spraying in areas with *no* predicted Zika occurrence or no Aedes are probably not great for human health or the environment, and there's already some visible consequences. Also I learned this last weekend that a lot of people involved in governmental response (domestic or international) have their hands somewhat tied in terms of recommendations re: access to safe and legal abortions in pregnancies with Zika-related complications. This is somewhat unfortunate given the importance of that issue.

As a resident in Wyoming:

How scared I am of Zika: 0/10

How scared I should be of Zika: X/10

Solve for x?

x7x_

Colin: X = 2. Of the three models that are out there, only one says mosquitoes in Wyoming could carry Zika and even then you really don't have the Aedes for it. Sexual transmission is still a big question mark. And, people travel.

I know what the Lotka-Volterra model is and what SIR models are. What exactly is your model? What influences the population in your model?

winz3r

Colin: The models we do actually don't explicitly model cases, humans or mosquitoes. The way they work is they relate probability of a disease existing to environmental variables. The response variable is either a 0 or a 1 - points where we know Zika has existed are a 1, and "background points" from random spots in the environment are set as 0 (we call those "pseudoabsences"). Then we run a regression - or, something much more complicated that does the same job - and the output is just a prediction of whether or not Zika is "there". Niche models break down the ecology; and SIR models can tell us about the epidemiology once we know where to look!