our speaker is dr matthew gray he is a professor of forestry wildlife and fisheries
uh dr gray is a founding member of the one health initiative and he's also the associate director of the utia center for wildlife health he specializes in disease ecology and his interests include transmission dynamics of emerging infectious disease and identifying management strategies that can thwart or eradicate outbreaks dr gray has degrees in wildlife ecology mathematics and statistics and he uses these skills to unravel complex epidemiological interactions with his students post-docs and colleagues dr gray also studies wetland ecosystems especially focusing on anthropogenic impacts on wetland communities and management activities to conserve biodiversity now dr gray i want to add is one of the few folks that i know who has overcome geographic language and other barriers and managed to build multiple global teams to tackle emerging pathogens these teams are composed of folks who have historically refused to work with or share the results with anyone and in many cases they have been on opposite sides of an issue but dr gray has been able to bring these people to the same table and impress upon them the importance of working together by creating these platforms where each team member explicitly states the details of their
work
and then as a team they brainstorm and
divvy up tasks
research has been streamlined data has
been
shared and most importantly research
findings have put into
been put into action and this
i am not hearing deb is oh yeah i think
she's frozen
oh a flattering introduction thank you
deb
i'll take it from here uh you're you're
muted or something or froze up that so
i'll just go ahead and continue but
thank you very much for that
introduction it was very nice um
and as deb kind of hinted um
the the work i'm talking about today and
and a lot of the work that i've done in
the past is multi-disciplinary
and it really takes a team approach to
address some of these complex
issues related to one health
and so what i'm going to talk about
today is uh really focused around
the project that the ut-1
health initiative is supporting through
a sea grant
and uh because we just started um really
just a few months ago
um we're not going to provide any uh
data or anything like that we'll talk a
little bit about our progress
so it's really heavy on the
justification for our work
and uh and really what we hope will be
the
the long-term outcome of our efforts so
first of all i do want to acknowledge uh
my
the co-pis for the seed grant which are
neelam pudial
who's a social scientist within fwf
and Nina Fefferman who's a mathematician from UTK which you all know and one of the co-directors of the one health initiative. Um we also have collaborators at uh multiple other universities which you can see listed below which include ecologists, economists, folks that specialize in trade, etc. So just want to acknowledge them as well and we do have partnerships which you'll see as I go through with the fish and wildlife service industry which is p-jack and then the state wildlife agencies. So our question is really focused around this big issue of wildlife trade and global movement of pathogens and wildlife trade is a is a fairly large business. It comprises around uh 300 billion dollars annually and encompassing you know 2.5 million animals per year over a thousand species and 180 nations and it's the high income countries especially the United States and the EU that's driving over 75 percent of that demand. Although many of those animals are not coming from our particular countries they're coming from other parts of the world often underdeveloped parts of the world. This figure here on the left really kind of shows on the bottom you can see the increase in the number of shipments per year going up it's continuing to go up as far as wildlife imports and really just as far as imports into the United States which again
this talk is going to focus on really originating from all different continents but especially originating from asia the americas outside of north america and um africa and then going to various regions within the united states so really all uh pulling from across the globe and really dispersing across the united states and one thing we don't know very much about is we know what comes into our country but we don't know how it disperses within the country okay so we know very little that little about the domestic trade network um the other thing that um you may not know if if you haven't dealt with wildlife or wildlife trade is that there are no u.s policies or regulations to control regulate or support the clean trade of wildlife you know with agricultural animals um there's a the world health organization uh oie and uh they list diseases as being or pathogens as being notifiable and usda aphis controls requires animal health certificates for any any agricultural animals that are that are traded but that does not exist they a aphis which we'll talk about a little bit uh later usda aphis does not regulate wildlife and they consequently there's this regulatory loophole so basically you can trade wildlife across international borders um and not
have to declare things as being free of notifiable pathogens and you know that really just leaves the floodgates wide open you know we have basically open borders where pathogens can move uh freely across the globe and you know we're really talking about millions of animals per year being traded um and there are industries associated with obviously wildlife trade which i just you know we just mentioned here and so that can affect those economies by moving uh maybe novel pathogens that can negatively impact their stocks um their captive stocks but there's also this opportunity of this chance um that there can be spill over to wild uh wild populations and and there's multiple examples of that occurring which i'll reference a few a little bit later on the um particular model system that we're focusing on is trying to take um a sliver of the wildlife trade industry about just one percent of trade which is the amphibian trade industry but it has all the complexities just not as the magnitude of typical wildlife trade which makes it a nice model system and within the united states um well globally uh trade is comprised mostly of frogs uh and that's what you see with these big bands here on the top and then the caudates or the salamanders are down on the bottom so there is a small salamander trade as well and again uh if you can see with um
the window over here um you can see that this is the origin countries here and these are the destination countries where the united states comprises over 50 percent of the global amphibian imports um into the into our country so it's about uh about a three billion dollar a year industry and um what we are particularly interested in are um three uh globally emerging pathogens uh there's two species of kitrid bd and b sal and ronovirus uh and i'll talk a little bit about those in a second and they've collectively been responsible for the decline of over 500 species of amphibians so let's talk a little bit about um just give a little bit of a background about those three pathogens so bd or betrayal kendrim dental batteries is um the if you study emerging infectious disease especially with wildlife you've heard of it it's responsible for the greatest uh biodiversity loss in modern history associated with with pathogens okay so um we within the last 40 years uh 34 years we've documented a species distinctions associated over 100 species extinctions associated with this one pathogen it has a global distribution of trade is facilitating that which we'll talk a little bit later about and what it does is it causes epidermal hyperplasia or thickening of the skin and if you're an amphibian that's not a good thing because
uh amphibians use their skin as semi-permeable and they osmo regulate through their skin okay so they change the the composition of you'll take up electrolytes etc from water they take water in and and etc through their skin also let water out they also respire through their skin so what happens when you have thickening of that skin that permeability is compromised and that creates this dysfunction and it's actually that that reduction in osmoregulation that causes electrolyte imbalances and ultimately that affects muscle function leading to paralysis and cardiac arrest and so the this animal here before i show that this animal here speaking of paralysis is an animal the top left let's see if i can find my cursor okay well i don't seem to see my cursor but the okay the the image the the right image of the really nice stoic glass frog that animal's dead um it's actually sat there it's got ketrial mycosis and it's had cardiac arrest it's sitting on a leaf and it is paralyzed and that's what that pathogen that pathogen does um the new species so again vp is relatively recently discovered 1997 more recently just within the last decade a new betrachurian was discovered the kitchen settlement of orange and it's originally thought to be from asia where it's been documented
living with infected hosts and just basically subclinical infections and no apparent disease in the wild but now is emerging uh in europe and moving across the continent from from north to south and um it's really been associated with declines especially in salamander salamander that you can see here which is the fire salamander and um it's called cause uh multiple population extra patients across across its range and what b cell does unlike bd it does affect the skin too but it actually creates these necrotic ulcerations through the skin so it pearls literally kills the cells and and and the the pathogenesis hasn't been um worked out quite yet of this pathogen that's part of deb's work uh but it's probably again a cons a function of of a reduced ability to do osmoregulation potentially affecting cutaneous respiration which many of our salamanders uh in the united states don't have lungs so if your skin they totally respire through their skin so if your skin isn't functioning that's not good and then finally uh these little necrotic ulcerations create opportunities for uh for bacteremia so for bacteria to enter get in the blood system and cause complications um this is a a stripe newt which is a a threatened species of great
uh species of greatest conservation need here in the united states and this animal here is in its later stages of cycle treated mitosis again paralysis lethargy an inability to to have a writing reflex to flip yourself over um are our diagnostic signs of the later stages of disease this animal uh was mainly euthanized immediately after this the other major pathogen that has been associated with declines um are rhona viruses uh fe3 or frog virus three is the type species there's actually six different species of rhinoviruses that have been recognized um they do have a global distribution they're discovered back in the 60s and they've been associated with declines in in wild populations and captivity now the interesting thing about rhona virus is they infect amphibians reptiles and fish and they've been associated with with die-off events and over 100 species of amphibians 30 species of reptiles and over 50 species of fish so lots of reservoirs associated with with that pathogenic and unlike the kitchens which are a skin pathogen rhinoviruses are a hemorrhagic disease they call hemorrhagic disease very similar to ebola in fact it's been called the ebola of ectothermic vertebrates and it attacks and and destroys the liver the the spleen and the kidney and brain um and you can see it it causes significant hemorrhaging which you can also see often you'll see
grossly underneath the skin
and we've had die offs uh in right up in
the great smoky mountains national park
and uh near kate's cove upon called
gorilla
there’s been die offs of turtles like
you see here
um in in blount county and um
you know turtles uh really uh it affects
their respiratory system this one here
is a box drill that's in respiratory
distress and uh dying from rhonda virus
and you'll often find this one here that
i found was uh
actually still alive covered in this mud
puddle covered with
soot and everything and could barely
move
and and was still moving it a little bit
and respiring
but uh really a horrific pathogen
um all of these pathogens have
tremendous uh transmission capability uh
one contact one one second contact from
host the host is
sufficient to result in transmission and
they have a fairly
decent environmental persistence which
can add uh to that
those transmission pathways and the r
naughts
have been estimated between 5 and 10 for
for these pathogens which really
emphasizes the ability for a very rapid
invasion and we often see these dials
happening and
ending with you know hundreds of
thousands of animals dying within a
couple weeks
um you know the the concern of these
pathogens in the wild
it's been well documented in their
impacts on natural populations but again
we're also talking about industry
and uh the amphibian pet industry as well as the amphibian food industries affair is a big industry and there could be pretty significant losses so this was one that we were associated with diagnosing for this company and in in basically a couple of weeks they lost over a hundred thousand dollars in profit um because ron of our this is associated with ron of ours ron's virus got through transmitted through their tanks and boom they lost um tons of animals so what two thousand uh tadpoles of horn frogs and three thousand five thousand animals dead within a week so industry doesn't like these pathogens either uh and so we want to keep them out of industry we want to keep them out of the wild or or and especially minimize how trade may impact those movements and it is happening we there has been some previous research especially on a global level uh some work that's been done that's coming into our into the united states and also in other ports and so um you know american bull frogs are a big part of the trade actually it's a big part of the amphibian food trade if you didn't know um there are amphibians are there american bull frogs all over the world um that we have shipped for basically bull frog farming and actually we receive generally half of those frogs back ironically there aren't very many
bullfrogs farms here in the united states anymore because it's not that profitable but in developing countries it still is a very profitable way to make a living it's also an excellent food source uh for local communities and of course we eat bull frog lakes here so lots of frogs being moved around the world this is uh some work that was done in one of the largest um eastern ports for amphibian trade which is the hong kong port and uh they documented a prevalence ranging for for bd around 12 to you know the average prevalence for ronna virus being around 60 percent so these animals are being moved around um there are different strains that exist and species of rhinovirus that exist globally there's also different strains of ketrad that exists and and b sal uh hasn't yet been detected here in the u.s so you know trade there's a big concern that trade is moving these around and there's some evidence that that is certainly happening in fact that is the main hypothesis that exists for how b cell got to europe is through the amphibian pet trade uh particularly with asia and asian salamanders often are very brightly colored and they dominate the international salamander trade and um so some of the collections here that with some work that was done over in europe has shown that you know at least 64 of the breeders
that were sampled had positive b cell uh within their system some had ongoing outbreaks of b cell or losing animals uh this is what we don't want happen you know coming to the united states we don't want that pathogen getting here or if it does we develop ways that we can squash out and minimize its impacts to industry as well as the potential for spillover and you know that potential real the potential that for that pathogen getting here is is pretty high is to me uh very likely it has crossed our borders um within the last you know decade or so um there have been some regulations which we'll talk about kind of put into place to try to prevent that but uh just as an example this publication that uh uh reported you know basically the prevalence of agents of b-cell and asian salamanders that are commonly traded with the united states uh b-cell prevalence is about three percent in the wild where they're collecting these animals and based on uh us importing around two million over ten years uh they suggested that the united states could have already had you know sixty to seventy thousand be sell positive asian salamanders come through our borders um in the last ten years and so um the uh that's really exacerbated by the fact that um that we now know that b cell can actually infect frogs
and it's been documented this is a very very common frog you might some of y'all may have seen these in pet stores the fire belly toad they can become infected with b-cell these comprise a huge percentage of our under our frog imports into the united states we've imported 3.5 million in in the last eight years and um in germany the prevalence rate for for the for b cell with this with this animal the species is around eight percent and if you multiply that out we could have potentially been importing you know 35 000 b cell positive fire belly toads per year last eight years so you know the the risk is is of entry is or the probability of entry i should say is is pretty high um and uh what we really need to do is kind of understand the movements um and how to potentially reduce infection the other pathway of of introduction you know into the um of any pathogen into the united states or elsewhere is through illegal trade right and so there have been cases um that have documented uh infection prevalence just a few though uh there hasn't really been a a and a really exhaustive um investigation of illegal trade and how that that facilitates pathogen movement and wildlife um but here are a couple with um you know with bd that you know 67 percent were infected
in this particular case for these animals that were confiscated and 60 in fact with bd and i'll just mention as far as the prevalence estimates that have been uh reported in typical legal trade have generally for for kitchen have been around 10 to 20 percent so you know illegal trade may facilitate you know the increase in prevalence of pathogens perhaps they're more crowded they're more stressed underneath those conditions so it's really important for us to take into consideration a legal trade as well uh albeit it may be a smaller pathway it may have higher prevalence or an increased risk so for y'all that um you know work with domestic animals livestock etc you know that um oie that you need to have animal health certificates that are required i alluded to you before that right now we're in a regulatory loophole um within the united states when it comes to wild animals um so usda requires that all imported uh animals for agriculture or aquaculture uh need to be free of oie pathogen oiu listed pathogens and actually uh rhonda virus and both kitrets are listed as oiu notifiable but um usda will not require animal health certificates because they do not regulate wildlife at the same time fish and wildlife service does has no authority to regulate pathogens so we're in this loophole of these two major federal agencies not
being able to solve this problem because nobody has been directed of what they can do now when b cell was discovered in the threat to amphibians here um in the united states fish and wildlife service said we have to do something and so what they did do and and what they can do is they can regulate wildlife trade underneath of the lacy act which is basically the regulation to prevent the international movement of threatening endangered species um or invasive species that could threaten threaten native biodiversity and so the interesting thing is they listed this interim rule which listed that actually the species themselves that could be potential hosts for b-cell were injurious to our native species because they could um become infected with b-cell and it's really kind of unprecedented to to do that um and is to really list the species as injurious because of the microorganism on it um and so they listed if if there was any evidence that a genus could be uh potentially infected with b-cell they listed all the species under it as injurious so that still has not really been challenged in court yet it's it exists out there and so what that did is it essentially stopped international trade of salamanders now as you can imagine um well p jack which represents the pet industry um uh for all pets um
were in the amphibian trade industry
they were
upset about this uh but salamanders only
comprised six percent of the market
so they were willing to go
along and basically say okay yeah we
support
uh this this ban in fact we'll do a
voluntary ban on it
anyways you know and so but uh
frogs are another story because they
comprise a
sh the majority uh now 99 of our
of our international trade okay
so um you know how does do pathogens
move again this could be any wildlife
species
but you know they're moving globally um
they're coming through our borders
for wildlife they're being checked to
make sure that they're not you know
globally listed species that are listed
underneath of societies
and um so that's basically equivalent of
our like endangered species act these
are species of concern or they're not
listed as being injurious
in the context that they could um really
be a concern as far as an invasive
species
first of all the load of of
trade into our borders is way beyond
the the surge capability of the
wildlife inspectors okay so only a small
percentage
maybe one percent of the shipments are
really actually opened and looked at in
the first place
um and so uh
with and then if they are it doesn't
matter if they're infected with
something because they
there's no monitoring at all so as you
can imagine you know
wherever these animals come from they're shipped in they go to distributors and eventually um you know they get to consumers and um those consumers may have actually different values um you know maybe a more a specialist uh that really is trying to get certain types of amphibians uh maybe very knowledgeable about pathogens or when it you know necessarily release an animal uh they know that being not a good thing but maybe the uh less knowledgeable consumers just would they maybe think it's a good thing to take their salamander they no longer want or their frog they no longer want and take it to the great smoky mountain national park and let it go and be free with its you know with its fellow amphibians out there in this beautiful habitat unbeknownst to them that animals infected with a deadly pathogen from around the world on the other side of the world and then of course we have um um our native amphibians here and i'll touch on this a little bit later but for those of you all that don't know when it comes to salamander biodiversity the united states leads the entire world in salamander biodiversity 50 of the biodiversity of salamanders exists in north america and right here in southern appalachia we are the global hot spot so it's a big concern with respect to something that could impact like b-style that biodiversity so uh it does happen i just went on caudate.org and googled uh salamander
release or or detections and this is a fire bell
a chinese firebelly newt and so this is a posting from a couple people interacting and discussing this was found outside of the san francisco bay area
and uh this particular newt can be infected with b cell it's one of the most traded species that exists out there in the pet trade and it's going around a wetland here okay and um you know this person's you know asking you know is this do you think this could be a concern i left it out there and somebody's coming back and he says well i don't i i'm not i'm not an expert although when i read the the uh the blog uh the person knew a lot about the life history of of salamanders but i see no reason why this species uh couldn't thrive here except for possibly being out competed by a larger native newt species and then you know the guy comes back says you know i'm not i'm not condoning you know releasing these animals in the wild what i'm saying it's unlikely that they could be a threat to other species so it may be true that if you release one animal and it's a male and it's of one species or a female most of our and amphibian species can't just reproduce by themselves uh some can actually but um this one can't and and so maybe they're thinking about it's not really that big of an effect but they're not thinking about the microorganisms on
on them that could have a substantial effect on survival of populations so that's where our work is really focused on a lot um in the last five years is trying to understand the threat um in particular of b-cell to potential biodiversity losses here in the united states if it if if or when it it emerges and so we've been you know fortunately supported by the fish and wildlife service and nsf and and lots of other collaborators state agencies and even private organizations providing funds and uh what i'll just do is i'm just going to give you a quick overview of this threat just as a case example of why we need to be concerned about pathogen movements and trade and and what we've done again over the last several years is we've tested the susceptibility of 36 species of amphibians to this particular pathogen b cell and biosecure facilities here at ut and a couple of the other collaborating universities and what we've learned as far as our native species is that 72 percent of them can become infected and uh that includes um these most specious families uh so we've got the the the newt families and we also have the lungless fam this is the lung with salamander family which is the most specious and what are our biodiversity lies up in the smokies this is actually a blue ridge two-line salamander that's very susceptible to b-cell but we've also found invasive species
such as the cuban tree frog can become infected
and another highly traded species the mexican
mexican axolotl which is actually dangerous endangered mexico but
it's a big part of the medical and pet trade which we'll talk about
a little bit later and of those you know over a third of the species actually
developed the disease so you do have some species that become infected and
live with it with subclinical infections and even uh may clear the infection
and then you do have about a third they actually develop the disease
and what we did when we did this research was attempt to provide
or attempt to test across the phylogeny that exists within the united states
attempt to get a representative estimate or sample of what invasion might look
like within a community here and i think we did a pretty good job in
doing that and assuming that you know 36 percent of our species you
know could potentially uh develop the disease um
that you've already seen that video over 60 species
in the us and over 140 species in north america
could experience declines and be in threat of extinction if b-cell gets here
so we've done some pretty exhaustive work to demonstrate
that we have a this that here in north america our
uh our communities are composed of of lots of species that could be
suitable hosts and
about a third or a little more of those species could develop the disease and
experience declines or extinctions and so what we did after we did those um initial analyses is that we did some geographic analyses of invasion risk so we coupled our species suitability you know where those species are located that the distribution of species and environmental suitability of b cell within the united states to map risk of invasion within communities so this is the likelihood of infection and you can see that uh the northwest here but uh pretty much the entire united states has excellent climate and suitable hosts there aren't too many places where they would escape the likelihood of a b cell getting into those communities that's just risk of infections so we combine that with risk of mortality of disease developing and the the map changes a little more again the eastern united states being highlighted uh in the western united states being highlighted uh for at high at-risk communities um composed of species that have a high likelihood of mortality and then we combine those to really look at extinction risk and that's what you finally see here in the far right here with tennessee and kentucky and several the southeastern states really you know southern appalachia here having a high risk of extinction as well as again the western united states here um we took that and this is just looking at risk of extinction
and we combine that with um actually species richness where do we expect the greatest biodiversity losses um and as i mentioned before fifty percent of the world's salamanders are in north america tennessee is number two in the united states georgia’s number one north carolina’s number three so i mean all the biodiversity is centered as you can see right here in southern appalachia and we do expect the greatest biodiversity losses to occur within the appalachian region and right here within like the tri corners here um and of course the western united states we expect pretty high biodiversity losses too okay um where are the where are their resistance species are where communities most compose the resistant species not many places okay uh the upper midwest is expected to have uh less declines because they have their dominated their at least salamander communities dominated by a a group of of salamanders that are pretty resistant they're called the mole elements and viscomatity they may get infected but they usually don't develop the disease okay so you know why should we care again this is just building on this justification of amphibians for those of y'all that don't study wildlife or or don't study amphibians is that amphibians are in peril in fact they're the most imperiled class of verbal vertebrates that exist on on the earth
on earth
so um over a third of them are in threat
of extinction which you can see here as
listed by the iucn
and it's estimated that 40 to 50 percent
of the species are in decline in
comparison to 12 percent of birds
and 23 of mammals um
and and we should care because they're
important components of our ecosystems
there's a variety of ecosystem services
that that they provide this is really
that one health connection
um and so they are important in carbon
sequestration and nutrient cycling
the biomass of salamanders in appalachia
can exceed per unit area all the other
vertebrates combined
so you can add up all the biomass of the
salamanders
and then take your bears and your
raccoons
and your your birds that your snakes
that are in an acre and it can exceed
that biomass so as you can imagine
they're extremely important with respect
to
sequestering carbon organic carbon in
their biomass but also nutrient cycling
through their consumption of of
invertebrates so all
amphibians are insectivores and they
take that matter and obviously consume
uh
uh in invertebrates and um and then
defecate that and break those down into
different nutrients and stuff
and so you know the food web is
extremely reliant
on on amphibians so you have various
mammals and reptiles
that are eating amphibians and they
in turn are eating thousands upon
thousands on millions of insects and
that really links into this other aspect
when it comes to public health and so uh
just like bats
um amphibians are excellent insectivores
they eat insects as larvae so in the
aquatic stage
which could be very important for
consuming like mosquito larvae
and they're very effective at
controlling mosquito larvae
as well as adults like this one inch
this this is a cricket frog one inch
cricket frog
um can a thousand of them can eat five
million insects per year
so you can have substantial control uh
of of insects some of these which have
you know agricultural pest uh
consequences
or connections as well as links to
zoonotic pathogens
so they can play a big role in public
health
and they also have tremendous biological
potential
amphibians um are the first land
vertebrates
uh they have existed for uh over uh 300
million years on this planet they've
survived
three mass extinction events including
the one that ended the dinosaurs
and they have a tremendous amount of
potential
biological mysteries locked up within
their evolution
and so um one a couple of
known um aspects of their
of their physiology as they produce
antimicrobial peptides
one discovery made by louise rollins
smith who's down at vanderbilt
university that we collaborate with
she's
demonstrated that some of those antimicrobial peptides can inhibit hiv um some work that was done by john daly and the late john dalia nih uh was uh looking at sequestering some of the skin toxins out of amphibians and um using those for for analgesics and uh so it's been demonstrated that these toxins can uh uh target the the the uh the the the nicotinic and the the opioid receptors uh uh with for for pain pain relief and be 20 to 40 times more potent than than morphine and not be addictive um and lastly um they are there's a lot of work being done with axotolts this mexican axolotl uh with respect to limb regeneration and uh so unlike our cells that become programmed into skin muscle connective tissue cells they can never go back to the original stem cells amphibian cells are different amphibian cells can change back into undifferentiated cells like stem cells and help regenerate limbs and so right now there are there are various uh medical professionals scientists that are attempting to understand how that program occurs and can we replicate that to be able to grow organs or to grow limbs or etc in humans so there's a lot of biomedical potential and among a variety of other areas of research that folks are doing they also as i mentioned play a big role in the food and pet trade and lastly you may have heard that
amphibians are good ecological indicators and the reason is and that's true the reason is because they use both the aquatic and the terrestrial environments they're exposed to stressors in both environments plus they have that semi-permeable skin where they can absorb you know various uh toxins etc um in the chemicals in the environment so there if you see amphibians dying they could be good ecological indicators for other wildlife species and humans for that matter but with that that's our model system um you know amphibian trade is just our attempt to really get at a bigger question which is you know global wildlife trade and so this uh article that was published in national geographic i encourage you to go and take a look at it by jonathan colby right during the admits the uh the coveted pandemic he published this and raise the concern about um you know every year 200 million live wild animals are imported into the us every year and the global movement of animals without any um requirements for clean trade is asking for negative impacts on wild populations on domestic populations and on human health and um i mean we just lived a pandemic that from a pathogen that evolved in bats right and and so uh these these species jumps
have occurred multiple times in history they will occur again and uh the unregulated trade um of the the lack of requirement for clean trade and the support of government for clean trade is uh is really um uh is needed and has been for a long time and and so we need to to begin to understand pathogen movements and wildlife and start thinking about clean trade and i i stole this from the one health initiative uh presentation website and um you know just to to recap uh for those that um um may not be aware is that is that as far as emerging infectious diseases 75 of emerging infectious diseases are zoonosis okay they they move between animals and humans and of that about 70 percent of them come from wildlife so around 50 percent of the emerging infectious diseases associated with zoonoses are wildlife derived okay so it is you know it's critical that that we think about uh pathogen movement and trade now this uh used to be a big number to think about when we think about how zoonosis impact um the us economy of causing around seven billion dollars per year in losses but now with covid and the coveted emergence it's kind of almost laughable um that's a big number seven billion but when you think that the estimates out of harvard are someplace close to 16 trillion by the time this pandemic ends you know that's 90 percent of the
annual u.s gdp
you know so movement of
of zoonotic pathogens in trade
their emergencies and the consequences
on on economics are substantial
and the key is early monitoring
detection and control
okay and eradication you don't want to
wait until it gets into your general
population of humans
or wildlife for that matter because
controlling it as we all saw
is very difficult it's very political
it's
a challenge okay so we want to be able
to monitor and respond
all right so let's uh quickly turn here
towards the last part of the
presentation i see we’re at 1250
to what our system sort of looks like
and um the uh
and how you know it may move and it's
really this trade system the amphibian
trade system is like most wildlife trade
systems where you have
imports that can be coming from legal
and illegal pathways
um they're moving to distributors
they're uh they could be going to
breeders uh
one unique thing about the amphibian
trade uh
industry is that they also have
hobbyists so you may have some folks
that just have maybe
five ten tanks and that there's a whole
hobbyist group
as opposed to a commercial breeder and
then of course you've got retailers like
petsmart and other places like that
um and of course the consumers are
interacting here right so they're
purchasing from this trade network
okay and uh when we think about
um you know when we think about the threats to
wildlife it's really this network itself
um as well as the consumers both have this
opportunity to have spill over to the
natural ecosystem
uh either through deposition of of contaminated
aquarium contact uh contents into the environment
or release of unwanted animals um and so
um we've got this opportunity for spillover
and the really cool thing scientifically
uh kind of the edge
of i think our proposed research is really looking at how humans
affect and modify the movement of pathogens
the amplification of pathogens across across this network so how do
you know how do consumers make different decisions that drive
industry dynamics you know to if that could affect
um you know pathogen movements and amplification how can government
uh policies change that how can industry strategies change those dynamics
and right now we don't have a good model to do that and so that's what
we've proposed to do over the next several years uh for the one health initiative project is just a sliver of that okay
um just to get some preliminary data so you know ultimately you know the kind of big questions is you know what is pathogen prevalence in international shipments and domestic trade
what factors in industry and nodes
contribute to amplification

how are factors driven by the social economic feedbacks of industry and consumers

what's the willingness of industry or consumers to implement strategies to use to reduce disease risk and what is the you know the the non-mar the perceived non-market value of wildlife in this case amphibians

uh that the public has or consumers have and so as you can imagine there's uh you know what you saw from one of the first slides we have

a group of economists social scientists mathematicians ecologists that are working together to attempt to start to tackle this question for this system that can hopefully be applied to um later to other trade networks and so this is what we propose for our one health initiative grant

is to get initial estimates of pathogen prevalence in the amphibian pet industry um obtain estimates of of total trade volume economic value and husbandry practices in each of these these nodes of the of the industry and the connectivity of those nodes um and to evaluate consumer preferences and and also then to build a simplified model using our sampling that we do within industry

use a model to basically say this is where we should be focusing our efforts in the future on sampling as we begin to roll out the larger project the larger project has been proposed nsf uh deb division environmental biology
the id program and uh we just found out unfortunately this morning um that uh we weren't ranked as highly competitive the highest ranking you can get uh from this panel but uh that it wasn't supported um and so they want a few more details on some of our methods and they also said they ran out of money unfortunately so um we're excited to revise the proposal and resubmit it and uh hopefully bring these funds to the university of tennessee uh with that i'm at 12 55 i do have like another probably 15 slides to go through but uh we're at the end so i'll just open it for questions and so let me actually so uh flip to the end this is just going through how we're going to do everything so it's you know just basically methods we can uh discuss offline share a proposal um and and how sampling can work thank you for providing those nina i'm sorry to get to talk about with a really good illustrations of how we can identify the network um and where we are right now so we have been in discussions with the pet industry we have weekly meetings with them they've been great and very eye-opening with respect to the uh the implementation of this project and we've got some really good partners they're willing to champion this for they're kind of leaders in the industry which is cool that's the nsf grant i wanted to end oh yeah oh john nash with uh game theory the super interesting cool part of the
modeling aspect
that we proposed that Nina was a big part of
um and but this is where we kind of want
to be at the end
is you know to help develop this
knowledge is in a predictive capacity
and partnerships necessary to establish
clean trade
you know and and you know have that
ultimately be supported by
ideally by the federal government to
facilitate the program
but not just amphibians you know
wildlife wide i mean this is what
really needs to be to be done and so
with that i'll leave it on that slide
for questions
and sorry for running a little bit late
i meant to leave more time but i don't
have anything after this for anybody
that
wants to stay on longer
thank you um does anybody have questions
you can either type them
in the chat or or just unmute yourself
and ask
so i do want to point out that and i'm
sorry i got cut off earlier
this is an excellent example as i know
matt already pointed out
of of one taking a one health approach
and i hope that that's obvious to
everybody
so it's clearly something that
uniting across across
disciplines and building
a team that will do something that's
going to have
far-reaching effects
stop the share there
and see everybody
any questions
and also if nina or neelam i'm not sure
if new one's still on
if either of you want to add anything
you can go ahead
thanks matt i thought you gave a great
talk on the the system and what we
wanted to do thank you
the real fascinating part of the
proposal is is the modeling stuff
[Laughter]
yeah this is joshua oh yeah
good match this is a great presentation
i learned a lot from this and um i i got
a question for you because i'm working
on the climate change
uh a lot and uh there is one is
involved to the uh a heat wave caused
the
waterborne disease uh well that
to linkage to the your result or you
consider that
to be a part of your model maybe nina
and
nina you have
yeah um so we we didn't propose that
uh that's something we could maybe
incorporate um
you know but these are captive systems
so they're relatively climate controlled
uh we didn't model anything outside of
the captive network that was our goal
and so they're kept under pretty strict
kind of
climate conditions based on the needs of
the species
but there's no doubt that um climate
change
um can impact uh the likelihood of
emergence of pathogens across
multiple sp uh systems including
amphibian diseases
and we expect okay we'll see anina we
expect that to have uh
different effects on different species
or even different pathogens so there are
some pathogens
such as rhinoviruses you increase the
temperature you increase the replication
rate you increase the pathogenicity
but for example for b-cell um
it's actually a fairly cool-loving
pathogen and if it increases up to you
if you even have an amphibian increase
it above 22c
it tends to clear the pathogen and
that's just thinking about temperature
moisture itself also can
uh affect the likelihood of transmission
um especially with the amphibians so the
more moist it is more humid is maybe the
environmental persistence of the
pathogen is greater so
uh climate change is really important um
you know and and it's a really good
point we do have some work where you saw
those
um you saw the risk map so the next step
with those risk maps
um that we're collaborating with bill
sutton at tennessee state university is
to incorporate
climate change into risk
thank you hey
i do wonder though that's a good point
and so
sometimes these species are collected
from the wild correct
so might there you might there be some
impact that we might see pathogens we
didn't
expect to see more likely to be
in the trade route with yeah
potentially yeah depending on how
they're holding them in captivity and
that could be
temperature humidity dependent but also
just you know how are they circulating
the water
you know their biosecurity practices the
density of the animals
and that's really the nitty-gritty of
our proposal is to try to understand
those basic husbandry animal care
practices
that would facilitate that would cause this
like magnification the pathogen within a
facility
and to build models that would say okay
these are the key points
you know that basically industries
making this decision and this is how
they could change
humans could change the dynamics by
changing those few factors is
ideally you know that's that's the goal
hey man i i feel kind of a naive
question uh you mentioned
the water animal trading
not much inspection was done to look at
the pathogens
so so what what what what what kind of
is
inspection they're actually useful
to prevent the pathogens being treated
around
okay so what kind of inspections are
done with wildlife
the only inspections that are done are
to make sure that we are not importing
or exporting
species that are not allowed to be
imported or exported
based on their species status and their
listing
here in the united states or listing um
globally
from an endangered species sort of
standpoint
um so there is no requirement for
wildlife
to to test them for pathogens
um so it's the only thing that's close
that our fish that are not aquaculture
uh
y
they consider usda considers them a part of
agriculture and so they will
do the inspections now the
infrastructure is all there
usda could just inspect you know
wildlife inspectors could
inspect um you know for the species
composition of of a shipment and then
usda could simply make sure the animal
health certificates are there or they
could
train fish and wildlife service to do
that but it's like that simple of a
solution
of okay we require animal health
certificates
and we're going to give the authority of
the fish and wildlife service to do it
for wildlife
so while you're doing your wildlife
inspections just make sure they have
these animals
that is a solution period i mean that
would solve it
but it's amazing that something so
simple like that
cannot be accomplished um they just look
at each other like
it's not my responsibility not my
responsibility so
we've got this open floor okay i assume
that we will see
some sort of in the future and that's
the goal some comprehensive um
you know legislation would be put
together to have to facilitate
clean trade you know like there is for
agriculture
because that's what's needed you know to
do it the thing is is it's
to be fair um it's like okay fish and
wildlife service
now this is your responsibility but it's not like you just say it's your responsibility you've got to have the inspectors you got to have the resources and if that tanks the entire industry um because all of a sudden you go from a 5 amphibian to a 30 amphibian because you have to have molecular testing done well that's you know you're destroying the industry so there needs to be government support in that capacity so our goal is to actually estimate the cost the worth of the amphibian pet industry or trade industry here in the united states and the cost of what would take to implement these different strategies what would be the most effective strategies so that you can you know approach this issue you know with um in the response to it and and maybe future programs with with more information right now there's zero information for them it's it's amazing when you talk about this to think about all the potential risk of oh yeah the packaging around yeah yeah no doubt yeah thank you for a very nice talk okay it looks like we just have a few folks left uh any other questions yeah okay looks like that's it yeah all right thanks we'll see you later