Sustaining Life: Biodiversity and Human Health

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Eric Chivian *founder, Center for Health and Global Environment*
Noel Michele Holbrook *professor, biology, Harvard*

http://forum-network.org/lecture/sustaining-life-conversation

Good evening and welcome
to the Museum of Science.
I'm Lisa Monrose, producer from the
Lectures and Special Programs department,
and I'm happy to welcome you to the
Reno Family Foundation Symposium,
which is part of our
celebrity science series.
The museum is very honored to host
tonight's guests. In 1980 Dr. Eric Chivian
co-founded International Physicians
for the Prevention of Nuclear War,
which was awarded the
Noble Peace Prize in 1985.
Dr. Chivian founded and became
director of the center for health
and the global environment
at Harvard Medical School, in 1996.
This is the first center
in a U.S medical school
to focus on the human health affects
of global environmental change.
Under Dr. Chivian's leadership
the center co-ordinated
an ambitious international
scientific effort, to record
what was known about how
other species contribute to human health.
The result - was 'Sustaining Life - How
Human Health Depends on Bio-diversity'.
This book, published earlier this year, is
the most comprehensive report available
on the relationship between
human health and the natural world.
Vice President Al Gore called 'Sustaining
Life' "The most powerful argument
I have ever seen for the importance
of preserving bio-diversity."
Joining Dr. Chivian in conversation
tonight is another notable luminary,
in the field of Biological Diversity,
Dr. Michelle Noelle Holbrook.
Dr. Holbrook is the Charles Bullard
professor of Forestry, and a faculty member
in the department of Organismic
and Evolutionary Biology at Harvard.
She has published more than 120 papers
in international journals, and serves on
the editorial boards of 'Plant Physiology',
and 'Plant Cell and Environment'.
Dr. Holbrook's research focuses on
the productivity of plants under drought.
She has made major contributions to
the bio-physics of water transport implants.
She believes that greater understanding
of photosynthesis and plant biology
is critical for addressing
environmental challenges
related to the sustainable use of water,
land and other natural resources.
According to Dr. Holbrook we are at a very
serious juncture in the history of earth,
for a potentially large amount of
biological diversity to go extinct.
I hope people come away from
tonight's program thinking there is hope.
As you all know,
Dr. Edward O. Wilson
could not participate in tonight's
program because of a family emergency.
We would like to take a moment
to acknowledge the work
that Dr. Wilson has done in collaboration
with Dr. Chivian, especially in the effort
to educate the public about the
importance of our planet's bio-diversity.
Along with Dr. Chivian, Dr. Wilson
has been a prominent force
in the movement to address
the important relationship
between bio-diversity and human health.
This past June, Doctors Chivian and Wilson
appeared together before the U.S Senate,
to apprise senators on bio-diversity laws
and the implications for human health.
With input from Doctors Chivian and Wilson
Senator Joseph Biden drafted
and submitted a resolution
calling for The United States
to assume a leadership role

in international efforts to protect
biological diversity world-wide.
This resolution was passed unanimously
by the Senate Foreign Relations committee
And will be taken up by the full senate,
most likely early in 2009.
We congratulate Doctors Chivian for succefuly
demonstrating that bio-diversity is not just
a moral, ecological and economic issue, but
also one of major importance to human health.
Please join me in welcoming
Doctors Chivian and Holbrook.
Thank you so much, lisa,
for that wonderful introduction.
I am absolutely delighted to be here tonight,
for the Boston Museum of Science has played
an extremely important role in my life.
It was here in the museum shop,
21 years ago this coming December, that I
first met my wife Jake, the love of my life.
So I owe a debt to the museum
that I can never-ever fully repay.
I'm very sorry that Ed Wilson
could not join us this evening,
he is truly one of the great minds in
biology and science of the last many decades.
Really, a true heir of
both Darwin and Linnaeus,
and he would have added immeasurabely
to the richness of tonight's program.
But I'm delighted that Professor Holbrook,
my friend Missy, is here, because
the two of us share a deep love for trees
and for the town of Petersham, Massechusetts.
But I must admit that speaking about
bio-diversity in front of Ed can be,
sometimes, a bit unnerving. It's sometimes
a bit like giving a lecture on painting
with Degas sitting in the front row,
staring at you while you're speaking.
So, I want to open my talk with a story -
It seems that when
George Bush was visiting Alaska,
Sarah Palin invited him to go bear hunting.
So they got in her Hummer and they drove to
a nearby mountain and they waited
with their shotguns loaded,
and after a while a large brown bear
came into view and both Bush and Palin
raised their guns and aimed and when the
bear started coming toward them they fired.
But both triggers stuck at that point, and
as the bear started charging, in unison,
President Bush and Governor Palin
began to pray. They said "Dear Lord,
we have always been
your humble servants.
Dear Lord, please, please
make that bear a Christian."
And just at that moment the bear
put, came to a sudden halt,
and it put it's huge paws together, and it
looked up at the sky and it said:
"Dear Lord, I thank thee for
the gift I am about to receive."
So as you can probably tell
I'm rooting for the bears.
But I'm rooting for the bears
because they are truly remarkable
creatures, valuable to human
medicine, which you will soon hear.
In the 1980s, as Lisa mentioned, with
three other Harvard faculty members,
we started the International Physicians
for the Prevention of Nuclear War,
And the most important contribution of the
tens of thousands of physicians who were,
eventually, part of this federation,
was to help people grasp
what a nuclear war would really be like, so
that they knew that these weapons were so
catastrophically destructive that they could
never be used in war time, and so
that they would do everything in their power
to prevent a nuclear war from occurring.
And physicians did this by translating
the abstract technical science
of nuclear weapons' explosions
into human health terms.
That is, into concrete, personal terms
that people could really relate to
and understand. And as a result,
I think those efforts really helped
change public opinion and
change, indeed, public policy.
But with changes to the global
environment, like climate change
and the loss of biological diversity,
the level of complexity and abstraction
is an order of magnitude greater
than it is with nuclear weapons.
And the changes occur slowly and
on a global scale, and are often
very hard to see over natural
fluctuations, like those in temperature,
or precipitation, or which species
are present and which are not.
Particularly for those of us

who live in urban settings
in wealthy, industrialized
countries like this one.
And it is therefore even more essential
for physicians to be involved
in helping the public
understand the implications
of these global environmental
changes for our lives.
We have no Hiroshimas or
Nagasakis to serve as models,
and the task is made
much-much more difficult
because there is such a
fundamental misunderstanding
that most people have about the environment.
That human beings are separate from it,
that it exists outside of us,
and therefore that we can degrade
the oceans, and atmosphere and soils,
and lose countless species in the process,
as if these changes had no
effect on us whatsoever.
Almost as if they were happening
somewhere other than where we live.
And this, in my view, is at the heart
of the global environmental crisis.
Now, my parents told me many things
about being a person of good character,
but one that has always remained with me, is
"never be guilty of blowing your own horn".
Clearly, I have not listened
to them, as you shall soon see.
So you must please forgive my blatant and
shameless act of self-promotion this evening,
as I tell you about our new Oxford
University Press book, "Sustaining Life".
But I, and the more than a 100 leading
scientists from around the world
who put this book together,
are enormously proud of it,
and I can honestly say that I have never
worked harder on anything in my entire life.
So, let's see if I know how to work this.
OK. Where?... Here it is.
So I need to mention here that Ari Bernstein,
my fellow editor and lead author,
this brilliant young physician.
The book could never have been
put together without Ari.
So, this is the cover of our book,
with Art Wolve's spectacular photo
of a Blue Dart Poison
Frog, Denderobates Tinctorius,
comes from Suriname and
other parts of South America.
And we chose this photo, not only because
amphibians are among the most endangered
of all groups of organisms on earth, with
some one third of all known species
at risk of extinction, and because they are
enormously valuable to human medicine.
This frog's toxins, for
example, are very useful
in understanding the action
of local anesthetics.
But we chose this photo because clearly
it is a totally gorgeous photograph,
and the frog, if you look carefully,
it seems to be admiring our title.
And if you look very carefully, you can
notice that he may even be smiling,
because he's noticing that the world's
most famous ant biologist,
who studies Tinctorius's favorite food,
has written the forward of this book.
So, more exquisite design from Oxford, lots
of jacket quotes, Lisa read you
Al Gore's quote, from Bill Moyers and Gro
Brundtland, Harold Varmus and others.
So, it was an enormous challenge, to decide
how to organize the material for this
ambitious project. We wanted the book to
stand on it's own as a reference for scholars
in ecology and medicine,
as a resource for those
who are concerned about the natural
world and about human health,
buy may not have the technical
background, including policy makers
and some environmentalists.
And also as a textbook,
for classes in high-schools, even,
and colleges and universities.
And I'm going to go rapidly through
the cover plates of the chapters,
so you can get an idea of what's in the book
before getting to the heart of my talk.
So this is chapter one -
'What Is Bio-diversity'.
And one must always show an image
of beetles when asking this question,
as there are some 350,000
known beetle species,
more than 6 times the number
of all vertabrets combined.
Each of the chapters has a
full-page color plate like this one,

of the highest quality four-color printing,
and there's some 20 more
in the book, for a total of 30.
This is chapter two,
showing the Gulf of Mexico,
and the outflow of the Mississippi River.
This is the chapter on how is bio-diversity
threatened by human activity.
We show this because it's forming
the nutrients from the Mississippi
flowing into the gulf, the brown is sediment,
but the green are algal blooms leading
to dead zones, so this is a complex cascade
of things that lead to loss of bio-diversity.
Chapter also covers, of course, loss of
habitat over exploitation, invasive species,
pollution, conflict and war,
and of course, climate change.
This is chapter three.
On ecosystem services.
And this is a photograph of women,
pollinating, hand-pollinating apple blossoms,
This is from the Maeotian county
at the border of China in Nepal,
and they're doing so because the
bees in this area have gone extinct
from an overuse of pesticides. This is
an especially moving picture to me,
as I keep bees on a small, almost
fully organic, air-loom fruit orchard
in Petersham, Massachusetts. And it's,
as I mentioned, the front plate
of the chapter on ecosystem services,
which looks at all the ways
that nature keeps all life on this planet,
including human life, alive.
This is the chapter on medicines from nature.
These are cone-snails, I'm gonna talk more
about them in a moment.
The chapter looks at medicines
that come from plants, animals
and microbes, on land and in the oceans.
This is chapter five, on bio-diversity
in bio-medical research.
Many of you may recognize, this is
Drosophila melanogaster, the Fruit Fly,
which has been one of the most
important organisms in genetics research.
It's, it's basic understandings from studying
this organism have led to our ability to,
to understand the genome of organisms,
including the human genome.
And it's the front plate of chapter five.
This is chapter 6, which looks at seven
groups of organisms that are threatened,
and looks at the contributions they've
made to medicine, and, of course,
those that we expect them to make
if we don't drive some of them to extinction.
This chapter looks at bears, amphibians,
sharks, non-human primates, cone-snails,
and gymnosperms, and horse-shoe crabs.
I'll get back to some of that in a moment.
This is the chapter on bio-diversity
and infectious diseases. This is from
a 1901 folio published by The British
Museum, these are anopheles mosquitoes
that carry Malaria. Number 15,
this gal here, is Anopheles Gambiae,
which is the principal
Malaria vector in Africa.
And this chapter organizes
the material in a way that
we don't believe has really been
done before, looking at the diversity
of pathogens, of vectors that
carry the disease like mosquitoes,
and also the hosts that serve
as reservoirs for infectious agents.
This is a chapter on
bio-diversity in food production,
making the point that soils
are incredibly rich ecosystems,
about which we understand not a great deal,
particularly at the microbial level,
but how all kinds of organisms
contribute to making soils fertile.
This chapter looks at
growing land on food,
and also in aquatic systems -
fresh water and oceans.
Chapter nine is on genetically modified
foods and organic farming.
This is my friend Fred Kirschenman,
standing before his 3,700 acre organic farm,
in the state of North Dakota,
which he has run for over 30 years.
This is buckwheat in the foreground,
these are some of his hedgerows.
Fred is a totally organic
farmer on a very large scale,
his yields almost the same, or as the
same, in good weather, and his yields
are much-much better during drought
conditions, than his conventional neighbors.
And finally, chapter ten. This is a man in
Haiku, China, recycling plastic bottles.
This is the chapter on what individuals

can do to help conserve bio-diversity.
Quite a remarkable individual.
And we think this offers a really nice guide
to the kinds of choices people can make in
their homes, and in terms of transportation,
in buying foods, etc. to help
protect species and ecosystems.
So what I thought I would do
with my remaining time
is go over some of
the book's case studies.
Stories that illustrate what we have
already lost, and what we may lose
with a further loss of bio-diversity,
if we don't turn some of this around.
So, going back to bears.
I wanna talk about Polar Bears.
These magnificent creatues,
the largest land carnivores,
an adult male can weigh 1,300 pounds,
and standing up can be 11 feet tall.
They evolved at roughly the
same time that we did,
some a 190,000 years ago,
evolving from brown bears.
It's predicted that they will be extinct in
the wild by the end of this century,
if not before, largely because of the melting
of the arctic ice-sheet, from global warming.
So the reason is that the main
food supply for polar bears are seals.
And with an intact ice-sheet
they wait at blow-holes
for seals to come up for air,
and then they grab them.
So if the ice is melted all over,
the seals can then come up for air here,
and evade being captured by polar bears.
And polar bears are losing weight,
and some are starving,
and populations are dropping
in parts of the northern regions,
and that's caused great concern.
So, polar bears have become iconic figures
in discussions about global warming,
but their medical value is
almost never mentioned.
So these are hybernating, or what's
called 'denning', black bears.
And like all bears that hibernate, and I
use the word 'den' instead because
bears don't fully hibernate,
their metabolism drops,
their temperature drops, heart-rate drops,
they become somewhat less responsive,
but unlike woodchucks, which go into a very
deep slumber and have a very low metabolism,
bears are fully, hibernating bears,
or denning bears, are fully arouse-able,
as some bear biologists have
discovered to their dismay.
So denning bears are essentially immobile,
for periods of five, and even seven months.
And yet they don't get Ostioporosis.
Every other mammal, including us,
if we're immobile, if we're in a
hospital bed or we're paralyzed,
or we're not moving around much, sitting
in front of our computers or televisions
and not going out for walks - we lose
a third or more of our bone mass
after five months of immobility.
There's a process where
there's cells that are breaking down bone
and laying down new bone all the time,
it's a dynamic process, and the breaking
down of bone process speeds up,
and overwhelms the laying
down of new bone.
Osteoporosis is an enormous
public-health problem.
For the elderly, especially,
for post-menopausal women.
It results in more than 70,000 deaths
in The United States every year,
it costs the U.S economy more
than 18 billion dollars a year
in direct health costs and lost productivity.
Denning bears have compounds in their blood
that prevent them from getting osteoporotic,
no one fully understands how this works.
But if we did understand that, we
might be able to treat, or even prevent,
this very difficult and
largely untreatable disease.
For any of you have... who have bone
thinning, you know you can take medications
that prevent the continuation of the
loss of bone. Obviously we can exercise,
we can take Calcium, we can take
Vitamin D, all of that's helpful,
but largely it's an untreatable disease -
you don't lay down new bone.
Denning bears also don't eat,
drink, urinate or defecate,
for periods of five to seven months.
They are physiologic evolutionary marvels.
They don't drink but they

don't become dehydrated,
they don't eat but they
don't starve, they don't urinate
and they don't get sick from that. If we
don't urinate for a few days - we're dead.
The build-up of toxic urinary waste
is... shuts down our metabolism.
Many... you get organs...
severe organ failure.
There is no treatment for chronic
end-stage renal disease,
except dialysis or a kidney transplant.
There's no medicine one can take
to cure the fact that one's kidney
cannot get rid of urinary waste.
End-stage renal disease kills 80,000
people in The Unites States every year,
Costs the U.S economy 27 billion dollars.
We don't really understand how denning bears
prevent themselves from becoming uremic.
They break down the urinary waste, the urea,
they make new proteins from the amino-acids
that come from that bio-chemical reaction.
Finally, polar bears become
massively obese prior to denning,
and yet they don't develop diabetes type-2.
When we become massively obese
there's a metabolic shift
in the way we handle fat
and they way we metabolize
sugars, like Glucose.
And our cells become insulin-resistant,
we come... become diabetic.
No one understands how they are...
do not become diabetic
even though they're massively obese.
We have to study all these things in the wild
so if we lose polar bears in the wild,
we will lose, perhaps, a secret
of something that kills... a disease
that kills a quarter of a million people
in The United States every year.
Obesity-related diabetes type-2
is virtually epidemic in The United States.
16 million Americans have it,
almost six percent of the population,
I'm sorry, five percent of the population.
So, I wanted to go back to those cone-snails.
This is a species called Conus Bullatus.
Cone-snails are a large group of
predatory snails, they live
in tropical coral reefs,
mostly in the south-pacific.
And they, they attack their prey
both for food and also for defense
with poison-coated harpoons.
They fire these at their...
at things like fish, or
other mollusks or worms.
They paralyze them and then they bring their
prey into their stomachs and digest them.
So there's some 700 cone-snail species.
Again, this is an evolutionary marvel,
and explosion in evolution, they've
only been around 30 million years or so.
Each of the 700 species
is thought to make
a 100 to 200 distinct poisons,
to coat these harpoons, each one.
And they release a cocktail of these
when they coat the harpoons.
So there maybe as many as
140,000 poisons in all.
Now, they're peptides, they're
like the poisons of sea-anemones
or spiders, or snakes, or scorpions.
Except, unlike those, they're
so much more numerous,
they're very potent
and they're very selective.
They attack receptor sites
on cell membranes
that regulate the function of cells,
or heart cells, or nerve cells.
And only six species out of 700 have
really been studied in any detail,
only about a 100 out of maybe 140,000
toxins have been studied in any detail,
and there are several new
medicines that are in clinical trials,
because they seem to attach
themselves to almost all the known
human receptor site molecules.
Acetylcholine, Neuro-adrenaline, Vasopressin,
All... all types of different...
sub-types of those.
So the best work has... the most important
work that's been advanced is...
comes in terms of pain relief.
There's one cone-snail toxin,
it's a synthetic form, that's now
on the market, it's called Pre-Alt.
Let me tell you a bit about it.
It's a pain killer,
it's a 1000 times more potent than morphine,
but what's more important than that,
is it doesn't cause
what's called 'tolerance'.

So, the big people in treating
people with severe ongoing pain
is that you have to keep giving them
more and more opiates, like morphine,
and you run into two problems. One is that
you can run into various side effects,
like respiratory depression,
or you develop tolerance.
Very common when you keep increasing
the dose, because the pain's not going away.
And the morphine becomes
less and less effective,
so there are millions
of people around the world
in severe chronic pain that morphine
and opiates can't really help very well.
And so that the discovery
of a molecule like this one,
this, it's a calcium channel blocker from
cone-snails that doesn't cause tolerance,
it's a discovery that is almost akin
to the discovery of penicillin.
It's a huge watershed event in medicine.
Let me talk to you about infectious
disease and bio-diversity.
So, this is about Lyme Disease. It's a map
of The United States, about, 2004.
And each of these... each of
these dots is a case of Lyme.
And you can see how Lyme
is very much concentrated
in the middle-Atlantic states, in
southern New-England, where we are,
very big dots on Martha's Vineyard
and Nantucket and on Long-Island.
A collection of cases in the upper
Midwest. A smattering of them...
A smattering of them in the southeast,
and some in the upper pacific,
northwest, and California. And if
you look at this distribution carefully,
you'll notice that it matches that of
the blue states in the last elections.
And this fact has caused some to conclude
that Lyme disease may be affecting
a part of the brain positively,
that deals with improved
intelligence and judgment.
Just wanted to see if
you were paying attention.
So, Lyme is the most common
vector-borne disease in The United States,
some 20,000 cases, there are also a
very large number of missed cases,
it's sometimes very hard to tell,
Lyme starts with a flu-like illness,
is almost identical with flu, only 70-80
percent of the people get the rash,
so if left untreated Lyme can be a major
problem for cardiovascular system,
neurologic system, and joints, and it's a
major disease of importance in this country.
Now, it was noted that in areas
where there was little bio-diversity,
vertebrate diversity, there was an
increased number of cases of lyme,
increased incidents of Lyme.
And some very elegant field work
by some of my colleagues,
Rick Osfeld and others,
at the Cary Institute of Ecosystem
Studies in New-York,
really tried to understand why that was so,
and they came to a very elegant, and I think,
the right explanation, and the
literature seems to be bearing this out.
So, so the tick... The Lyme disease
involves this organism as the vector,
the Eastern Black-legged Tick. It's a
very small insect for those of you who...
who have seen it. And this organism,
which the, is the White-footed Mouse.
This is the main host for Lyme in this area.
Now, the tick bites anything that crosses
it's path, a chipmunk, a squirrel,
our cats, our dog, birds, even
reptiles, and of course, us.
And it passe son, if it's infected
with the bacteria that causes Lyme,
passes on that disease to whatever it bites.
But we are a dead-end host. In other
words - a tick bites us, gives us Lyme,
and it's in our bloodstream, we get the
disease, but if another tick bites us,
it can't pass that infection on to another
organism. So we're a dead-end host,
or a totally incompetent host.
So, the most competent host
is this white-footed mouse which does
very well in degraded environments.
But most, if you have a lot of
vertebrate diversity in the forest,
squirrels and chipmunks, and birds and
other organisms that the tick is biting,
most of those are less... all of those are
less competent than the white-footed mouse,
and many of the are incompetent
or even dead-end hosts like us.

So, what happens is, if you have
a lot of organisms in the forest,
or at the edge of the forest,
the tick is biting all of them
and the infection gets diluted
in this great pool,
most of which do not keep
the cycle of infection alive.
So that's why when you have great
diversity of vertebrates in forest, the risk
of a tick being infected, and the risk
of our getting Lyme, is less. Is that clear?
OK, the other thing that happens,
is if you have a lot of vertebrate diversity,
you have organisms like...
like red squirrels and chipmunks
that are competing with the
white-footed mouse for food,
keeping it's population down, keeping the
most competent host's population down.
And you have all kinds of organisms
that are predators of white-footed mice -
weasels, bobcats, foxes, hawks, that
eat white-footed mice, snakes,
also, keeping the population down, so
there's a less risk of our getting lime. OK.
I want to end my talk by talking about three
more stories, and they're all about frogs.
Started with frogs,
and we'll end with frogs.
So, this frog, this is a living
organism, hard to believe.
This is the Waxy Monkey Tree-frog,
Phyllomedusa Sauvagii.
It's found in dry prairie
regions of South America.
Now, frogs have anti-microbial compounds
that they secrete by their skins,
that protect them against infection.
They don't have the elaborate antibodies
and kinds of immunity that we have.
A class of these, in this particular
frog, are called Dermaseptins.
And they have shown very potent activity
against some of the fungal infections
that cause fatal illness in people
with compromised immune systems
like those with H.I.V - Aids. But what maybe
more important is that these and other frogs,
these antimircrobial compounds
that they secrete
have been working against bacteria
and fungi and other infectious agents,
for over 250 million years, without
these organisms developing resistance
to these antimicrobial compounds. Now,
one of the crisis that we face in medicine,
and I'm sure many of you have
read a great deal about this,
is that the antibiotics that
we have, bacteria especially,
are very good at evolving ways of
developing resistance to these chemicals,
and we are chasing, trying to be one
step ahead of the... of the organisms.
And now there's some bacteria, for example,
some strains of Staphylococcus Aureus,
which people can get in hospitals,
or some strains of Tuberculosis,
and some strains of other organisms that
people are getting in intensive-care units,
Gram-negative bacteria called Klebsiella,
which none of our antibiotics work against,
none of them. So this is an ongoing crisis.
So people are very interested in these
antimicrobial compounds - how they work,
and yet don't lead to antimicrobial
resistance being developed.
Very interesting problem, and some of these
frogs may hold some of the solutions to
this ongoing medical potential emergency.
This another real frog, believe it or not.
This is the Crucifix Frog.
This actually is a...
forms a cross on it's back.
It's also called The
Holy Cross or Catholic Toad.
It's found in Southeastern Australia
and for as long as nine months of the year
it lives underground, in dried mud.
It emerges only during terrential rains,
and when it emerges it's totally vulnerable
to being attacked by biting insects.
And it secretes this very, extremely sticky,
protein-based glue from it's skin,
that hardens in seconds, catches
insects even when it's totally wet,
in these terrential rains. Now, for the
surgical repair of various human tissues
there's a need for a very strong,
flexible, porous adhesive.
Synthetic glues like Superglue
are enormously strong glues,
but they're generally toxic, they're brittle
and they don't allow for the needed exchange
of fluids and gasses, they
don't allow cells to infiltrate,
and... all of which is necessary

for healing tissues.
Most biological glues are
too weak to really hold
the severe shearing forces of
things like Tom Brady's knee.
So Tom Brady tore his medial...
his meniscus in his knee,
so to repair that, biological
glues are not strong enough.
So the glue from this frog
has starting to be tested in
experimental meniscal tears
that require such a strong glue,
and it's been done in sheep
and it's been extremely effective,
and surgeons are now thinking about
using this in surgical repair.
Finally, the Gastric Brooding Frog.
Two species of gastric brooding frogs were
discovered in the rain-forests of Australia.
The female swallows the
eggs, fertilized eggs,
which than hatch in her
stomach, form into tadpoles,
and when they reach a
certain level of development
the female vomits them out
into the outside environment
where they complete their development
into adults, in aquatic settings.
Now, and then, you know, they mate
and the cycle starts all over again.
So all vertebrates - including
amphibians, including us -
produce substances that begin the
process of digestion in the stomach,
we secrete acids and enzymes
that start breaking down food
as soon as the trigger of presence
of food starts that process going.
And, of course, after
a certain amount of digestion
we empty the food into the small intestine.
So, it was discovered, not
surprisingly, that these tadpoles
secreted a substance or
substances that prevented
these acids and enzymes from being
released so that they weren't digested.
And also, of course, prevented themselves
from being emptied into the small intestine,
which would be the end of them.
And scientists, and medical people
and pharmaceutical companies
were very interested in finding out what
these substances were and how they worked.
Because there are 25 million americans
that have Peptic Ulcer Disease.
And again, we have medicines
that stop the acids' secretion,
quite effectively, Prilosec and others,
but these compounds may have
worked by a completely different pathway,
and may have been much more effective
in treating peptic ulcer disease
and maybe even curing it.
But the studies that tried to
characterize these compounds,
and tried to understand
how they worked, had to stop
before we really knew what the compounds
were. Both species of gastric brooding frogs,
the only ones ever discovered
in the entire world, went extinct.
And those compounds, the identity
of them and how they worked,
that information, which may have
evolved over millions of years,
is gone. Forever. We will never know
what those compounds were - ever.
So, in closing, I want to read from the last
paragraph of the preface in our book,
and from the dedication, because I feel
they will say more concisely and better
than anything I would want to
say in closing. So, form the preface -
"Scientists with expertise in a wide
range of disciplines, from industrialized
and developing countries alike, have been
involved in putting this book together.
We have done so because we are convinced
that it can help people understand
that human beings are
an integral part of nature,
and that our health depends, ultimately,
on the health of it's species, and on
the natural functioning of it's ecosystems.
We have done so because all of us hope that
our efforts will help guide policy makers
in developing innovative and equitable
policies based on sound science,
that will effectively preserve bio-diversity,
and promote human
health for generations to come.
And we have do so, finally, because
we all believe that life on earth is sacred,
and that we must never give
up in trying to preserve it.

And because we all share the conviction that
once people recognize how much is at stake,
with their health and lives and with
the health and lives of their children,
they will do everything in their power to
protect the global environment." -The Editors
And then finally, the dedication -
We dedicate this book to
the millions of plant, animal
and microbial species we
share this small planet with,
and to our own species - Homo sapiens,
who first walked on earth
some 195,000 years ago, and struggled
to survive over the millennia,
to become the magnificent and extraordinarily
powerful beings we are today.
May we have the wisdom and the love
for our children and all children to come,
to use that power to save
the indescribably beautiful
and precious gift we have
been given. Thank you.
You're welcome, let me just say a few words
first, that, how I've come to know Eric.
I teach at Harvard, a... the introductory
course on biological diveristy,
we call it 'Foundations
of Biological Diversity",
because it's more than a survey,
it's an understanding of the processes that,
thorugh the history of life and the tree of
life have brought all of this diversity
into place, but also the processes
that cause it to ebb and flow,
and the whole dynamic processes.
And because teaching in that course...
I came to know Eric because
we invited Eric to come
and be a guest lecturer, and
he does this now every year.
And we've now adopted his book -
'Sustaining Life', this is the first year,
as one for our students. And many of
our students are thinking about their futures
and many are interested in
a carear in... related to health,
public health or medicine, they're not sure.
And we're always trying to connect,
you know, 'why are we doing this' with
what they thinking about their future.
and I got a question last week,
I started lecturing last week,
and a young woman came
up in the very beginning
and she said "well, you're
explaining all this stuff..."
We were talking about microbial
diversity, bacteria and the different
metbolic pathways, the domains of life,
the basics of our entire family tree of life,
and she said "I can understand
there's all this diversity,
but why do I need to know?
Why does it matter
to know about the different metabolic
pathways and this part of the
prokaryotic tree, and immediately
all I could think, you know, it was...
I don't know, but I said "But if we know
that there are differences we may find
treatments, applications..." The easiest
way was to go first to human health.
And then was the go to environmental
health, because a later example I used
several lectures later, had
to do with the arsinic poisoning
public health issue in Bangaladesh, which
appears may have a microbial component
that has interacted with human activities.
So, again, I'm trying to teach them
about the way that organisms interact
with their environment and so...
But the very first thing and
the one that really hits home,
was about human health. And so, we invite
Eric to come and... and lecture in our course
because as you heard tonight he can... He
makes this... Brings it so deep inside.
And he also is, I know it didn't
come up in his biography,
he's also an alumni of the college.
and the students can,
of course, really connect, as I
tell them - you don't know this -
the day before Eric comes we tell them -
"We want you to do great things in the world
and here is an example, and
maybe you will go out and have...
and have a really positive
impact on the world,
so you're actually one of our
rolemodels that we use.
So now we're gonna begin
our conversation, so let me...
You make a compelling case in
the book and... And with your work that
biological diversity and the loss of

bio-diversity is one of the most important
problems and challenges facing our
species. And I guess I wanna ask
why is this not at the top of
the environmental agenda?
There are many environmental
issues that we hear a lot about -
climate change is certainly one that is very
important - I'm not trying to undermine it,
but biological diversity doesn't
appear to get as much discussion,
and I was pleased to hear about the
resolution put forward by senator Biden.
I'm not sure I know the answer
to that. I mean, it's been something
that we've struggled with for a long time.
Many of you know that there was a Rio summit,
in 1992, and at the Rio summit there
was a convention to protect climate,
the Climate Change Convention, which led to
intergovernmental panel on climate change,
and there was also a convention
to protect biological diversity,
a convention on Biological diversity.
So they were both established in 1992,
but there was a major
effort with climate change.
And, you know, major scientific
effort and major medical effort.
The medical community, public health
community, got very involved
in trying to understand the human-health
dimensions of a changing climate -
Heat waves, and precipitation
events, changing insect patterns.
But the same wasn't true
for biological diversity.
And I've never fully understood
that. I have some ideas.
Maybe it's easier... I mean, there was a lot
of discussion at that conference for example,
about other species - about whales,
and about wolves, and, you know,
the so-called charismatic mega-fauna
that we all see on environmental journals,
on the pictures on the front of journals.
But maybe it's easier for us to talk about
whales and wolves and all these beautiful,
wonderful, gorgeous animals and
plants also, than it is about ourselves.
You know, some of you may
know that I'm a psychiatrist,
and I'm not a Freudian, but one
of the most wonderful things...
I trained at Mass General, so Mass General
was very much an eclectic program.
You learned a lot of neurology,
you learned a lot of medicine,
you did learn Freudian theory,
but it wasn't pushed down...
down your throat. but one of the
wonderful things that Freud said,
is that looking at your own death,
is a little like looking at the sun.
You have to turn away
after a very brief time.
And I think there maybe
something of that when we
talk about bio-diversity in
health, you'd think that
scientists and the medical community
would have been on that in a moment,
because, as you and I know,
and I'm gonna talk a little bit later,
it is the most fundemental thing.
In fact, all the environmental
changes that we talk about,
and I'm gonna talk about this
a little bit inclosing remarks,
everything ultimately
affects living systems.
So, climate change, pollution,
a loss of Ozone,
you know, over-exploitation in the oceans,
all of those things eventually
affect living systems.
So you'd think that the most basic and
fundemental focus of this attention would be
on what those impacts on those
living systems would be on us.
And yet it hasn't been, and this book,
you know, I told you I was shameless,
but it's the first book that's really looked
at this issue in a comprehensive way,
and that's very strange, when you think
about it. I think it's very strange.
Because you think it would be
very much more of interest.
Now, one of the other
problems is that a lot of...
In my earlier comments I was talking
about how abstract these issues are,
and complicated. And, there's nothing
more complicated than biological systems.
I mean, for one, you know,
there's some much we don't know.
So it's very hard to have cuase and
effect, there's multiple variables,

some of which you know,
some of which you don't.
So, conversations about the importance
of protecting bio-deiversity, as we all know,
have been on asthetic grounds - the
charismatic mega-fauna, they're beautiful,
we can't afford to lose them, a lot of the
discussion of polar bears is about that.
They've been on ethical grounds -
we have a reposibilty, it's in the bible.
We have an ethical and moral and
religious and spiritual resposibility
to these other organisms.
They've been on economic grounds, you know,
if we lose this it's gonna cost us a lot,
ther've been evaluations in monetary
terms of ecosystem services,
that's a whole other interesting discussion.
And, of course, they've been on
ecological ground, and biological grounds.
But, those are very hard
for people to understand.
And I guess part of the motivation
for us to have done this book,
is that it felt to us that one of the most
direct and concrete ways to reach people
was to talk about health.
And the other thing about it is
when you talk about climate
change on capital hill
all the politcal and
ideological flags go up,
I mean, wea heard it in
last night's debate, for example.
But when you talk about health, it kinda cuts
through a lot of that. Which is very nice.
What occurs to me - and I haven't... I pose
this question becuase it was on my mind
in hearing you talk - is that a lot of what
resonated for me, when you were speaking
was this sense of losing the
unknown, and that's not...
The unknown is certainly something
that scientists pursue,
but we pursue things we
think we can quantify.
Our comfort realm, as a scientist,
is to study things we can quantify
and make sense of.
And yet, what hit me,
listening to you speak tonight,
and every time when you come to class,
is this sense of these unknown riches
that will have value but they're...
Because they're unkown I can't
quantify them. we can project,
You can mention the costs of the health
issues that we are currently facing,
but it's sort of... It maybe
because scientists may have...
Your medical colleagues may have
felt more comfortable thinking
about some of these other
major environmental issues,
because, in fact, they fit more
comfortable into the realm of science,
Right.
- and I don't know if that's true.
Well, in medicine it's
particularly a problem.
There hasn't been a recent study, to my
knowledge, but about ten years ago
there was a study about how
much envrionmental education
the average American physician gets
in four years of medical school.
And it was six hours.
That was the total.
Four years of medical school - six hours.
Most of that was asbestus, lead,
you know, air pollution and astma,
that's about the toal of the six hours.
So, physicians find themselves
not educated on these issues,
and you're right, they won't feel
comfortable talking about things that...
that is outside their area.
So that's a problem.
Another problem, and Missy
and I have talked some about this,
and Corey Dean sort of talks
a lot about this issue,
of the communication of
science to the general public,
and to policy makers, and to the media,
and that... I mean, part of the purpose
of our center was to really try to be
clear and understand what are the
best ways to communicate concerns.
Now, you all know science is becoming
more and more specialzed all the time.
Medicine is becoming more
and more specialzed, you know
a small part of a really complicated subject
and you're the expert on that part.
So, we're not really trained to talk in every
day language, it's not what our education is.
We're trained to talk in scientific language,

technical language, technical concepts.
I mean, I read science and
nature magazines pretty regularly,
most of the articles, I have no idea
what they're talking about.
You know, some I do, obviously some I do that
I follow, but... So, that's a huge problem.
because if scientists who are
very concerened about an issue
can't make themselves understood,
especially to people on capital hill
or the political leaders, or to the public,
or to the media, then we're in trouble.
And to some extent that's
happened with bio-diversity,
and to some extent that's happened
with climate change.
It's they're complex, abstract topics.
- So is this something that
when you were putting together this book
and assembling, this was a 100 plus
leading scientists, and they're all a pretty
eggheaded group you found there,
did you, did you discuss with them or is
this something that you worked to...
to make this book more...
-Yes.
Reach across the divide...
- Thank you for that question.
Yeah, I mean, the book took
over seven years and part of the...
part of the time was not only...
because the subject is so vast
and trying to read the material and
understand it and communicate it.
But part of it was trying to have
people write in every-day language,
and that's a real challenge.
And having the editors make sure
that things were really clear.
And I'm delighted to say that
you know, I know freshmen in highschool who
are reading the book and can understand it.
The other thing that...
Many of you reead scientific
articles or scientific books,
and what happens is that there are
foot-notes about every three words,
or not foot-notes so much as a parentheses
with the author and the date of the reference
for that citation. Extremely important in
science to know where things are from.
You to cover what your'e
saying with literature.
But if you read a book like that,
it's very offputting for a general reader.
Because you're interrupted
every three words,
And the other thing, I'm reading the new
translation of Ana Karenina now,
which by the way, I highly
recommend, it's incredible,
But the glossary is in the back, and
a lot of glossaries for scientific books
are in the back, so you come to a word
or concept you can't understand
and you have to go to the very end
of the book to figure out what it's saying.
And it makes me crazy, I've stopped
going to the back of Ana Karenina,
I just can't do it anymore. But, so in our
book we asked everybody to define everything.
If you can't translate it
into every-day language,
define it right after in a parentheses
in every-day language.
And I think it just makes it easier,
and I think it's so important, Missy,
for us to do that more. You know,
the other thing that Corey talks about,
and I probably have encountered
this a lot more than you have,
but our colleagues end up
being a little suspect of us,
or sometimes even condemning.
Not so much now,
but this was certainly true with poeple
like Carl Sagan, or Jonas Salk.
You know, Carl Sagan, world-class
astronomer, world-class,
never elected into the academy, never.
Jonas Salk, also, same story,
major-major physician and researcher. And
their colleagues were condemning of the fact
that they talked to the public,
that they talked to the media,
that they dummed down the complex science
to make, have... help people understand it.
So there's a kind of prejudice
that holds some people back.
But I'm happy to say I agree with you that
I think that it's changing, I should say...
It is changing.
- Corey, Corey Dean, Cornelia dean
is our science writer at the
New-York Times and also teaches
science-communication at Harvard both to
undergraduates and to the gradutate students.

And I think that... And also
through the funding agencies,
the National Scicene Foundation...
- Right.
For which we all depend on...
- Right.
Are requiring that we document
our outreach activites.
To communicate, to connect, to educate,
at the broadest level of society,
and I think that that is...
This is an example of where,
coming from a gonvernmental policy, I
think it's having really great ramifications.
That's great, I didn't know
that, that's fantastic.
Yeah, so that's like something
we all... we all do and it's...
it makes sense. It's a partnership, that we
work with the gonvernment on our research.
So let me switch topics a little bit
and another thing that struck me
as I'm listening to you, was your...
as you were talking about the work you did
in informing, I have it wirtten down here,
the International Physicians for
the Prevention of Nuclear War.
and I was, you know, and you were making
that contrast, which I think is a very
important one between, you know, how you
are able to engage people on this issue,
and the somewhat greater challenges with
biological diversity. I was thinking about my
colleague, Jeremy Jackson, who's
at the scripts institue and Jeremy
is a marine ecologist and also a
paliontologist, he really looks at,
takes a long view of the history of life,
and he's taken to describing,
he uses a concept called 'shifting
baselines', I don't know if you know
that term, but the shifting baseline
is that as the environment changes,
it's changing sort of slowly,
I guess it's sort of like the frog
in the pot and it's heating up and
we don't notice that it's changing,
but it's true with
biological diversity as well,
and we forget what an ocean
full of fish really was like.
And he's got some wonderful archival
photograph showing of the catch of,
of fish from, you know,
boats going out of Miami
and people with big fish, and now,
you now, you get little fish, and there's...
But we forget that, and we don't have, it's
just, we don't have the historical record,
and how you're going to connect
how we're all going to understand,
not only the riches of biological diversity,
but also how we are impacting that
and how we get across immediacy...
- Right.
with this issue, when we're sort of,
slowly, having these changes pass.
Right. I think it goes back
to that whole issue
of how abstract these issues are
and how hard they are for us to see.
I mean, if we live in Boston, our food comes,
our water comes, our waste goes away,
you could live here, if you didn't read the
paper, and not know anything is wrong.
I mean, you know, we may ???? getting
a little more rain than we used to,
it's a little warmer, I... My farm
is in central Massachusetts,
I've been there for 15 years.
When we were first there
we were clearly zone five, there were...
You know, horticultural zone five.
There were many winters where it was
minus 15 below for days at a time.
I can't remember, I think it's,
we haven't had a temperature that low
in Petersham for, I'd say, five more years.
It got to zero this last winter,
maybe a few degrees below zero.
A few years before that I think
it may have been five to ten below.
But, it was fairly routine at 15 below.
So, these changes are incramental,
they're very hard for us to see.
We're not... It's this frog
in the boiling water,
we're not, sort of programmed,
to see, sort of slow trends.
We're, you know, our nervous
systems see quick changes
and things that happen before our eyes.
So, it makes it very hared to know that
something's wrong, and that's a...
that's big, that's a big problem.
And the, you know,
fortunately we have people
like bird-watchers,

and butterfly-watchers and people
who are taking temperatues,
and lots of amateurs and proffesionals who
are following things, and can find, you know,
a new Hummingbird on the cape, that
hasn't been there before, I understand,
or a type of Thrush in our woods
that I don't hear anymore,
used to be there 15 years ago.
So, I think that's a real, a real challenge.
Your bringing up the nuclear issue is
a really important part of my life,
and my involvement in environmental stuff,
because I've always been involved
in environmental things, but... So there was
this very large physician organization,
we had 250,000 members
at one time, in 80 countries,
this international physicians organizaiton,
and what was interesting is that,
you know, physicians don't know
anything about nuclear weapons also,
just the ways they don't know
anything about the environment,
so they became very active
in learning about it,
and doing the same thing, in a way,
that we're trying to do here,
because scientists had talked about
the dangers of nuclear weapons
for a very long time, very good scientists,
very reputable discussions,
but people still didn't quite get it,
even with Hiroshima and Nagasaki.
And so, by talking about the effects
of nuclear weapons in terms of
injuries, blast injuries, instead
of the pressure inside the blast.
Or tlaking about burns instead
of the temperature of the fireball.
Or talking about what radiation
sickness really looks like,
instead of how many rads of radiation
the explosion gives off.
And, you know, doing these, they
where pretty macabre in a way,
they were discussions about, presentations
about what would happen to Boston
if you dropped a one megaton nuclear
weapon on the center of Boston.
So, you go through how far the effects
go, how many miles out they go,
and that is very terrible but it was also,
it reached people, people got it,
you know, we couldn't, we
can't use these weapons.
There's no way you can
use these weapons in war
and have anybody win,
there's no such thing as a winner.
So all those people who
were involved in that,
in trying to make these issues concrete by
talking about them in human health terms,
all these physicians, many of them
shifted to environmental issues
sort of in the mid to late 80's.
So Gorbachov came into power,
Reagan and Gorbachov were talking
about reducing nuclear weapons,
and improving relations, the danger
of a nuclear confrontation between
our two countries lessened
considerably, at the same time
that the ozone hole was discovered
over The Antarctic, mid 80's.
At the same time that became
much more intense discussions
about global climate change
and greenhouse gasses,
and poeple began to really
make those connections.
And there was a very famous and prominent
Harvard physician named Alexander Leaf,
I don't know, Alex, I don't know
if you're in the audience or not.
Alex was chief of medicine at Mass
General. Alex was the proffessor of, of,
the Jackson proffessor of
clinical medicine at Harvard,
you know, the major chair
of medicine at Harvard,
he was a giant in medicine.
Alex was very involved
in the nuclear weapons issues
and the nuclear war questions,
involved with the International
Physicians, and in 1987 he wrote
this seminal article in the
New-England Journal of Medicine,
saying, as physicians, we have
to enlarge our perspective
to include global environmental
issues. because ultimately,
like with nuclear war,
they're public health matters.
And physicians have, potentially,
one of the strongest voices of advocacy

with the general public,
people will listen to us.
So we have to really understand
these issues and then communicate them.
And that, that's where I, that's
how I shifted, that's how a lot of,
of my colleagues in the
International Physicians movement
started becoming much more involved
in these issues, environmental issues.
So let me ask that question then,
you say you had 250,000 members
in the nuclear consortium of physicians,
and for biological diversity, are you?...
it's been a much harder ???sell???.
- Much harder ???sell???.
Yeah, much harder.
- This is fascinating.
Much harder.
- Yeah, it's very interesting.
I don't know the answer to that.
I mean, it seams so obvious to me, but...
Maybe your book is gonna...
- I hope.
Move along ???.
So let's, let's shift the topic then,
let's talk now a little bit about
agriculture. Here's a, here's something that,
a topic where Eric and I come to,
to agreement on. Which is of interest in
the ways, the major way, of terrestrial
ecosystems of which our species impacts
the land cover is through our need
to produce food. It's a very important part
of biological diversity
because it alters... we don't even,
sometimes we don't even think about it,
people think about biological diversity
and they immediately start to think
of parts, things that are not cultivated,
and they sort of leave the
cultivated lands out of the equation.
But in fact it's the, you know, a large
part of our land area and only increasing.
And it's in... There's a lot of biological
diversity associated with agricultural lands,
that agriculture itself is an
endeavor in biological diversity,
with, let me think about the,
both the genetic diversity of the,
the species that we eat, and also the
other species that they depend upon
to make even these simplified
managed ecosystems work.

So I guess that the question then, with these
systems is, is sort of the challenge then,
of the efficiency of food production, many...
There's arguments for increased efficiency
with a simplified monoculture
and agricultural approach,
whether or not we can continue to
feed an ever increasing population
without necessarily impinging on biological
diversity, so I guess I'd just like to
move our conversation towards, towards
the... towards these managed ecosystems.
I wanna hear... Missy teaches a
course on this subject at Harvard
and knows a million times more
than I do about this, so...
Well, I'm actually, I'm actually,
challenged, I think, in my thinking about
the whether or not... I think, I think this
is one of our great challenges now
is, you know, we've hit the point
where the production of food
and the demands on land, on water and
on nitrogen to make high productivities,
that the green revolution, have all
come to a head, and now we have to
sort of face what are these tradeoffs will
be. I don't have all of the answers of that,
I'm very, of course, interested in
your colleague, Kirsch, Kirschbaum?
Fred Kirschenmann.
- Fred kirschenmann's farm, I've seen his,
his documentary about his farm,
where they have high productivity by,
by mimicking and engaging in sort of
natural diverse systems in this organic farm,
but it's true. When you take
a commercially farmed system
and move it back to an organic one,
productivity will go down for,
for a number of years, maybe
quite a few, before you can
start to reap the benefits of
the enhanced bio, bio-diversity.
I think we're, I think we're
at a very interesting time
where the costs of high intensity
agriculture in terms of water,
pesticides, and nutrient loading,
both in terms of their impact on climate,
and you showed a pocture of the
dead zone in the gulf of mexico,
and when you start to put in the costs
that effecting of the ???comlinks???

that we may see some changes, but I'm...
- Right, right right.
Well, I, I have, I have a bit of a bias,
because I do run this orchard
and I try to be as organic as I can be.
When I say I try to be as organic as I can
be, it's almost, it's impossible for me
to grow organic apples, totally organically,
and organic plums, where I live.
There's a weevil called the Plum Curculio,
which comes out of the edge of the forest,
lays it's egg in the developing fruit,
and if the fruit doesn't fall off,
which it generally does, it's
riddled with, with it's trails.
There's is one way of treating that
organically, which is to cover
the whole tree and the whole fruit with
a chalk substance called 'Surround',
and the microscopic sharp
edges of the chalk,
the Plum Curculio doesn't like
to land on it, so it's protected.
The trouble is when it rains a lot,
which it rains a lot in Petersham,
it washes off the Surround and
you have to spray it all over again
and I'm not there all week, so the
fruit would be totally vulnerable.
So I do use one pesticide, it's a
synthetic pesticide, it's called
a cholinesterase inhibitor, the good news
is that it breaks down in a few weeks.
But most of what I do, the
rest of what I do, is organic.
And my... I'm not comparing
my yields to other farms,
but I did mention Fred Kirschenmann,
because, because on of the discussions about,
about organic versus conventional
versus genetically modified organisms
is that, well, it's fine for you to have
an organic garden in your back yard,
to grow your carrots and your
lettuce and your peppers and stuff,
but we can't ever put it, raise it up
to scale. So that's one big discussion.
And there are two models
that we talk about in the book
and Missy may have
some comments about that,
but one is Fred Kirschenmann's,
because these are thousands of acres.
Actually another one is John Tester, John
Tester is the new senator from Montana.
Large-scale organic farmer, several
thousand acres at the Tester family farm.
They grow different kinds
of wheat and buckwheat,
so they're not growing corn and soy-beans,
the way most, a lot of our farming is,
certainly in the farm-belt.
And there's some issues that make
organic farming more and more appealing.
One is the price of oil,
because Fred and others,
and there's some real literature about this,
talked about the increased energy efficiency
of organic farming, so that's one issue,
especially as the price of oil goes up,
because pesticides and
fertilizers also come from oil.
So that the farmers profit margin is
getting less and less, so that's one issue.
The other issue is that when you
really build up those organic soils
they really hold on to water, and when
we've been seeing severe drought
in the farm-belt and other parts
of the world my suspicion that there...
is there going to be more and more push, at
least in some parts of the world to organic.
And it's no, there's no question about
the fact that if you eat organic food
you're getting less exposure to
pesticides, there's just no question.
Now, the exposures may be so small
that it doesn't matter, although
some of those studies are done
with adults and not with children,
and children are just, are not just
little adults, so the threshold levels
of some of these studies is really being
debated a lot by pediatric toxicologists,
including friends of mine.
So, there's some advantages to organic.
The other big argument, and I know
Missy knows a lot more about this,
is the whole issue of nitrogen,
and the concern that
we're gonna have to use a lot more
farmland, because we're gonna have,
we're gonna have to cut down a lot
more forests and use a lot more land
to graze out animals, to bring their waste
back into the farm to fertilize the crops.
Now, there have been some recent studies and
I don't follow this literature that closely,

but that talk about legumes
and nitrogen-fixing crops
being really very good
contributors to that nitrogen
and that the values are really adequate
in many parts of the worlds.
So, some of these arguments may
be important to be looking at.
I think we're gonna need a
mix of different systems.
I worry about the genetically modified...
A massive increase of the way it's done now,
with, you know, Bt crops
and roundup ready crops.
I worry about the mass proliferation,
millions and millions and millions of acres,
'coz it seems to me that there's still some
things that aren't terribly well understood,
and you know, we've made a, we've
made a pact to go in this direction.
And I guess I also worry that conversations
are always GM crops versus conventional,
and organic is never, sort of,
part of that future foods security,
at least in the things that
I've read. So, I do have a bias,
I would like us to invest a lot more money
trying to do large-scale organic farming
and see, see how it goes, particularly
in a climate change world,
with increasing droughts, with
the high price of petroleum.
the other model that we talk
about in the book is Cuba,
and it's a very interesting story. Cuba
had very high-intensitive, high-end...
High-intensity, high-input
conventional farming prior to the,
the Russian, the Soviet
Union sort of falling apart,
and the Soviet Union was the major
supplier of petroleum to Cuba
so they were totally dependent
on oil from former Soviet Union.
and that's what ran their agriculture,
it ran their machines, it ran,
it made their pesticides
and their fertilizers,
and so with the US embargo of Cuba
plus Russian... Soviet oil stopping
they were in a crisis about how they were
gonna grow enough food for their country.
And there's some very interesting
literature about what they did,
including, hire one of the brightest people
at the Harvard School of Public Health,
Dick Levans, who became a
consultant to the cuban government
about how to utilize natural systems -
Nitrogen fixation, bio-controls of crops.
And in my own farm I, you know, I,
I do very well with this almost organic
method, I don't do anything with my peaches,
I don't do anything with my Asian pears,
I don't do anything with my pears,
in terms of spraying, except dormant
oil, which is, counts as organic
and lime sulfur which counts as organic.
Because I think I live in such
a rich biological area, where,
you know, a few weeks ago, at the
end of day, the you open the door
and there are thousands of dragonflies, just
everywhere, and birds, you know, gobbling...
The dragonflies look like
vacum cleaners in the sky,
they're going back and forth
eating everything in their path,
I mean, they're amazing. So, there's such
biological richness in this environment,
as there is in Fred Kirschenmann's, that
I think there's a lot of biological control
of some of the insect pests and
diseases that are affecting crops.
So let me ask one or two
more questions and then
we are gonna open it up for some questions
from the audience and there'll be
a couple of Museum of Science staff who have
a microphone, 'coz this is all being taped.
And so if you ???have one, have??? a
question I want you to raise your hand
and the people with the microphones will
find you and they'll organize the questions.
But let me ask a question now,
about broadening this discussion,
we've heard a lot in the last
couple days from the discussions
in Washington about by-partisan
effort and reaching across the isle,
and I don't really mean in a political
sense, but I'd like you to say something,
or I'd like to, about your work
in the last year or two,
and if Ed were here he certainly
would have talked about reaching
to the evangelical community, and
sort of, broadening this alliance

for biological diversity.
We've talked about your
attempts to engage the medical community,
we've talked about reaching the public,
through education, but what about through...
- Yeah...
the religious community?
- Well, I'm very sorry Ed Wilson is not here,
because Ed has been pivotal
on this whole effort.
I don't know how many of you know
his book 'The Creation', it's really,
it's an amazing work. I guess
one of the things about Ed,
his creativity and the range
of his mind knows no bounds.
And if someone had asked me, had
told me, five years ago, six years ago,
that I would number one of my
closest friends as one of the leaders
of the US Evangelical Movement,
I would have told them they were crazy.
Because I saw evangelical,
evangelicals as being largely,
you know, Jerry Falwell and, who,
I don't know, what did he say,
9-11 was because of homosexuality
and the lord was punishing us,
or others said Katrina was the lord
punishing us, and Jim Dobson and others.
And so I would have been totally surprised
that they would have made that statement.
But about three years ago
a mutual friend of Richard Cizik,
Richard is the vice president
for governmental affairs
of the National Association
of Evangelicals, which is
the largest evangelical group in the
country. It has 45 thousand churches
that are part of it, over 30 million people.
A mutual friend introduced us,
and both of us approached this meeting
with a fair amount of anxiety.
I saw... Richard saw me,
as he admited later,
as a kind of, latte-sipping, endivemunching,
chardonet-drinking,
you know, New-York
Times-reading, Prius-driving,
effete Harvard, you know, snob.
And I saw him as a, you know,
Hummer-driving, Bud light-drinking,
pork rinds-munching, I don't know,
you can fill it in, you can fill it in.
And so we both approached
this with some trepedation,
and what was amazing and wonderful is that
we both really liked each other right away.
And we both felt like we were seperated
from birth in a way, I mean,
Richard grew up on a cherry orchard
in the eastern part of Washington state,
so he was totally interested in
my orchard, but it wasn't just that,
I think what was so interesting
and life chaniging for me,
and for the, we brought together
15 leading scientists,
Peter Raven, Ed Wilson,
Jim Hansen, Jim McCarthy,
and 15 leading evangelical christians
at a retreat, three-day retreat.
And I think everybody
approached that retreat
with the same kind of trepedation
that richard and I did,
and everybody left changed people.
Because I think what, what we discovered,
and, you know, it's sort of the
most wonderful thing of all,
is that what we shared was so much
deeper than what we differed on.
You know, we may not agree about
abortion or stem cell research,
or even evolution,
although, it's interesting,
many of them have no problem with evolution,
you'd never know that from the discussion
that we hear, but what we shared
was this evry deep and fundemental
thing that defined us, defined all of us,
that was this reverance for life,
that's what we shared. And it was,
it was no different, I mean,
it didn't matter whether they,
it really didn't matter,
whether they felt that this life
was created by god in an instant,
or whether we felt it evolved over
three and a half billion years.
We both felt it was sacred, and that
we had a reponsibility to protect it.
And it was so moving to
all of us to realize that,
and so powerful, I mean amazing. And so,
you know, we've been working together.
this group of people, and,

very closely together.
And we're both changing each other in quite
wonderful ways. Now what's interesting,
and this get back
to your first question,
The, they are dealing with
their own constituancy,
so the people we've been
working with are out front
and are more progressive than
the general group, although
some 70 percent of evangelical
christians in this country
are concerned about climate change, so,
you know, I don't know if Sarah Palin's
really tapping in to the broard constituancy
of evolution... of climate change.
But climate change was an easier
thing for us to work on together,
than bio-diversity.
- Wow, that is interesting.
And again, you think it would
be the other way around, right?
You'd think that climate change
is this, you know, liberal,
you know, against capitalizm,
oil company, against oil companies thing,
and bio-diversity is god's creation.
But the bio-diversity issue raises some
red flags for conservative evangelicals.
One is this whole issue of pantheism.
So when Richard was talking
about the importance
of protecting bio-diversity
to a group of evangelicals,
very conservative woman asked him - "are you
talking about worshipping god's creation,
or are you talking about
worshipping god?"
So this was sort of a
red flag, that, it's,
it's the whole thing that we've
all heard about tree lovers.
You love frogs and trees and wolves
and whales more than you love people.
So, and the connection that we hope this
book will do, and it's sort of interesting,
a very prominent evangelical
christian biology proffessor
at the university of Wysconsin,
has also made the book his textbook
in his course in
environmental science,
and is telling his evangelical biological
proffessor colleagues about it as well.
So we're hoping to make the connection,
you can't seperate people from bio-diversity.
You can't talk about protecting bio-diversity
and not protecting people and vice-versa.
They're, they're interconnected,
we have to protect the natural world,
if we're going toprotect people.
And that becamse clear,
we took a trip to Alaska together,
ten of us, five, Jim McCarthy went,
Peter Raven went, Carl Sofina,
myself, Meg Tompson went,
and the president of the American...
National Association of Evangelicals went,
and Richard, the president went.
And we, we traveled together
for month... a week. All over Alaska,
looking at glaciers, and salmon rivers,
and forrests that have been
devastated by warming.
And, but it wasn't those things
that really got to them.
What really got to them
was when we went to this
island on the arctic circle called
Shishmaref, which is a native
Inupiak village, where they've
been there for 400 years.
They've actually been in that area for
4000, but they established this island
as a village 400 years ago,
same time as Jamestown.
And they have to leave that island
now because of global warming.
Because the sea, sea ice that
used to keep the storms down
has now melted, so that huge
severe spring storms are washing
into the island and eroding it.
And the perma-frost is melting
so it doesn't have any
resistance to these waves.
So the island is essentially washing
away, they have to leave the island.
That's what really affected the conservative
evangelicals who came with us.
About how climate change, in this
case, or environmental change,
is affecting the poorest among us.
And that's where christ' teaching really
took hold of them and affected them.
So, very interesting.
So why don't we open it up now

to some questions from all of you,
we'll sort of broaden the
conversation, and maybe there,
if anybody has a few
things they would like to
direct to Eric, or to me,
or comments they wanna make.
Hi, ?????
Thank you very much for your talk today,
I enjoyed both the
conversation and the lecture.
In the past, in terms of maybe
not a solution but an attempt to
protect bio-diversity ????
Ed wilson talked about
the hotspots and attempts
to secure and protect them,
could you give us an update as to
how that strategy is progressing?
Have you kept in touch with where that is?
-I don't have any up-to-date numbers on that,
So, hotspots are areas where there's
concentrations of biological diversity
that coincide with areas with
the possibilities for preservation.
And the problem is, and you need to engage
the entire social and economic system to,
to provide jobs and prosperity to the people
that are, connect them with the conservation,
and it takes a great will and,
of the broader community to do that.
So yes, there are signs of progress but I
don't know, I don't have any, anymore data.
It's a very important...
- I don't know an update.
The thing that makes them so
appealing and attractive is this
enormous concentration
of terrestrial life in those hotspots,
and the small cost,
relatively small cost,
that would need to
be spent to protect them.
I think on the order of a few tens
of billions of dollars, or something,
which, you know, is spent in
a month, or a few months, in Iraq.
Another question.
Well I too would like
to thank the museum and you
for making such an
interesting presentation.
I'd like to make one brief comment
and ask a question. My impression is
that the government of the United States
is not so fearful of nuclear weapons,
because our president has stated
that he would use them preemptively.
But my question is about
biological diversity of plant life.
Now, I've failed to pick up reference
to this, but it would seem to me
that there are questions being raised
about plant and animal, about,
various species being lost,
but new species appearing.
And I think it could be very interesting
if you could comment a little bit
on the rate at which important crops
and plant life are disapearing
and what kind of impact there would be,
and whether or not there is any likelihood
that there will be new species farmed that
will be a replacement. Thank you very much.
I'll happily... So yes, extinction and
the generation of new species is a,
a part of the natural cycle, and we see
that if we look through the fossil record,
and we can see evidence of that if we
look at just the way life is distributed,
on the ???Filo de Genetic???,
or the tree of life.
But what is, what is happening
now that makes this such a crisis,
is the rate at which activities
mediated by our species
are leading to the extinction
of all forms of life.
So we are having an effect
on biological diversity
that's on par with when the giant
meteors crashed into the Yukatan
and led to the environmental change
that led to the demise of the dinosaurs.
It's on the order of that level
in terms of speed and severity,
so it's not happening over thousands
and tens of hundreds of thousands of years,
and species are coming and going,
but we're having a really dramatic effect.
So, relative to the generation
of these species,
our impact in terms of extinction,
are sort of off the charts.
Now, I would say that it would be
advantageous to provide quantitation
of the decrease in diversity of plants.
I know you kind of dismiss quantitation,

but I think that it is very important
to have hard numbers,
to whatever extent that's feasible.
I know you can't do it...
I couldn't actually agree with you
more about the importance of
quantifying both the, both the
reductions in numbers of species and the,
the extent to which populations are at threat
by fragmentation and reduction in numbers.
So, it is important to,
to be able to look at what the,
what effect we're having
relative to, you know,
sort of, as you might say background levels
and across the geologic timescale, you know.
Because in the long, if we take the
very long view in the billions of years,
life will be OK. We may not
be here, certainly many of...
all the species that Eric showed,
species come and go, but,
but if we're interested
in the health of
our children, our children's children,
the next hundrerds of years,
then we have to think very sort of myopically
and we do need to quantify what's going on.
your, your comment also about crops...
There are many efforts to save seeds
of all the various present crops species
and, you know, there's such a depository,
repository at the Q' gardens,
there, there are others around
the world, and now there's a new one,
some of you may have read about,
in Spitzburgen, Norway, in the perma-frost,
very deep in a mountain,
that is called The Doomsday Vault.
Because the effort is to preserve these
crop genetic information and seeds
for very-very long periods
of time in the event of
nuclear war, global warming,
flooding, etc.
And so there's really an intense effort
to make sure these are not lost.
I'm wondering about natural
allies in the political battle to help
our congress and the
president understand
bio-diversity and the
connection to humankind,
And I think it's very wise and
strategic that you've chosen
the evangelicals.
And I'm wondering,
it seems like there would be a great interest
among the pharmaceutical companies in keeping
alot of these medical and
pharmaceutical opportunities
for their profits, for their
markets, for human health.
And I'm wondering if you've
explored the possibility of working
with the phramaceutical lobbies
who are quite powerful in DC.
Well, it's great question. The, Lisa
reffered in her introductory remarks to,
this sense of the Senate rsolution
that Joe Biden introduced at,
through a Senate foreign
relations committee,
and what was wonderful about that, it's
really a terrific document and I, I think,
I was delighted when Biden was selected
because I think his intent in doing this
was to reestablish The United States
as a leader in world efforts to
protect the global environment,
something that we've really lost
in the last eight years.
And even a bit longer than that,
I mean, the 1997 Kyoto protocol we signed,
but never got ratified in the senate,
and it wasn't pushed becuase
it was thought it would never,
never make it. So, we're not
a signatory of the Kyoto protocol,
we're not a signatory of the convention
on biological diversity, the law of the sea.
So I think this was Biden's effort to
start a process to make that happen.
And what was very interesting is it had very
broad bipartisan support. Richard Lugar
is co-chair, or ranking member of foreign
relations, joined it very-very strongly.
Richard Lugar is a very
thoughtful and interseting guy,
But Sam Brownback also joined.
So, Sam Brownback is a very religious,
conservative religious
senator from Kansas,
and what was interesting is
that Sam Brownback joined
because one of our
Evangelical colleagues
who went to us, with us to Alaska,

who we now got very friendly with,
used to be one of the people running his
presidential campaign when he was running.
And really encouraged him to sign on to this
resolution, so that was very interesting.
And he is also a very interseting guy,
very thoughtful and very...
so there's some strange,
but potential strange bedfellows
that really could be brought
on board, same with climate change.
Chuck Hagel is also very
interested in climate change,
he's no longer gonna be in the Senate,
but you know, Kansas is very big on
sequestration of carbon
in farm, in farms,
and you know, what the
government can do to that.
Pharmaceutical industry - Johnson & Johnson
is very involved with our center,
and has been very interested
in help fund this book.
And they have several natural products,
their stents, for example,
are coated with a natural
product called Sirolimus.
And you're right, I think pharmaceutical
companies could be very important allies.
They, they didin't prevail with the
convention on biological diversity,
which they supported, but it still
never got through, past Jesse Helms
in foreign relations committee.
But I think that's, that may be changing.
You know, many of you may know that,
of the hundred most perscribed medications.
Is that still on?
I'll just have to speak loudly. Of the
hundred most perscribed medications,
in The United States, half of them are either
directly derived from natural products,
or are patterned after compunds
derived from natrual products.
So, it's a gerat of pharmaceutical companies.
- And the country of Costa Rica
has partnered with Merck, and they have a,
through the government has a
very large institute that both trains
young scientists but also
is used for both education and coservation,
so that's an excellent model.
It struck me that your most effective
political effects have come by the portrayal,
the stark portrayal of the negative
consequences of the nuclear threat,
and your last example which was
the people leaving the island in Alaska.
So you portrayed very clearly on both those
situations real negative consequesnces
of the advocacy you were putting
forth for for you various positions.
For bio-diversity, as pointed out
at the beginning of the talk session,
the emphasis in your book and your talk
was on all the things we're missing
by not paying attention to this. But this
country seems to react more to crisis
to get things done, then it does
to the potential for what can be done.
and I wonder of you can portray
real negative consequences
of the lack of having paid
attention to bio-diversity,
that would then help the political
position you're taking
and certainly, which I support.
- Yeah, I think that's very astute comment.
I, the reason that the Gastric-brooding...
Is this on? Is this on? Yeah.
The reason the Gastric-brooding frog
is in the preface of our book is that
I think it does provide that exact
model that you describe.
The trouble with too much negative
consequences is that people also say
"well, you know, what's the use?
I mean, it's hopeless."
So I think you also have to be celebrating
all the wonderful things that
are there for us, and what this
miraculous natural world has provided for us.
But I think, I think your comment is very
astute. Missy, do you...
I'd, I would have to, yeah,
just agree, and I think that maybe,
this is maybe a time that we might want to
continue, to end the conversations.
it's getting a little late and we wanna
continue it in a more informal fashion.
And also, we finally hit a slightly positive
note, because we do want you to leave
here not... But you know, focused on the,
you know, that there is a lot of progress,
and that this is a widening conversation
and the importance of this issue,
this is why all of are here this
evening, and why Eric is,

is doing all the work that he's doing with
the center, that I'm doing with teaching.
And so, I don't know, Eric if you
want to say a few final words,
and, otherwise we, I guess we...
I'll pass it back to Lisa then.
Well we just want to say thank you
to Dr. Chivian and Dr. Holbrook
for sharing that wealth of information
and deep insight with us.