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THREATS TO NATIVE WILDLIFE SPECIES

JOINT HEARING

BEFORE THE

SUBCOMMITTEE ON WATER AND WILDLIFE

AND THE

SUBCOMMITTEE ON OVERSIGHT

OF THE

COMMITTEE ON ENVIRONMENT AND PUBLIC WORKS UNITED STATES SENATE

ONE HUNDRED ELEVENTH CONGRESS

FIRST SESSION

JULY 8, 2009

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C O N T E N T S

THREATS TO NATIVE WILDLIFE SPECIES

WEDNESDAY, JULY 8, 2009

U.S. SENATE,
COMMITTEE ON ENVIRONMENT AND PUBLIC WORKS,
SUBCOMMITTEE ON WATER AND WILDLIFE,
SUBCOMMITTEE ON OVERSIGHT,
Washington, DC.

The subcommittees met, pursuant to notice, at 10 a.m. in room 406, Dirksen Senate Office Building, Hon. Benjamin L. Cardin and Hon. Sheldon Whitehouse (chairmen of the subcommittees) presiding.

Present: Senators Cardin, Whitehouse, Lautenberg, Barrasso, Crapo, and Gillibrand.

OPENING STATEMENT OF HON. BENJAMIN L. CARDIN, U.S. SENATOR FROM THE STATE OF MARYLAND

Senator CARDIN. The subcommittees will come to order.

Today we are having a joint subcommittee hearing of the Environment and Public Works Committee of the Water and Wildlife and Oversight Committees. I want to thank my colleague and friend, Senator Whitehouse, for arranging for this joint hearing with the Water and Wildlife Committee that I chair. He chairs the Oversight Committee. And we want to thank Senator Barrasso for his help in arranging this morning's hearing.

We are talking about the threats to native wildlife species. And we are pleased that two of our colleagues have joined us: Senator Levin, in talking about the threats to the Great Lakes; and Senator Nelson, who will talk about the unique wildlife and ecosystems in Florida and the python which he brought, it looks like the skin, with him today to demonstrate the danger to the ecosystems in Florida.

The threat to native wildlife comes from many sources. Today we will be talking about two of those, one dealing with invasive species, the other dealing with diseases.

The release of invasive species into the local environment presents a real risk to our environment. The Burmese pythons in Southern Florida have caused a major problem, and our colleague Senator Nelson will be talking about that. In my own State of Maryland, we have had the snakehead fish which has been released that has caused major problems.

These are wildlife animals and fish that are just released into the wild because they are mainly taken as pets, people get tired, and then think they are doing a favor to release them to the wild. They cause huge problems with the native wildlife.

We have a disease called white-nose syndrome in the Northeast with the bat colonies. We will be talking about those issues.

What we have done is try to manage these invasive species, and that continues to be a great challenge. It is expensive, and it is a challenge. In my own State of Maryland, we have dealt with the nutria. The nutria is a furry animal that was originally brought into Maryland and, I believe, also Louisiana, because of its commercial value. They thought it could be used, the skin could be used, for commercial reasons. It was a commercial activity.

Well, it did not work very well, so they decided to release the nutria to the wild. And in Louisiana and Maryland, it is creating a huge problem. They literally eat the grasses and destroy the wetlands that are critically important for the ecosystems that are protecting the species as well as eliminating the filtering system for the water quality. In the Blackwater Wildlife Refuge, which is on the Eastern Shore of Maryland, we have lost 5,000-plus acres of wetlands as a result of the nutria. That has a direct loss to the local economy and to the fisheries of $4 million per year.

Well, in 2000, Congress developed a public-private partnership to deal with the nutria population, and it has been somewhat successful. But there is more work that needs to be done, and we will have a chance to talk about during today's hearing.

I know that Senator Lautenberg will be talking about the bats, a keystone species in the food web that help to control insect and pest populations. They are vitally important to our agricultural community in eating the bugs that would otherwise feed on our crops. Well, there is a disease, white-nose syndrome, which is causing us to lose a lot of our bat colonies, and we are struggling to understand this disease. But we do know that it is related to human activity, and we need to talk about that.

We know that in certain animals and birds, they carry diseases from imported animals and birds that can affect human health, such as the West Nile and avian flues, just to mention two by example.

Our first priority should be to prevent the introduction of invasive species or diseases into America. I hope that during the course of this hearing we will have a chance to talk about our strategies as far as border control is concerned. Do we have adequate laws that deal with animals and wildlife that come into America? Do we need additional resources? It would be far more productive to stop the problems at the border than trying to clean up the problems once they get to our shores, and I hope during today's hearing will have the chance to talk about that.

I am pleased to call upon the Chairman of the Oversight Subcommittee of the Environment and Public Works Committee, Senator Whitehouse.

[The prepared statement of Senator Cardin follows:]

STATEMENT OF HON. BENJAMIN L. CARDIN,
U.S. SENATOR FROM THE STATE OF MARYLAND

I want to thank my colleague Senator Whitehouse for his assistance in co-chairing this important hearing to examine the threats disease and invasive species pose to the country's native wildlife.

I also want thank our distinguished colleagues, Senator Nelson and Senator Levin, for joining us today. Senator Nelson is especially interested in addressing

specific threats to the unique wildlife and ecosystems of his home State of Florida, and Senator Levin will be adding his perspective on the threats to the Great Lakes.

We also want to thank our Agency and expert witnesses for coming before our subcommittees.

The recent emergence of Burmese pythons in South Florida and snakehead fish in the Chesapeake watershed are a direct result of people who simply did not know better releasing these invasive species into the local environment. White-nose syndrome in Northeastern bat colonies, which we need to study and learn more about, has had a devastating impact on these native species.

These are just some of the numerous threats to native species that motivated our subcommittees to examine a host of both new and persistent diseases and invasive species threatening the country's native wildlife populations. We hope to learn what we are doing well and what we can do better to curb these problems.

Managing the threat of invasive species continues to be one of the greatest challenges facing U.S. Fish and Wildlife Service refuge managers.

I know it has not been easy, but in some instances we are seeing real progress. For nearly six decades at the Blackwater National Wildlife Refuge in Maryland, nutria have been killing wetland grasses that provide vital habitat for native shorebirds, muskrats and blue crabs, not to mention the role these grasses play in maintaining water quality.

Nutria are responsible for the loss of more than 5,000 acres of wetlands in the Blackwater refuge alone. The loss of these wetlands, that are vital to the fishery, was estimated to cost Maryland's economy nearly $4 million annually.

In 2000, Congress established a Federal funding source to develop a public-private partnership program to address nutria in Maryland. The partnership has implemented a successful effort to manage the species. Healthy wetlands are returning to places where nutria have been removed. But the job is not yet done.

Bats are a keystone species in the food web that help control insect and pest populations. They are vital to agricultural food growers by eating bugs that feed on crops. Since 2006, hundreds of thousands of hibernating bats have died from white-nose syndrome. Without bats we face the real possibility that certain insect species could boom out of control, threatening crops as well as human health.

State wildlife managers are struggling to understand the full nature of the disease. This struggle is further hampered by the lack of capacity and resources wildlife managers have to work with.

The spread of the disease to such a wide range of locations may be linked to human activity. Exploring caves that have infected bats may inadvertently be spreading the fungus. The rapid spread and the rate of morbidity caused by white-nose syndrome requires rapid action be taken.

West Nile and avian flu are examples of imported exotic animal diseases with strains that can infect humans.

Our panelists have been on the front lines doing the research and implementing programs on the ground to address these problems. You know what works and what does not work when it comes to stopping the spread of established diseases and invasive species. I look forward to hearing your recommendations. We all know that an ounce of prevention is worth a pound of cure, so I hope our witnesses will focus on how to stop these threats rather than simply discuss ways to manage them.

Consideration must be given to preventing the next nutria or snakehead invasion and keeping animals infected with the next avian flu from ever reaching the U.S. in the first place.

OPENING STATEMENT OF HON. SHELDON WHITEHOUSE, U.S. SENATOR FROM THE STATE OF RHODE ISLAND

Senator WHITEHOUSE. Thank you very much, Ben. I am delighted to join you in this hearing. I appreciate your leadership in convening it.

I welcome Senator Carl Levin of Michigan and Senator Bill Nelson of Florida here, who will be our opening presenters. I appreciate very much that you have taken the trouble to attend, and I am glad to be joined by so many colleagues here.

This is a significant issue. Two factors drive it. One is global commerce, and the other is a changing climate. And whether, as Senator Cardin indicated, the invasive species are ones that are brought in lawfully and then escape into the wild and acclimate

themselves to this new environment, or whether they are hitchhikers on the stream of global commerce and come with shipping and packaging inadvertently and make their homes, or whether they simply find that as climate changes they are able to expand into new areas where we have not experienced them before, it creates very significant issues. And I am very pleased to participate in this hearing.

I want to mention that a very prominent Rhode Island environmentalist, John Torgan, is here and will be presenting in the second panel, and I look very much forward to his participation.

I have to warn everybody that I am in my waning days on the Health Committee and we are marking up the healthcare bill as we speak. So, I will be in and out of the hearing. But I appreciate very much and take a keen interest in the topic that you have brought to our attention, Senator Cardin.

Thank you.

Senator CARDIN. Thank you.

Senator Crapo, the ranking Republican on the Water and Wildlife Subcommittee.

OPENING STATEMENT OF HON. MIKE CRAPO, U.S. SENATOR FROM THE STATE OF IDAHO

Senator CRAPO. Thank you very much, Mr. Chairman, and I appreciate the fact that both of our Chairmen here have called this joint hearing and are bringing attention to this important issue.

As you have already well indicated, Senator Cardin, this is a very, very critical issue in I think probably all 50 States where we face the question of what kind of management we need to undertake to effectively deal with invasive species. And Idaho is certainly one of those States that has its share of issues.

In Idaho, a number of the problematic invasive species are things like the yellow star thistle, the quagga mussel, cheat grass, bark beetles and your Asian millfoil, to name just a few. One of these issues that we have in Idaho is that, because such a large percentage of our State is owned by the Federal Government, it is more than half, closer to two-thirds of our State is Federal land, the activities and enforcement of the Federal Government and the agencies that manage these lands are critical to our ability to control and manage these invasive species.

So, among the many other different types of issues that we face, one of them is simply the interaction at the different levels of government, between State and Federal, as well as local governments, to deal with this and, frankly, the private citizens as they have responsibilities as well.

Again, I thank you for your attention to this. I know there is legislation in several different forms being considered that can significantly change the way that we are approaching these efforts to control invasive species, and I have not yet reached a conclusion in my own mind as to whether the proposed changes are going to be an improvement or not. But it is important for us to evaluate these proposals as you are doing here today and, again, I appreciate your bringing attention to these issues.

Senator CARDIN. Well, thank you.

Senator Barrasso, the Ranking Republican on the Oversight Committee.

OPENING STATEMENT OF HON. JOHN BARRASSO, U.S. SENATOR FROM THE STATE OF WYOMING

Senator BARRASSO. Well, thank you very much, Mr. Chairman, for calling this important hearing. I am very pleased that we are going to be here today discussing invasive species and the impact on native wildlife. I welcome our guests as well.

In Wyoming, just as in the other States we have heard about, we do have a number of invasive species issues. Saltcedar and Russian olive trees severely impact water availability for farmers along the North Platte River. Cheat grass, juniper and other invasives threaten the sage brush ecosystem that our sage grass depends upon. Our State is also on the watch for the potential threat of zebra mussels, which is a problem I already know is plaguing the Great Lake States. Noxious species are also a threat on native species in Wyoming.

Wyoming faces an urgent problem, as they do in Idaho, for the bark beetle infestation. In the Medicine Bow National Forest, almost a half-million acres of these trees are infected already by bark beetles. We have over 9 million acres of national forest lands in Wyoming, and a Forest Service analysis shows this epidemic doubled in size between 2007 and 2008.

These beetles destroy our forests and leave nothing but dead timber standing in the wake. This represents a clear and present threat to public land users, to communities, and to homeowners. We have mountains of kindling just waiting to burn. This is not a safe situation for the communities in and around these mountains. So, we must go into the forests, remove some of this dead timber, and reduce the risk of catastrophic fire.

The threat to our forests and the species that inhabit those forests are very real for Western States, and more must be done to address this threat.

Now, in terms of regulating invasive species from foreign countries, I do have a number of concerns. We have a very limited number of resources available. We need to put those resources where they will do the most good. We have laws on the books that regulate the importation of species. We need to make sure that the funding is there to ensure that these laws are properly enforced and that the agencies are properly staffed. I would not want to pass additional legislation that would in any way hurt our economy, including our pet economy, our sport fishing economy, or our farming industries.

Let us not forget that, historically, the majority of livestock and crops in the United States are non-native species to North America. Many breeds of cats and dogs are non-native to the States, as are many of the breeds of fish that we use to stock our lakes, our reservoirs and our ponds for sport fishing. So, to this day, species are brought from overseas for these and other industries.

Most of these species, if left unchecked and not properly managed, can cause significant damage to the surrounding ecosystem. These species have been vital to key industries in our economy and to pet owners and recreationists across the country.

I am looking forward to the testimony today. I have a very open mind on this and thank the Chairman for holding the hearing.

Senator CARDIN. Thank you very much.

Senator Crapo.

Senator CRAPO. Mr. Chairman, I just wanted to indicate that I, too, have another hearing right now, a climate change hearing in the Finance Committee, so I will also be moving back and forth.

Senator CARDIN. I pointed that out, that I know members will be coming in and out because of the commitments for other committees, and every member's opening statement will be made part of the record.

Senator Lautenberg.

OPENING STATEMENT OF HON. FRANK R. LAUTENBERG, U.S. SENATOR FROM THE STATE OF NEW JERSEY

Senator LAUTENBERG. Thanks, Mr. Chairman.

When you see our colleagues here from other States, from Western States as well as those of us from the Eastern side, joining together, we know that we have a problem of serious magnitude. I appreciate greatly your holding this hearing about threats to animals and ecosystems across the country from changing climate, vanishing habitats and invasive species.

Now, as you know and mentioned, and I appreciate it, I am particularly concerned about a threat that could wipe out an entire bat population from New Hampshire to Virginia. One might react less concerned about bats. They are typically thought of as an ugly little thing that is often rabid. But nothing could be more invalid.

The threat to their population is a fungus called white-nose syndrome. Since it first surfaced in 2006, it has spread from cave to cave, leaving 90 to 100 percent of bat populations in some caves dead or dying. And since bats are slow breeders, scientists fear that the white-nose syndrome could cause many bat species to go extinct. Over the last two winters, more than 1 million hibernating bats have died.

Now, at one bat cave in New Jersey, the Hibernian Mine, which I entered for my own familiarization with that population, there are normally 30,000 bats hibernating. As of April, this past April, only 750 bats were found alive there. The thing that struck the great alarm was the number of dead bats lying all over the place.

We have got to stop the spread of this disease. We are dealing with a major threat to an entire ecosystem, potentially able to cause major environmental and economic problems, as my colleagues have discussed, with their non-invasive species. This is not a non-invasive species, but the disease is a threatening one to that particular species.

Bats are on the front line of defense in protecting the public's health and our crops. They prey almost exclusively on insects, such as mosquitoes, which spread disease, and moths and beetles as well, which damage crops. A single bat can easily eat more than 3,000 insects in a night, and an entire colony will consume hundreds of millions of insects. It is said that a single bat will eat enough insects to be half its weight. So, it is a pretty voracious and very important species.

Bats also reduce the needs for pesticides which costs farmers billions of dollars every year and can be harmful to ourselves. With fewer bats, there are more mosquitoes to breed disease, more insects to destroy the crops grown on New Jersey's farms, threatening the livelihood of our farmers, and damaging our economy.

And the problem is not limited, as you know, Mr. Chairman, to New Jersey. This serious threat to our health, environment and economy is repeating itself all along the East Coast. We need to act fast, and we need help from the Administration.

In May, along with Senate and House colleagues, I sent a letter to Interior Secretary Ken Salazar requesting emergency funding for research into the cause of white-nose syndrome, and to develop a solution to stop its spread. I look forward to the Secretary's response.

Now, some of the witnesses on this panel have experienced fighting the spread of diseases like white-nose syndrome and helping species survive such threats. I look forward to hearing their ideas on how we can save the bat population in New Jersey and nationwide. Much is at risk. And the bats have become more beautiful as we learn more about them.

Thanks very much, Mr. Chairman.

Senator CARDIN. Thank you.

Senator Gillibrand.

OPENING STATEMENT OF HON. KIRSTEN GILLIBRAND, U.S. SENATOR FROM THE STATE OF NEW YORK

Senator GILLIBRAND. Thank you, Mr. Chairman.

I appreciate the remarks of my colleague from New Jersey.

The issues that we are addressing today are about invasive species. But the reason why it is so important is because it fundamentally affects our economy, it fundamentally affects our health and well being, and it fundamentally affects the costs of having to address these invasive species at a time when we have record high unemployment and enormous burdens on our municipalities and towns and local governments.

When they have to address some of these invasive species, those are costs that will have to be spent on addressing the invasive species as opposed to other priorities that we have. So, these are significant issues for our economy.

I will start with the white-nose bat syndrome. One of the reasons why it is so important, just as Senator Lautenberg said, is that because bats eat mosquitoes, in particular, and other insects, they are very important to keeping our communities safe.

One of the biggest threats we had around New York State was the West Nile virus and I watched in many, many towns, where we sprayed towns to kill mosquitoes to prevent our children from getting the West Nile virus. It was a significant expense for local municipalities and local towns.

Without the natural order of things, the natural life cycles and many of the roles that bats and insects and other species play, if we do not have the natural order of things, there is much in disarray and it creates enormous expense and risk. So that is one area.

The second area is that bats also help pollination, and that brings to mind another problem, the colony collapse disorder. The bee populations are being seriously decreased, all across America and the world. In fact, 36 percent of bee colonies were reported to be wiped out in the United States because of the colony collapse disorder.

If you do not have bees, and you do not have bats, you do not have pollination. If you do not have pollination, you do not have fruits and vegetables in America. If you do not have fruits and vegetables in America, we have a serious national security risk to our food chain or our food supply. These issues are critical to America's safety, from an agricultural safety perspective, a national security perspective, and an economic perspective.

We also have other great costs in New York State because of some of our invasive species because we have so many natural resources in our lakes. We have the Great Lakes, we have the Adirondack Lakes, we have lakes all across New York. And a number of the species are particularly threatening to our economy of tourism in these lakes.

Whether we are looking at millfoil, which was mentioned by my colleague Mr. Barrasso, or zebra mussel, what these kinds of invasive species do is go so far as to clog drainage pipes, to clog intake pipes, to clog damns, to really affect tourism. Those are all of significant importance to our communities for our clean water and for economic growth for our communities. So, many of these invasive species must be addressed.

And the last group that I would like to just touch on is some of those that affect our timber industry. We have the Asian longhorn beetle and we have the cyrus wood wasp. Both of them are extremely expensive to eradicate. But they must be eradicated because, if they are left unchecked, they will destroy the timber industry, they will destroy a lot of our forestry, which will undermine many other economic issues like tourism.

For example, the Asian longhorn beetle, it has cost more than $180 million to eradicate it in the suburbs around New York City so that it does not spread toward the Catskills and the Adirondacks where it could be devastating to our tourism and timber industries.

So, I am very appreciative of this hearing because, you know, these are very serious economic, health and agricultural impacts that affect not only the livelihood of New Yorkers, but the health and well being of our children.

I appreciate your focusing attention on these very important issues.

Senator CARDIN. Well, I think each of the members' opening statements points that we have a common challenge around the Nation on dealing with the protection of our native wildlife species, and we look forward to trying to work together to figure out what we can do in a constructive manner.

Our first panel includes two of our colleagues that are very actively involved on this issue, Senator Carl Levin from Michigan who has been a leader in regards to the Great Lakes, and Senator Bill Nelson from Florida, who has been very actively involved in the Everglades and preserving those issues.

Senator Levin.

OPENING STATEMENT OF HON. CARL LEVIN,
U.S. SENATOR FROM THE STATE OF MICHIGAN

Senator LEVIN. Thank you, Chairman Cardin and colleagues, for inviting us to testify very briefly and to make an introduction.

As the Chairman mentioned, I represent Michigan, a Great Lakes State. Invasive species have done severe damage to our Great Lakes as well as to the land mass of Michigan. Everything from zebra mussel, which a number of you have mentioned, to the emerald ash borer which are destroying ash trees. We have 180 invasive species identified in the Great Lakes alone.

I was thinking about bringing in a zebra mussel, by the way, but then I had word that Senator Nelson might bring in an exhibit which would make our poor zebra mussel look so puny by comparison that you would think it would not be a problem.

[Laughter.]

Senator LEVIN. Let me just mention, I am not going to tell this panel and these two subcommittees about the problems of invasive species. You all know them. You have them in your States. You have all made reference to them in your opening statements. I just would reinforce one point that you made, which is the universality of the problem, at least in terms of all of our States.

The zebra mussels started in the Great Lakes. Thirty States are now infested with zebra mussels. Like global warming, these things do not stay in one place.

Second, the solution, at least one of the key remedies, lies in your hands. That is to adopt a significant ballast water treatment technology requirement for our ships. Most of our invasive species in the Great Lakes States come in through the water. In the ballast is our invasive species that come in from other places. And when that ballast is exchanged in the Great Lakes, it drops these invasive species in the Great Lakes, including zebra mussels.

You had under your consideration, as has the Commerce Committee had under consideration for many years, bills which would require ships to have new technologies to destroy the species instead of just being to remove or transfer ballast from saltwater to fresh water and so forth. We actually have a technology to destroy the species.

There has been a conflict in two bills. One bill, which I think has been favored by many members on this committee and these two subcommittees, basically would allow the States to adopt a higher technology over the years than the national standard which we would start with.

The Commerce Committee, and I do not want to generalize here because I am not sure it applies to every member, but in general, there is a Commerce Committee bill, I will identify it, which says we are going to have a national standard, and we are then going to let that standard apply for a reasonable period of time without the shipping companies facing the possibility that States will up the ante.

This is a traditional conflict. It is the not the first time that we have faced this kind of a conflict. We have it all the time. But it needs to be resolved. And I believe the right resolution is for us to adopt a tough national standard, and then to give the shipping industry a period of repose. They will be guaranteed that there will

not be any increase in that standard for a reasonable period of time.

That is not the bill which many members of this committee have favored. But that is the conflict that needs to be resolved. I have taken a position on it which is, by the way, different from the position I think of my own legislature, which would like the State to be able to have a higher standard a year from now. You have shipping companies put in expensive technologies this year, and then a year from now any one of the States can say, whoops, there is a new technology and we want you to adopt a new one?

We are never going to get this accomplished unless we adopt a national standard and let it stick for a reasonable period time, whether it is 5 years or 10 years. I would urge the members that are considering this to consider that option. But it is in your hands. This conflict needs to be resolved between these two bills. And again, the position I have taken is not my own State legislature's position.

Having said that, I am really here to make an introduction, not to lobby my colleagues.

I want to introduce a panelist who will be on the second panel, Rebecca Humphries. She is the Director of the Michigan Department of Natural Resources. She worked her way up through the ranks of the Michigan of Natural Resources. She has more than 30 years' experience in the field. She has considerable knowledge on the impacts of invasive species and disease on native wildlife. She has served, in recent years, as Chair of the Fish and Wildlife Health Committee of the Association of Fish and Wildlife Agencies.

So, she has a lot of information. She has tackled issues in Michigan involving invasive species such as VHS, chronic wasting disease, emerald ash borer and so forth. She is going to have a lot of valuable information for these two subcommittees that meet today.

We are grateful for your doing what you are doing. I know that you are going to excuse me, and I appreciate that.

I have talked to Senator Nelson about his testimony and I agree with everything that he says, for what that is worth. And I am glad this damn python is a long way from where we live.

[Laughter.]

[The prepared statement of Senator Levin follows:]

STATEMENT OF HON. CARL LEVIN,
U.S. SENATOR FROM THE STATE OF MICHIGAN

Thank you, Chairman Cardin and Chairman Whitehouse and the members of your subcommittees, for holding today's hearing on the very important topic of threats to our wildlife.

As a Senator from Michigan, a Great Lakes State, I have seen the consequences of allowing aquatic invasive species to enter our waters. About 180 non-native organisms have been identified already in the Great Lakes. Some of my colleagues may remember that back in the late eighties and nineties, the zebra mussel was released into the Great Lakes through ballast water. At that time people considered the zebra mussel to be just a problem for the Great Lakes. Today, almost 30 States are fighting to control and prevent them. Zebra mussels can significantly change the nature of the lake bottom, affecting fish habitat and spawning. They trap nutrients and disrupt the normal flow of these nutrients into deeper waters. The mussels also excrete nutrients creating an environment that may be linked to water quality problems, such as algal fouling on rocky shorelines, off-tastes in drinking water and lethal outbreaks of botulism in wildlife, especially during warm water periods. Mussels eat by filtering algae from the water. This is the same food source for many native fish which means less food available to native species. Zebra mussels have

caused drastic declines in the native Great Lakes mussels (commonly called clams) not only by competing for food, but also by nesting on top of exposed clamshell so that the native mussel cannot get enough food to survive.

Because invasive species can quickly spread throughout the country, the best effort that we have against invasive species is prevention. Maritime commerce is the largest pathway for new species to be introduced into our waters, and I believe that we need to enact legislation that will require ballast water discharge management that will result in ballast water treatment technology onboard ships as soon as possible. I support establishing a strong national ballast water technology standard for all ships. Technology that meets this standard would be approved for a minimum period of time—5, 8, or 10 years.

I also believe it is important to address other pathways of introduction such as intentional introductions. Right now, anyone can order almost any organism on the Internet and have it shipped into the U.S., and no one considers whether that organism is invasive and harmful. We need to establish a process to screen incoming organisms. The Great Lakes Collaboration Implementation Act, which I and Senator Voinovich introduced, establishes a screening process for invasive organisms.

Third, we need to be more aggressive about adding organisms that are invasive and injurious to the Lacey Act list. Listing a species as injurious under the Lacey Act would prevent the intentional introduction of these species by prohibiting the interstate transportation or importation without a permit. One species that I believe should not be imported is the bighead carp, and I will introduce legislation to list the bighead carp as injurious under the Lacey Act. Three other species of Asian carp have already been listed. The Asian carp grow very big, reproduce quickly, and are now the most abundant fish in the Mississippi River. It's important to Michigan to prevent these fish from entering the Great Lakes and destroying the native fishery.

Mr. Chairmen and Ranking Members, the impact of invasive species on Michigan's native wildlife is large. I am only able to touch on a few of the invaders that have had such a negative impact to my State, and I know that each of your States is also suffering. So I encourage this committee to support legislation to implement a strong ballast water management program, to create a screening process for live organisms being imported into the country, and to simplify the process of listing a species as injurious under the Lacey Act.

And now I want to say a few words of introduction about Director Rebecca Humphries, the Director of the Michigan Department of Natural Resources, who will testify later on the third panel. Director Humphries has worked her way up through the ranks of the Michigan DNR and has more than 30 years of experience in the natural resources field. She has considerable knowledge on the impacts of invasive species and disease on native wildlife. Over the last few years, she has served as the chair of the Fish and Wildlife Health Committee for the Association of Fish and Wildlife Agencies helping to develop a package of information related to State and Federal authorities to manage diseases in fish and wildlife so that when a disease outbreak occurs, State agencies are prepared with plans, well trained staff, and legal authorities. Director Humphries has tackled issues in Michigan such as viral hemorrhagic septicemia (VHS), chronic wasting disease, emerald ash borer, and I believe that she will have some valuable recommendations on how the Federal Government can work with States to minimize the threats to native wildlife. Thank you, Director Humphries, for coming to Washington to share your insights into these issues.

In closing, I want to thank the members of the two subcommittees for today's hearing as well as the other witnesses.

Senator CARDIN. Senator Levin, thank you very much for sharing your thoughts on the subject with us. We appreciate your testimony.

Senator Nelson.

OPENING STATEMENT OF HON. BILL NELSON, U.S. SENATOR FROM THE STATE OF FLORIDA

Senator NELSON. Mr. Chairman, while Senator Levin is still here, I just want to say that I am a sponsor of that bill in the Commerce Committee.

This mussel, this zebra mussel, is really a problem. What happens is, instead of using rocks like they did in the old days for ballast on ships, they use water. They take this water from a foreign

land. Well, this water is invaded with all of these species, and they come into the Great Lakes and they dump the water, and then the species get out. This zebra mussel goes and attaches itself to drain pipes and so forth, and it completely clogs up everything.

So, it is just another example that the Congress of the United States needs to address this problem in law. It needs to address what I am going to show you in law as well. And there is something that you can do about that, and that is the bill that we filed which adds to the List of Injurious Species the Burmese python.

Now, let me tell you how bad this has become in the Florida Everglades. These snakes that people import into this country and buy as pets, well, a Burmese python can grow as much as 7 feet in 1 year. So they get them as these little bitty snakes, and then they get too big, and people release them. And they are so prolific.

As a matter of fact, in an environment like the Florida Everglades that, by the way, the U.S. Government is spending a lot of money, along with the State of Florida, to reform the Florida Everglades from the diking and draining that had occurred for the last three-quarters of a century, and now we are allowing a species to take over that is at the top of the food chain, and all of the natural species that is in the Florida Everglades that we are restoring back to what Mother Nature intended, all of that native species is being thwarted.

For example, they found that this snake has swam across the ocean to Key Largo. It is the top key in the chain of the Florida Keys. And there they found, in the belly of one of these snakes, the endangered Key Largo wood rat. They have found in these snakes a full grown Florida deer. They have found a full grown Florida bobcat. It is only a matter of time before a Florida Panther is found inside of one of these invasive pythons.

As you can see, by the size of this critter, you can see that this one is probably 16 or 17 feet, what they do is they have fangs that have fish hooks on them. Their modus operandi, since you cannot see them, they will lie in wait perfectly still for their prey. They then strike, and grab their prey with their fangs which, because it has a barb on the end, the prey cannot pull away, then immediately wrap their constrictor body around the prey and suffocate their prey to death.

Unfortunately, the worst happened last week in Florida. A pet Burmese python only 8 feet long, not this long, slithered out of its glass cage and, in the middle of the night, worked its way up into the baby crib, attached its fang to the head of a 2-year-old child, wrapped its body around the child and strangled the child to death.

This happened in Sumter County, which is to the west of Orlando and north of Tampa. It is just a matter of time before one of these snakes gets to a visitor in the Florida Everglades.

Mr. Chairman, I have had the Superintendent of the Everglades Park tell me that they now estimate that these snakes have proliferated to the tune of 150,000 in the Florida Everglades National Park. The reason they are so prolific is, they killed a 16-footer and inside of her were 56 eggs ready to hatch. So, you see how it has become such an invasive species. And it is taking over anything that is natural to the Florida Everglades.

Now, fortunately, at the end of May, we took Secretary Salazar down the Everglades, took him out in an airboat and he got to see this natural phenomenon called the River of Grass. But before we took the tour in the airboat, we brought this, it is a 16-footer, you can see the body, and you can see Secretary Salazar here looking at this snake. This snake is about as large as this one. And you see the power. It took three men to hold that snake and that snake was not hungry. You can see the power.

The middle of that snake, the middle of him, is this big around. And it is all muscle. You have heard the phrase a pig in a python, with the hump in the middle of the snake? Well, that is exactly what they do. Once they have suffocated their prey to death, then these jaws separate and they ingest the whole prey and the body expands and that is where the phrase the pig in the python came from.

In the food chain, there is only predator that is higher than this, and that is the alligator. But that is only a very large alligator. We have had a 12-foot python attack an 8-foot alligator. And they thrashed around in the water for 30 hours right off of the headquarters of the National Park in the Florida Everglades.

We have found a 6-foot alligator inside of a python. Here again, this is only a 6-footer, and you can see what they look like against St. Augustine grass, but when these critters get into the natural swampy conditions, you cannot find them. They had captured one, they put an electronic chip in one. So they trapped it and they had the electronic antenna saying that the snake is right there, and all of the biologists standing around could not see the snake. That is how difficult they are.

What I am going to enter into the record, with your permission, is a 10-page document that will detail the number of python attacks on human beings in the last 10 years. And I can tell you, Mr. Chairman, it has been 17, and 7 people have died as a result of the attack.

So not only do we have a species that is threatening to humans, and the superintendent of the park told me one day that he has never experienced anything like this, they saw a python starting to come across the road out in the park. He said his attention was diverted momentarily and he turned around and the python was right in front of him. They move that quickly.

So, endangerment to humans, especially endangerment to the natural ecological phenomenon of what Mother Nature intended because of this snake going after all the other prey, and, ultimately, changing the very nature of something that we are trying to return to what Mother Nature intended, and that is the Florida Everglades.

I would close with this. This snake coming out of Burma, all it knows is that it likes moist, humid climates. This is not restricted just to the south end of the peninsula of Florida. This snake, if it continues to proliferate, you are going to find it all over the southern United States and that is all the way, and the biologists will tell you as they testify, there are conditions in California and all across the sunbelt that are conditions for this snake to prosper in.

As you look at these invasive species, and there are plenty of others you all have mentioned, and I would add that the Brazilian

pepper plant and the Nile monitor lizards are other invasive species, we have got to have the ability to stop it.

Because we have the problem in Florida, I have been asking the U.S. Fish and Wildlife Service, administratively, to do something about the import. And for 3 years they have not. They said that they are studying it. I am hopeful now that, under Secretary Tom Strickland, who was down there with us, I am hopeful that they are going to administratively get into it.

But you can do something about it, Mr. Chairman, by a one word change in the law and restricting it to, not all of the constrictor snakes, but to this particular one. And that would be the help that we need to address this problem.

Thank, you, Mr. Chairman.

[The prepared statement of Senator Nelson follows:]

STATEMENT OF HON. BILL NELSON,
U.S. SENATOR FROM THE STATE OF FLORIDA

Chairman Cardin and Chairman Whitehouse, thank you for inviting me to testify at this hearing today.

Last week tragedy struck in a small town northwest of Orlando, Florida. As the family awoke a scene of horror unfolded. An 8-foot albino Burmese python escaped from its container, slithered through the house and up into a crib where 2-year-old Shaiunna Hare lay asleep. The snake bit the child and wrapped itself around her body. By the time the paramedics had arrived, the child was already dead from asphyxiation. This is truly the scene of a parent's worst nightmares.

We have been warning about the dangers that these lethal snakes present. I have a 10-page document that I will submit for the record detailing python attacks over the last 10 years. During that period at least 17 people have been the victim of an attack, of which 7 died as a result.

Besides posing a threat to safety, invasive species like the Burmese python are wreaking havoc in our most treasured environments. Some estimate there are upwards of more than 100,000 of these deadly pythons in the Everglades National Park. The crown jewel of our national park system has been transformed into a hunting ground for these predators.

When is the time for action? We already have one tragedy on our hands. How long will it be before one of these snakes gets a hold of the extremely endangered Florida Panther? How long will it be before a tourist in the Everglades National Park has a dangerous encounter with one of these massive pythons? It took this tragic event to bring back focus to this problem, but there is something we can do about it.

The Fish and Wildlife Service has the capability, under law, to declare this an injurious species under the Lacey Act.

After the South Florida Water Management District made a request in June 2006, Fish and Wildlife has spent the last 3 years studying it. I think that Secretary of the Interior Ken Salazar will take them from studying this issue to acting on it. But there is something else we can do. Congress can change the law.

I filed a bill in February which amends the Lacey Act and declares pythons as an injurious animal. This will halt the importation and interstate commerce of these deadly snakes. Classifying the Burmese python or python molurus bivittatus as an injurious animal would also stop the importation of these snakes between States. This is of particular importance—while Burmese pythons have already established a breeding population in South Florida, climate maps from the United States Geological Service indicated roughly a full third of the U.S. is suitable habitat.

The State of Florida has been working from its end to get a handle on these snakes. They now require a yearly registration fee, owners must display knowledge of handling and care, and snakes are now micro-chipped—so if one got loose you would have a chance to chase them down. It's time for the Federal Government to step up and address this ecological crisis.

With more than a hundred thousand of these snakes on the loose in the Everglades we must do something before the ecological balance is destroyed. We must change the law, and we must do it quickly.

Finally, I would like to thank you again for taking a look at the impact non-native plants and animals are having on our Nation's natural resources and protected ecosystems. Florida is ground zero for exotic plants and animals. From the Brazilian pepper to Nile monitor lizards, we have seen it all.

I would welcome the opportunity to work with you on reforming the way we allow species from all over the world into the United States. There might be a way to stop the next Burmese python from establishing a foothold here.

Senator CARDIN. Well, thank you for your very powerful testimony, Senator Nelson.

Our first panel will consist of our Federal agencies. We have, representing the United States Fish and Wildlife Service, the Assistant Director for Fisheries and Habitat Conservation, Gary Frazer, and then from the United States Department of Agriculture, Animal and Plant Health Inspection Service, Acting Associate Administrator Bill Clay.

Mr. Frazer, we are glad to hear from you. Your full testimony will be made part of the record. You may proceed as you like.

STATEMENT OF GARY FRAZER, ASSISTANT DIRECTOR FOR FISHERIES AND HABITAT CONSERVATION, U.S. FISH AND WILDLIFE SERVICE

Mr. FRAZER. Thank you.

Chairman Cardin, Chairman Whitehouse and members of the subcommittees, I am Gary Frazer. I am the Assistant Director for Fisheries and Habitat Conservation of the U.S. Fish and Wildlife Service. I also serve as co-chair of the Aquatic Nuisance Species Task Force.

I am joined today by Dr. Jonathan Sleeman, Director of the U.S. Geological Survey's National Wildlife Health Center. And thank you for the opportunity to testify today.

Non-native invasive species have significantly affected the health of our native species and ecosystems, and the U.S. continues to see non-native potentially invasive species crossing our borders through various pathways. Given the global nature of our economy and transportation systems, we expect this trend to continue.

Invasive species are among the primary factors that have led to the decline of native fish and wildlife populations in the United States and are among the most significant natural resource management challenges facing the Fish and Wildlife Service.

We know that about 4 in 10 species that the Service protects under the Endangered Species Act are at risk in large part due to the effects of invasive species. Aquatic invasive species have harmed America's sport and commercial fisheries. And invasive species are one of the most significant threats to the National Wildlife Refuge System.

A September 2008 report of the Government Accountability Office listed invasive plants as the No. 1 threat to habitats on refuges and invasive animals as the third greatest threat.

Preventing non-native species from being introduced or established is the most cost-effective strategy for dealing with invasive species. Control is costly, and the conservation community has limited tools for long-term management, particularly of aquatic invasive species once they become established.

Preventing the introduction and spread of non-native invasive species requires a comprehensive approach including Government regulatory tools, such as import screening and injurious wildlife prohibitions, pathway management, and public education and outreach.

Now I would like to turn to the threats of disease to native fish and wildlife.

Human-induced changes to the landscape, including the introduction of non-native species, climate change and declining water and environmental quality, appear to be contributing to a surge in infectious disease and parasites afflicting native fish and wildlife. Some pathogens are endemic to the United States while others are introduced and the pathogens themselves could be classified as non-native invasive species.

Non-native infectious diseases are of particular concern because native wildlife populations are less likely to have developed immunity to these pathogens. Non-native pathogens introduced into highly mobile wildlife species can spread rapidly, be difficult to control, and have severe ecological, economic and even human health impacts.

An example is white-nose syndrome of bats, which was first documented in January 2007 in hibernating bats in New York. It has since been documented in hibernating bats in 9 States including Virginia and West Virginia. More than 90 percent of bats in affected caves have died, with a few caves showing close to 100 percent mortality.

Thus far, six bat species have been affected, including the endangered Indiana bat. The sudden and widespread mortality associated with white-nose syndrome has never been observed before in any of the more than 1,100 species of bats known to science.

The Service is leading the Department of the Interior's response to the emergence and spread of white-nose syndrome in bats, in cooperation with the USGS, the National Park Service, the U.S. Forest Service, State fish and wildlife agencies and many other partner agencies and organizations. And we expect to have management recommendations in place by September of this year.

The Service and USGS work very closely with State fish and wildlife agencies on surveillance, diagnosis and management of fish and wildlife disease. The nature of State and Federal authority over fish and wildlife requires close and collaborative relationships and capability among all the partners. To this end, the Service and USGS are partners with the State fish and wildlife agencies in development of a National Fish and Wildlife Health Initiative, an initiative of the Association of the Fish and Wildlife Agencies.

The overarching goals of this initiative are to establish and enhance fish and wildlife agency capability to address health issues of free ranging fish and wildlife and to minimize the negative impacts of health issues affecting free ranging fish and wildlife through management, surveillance and research. As with invasive species, preventing and controlling disease in fish and wildlife requires capability and coordinated effort among many parties.

Invasive species and fish and wildlife disease are existing threats to fish and wildlife populations that will only grow in significance in the face of changes to the physical environment caused by climate change. Managing these existing stressors to fish and wildlife, and anticipating how they may be exacerbated by a changing environment, are essential elements of sustaining our Nation's fish and wildlife in the face of climate change.

Mr. Chairman, the Service appreciates your interest in these issues and looks forward to working with you to address these threats to our Nation's fish and wildlife.

Thank you again for the opportunity to appear before you today, and I would be happy to respond to any questions you or the subcommittees may have.

[The prepared statement of Mr. Frazer follows:]

TESTIMONY OF GARY FRAZER, ASSISTANT DIRECTOR FOR FISHERIES AND HABITAT CONSERVATION, U.S. FISH AND WILDLIFE SERVICE, DEPARTMENT OF THE INTERIOR, BEFORE THE SENATE ENVIRONMENT AND PUBLIC WORKS SUBCOMMITTEE ON WATER AND WILDLIFE AND THE SUBCOMMITTEE ON OVERSIGHT, REGARDING THREATS TO NATIVE WILDLIFE SPECIES

JULY 8, 2008

INTRODUCTION

Chairman Cardin, Chairman Whitehouse, and Members of the Subcommittee, I am Gary Frazer, Assistant Director for Fisheries and Habitat Conservation of the U.S. Fish and Wildlife Service (Service) within the Department of the Interior (Department). I also serve as co-chair of the Aquatic Nuisance Species Task Force (ANS Task Force). Thank you for this opportunity to testify on threats to native wildlife species. The Service appreciates the Subcommittee's efforts to address invasive species and wildlife disease. Today, my testimony will focus on the threats posed by both invasive species and fish and wildlife diseases, and what the Service is doing to address those challenges.

THREATS TO WILDLIFE FROM INVASIVE SPECIES

The introduction and establishment of invasive species have significantly impacted the health of our native species and ecosystems. Executive Order 13112 defines invasive species as an alien (with respect to the ecosystem under consideration) species whose introduction does or is likely to cause economic or environmental harm or harm to human health. We only need to look at the history of invasive species introductions, from the sea lamprey to the zebra mussel to tamarisk, to understand the broad scope and extensive impact of the problem. The United States continues to see an increasing number of nonnative, potentially invasive species crossing our borders through various pathways. Given the global nature of our economy and transportation systems, we expect this trend to continue. The United States is a leading import market for live animals and the majority of these imported species (more than 80 percent) are not native to the United States. This increases the likelihood or risk of additional invasive species being introduced and becoming established in the environment. Invasive species are among the primary factors that have led to the decline of native fish and wildlife populations in the United States and are one of the most significant natural resource management challenges facing the Service.

It is difficult to estimate the full extent of the environmental damage from nonnative invasive species. However, we know that about 4 in 10 species that the Service protects under the Endangered Species Act are considered to be at risk in large part due to competition with, predation by, or effects on habitat from, invasive species. Invasive species can also alter ecosystem functions. The brown tree snake is a major threat to the biodiversity of the Pacific region. A native of Indonesia, New Guinea, the Solomon Islands, and Australia, the brown tree snake arrived on Guam sometime during the 1940s – 1950s as stowaways on boats. The snakes have since spread across the entire island and have caused or been a major factor in the extirpation of 17 of Guam's native terrestrial vertebrates, including fruit bats, lizards, and 9 of 13 native forest bird species. Insect species that are no longer naturally controlled by native birds and lizards on Guam reduce fruit and vegetable production and their uncontrolled numbers

require greater reliance on pesticides. Brown tree snakes also cause millions of dollars in damage to Guam's infrastructure and economy by climbing power poles and causing power outages. Of major concern is that the brown tree snake could be carried to other Pacific Islands (including Hawaii) and subtropical regions of the continental United States in cargo.

The Service is concerned about the impact of aquatic invasive species to America's sport and commercial fisheries. In the Great Lakes region, the sea lamprey was accidentally introduced in the early 20th century as a result of the construction of shipping canals. This parasitic fish has been extremely destructive to economically important sport fish, including lake trout, salmon, rainbow trout, and walleye. During its life cycle, a single sea lamprey can kill 40 or more pounds of fish, and under certain conditions, 40 to 80 percent of fish die from a single attack by a sea lamprey. Before sea lampreys invaded the Great Lakes, about 15 million pounds of lake trout were harvested in Lakes Huron and Superior annually. However, by the early 1960s, sea lampreys and other factors reduced the catch to 300,000 pounds.

Zebra and quagga mussels are invasive freshwater mollusks that impact both the natural environment and human infrastructure. The mussels impact native species through competition and biofouling, the impairment or degradation of underwater surfaces or equipment as a result of the accumulation of living organisms. They can even cover other living organisms. The St. Croix River, a National Wild and Scenic River in the upper Mississippi River basin, contains the only viable population of the winged mapleleaf clam (*Quadrula frugosa)*. Zebra mussels could wipe out this already endangered species if they become established in the river. The mussels impact civic operations and development by clogging municipal and industrial water systems such as water intakes needed for hydroelectric development and other industries. Both mussel species are easily spread unintentionally by recreational boaters and annually cause an estimated $30 million in damage to water delivery systems in the Great Lakes. In early 2007, quagga mussels were discovered in the Lake Mead National Recreation Area. They have since been found in Arizona, California, Nevada, and all 242 miles of the Colorado River Aqueduct. In January 2008, the first populations of zebra mussels were found in the San Justo Reservoir in California and Lake Pueblo in Colorado. The U.S. Geological Survey (USGS) Nonindigenous Aquatic Species database allows the precise tracking and distribution of occurrences of non-native aquatic species throughout the United States. An alert system was recently developed to allow users to automatically receive email alerts when new occurrences are reported to the database. This database and mapping capability have been vital to tracking the spread of quagga mussels in the western United States and have provided managers with a real-time tool to assist in developing management strategies.

Invasive species are also one of the most significant threats to the National Wildlife Refuge System (NWRS), where they can destroy habitat, displace wildlife, and significantly alter ecosystems. Presently, about 2.4 million acres of NWRS lands are infested with invasive plants. There are at least 4,423 invasive animal populations recorded on NWRS lands as well. A September 2008 report released by the Government Accountability Office listed invasive plants as the number one threat to habitats on refuges and invasive animals as the third greatest threat. Although the NWRS is committed to controlling and eradicating these invasive animals and plants, the task is big and challenging. For example, the Service has treated an average of 13 percent of the acres infested with invasive plants on an annual basis between fiscal years 2004

and 2008, despite the fact that the cost of treating invasive plants and animals on refuges has skyrocketed. Between 2004 and 2009, base funding spent on managing invasive species increased 155 percent from $6 million in 2004 to $15.3 million in 2008.

For example, the invasive, aquatic rodent, nutria was brought to the Chesapeake Bay and to Louisiana to bolster the fur trade. By the early 1990's, the Delmarva Peninsula population was estimated to exceed 150,000 animals. Although harsh winters cut back the population, the rodent's capacity to reproduce allowed it to quickly rebound. Nutria eat aquatic plants, and particularly favor the Olney three-square, saltmarsh hay, and smooth cordgrass marshes in and around the Blackwater National Wildlife Refuge. Nutria damage these wetlands, and have contributed to significant and measurable losses of marsh habitat. Building upon support from Congress, the State of Maryland, the Service, USGS, USDA Wildlife Services, the University of Maryland, and private landowners bordering the refuge worked together to establish the precise damage nutria causes to the marsh, its biology and population dynamics, and methods of control.

By 2004, nutria had been extirpated from the refuge. The project continues as the partners work to remove nutria from all available habitats in the upper reaches of the watersheds feeding into the refuge. Nutria is found in all three peninsula states – Maryland, Virginia, and Delaware – and until it is eradicated, the opportunity remains for these rapidly reproducing animals to repopulate previous cleared habitat. Nutria are found in a total of 16 U.S. states, including the West Coast States of Washington and Oregon, and the Service has been involved in helping other states establish nutria eradication efforts based on the protocol and partnerships established in Maryland.

Addressing the Challenges of Invasive Species

As the old proverb goes, "an ounce of prevention is worth a pound of cure." The proverb resonates particularly well when addressing invasive species. Preventing additional introductions is a primary focus of the Service and is the most effective strategy to protect our nation's wildlife and habitats. The Service has a broad array of programs that complement the efforts of the Animal and Plant Health Inspection Service (APHIS) of the U.S. Department of Agriculture (USDA) and support our ability to prevent introductions and manage invasive species problems.

The Nonindigenous Aquatic Nuisance Prevention and Control Act of 1990 (NANPCA), reauthorized by the National Invasive Species Act of 1996, established the Service's Aquatic Invasive Species (AIS) Program as well as the ANS Task Force, which is an interagency Federal Advisory Committee Act (FACA) group with 13 federal and 12 Ex-officio members co-chaired by the Service and the National Oceanic and Atmospheric Administration (NOAA). The ANS Task Force encourages federal and state agencies to establish partnerships with stakeholders at all levels to enhance our collective efforts to address aquatic nuisance species issues. The ANS Task Force relies on the expertise of its six Regional Panels to identify regional ANS priorities; coordinate ANS program activities in each region; make recommendations to the ANS Task Force; and provide advice to public and private interests concerning appropriate methods of ANS prevention and control.

For example, the ANSTF recently tasked its Western Regional Panel (WRP) to develop a quagga/zebra mussel action plan (QZAP) to address the rising threat of this mussel invasion in the west. The WRP unveiled the first draft of the QZAP calling for mandatory inspection and decontamination stations at infested water bodies as well as many other actions. The primary objective of the QZAP is to highlight the actions necessary over the next five years to minimize the impacts of these invasive shellfish on native species, water delivery infrastructure (e.g., municipal, agricultural, and hydro-electric), and other vulnerable resources. The Task Force and the members of the WRP have agreed that it would use the QZAP as the guiding document to direct the western response to these invasive mussels.

The Service's AIS Program was established to help coordinate prevention, control, and management action on invasive species that span geographic and jurisdictional boundaries. The program supports an AIS Coordinator in each of the Service's eight regions who works closely with Service field stations, State invasive species coordinators, nongovernmental groups, private landowners, and many others in their day-to-day activities. This dedicated network organizes cooperative surveillance efforts with other federal, state, and local agencies, universities, and public interest groups to track the distribution of aquatic invasive species. It also conducts a variety of outreach activities to inform the public about the definition, biology, and impacts of aquatic invasive species and what they can do to help prevent their spread. These Regional Coordinators are in tune with both the national priorities of the ANS Task Force and the various emerging regional priorities. Their unique position allows them to play a critical role in bridging the gap between national and regional aquatic invasive species issues and translating the national priorities of the ANS Task Force into on-the-ground projects.

The Service also contributes to the work of the National Invasive Species Council (NISC). Executive Order 13112, issued in 1999, charged all federal departments and agencies to prevent and control invasive species and created (NISC). NISC is co-chaired by the Secretaries of the Interior, Agriculture, and Commerce. NISC members include the Secretaries of State, Defense, Homeland Security, Treasury, Transportation, Health and Human Services, the U.S. Trade Representative, the Administrators of the U.S. Environmental Protection Agency, NASA, and the U.S. Agency for International Development. The Service has significant role in the implementation of the 2008 – 2012 National Invasive Species Management Plan that was issued by NISC on August 1, 2008. This plan coordinates the invasive species efforts and sets out objectives and implementation tasks within five strategic goal areas.

The Service's AIS program also administers the Injurious Wildlife provisions of the Lacey Act (18 U.S.C. Section 42(a)). Species listed as injurious may not be imported or transported across state boundaries by any means without a permit issued by the Service. Permits may be granted for zoological, educational, medical, or scientific purposes. Regulation of intrastate transport or possession is the responsibility of each state, except for those species covered under a Service permit issued by our Division of Management Authority.

The Service's Office of Law Enforcement's (OLE) wildlife inspection program forms an important part of the nation's frontline defense at ports of entry by interdicting injurious wildlife species. Wildlife inspectors are stationed at 38 major U.S. airports, ocean ports, and border crossings, where they monitor imports and exports to ensure compliance with U.S. laws and

regulations. Wildlife inspectors focus on detecting and deterring illegal trade in protected species and preventing the introduction of injurious wildlife. As part of OLE's efforts to prevent such introductions of injurious wildlife, Service special agents investigate illegal interstate commerce of injurious species (including Internet sales) and assist state counterparts with the enforcement of both federal injurious species prohibitions and state laws that ban the introduction, possession, and sale of state-listed injurious wildlife.

The Service is also using partnerships to minimize new introductions and prevent the spread of invasive species. For example, the governments of the United States and Canada, working jointly through the Great Lakes Fishery Commission, have implemented a successful sea lamprey control program on the Great Lakes since 1956. The Service's Fisheries Program has two Sea Lamprey Management Offices located in Marquette and Ludington, Michigan. Jointly funded by the Service and the Great Lakes Fishery Commission, these offices employ approximately 110 staff to implement an integrated sea lamprey control program within the United States portion of the Great Lakes. Sea lamprey abundance has been reduced by 90 percent as a result of the integrated control program. Congress appropriates more than $10 million annually through the State Department for sea lamprey management and research.

For the past 10 years, the Service's Fisheries Program has worked extensively to prevent the introduction and spread of Asian carp. We have supported a feasibility study on barrier options to prevent the introduction of these large fish into the Great Lakes; led the Asian Carp Working Group of the ANS Task Force which completed the National Management and Control Plan for Asian carp; assisted in creating a Rapid Response Plan for Asian carp in New York canals; funded research on the use of pheromones as a deterrent to carp spread and research on native fish alternatives to the use of black carp in aquaculture; and conducted monitoring for early detection and rapid response. USGS researchers studying Asian carp have found that they have spread to 23 States and their numbers are increasing exponentially. In developing control options, researchers are studying carp sensitivity to a variety of chemicals at different life stages (eggs, larvae, etc). Black, silver and large-scale silver carp were listed as injurious wildlife under the Injurious Wildlife provisions of the Lacey Act in 2007. Additionally, the evaluative injurious wildlife process for bighead carp is currently underway.

The Service's Partners for Fish and Wildlife Program provides technical and financial assistance to private landowners and Tribes to restore and protect habitat, including invasive species management and the reintroduction of native plants. From 2003-2008, the Partners for Fish and Wildlife Program was a cooperator in 3,718 habitat improvement projects that involved control of invasive species on approximately 1.3 million acres. The Service's Coastal Program assists communities in conserving coastal resources and forms partnerships to conduct on-the-ground restoration, including invasive species control activities in coastal areas. Between 2003 and 2008, the Coastal Program cooperated in 570 habitat restoration and enhancement projects that involved control of invasive species on approximately 256,287 acres of coastal habitat.

The NWRS invasive species program focuses on early detection and rapid response by engaging Friends groups and volunteers in the fight against invasive species. Over a period of three years, 2,750 volunteers contributed more than 49,000 hours to the treatment, inventory, and restoration of over 211,000 acres of refuge land through its invasives and volunteers competitive grants

program. Additionally, the NWRS has created five Invasive Species Strike Teams to focus employees highly skilled in invasive species management on seeking out and eradicating new infestations of invasive plants and animals. These teams are working to control and manage invasive species in key geographic locations, including south Florida, the Lower Colorado River and New Mexico, the Columbia-Yellowstone-Missouri River basins, North Dakota, and the Hawaiian and Pacific Islands. Another example of the importance of early detection and rapid response to new infestations can be seen in the partnership between the NWRS and USDA's Wildlife Services to eradicate the giant Gambian pouch rat from the Florida Keys. These giant rats, which can grow up to nine pounds in the wild, escaped from a pet owner on Grassy Key. Recognizing a threat to the nearby National Key Deer Wildlife Refuge, the NWRS partnered with Wildlife Services to support trapping the giant rats over the entire island. By eliminating this population before it spread to other islands, millions of dollars in future control efforts were potentially saved.

Education and outreach efforts continue to be critical elements to the success of invasive species prevention and control. The Service and the ANS Task Force have been working for many years on educational outreach programs aimed at preventing additional introductions and controlling the spread of invasive species. The *Stop Aquatic Hitchhikers!* Public Awareness Campaign targets aquatic recreation users and promotes voluntary guidelines to ensure that aquatic nuisance species are not unintentionally spread through recreational activities. To promote prevention of introductions through other high-risk pathways, the Service, the Pet Industry Joint Advisory Council (PIJAC), and NOAA Sea Grant created the Habitattitude™ Initiative. This campaign encourages aquarium hobbyists and water gardeners to be responsible caretakers of their plants and pets and to prevent the release or escape of non-native animals and plants into the wild.

Preventing Invasive Species is the Key

The invasive species issue is complex and represents multiple challenges for the world's conservation community. The complexity is further exacerbated by climate change, water fluctuations and other challenging social issues that compete for scare resources. Additionally, building capacity at multiple levels to complement each is equally as important. As a result, the collective response must be holistic and all-encompassing with an emphasis on prevention.

Preventing non-native species from being introduced or established is the most cost-effective strategy for dealing with invasive species. Control is costly and the conservation community has limited tools for long-term management, particularly aquatic invasive species, once they become established. Everyone can become part of the overall prevention equation through a combination of methods, including government regulatory means such as import screening and injurious wildlife prohibitions, pathway management such as the Hazard Analysis and Critical Control Point methodology, and citizen and private sector prevention efforts through education, outreach, and individual and organizational behavioral change processes.

THREATS TO WILDLIFE FROM DISEASE

Although the source and transmission of many emerging fish and wildlife diseases is not well known, human induced changes to the landscape—especially the introduction of nonnative species, climate change, declining water and environmental quality—are contributing to a surge

in infectious diseases and parasites afflicting animals as seen in the latter part of the 20th century and into the 21st century. In some cases, the impacts on fish and wildlife populations are unprecedented and devastating. The impacts present tremendous challenges for conservation through the mortality of productive individuals—especially in threatened populations—and the loss of their direct and indirect roles in the ecosystem. Diseases that can be transmitted from animals to humans are called zoonotic diseases, and some pose threats to domestic animals as well as humans and wildlife. Since 1970, 40 new infectious diseases have been identified throughout the world. More than 75 percent of diseases currently classified as "new or emerging" are zoonotic. Major health threats to wildlife populations also arise from noninfectious diseases associated with natural toxicants and anthropogenically derived environmental contaminants, such as pesticides, lead, and endocrine disrupting chemicals.

Some pathogens (including parasites) associated with infectious disease are endemic to the United States, others are introduced and the pathogens themselves can be classified as non-native invasive species. Non-native infectious diseases are of particular concern because native wildlife populations are less likely to have developed immunity to these pathogens. As illustrated by the West Nile virus outbreak in 1999, the introduction of a non-native invasive pathogen into the United States population can be difficult to control and can have severe ecological, economic, and even human health impacts.

The range of disease threats to fish and wildlife populations is tremendous, and native species impacts are regional, national, and even global in significance. Today, I will discuss some of the infectious diseases that have most recently emerged or re-emerged in North America, including: White-nose Syndrome, Sylvatic Plague, West Nile Virus, Chronic Wasting Disease, Avian Pox, Malaria, and Viral Hemorrhagic Septicemia.

White-nose Syndrome

White-nose syndrome (WNS) was first documented in January of 2007 in hibernating bats in New York. It has since been documented in hibernating bats in nine states, including Virginia and West Virginia. More than 90 percent of bats in affected caves have died, with a few caves showing close to 100 percent mortality. Thus far, six bat species have been affected, including the federally endangered Indiana bat. The sudden and widespread mortality associated with WNS has never been observed before in any of the more than 1,100 species of bats known to science.

Affected bats display a white, powdery substance on their faces and, on closer examination, many show tissue damage and scarring in their wings. Based on microscopic analysis, the powdery substance and tissue damage is a fungus—a new species only recently described by science. This species grows only in cold temperatures, and unlike most fungi, it invades living tissues. When hibernating, bats lower their body temperature significantly, and they pack tightly together—two factors which seem to promote the spread of the fungus from bat to bat. Although this is likely the primary vector of transmission, WNS may also be inadvertently spread from cave to cave by human activity in caves. Because the high mortality rate associated with WNS and its rapid spread, biologists are concerned that more hibernating species in other states are at risk. Twenty-five species of bats in the United States rely on hibernation to survive winter, and four species and subspecies are federally listed as endangered.

The Service is leading the Department of the Interior's response to the emergence and spread of WNS in bats, supported by the USGS, the National Park Service, the USDA, State fish and wildlife agencies, and numerous other partners. Through its coordination and response framework, the Service is working with more than 50 partner agencies and organizations to identify the mechanisms by which WNS is transmitted, identify how it contributes to mortality in affected bats, monitor its spread, and develop management and containment options for federal and state wildlife managers. To this end, the Department is engaged in a structured decision making process in which bat experts from multiple agencies are weighing various management alternatives against much uncertainty. We expect to have management recommendations in place by September of this year.

Specifically, the Service is collecting and distributing surveillance data and other critical information to other federal agencies, states, partners, and the public; administering several working groups focused on specific elements of the problem; funding key research; and working with stakeholders to identify and conduct collaborative investigations, monitoring, and management actions. The Service serves as the primary resource for the most current information and recommendations for all partners, such as important decontamination protocols. For instance, the Service developed a March 2009 cave access advisory that requested a voluntary moratorium on recreational activities in caves in the nine affected states and the eight neighboring states to minimize the potential spread of WNS. Cave closures have occurred on national park units and National Forests, specifically to reduce the potential of human spread of the disease. Caves supporting wildlife on National Wildlife Refuges are permanently closed to protect all species they support, including bats. The advisory also includes guidelines on scientific activity in caves supporting bat hibernacula.

Investigation into the disease and the implicated fungus species has been conducted at the USGS-National Wildlife Health Center, in collaboration with multiple partners, including the USGS-Fort Collins Science Center, the Service, Symbiology LLC, Cornell University, and conservation agencies from all WNS-affected states. Much of this work was summarized in a paper published in the journal Science. USGS has also led efforts to publish two additional studies that define criteria for diagnosing WNS and that describe and name the fungus that causes the skin infection characteristic of WNS.

To close gaps in scientific understanding of affected bat populations, this fungus, and its affect on bats, the Department has funded research through USGS into several lines of investigation. Data collected during a WNS infection trial are being analyzed to identify mechanisms by which WNS is transmitted. Additionally, an environmental survey is underway to determine the prevalence of the WNS fungus in the eastern United States and to evaluate the potential role of the environment in maintaining the WNS fungus. USGS is preparing to conduct epidemiological studies to determine the origin of the WNS fungus, ecological studies to ascertain whether bats are surviving the disease, and modeling studies to determine the potential for further WNS spread.

Sylvatic Plague

More than half of the species of North American rodents of conservation concern reside within the range of plague outbreaks in western North America. Since its introduction to North America in the early 1900s, sylvatic plague has had a major and sometimes near catastrophic impact on some populations of native mammals.

Plague is a bacterial disease transmitted by fleas, it affects many mammalian species, including humans, and it poses a serious challenge to conservation. For example, recovery of the black-footed ferret —one of the most endangered mammals in North America —is obstructed by plague fostered in colonies of the three prairie dog species (Gunnison's, black-tailed, and white-tailed prairie dogs), upon which the ferret depends for food and in whose burrows they shelter. Plague has reduced these prairie dog species populations to historic lows, and this, as well as the transmission of plague from prairie dogs to ferrets, has caused the near extinction of the ferret. Today, all three prairie dog species are considered "at risk" and have been petitioned for federal listing as threatened or endangered. The loss of these prairie dog species affects the biotic diversity and integrity of the western grasslands that stretch from southern Canada to Northern Mexico, because many animals, including badgers, fox, wolves, hawks, and owls, depend upon prairie dogs.

Plague was first documented in wild animals in the United States near San Francisco and quickly spread through western States to about the 100th meridian where it remained stable for nearly 50 years. From 2005-2008, however, plague moved further eastward into South Dakota, causing large outbreaks on Pine Ridge Indian Reservation and on the portion of the Buffalo Gap National Grassland in Conata Basin, where the largest breeding colony of re-introduced black-footed ferrets resides.

Plague has been responsible for numerous, devastating epidemics in humans throughout the centuries. Worldwide, 1,000-3,000 human cases are reported annually, with 10-20 cases per year in the United States. In 2007, a 37 year old Wildlife Biologist with the National Park Service died of plague after being exposed to the carcass of an infected mountain lion. Increased numbers of plague cases in humans in New Mexico, Arizona, and Colorado coincide with outbreaks in prairie dogs and rock squirrels. As a result of expanding residential development, there has been an upward trend in transmission from wildlife to domestic animals, including increased transmission of plague from domestic cats to their owners and veterinarians. From 1977-1997, 18 human cases resulted from contact with infected cats.

In Conata Basin, primarily on the Forest Service National Grassland in South Dakota near Buffalo Gap, black-footed ferrets have been successfully reintroduced, but this population is threatened by sylvatic plague. To manage the disease, the Service and its partners have applied an insecticide, which disrupts the flea life cycle, to prairie dog burrows. Also, the Service is working in cooperation with USGS and the U.S. Army Medical Research Institute of Infectious Diseases (USAMRIID) to use a plague vaccine for ferrets. These two techniques have proven successful in maintaining the Conata Basin ferret populations, despite several outbreaks of plague in recent years.

West Nile Virus

In 1999, West Nile virus (WNV) was first documented in birds in New York. By 2004, WNV had spread from the New York City region to almost all of the continental United States, 7 Canadian provinces, and throughout Mexico and to parts of the Caribbean. The virus is transmitted by mosquitoes; the life cycle of the virus primarily involves mosquitoes and wild birds, but it can also spread to humans and livestock through mosquito bites.

West Nile Virus has affected more than 326 bird species. Many of these bird species are highly susceptible to disease and death caused by WNV. Species most susceptible to WNV include crows, jays, magpies, and other species, including several raptors, and it can infect horses and humans. Commonly found in Africa, western Asia, and the Middle East, WNV was never recorded in the Western Hemisphere prior to 1999. It is not possible to determine the number of birds killed by WNV since its introduction to North America, however, hundreds of thousands of dead birds have been submitted in surveillance programs. WNV outbreaks continue in North America, and there is no way to predict how it may affect wildlife populations in the future.

Data reported in 2003 from individually marked populations of crows in New York State and Oklahoma (McGowan, et. al, 2003) show that these populations are experiencing important declines after the initial WNV outbreak. Analysis of breeding bird surveys indicate large-scale declines in WNV "hot spots" but did not indicate declines at the range-wide scale that can be attributed to WNV (Sauer, et. al, 2003) several species of passerine birds following the introduction of WNV into North America. (LaDeau, 2007)

As WNV spread westward from New York, state fish and wildlife agencies and state public health agencies coordinated on surveillance and monitoring of WNV. State and federal laboratories provided technical expertise to test both dead birds and mosquito pools. These agencies worked together with the U.S. Department of the Interior, the U.S. Department of Agriculture, and Department of Health and Human Services to educate the public on how to avoid contracting the disease. While the response to WNV has scaled back in recent years, the threat to wildlife, human, and livestock health remains. Almost all states reported cases of WNV in animals in 2008, and 44 human fatalities occurred that same year. In 2009, one human case has already been identified, and ten states are reporting infections in animals.

Chronic Wasting Disease

Chronic Wasting Disease (CWD) is a contagious disease that affects the brains of deer and elk. Although its impacts on wild deer and elk population dynamics are unknown, modeling suggests that CWD could substantially reduce infected populations by lowering adult survival rates and reducing productivity of these populations. The disease has been found only a few miles from the National Elk Refuge in Wyoming.

Fatal to affected wildlife, CWD has not been found to be transmittable to humans. The agent responsible for the disease may be spread both directly (animal-to-animal contact) and indirectly (soil or other surface to animal). Animals held in contaminated facilities have contracted the disease. It is thought that the most common mode of transmission from an infected animal is via saliva, feces, and urine. CWD has been found in free-ranging deer and elk in Colorado,

Wyoming, Kansas, Nebraska, South Dakota, Utah, New Mexico, Wisconsin, Illinois, New York, West Virginia, Alberta, and Saskatchewan. It has also been documented in deer and elk in game ranches in Colorado, Nebraska, South Dakota, Montana, Minnesota, Wisconsin, Oklahoma, Kansas, New York, Michigan, and in the Canadian provinces of Alberta and Saskatchewan. It is associated with individual, oddly-shaped proteins, called prions, which accumulate in the nervous tissue of the affected animal.

State fish and wildlife agencies have primary jurisdiction over deer and elk species. Individual States are attempting to control the spread of CWD by prohibiting the importation of live deer or elk, limiting the parts of animals that may be taken out of the state by hunters, and quarantining or destroying affected herds.

Avian Pox and Malaria

Environmental stressors such as climate change may exacerbate the emergence and transmission of non-native invasive pathogens to wildlife. Native Hawaiian forest birds, particularly the endemic honeycreepers, face one of the highest rates of extinction in the world. Introduced mosquito vectors and the diseases they carry, including avian malaria and avian pox virus, are widely considered to be primary factors responsible for these population declines and extinctions. The expanding ranges of these diseases pose a major threat to native birds that have not previously been exposed to them.

After being introduced to the Hawaiian Islands, avian malaria was responsible for a wave of extinctions of Hawaiian forest bird species during the 1920s and 1930s. Susceptible native birds below 1500 meter elevation were at continual risk from malaria. Above that elevation mosquitoes were rare, so many native forest birds are those living in higher elevations. Avian pox and malaria transmission in Hawaii depends on climatic conditions, especially seasonal changes in temperature and rainfall that increase or decrease mosquito populations.

A recently published USGS review discusses the likelihood of a forthcoming "disease invasion" by examining the present altitudinal range of avian malaria and pox, honeycreeper distribution, and the future projected range of diseases and honeycreeper habitat with climate change. Climate Change is predicted to expand the distribution of disease vectors, further increasing the risk to native Hawaiian forest birds.

Avian Influenza

While highly pathogenic H5N1 avian influenza (H5N1 HPAI) has not yet been detected in North America, it continues to pose a threat to the U.S. due to ongoing outbreaks in Asia, Africa, and Europe. This virus was first detected in 1997 in Hong Kong, gained resurgence in 2003, and has since spread quickly to over 60 countries. Worldwide, H5N1 HPAI has caused mortality events in thousands of wild birds including swans, geese, passerines, herons, and raptors. Avian influenza viruses rarely cause mortality in wild birds, so the virulent nature of the current strain of H5N1 HPAI is of great concern. The potential impacts of H5N1 HPAI on the North American ecosystem are unknown; however based on experiences in Europe, Asia, and Africa, introduction of the virus would most likely cause mortality events in wild birds as well as creating increased pressure on wild bird populations through surveillance and control activities. Potential routes of

H5N1 HPAI introduction into North America include migratory birds as well as legal and illegal importation of live birds and bird products.

Since 2006, the USFWS Division of Migratory Bird Management has played a key role in the collection of avian influenza biological specimens from wild birds. This work has been conducted on a national scale in collaboration with USGS National Wildlife Health Center, U.S. Department of Agriculture (USDA), state wildlife management agencies, and non-governmental organizations. The USFWS activities are guided by the "*Early Detection and Response Plan for Occurrence of Highly Pathogenic Avian Influenza in Wild Birds*", an 80-page guide to the Service's response to this disease threat last published in 2007.

Viral Hemorrhagic Septicemia

Viral hemorrhagic septicemia (VHS) is considered to be the most important viral disease of finfish worldwide and is listed as a reportable disease by many nations and international organizations. Prior to 1988, the causative agent, viral hemorrhagic septicemia virus (VHSV) was not known to occur outside continental Europe where it remains a major pathogen affecting rainbow trout aquaculture. Subsequently, a North American strain of VHSV was found to be widespread among marine fish on the Pacific coast of North America where it has been shown to be highly pathogenic for marine species, especially herring. Surveys of marine fish in other regions of the world have revealed that VHSV is also common among marine species in the North Atlantic, the Baltic Sea, the North Sea, and Japan.

In 2005-2006, the Great Lakes region reported that wild fish exhibited the disease or, in some cases, a related strain that caused very large fish kills. As of April 2009, VHSV has been isolated from several species of fish in much of the Great Lakes Basin including Lake Huron, Lake Michigan, Lake St. Clair, Lake Erie, Lake Ontario, the Niagara and St. Lawrence Rivers and from inland lakes in New York, Michigan, and Wisconsin. This isolate found in the Great Lakes region is the only strain of VHSV that has been linked to large mortalities among freshwater species. In 2008, an isolate of VHSV was obtained from muskellunge broodstock (a native fish) collected from a reservoir in Ohio that drains into the Mississippi River.

To date, significant disease or mortality has been reported in muskellunge, freshwater drum, goby, burbot, yellow perch, gizzard shad, and smallmouth bass, and VHSV has been isolated from more than 20 additional species in the region. The full effect of the virus on fish populations is not known. However, the presence of a reportable pathogen in the region, the large-scale mortalities among wild species, the potential impacts on commercial aquaculture, the outstanding Great Lakes recreational fisheries and lucrative bait fisheries, and the impending disruptions of interstate and international trade have caused substantial concern among many entities.

Chytridiomycosis in Amphibians

Chytridiomycosis (a.k.a. "Chytrid" or "Bd") is a newly-identified fungal disease that is implicated in the precipitous population declines and species extirpations that have gained global notice since 1970. Bd is believed to have originated in South Africa and initially spread via the commercial trade in clawed frogs, a species used in human pregnancy testing worldwide

beginning in the 1930's. Since its discovery, Bd has been identified in association with amphibian population declines on every continent that supports amphibians, including North America. At least 200 species of frogs are believed to have severely declined or been extirpated as a result of this pathogen. The impact on frogs from Bd represents the most spectacular loss of vertebrate diversity due to a disease in recorded history. It has been described as having the most significant impact of any wildlife disease on wildlife conservation, in terms of the numbers of species it impacts and the tremendous mortality associated with it.

Bd is capable of causing sporadic deaths in some amphibian populations and 100% mortality in others. Although the mechanism by which Bd attacks the host species is imperfectly understood, it appears that the fungus is able to grow and reproduce through amphibian skin. The disease then progresses as the newly generated fungus re-infects the host. Amphibians infected with the fungus exhibit a reddening of the ventral skin, convulsions with extension of hind limbs, accumulations of sloughed skin over the body, sloughing the outer skin layer of the feet and other areas, and occasional small ulcers or hemorrhaging. Affected animals can appear lethargic and can fail to respond normally to threats or other stimu, and they may exhibit abnormal posture. The fungus is believed to kill the animals through the production of lethal toxins and through interference with the exchange of oxygen and carbon dioxide through the skin.

In some instances where Bd has been encountered, 50% of amphibian species and 80% of individuals have disappeared within one year. Currently, there is no effective measure for control of the disease in wild populations; a few species appear able to survive with a Bd infection as larvae or as adults and these animals likely serve as reservoirs and vectors for future outbreaks. Notable among resistant species are worldwide invasive pest species including marine toads, American bullfrogs and the African clawed frog.

There are many gaps in our understanding of Chytridiomycosis; however, the Service is working with partners to improve our understanding of the pathogen and how to treat it, while educating the public and wildlife managers about the disease. USGS research relevant to Chytrid is performed and planned under their Amphibian Research and Monitoring Initiative. In 2007, the Service and Partners in Amphibian and Reptile Conservation (PARC) co-sponsored a landmark International symposium on Amphibian Declines and Bd, bringing over 200 scientists, managers, and others from nine countries representing four continents. Strategies, field protocols and recommendations were generated during this workshop to reduce the spread of the amphibian chytrid fungus at local, regional, national and international levels. These efforts, however, may not come in time to save some amphibian species from dramatic losses worldwide (Stuart and Chanson, *et al.*, 2004; Daszak, 1999).

Response to Fish and Wildlife Disease

The Department of the Interior has long recognized the threat of disease to fish and wildlife populations and to their conservation.

The Department provides cutting edge wildlife disease research and diagnostics through the USGS National Wildlife Health Center in Madison, Wisconsin. The Center provides information, technical assistance, and research on national and international wildlife health issues; monitors disease and assesses the impact of disease on wildlife populations; defines

ecological relationships leading to the occurrence of disease; transfers technology for disease prevention and control; and provides guidance, training and on-site assistance for reducing wildlife losses when outbreaks occur.

Within the Fish and Wildlife Service (Service), the National Wildlife Refuge System is staffed with biologists who are trained to monitor for wildlife morbidity and mortality events. Each refuge has a disease contingency plan that outlines procedures, roles, and responsibilities for responding to a disease outbreak. The Service also employs several disease specialists, including three veterinarians who specialize in mammalian, avian, and fish diseases, respectively.

The Service coordinates closely with USGS, other federal agencies, and our state partners to monitor and respond to wildlife diseases. In the case of avian influenza and white-nose syndrome, the Service is providing a key leadership role in coordinating surveillance, monitoring, and response, but in most cases, state fish and wildlife agencies are in the leadership role. The Service, along with the USGS and USDA-APHIS, assist the states in identifying and managing disease outbreaks when appropriate.

On the aquatic side, the Service's nine Fish Health Centers are on the front-lines of detection and diagnostics of potentially devastating aquatic pathogens and disease. USFWS Fish Health Centers maintain on-site capabilities for rapid response to pathogen detection, screening, and isolation, disease diagnosis, treatment recommendation, infection control via biosecurity implementation, and technical assistance regarding fish health and propagation. USFWS Fish Health Centers have expertise in several laboratory disciplines, including virology, bacteriology, parasitology, histology, epidemiology, pathology, and molecular biology.

The USFWS Fish Health Centers work closely with regional aquatic animal health compacts, state fish and wildlife agencies, Native American tribes, private aquaculture, and university researchers to ensure coordination across state, regional, and international boundaries. A vital part of the Service's proactive and cooperative approach to address emerging aquatic animal health issues is our National Wild Fish Health Survey, a watershed-based sampling protocol for water and fish that began in 1997. Utilizing state-of-the-art equipment, USFWS Fish Health Centers perform diagnostics and laboratory analyses on samples collected by Service personnel, as well as other federal, state, and tribal partners. The data generated from the Survey is essential for informed management decisions to protect America's aquatic resources. Samples of reportable pathogens (VHS, SVC, etc.) are sent to the USDA-APHIS Laboratory in Ames, IA for verification.

To address potential future aquatic pathogens and their management, the Service is working closely with USDA-APHIS and NOAA to develop a National Aquatic Animal Health Plan. Drafted with input from both private and public sectors, the plan is not regulatory in nature but provides a framework on how future regulatory and non-regulatory actions regarding aquatic animal health issues will be formulated. It pledges our shared commitment to promoting and facilitating national aquatic animal health.

The Department, through the Service and the USGS, work very closely with state fish and wildlife agencies on surveillance, diagnosis, and management of fish and wildlife disease. The

nature of state and federal authority over fish and wildlife requires a close and collaborative relationships and capability among all the partners. To this end, the Service and USGS were original partners of the states in development of the National Fish and Wildlife Health Initiative (NFWHI), an initiative of the Association of Fish and Wildlife Agencies. The overarching goals of the NFWHI are to: 1) establish and enhance state, federal, and territorial fish and wildlife agency capability to address health issues of free-ranging fish and wildlife, and 2) minimize the negative impacts of health issues affecting free-ranging fish and wildlife through management, surveillance, and research. The Service and USGS are both on the NFWHI Steering Committee that is guiding implementation of this Initiative.

CONCLUSION

The Department of the Interior, as a steward of the nation's fish and wildlife resources, uses all of its authority and resources to conserve our native living resources. Invasive species and fish and wildlife disease are current threats to fish and wildlife populations that will only grow in significance in the face of changes to the physical environment caused by climate change. Managing these existing stressors to fish and wildlife, and anticipating how they may be exacerbated by a changing environment, are essential aspects of sustaining our nation's fish and wildlife in the face of climate change.

Chairman Cardin, Chairman Whitehouse, and Subcommittee Members, the Department, in cooperation with other federal, state, tribal, and local agencies, and other partners, remains committed to addressing all threats to native fish and wildlife. We appreciate your interest in these issues and look forward to working with you to address these threats to our nation's fish and wildlife. Thank you again for the opportunity to appear before you today. I would be happy to respond to any questions you may have.

References:

Stuart, S. N., J. S. Chanson, *et al.* (2004). "Status and trends of amphibian declines and extinctions worldwide." Science 306: 1783-1786

Daszak P, Berger L, Cunningham AA, Hyatt AD, Green DE, Speare R. Emerging infectious diseases and amphibian population declines. Emerg Infect Dis. 1999;5:735–48.

Senator Barbara Boxer

1. In your testimony before the committee, you stated that preventing non-native species from being introduced or established is the most cost-effective strategy for dealing with invasive species. Can you please elaborate on the U.S. Fish and Wildlife Service's (FWS) legal authority to address the importation and interstate movement of non-native wildlife species, as well as complimentary authorities of any other federal agencies? What improvements can be made in the implementation of existing programs and what gaps in existing programs create barriers to more proactively and comprehensively addressing the threat of non-native species?

For issues related to injurious wildlife, the U.S. Fish and Wildlife Service (Service) has authority through the Lacey Act, 18 U.S.C. 42, to undertake rule making to add a species to the list and prevent its importation and interstate transport. The injurious wildlife listing is only one "tool in the toolbox" and works in conjunction with state regulations by addressing the movement of species between states. State injurious species laws often predicate the enforcement of the Lacey Act, Title 16 USC 3372. State law retains regulatory authority over any species within state boundaries. Section 42 specifically prohibits the importation of mongoose, flying squirrels or fruit bats of the genus *Pteropus*, zebra mussels, in addition to any other species of wild mammals, wild birds, fish (including mollusks and crustacean), amphibians, reptiles, brown tree snakes or the offspring or eggs of any of the foregoing which the Secretary of the Interior may prescribe by regulation to be injurious to human beings, to the interests of agriculture, horticulture, forestry, or to wildlife or the wildlife resources of the United States. Under the Service's regulations, CFR 50 Part 16 Injurious Wildlife, the regulations list several other species which are specifically prohibited. Furthermore, the Service's regulations delineate the requirements regarding importation of live wild mammals, wild birds or their eggs, live or dead fish, mollusks, and crustaceans or their eggs, amphibians or their eggs, and live reptiles or their eggs. Finally, the regulations provide the Service the authority to issue permits and additional exemptions.

There are multiple other authorities that address the importation and interstate movement of non-native wildlife species. When it is a public health issue, the Center for Disease Control has authorities under the Public Health Service Act 42 USC 264(a). When it is an agricultural health issue, the U.S. Department of Agriculture has authorities under the Animal Health Protection Act 7 U.S.C. 8303(a) and Plant Protection Act 7 U.S.C. 7711(a).

With respect to changes that would improve the implementation of existing programs, the Service believes that streamlining the process of listing species as injurious would be very beneficial.

2. During the hearing, concerns were raised about the process for listing species under the injurious wildlife provisions of the Lacey Act. What suggestions can you provide to enable FWS to more quickly and efficiently list species under the Lacey Act? Does authority exist under the current Lacey Act provisions to implement more proactive prevention efforts, such as a non-native wildlife screening program?

The Service has not been able to make injurious wildlife designation under the Lacey Act into the nimble, timely, and proactive tool needed to address importation and transport of potentially harmful non-native species; however, opportunities do exist to minimize the time between when information

is received indicating that a species is injurious and completion of the listing process. The Service is working closely with the Department to make this process more efficient, effective, and proactive and we would be happy to follow-up with the Subcommittee as we consider these opportunities to improve the listing process.

The Service believes that the legal authority exists to create a screening mechanism under the Lacey Act; however, the costs of such a process have not recently been evaluated. In the 1970s, the Service used screening to develop comprehensive approved and unapproved species lists to be implemented via the Administrative Procedures Act rulemaking process. However, these approaches were withdrawn primarily due to concerns that the rules would have deleterious affects on entities such as the pet trade, aquaculture industry, and others.

3. Global Warming is one of the most pressing threats facing native wildlife species and has the potential to exacerbate other threats, such as the spread of invasive species. How is the FWS projecting the impacts of global climate change on native species and incorporating adaptation measures into FWS programs to respond to this threat? Can you also describe any measures being taken to promote a comprehensive and coordinated interagency approach to addressing global warming impacts to native wildlife species?

The Service considers accelerated climate change to be the greatest threat we face in conserving fish, wildlife, plants, and their habitat because the best available science indicates that the pace of climate change has the potential to cause abrupt disruption in ecological systems and mass species extinctions. As your question correctly notes, it is not simply the direct physical effect of changing temperatures, precipitation, and sea levels, but the effect of those changes combined with other existing factors such as habitat loss and fragmentation, water scarcity, disease, and invasive species. These existing factors are already overwhelming our capacities to conserve native biodiversity.

The Service is undertaking a comprehensive review of climate change and working with conservation partners to develop coordinated responses. We have sponsored workshops with key partners in all of our regions. We requested significant new funding in the President's FY 2010 Budget, which will catalyze a new generation of science-based partnership within Landscape Conservation Cooperatives; a comprehensive National Wildlife Refuge System inventory and monitoring program that will link with other large-scale monitoring efforts, such as the National Park Service Vital Signs Network and the U.S. Forest Service National Forest Inventory Assessment; and development of new methodologies for assessing species and habitat vulnerabilities, and design of a framework process for developing a National Fish and Wildlife Climate Adaptation Strategy.

Landscape Conservation Cooperatives will be key assets for the Service and its partners in promoting comprehensive and coordinated adaptation strategies. Using funding requested in FY 2010 (and provided in both the pending House and Senate Appropriations bills), we intend to initiate the first generation of these cooperatives covering ecological regions like the Hawaiian Islands; the Northern Prairies; the South and Central Atlantic; the Northern Rockies; Northern Alaska; and the Interior Columbia Basin. Within each cooperative, scientific and technical experts will network with experts in the relevant landscape and ecological region. Each cooperative will use downscaled

climate information and regional-scale ecological response models to develop habitat and population models that will predict species response to climate change and other factors, like invasive species.

The Service recognizes the challenge of addressing climate change cannot be addressed within our organizational footprint, so we are approaching this issue with the realization that we are interdependent with other federal agencies, states, tribes and NGOs, and other interested partners.

Secretary of the Interior Ken Salazar signed a secretarial order on September 14, 2009 to establish a framework through which Interior bureaus will coordinate climate change science and resource management strategies. Under the framework:

- A new Climate Change Response Council, led by the Secretary, Deputy Secretary and Counselor, will coordinate DOI's response to the impacts of climate change within and among the Interior bureaus and will work to improve the sharing and communication of climate change impact science, including through www.data.gov;

- Eight DOI regional Climate Change Response Centers, serving Alaska, the Northeast, the Southeast, the Southwest, the Midwest, the West, Northwest, and Pacific regions – will synthesize existing climate change impact data and management strategies, help resource managers put them into action on the ground, and engage the public through education initiatives; and

- A network of Landscape Conservation Cooperatives will engage DOI and federal agencies, local and state partners, and the public to craft practical, landscape-level strategies for managing climate change impacts within the eight regions. The cooperatives will focus on impacts such as the effects of climate change on wildlife migration patterns, wildfire risk, drought, or invasive species that typically extend beyond the borders of any single National Wildlife Refuge, BLM unit, or National Park.

In addition to coordinating DOI's response to the impacts of climate change, the Climate Change Response Council will oversee the DOI Carbon Storage Project, through which the Department of the Interior is developing methodologies for both geological (i.e., underground) and biological (e.g., forests and rangelands) carbon storage, and the DOI Carbon Footprint Project, through which DOI will develop a unified greenhouse gas emission reduction program, including setting a baseline and reduction goal for the Department's greenhouse gas emissions and energy use.

Finally, this is a challenge of immense scale and complexity. We look forward to working with the Committee, the Senate and the entire Congress in considering this issue further.

Senator Frank R. Lautenberg

1. I understand that the US Fish and Wildlife Service intends to dedicate about $2.6 million this fiscal year on activities related to white-nose syndrome. What level of funding would the Service need to comprehensively address this crisis?

In total, since 2006, the Department of the Interior has spent about $5 million on developing and implementing monitoring, research, and management for white-nose syndrome (WNS). As noted in the question, the Service expects to spend about $2.6 million to address WNS in the Northeast in FY 09. Thus far, in FY 09, the Service has dedicated about $1.9 million, including $940,000 in State Wildlife Grants and $962,000 from discretionary funds through Endangered Species Act recovery accounts. The Service continues its commitment to address WNS, using existing funds, to monitor this disease and its spread and to develop management recommendations to prevent its spread from its current locations. The Service is treating WNS as a wildlife disease crisis, combining state funds with redirected funds from Service accounts in Region 5 that are meant to address contaminants and endangered species recovery.

The Service is working with our partners, such as the National Park Service, the U.S. Forest Service USDA Animal and Plant Health Inspection Service and the U.S. Geological Survey, to develop an adaptive and cooperative management plan framework for long-term management and prevention of its spread. We anticipate release of this framework of recommended actions in late September of this year; this will inform budget planning for the Service and its partners for FY 10/11.

2. I appreciate that the US FWS is playing a lead in coordinating national efforts and developing a national strategy to combat WNS. How will this strategy be implemented and how will the federal response incorporate assistance from non-federal partners, such as scientific experts, universities and conservation organizations?

Currently, the Service is working with the National Park Service, the U.S. Forest Service, the U.S. Geological Survey, USDA Animal and Plant Health Inspection Service, and other federal agencies, as well as the fish and wildlife and public health agencies in states affected by WNS, local governments, scientists and academia, and private organizations and individuals in a coalition of over 50 partners. The Service, working with USGS, has identified research and management needs, which are disseminated or coordinated with these partners. Partners feed information back to the Service for continued revision of an adaptive strategy to address WNS. The Service also works closely with stakeholders affected by management steps taken to prevent the spread of the disease, including the recreational caving community, to accomplish support for cave closures or limitations on activities occurring in caves.

The Service released a Cave Advisory on March 26, 2009, calling for a voluntary moratorium on recreational caving and providing guidance on research and other activities occurring in caves. The voluntary moratorium calls for cave closures in the 9 affected states, as well as adjacent states. The USGS worked with the science community to identify the species of fungus implicated as the cause of the disease, and this peer reviewed finding was published in June of this year. Organizations, like Bat Conservation International, are working with the Service to educate the public about the disease. A full list of coordinated actions being taken by the partnership can be found at http://www.fws.gov/northeast/white_nose.html.

3. What immediate actions should be taken now to attempt to reduce the impacts of WNS at hibernacula this winter?

Currently, the Service is working with affected states and adjoining states to implement the March 2009 voluntary moratorium on recreational cave activities and the guidelines for research or scientific activities in caves. The Service is working with its partners to develop management recommendations, based on research that is currently underway or being analyzed, including how WNS is spread and whether or not it can spread from bat to bat during the summer months. This adaptive management framework is scheduled for release in late September 2009.

4. If it is possible that people are inadvertently spreading this disease, can stronger actions be taken to protect caves that are not on federal lands? Should affected states be banning human activity in all hibernacula?

The Service has no authority to restrict activities occurring in caves on state or private lands, and indeed, the federal government has limited jurisdiction over the management of bats. Most legal jurisdiction over bats rests with the states, so the strong working coalition of federal, state and local agencies is critical to protecting hibernating bats from this disease.

Based on evidence that indicates human activity in caves and mines may be a factor in the spread of WNS, the Service issued an advisory on March 26, 2009, recommending a voluntary moratorium on all caving activity in states known to have hibernacula affected by WNS, and all adjoining states, unless conducted as part of an agency-sanctioned research or monitoring project. In the March advisory, the Service also recommended that cavers not use equipment or clothing that has been used in WNS-affected areas, which applies to all states not currently affected by WNS. More detailed recommendations for the management of WNS are scheduled for release in September 2009.

5. What actions are being taken now to protect major hibernacula in states such as TN, KY, IN and OH?

The Service issued an advisory on March 26, 2009, recommending a voluntary moratorium on all caving activity in states known to have hibernacula affected by WNS, and all adjoining states, unless conducted as part of an agency-sanctioned research or monitoring project. The Service is working with all of these states to build cooperative networks to respond should WNS be identified in these states. Activities include development of educational materials, working with affected stakeholders, monitoring bat populations for WNS, and restricting access to caves most likely to be affected.

The State of Indiana has restricted access to all state owned cave properties serving as bat hibernacula and met with the caving community in an attempt to limit the potential spread of the fungus that causes White-nosed Syndrome. In addition, the State of Indiana is cooperating with the U.S. Fish and Wildlife Service in formulating management strategies to combat White-nosed Syndrome should it arrive in the Midwest this winter. The Ohio Department of Natural Resources participates in bi-weekly multi-agency calls on White-nosed Syndrome; Ohio doesn't have many hibernacula or cave resources used by bats, and caving in Ohio is not as popular as it is in other states. Both the State of Kentucky and the State of Tennessee have adopted the recommendations identified in the Service's March cave advisory.

Cave closures within the southeast currently include caves managed by the National Wildlife Refuge System, U.S. Forest Service, National Park Service (Commercial caves exempt), State of Tennessee, The Nature Conservancy (TN), and the Southeastern Cave Conservancy.

6. What is the status of the current research on WNS, its causes, transmission and possible treatment or cure?

Through its disease diagnostic and surveillance program, the USGS – National Wildlife Health Center continues to investigate the cause of WNS and has demonstrated a clear association between a new species of fungus, *Geomyces destructans (G. destructans)*, and WNS. The fungus, causative of the skin infection that is hallmark of WNS, has only been identified on sick bats and has not been identified outside of the region where WNS has been documented to occur. Additionally, diagnostic evaluations have not revealed other contributing infectious agents. Transmission studies conducted using hibernating, captive little brown bats demonstrated that *G. destructans* is transmissible both bat-to-bat and through the air. Additionally, *G. destructans* has been found in sediments collected from the cave floors of bat hibernation sites within the WNS-infected region, but the fungus has not yet been found outside of this region. Studies are currently underway to identify therapeutic compounds for the treatment of WNS and to test the efficacy of these compounds for the treatment of infected bats.

7. Has there been a study of the ecological, agricultural and economic impacts of this crisis? If not, are there plans in place to execute one?

It has been estimated that up to one million bats have died as a result of WNS within the infected region. The magnitude of WNS mortality and the speed at which this epidemic has spread is unprecedented among any of the over 1,100 bat species of the world. Although we are not aware of a current study investigating the ecological, agricultural, and economic impacts of WNS in the northeastern US, previous studies (Cleveland, et al. 2006. Frontiers in Ecology and the Environment 4, 238) estimated that bat control of cotton crop insect pests in south-central Texas was worth over $1 million dollars per year. As the bats affected by WNS are long-lived (5-15 years or more) and produce only one offspring per year, populations will not recover quickly.

Senator Bernard Sanders

1. What resources is the Administration putting towards solving the White-Nose Syndrome that is killing bats, and does the Administration anticipate releasing fiscal year 2009 emergency funds to provide critical research dollars?

In total, since 2006, the Department of the Interior has spent about $5 million on developing and implementing monitoring, research, and management for WNS. In FY 08, the Service spent about $1.1 million to address WNS in the Northeast. Thus far, in FY 09, the Service has dedicated about $1.9 million, including $940,000 in State Wildlife Grants and $962,000 from discretionary funds through Endangered Species Act recovery accounts. The Service expects to dedicate about $2.6 million this fiscal year to activities related to WNS. The Service continues its commitment to address WNS, to monitor this disease and to develop management recommendations to prevent its

spread from its current locations. The Service is treating WNS as a wildlife disease crisis. Therefore, the Service is not only spending FY 2009 funding originally dedicated to the WNS on this issue, but has also has redirected funds from the contaminants and endangered species recovery account in Region 5 to address the issue. In addition, the Service is combining its funds with state funding.

Senator Vitter

1. Can you explain how FWS determines the difference between a wild, native, and nonnative species? And when a species may be wild and native?

A native species is a species that, other than as a result of an introduction, historically occurs or occurred in a particular ecosystem and habitat and its occurrence is not a consequence of human activity, either deliberate or accidental. A non-native or exotic is any species, including its seeds, eggs, spores, or other biological material capable of propagating that species, that is not native to a particular habitat or ecosystem. The term "wild" in 18 USC 42 of the Lacey Act relates to any creatures that, whether or not raised in captivity, normally are found in a wild state. Therefore, any species that lives and reproduces in a particular habitat or ecosystem and was not introduced directly or indirectly via human activity is wild and native. When appropriate and necessary, the Service can look at additional biological, ecological, and genetic information to help determine the difference between a wild, native and nonnative species.

2. Is it FWS policy to always protect native species over nonnative species? In other words, have there been instances when it was the policy of FWS to support nonnative species at the expense of native species?

The Service's mission is to "...work with others to conserve, protect and enhance fish, wildlife, and plants and their habitats for the continuing benefit of the American people." There are many laws that provide the Service with legal authorities to accomplish this mission and to manage and protect wildlife in concert with state, tribal, non-governmental, and other federal partners. While native species conservation is one of the agency's highest priorities, there are instances where the Service supports nonnative species management. For example, the Service mitigates losses of fish, wildlife, their habitats, and uses thereof caused as a result of federal water development projects. These projects have altered existing ecological systems and caused extirpation of native fishes and fisheries they supported. The Service works with its state partners and others to manage fish and wildlife populations that can thrive in these altered habitats; it may be a nonnative species like the rainbow trout that are best suited to these conditions. In this case, the nonnative species has created significant social and economic benefits in these tail-water fisheries that support tourism, recreation, and jobs in rural communities.[1]

[1] Caudill, J. 2005. The economic effects of rainbow trout stocking by Fish and Wildlife Service hatcheries in FY2004. USFWS, Division of Economics, Arlington, VA. 44 pages.

Senator CARDIN. Thank you very much, Mr. Frazer.
Mr. Clay.

STATEMENT OF BILL CLAY, ACTING ASSOCIATE ADMINISTRATOR, ANIMAL AND PLANT HEALTH INSPECTION SERVICE, U.S. DEPARTMENT OF AGRICULTURE

Mr. CLAY. Good morning, and thank you for the opportunity to testify before your subcommittees.

I am Bill Clay, the Acting Associate Administrator for the USDA Animal and Plant Health Inspection Service, or APHIS. I am joined this morning by Dr. Jere Dick, Associate Deputy Administrator for APHIS' Veterinary Services Program, and I will be speaking to you about APHIS' role in relation to wildlife diseases and invasive species.

APHIS' mission is to protect the health and value of American agriculture and natural resources, which we primarily accomplish under the Plant Protection Act, the Animal Health Protection Act, and the National Animal Damage Control Act.

Wildlife are reservoirs for a number of serious diseases such as chronic wasting disease, brucellosis, plague, rabies and bovine tuberculosis, to name a few. Many pose a risk of disease spread to agricultural animals, particularly as the interaction between wildlife and livestock continues to increase. And in several cases, wildlife can pose an elusive reservoir for diseases that APHIS is trying to eradicate in livestock.

APHIS, through its Veterinary Services and Wildlife Services Programs works to address the animal disease threats from both the wildlife and livestock interface. In addition to protecting livestock, our agency also seeks to safeguard wildlife resources from livestock diseases, as well as emerging diseases and invasive species.

One example is our cooperative effort in Michigan to combat bovine tuberculosis in both wildlife and livestock. We are a lead agency, in cooperation with the Michigan Department of Natural Resources and our industry partners in the Federal-State Wildlife Risk Mitigation Program, which assists livestock producers in preventing disease spread from wildlife to livestock.

APHIS conducts wildlife risk assessments of livestock facilities, develops and funds mitigation plans to increase the separation between wildlife and livestock, and conducts bovine tuberculosis surveillance and disease management in affected herds, among other things.

Another example is viral hemorrhagic septicemia, which has caused die-offs in many freshwater species in the Great Lakes. The virus could also affect commercially raised fish in other parts of the country. So, in cooperation with the U.S. Fish and Wildlife Service, we issued a Federal order preventing the movement of potentially infected fish out of the Great Lakes watershed region to unaffected parts of the country.

Our work to address rabies has significant public health and wildlife health impacts. We work closely with our State partners and others to annually distribute more than 11 million oral rabies vaccination baits to reduce the threat to humans, domestic animals and wildlife.

We also work closely with the U.S. Centers for Disease Control and Prevention and with Canada and Mexico as part of an international strategy for rabies. This program is a model for the One Health Initiative, a worldwide strategy that promotes expanding interdisciplinary collaboration and communication and that recognizes the critical link between human health and animal health.

We also work cooperatively with the States to eradicate invasive species which can devastate ecosystems. For example, nutria, a large semi-aquatic rodent native to South America has caused extensive damage to wetlands, agricultural crops and structural foundations and may serve as a reservoir for disease. We are working to eradicate nutria on the DelMarVa peninsula in Maryland and have removed more 13,000 to date.

Also, in Florida's Grassy Key, we are working with the State to eradicate the Gambian giant pouched rat, a rodent native to Africa. We are in the final stages of surveillance and removal of any remaining rats which could cause significant agricultural damage and damage to natural resources if they reach the mainland. We also have ongoing invasive species programs for brown tree snakes in Guam, for coqui tree frogs in Hawaii and for feral swine in several of the States.

Finally, research is a vitally important part of our wildlife disease management efforts. Our National Wildlife Research Center scientists design, develop and test new tools for minimizing human-wildlife conflicts that are biologically sound, environmentally safe and socially acceptable. National Wildlife Research Center scientists investigate the ecology and transmission of wildlife diseases, as well as develop and test wildlife vaccines and new disease surveillance methods.

Wildlife diseases studied there include avian influenza, bovine tuberculosis, chronic wasting disease, pseudorabies, West Nile virus, rabies, and others.

In summary, APHIS has a deep understanding of the link between the health of wildlife, the health of our Nation's agricultural animals, and the impacts of invasive species. We are committed to continuing the strong cooperative partnerships with other Federal agencies and our State partners as we work to protect the agricultural and natural resources of our Nation.

We appreciate the interest of your subcommittees in these efforts, and we look forward to working with you on wildlife issues of mutual interest.

This concludes my testimony, and I would be happy to answer any questions that you may have.

[The prepared statement of Mr. Clay follows:]

Testimony of Mr. Bill Clay
Acting Associate Administrator
Animal and Plant Health Inspection Service
U.S. Department of Agriculture
Senate Environment and Public Works
Subcommittees on Oversight and on Water and Wildlife
July 8, 2009

Good morning and thank you for the opportunity to testify before your Subcommittees. My name is Mr. Bill Clay, and I am the Acting Associate Administrator for the Animal and Plant Health Inspection Service (APHIS). I am joined by Dr. Jere Dick, Associate Deputy Administrator for APHIS' Veterinary Services program. I'll be speaking to you about APHIS' role in relation to wildlife disease issues and invasive species.

The mission of APHIS is to protect the health and value of American agriculture and natural resources. APHIS helps to defend the environment from invasive species; ensure commodities traded internationally are free of animal and plant pests and diseases; protect agricultural resources, natural resources, property, and public health and safety from damage caused by wildlife; and protect natural resources while contributing to efforts to ensure public health and safety. Our primary authorities for these activities come from the Plant Protection Act, the Animal Health Protection Act, and the National Animal Damage Control Act of March 2, 1931, as amended.

Wildlife populations have become reservoirs for a number of serious diseases, including chronic wasting disease, rabies, tularemia, bovine tuberculosis (TB), and viral hemorrhagic septicemia, among others. Some of these diseases, such as bovine TB, rabies, and influenza viruses, are zoonotic, meaning they can affect both animals and humans. Many pose a risk of disease spread to agricultural animals, particularly as the interaction between wildlife and livestock continues to increase. And some present risks to the health and viability of our native wildlife populations.

The transmission of diseases from wild animals to livestock can have profound economic effects. Diseases such as bovine TB can trigger trade restrictions across State and international borders and prompt the need for quarantines, depopulation, and indemnification, resulting in significant costs for producers and taxpayers alike. In several cases, wildlife pose an elusive reservoir for diseases APHIS is striving to eradicate in livestock. In addition to protecting livestock, our Agency also seeks to safeguard wildlife resources from livestock diseases, as well as emerging diseases and invasive species that can have devastating impacts on wildlife populations. Finally, our work to address certain zoonotic diseases helps protect the public health.

To meet these challenges, APHIS is leveraging its vast expertise in both veterinary science and wildlife biology through its Veterinary Services and Wildlife Services programs. Veterinary Services, the animal health arm of APHIS, is dedicated to safeguarding the Nation's livestock and poultry and to facilitating agricultural trade. Veterinary Services enforces the Animal Health Protection Act, which grants APHIS authority over diseases and pests that affect livestock (including poultry) health.

Wildlife Services, in partnership with other Federal agencies, provides Federal leadership and expertise to resolve wildlife conflicts that threaten public health and safety, natural resources, and agriculture. The Animal Damage Control Act gives APHIS broad authority to "conduct a program of wildlife services with respect to injurious animal species and take any action the Secretary considers necessary in conducting the program." It further authorizes us to conduct activities and to enter into agreements with States, local jurisdictions, individuals, and public and private agencies, organizations, and institutions in the control of nuisance mammals and birds and those mammal and bird species that are reservoirs for zoonotic diseases (with the exception of urban rodent control). Together, the Wildlife Services and Veterinary Services programs address animal disease threats from both sides of the wildlife-livestock interface.

Under these authorities, APHIS conducts a wide array of activities to protect our Nation's agriculture and natural resources. These activities are designed to prevent the entry of invasive species and exotic pests and diseases into the United States, including those that can affect livestock and other animals; look for signs of these pests and diseases within our borders; and, when necessary, mount cooperative response programs with States to prevent their further spread.

Our Agency's scientific and technical knowledge, legal authorities, and nationwide field force make us particularly well equipped to address diseases, pests, and invasive species that affect wildlife populations. Through our cooperative programs, we work very closely with our State partners—including State departments of agriculture, State Veterinarians, and State wildlife agencies—to conduct disease surveillance and safeguarding activities to manage the risks posed to and by wildlife. We also conduct research and develop specific methods to mitigate the risk posed to wildlife by pests, diseases, and invasive species. APHIS' National Wildlife Research Center, or NWRC, is the only organization of its type in the United States devoted exclusively to wildlife damage management research.

An example that shows many aspects of our work is our Agency's cooperative efforts in Michigan to combat bovine TB in both wildlife and livestock. Bovine TB is a serious disease with animal health, public health, and international trade consequences. In Michigan, we are a lead Agency in the cooperative Federal-State Wildlife Risk Mitigation Program, which assists livestock producers in preventing disease spread from wildlife (primarily white-tailed deer) to livestock. The program conducts wildlife risk assessments of livestock facilities, develops mitigation plans to increase the separation between wildlife and livestock, and provides cooperative funding to help implement the plans. Our cooperative efforts include bovine TB surveillance, epidemiological investigations, disease management in affected herds, and herd depopulation.

In addition, our National Wildlife Research Center is conducting studies to better understand how livestock and deer interact. NWRC is also researching ways to detect bovine TB in wildlife, improve barriers between livestock and deer, and vaccinate white-tailed deer against the disease.

As this example shows, our authorities enable us to take action in situations—including those involving wildlife species—that present a risk of harm to animal or crop production in the United

States. Another example is viral hemorrhagic septicemia, a severe, exotic fish disease, that has caused die-offs in many freshwater fish species in the Great Lakes watershed since it was first discovered there several years ago. APHIS became aware that the virus could also affect several species of fish raised commercially in other parts of the country—including economically significant species such as baitfish species and channel catfish. To prevent the disease's further spread, we issued a Federal Order preventing the movement of potentially infected fish out of the Great Lakes watershed region to unaffected parts of the country. This action is intended to protect U.S. aquaculture and natural resources industries, such as recreational fishing and boating, from the impacts of this very serious disease.

We responded similarly after chronic wasting disease, a transmissible spongiform encephalopathy that affects ruminants such as wild deer and elk, was detected in farm-raised species in several States. This degenerative neurological illness has affected both farmed and wild cervids in the United States, impacting the hunting and wildlife industries as well as domestic and international markets for farmed cervids and cervid products.

APHIS developed regulations for a certification and monitoring program that would facilitate the interstate movement of farm-raised cervids and guard against the further spread of the disease within this industry. In 2006, APHIS published a final rule for the chronic wasting disease program; however, based on concerns and feedback we received from our State veterinary and natural resources partners, our Agency delayed the rule's implementation and has been developing a new regulation. In March 2009, we proposed changes to the final rule that address, among other things, recognition of State bans on the entry of farmed or captive cervids for reasons unrelated to the disease, the number of years an animal must be monitored for the disease before it may move interstate, interstate movement of cervids that originated from herds in proximity to a chronic wasting disease outbreak, and herd inventory procedures. The changes are intended to help eliminate chronic wasting disease from farmed or captive cervid herds in the United States.

Our work to address another disease, rabies, has significant public health as well as wildlife health impacts. The Centers for Disease Control and Prevention estimate that the public health costs associated with rabies disease detection, prevention, and control exceed $300 to $450 million annually. APHIS' National Rabies Management Program, a multi-agency cooperative program, is working to implement a coordinated, cost-effective, science-based program to contain and eventually eliminate rabies in wildlife.

Wildlife Services and its partners currently conduct rabies control efforts in 25 States. These efforts include distributing oral rabies vaccination and/or carrying out enhanced wildlife rabies surveillance. We also work closely with State departments of health, agriculture, wildlife, and others to contain specific strains of the rabies virus in raccoons, coyotes, gray foxes, and feral dogs. Together, we annually distribute more than 11 million oral rabies vaccine baits in 15 States to reduce the threat of rabies to humans, domestic animals, and wildlife.

Wildlife Services also works closely with Canadian and Mexican partners along shared borders to manage rabies in wildlife as part of an international strategy outlined in the North American Rabies Management Plan. The program is a model for the "One Health Initiative," a worldwide

strategy that promotes expanding interdisciplinary collaboration and communication and that recognizes the inextricable link between human and animal health.

We also form cooperative relationships with our State counterparts to eradicate invasive species, which can devastate ecosystems. For example, nutria, a large, semi-aquatic rodent native to South America, has been found in 22 States, is currently established in at least 16 States, and has caused extensive damage to wetlands, agricultural crops, and structural foundations such as dikes and roads. The rodents may also threaten human health and safety and serve as a reservoir for tularemia and other diseases. APHIS and the Department of the Interior are leading the first large-scale North American effort to eradicate a mainland population on the Delmarva Peninsula in Maryland where the rodents have devastated coastal Chesapeake Bay marshes. In cooperation with the Department of the Interior's Fish and Wildlife Service, Maryland Department of Natural Resources, U.S. Geological Survey, Tudor Farms (a 6000-acre private wildlife management area), and 400 private landowners, APHIS has completed an initial nutria removal from more than 150,000 acres of coastal marsh in Maryland.

We are also working cooperatively in Florida to eradicate the Gambian giant pouched rat, a rodent native to Africa, which had become established on Grassy Key. If this rodent reaches the mainland, it could cause significant damage to agriculture and natural resources. APHIS and the Florida Fish and Wildlife Conservation Commission began working together to eradicate the rat several years ago and are in the final stages of surveillance and removal of any remaining rats.

In Hawaii, we provide technical and operational assistance to Hawaii Island communities who are involved in efforts to control the coqui frog, an invasive Caribbean tree frog. These frogs—which are abundant and have no predators—pose a threat to agriculture, tourism, and Hawaii's fragile habitat of rare and endangered plants and animals.

Our fight against invasive species also extends to U.S. territories such as Guam, where the invasive brown tree snake has caused extensive economic and ecological damage. The species is an opportunistic feeder and has eradicated most of Guam's native forest birds and is responsible for numerous power outages across the island each year. APHIS coordinates operational efforts on Guam aimed at keeping the snake from spreading to other destinations. APHIS program specialists use snake trapping in high-risk areas, trained snake-detector dogs to search cargo, nighttime spotlight searches, and public education as tools to achieve this goal.

Finally, research is a significant and vitally important part of our wildlife disease management efforts. The National Wildlife Research Center is the research arm of the APHIS Wildlife Services program. The mission of NWRC is to apply scientific expertise to resolve human-wildlife conflicts while maintaining the quality of the environment shared with wildlife. NWRC scientists design, develop, and test new tools for minimizing human-wildlife conflicts that are biologically sound, environmentally safe and socially responsible. NWRC employs a diverse team of approximately 160 scientists, technicians, and support staff. NWRC works closely with the operations arm of Wildlife Services and collaborates with international, federal, state, academic and private partners.

Among other activities, NWRC investigates the ecology and transmission of wildlife diseases, as well as develops and tests wildlife vaccines and new disease surveillance methods. Diseases studied include avian influenza, bovine TB, chronic wasting disease, pseudorabies, rabies, and West Nile virus, among others.

For example, NWRC and collaborating scientists are developing risk assessment models to identify potential routes of introduction and subsequent spread of avian influenza by waterfowl in the United States. These models allow scientists to identify areas where highly pathogenic strains of avian influenza may be introduced into the United States and where they may subsequently spread in relation to domestic poultry operations and human populations.

NWRC has been active in the development and testing of wildlife rabies vaccines. Though rabies is well controlled in domestic animals, its spread among wildlife populations is still cause for concern. In support of our national rabies program, NWRC scientists helped to identify an effective, easy-to-use biomarker that allows for noninvasive identification of animals that have been exposed to oral rabies vaccine baits.

NWRC scientists are also testing the efficacy of infrared thermography to successfully detect signs of rabies in raccoons and other diseases, such as foot-and-mouth and classical swine fever, in domestic livestock. Thermography is a technique that detects and measures variations in the heat emitted by various regions of the body and transforms them into visible signals that can be recorded photographically. Coupled with what we know about certain diseases and their clinical signs, this technique could potentially be used to detect and measure increases in an animal's surface temperature as a result of infections. These changes in temperature often occur at specific locations on the animal's body and form thermal patterns that may be unique to particular diseases.

In other research, NWRC scientists and collaborators have developed a new live rectal-tissue biopsy method for detecting chronic wasting disease in captive deer and elk. This live test appears to be nearly as accurate as proven post-mortem diagnostic tests, but has the key advantage that it can be performed on live animals. Until now, there was no practical live test for CWD in elk.

To help further enhance its research capabilities, Wildlife Services will be moving into a new Biosafety Level 3 Ag research facility on the NWRC campus in Fort Collins, Colorado being rented from the GSA. The new research building will contain approximately 21,000 square feet of user space and will greatly expand APHIS' capabilities to respond wildlife disease emergencies and resolve important disease issues that involve livestock-wildlife and human-wildlife interactions.

We also are in the process of finalizing a memorandum of agreement with the Association of Fish and Wildlife Agencies (AFWA), several Department of the Interior agencies (the U.S. Geological Survey, Fish and Wildlife Service, National Park Service, and Bureau of Land Management), and our colleagues with USDA's Forest Service to foster closer collaboration in identifying high-priority science and research needs. Under the terms of the agreement, the AFWA's Science and Research Liaison will coordinate with all parties to identify State science

capabilities that will help Federal agencies make management decisions and facilitate communication.

In summary, APHIS has a deep understanding of the link between the health of wildlife, the health of our Nation's agricultural animals, and the health and safety of our human populations. We are committed to continuing the strong, cooperative partnerships with other Federal agencies and the States as we work to protect both the agricultural and natural resources of our Nation. We appreciate the interest of your Subcommittees in these efforts, and we look forward to working with you on wildlife issues of mutual interest.

Now I would be happy to answer your questions.

Senate Environment and Public Works, Subcommittees on Oversight, and Water and Wildlife
July 8, 2009, Hearing on Threats to Wildlife
APHIS Witness: Bill Clay

Questions from: Senator Barbara Boxer
1. In your testimony before the committee, you described efforts by the Animal and Plant Health Inspection Service (APHIS) to prevent, control, and eradicate invasive species and diseases that threaten wildlife. Can you please elaborate on how APHIS' programs work in cooperation with other federal and state programs? What improvements can be made in the implementation of existing programs and what gaps in existing programs create barriers to more proactively and comprehensively addressing the threat of non-native species?

Wildlife is a publicly-owned resource held in trust and managed by State and Federal agencies. APHIS, through its Wildlife Services (WS) and Veterinary Services (VS) programs, addresses diseases, pests, and invasive species that affect wildlife. APHIS WS provides assistance by request and works cooperatively with State, local, and other Federal authorities to resolve conflicts with wildlife when U.S. agriculture, natural resources, or public safety is threatened. Problems to which APHIS may respond may be associated with individual landowners, groups of landowners or larger entities. APHIS WS conducts programs of research, technical assistance, and applied management to resolve problems that occur when human activity and wildlife conflict with one another. Accordingly, as both human and wildlife populations expand, the demand for APHIS services continues to increase. There are estimated to be more than 50,000 non-native or invasive species in the United States. The cost of APHIS' wildlife damage management activities is shared by the Agency and its Federal, State, industry, or private cooperators, and the percentage contributed by cooperators differs according to the program activity. In addition, overall cost share percentages vary significantly from state to state; and APHIS has encouraged increased cost share by cooperators as a way of making the Federal dollar go further.

Wildlife disease surveillance is an increasingly important part of APHIS' work, the majority of which is carried out in partnership with State cooperators and other Federal agencies. In 2003, APHIS established the Wildlife Disease Surveillance and Emergency Response System (SERS) to assist Federal, Tribal, and State agencies with numerous wildlife disease threats. As part of the program, 44 wildlife disease biologists are stationed in 43 States and act as liaisons between State wildlife agencies and USDA. These biologists conduct monitoring and surveillance activities and collect biological samples. The SERS conducts surveillance in all 50 States, for approximately 25 diseases caused by viruses, bacteria, parasites, and pathogens, including highly pathogenic avian influenza (HPAI), bovine tuberculosis (TB), and chronic wasting disease (CWD). The SERS program also conducts field investigations of sick and dead wildlife to determine if foreign animal diseases such as virulent Newcastle disease, foot-and-mouth disease, or classical swine fever are causing such events.

SERS is the only comprehensive, nationally coordinated system in the United States capable of conducting disease surveillance and emergency response for emerging infectious diseases of concern in wildlife. Although SERS has already proven extremely successful in providing

domestic and international disease surveillance and emergency response capacity, continuation and enhancement of the system will be necessary to protect Americans, agriculture, and wildlife from the increasing threat of emerging infectious diseases.

We also work closely with our Federal partners to prevent threats to wildlife from entering our country. APHIS places restrictions on imports from countries that have a disease of concern to livestock, and prevent the import of any animals or animal products, including pets, which could transmit those diseases. Despite differing authorities, APHIS has strong working relationships with the Department of Interior and other Federal partners at ports-of-entry. APHIS has worked for decades with these partners to address the threats that imports pose. For example, when viral hemorrhagic septicemia (VHS) was recently identified as a threat to farmed and wild fish through the importation of wild fish from Canada, APHIS and the U.S. Fish and Wildlife Service (USFWS) jointly used our authorities to ban the importation of VHS-affected Salmonid and non-Salmonid fish.

APHIS has an equally strong relationship with its state partners, and we continue to work closely to address invasive species. In fiscal year 2008, APHIS collaborated with agencies in 48 States, 3 territories, as well as the Department of the Interior and Department of Defense, to resolve damage caused by 14 of the 23 bird, mammal, and reptile species found in the United States and identified by the World Conservation Union (IUCN) as being among the top 100 invasive species in the world. Of all the millions of nuisance animals that APHIS dealt with in FY08, over 75% were invasive species.

In addition to partnering with Federal and State entities, APHIS also recognizes the benefit of working internationally to protect U.S. wildlife from disease. APHIS has been working with our Canadian and Mexican partners along shared borders to manage rabies in wildlife as part of an international strategy outlined in the North American Rabies Management Plan. The plan establishes a framework and forum for constructive interaction among the countries to build long-term wildlife rabies management goals.

We are also working with Mexico regarding the incidence of other wildlife diseases that are transmitted by migratory wildlife including highly pathogenic H5N1 avian influenza, classical swine fever, plague, and pseudorabies. We have previously proposed to Mexican wildlife and agriculture representatives a comprehensive wildlife disease surveillance plan that includes information exchange about these and other wildlife diseases. Mexican wildlife representatives have recently communicated to us that they would like to collaborate and share information regarding the role of wildlife in the transmission of cattle fever ticks and bovine tuberculosis. We hope that this will lead to the implementation of a memorandum of understanding that focuses on the information and technology exchange outlined in our proposed comprehensive wildlife disease surveillance plan.

As part of another collaborative effort, APHIS and USFWS are working with the Association of Fish and Wildlife Agencies (AFWA) to develop a National Wildlife Health Initiative that proposes to increase communication among Federal and State Agencies in identifying emerging zoonotic diseases that may impact wildlife health. The initiative will improve communications,

develop tools to assess wildlife disease threats, indentify needed resources, and help to establish baselines levels for wildlife diseases already present in the wild, among other things.

Overall, APHIS has the authority needed to achieve our mission. We recognize that the steps we take to protect U.S. agriculture can also protect wildlife from diseases and invasive species, and in a similar way, Federal and state actions related to wildlife health do the same for livestock. From a regulatory standpoint, our focus is on keeping livestock pests and diseases out of the country. However, when appropriate, we take steps to prohibit other animals such as exotic pets from entering the country if they pose a threat to U.S. agriculture. We believe that the varied and multi-faceted work APHIS carries out every day with its many Federal, State, and international partners not only creates greater coordination on many of the intersecting issues between agricultural, wildlife, and human health but ultimately assists APHIS in preventing, controlling, and eradicating invasive species and diseases that threaten wildlife.

Senator CARDIN. Thank you very much.

Senator Nelson has asked the committee to include the fact sheets on the python incidents. Without objection, that will be made part of the record.

[The referenced information follows:]

Fact Sheet

Python Incidents Demonstrate Risks To Public Health and Safety, Animal Welfare, and the Environment

July 2009 (Florida): A 2-year-old girl was killed by an 8-foot Burmese python who escaped from an aquarium in her home. Source: Florida Fish and Wildlife Conservation Commission

July 2009 (Arizona): A Yuma family found a 6-foot long python on their front porch. Source: *The Arizona Republic*

May 2009 (Florida): A Punta Gorda police officer removed an injured 4.5-foot python from an intersection. The snake suffered from a broken jaw and died soon afterward. Source: NBC2 News

May 2009 (Florida): An investigation into the escape of a 10-foot Burmese python in Pinellas Park determined the snake had escaped almost two months earlier. Source: Florida Fish and Wildlife Conservation Commission Division of Law Enforcement Field Operations Weekly Report

March 2009 (New York): A woman found a 4.5-foot ball python in her kitchen in upstate New York. The snake belonged to her neighbor and had been missing for about two weeks, according to police. Source: 1010 Wins (Associated Press)

February 2009 (Pennsylvania): A ball python escaped his enclosure, and in the process caught and ripped his skin, nearly skinning himself. The family's cats then bit the snake, who required about a dozen stitches. Source: *The Evening Sun*

February 2009 (Wisconsin): Two Burmese pythons and a ball python were turned over to a shelter after the owners were arrested on drug-related charges. Source: *Beloit Daily News*

January 2009 (Nevada): A 3-year-old boy was bitten and squeezed to the point of unconsciousness by an 18-foot python. His mother stabbed the snake with a kitchen knife and freed the child. The snake had been in the home for four to six weeks. Source: kvbc.com and *Las Vegas Review-Journal*

January 2009 (Georgia): A Home Depot employee found a ball python was loose in the parking lot. Source: *The Augusta Chronicle*

January 2009 (New York): A 7-foot reticulated python escaped from an enclosure, and authorities were called to capture and remove the snake. Source: *New York Daily News*

January 2009 (New York): A Burmese python was found in a field in Brooklyn. The cold weather had taken a toll on the animal who had lost an eye and developed an infection, causing some teeth to fall out. Source: *York Daily Record*

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November 2008 (Florida): Investigators captured three Burmese pythons, ranging from 9 to 11 feet, within a 50-yard span of an area known as the 8.5 Square Mile in Miami-Dade County. Source: Florida Fish and Wildlife Conservation Commission, Division of Law Enforcement Field Operations Weekly Report

October 2008 (Virginia): A woman was found dead by asphyxiation, thought to be caused by her 13-foot pet reticulated python who was found outside his enclosure. Source: *The Virginian-Pilot*

October 2008 (Colorado): A woman was attacked by her 6-foot albino Burmese python. The animal was sprayed with a fire extinguisher to get him to let go of her finger and then according to the woman it took five paramedics to hold the snake down. Source: KRDO.com

October 2008 (Florida): A 12-foot 100-pound Burmese python was found slithering across a road in Jupiter Farms. The snake appeared to be injured and may have been hit by a car. Source: South Florida Sun-Sentinel.com

October 2008 (Utah): A boy found a ball python among documents in the glove compartment of his father's rental car. Source: Fox 13

September 2008 (Florida): A Myakka City homeowner found a 10-foot albino Burmese python in her driveway. Source: *Sarasota Herald-Tribune*

August 2008 (Nevada): A 13-year-old girl was attacked by her family's pet Burmese python; her father killed the approximately 15-foot snake to rescue her. The snake reportedly escaped from a large tank with locks. The same day, a student zookeeper in Venezuela was crushed to death by a Burmese python. Source: KVBC

August 2008 (Michigan): A state trooper shot and killed a nearly 7-foot long snake, believed to be a Burmese python, after it slithered onto a Port Sheldon Township road. Source: *The Grand Rapids Press*

July 2008 (Maine): A man discovered an 8- to 9-foot reticulated python under the engine compartment of his pickup truck in Wilton. It was the second such incident in Maine in less than a week. A Gorham woman found a reticulated python in a washing machine on Wednesday. The snake had injuries on its upper jaw from being dragged. Source: *Sun Journal*

July 2008 (Florida): A 3-foot ball python was reported in a tree and captured by authorities. Source: *Florida Today*

June 2008 (Florida): A woman found a 7-foot Burmese python in her Key Largo yard. She and a friend killed the snake. Source: *The Reporter*

June 2008 (Illinois): A woman found a 4-foot albino Burmese python in a Starbucks parking lot in Rockford. Source: rrstar.com

June 2008 (New York): A 14-foot 80-pound Burmese python was found after more than two days on the loose in the Jordan-Elbridge area. He had been at a reptile rescue center and the owner believed someone cut the bungee cords on his cage, letting him get out. Other cages were also tampered with and an iguana was still missing. Source: news10now.com

May 2008 (North Carolina): A 4-foot python was found loose in a restaurant. Source: WECT TV6

May 2008 (Florida): Firefighters battling fires in the Everglades encountered pythons, boa constrictors, and other exotic animals. Source: National Geographic News

April 2008 (Oregon): A pet store owner reached into a cage to show a customer a 12-foot Burmese python when the snake bit her hand and coiled around her arm, throwing her to the floor. It took several emergency responders to unwrap the snake. Source: MSNBC (Associated Press)

April 2008 (Florida): Deputy Secretary of the U.S. Department of the Interior Lynn Scarlett found an 8- to 9-foot Burmese python while hiking in the Everglades. Source: People, Land & Water, U.S. Department of the Interior

April 2008 (Connecticut): A 6-foot python escaped from a home and was found two days later curled up in the yard. Source: *The News-Times*

April 2008 (Florida): A Burmese python about 8-feet long was found in the rafters of a Marco Island Executive Airport hangar. Source: *Naples Daily News*

April 2008 (Illinois): A ball python, three Brazilian rainbow boas, a sand boa, and a red-tail boa were among the animals who escaped when a car crashed into a home and broke open their tanks. Most of the animals were recaptured. *Source: Belleville News-Democrat*

March 2008 (Maryland): A woman was surprised by a 3-foot python who slithered out from behind her media stand while she was watching television in her living room. She had lived in the apartment for two months. Officials believe the snake was left behind by a previous tenant. Source: WTOP News

March 2008 (Kentucky): Authorities seized a python and boa constrictor, along with venomous snakes and other reptiles, from a man's home. At the time of the seizure, the owner of the animals was in the hospital having two fingers amputated because of a snake bite. Source: LEX 18 News

March 2008 (California): A woman pleaded guilty to animal cruelty. A nearly 15-foot Burmese python was one of more than 200 animals found in her home, many of them malnourished and in need of veterinary care. Source: *The Sacramento Bee*

February 2008 (Florida): A 4-foot python was found beneath a water heater in a newly rented home. Source: *Sarasota Herald-Tribune*

February 2008 (Florida): A 13-foot python was seen in a Wal-Mart parking lot. A rescue worker found the animal in a culvert more than two weeks later. Source: *Sarasota Herald-Tribune*

February 2008 (Florida): A woman was arrested for animal cruelty after authorities found a Burmese python, 12 dogs, and a cat living in deplorable conditions in her home. The snake was kept in a small dog crate that was full of feces and shredded snake skins. Source: *St. PetersburgTimes*

January 2008 (Montana): A man was driving with a 5-foot long Burmese python when the animal crawled out of a pillow case and into the van's duct system. Auto mechanics retrieved the snake. Source: *Great Falls Tribune*

December 2007 (Ohio): A 7-foot African rock python was found in the Metzger Marsh State Wildlife Area. The animal was alive though it was 37 degrees and sleeting. Source: *The Toledo Blade*

December 2007 (Florida): A man mowing the lawn for the county ran over and killed a 16-foot python. An animal control officer said the snake was among the largest of the 20 large pythons or boas he has found in the past decade in Indian River County, comparable in size to one found two years before. Source: tcpalm.com

November 2007 (Texas): A teenager's pet ball python escaped from a cage, coiled up around the teen's hand, and bit her. It took an emergency crew an hour to get the animal to let go. Source: KHOU.com

October 2007 (Florida): A Summerland Key resident was cited for allowing the escape of captive wildlife and inadequate cage size for a reptile. The incident began after citizens saw a 14-foot python in the bushes along a public parking lot. The owners of the snake – who used the animal for photos with tourists – said the snake had escaped two days before. Source: Florida Fish and Wildlife Conservation Commission Field Operations Weekly Report

September 2007 (Florida): Officials removed a python from beneath the deck of a private residence in Collier County. Source: Florida Fish and Wildlife Conservation Commission Field Operations Weekly Report

September 2007 (Florida): Firefighters responding to a Delray Beach warehouse found more than 100 snakes in the building, including 8-foot boa constrictors and pythons between 12- and 17-feet long. Several small snakes were killed in the fire. The owner says he sells the animals to retailers. Source: firstcoastnews.com

August 2007 (Ohio): A man brought a 10-foot python to a festival. The snake was killed by a boy who stomped on the animal's head. Source: 13abc.com

August 2007 (Florida): A couple's pet bird was found dead next to a 4-foot ball python. The bird had apparently been fatally constricted by the snake. Source: *The Gainesville Sun*

August 2007 (Florida): Two large snakes were captured in Lee County: a 10-foot Burmese Python found by two maintenance workers at an apartment complex and a boa constrictor longer than 6 feet who was spotted in the middle of an intersection. Source: *Naples Daily News*

July 2007 (North Carolina): A toddler was playing in a park when a four-foot long ball python wrapped around the boy's leg and bit him. Source: WCNC.com

July 2007 (Florida): A reticulated python approximately 15-feet long was found in a yard in a residential community. Source: WFTV.com

June 2007 (Pennsylvania): Officials caught a 9 1/2-foot Burmese python, but a second large snake remained on the loose. That snake was thought to have killed a cat, a bird, and several kittens. Source: *Courier Times*

July 2007 (New York): Two Burmese pythons were found on the loose in Albany. An 8-foot snake had escaped from a second-floor pen and was claimed by the owner. No one had claimed the 4-foot snake. Source: *The Times Union*

May 2007 (New York): A firefighter found a large Burmese python in the basement of a home after a fire was doused. Source: *The New York Times*

April 2007 (Florida): A 7.5 foot Burmese python was captured on Key Largo. The animal was found by researchers tracking a Key Largo wood rat -- an endangered species -- fitted with radiotransmitter collar. The remains of two wood rats along with the radio transmitter were found inside the python. Source: keynoter.com

April 2007 (New York): An employee's 3-foot ball python escaped in Google's Manhattan office. Source: USAtoday.com

March 2007 (Alaska/Alabama): An Alaska woman took in an 8-foot Burmese python around 2002 after a landlord found the animal without food in an empty apartment, two weeks after the previous resident was evicted. The snake grew to 16 feet, and was shipped to an Alabama zoo, but during transport she spent many hours in cold temperatures in a small crate. The snake died four weeks later. Source: *Anchorage Daily News* and KTUU.com

December 2006 (Ohio): A man died at the hospital after being strangled by his pet python. Source: United Press International

December 2006 (Florida): A 14-foot, 14-year-old Burmese python being exhibited at an aquarium wrapped around the handler's arm and waist and bit her. A police taser was needed to get the snake to let go. The woman was treated at the hospital for wounds to her hands. Previously a man was bitten when feeding the snake. Source: *St. Petersburg Times*

September 2006 (Indiana): A 23-year-old man with experience handling reptiles was killed by his 14-foot Reticulated python. A medical examiner determined that the death was consistent 27 with asphyxiation caused by compression of the neck and chest. Source: MSNBC and *The Corydon Democrat*

September 2006 (Montana): A man trying to enter Canada with five snakes turned them over to U.S. authorities rather than obtain the proper permits to export them. The two red-tail boa constrictors and three ball pythons were dehydrated and had mites. Source: *Great Falls Tribune*

August 2006 (Florida): A 9-foot Burmese python was found near the Tallahassee airport. After police initially captured and put the snake in a bag, the animal escaped from the back seat of the patrol car and had to be recaptured. Source: KHOU-TV Animal Attraction Blog

July 2006 (Hawaii): A 3.5-foot ball python was found by police and turned over to the Department of Agriculture. Snakes are illegal as pets in Hawaii, where they have no natural predators and pose a serious

threat to the environment. Many species prey on birds and their eggs, and larger species can be a danger to the public and small pets, according to state officials. Source: Hawaii Department of Agriculture

June 2006 (Connecticut): Officials investigating a report of an alligator in an apartment also found 36 snakes including boas, pythons and an anaconda. The tenant had been evicted the previous day. There were two dead lizards and the remaining reptiles were left in extremely dirty and unhealthy conditions, with no food or water. Source: 2006 Annual Report, State of Connecticut, Department of Environmental Protection, Division of State Environmental Conservation Police

May 2006 (Kentucky): A man was surprised to find a 2-foot ball python inside a rental car. Source: washingtonpost.com (AP)

March 2006 (Florida): A man driving with his pet snake wrapped around his neck crashed his car into roadwork barricades after the snake began biting him. According to reports, when police first encountered the man, he had numerous small cuts on his body, and freshly dried blood on his forehead and right hand. Source: *Naples Daily News*

February 2006 (Florida): A man walking his dog – an 8-pound rat terrier – let the dog off his leash. A neighbor's pet python had gotten free and grabbed the dog by the head, wrapping around him. The man used a golf club to get the snake to release the dog, but the dog ran away and was found dead the next day with injuries consistent with constriction. Source: orlandosentinel.com (AP)

February 2006 (Idaho): After being missing for two weeks, a Burmese python was found in the bathroom ceiling of the apartment below the one she from which she escaped, apparently through a hole in the wall. Source: Foxnews.com (AP)

November 2005 (Florida): A woman was washing dishes when she found a 2-foot ball python in the drain. She suspected the animal was left by a previous resident and had been living in the apartment for months. Source: *The Gainesville Sun*

November 2005 (Georgia): A woman found a 7-foot Burmese python in a pillowcase in her backyard. Source: The Associated Press

October 2005 (Florida): A woman looking for her pet Siamese cat instead found a bulging Burmese python in her backyard. X-rays showed that the snake had eaten the cat. Source: NBC6.net

October 2005 (Florida): A 10-foot African rock python was found after crawling into a turkey pen and eating a turkey. The bulging snake was too large to slither back through the fence. Source: NBC6.net

September 2005 (Florida): Captured in a now famous photograph, the body of a Burmese python who tried to swallow an alligator was found in the Everglades. Exactly what happened may remain a mystery, but with the Burmese python as a new top predator in the Everglades, each of the snake's potential prey species could be at risk. Source: *St. Petersburg Times*

August 2005 (California): A 12-year-old boy awoke when he was bitten by a ball python clinging to his arm. The family had moved into the home two weeks before and did not know where the snake came from. Source: *The Fresno Bee*

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August 2005 (Missouri): A UPS driver found a 9-foot Burmese python among packages in his truck. The teenager who ordered the snake instead received an empty box. The python was shipped in a plastic container that was taped shut and placed inside the box. The tape was intact but the container was cracked and the cardboard box had tears in it. Source: *First Coast News* (AP)

July 2005 (California): A 15-foot Burmese python was discovered in a Sacramento warehouse. The animal belonged to a man who worked down the street. He had unknowingly poked a hole in the cage with a forklift. This was the snake's third escape. Source: *The Sacramento Bee*

July 2005 (Pennsylvania): The owners of a 9-foot Burmese python turned the snake over to authorities. The animal was reportedly underfed and living in a cage that was too small. Source: *The Intelligencer Journal*

June 2005 (Florida): Police responded twice in a month to reports of snakes roaming a neighborhood. A 13-foot Burmese python was recaptured, then got loose and was recaptured again. An 8-foot python (and five monitor lizards) remained at large. Source: News4Jax.com

February 2005 (Florida): A giant python was found sprawled across a busy street in Englewood. Source: *Venice Gondolier-Sun*

November 2004 (Connecticut): A New Haven couple reported their 15-foot python was missing. Authorities responding did not find the python, but did find other animals the couple had illegally including an Argentinean boa. Source: WTNH

October 2004 (Hawaii): A 4- to 5-foot ball python was caught on a golf course. The animal was at least the third snake captured recently on Maui. Another ball python was caught in a garage, while a boa constrictor was caught after being seen in a tree. Source: *The Maui News*

September 2004 (Mississippi): A 17-foot Burmese python missing for four days was lured out of hiding with a rabbit. The snake had escaped from the bathroom where she was being kept when the door was left open, and taken refuge underneath insulation in the attic of the apartment building. Source: *The Sun Herald*

August 2004 (Texas): Authorities searched for weeks for a large snake who was reported missing. A 7-foot python believed to be a different animal was caught the previous week at a landscaping company. The curator of the Houston Zoo's herpetology department said his department receives dozens of calls each week from people looking to turn over a snake to the zoo -- 15 to 20 calls per week just on boas. Source: *Brenham Banner-Press* and The Associated Press

July 2004 (Florida): A 16-foot Burmese python was captured on a city street. An animal control officer said he had picked up dozens of loose Burmese pythons and boa constrictors over the years, but this was the largest. Source: cbsnews.com

June 2004 (Kansas): A teenager was showing off the family's 15-foot pet python when the animal coiled around his arm and began to squeeze, turning the boy's arm blue. The snake bit the teen and his mother, and they called 911. Emergency crews used a fire extinguisher to get the snake to loosen his grip. Source: News4Jax.com

February 2004 (Florida): A 14-foot Reticulated python escaped. Source: Local6.com

October 2003 (New Jersey): Pythons, boa constrictors, and an anaconda were among the 180 reptiles authorities took into custody when their caretaker had not been seen for a week. The man was in the hospital being treated for a venomous snake bite. Source: *The Star-Ledger*

September 2003 (Virginia): A Burmese python about 12 feet long was found after being on the loose for more than three weeks. The snake had pushed open a window to escape. Source: *The Virginian-Pilot*

September 2003 (Florida): A teenager took his 9.5 foot Burmese python into the backyard and the animal disappeared. He found the snake 20 hours later in the neighborhood. Source: *The News-Press*

August 2003 (Washington): A man found an escaped 7-foot python slithering through his yard. The week before, a park ranger found a similar-size python in a lake. The local animal shelter generally takes in about 10 loose snakes a year. Source: *The Seattle-Post Intelligencer*

August 2003 (Arizona): Authorities took a 12-foot Burmese python from a yard. The mobile homes on the property seemed to be vacant, and the animal appeared to be abandoned. Source: The Associated Press

August 2003 (Florida): A 12-foot Burmese python escaped from a Florida home and was on the loose. Source: United Press International

July 2003 (Rhode Island): A 14-foot Burmese python escaped from his tank and through a window screen. Source: The Associated Press

July 2003 (Florida): A man reported his 12-foot Burmese python was missing and had not eaten for a week. A neighbor found the snake the next day. The python had a bulge in his stomach but it was unclear what he had eaten. Source: *The Bradenton Herald*

June 2003 (Florida): A 13-foot Burmese python escaped from a home. The mother of the snake's owner found the snake in the yard wrapped around her 3-year-old Mountain Feist dog. She was able to free the dog, but the snake wrapped then around her leg. Rescue workers freed her and return the snake to his cage. Source: *Florida Today*

June 2003 (Maryland): A man was charged with animal cruelty following an investigation of conditions at a reptile wholesale business in a warehouse. Boa constrictors and 500 to 1,000 baby ball pythons were among the animals being housed in the facility; 199 animals were found dead. Source: *Washington Post*

September 2002 (Ohio): A 10-foot Burmese python escaped and was on the loose about three weeks. The snake was found in a vacant home being renovated, with a telltale bulge in its middle. X-rays showed the snake had eaten a small canine, possibly a fox or stray dog. Source: The Associated Press

September 2002 (Tennessee): A Burmese python about 8- to 10-feet long escaped – for the second time. The first time the snake was at large for about a month. Source: *Knoxville News-Sentinel*

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July 2002 (Texas): A landlord in southwest Houston found reptiles including three Burmese pythons in a house he owns. The reptiles were in cages and had been abandoned for at least two months. None of the cages had water and the animals were dehydrated. Source: KSBW.com

July 2002 (Louisiana): A 12-foot Burmese python escaped and was recaptured a week later. Source: *Times-Picayune*

June 2002 (North Carolina): A 12-foot pregnant Burmese python escaped and was on the loose for two days. Source: *News & Record* (Greensboro)

May 2002 (Florida): Six snakes ranging in length from 9 to 20 feet escaped from a woman's apartment. Two were found curled up in a friend's apartment, but authorities were looking for four large Burmese pythons. Source: *Florida Today*

April 2002 (Florida): An 18-foot Burmese python who had been living for at least a year near a service plaza on Florida's Turnpike was captured. A state crew mowing the grass in the area had reported seeing the animal a year before, and there had been several sightings since. Source: *Orlando Sentinel*

February 2002 (Michigan): A 4-foot ball python brought to a middle/high school by a student teacher escaped from a glass tank. Except for one sighting by a school custodian the day he disappeared, the snake has not been seen since. Source: *Grand Rapid Press*

February 2002 (Colorado): A man had his pet Burmese python wrapped loosely around his neck when the snake suddenly constricted. By the time rescue workers wrestled the animal off the man, it was too late and he later died. Source: *Rocky Mountain News*

December 2001 (California): A 3-month-old infant was taken to an emergency department after a day of bloody diarrhea and fever caused by *Salmonella*. The infant's father was a high school biology teacher who often draped a large snake over his shoulders in the classroom. He would wash his hands – but not change his clothing – before going home and holding his child. The snake was found to be the source of the child's Salmonella. Source: U.S. Centers for Disease Control and Prevention

August 2001 (Pennsylvania): An 8-year-old girl was strangled by her father's pet Burmese python. The child had been left home alone, and the snake broke through the top of the cage. Paramedics said she was not breathing when they arrived; she was taken to a hospital and placed on a ventilator until she was pronounced brain dead two days later. An autopsy showed the cause of death was compression of her neck and chest. Source: *The Augusta Chronicle* (Scripps) and *Pittsburgh Post-Gazette*

August 1999 (Illinois): A couple's 7.5-foot African rock python escaped from an enclosure and killed their 3-year-old son. A ball python previously kept in the same aquarium escaped and disappeared. Source: *St. Louis Post-Dispatch*

October 1996 (New York): A 13-foot python, kept as a pet by two teen-age brothers who hoped to have careers caring for reptiles, killed one of the brothers, possibly mistaking him for food. The 19-year-old was found by a neighbor with the snake coiled around his midriff and back. Source: *The New York Times*

1993 (Colorado): A 15-year-old was killed by his brother's 11-foot pet python. He had snake bites on his body, and an autopsy found he was suffocated. The 8-year-old snake had been a family pet since she was only a foot long. Source: The Associated Press

1983 (Missouri): A man was crushed to death by his 16-foot pet Burmese python. Source: The Associated Press

August 1982 (Nevada): An 8-foot python escaped from his cage, crawled into an adjoining bedroom, and killed a 21-month old boy in his crib. The snake belonged to an unrelated man who lived in the house. Source: United Press International

November 1980 (Texas): A 7-month-old girl was killed by her father's 8-foot pet reticulated python. The child died of asphyxiation and her head was covered with dozens of needle-like tooth marks. The snake had forced his way out of a covered 30-gallon aquarium and crawled into the baby's crib. Source: The Associated Press

Compiled from news reports by The Humane Society of the United States

Senator CARDIN. Let me point out to the members of the committee that I have been informed there will be two votes starting in a few minutes on the floor of the Senate. It is my intention to keep the hearing in session. Senator Whitehouse has indicated that he will be back after the first vote, in time for me to do that. If that, in fact, carries out, we will try to continue the hearing.

Let me start with some questions, if I might, in regards to the eradication programs, Mr. Clay, which you are referring to. I have seen first hand the work that has been done on the nutria in Blackwater, and I am very impressed with the public-private partnership. I think you said it was 13,000 or 8,000——

Mr. CLAY. Thirteen thousand.

Senator CARDIN. Thirteen thousand nutria have been removed. That is quite an impressive effort, and I know that we have seen the result, the effects of these results.

My question is, how effective is this program? Can we expect that we can completely eradicate the nutria from the Eastern Shore of the DelMarVa peninsula? Or is this a management issue more so than effort to completely eradicate?

Mr. CLAY. Well, Senator, once that invasive species becomes firmly established, like nutria have in the DelMarVa peninsula or in Louisiana, or as brown tree snakes have become established in Guam, I think we have to be careful about using the word eradicate because I am not convinced that we can entirely eradicate every single animal.

I do think with the nutria, brown tree snakes and other invasives that have become firmly established, we can control the problem to the point where it is no longer, where it does not cause any environmental effects. I am not sure that we can entirely eradicate them, but I do think that we can make it not the problem that it is today.

Senator CARDIN. So it is more of a management issue than an eradication issue?

Mr. CLAY. Yes.

Senator CARDIN. Mr. Frazer, I heard you say that our strategy should be to try to prevent the introduction of invasive species. We have the Lacey Act dealing with injurious species. Do we need to look at changing that law? Is there the right balance? As I understand it, there is more focus on livestock-type products than there are for general control at our borders. People can bring in pets and then release them, as we have seen with the snakehead, as we have seen with the python.

Do we need to look at changing that law? Is this an enforcement issue? What do we need to do to be more effective in dealing with injurious types of introductions into the United States?

Mr. FRAZER. Well, Senator, there are multiple authorities to address controlling the importation of non-native species into the United States. When it is a public health issue, CDC has authorities. When it is an agricultural health issue, USDA has authorities. When it is an issue related to injurious nature to fish and wildlife, the Service has authority under the Lacey Act to undertake rulemaking to add a species to the list and prevent its importation and to interstate transport of those species.

It is a rulemaking process. It is process laden and cumbersome. The Service has not been resourced to staff that program at a high level. And so it has taken, in many cases, several years for us to move through the process of adding a single species to the list.

It is also been administrated in a fashion that is more reactive in the past. Species that already have been imported and demonstrated to be of concern in the U.S. or those that have tended to be the focus of adding them to the list.

So, I do think that we need to be looking both administratively to improve the process and do what we can, in terms of adding more resources, doing everything we can to improve the administrative process of getting through the rulemaking, and we should also be looking at other approaches that will be more proactive in nature.

Senator CARDIN. We would look forward to your recommendations there. I mean, I think Senator Nelson makes a very strong point about the Burmese python, that even if it were added to the list, the damage has been done. The question is, can we stay ahead of the curve?

Are there certain types of animals that should not be permitted in this country because of its tendency to be a pet for a short period of time and then released to the wild that could cause damage here in America? I think that is an issue that we should try to stay ahead of the game, rather than just trying to be reactive, as you said. I am not sure what the answer is, but we certainly welcome your thoughts as to giving you additional tools to deal with that.

Mr. FRAZER. We would be happy to work with you. I testified recently before the House Natural Resources Committee on a bill that has been introduced on the House side that took a different approach. So, we would be happy to explore options with you.

Senator CARDIN. And what was that approach?

Mr. FRAZER. It was one that established two different lists, an approved list and an unapproved list. It recognizes some species that might fall in the middle, and you have to do a case-by-case approach. It was one that sought to provide a more proactive approach, provide more certainty to importers. It placed the onus upon importers to provide information upon which to make the risk assessment. It was designed to be more timely, more proactive. There are a number of issues that are associated with making such a thing work, not the least being the resources that would be involved.

Senator CARDIN. I think Senator Barrasso raises a very valid point about industries in America depending upon diversity in species, which is certainly something that we do not want to stop. But there are certain types of wildlife that really does not serve that purpose, that the potential danger seems to me outweighs any of the benefits, including it being an exotic pet. And we would hope you have the authority to move more rapidly to prevent a Burmese python circumstance in the future.

Senator Barrasso.

Senator BARRASSO. Thank you very much, Mr. Chairman. And thank you for that reference. I do have letters from the Chamber of Commerce of the United States and the Retail Leaders Association. I would like to introduce those——

Senator CARDIN. Without objection, it will be included in the record.

Senator BARRASSO. Thank you, Mr. Chairman.

[The referenced letters follow:]

CHAMBER OF COMMERCE
OF THE
UNITED STATES OF AMERICA

R. BRUCE JOSTEN
EXECUTIVE VICE PRESIDENT
GOVERNMENT AFFAIRS

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July 6, 2009

The Honorable Benjamin Cardin
Chairman
Subcommittee on Water & Wildlife
Committee on Environment &
Public Works
United States Senate
Washington, DC 20510

The Honorable Mike Crapo
Ranking Member
Subcommittee on Water & Wildlife
Committee on Environment &
Public Works
United States Senate
Washington, DC 20510

The Honorable Sheldon Whitehouse
Chairman
Subcommittee on Oversight
Committee on Environment &
Public Works
United States Senate
Washington, DC 20510

The Honorable John Barrasso
Ranking Member
Subcommittee on Oversight
Committee on Environment &
Public Works
United States Senate
Washington, DC 20510

Dear Chairmen Cardin and Whitehouse, and Ranking Members Crapo and Barrasso:

As your Subcommittees prepare to examine the issues surrounding the import of nonnative wildlife species at a July 8 joint hearing, the U.S. Chamber of Commerce, the world's largest business federation representing more than three million businesses and organizations of every size, sector, and region, urges you to carefully consider the impact of greater regulation on sectors of the business community and activities that pose no threat to the environment or native species.

The Chamber recognizes that the introduction and establishment of nonnative wildlife species can potentially harm indigenous species and habitats; however, any legislative reforms, unless carefully tailored, could inadvertently place onerous new restrictions on the business community while doing nothing to address the problem of invasive species. Legislation introduced in the House earlier this year to address non-native species, for example, is so overly broad that it would negatively impact several industries, including retail, agriculture, sporting, and aquaculture.

Any legislation that Congress considers should include a "risk analysis" process that would take into consideration socio-economic factors and less-restrictive "risk management" options for controlling non-native and ultimately environmentally benign species. Similar "risk

management" and "risk analysis" processes are currently used by other federal agencies and could effectively be applied to invasive species without requiring industries to spend time and resources determining what is already widely known: that the vast majority of non-native species in the United States are safe and present little or no harm to the environment or other species.

While no amount of regulation will prevent the malicious and intentional introduction of a nonnative species to a habitat, it is possible to reduce the number and frequency of nonnative wildlife species introduced to indigenous ecosystems through commonsense reforms. The Chamber looks forward to working with you to develop commonsense reforms that address the problem of invasive species while simultaneously protecting the interests of the business community.

Sincerely,

R. Bruce Josten

1700 N. Moore Street, Suite 2250, Arlington, VA 22209
Phone: (703) 841-2300 Fax: (703) 841-1184
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July 6, 2009

The Honorable Sheldon Whitehouse
Chairman
Environment and Public Works Committee
Oversight Subcommittee
United States Senate
Washington, DC 20510

The Honorable John Barrasso
Ranking Republican
Environment and Public Works Committee
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The Honorable Benjamin Cardin
Chairman
Environment and Public Works Committee
Water and Wildlife Subcommittee
United States Senate
Washington, DC 20510

The Honorable Mike Crapo
Ranking Republican
Environment and Public Works Committee
Water and Wildlife Subcommittee
United States Senate
Washington, DC 20510

Dear Chairman Whitehouse and Cardin and Ranking Republican Barrasso and Crapo,

On behalf of the Retail Industry Leaders Association (RILA), I am writing in regards to the Senate Environment and Public Works Committee's Oversight and Water and Wildlife joint Subcommittee hearing regarding "Threats to Native Wildlife Species." Examining threats to native wildlife species is an important issue and careful consideration should be given to instances where wildlife overtakes indigenous species and disrupts sensitive ecosystems. We look forward to working with you and your staff on a solution that effectively addresses this problem while carefully balancing the needs of the retail and specialty pet industries without hampering the legitimate flow of commerce.

By way of background, RILA is a trade association of the largest and most successful companies in the retail industry. RILA promotes consumer choice and economic freedom through public policy and industry operational excellence. RILA members include more than 200 retailers, product manufacturers, and service suppliers, which together account for more than $1.5 trillion in annual sales. RILA members operate more than 100,000 stores, manufacturing facilities and distribution centers, bave facilities in all 50 states, and provide millions of jobs domestically and worldwide.

We applaud your commitment to addressing this issue and we agree with you that in certain cases nonnative species, or "invasive species," are threatening or have threatened wildlife habitats. Common-sense reforms are needed to prevent the importation or breeding of species that would be harmful to our ecosystem. The retail industry takes seriously its commitment to responsibly introduce pets into our communities. Pets add to our quality of living and in many instances are treated as members of our own families.

However, we urge caution in ensuring that any legislation would not place cumbersome requirements on the retail industry or threaten to ban the legitimate sale of most common household pets such as gerbils, hamsters, aquarium fish, many varieties of birds and reptiles, and the accompanying jobs and hard lines associated with those pets. These are examples of pets that have been in American homes for decades with no discernable harm to the environment. We support language that would include a "risk analysis" process that would take into consideration socio-economic factors and less-restrictive "risk management" options (e.g., spay/neuter of certain species or possession permits). For example, ferrets sold into commerce are already required to be spayed and neutered and therefore present no risk of repopulating and damaging their environment. Acknowledging similar "risk management" and "risk analysis" processes would effectively address the issue at hand and would be based on existing evidence without requiring industry to spend resources and time completing scientific testing that tells us what we already know: the vast majority of pets offered for sale in today's marketplace are safe and present little or no harm to their surroundings.

Finally, as the Committee looks to address this issue, it's important to point out that no amount of regulation can prevent those rare instances where someone knowingly and even maliciously introduces a damaging nonnative species to a habit that ultimately destroys precious wildlife. The goal of any legislative remedy should be to introduce some amount of risk-based analysis into deciding what species should be banned from importation into the United States and should create stiff penalties for when the laws are knowingly circumvented. However, it should not create undue burdens on the business community in hopes of preventing something that may not be under our control – the negligent and intentional introduction of an invasive species into wildlife by an irresponsible party.

In closing, we support legislation that takes a manageable and practical approach that will address the issue of nonnative species while not overly burdening the retail industry, leading to the loss of commerce and jobs, and depriving consumers of access to pets. We look forward to working with you and your staff on this important issue. If you or your staff should have any additional questions, please contact Andrew Szente by email at andrew.szente@rila.org or by phone at (703) 600-2033.

Sincerely,

John Emling
Senior Vice President, Government Affairs

Senator BARRASSO. Mr. Clay, my impression has been that the USDA has broad authority in controlling injurious wildlife species in terms of entering into agreements with States, with local jurisdictions, with individuals to control these invasive species. How can we use the existing authorities, which the USDA already has and the Fish and Wildlife Service has, to address some of these threats to our native species? Are there things we can do right now with the laws already in place?

Mr. CLAY. Well, I think, as far as the APHIS wildlife services program, we are not a regulatory program, unlike the other programs in APHIS. So, we would work strictly on a request basis from State or Federal agency or the private sector. As far as the regulatory authorities in APHIS regarding livestock health, I think there are appropriate authorities that cover veterinary services activities there.

So, we will be glad to assist any State or Federal entity that requests our assistance if it falls under the regulatory authority.

Senator BARRASSO. Following up with Mr. Frazer, I look at the Game and Fish Department in Wyoming. It is very concerned about some of these aquatic invasive species that we talked about, that Senator Levin talked about beginning in the Great Lakes, and we have concerns.

What can the U.S. Fish and Wildlife do to support a State effort to tackle this threat, short of adopting some sweeping new Federal law which I know my State is not really asking for? They are just asking for some help.

Mr. FRAZER. Well, as I said, I co-chair the Aquatic Nuisance Task Force, which is organized to coordinate Federal efforts to address aquatic nuisance species but also is closely connected with six different regional panels that reach out to State agencies.

Through that effort, the Fish and Wildlife Service led what we called the Hundredth Meridian Initiative, which, through the 1990s, served to try to prevent the movement of zebra and quagga mussels from the Great Lakes into the Western States. For a number of years, it was successful. But that barrier was breached and, as you know, zebra and quagga mussels are now established in the Colorado River.

But we are still working closely with our States, including through the limited dollars that we have, to provide support, financial support, to State invasive species programs, to mount effective prevention and control programs, to contain the species where it is now, to do extensive public education and outreach, because much of the movement is through recreational boating and other pathways, and otherwise to provide leadership and support to the States and others that have to be part of a solution dealing with prevention and containment.

Senator BARRASSO. Can I ask, also, have you done an economic analysis? I mean, I introduced a letter from the Chamber of Commerce about some of the impact that a broad piece of legislation would have on things like sport fishing if you really go ahead and adopt a precautionary approach, as opposed to a risk-based approach.

Mr. FRAZER. We have not done them in a generic fashion. But part of the challenge of us moving through an individual injurious

wildlife determination is that we do need to do an economic analysis and look at the effects of any prohibition on importation on small businesses, small organizations. Those are the sorts of additional analyses that require time and resources and make the process challenging.

Senator BARRASSO. Mr. Chairman, I know they are calling for the vote. If I may just introduce a couple of other questions in written form so that Senator Lautenberg has an opportunity to ask questions.

Senator CARDIN. Certainly.

Senator BARRASSO. Thank you very much. I appreciate that.

Senator CARDIN. Senator Lautenberg.

Senator LAUTENBERG. Thanks, Mr. Chairman. And thank each of you for your very depressing testimony.

This has been a difficult hearing because we are facing up to a problem that exists all around us, and one that has not received the right kind of attention, in my view. When I think about recreational boaters and what they might carry, what does one do about that? I mean, are we out saying that you have to wash down your boat with a particular kind of material, and so forth, and I just cannot imagine getting people that alarmed about it. That question does not deserve an answer. It is just a rhetorical question.

Mr. Frazer, I have asked Interior to devote more resources to curbing the white-nose syndrome. Now, is this situation considered among the more serious in terms of the bat population? Is this recognized as an imminent and massive danger?

Mr. FRAZER. We consider this a crisis in bat conservation, particularly in the Eastern United States, and we are redirecting existing dollars to tackle that now to the extent that we can.

Senator LAUTENBERG. So, is there a provision in the structure that enables you to move funds to the more critical situations? Are there enough funds, as we listen to the testimony and our colleagues have presented, are there enough funds in reserve that are available to get out and start fighting these situations where there are invasive species or, in this case, a virus or whatever it is that is killing these bats?

Mr. FRAZER. We are directing funds under the Endangered Species Act Recovery Program, as well as within our Environmental Contaminants Program, to tackle this. USGS is directing their discretionary research dollars to this. And a number of other agencies are also directing, to the extent that they have discretion, resources to tackle this issue. I cannot speak to whether that is viewed as adequate. Now, we are all Federal bureaucrats, so we could always do more. But there is a significant effort mounted.

Senator LAUTENBERG. Thank you. Scientific studies suggest that humans may play a role in the spread of white-nose syndrome. The Fish and Wildlife Service has called for a voluntary moratorium on caving in affected areas.

Now, since most of this depends on State supervision, what does the Federal Government do to monitor what State activities are taking place to do their part since this is not typically a Federal jurisdiction?

Mr. FRAZER. As I said in my testimony, management of fish and wildlife disease requires a very close and collaborative partnership with State fish and wildlife agencies. They have the authority and responsibility, as well as the field presence, to deal with wildlife disease that exceeds most Federal agencies. The Federal Government can provide leadership, it can provide financial support, it can provide research, but in many cases it is the State agencies that are going to be involved in the operational management activities——

Senator LAUTENBERG. But what happens, Mr. Frazer, if it is observed that a particular State is not doing quite what they should? Is there a corrective action that can be taken by the Federal Government that says, hey, it is going to get you involved with us in funding or something like that?

Mr. FRAZER. We have not experienced that situation. But if we did, at least the Fish and Wildlife Service does not have the kind of authority to step in and federalize management of a disease issue affecting a resident fish and wildlife population.

Senator LAUTENBERG. Not to manage it, but rather to report on it in some manner or form so that we look at whether or not we have to make adjustments and, considering the threats that these conditions pose, we would like to stress as much action as we can possibly muster. Is it possible the white-nose syndrome will result in serious direct human health impacts if it continues to spread?

Mr. FRAZER. We do not know of human health impacts associated with this disease. Certainly, ecological impacts to bats, a potentially catastrophic affect to bats.

I would say, with regard to our relationships with States, it is a very close and very positive relationship, and I would not anticipate a situation where we would be at loggerheads.

Senator LAUTENBERG. OK. Thanks, Mr. Chairman.

Senator CARDIN. Thank you. As you pointed out, you have a great deal of authority under different sections. I am trying to understand when you consider it urgent to act quickly. I know you have emergency powers to protect the public health of the people of this Nation.

What standards are used in order to take emergency precautions where there is an immediate threat? And is there anything that we can learn from that that could help us, perhaps, deal with some of these other problems in trying to streamline the process for making decisions on border issues?

Mr. FRAZER. The Fish and Wildlife Service does not have authority to an emergency listing under the Lacey Act. We are governed by the Administrative Procedures Act. So, the standard there would be, basically it is a due cause standard that we have to establish in order to take emergency action under the Administrative Procedures Act. We do not have authority like under the Endangered Species Act to just simply do an emergency listing.

Senator CARDIN. But you do have, USDA does have certain emergency powers. Maybe I can try to get Mr. Clay involved here.

Mr. CLAY. Yes, sir. Senator, the Animal Health Protection Act does give APHIS broad authority to deal with any type of animal that poses a risk to livestock or to agriculture, whether it is a pet or any kind of animal. If there is a risk specifically to agriculture

and it can impact agriculture, APHIS has the authority to go in and deal with that.

Senator CARDIN. But it does not extend to the situation such as the python or the invasive nutria. If there are snakehead, you could not list prohibited imports because of the fear it would have on agricultural products in the country, or could you?

Mr. CLAY. We could if there was a threat from the animal. Like, for instance, hedgehogs are prohibited from entering the country because of the threat of tuberculosis or foot and mouth disease from them. So, they are an animal that would be regulated as far as watching closely. Other animals, if they do not pose a disease threat to livestock of agriculture, would not fall under the regulatory authority of APHIS.

Senator CARDIN. It seems that is a pretty narrow area where you can act. It is hard to anticipate that an exotic pet, which could pose a threat to livestock, or a plant to agriculture, would be prohibited from being introduced into America because of the fear that it would be released into the environment.

Mr. CLAY. There have been several species of tortoises that have been prohibited because of the ticks and other arthropods that they carry on them that are vectors of livestock diseases. So, it really depends on the type of animal and the country it is coming from, if there is foreign animal diseases, foot and mouth disease or high path avian influenza or whatever, coming from that country. That is when there would be specific restrictions or import regulations.

Senator CARDIN. And when you have taken this action, how effective is the border control and enforcement?

Mr. CLAY. Well, we work closely at all the ports of entry with the Fish and Wildlife Service and the other Federal partners on this. We all have different authorities that we operate under, some of them impact wildlife or affect wildlife and others do not. But we have been working with these Federal partners for years. We have had long standing cooperative relationships with them, so we understand their authorities, their expertise, and I believe we are working very closely with them at the ports of entry.

Senator CARDIN. But there are certain prohibited items and of course we all know what happens at the borders. Is this generally monitoring commercial activity at our borders more so than the individual who is returning to our country?

Mr. CLAY. Well, it is looking at, primarily, wildlife or agricultural animals coming in or their products that are coming in that could pose a threat to the livestock or agricultural health.

Mr. FRAZER. For the Fish and Wildlife Service, Senator, there are designated ports of entry for legal commerce and wildlife. We permit and license importers of wildlife. They are required to file declarations that describe what and where their products come from. So, legal commerce is something that comes through those designated ports, and it is in the form of commercial activity. There are certainly illegal and unauthorized imports of wildlife and wildlife products that come into the country.

Senator CARDIN. I will just make one final observation, and that is that some of this could be better education, to let the public understand the dangers of these types of releases. I think that publicizing what has happened in Florida, for example, the loss of life

as the result of someone innocently, they thought, releasing a snake into the wild. I think we could do a better job. That is something that I think all of us need to take a look at to see what we can let people know——

Mr. FRAZER. Public education is, excuse me, the effective educating and really changing the perspective of the public on invasive species is extremely important. Senator Lautenberg talked about washing boats or modifying the behavior of recreational boaters. We have a specific campaign to do that, and it has been very effective.

With regard to invasive species, particularly pet species, we have something called Habitattitude that seeks to educate pet owners about the dangers and risks of releasing their pets or aquatic plants into the wild. So those are effective parts of our strategy.

Senator CARDIN. Well, let me thank both of you, and we look forward to working with you as we try to improve our tools to deal with this problem through our Federal regulators.

Before calling the next panel, we are going to take a very brief recess. I expect that Senator Whitehouse will be returning shortly which will reconvene the second panel. And as soon as I have a chance to cast my votes, I will be returning.

[Recess.]

Senator WHITEHOUSE [presiding]. I call the hearing to order and start getting under way. The other members of the committee will come back from the vote as they have concluded their business. I gather they are back-to-back votes, so they will be able to vote twice and then come on back.

In the meantime, Chairman Cardin has asked that we continue the hearing, and I am delighted to welcome the witnesses who are here today.

I gather that Director Humphries has already been somewhat introduced by her Senator, Carl Levin. We are so pleased with Senator Levin's and Senator Stabenow's contributions to the Senate. I have to say you come very well represented here, and I am very pleased to have you here as Michigan's Director of the Department of Natural Resources.

We are also joined by Dr. Gregory Ruiz, who is a Senior Scientist at the Smithsonian Environmental Research Center, Marine Invasions Research Laboratory. The Smithsonian Environmental Research Center is a global leader for research focused on the connections between terrestrial and aquatic ecosystems. Dr. Ruiz leads SERC's Marine Invasions Laboratory, a national-international center for research on biological invasions in coastal marine ecosystems.

I want to tell Dr. Ruiz that I am married to a marine biologist who specializes in estuary science, and during the course of my pursuit of her, I was actually dragged into her sampling, some of which took place underwater in Narragansett Bay in February. I guess with that I impressed her enough that we have now ended up man and wife, or, in her case, probably woman and husband.

I am very pleased to have you here with us to bring the marine and coastal side of this. I think it is extremely significant.

Also to a degree emphasizing the marine and coastal side of this is my friend, John Torgan, from Rhode Island, who is the

Baykeeper of Narragansett Bay and works for our really primary environmental organization of Rhode Island, Save the Bay. John has been connected to the Narragansett Bay watershed his entire life. His Baykeeper Program is part of the National Waterkeeper Alliance, specialists with a passion for defending the environment and a devotion to working among communities.

As our Baykeeper, Mr. Torgan is responsible for monitoring invasive species in the bay and collaborating with Federal, State and local agencies to help prevent the introduction and spread of invasive species. Narragansett's native scallop, river herring, Atlantic salmon, rainbow smelt, sturgeon and American shad populations are all impacted by invasive species.

Finally, we are joined by Dr. Jeffrey Hill, who is an Assistant Professor with the Department of Fisheries and Aquatic Sciences at the University of Florida.

We welcome all of the witnesses, and why do we not go across the board beginning with Dr. Ruiz.

STATEMENT OF GREGORY RUIZ, SENIOR SCIENTIST, SMITHSONIAN ENVIRONMENTAL RESEARCH CENTER, MARINE INVASIONS RESEARCH LABORATORY

Mr. RUIZ. Thank you, Mr. Chairman. Good morning and thank you for the opportunity to be here today.

My name is Greg Ruiz. I am a Senior Scientist at the Smithsonian Environmental Research Center or SERC, located on the Chesapeake Bay. SERC is a leading national center of research on non-native species invasions in coastal marine systems. A primary goal of SERC's invasion research is to advance fundamental science to understand patterns and mechanisms of coastal invasions.

Today, I would like to highlight the current state of knowledge about invasions in marine ecosystems, considering Chesapeake Bay and Nation more broadly. I also wish to underscore the need for vector management to reduce the risk and impacts of invasions.

Invasions are rapidly changing the earth's ecosystems, having dramatic effects on ecological processes, critical habitats, commercial fisheries and disease outbreaks. The cost of invasions to society is enormous, estimated in excess of $100 billion a year in the United States alone. Invasions result in the loss of crops and fisheries, damage to infrastructure and water supplies, and effects on human health.

Coastal bays and estuaries are especially vulnerable to invasion by non-native species. This is exemplified by Chesapeake Bay, the Nation's largest estuary. SERC's research has documented over 177 non-native species with established populations in Chesapeake tidal waters. The rate of documented invasions here has increased dramatically over the last century. These organisms were delivered from around the globe by a diverse range of human activities.

Some invasions have large effects on the Chesapeake Bay region. For example, the oyster parasite MSX, from Asia, causes mass mortality of the native Eastern oyster, contributing to the collapse of Chesapeake's iconic fishery and undermining efforts for recovery.

As Senator Cardin indicated, the nutria, a South American mammal, is responsible for destruction of salt marsh habitat, converting

marsh to bare mud and removing critical habitat for waterfowl, fish and other organisms.

Also of great concern is the observed increase in new invasions for the Chesapeake. On a daily basis, non-native species are delivered to our shores by many different human activities, including the movement of ships, recreational vessels and live trade organisms such as seafood, bait, aquarium pets and aquatic plants. As a result, new invasions continue to occur, such as the mitten crab, which has been found now from Chesapeake up to New York.

The Chesapeake serves as a model for what is occurring with invasions across the Nation. As Senator Nelson indicated today, invasions pose a significant challenge for resource management and undermine restoration efforts. This situation is exacerbated by the growing number of invasions and also the effects of climate change. Increasing temperatures expand the number of species that can colonize by creating suitable conditions for survival and reproduction that did not previously exist.

There are two key steps that are needed to address invasion impacts. The first is to reduce the risks of future invasions by new species. The second is to eradicate or control selected high impact species that are already established. However, unless we address the increasing number of new invaders, our capacity to mitigate established evasions is rapidly overwhelmed.

One obvious priority for the Nation is vector management. Rather than a species-by-species approach, vector management seeks to disrupt the shared transfer process of many species at once. I describe this in more detail in my written testimony.

There is still considerable work to be done to achieve effective vector management. The Nation's current approach is a patchwork applied inconsistently across different transfer mechanisms or vectors.

There are also critical scientific gaps that limit vector management. One of these is tracking and measuring the occurrence of invasions over time. This is key to identifying the source of new invasions for response. This is also needed to assess the long-term effectiveness of vector disruption.

Remarkably, there exists no national program to provide the type of standardized measures needed to assess the status and trends of coastal invasions in America today. This presents significant problems for vector management. Many regions, habitats and taxonomic groups have not been surveyed in recent years or even decades, providing only a party picture of invasion dynamics.

Piecing together data from existing programs is insufficient because they have conspicuous gaps. To reduce invasion risks and impacts, we need a consistent approach to vector management. This requires the use of standardized quantitative surveys to track invasions. Without such field measures, we are often left guessing about the status, trends and emerging threats of invasions, limiting effective responses.

In my written testimony, I have outlined some possible approaches to meet this challenge.

Thank you very much.

[The prepared statement of Mr. Ruiz follows:]

Gregory M. Ruiz, Ph.D., Senior Scientist
Smithsonian Environmental Research Center

Before the Subcommittees on Oversight and Water & Wildlife
Committee on Environment and Public Works
United States Senate

Wednesday, 8 July 2009

Good morning and thank you for the opportunity to be here today.

My name is Gregory Ruiz. I am a Senior Scientist at the Smithsonian Environmental Research Center (SERC), located on the shore of Chesapeake Bay.

SERC is a leading national and international center for research in the area of non-native species invasions in coastal ecosystems. I head the Marine Invasion Research Laboratory based in Maryland. The Laboratory also maintains resident staff and research facilities in California and Oregon. Collectively, this group provides synthesis, analysis, and interpretation of invasion-related patterns on a national scale.

A primary goal of SERC's research on non-native species invasions is to advance the fundamental science, which is critical to developing effective management and policy in this area. Our research aims to address gaps between science and policy, providing the needed scientific understanding to inform and evaluate management strategies for invasive species.

Today, I wish to highlight briefly the current state of knowledge about invasions for marine and aquatic ecosystems, considering Chesapeake Bay and the Nation more broadly. I also wish to focus particular attention on (a) the importance of tracking invasion patterns and trends – as a critical building block of invasion science and management, and (b) the need for vector-based management to reduce the risk and impacts of invasions.

Current State of Knowledge

Biological invasions, the establishment of non-native or nonindigenous species outside of their historical range, are rapidly changing the earth's marine and freshwater ecosystems. A growing number of natural communities are dominated by non-indigenous species (NIS) in terms of number of organisms, biomass, and ecological processes. It is clear that invasions have caused dramatic shifts in food webs, chemical cycling, disease outbreaks, and commercial fisheries.

The cost of invasions to society is enormous, including loss of crops and fisheries, damage to infrastructure and water supplies, and effects on human health. One estimate is that invasions cost the United States approximately $137 billion per year in losses and damages (Pimentel et al., Bioscience, 2000). Although the impacts of most invasions remain unexplored, ***there is no doubt that biological invasions have become a major force of ecological change, as well as economic and human health impacts, operating on local to global scales.***

Coastal bays and estuaries are especially vulnerable to invasion by non-native species. This is exemplified by Chesapeake Bay, the Nation's largest estuary. SERC's research has documented 177 NIS that have established, self-sustaining populations in tidal waters of the Chesapeake. Over the past century, the rate of detected invasions has increased dramatically. These organisms have been delivered here by a diverse range of human-mediated transfer mechanisms (vectors), including shipping and fisheries activities. The Chesapeake invaders arrived from throughout the world, reflecting the global

scale of commerce and connectivity. [Additional detail on the invasion history for Chesapeake Bay is included in Appendix 1 and is also available online through the National Exotic Marine and Estuarine Information System (NEMESIS; http://invasions.si.edu/nemesis/cbsearch.html.)]

Some invasions have large effects on the Chesapeake Bay, in terms of both the natural resources and society. Examples of high-impact species occur across taxonomic groups and habitats, arriving by multiple vectors:

- The oyster parasite MSX (*Haplosporidium nelsoni*) causes mass mortality of the native Eastern oyster, contributing to the collapse of Chesapeake's iconic fishery and undermining efforts for its recovery. The parasite first appeared in the mid-20th century. It is native to Asia, where it infects oysters, and was apparently transferred to the mid-Atlantic region either by importation of infected (nonindigenous) oysters or associated with the hulls or ballast water of vessels arriving from Asia.
- The nutria (*Myocastor coypus*) is responsible for destruction of salt marsh habitat, converting marsh to bare mud and open water and removing critical habitat for waterfowl, fish, and other organisms. This mammal was brought to the region for fur production and became established in the 1940s due to both escapes and intentional releases. Native to South America, this species is the focus of active eradication efforts in the Chesapeake Bay.
- A Eurasian genotype of the common reed (*Phragmites australis*) forms dense, mono-specific stands that crowd out native marsh vegetation and affect fish and other wildlife. The introduced plant was present in the Chesapeake by the late 19th century and was delivered unintentionally in dry ballast of ships or in agricultural products. Unlike the native genotype (which was historically uncommon), this invader occupies large areas and is continuing to spread aggressively in Chesapeake Bay and elsewhere along the Atlantic coast. Various local efforts have existed to control the species and limit its spread in the Chesapeake.

Also of great concern is the observed increase in new invasions for the Chesapeake. On a daily basis, NIS are delivered to our shores by many different human-mediated activities, such as the movement of ships, recreational vessels, and live trade organisms (seafood, bait, aquaria pets, plants). These operate to transfer NIS on a global scale. As a result, we see new invasions occurring, such as the Chinese Mitten Crab (*Eriocheir sinensis*), which we are finding (only since 2005) in Maryland, Delaware, New Jersey, and New York waters. Listed as "injurious wildlife" by the U.S. Fish and Wildlife Service under the Lacey Act, this species has caused significant problems with water management in the San Francisco Delta of California, where it is also established and undergoes "outbreaks" of high abundance.

The Chesapeake Bay serves as a model for what is occurring throughout the Nation. Marine and freshwater invasions are having significant ecological and economic impacts in many other regions. This issue has sparked great concern in many states. On a national scale, like the Chesapeake Bay, our research indicates that the rate of newly detected invasions is increasing through time. This means that the impacts of invasions are increasing through time, due to combined effects of (a) those high-impact species already established and (b) new species that continue to accumulate, which will surely include some proportion of high-impact species.

Invasions pose a significant challenge for resource management and restoration efforts, due to the scale and often unpredictable nature of associated impacts. This is further exacerbated by the growing number of NIS and also climate change. Increasing temperature will serve to expand the number of NIS that can colonize, by creating suitable conditions for survival and reproduction that did not previously exist. Changing conditions will also allow some established species to exert stronger effects than is currently the case. However, one of the biggest challenges of shifting climate regime is the associated uncertainty of ecological consequences, and much work is needed to predict effects on invasion dynamics.

There are two key steps needed to address invasion impacts. The first is to reduce the risk of future invasions by preventing establishment of new species. The second is to mitigate the effects of NIS that have already colonized, using available control or eradication methods for selected, high-impact species. These are best pursued concurrently. However, unless we address the increasing supply of new invaders, our ability to mitigate for established invasions on a species-by-species basis is rapidly overwhelmed, especially since difficult choices are already being made about how to allocate limited resources for control and eradication.

Vector Management to Prevent Invasions

One clear priority for the Nation is vector management to greatly reduce the risk of new invasions. The continued introduction of new NIS is often viewed as a "surprise", one species after another, and year after year, but these invasion events are not unexpected. Each new invasion is a warning signal, telling us that the vector is operating and the door is open for new invasions. Instead of responding individually to each introduced species as a novel occurrence, a strategy of vector management seeks to simultaneously prevent invasions by many species through interruption of the general transfer process.

Vector management involves three fundamental components: Vector Strength, Vector Analysis, and Vector Disruption. First, an assessment of Vector Strength is required to identify the relative importance of various vectors. This is accomplished by analysis of data on the patterns and rates of invasion, identifying which vectors are responsible for invasions (i.e., the relative importance of different vectors in space and time). Second, Vector Analysis is needed to describe the operational aspects of how, where, when, and in what quantity a vector delivers viable organisms (propagules) to the recipient environment. Among other things, this component identifies potential approaches for management action. Third, some form of Vector Disruption is designed and implemented to restrict or stop the flow of propagules (i.e., reduce the risk of new invasions) to the recipient environment. [This framework is presented in the following book chapter: Ruiz GM & JT Carlton. 2003. Invasion vectors: a conceptual framework for management. In: *Invasive Species: Vectors and Management Strategies*, GM Ruiz and JT Carlton (editors), pp. 459-504. Island Press, Washington.]

There is still considerable work to be done to achieve effective vector management. The Nation's current approach to vector management is a patchwork, applied inconsistently across different vectors, rather than a coherent and effective policy. For some vectors, such as ships' ballast water, a vector management framework (including vector disruption) is being implemented. For others, such as transfer of live aquatic organisms or coastal movement of recreational vessels, vector management is poorly developed.

There are also critical scientific gaps that limit vector management. One of the most critical gaps is in tracking or measuring the occurrence of invasions over time. Remarkably, there exists no national program designed to collect the type of standard, repeated, and quantitative measurements needed to assess status and trends of coastal invasions in America. This presents significant problems for vector management, as outlined below.

The Importance of Tracking (Measuring) Invasions

Tracking invasion is of paramount importance to vector management, both to measure Vector Strength --- or the source of new invasions ---and to assess the long-term effect of Vector Disruption on invasion rates and patterns. Measuring invasion occurrences, patterns and rates is the cornerstone of invasion science and invasion management. Without a reliable information base, many fundamental questions in marine invasion ecology will remain unresolved, limiting advances for basic science as well as its ability to guide effective management and policy.

Only rigorous, standardized and repeated field measures can inform us about (a) the spatial patterns and tempo of invasion --- the where, when, and how of invasions --- and (b) the efficacy of Vector Disruption to reduce new invasions. Knowledge about contemporary and emerging patterns of invasion is needed to guide management and policy decisions. Importantly, tracking invasions pattern, and especially long-term changes in invasion rate in association with Vector Disruption efforts, is essential for adaptive management --- testing for the desired effect of management action and whether further adjustments are required.

More broadly, measuring invasion occurrence is at the core of several management goals. In addition to the direct application for identification and management of vector activity, occurrence records are critical for modeling and predicting invasion risk, spread, and impact. The technical capacity exists to develop predictions, but applications are often limited by sufficient occurrence data. Occurrence data are also necessary for eradication and control efforts of established species. There has been considerable discussion in recent years about development of an "early detection, rapid-response" capability in response to new invasions or outbreaks. Although the scope of this may vary, from attention to a small subset of species to a wider spectrum of potential invasions, ***any rapid-response system by definition relies upon an effective field-based detection system.***

Status of Tracking (Measuring) Invasion Patterns & Rates

Numerous analyses now exist to describe patterns of marine invasion in the United States. These analyses result primarily from literature reviews, providing a synthesis of published reports. ***Although existing syntheses provide useful information and apparent patterns, the information quality is insufficient to support robust conclusions about actual rates and patterns, including especially current trends associated with specific vectors.***

Current analyses provide a minimum estimate of established marine non-native species in U.S. estuaries. Many regions, habitats, and taxonomic groups have simply not been surveyed in recent time, providing only a partial picture of contemporary invasion dynamics. Thus, emergent patterns and rates must be viewed with a great deal of caution --- because the data include very strong temporal and spatial biases. These biases result especially from uneven or haphazard collection effort. ***In essence, the data used in most analyses are "by-catch" and have limitations, as they were not collected for this purpose.*** A review of these issues is presented in a recent article entitled "Invasion of Coastal Marine Communities in North America: Apparent Patterns, Processes, and Biases" (Annual Review of Ecology and Systematics, 2000, Vol. 31: 481-531).

SERC has developed the National Exotic Marine and Estuarine Species Information System (NEMESIS) to summarize existing data on marine invasions. The U.S. Geological Survey (USGS) has developed the Nonindigenous Aquatic Species database, a complementary national-level database for freshwater invasions. Under a Cooperative Agreement, SERC and USGS are coordinating the further development of these databases, along with analyses and electronic access of the resulting information.

However, at the present time, ***there exists no national program designed to collect the type of standard, repeated, quantitative, and contemporary field-based measures across multiple sites that is needed to measure rates and spatial patterns of invasion***. Although this has been evident for many years, and was the focus of a workshop in 1998 (sponsored by U.S. Fish & Wildlife Service and SERC, and presented to the inter-agency Aquatic Nuisance Species Task Force), a program to address this gap has not yet emerged. Importantly, piecing together disparate data from existing programs, as has been suggested, will suffer limitations --- similar to those that exist today --- because these programs were not designed explicitly to measure invasion patterns.

Most recently, SERC has implemented a series of quantitative surveys across 26 different bays in North America, focusing on sessile invertebrates. Funded by Department of Defense, National SeaGrant, and U.S. Fish & Wildlife Service, this work is intended to compare pattern of invasions among sites, using a single standardized survey (in one year) at each bay. Although this is not presently a sustained effort, it moves toward developing a quantitative baseline, and could serve as a prototype for repeated, temporal measures.

Approach to Track (Measure) Invasions

To effectively measure invasion patterns and rates for vector management requires the use of standardized, quantitative surveys that are replicated at many sites and repeated regularly over time. Multiple sites are necessary, because significant variation exists among sites --- such that one or a few sites cannot serve as a proxy for others. For example, invasions in Chesapeake Bay may differ greatly from those in San Francisco Bay, Columbia River, Raritan Bay, Narragansett Bay, or Tampa Bay. Further, repeated measures are necessary to build statistical confidence about the existing assemblage of species (or develop a baseline) with which to measure temporal changes.

As a minimum, one lead group should be charged with oversight and coordination of the surveys to develop standardized protocols, provide continuity in taxonomic identification, and manage, analyze, and interpret the resulting cumulative data. Without such oversight, measures of invasion patterns and rates will remain uneven and cannot contribute to a larger picture (beyond an individual site) or be used to address questions on a national scale.

Although I emphasize the importance of identifying a lead science group to coordinate and oversee surveys, providing many centralized services, ***a distributed network of research groups (including the lead group) may be the most effective model.*** For example, the lead group could establish standard protocols, develop some demonstration sites, and serve to coordinate replicated surveys among the network of collaborating researchers (including those at universities as well as state or federal labs) who work at many sites throughout the country. Further, field-based surveys at each site could include some standardized core elements (i.e., identical across all sites) and possibly some measures that are of relevance or particular interest at only a subset of sites.

A distributed network would require clear and frequent communication across sites, to achieve coordinated and standardized measures. A clear advantage with such a network approach lies in the local implementation of surveys, drawing on local or regional expertise in a cost-effective manner. Further, ***the development of a distributed network with centralized services, including especially data management and analyses, would assure rapid access to current information --- which could inform analyses of invasion patterns and rates or rapid-response actions***. Further, such a distributed network is readily scalable, allowing for established links and coordination with many groups --- both nationally and overseas.

Beyond the specifics of survey design, there are many other elements that require attention, having important consequences for the possible analyses and interpretation, including: (i) taxonomic identification, (ii) reference material, (iii) geographical information, (iv) information management, and (v) environmental characteristics. One role of the coordinating group could be to implement standard protocols across each of these topic areas and also to develop partnerships with existing programs to contribute relevant expertise on physical, chemical, and biological dynamics of survey sites.

[Further background and discussion are included in the following book chapter: Ruiz GM & CL Hewitt. 2002. Toward understanding patters of coastal marine invasions: A prospectus. In: *Invasive aquatic species of Europe*, E. Leppakoski, S. Olenin, & S. Gollasch (editors), p. 529-547. Kluwer Academic Publishers, Dordrect.]

Conclusions

Chesapeake Bay and estuaries throughout the country are experiencing significant impacts due to non-native species, and the rate of invasions appears to be increasing. Vector management to reduce invasion risk is a high priority for the Nation. Advancing scientific understanding and vector management for invasions depends critically upon high-quality empirical measures, which are now lacking. This gap is especially conspicuous for marine systems. Quantitative field surveys, which employ standardized and repeated measures, are needed to truly understand and effectively reduce invasion risk.

Appendix 1: Historical Analysis of Chesapeake Bay Invasions. Published in "Biological Invasions in Marine Ecosystems", 2009, Springer-Verlag.

Chapter 28
Four Centuries of Biological Invasions in Tidal Waters of the Chesapeake Bay Region

Paul W. Fofonoff, Gregory M. Ruiz, Anson H. Hines, Brian D. Steves, and James T. Carlton

28.1 Introduction

Biological invasions are prevalent in marine ecosystems throughout the world. Several studies demonstrate that the number and abundance of non-native species have increased dramatically in recent time (Cohen and Carlton 1998; Cranfield et al. 1998; Reise et al. 1999; Ruiz et al. 2000a; Hewitt et al. 2004). Although the impact of many non-native populations remains unexplored, it is also evident that some species have fundamentally altered the structure and function of marine systems (Ruiz et al. 1999; Crooks 2001; Carlton 2001).

Most marine invasions are known from protected waters of bays and estuaries, instead of exposed outer coasts (Chap. 33, Preisler et al.). This results at least partly from the concentration of human activities surrounding estuaries, creating many transfer mechanisms (vectors) for the human-aided movement of organisms from other global regions. Most of the world's trade occurs by shipping among ports, concentrated in bays and estuaries, creating opportunities for species transfers associated with ships' hulls and ballasted materials (Carlton 1985). In addition, bays are foci for many other activities known to transfer organisms, such as aquaculture, fishing, and outdoor recreation. Estuaries also represent an intersection between marine, freshwater, and terrestrial environments, and potentially can be invaded by organisms from each of these adjacent regions. Although estuaries include a diverse range of habitats and have undergone many anthropogenic changes, both potentially affecting colonization by non-native species, it appears certain that the propagule supply moved among bays is an important driver for the predominance of non-native species in more protected waters.

For North America, analyses and syntheses of marine invasions now exist for several estuaries along the Pacific coast (Carlton 1979; Cohen and Carlton 1995; Cohen et al. 1998, 2001; Wasson et al. 2001; Boyd et al. 2002; Wonham and Carlton 2005). European colonization and modern human activities are relatively recent here, with the major expansion in shipping in the 1800s. In contrast, extensive colonization and shipping to eastern North America began in the 1600s, and

G. Rilov, J.A. Crooks (eds.) *Biological Invasions in Marine Ecosystems.* Ecological Studies 204,

a comprehensive analysis of invasions for such an Atlantic coast estuary has not been published.

In this chapter we provide an overview of invasion patterns for the Chesapeake Bay, a major estuary on the Atlantic coast and one of the earliest sites of continuous European settlement in North America. Following the first European settlement at the mouth of the Chesapeake in 1608, the region experienced rapid and sustained growth in human population size, shipping, fishing, and agriculture. Today, the Chesapeake remains a major hub of human activity, and the combined ports of Baltimore and Norfolk have the second largest number of ship arrivals in the U.S. (Smith et al. 1999). This long history of modern human activities suggests the Chesapeake Bay region has been exposed to non-native biota delivered by many vectors.

We compiled information on species in the Chesapeake Bay region from a variety of sources, including published literature, "gray literature", Internet datasets, and interviews with scientists. Records were included in the database when a museum specimen was reported, or other evidence was given to verify the identity and occurrence of a species in the study area. We also conducted intensive field surveys of sessile invertebrates in the lower Chesapeake Bay (for description see Ruiz and Hewitt 2002; NEMESIS 2005), providing additional information and several new species records for the region.

With these information sources, we classified species using several categories, which describe their invasion history and distribution in the Chesapeake Bay region, as follows:

- Invasion Status [Introduced, Cryptogenic, Native].
- Population Status [Established, Extinct, Failed, Unknown].
- Residency [Regular Resident, Boundary Resident, Unconfirmed]. Boundary resident species occur commonly in terrestrial or freshwater habitats, and less frequently in tidal or marine waters.
- Native Region [Western Atlantic, Eastern Atlantic, Pacific, Unknown Marine, North America, South America, Eurasia, East Africa, Africa]. Marine species are attributed to ocean basin and others (freshwater/terrestrial) to continental regions.
- Source Region [Categories as described for Native Region].
- Date of First Record – First documented date of sighting, collection or report.
- Vector(s) of Introduction – Plausible mechanism(s) of introduction.

These classifications and detailed histories were entered into our database (the National Estuarine and Marine Exotic Species Information System, NEMESIS) and used for analysis of invasion patterns by taxonomic group, time, transport mechanism (vector), and origin. We provide further description and detailed information in supplemental materials (http://www.serc.si.edu/labs/marine_invasions/publications/supplements.jsp). Additional information for each species is also available on-line at http://invasions.si.edu/nemesis/chesapeake.html.

28.2 Description of the Chesapeake Bay Region

We defined the Chesapeake Bay region as the tidal waters, including tidal wetlands of the Chesapeake Bay and its tributaries, the adjacent Atlantic waters of Virginia and Maryland, and the chain of coastal Atlantic bays north of the mouth of the Chesapeake and up to the Maryland-Delaware border (see Fig. 28.1). The landward boundary of our study area is the monthly-mean high-tide line of shores and wetlands, and the limit of tidal influence in tributaries.

28.2.1 Physical Features

Chesapeake Bay is the largest estuary in the United States, with a total surface area of 11,500 km^2. The watershed includes 163,170 km^2 across six states, with ten major tributary rivers (Fig. 28.1. The estuary is less than 10,000 years old, and the history geological, climatic and ecological change has received considerable attention (Schubel and Pritchard 1987; Brush 2001; Kutzbach and Webb 2001). The Bay's large freshwater inflow (~48% of which comes from the Susquehanna River, entering at the north) and shallow depth result in a gradual salinity gradient and extensive regions of tidal freshwater regions in the Upper Bay and the major tributaries, with large areas grading from oligo- and mesohaline to polyhaline waters in the Lower Bay (Schubel and Pritchard 1987). Fully marine salinities (euhaline, 30–35 PSU) occur only in the adjacent Atlantic waters, and in the coastal bays (from Assawoman and Chincoteague Bays, south to Hog Island Bay) along the Atlantic shoreline (Fig. 28.1). The low elevation of much of the surrounding Coastal Plain means that, even with a relatively small tidal range (0.3–0.9 m) (Schubel and Pritchard 1987), the Bay is surrounded by more than 79,000 hectares of freshwater, brackish, and marine tidal wetlands (Chesapeake Bay Program 2005).

The climate of the Chesapeake Bay region is marked by drastic seasonal changes in temperature, with typical mid-Bay ranges from 0 to 2 °C in winter and ≥30 °C in summer in water, and −5 to 40 °C in air (Schubel and Pritchard 1987). Spatially, the Chesapeake Bay region, which spans ~2° of latitude, has a noticeable North-South climate gradient, with mean air temperatures about 2 °C higher at the mouth of the Bay, and at least 30% fewer days below freezing, compared to the head of the Bay (Kutzbach and Webb 2001). Along the major tributaries, summer temperatures are coolest in tidal freshwater just below the Fall Line (the boundary between the Piedmont and Coastal Plain), and increase moving bay-ward across the low Coastal Plain. The Bay's mouth and the adjacent Atlantic waters, subject to a more marine climate, have a narrower seasonal temperature range, in both summer and winter (Kutzbach and Webb 2001).

The Chesapeake Bay region includes a great diversity of habitats. Among the major habitat types are unstructured sediments (including intertidal mudflats and beaches), oyster beds, freshwater to marine submerged aquatic vegetation (SAV), coarse woody debris, tidal marshes (fresh to salt), and freshwater tidal swamps.

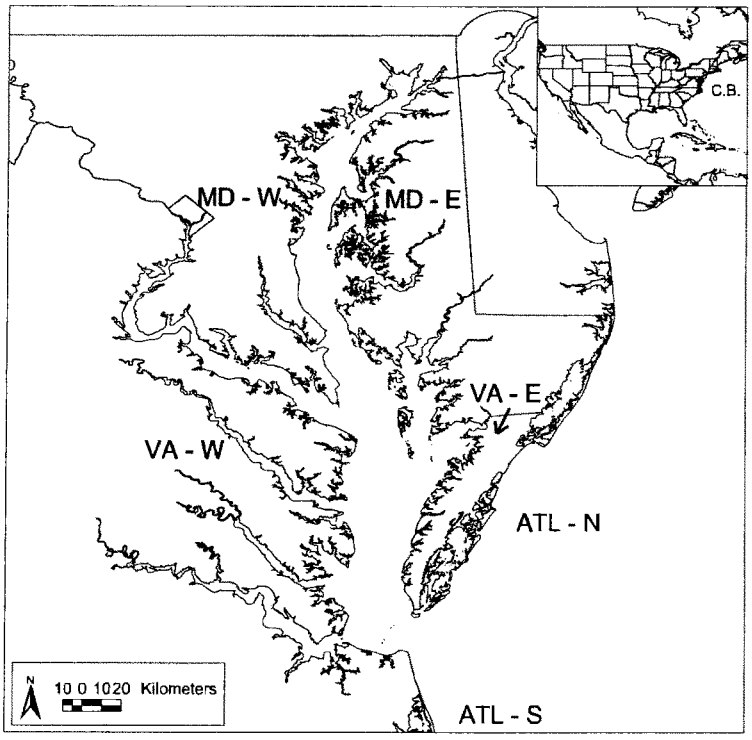

Fig. 28.1 Map of Chesapeake Bay region. The labeled sub-regions are: Maryland-West (MD-W), Maryland-East (MD-E), Virginia-West (VA-W), Virginia-East (VA-E), Atlantic-North (ATL-N) and Atlantic-S (ATL-S). Each region extends inland to the monthly mean high-tideline on shores, and to the head of tide of tributaries

However, natural rocky substrates are confined to small portions of the uppermost tidal fresh portions of tributaries, just below the edge of the Piedmont plateau (the Fall Line) (Jenkins and Burkhead 1993). The major natural hard substrates for attached organisms are logs and bivalve shells, especially oysters, which, until twentieth century over-harvesting, formed massive reefs (Kennedy 1995). As a major center of human activity, a large amount of anthropogenic hard substrate now exists as seawalls, rock rip-rap, docks, and piers.

28.2.2 History of Biological Studies

Our knowledge of the occurrence of biological invaders in a particular region, and especially the timing of their arrival, is dependent on the history (especially extent and timing) of biological studies in the region. In the Chesapeake Bay region,

botanical collections began in the late seventeenth and early eighteenth centuries (Gronovius 1739; Reveal 1983; Brown et al. 1987), while regional species lists of such economically important animal groups as fishes, mollusks, and decapod crustaceans were not published until the late nineteenth century (fishes – Cope 1869; Uhler and Lugger 1876; mollusks – Dall 1889; decapod crustaceans – Stimpson 1859, 1871; Kingsley 1879).

A few studies of other groups, such as hydroids (Clark 1878, 1882) and polychaetes (Webster 1879), were published in the late nineteenth century, but many invertebrate groups were not extensively collected in the region until the twentieth century. Surveys of macroalgae in the Chesapeake Bay region were first published in the 1960s (Zaneveld 1966; Wulff et al. 1968; Zaneveld and Barnes 1965; Mathieson and Fuller 1969). In the years preceding and following World War I, an extensive biological survey of Chesapeake Bay was carried out (Cowles et al. 1930), and in the 1960s, the Virginia Institute of Marine Sciences compiled lists of the biota of the lower Chesapeake Bay (Wass 1963, 1972). However, the last publication to give extensive species lists of Chesapeake Bay benthic invertebrate fauna was published in 1984, and was based on field work completed in 1978 (Dauer et al. 1984). Similarly, the most recent publication on Chesapeake Bay seaweeds was in 1980 (Orris 1980). The results of more recent monitoring programs are available as "gray literature" and in computer databases, but tracing identifications of species in these records can be difficult (Fofonoff, personal observation). Our knowledge of the invertebrate and algal fauna of the Chesapeake Bay region is thus confined to a narrow temporal window. Many invaders arriving before the late nineteenth and earliest twentieth century have doubtless been overlooked, while it is likely that some recent arrivals have been undiscovered because of the lack of researchers or knowledgeable taxonomists.

28.3 Patterns of Invasion in the Chesapeake Bay Region

28.3.1 Taxonomic Composition and Residency

We have documented a total of 170 species introduced and established in the tidal waters and wetlands of the Chesapeake Bay region. This total includes 121 regular residents and 49 boundary residents (primarily terrestrial or non-tidal freshwater species, occasionally entering tidal wetlands or waters). Eleven of the species, all regular residents of North American origin (six fish, one reptile, two birds, and two vascular plants), are native/cryptogenic in parts of the region (most frequently in the tidal James River, near the southern edge), but are well documented as introduced elsewhere in the Chesapeake. [See supplemental material at http://www.serc.si.edu/labs/marine_invasions/publications/supplements.jsp and NEMESIS 2005, for complete list and species-level information.]

These 170 established species are distributed among 17 different phyla, which we have combined into 4 major groups for comparison. These groups include invertebrates plus algae (7 species of algae, 58 invertebrates), vascular plants (68 species), fishes (27 species), and air-breathing vertebrates (reptiles, birds, mammals, 10 species) (Fig. 28.2). Among the 65 invertebrate species, the three most numerous groups are insects (Hexapoda) (13 species, 20%), mollusks (12 species, 18%), and crustaceans (11 species, 17%) (Fig. 28.3).

The major groups of organisms vary greatly in the proportion of regular and boundary residents. Non-indigenous vascular plants in the Chesapeake Bay region are almost equally divided between regular (33 species) and boundary residents (35 species), whereby 33 of the latter are predominantly terrestrial in habitat preferences (exceptions are *Rorippa nasturtium-aquaticum*, Watercress; *Landoltia punctata* – Dotted Duckweed). By contrast, almost all the invertebrates/algae group (63 of 65 species), are considered regular residents of tidal waters or wetlands. All of the introduced fishes are freshwater species, of which 19 regularly occur in estuarine waters, while 8 are predominantly species of non-tidal freshwater streams, but occasionally are collected in upper reaches of tributaries. We consider six of the air-breathing vertebrates (one turtle, three waterfowl, two mammals) to be regular residents of the estuary, while four terrestrial species (one bird, three mammals) occasionally reside or feed in tidal wetlands.

In addition to the established species, we have recorded at least 36 introduced species as having "unknown" population status, most of which are known from single or scattered records. Most (21) of these species are invertebrate/algal species which are

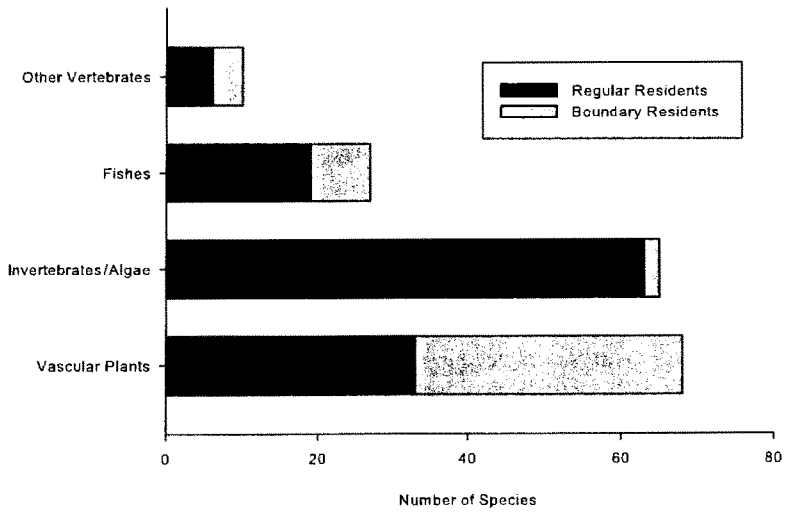

Fig. 28.2 Composition of Chesapeake Bay region non-indigenous species by broad taxonomic categories, showing each regular and boundary residents (n=170 species)

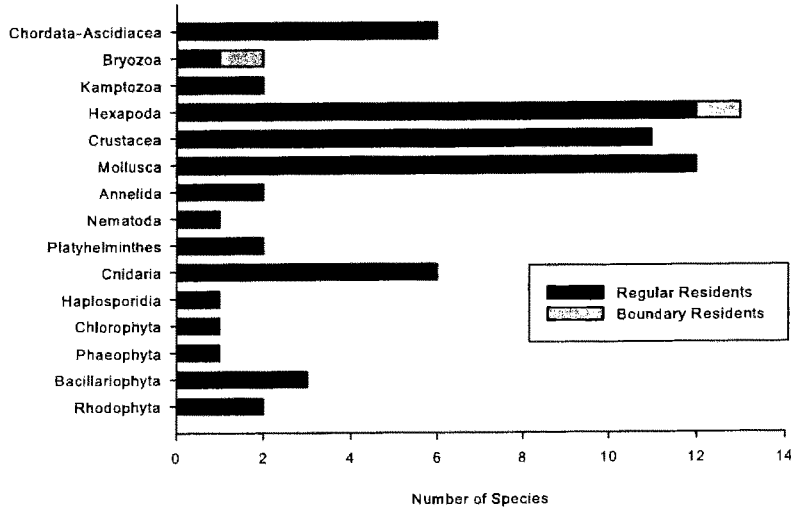

Fig. 28.3 Composition of Chesapeake Bay region non-indigenous invertebrates/algae by phyla, showing each regular and boundary residents (n=65 species)

likely to be overlooked in current sampling programs, because of small size or the scarcity of taxonomic expertise. Seven species, five fishes and the exotic oysters *Crassostrea ariakensis* (Suminoe Oyster, 1998) and *C. gigas* (Pacific Oyster, 1962), were all deliberately introduced and considered to have "unknown" status because of uncertain fertility. Most introductions of the oysters (all documented introductions of *C. ariakensis*) and the fish *Ctenopharyngodon idella* (Grass Carp, 1989) were of sterile triploid individuals, in order to reduce the likelihood of adverse ecological impacts from reproducing populations (NEMESIS 2005). However, reversion of triploids to diploid status, which occurs at a low probability, becomes more likely as the scale and time-span of stocking expands, as does the possibility of human error (Jacobson and Kartalia 1994; National Research Council 2003). Five "species" of fishes were artificially produced hybrids introduced for sport purposes, believed to be sterile or having reduced fertility, also with the intention of reducing unexpected impacts (Christmas et al. 1998). Establishment of some of these "unknown" species is likely to be confirmed in the future.

The establishment of 170 non-indigenous species in the Chesapeake Bay region implies that the flux of introduced species into the region must be many times larger, since most invasions fail (Williamson 1996). For most accidentally introduced invertebrates and algae, failed invasions are difficult to document, given the small size, scarcity, and difficulty of detection and identification of many species (and especially larval or immature forms). We have documented at least 22 failed invasions of tidal waters and wetlands, including freshwater

and anadromous fishes (12 species), wetland plants found in piles of dry ballast (4 species), and reptiles (3 species). Most of the fish introductions were attempted as part of state and federal fish acclimatization programs between 1874 and 1916. Seven species of cold-water salmonid fishes were introduced in large numbers (e.g. ~8 million *Oncorhynchus tschawytsha*, Chinook Salmon, 1876–1899; NEMESIS 2005), with no evidence of prolonged survival or reproduction. More recent failed introductions have been single or scattered captures of released pet fishes (two tropical species) and reptiles (three species). Failures of most of the fish and reptile introductions can be attributed to mismatches in climate. In addition, discarded pets are usually released as single individuals or in small numbers, making reproduction unlikely.

28.3.2 Changing Patterns of Invasion Over Time

Reports of introduced species in tidal waters and wetlands of the Chesapeake Bay region have varied over time, and the number of newly discovered species has increased sharply in the last 50 years. Taxonomic composition, native and source regions, and vectors of introduction of introduced species have all exhibited strong shifts through time, as outlined below.

28.3.2.1 Changing Taxonomic Composition and Residency Status

Until the late nineteenth century, vascular plants were the predominant group of introduced organisms first reported in tidal waters and wetlands of the Chesapeake Bay region, comprising 79% (33 of 42) of species reported before 1880 (Fig. 28.4). The majority of these early introduced plants (22 of 33 species) were terrestrial boundary resident species, primarily weedy species (e.g. *Rumex crispus* – Curly Dock; *Chenopodium ambrosioides* – Mexican Tea; *Echinochloa crusgalli* – Barnyard Grass) (Fig. 28.5). Between 1880 and 1955, more typically aquatic and regular resident species outnumbered the boundary residents, comprising 63% (18 of 29) species introduced during that period. Significant introductions during this period included *Lythrum salicaria* (Purple loosestrife), *Trapa natans* (Water Chestnut, first record 1923), *Myriophyllum spicatum* (Eurasian Watermilfoil, 1942), and the invasive form of *Phragmites australis* (1881). After the 1930s, the numbers of newly reported plant species in tidal waters decreased sharply, with only six new introductions reported after 1955 (Fig. 28.4). The most prominent recent introduction has been the submerged plant *Hydrilla verticillata* (Hydrilla, 1982) (NEMESIS 2005). The decline in reported vascular plant invasions has been somewhat puzzling, since possible vectors for plant transport, including shipping, agriculture, and water-gardening are still active (see Sect. 28.3.2.4)

The first documented introduction of a fish to tidal waters in the Chesapeake Bay region occurred by 1864, when *Micropterus dolomieu* (Smallmouth Bass),

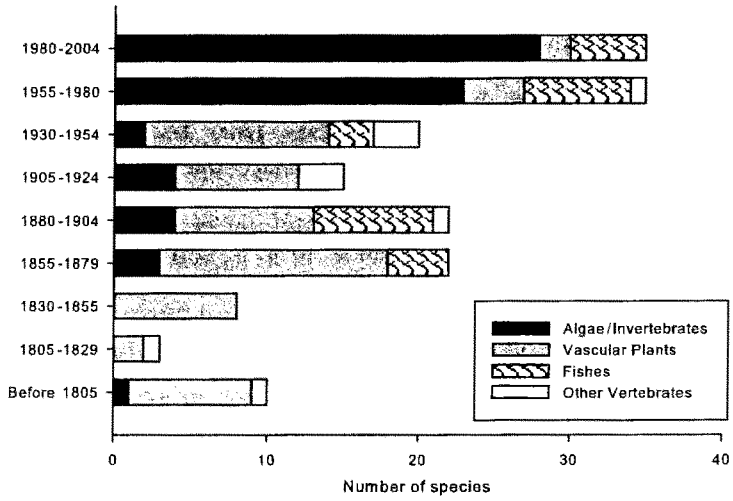

Fig. 28.4 Changes in taxonomic composition of newly reported non-indigenous species in the Chesapeake Bay region over time, by 25-year periods, using dates of first record (n=170 species)

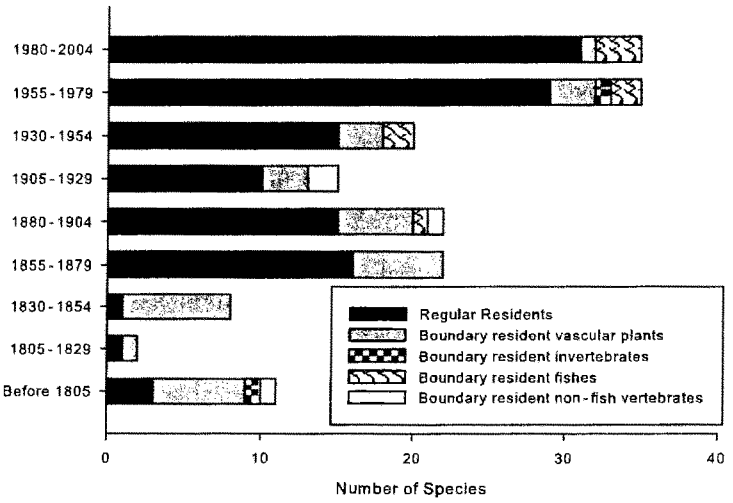

Fig. 28.5 Changes in residency composition of newly reported non-indigenous species in the Chesapeake Bay region over time, by 25-year periods, using dates of first record (n=170 species)

released in the Potomac near Harper's Ferry, West Virginia, in 1854, reached the tidal river. Subsequently, from 1869 to 1900, 11 additional species of freshwater fishes were newly reported from Chesapeake Bay tidal waters (Uhler and Lugger 1876; Smith and Bean 1898; Smith 1907; Jenkins and Burkhead 1993). Prominent species include *Cyprinus carpio* (Common Carp, 1882), *Micropterus salmoides* (Largemouth Bass, 1869) *Ictalurus punctatus* (Channel Catfish, 1889), and *Lepomis macrochirus* (Bluegill Sunfish, 1900). A second wave of fish introductions occurred in the post-World War II period, when nine more species became established in Chesapeake Bay tidal waters, from 1949 to 1979, including *Ictalurus furcatus* (Blue Catfish, 1974), *Pylodictis olivaris* (Flathead Catfish, 1965) and *Dorosoma petenense* (Threadfin Shad, 1953) (Jenkins and Burkhead 1993). The rate of fish introductions appears to have decreased somewhat since 1980, but five new species have been reported since then (Fig. 28.4). The best-known recent fish invader is *Channa argus* (Northern Snakehead), adults and juveniles of which were discovered in the tidal fresh Potomac in 2004 (Orrell and Weigt 2005; NEMESIS 2005). Fluctuations in the number of fish invasions have been driven largely by private and government interest in deliberate stocking for fisheries purposes (see Sect. 28.3.2.4).

Air-breathing vertebrates have been introduced to the region sporadically, beginning with *Rattus norvegicus* (Norway Rat), introduced around 1775, which we consider a regular resident, because of its frequent use of aquatic habitats (Paradiso 1969). Prominent regular resident invaders include *Trachemys scripta* (Red-Eared Slider Turtle, 1941), *Myocastor coypus* (Nutria, 1943), *Cygnus olor* (Mute Swan, 1962), and breeding populations of two waterfowl species (*Anas platyrhynchos* – Mallard Duck, 1913; *Branta canadensis maxima/moffati*, resident Canada Geese, 1935) (NEMESIS 2005).

The apparent dramatic increase in invasions in the Chesapeake Bay region in the last 50 years is due to the discovery of 44 species of invertebrates and 7 species of algae since 1955 (Fig. 28.4). This represents 78% of the total number (65) of non-indigenous invertebrates and algae known from tidal waters and wetlands. Among the invaders reported early are the boundary resident insect *Stomoxys calcitrans* (Stable Fly, before 1800; *Stomoxys calcitrans* breeds in washed-up vegetation in strandlines on shores and in marshes, as well as barnyard manure (Simmons and Dove 1941; Bickley and Seek 1975), *Carcinus maenas* (Green Crab, 1874), *Cordylophora caspia,* (Freshwater Hydroid, 1877) and *Teredo navalis* (Naval Shipworm, 1878). In the last 50 years, many ecologically or economically significant invertebrate/algal invaders have been reported as established, including *Haplosporidium nelsoni* (MSX disease of oyster, 1958), *Rangia cuneata* (Gulf Wedge Clam, 1960), *Corbicula fluminea* (Asian Freshwater Clam), *Codium fragile* ssp. *tomentosoides* (Green Fleece), *Hemigrapsus sanguineus* (Asian Shore Crab, 1994), *Anguillicola crassus* (Eel Swimbladder Nematode, 1997), and *Rapana venosa* (Veined Rapa Whelk, 1998) (Ruiz et al. 2000a; NEMESIS 2005). The observed increase in invertebrate invasions appears to be due largely to shipping (see Sect. 28.3.2.4).

28.3.2.2 Changing native regions

As shown in Fig. 28.6, we have documented 44 non-indigenous species of marine origin (7 algae, 37 invertebrates, all regular residents) and 126 species of continental origin (freshwater to largely terrestrial). The latter category includes 21 invertebrates, and all of the species of vascular plants, fishes, and other vertebrates, in the Chesapeake Bay region.

No marine fishes or truly marine vascular plants (e.g. mangroves, seagrasses, *Spartina* spp.; excluding salt-tolerant species of the upper intertidal, here considered continental) have been introduced to the Chesapeake Bay region. One marine fish, *Pterois volitans*, Red Lionfish, an Indo-Pacific native, is established in waters south of Chesapeake Bay, and can be expected to occur in Atlantic coastal waters in the Chesapeake Bay region (Whitfield et al. 2002).

The total number of continental invaders to the Chesapeake is increased by our decision to include in our totals 49 boundary resident species, 40 of which are predominantly terrestrial, but nonetheless frequently occur in tidal wetlands. However, the majority (65%, 82 of 126) of our aquatic, regular resident species, are also of continental, freshwater origin. The importance of continental invaders, in part, reflects the extensive areas of tidal fresh and oligohaline waters in the region, as well as the Bay's huge watershed, which can collect a large number of introduced species and concentrate them in tidal waters.

The biogeographical origins of newly reported introduced species have changed over time, with the first marine species being reported in the region in 1874

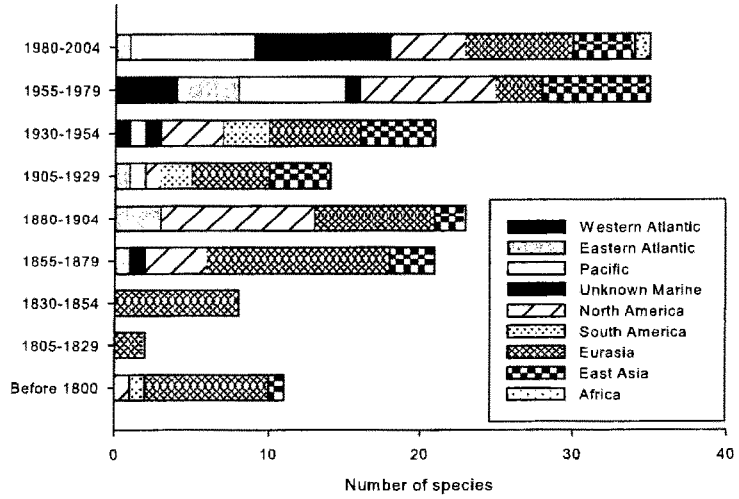

Fig. 28.6 Changes in native regions of non-indigenous species in the Chesapeake Bay region over time, by 25-year periods, using dates of first record (n=170 species). Marine regions are indicated by *solid colors*, and continental regions by *patterns*

(*Carcinus maenas,* Green Crab), with the numbers and proportion of newly discovered marine invaders (relative to continental species) increasing sharply in the second half of the twentieth century, from 22% in 1855–1954 (10 of 79 species) to 49% in 1955–2004 (34 of 70 species). Among marine species themselves, there also is an apparent shift in native regions, with Eastern Atlantic species making up 50% (5 of 10) marine species in 1855–1954, but only 15% of the marine forms in 1955–2004 (5 of 34 species). In the latter period, species of Pacific (50%, 17 of 34 species) and "unknown-marine" (29%, 11 of 34 species) origin comprised the bulk of newly reported marine invertebrates and algae (Fig. 28.6), representing a complementary shift through time. These shifts in the native regions of marine invaders likely reflect the globalization of trade, combining increases in inter-oceanic shipping and delivery of species of Pacific and cosmopolitan species of "unknown-marine" origin.

Six of the 10 species of Eastern Atlantic origin are species that occur on the open coast of the Northeast Atlantic (*C. maenas* – a crab; *Littorina littorea* – a periwinkle; *Striaria attenuata* – a brown alga; *Mysosotella mysotis* – a pulmonate snail; *Anisolabis maritima* – an earwig; *Gyrodactylus anguillae* – an eel gill trematode). The other four Eastern Atlantic species are all hydrozoan (Cnidaria) with Ponto-Caspian affinities (*Cordylophora caspia*; *Blackfordia virginica*; *Maeotias marginata*; *Moerisia lyonsi*), which have been collected in brackish waters of the Bay and its tributaries (NEMESIS 2005).

All but two of the 17 Pacific species are native to the Northwest or Indo-Western Pacific. Two diatoms (*Coscinodiscus wailesii*, *Thalassiosira punctigera*), introduced to the Chesapeake Bay region have broad amphi-Pacific ranges (NEMESIS 2005). Ten species, including many prominent invaders in the Chesapeake Bay region, are of northwest Pacific origin, native to the coasts of Japan, Korea, and China. Examples include: *Diadumene lineata* (Striped Sea Anemone, 1928), *Haplosporidium nelsoni* (MSX disease of oyster, 1958), *Codium fragile* ssp. *tomentosoides* (Green Fleece), *Hemigrapsus sanguineus* (Asian Shore Crab, 1994), *Anguillicola crassus* (Eel Swimbladder Nematode, 1997), and *Rapana venosa* (Veined Rapa Whelk, 1998) (Ruiz et al. 2000a; NEMESIS 2005). The five species with Indo-West Pacific ranges including the Indian Ocean and tropical West Pacific include several common-to-abundant species in the Chesapeake Bay region – *Ligia exotica* (Sea Roach, 1924), *Odontella sinensis* (a diatom, 1961), and *Loxosomatoides laevis* (an entoproct, 1994) (Wasson et al. 2000; NEMESIS 2005).

The 10 introduced species of "unknown marine" origin now have cosmopolitan ranges, but they have been so widely dispersed by shipping and other vectors that their original native regions are a source of speculation. Examples include *Teredo navalis* (Naval Shipworm, 1878); *Garveia franciscana* (Rope Grass Hydroid, 1946); and *Ficopomatus enigmaticus* (a serpulid tubeworm, 1994) (NEMESIS 2005).

The five Western Atlantic species, considered introduced to the Chesapeake Bay region, are all native to the North American coast south of Cape Hatteras, but are presumed to have been transported northward by human activities, and were discovered between 1953 and 1966. These species were: *Cyrenoida floridana* (Florida

Marsh Clam, 1953); *Stramonita haemastoma* (Southern Oyster Drill, 1955); *Rangia cuneata* (Gulf Wedge Clam, 1960); *Loxothylacus panopei* (mud crab parasitic barnacle, 1964); and *Ecteinascidia turbinata* (Mangrove Tunicate, 1966) (NEMESIS 2005).

Among continental invaders, the native regions of species have also shifted, with Eurasian species dominating newly reported invaders before 1855 (86%, 18 of 21 species), but decreasing in successive periods, to 39% in 1855–1954 (31 of 79 species) and to 14% in 1955–2004 (10 of 70 species). Most Eurasian invaders are vascular plants (71%, 42 of 59 species), so that the generally decreasing dominance of newly discovered Eurasian species primarily reflects the trends in plant invasions. However, seven insects associated with Eurasian wetland plants (*Typha angustifolia* – Narrowleaf Cattail, 1806; *Lythrum salicaria* – Purple Loosetrife, 1896; *Phragmites australis* – Common Reed, 1881, invasive genotype) have been released or discovered in the Chesapeake Bay region since 1955, contributing to an increase in Eurasian invaders in the last 25 years (Fig. 28.6). The insects associated with *Typha* and *Phragmites* could have been introduced with the plants and discovered long after, while the *Lythrum* herbivores were deliberately introduced for biocontrol (NEMESIS 2005).

Continental introductions of North American species have also fluctuated greatly over time, peaking in 1880–1904 and in 1955–1980 (Fig. 28.6). This largely reflects the temporal pattern of fish introductions, which comprise 67% of the species of North American origin. East Asian species constituted only 6% (1 of 18) of introductions before 1855, but 18% (14 of 79) in 1880–1954 and 16% (11 of 70) in 1955–2004. Most of these (61%, 16 of 26 species) were vascular plants, but East Asian invertebrates (5 species), fishes (3 species) and mammals (2 species) have also been introduced (Fig. 28.6). The increasing number of East Asian species, many of them ornamental, also likely reflects the globalization of trade and growing Asian economy.

28.3.2.3 Changing Source Regions

Species can spread from previously invaded regions, which serve as "stepping stones" for secondary introduction. Source regions may correspond more closely to patterns of transport than native regions. Since the Chesapeake Bay region was an early center of European settlement, most (81%, 31 of 42 species) of its early introductions (before 1880), primarily vascular plants, are presumed to have come from, or by way of Europe, including four East Asian and one South American native. However, in later periods, the relative importance of Europe as a source region declined, to 34% (19 of 58 species) in 1880–1954 and 13% (9 of 70 species) in 1955–2005 (Fig. 28.7). As continental trade developed within North America, the spread of introduced species along the coasts and within the continent also increased, and as regional natural history collecting developed, became easier to document. Thus, from the late nineteenth century, many Eurasian species, as well

as those from other continents introduced to other parts of North America, can be documented as spreading secondarily, by anthropogenic or natural means, into the Chesapeake Bay region. This is manifest by the total number of species with a North American source region (Fig. 28.7) exceeding the number of North American natives (Fig. 28.6). In 1880–1954, 15 North American continental natives were recorded, but at least 9 additional species, 4 native to Eurasia, 3 from East Asia, 2 from South America, spread into the Chesapeake Bay region from other parts of North America. In 1955–2004, in addition to 14 North American natives, 9 species (1 Eurasian; 7 East Asian; 1 African) dispersed into the region.

Examples of species with a well-documented spread through North America are: *Sturnus vulgaris* (Common Starling, North America-NA 1890; Chesapeake Bay-CB 1896; Kessel 1953); *Bithynia tentaculata* (Faucet Snail, NA 1871, CB 1927; Mills et al. 1993, 1997; NEMESIS 2005); (East Asian) *Corbicula fluminea* (Asian Freshwater Clam. NA 1924, CB 1971; Counts 1986); *Cipangopaludina chinensis* (Chinese Mystery Snail, NA 1892, CB 1960; Jokinen 1982); *Murdannia keisak* (Asian Dewflower, NA 1927, CB 1939; Dunn and Sharitz 1990).We have probably underestimated the number of invaders spreading from elsewhere on the continent, since we have not included species which were cultivated in the Chesapeake Bay region, and could have dispersed either from local garden or captive populations or else from wild North American populations.

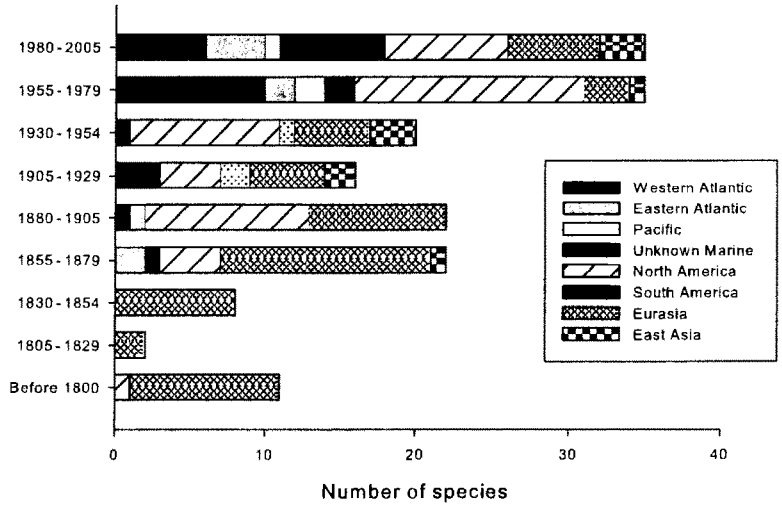

Fig. 28.7 Changes in probable population source regions of non-indigenous species in the Chesapeake Bay region over time, by 25-year periods, using dates of first record (n=170 species). The source region is the area from which the individuals invading the region resided prior to their introduction. Species can be either native or introduced to their source region. Marine regions are indicated by *solid colors* and continental regions by *patterns*

Although few marine invaders were documented for Chesapeake prior to 1900, a similar mismatch occurs overall between native and source regions, indicating secondary spread to Chesapeake from previous sites of invasion. While only 5 Western Atlantic species are documented as invaders to the Chesapeake Bay region, the Western Atlantic is a source region for 12 additional species, 4 species native to the Eastern Atlantic and 8 Pacific natives, which invaded the Atlantic coast to the north or south, and then spread, either by anthropogenic, or natural means, into the Chesapeake Bay region. Similarly, the Eastern Atlantic has been a source region for three Pacific species, as well as six Eastern Atlantic natives introduced to Chesapeake Bay.

Because of its early settlement and long history of trade, Chesapeake Bay could be expected to be a center for invasions into the rest of North America. Thirty species (2 algae, 9 invertebrates, 1 fish, 1 mammal and 17 vascular plants) had their first North American records in the region. However, the two algal species (planktonic diatoms *Coscinodiscus wailesii*, and *Odontella sinensis*, both first reported in 1961) and most of the invertebrates (e.g. the entoproct *Loxosomatoides laevis*, 1994; the hydrozoan *Moersia lyonsi* 1965), are small, obscure organisms which could have easily been introduced elsewhere, but overlooked. Six of the vascular plant species were collected in the seventeenth and eighteenth century botanical surveys, among the first made in North America (Gronovius 1739; Reveal 1983; Brown et al. 1987). The early history and spread of these plants, mostly widespread agricultural weeds and boundary residents of tidal wetlands (e.g. *Plantago major*, Common Plantain, 1739), is obscure, and most of these species were probably introduced independently at many of the sites of early European agriculture. The importance of Chesapeake Bay as an invasions center is thus difficult to assess, given historical gaps in biological knowledge. However, several recent and ecologically important invasions had their first North American records in Chesapeake Bay, including *Rapana venosa* (Veined Rapa Whelk, 1998), *Channa argus* (Northern Snakehead, 2003), *Myriophyllum spicatum* (Eurasian Watermilfoil, 1942), *and Typha angustifolia* (Narrow-leaved Cattail, 1806) (NEMESIS 2005).

Only four Chesapeake Bay invaders are apparently confined to the Chesapeake Bay region, based on reported records. Three are obscure invertebrate species (*Ilyocryptus agilis*, cladoceran, 1974; *Gitanopsis* sp., amphipod, 1994; *Loxosomatoides laevis*, entoproct, 1994) which could be overlooked in other locations. *Rapana venosa* (Veined Rapa Whelk) is a large marine gastropod, which so far has only been collected in Chesapeake Bay, but is expected to greatly extend its range on the Atlantic Coast (Mann and Harding 2000).

28.3.2.4 Changing Vectors of Transport

For 108 species introduced to the Chesapeake Bay region, we assigned a single broad category for the vector of introduction (e.g., shipping, fisheries, ornamental escape, agriculture, etc.), whereas two or more (multiple) vectors seemed plausible for the other 62 species (Fig. 28.8). Of those species attributed to a sole vector,

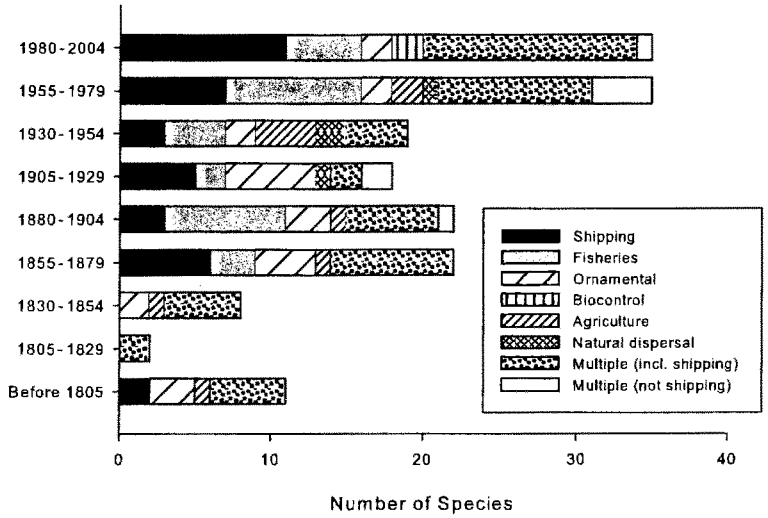

Fig. 28.8 Changes in vectors for newly detected non-indigenous species into the Chesapeake Bay region over time, by 25-year periods, using dates of first record (n=170 species)

shipping was the most frequent (37 species), followed by fisheries (31), and ornamental activities (24). Agriculture (14 species), biological control (2) and natural dispersal (4) dispersing secondarily from other invaded North American or Northwest Atlantic regions) were less important as sole vectors.

When considering species assigned to the multiple vector category, the potential importance of shipping is further increased. For such polyvectic species (see Cohen 1997), shipping was considered a possible vector for 56 species, compared to 27 for ornamental activities, 29 for agriculture, 13 for fisheries, and 16 for natural dispersal (Fig. 28.8).

28.3.2.4.1 Shipping

The number of species attributed solely to shipping introductions has fluctuated through time, with the highest number detected in the last two 25-year time intervals (Fig. 28.8). However, the number of newly recorded polyvectic species for which shipping is one of several possible vectors has risen from 12 in 1880–1954 (0.16/year, averaged) to 24 (0.48/year) in 1955–2004 (Fig. 28.8). Over this time, the mechanisms of shipping transport have changed drastically, as dry ballast has been replaced by ballast water, while fouling and other forms of transport have been affected by the increased speed and size of modern ships, and by the use of metal hulls and antifouling paint (Carlton 1985; Ruiz and Carlton 2003; Chap. 6, Hewitt et al.).

The earliest reported marine species introduced to the Chesapeake Bay region are the hydroid *Cordylophora caspia* (1877), the shipworm *Teredo navalis* (1878), and the Green Crab *Carcinus maenas* (1874). *Carcinus maenas* may have been collected in the region before 1817, as it was included on a list of Crustacea of the United States by Thomas Say, based on his collections on the Atlantic coasts of New Jersey, Maryland and Florida, but the location was given only as 'bays and inlets of the United States' (Say 1817). The first two species were probably introduced by fouling, while *C. maenas* could have been introduced either by fouling or solid ballast. The Chesapeake Bay region's earliest possible ballast-water introduction was the Black Sea hydromedusan *Blackfordia virginica,* first collected and described from the region in 1904.

A more detailed analysis of the shipping vector further indicates a large increase in the role of ballast water and hull fouling in the past 50 years, and this is driven primarily by an increase of invertebrates and algae for this time period (Fofonoff et al. 2003; see also Fig. 28.4).

28.3.2.4.2 Fisheries/Hunting

Introductions of aquatic species, either intentional introductions for improvement of fisheries and hunting, or accidental ones arising from fisheries/hunting activities, have been important in the Chesapeake Bay region since the late 1870s (Fig. 28.8). Probable fisheries introductions have been dominated by fishes (81%, 25 of 31 species), all of freshwater origin. The most frequent mode of introduction was direct stocking by federal or state agencies (15 species, all freshwater fishes). In the late nineteenth and early twentieth centuries, a federal "fish acclimatization" program, centered in Washington DC (Smith 1907), was responsible for many fish introductions to the Chesapeake Bay region. However, some species (e.g., *Micropterus dolomieu*, Smallmouth Bass, 1853 in upper Potomac, reaching the Bay by 1863) (NEMESIS 2005) were first introduced deliberately or accidentally by private individuals, but later stocked by government agencies. Major modes of accidental introductions include (1) escape from hatcheries or other holding facilities -*Pylodictis olivaris* and *Myocastor coypus* (Flathead Catfish and Nutria) (2) introduction with transported oysters (*Haplosporidium nelsoni* and *Loxothylacus panopei* (MSX disease and mud crab parasitic barnacle), both transported with planted oysters), and (3) introduction with discarded bait (*Orconectes virilis* and *Etheostoma zonale*, Virile Crayfish and Banded Darter) (NEMESIS 2005). Fisheries activities were a possible vector for at least 13 additional species, including 6 marine species for which transport with oysters was possible.

The frequency of fisheries introductions (Fig. 28.8) largely corresponds to federal and state interest in stocking of non-native fishes, peaking in the late nineteenth century and in the post World War II period. The last major intentional governmental introductions of fertile non-native fishes to the Chesapeake Bay watershed were those of *Ictalurus furcatus* – Blue Catfish, in 1974 and

Micropterus punctulatus – Spotted Bass in 1976, in Virginia (Jenkins and Burkhead 1993). Concerns about impacts of stocked predatory fishes have been one factor limiting recent state-government introductions of new game fishes (Christmas et al. 1998). In the last 25 years, accidental introductions of fishes and other organisms with discarded bait, contaminated hatchery stock, and illegal introductions by private individuals appear to be major sources of new introductions.

28.3.2.4.3 Ornamental

The cultivation of plants and animals for ornamental purposes has been responsible for the introduction of at least 24 aquatic/wetland species (21 of them vascular plants, escaped from terrestrial and water gardens) to the Chesapeake Bay region. Other ornamental introductions include released pets such as *Carassius auratus* – Goldfish, *Trachemys scripta* – Slider Turtle, and *Cygnus olor* – Mute Swan. Ornamental activities have been one of several possible vectors for 27 species, including 11 plants, 15 freshwater invertebrates, and 1 fish. Most of the invertebrates could have been transported accidentally in shipments of aquatic plants, but two freshwater snails (*Cipangopaludina chinensis*; *Viviparus georgianus*) were sold as aquarium pets and scavengers. Species, for which ornamental activities were the probable sole vector, were most numerous in 1905–1929, but temporal trends are not clear, given the large number of species for which ornamental activities are one of several multiple vectors (Fig. 28.8). The rearing of ornamental plants and fishes is the focus of several major commercial operations in the Chesapeake watershed, valued at ~$3 million in Maryland (Maryland State Archives 2006). In addition, the region's growing population suggests the likelihood of further pet and ornamental plant escapes.

28.3.2.4.4 Agriculture

Agriculture activities were considered a sole probable vector for 9 species (8 plants and one mammal), but a possible vector for 29 other species (20 plants, 8 invertebrates and 1 mammal). The most frequent type of agricultural invaders were weedy vascular plants, transported with contaminated seed, farm implements, farm animals, etc. ("agricultural weed", 5 probable, 17 species possible). The other major agricultural subvector was the use of plant material (rice straw or European marsh grasses) as packing material, a probable vector for three species and a possible mechanism for at least nine other species (two plants, seven invertebrates). Most (55%, 21 of 38 species) probable/possible agricultural introductions were terrestrial boundary resident species, invading primarily the upper edges of tidal wetlands. Agriculture was a probable or possible vector for 42% (18 of 43) species first reported before 1880, but only 20% (11 of 54) of species reported in 1880–1954, and 11% (8 of 70) in 1955–2004.

28.3.2.4.5 Biocontrol

Two species of beetles (*Galerucella calmariensis; G. pusilla*) were first introduced to wetlands in the Chesapeake Bay region in 1992 for the control of the invasive plant *Lythrum salicaria* (Purple Loosestrife).

28.3.2.4.6 Natural Dispersal

Four species were considered to have well-documented natural dispersal into the Chesapeake Bay region from other invaded parts of North America: *Littorina littorea* – Common Periwinkle; *Bassia hirsuta* – Hairy Seablite; *Murdannia keisak* – Asian Dewflower; *Sturnus vulgaris* – Common Starling). Natural dispersal was considered a possible vector for least 19 other species. Modes of natural dispersal include ocean currents (e.g. larvae of *L. littorina*, seeds of *B. hirsuta*), bird dispersal (*M. keisak*), and flight (e.g. *S. vulgaris*).

28.4 Conclusions

Non-indigenous species are a conspicuous component of the Chesapeake Bay biota in terms of species richness, abundance, and function. We know of 170 non-indigenous species with established, self-sustaining populations, and this must be viewed as a minimum estimate. Some of the established populations are relatively large and are known to have significant impacts as predators, competitors, pathogens, and physical structure (Carter and Rybicki 1994; Phelps 1994; Burreson et al. 2000; see also review by Ruiz et al. 1999). Although the direct and indirect impacts of most non-indigenous species in the Chesapeake remain unexplored, it is evident that invasions play a significant role in the ecology of Chesapeake Bay.

The number of newly detected invasions exhibits a strong increase in the last 50 years, climbing from a rate of 15–22 species per 25-year interval (1855–1954) to 35 species in each of the last 25-year intervals (1955–2004). This increase is driven by a sharp rise in the number of invertebrate and algal species reported, even as the reported number of plant invasions (previously the dominant component) has declined (Fig. 28.4).

We urge some caution in interpreting these temporal patterns of invasion. Although these are indeed the patterns from reported invasions, there are inherent biases in the data. As we have discussed earlier (Ruiz et al. 2000a), these records derive from historical sampling efforts that are unevenly distributed among time intervals, taxonomic groups, and habitats. The available data are essentially by-catch from a broad mix of prior studies, instead of a routine monitoring program designed to rigorously evaluate changes in species composition and abundance. Importantly, sampling effort was sparse in the first few centuries and episodic through time for many taxonomic groups (see Sect. 28.2.2

– History of Biological Studies), placing obvious constraints on the detection of new invasions in particular intervals and possibly inflating estimates of the overall rate increase.

More broadly, a lagtime in detection of new invaders may result from sampling effort operating in combination with population dynamics and species-level attributes (Crooks and Soulé 1999; Crooks 2005). Given a fixed level of sampling effort (field surveys), the likelihood of detecting a species will depend upon its abundance and the observer's ability to recognize it as unique from native (or previously described) residents. Clearly, if an organism occurs in very low abundance in only one very small area, the likelihood of detection is relatively low compared to an organism that is common over a large area. Likewise, a non-indigenous species that is small in body size or not easily identified may avoid detection, and this may explain the relative paucity of microorganisms among marine invasions (Ruiz et al. 2000a, b). At the present time, it remains a significant challenge to predict the population dynamics of invasions (Carlton 1996; Kolar and Lodge 2002; Drake 2004), making estimates of actual date of colonization uncertain.

In Chesapeake Bay, these issues of detection are illustrated by our recent surveys of the sessile invertebrate community. Using substrate deployed as passive collectors in the lower Chesapeake Bay, we have detected 15 non-indigenous species since 1994 that were previously undescribed for the bay (NEMESIS 2005), representing a significant fraction of the 35 species newly reported in the past 25-year interval. Although many of these species appear to be recent arrivals, surveys of the Chesapeake's fouling community have been very limited in the past few decades (Calder 1971; Wass 1972; Thompson 1993; Wasson et al. 2000), creating uncertainty about the actual date of colonization.

Despite the lack of precision, we have considerable confidence that the overall rate of invasions by marine invertebrates and algae have increased in the Chesapeake in the past 50 years. Many of the newly detected species are conspicuous such that they are unlikely to avoid detection for long (e.g., the whelk *Rapana venosa*, the rhizocephalan barnacle *Loxothylacus harrisii*, the serpulid polychaete *Ficopomatus enigmaticus*, the clam *Rangia cuneata*, the tunicate *Styela plicata*), or they have well documented patterns of spread (e.g., the shorecrab *Hemigrapsus sanguineus*, the clam *Corbicula fluminea*, the alga *Codum fragile*) (see NEMESIS 2005 for details). In previous 25-year intervals, the number of newly reported invertebrates and algae never exceeded 4 species (Fig. 28.4). Thus, given that the number of conspicuous or well-documented arrivals exceeds this number, we surmise a recent increase in invasion rate has indeed occurred.

Our analysis suggests that the shipping vector contributes strongly to the observed increase in newly detected invasions. Chesapeake Bay is one of the largest port systems in the U.S., both in terms of number of ship arrivals and ballast water discharge (Carlton et al. 1995; Smith et al. 1999). For 1991, the Chesapeake received an estimated 12 million metric tons of ballast water from foreign arrivals, the second largest in the country, and Smith et al. (1999) have characterized the diverse taxa present in this ballast. The number and size of ships arriving to the Chesapeake has certainly increased greatly over the past century, likely resulting in

an increasing transfer of organisms in ships' ballast water and outer surfaces (e.g., hull, rudder, propeller, etc.) to the region, but the magnitude of this change has not been quantified.

While shipping appears to be delivering an increasing number of marine species to the Chesapeake Bay region, invasions are also continuing in low salinity (including freshwater) and terrestrial habitats of the watershed. At least 67 aquatic and wetland species (18 plants, 26 freshwater invertebrates; 23 fishes) have been successfully introduced into the Chesapeake Bay watershed, but have not yet reached tidal waters (Fofonoff, unpublished data). Some of these species are unlikely to colonize the estuary because of habitat preferences, but others are probable future invaders. Examples include *Dreissena polymorpha* (Zebra Mussel), which was discovered to be established in the headwaters of the Susquehanna River in 2001, *Scardinius erythrophthalmus* (Rudd, a minnow), first collected in the watershed in 1991, and also established in the Susquehanna headwaters (NEMESIS 2005), and *Marsilea mutica* (Water-Clover, an aquatic fern), collected in 2001 near tidal wetlands near the city of Chesapeake, Virginia (Knepper et al. 2002). Vectors such as the cultivation of ornamental animals and plants, transfer of organisms with trailered boats, bait, and fishing gear, and release of live food organisms continue to be active in the region.

Changes in local conditions of the Chesapeake may also play a role in the observed invasion patterns, interacting with propagule supply. As an urbanized estuary with a large and growing human population in the surrounding watershed, the bay has been subjected to many changes in hydrology, eutrophication, sediment loading, fishing pressure, and habitat alteration (Brush et al. 2001; Kennedy and Mountford 2001). Major declines have occurred in the area occupied by submerged aquatic vegetation and native oyster reefs, the abundance of commercial shellfish and finfish, and the frequency of hypoxia events (Davison et al. 1997; Dauer et al. 2000; Paul 2001; Wennersten 2001). These changes represent major disturbance agents that may operate alone or in combination to affect susceptibility to invasion (Elton 1959; Cohen and Carlton 1995; Occhipinti-Ambrogi and Savini 2003; Jewett et al. 2003). To date, the relationship between these disturbances and invasion susceptibility is not well understood in estuaries (see Ruiz et al. 1999 and references therein).

It is interesting to compare magnitude of invasions in Chesapeake Bay to other marine bays and estuaries along the Pacific coast of North America that have been well studied. Studies exist for several Pacific coast estuaries in the continental U.S., including San Francisco Bay (Carlton 1979; Cohen and Carlton 1995), Elkhorn Slough (Wasson et al. 2001), Coos Bay (Wonham and Carlton 2005; Carlton unpubl. data), Willapa Bay (Cohen et al. 2001), and Puget Sound (Cohen et al. 1998). Four general features stand out:

1. There are more non-indigenous marine species known from San Francisco Bay than Chesapeake Bay and other Pacific coast estuaries. Cohen and Carlton (1995) reported 212 (150 marine, 62 continental) species and several dozen more have been reported in the last ten years. Their analysis focused primarily

on regular residents, of which we documented 121 (44 marine, 77 continental) species in the Chesapeake.

2. There is a higher proportion of non-indigenous plants in the Chesapeake (27%) compared to those reported for Pacific coast estuaries (~10% for San Francisco Bay, Cohen and Carlton 1995; probably fewer for other estuaries, Wonham and Carlton 2005), even when comparing only regular residents. This may be due in part to search effort, or to differing definitions of what should be considered "aquatic plants" (e.g., see recent survey for San Francisco Bay Delta by Light et al. 2005).
3. The number of introduced invertebrates and algae in Chesapeake Bay (65 species, 44 of them marine) are similar to those in west coast estuaries (43–56), with the exception of San Francisco Bay (~160 species). The numbers of non-indigenous species for these taxa have been estimated in all of many Pacific coast estuaries, providing some basis for these comparisons (but see discussion below).
4. There exists considerable overlap in introduced species between the Chesapeake and Pacific coast estuaries. For example, Chesapeake Bay and San Francisco Bay have 43 introduced regular resident species in common (8 vascular plants, 1 alga, 16 marine invertebrates, 5 freshwater invertebrates, 12 fishes, and 1 reptile). Many of these shared species have been introduced to other west coast estuaries, as well as many coastal regions around the world (Ruiz et al. 2000a). Moreover, this does not include the species that are native to the Chesapeake but introduced to San Francisco Bay and other Pacific coast estuaries (see references above).

We might expect to see far more non-indigenous species in Chesapeake Bay than Pacific coast estuaries, which did not experience rapid population growth and modern human activities until the nineteenth century, lagging roughly two centuries behind that in the Chesapeake Bay and Atlantic coast more broadly. The unusually high number of marine invasions in San Francisco Bay is attributable partly to a massive influx of Atlantic and Pacific oysters into this bay, transporting large numbers of associated species (Cohen and Carlton 1995; Miller et al. 2007). Some of these oyster-mediated introductions spread to other Pacific coast estuaries. Oysters were transported regionally to Chesapeake Bay but not across ocean basins or continents, limiting such oyster-mediating introductions relative to San Francisco Bay.

Nonetheless, it is still surprising that the extent of reported invasions in the Chesapeake is not greater than that of Pacific coast estuaries. Not only was there a relatively long duration of modern human activities (i.e., transport mechanisms) to this estuary, but the strength of shipping and ballast delivery to the Chesapeake has been relatively high, far exceeding that for San Francisco Bay and the other estuaries (Carlton et al. 1995; Smith et al. 1999; Ruiz et al. 2000a).

Several different mechanisms, operating alone or in concert, may explain why Chesapeake does not appear to be more heavily invaded than Pacific coast estuaries. These fall into three general categories, associated with regional differences in the historical record, trade patterns (source regions), and recipient regions.

It is clear that the historical baseline knowledge of biota for Chesapeake Bay and Atlantic coast estuaries was poor, developing long after European colonization, and many early invasions may have gone undetected. There is a high degree of species overlap between the eastern and western North Atlantic coasts. An initial survey of 780 marine species from Chesapeake Bay found that 34% also occurred in Europe (Fofonoff, unpublished data). Roughly 5% of these species are considered non-indigenous to the Chesapeake, but the invasion status of most has not been evaluated. There is also some overlap in wetland flora and freshwater biota, with many species usually considered "Holarctic", but with unexplored or disputed native/introduced status. Many of these taxa were first recorded in the Chesapeake decades to centuries after extensive European trade became established and may have been transported prior to early species inventories to the region.

In contrast, biotic inventories for Pacific coast estuaries did not lag far behind the rapid increase in human population and transport mechanisms. Intensive human activity in San Francisco Bay and Pacific coast estuaries commenced in the mid-nineteenth century and major species inventories commenced within 50–60 years, compared to a lag-time of centuries for the Chesapeake. As a result, many more invaders may in fact be undetected as such in the Chesapeake that Pacific coast estuaries. To our knowledge, a formal comparison of the proportion of cryptogenic species between Atlantic and Pacific coast estuaries has not yet been conducted.

Potential differences in propagule supply may explain some observed invasion patterns among estuaries, and these have not been adequately evaluated to date. It is interesting that the recent level of propagule supply to San Francisco Bay does not appear greater than that for the Chesapeake Bay. Historically, the shipment of oysters resulted in a large flux of species to San Francisco Bay that did not occur in similar fashion in the Chesapeake, but this activity ceased by the mid-twentieth century. In recent times, the number of ship arrivals and amount of ballast water discharged to the Chesapeake exceed that to San Francisco Bay (Carlton et al. 1995; Smith et al. 1999; see also http://invasions.si.edu/nbic/). It seems likely that propagule supply from ships, a leading vector in both bays, parallels this pattern, suggesting that quality of propagules may be much more important.

There are many conspicuous differences in the trade patterns between the Chesapeake and Pacific coast estuaries that may have affected the source and quality of propagules. For example, most recent overseas shipping traffic to the Chesapeake arrives from the northeastern Atlantic, whereas that to the Pacific coast arrives from the northwestern Pacific (Carlton et al. 1995). This results in a different species pool arriving to the two coasts in ships' ballast materials and on hulls. The effect of these different trade patterns and source regions on species richness, or physiological condition of propagules, delivered to the respective coasts has not been examined to date but may explain considerable variation in observed invasion patterns.

Recipient regions also differ dramatically in environmental and biotic conditions that can affect colonization. The continental climate in Chesapeake regions clearly differs from the Mediterranean climate of San Francisco Bay and the Pacific coast estuaries, and many differences exist in the biotic composition and disturbance

regimes (Chapman 2000). Although there are likely considerable differences in susceptibility to invasion between coasts (see Ruiz et al. 2000a and references therein), which also interact with different species assemblages being introduced to each coast from the respective source regions, the magnitude and direction of any such differences in susceptibility remain to be measured.

Our study provides the first comprehensive analysis of non-indigenous species for tidal waters of the Chesapeake Bay region, but there is still clearly much to learn about the number, abundance, and effects of non-indigenous species in the Chesapeake, as well as the mechanisms that underlie the patterns described in our analyses. While advances in these areas require both descriptive and experimental research in the Chesapeake Bay system, comparative analyses among estuaries are also especially critical to explain observed spatial and temporal variation in invasions. Only by measuring responses to different vectors, trade patterns, and source/recipient environments can we gain a robust understanding of invasion ecology and better guide management and policy in this area.

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References

Bickley WE, Seek TR (1975) Insects in four Maryland marshes. Agric Exp Sta Univ Maryl College Park, MD: Misc Publs 870:1–27

Boyd MJ, Mulligan TJ, Shaughnessy FJ (2002) Non-indigenous marine species of Humboldt Bay, California. Calif Dep Fish Game. State Water Resource Control Bd, Natl Fish Wildlife Foundation, Sacramento

Brown ML, Reveal JL, Broome CR, Frick GF (1987) Comments on the vegetation of colonial Maryland. Huntia 7:247–283

Brush GS (2001) Forests along the colonial Chesapeake. In: Curtin PD, Brush GS, Fisher GW (eds) Discovering the Chesapeake: the history of an ecosystem. Johns Hopkins University Press, Baltimore, pp 40–59

Burreson EM, Stokes NA, Friedman CS (2000) Increased virulence in an introduced pathogen: *Haplosporidium nelsoni* (MSX) in the Eastern Oyster *Crassostrea virginica*. J Aquat Anim Health 12:1–8

Calder DR (1971) Hydroids and hydromedusae of southern Chesapeake Bay. Spec Sci Rep Virginia Inst Mar Sci 1:1–125

Carlton JT (1979) History, biogeography, and ecology of the introduced marine and estuarine invertebrates of the Pacific Coast of North America. PhD dissertation, University of California, Davis

Carlton JT (1985) Transoceanic and interoceanic dispersal of coastal marine organisms: the biology of ballast water. Oceanogr Mar Biol Annu Rev 23:313–371

Carlton JT (1996) Patterns, process, and prediction in marine invasion ecology. Biol Conserv 78:97–106

Carlton JT (2001) Introduced species in coastal waters: environmental impacts and management priorities. Pew Oceans Commission, Arlington

Carlton JT, Reid D, van Leeuwen, H (1995) The role of shipping in the introduction of nonindigenous aquatic organisms to the coastal waters of the United States (other than the Great Lakes) and an analysis of control options. Report to US Coast Guard, Washington DC

Carter V, Rybicki, NB (1994) Invasions and declines of submersed macrophytes in the tidal Potomac River and estuary, the Currituck Sound-Back Bay system, and the Pamlico River estuary. Lake Reserv Manag 10:39–48

Chapman JW (2000) Climate effects on the geography of nonindigenous peracaridan crustacean introductions in estuaries. In: Pederson J (ed) Marine bioinvasions, Proceeding of a conference, January 24–27. MIT Sea Grant College Program, pp 66–80

Chesapeake Bay Program (2000) Chesapeake Bay: introduction to an ecosystem- Wetlands. Retrieved from http://www.chesapeakebay.net/info/ecoint5a.cfm on 30 January 2006

Christmas J, Eades R, Cincotta D, Shiels A, Miller R, Siemien J, Sinnot T, Fuller P (1998) History, management, and status of introduced fishes in the Chesapeake Bay basin. In: Therres GD (ed) Conservation of biological diversity: a key to restoration of the Chesapeake Bay and beyond. Maryland Department of Natural Resources, Annapolis

Clark SF (1878) A new locality for *Cordylophora*. Am Nat 12:231–234

Clarke SF (1882) New and interesting hydroids from Chesapeake Bay. Mem Boston Soc Nat Hist 3:135–141

Cohen AN (1997) Have claw, will travel. Aquat Nuisance Species Digest 2:16–17

Cohen AN, Carlton JT (1995) Nonindigenous aquatic species in a United States estuary: a case study of the biological invasions of the San Francisco Bay and Delta. U.S. Fish and Wildlife Service and National Sea Grant College Program (Connecticut Sea Grant). Washington DC, Silver Spring

Cohen AN, Carlton JT (1998) Accelerating invasion rate in a highly invaded estuary. Science 279:555–558

Cohen AN, Mills CE, Berry H, Wonham MJ, Bingham B, Bookheim B, Carlton J, Chapman J, Cordell J, Harris L, Klinger T, Kohn A, Lambert C, Lambert G, Li K, Secord D, Toft J (1998) Puget Sound expedition: a rapid assessment survey of non-indigenous species in the shallow waters of Puget Sound. Washington State Department of Natural Resources, Olympia, WA

Cohen AN, Berry HD, Mills CE, Milne D, Britton-Simmons K, Wonham MJ, Secord DL, Barkas JA, Bingham B, Bookheim BE, Byers JE, Chapman JW, Cordell JR, Dumbauld B, Fukuyama A, Harris LH, Kohn AJ, Li K, Mumford TF Jr, Radashevsky V, Sewell AT, Welch K (2001) Washington State Exotics Expedition 2000: a rapid survey of exotic species in the shallow waters of Elliott Bay, Totten and Eld Inlets, and Willapa Bay. The Nearshore Habitat Program, Washington State Department of Natural Resources, Olympia, WA

Cope ED (1869) On the distribution of fishes in the Allegheny region of southwestern Virginia. J Acad Nat Sci Phil 6:207–249

Counts CL III (1986) The zoogeography and history of the invasion of the United States by *Corbicula fluminea* (Bivalvia: Corbiculidae). Am Malacol Bull, Spec Ed 2:7–39

Cowles RP (1930) A biological study of the offshore waters of Chesapeake Bay. Fish Bull 46:277–381

Cranfield HJ, Gordon DP, Willan RC, Marshall BA, Battershill CN, Francis MP, Nelson WA, Glasby CJ, Read GB (1998) Adventive marine species in New Zealand. NIWA Tech Rep 34:1–48

Crooks JA (2001) Characterizing ecosystem-level consequences of biological invasions. Oikos 97:153–166

Crooks JA (2005) Lag times and exotic species: the ecology and management of biological invasions in slow motion. Ecoscience 12:316–329

Crooks JA, Soulé ME (1999) Lag times in population explosions of invasive species: causes and implications. In: Sandlund OT, Schei PJ, Viken Å (eds) Invasive species and biodiversity management. Kluwer, Dordrecht. pp 103–125

Dall WH (1889) A preliminary catalogue of the shell-bearing marine mollusks and brachiopods of the south-eastern coast of the United States. Bull US Natl Mus 37:1–221

Dauer DM, Stokes TL, Barker HR, Ewing MR, Sourbreer JW (1984) Macrobenthic communities of the lower Chesapeake Bay. IV. Bay-wide transects and the inner continental shelf. Int Rev Gesamten Hydrobiol 69:1–22

Dauer DM, Weisberg SB, Ranasinghe (2000) Relationships between benthic community condition, water quality, sediment quality, nutrient loads, and land use patterns in Chesapeake Bay. Estuaries 23:80–96

Davison SG, Merwin JG, Capper J, Power G, Shivers FR Jr (1997) Chesapeake waters: four centuries of controversy, concern, and legislation. Tidewater Publishers, Centerville MD

Drake JM (2004) Risk analysis for invasive species and emerging infectious diseases: concepts and applications. Am Midl Nat 153:4–11

Dunn CP, Sharitz R (1990) The history of *Murdannia keisak* (Commelinaceae) in the southeastern United States. Castanea 66:122–129

Elton CS (1959) The ecology of invasions by animals and plants. Methuen, London

Fofonoff PW, Ruiz GM, Steves B, Carlton JT (2003) In ships or on ships? Mechanisms of transfer and invasion for nonnative species to the coasts of North America. In: Ruiz GM, Carlton JT (eds) Invasive species: vector and management strategies. Island Press, Washington, pp 152–182

Gronovius JF (1739) Flora Virginica exhibens plantas quas V. C. Johannes Clayton in Virginia observavit atque collegit. Cornelius Haak, London

Hewitt CL, Campbell ML, Thresher RE, Martin RB, Boyd S, Cohen BF, Currie DR, Gomon MF, Keough MJ, Lewis JA, Lockett MM, Mays N, McArthur MA, O'Hara TD, Poore GC, Ross DJ, Storey MJ, Watson JE, Wilson RS (2004) Introduced and cryptogenic and species in Port Phillip Bay, Victoria, Australia. Mar Biol 144:183–202

Jacobson PT, Kartalia SD (1994) Ecological risk assessment of the effects of grass carp on submerged aquatic vegetation in Chesapeake Bay. In: Hill P, Nelson S (eds) Toward a sustainable coastal watershed: the Chesapeake experiment. Proceedings of a Conference. Chesapeake Research Consortium, Baltimore

Jenkins RE, Burkhead NM (1993) Freshwater fishes of Virginia. American Fisheries Society, Bethesda MD

Jewett EB, Hines AH, Ruiz GM (2003) Epifaunal disturbance by periodic low levels of dissolved oxygen: native vs. invasive species response. Mar Ecol Prog Ser 304:31–44

Jokinen EH (1982) *Cipangopaludina chinensis* (Gastropoda: Viviparidae) in North America, review and update. Nautilus 96:89–95

Kennedy VS (1995) Ecological role of the Eastern Oyster, *Crassostrea virginica* with remarks on disease. J Shellfish Res 15:177–183

Kennedy VS Mountford K (2001) Human influences on aquatic resources in the Chesapeake Bay watershed. In: Curtin PD, Brush GS, Fisher GW (eds) Discovering the Chesapeake: the history of an ecosystem. Johns Hopkins Baltimore, pp 191–219

Kessel B (1953) Distribution and migration of the European starling in North America. Condor 55:49–67

Kingsley JS (1879) On a collection of Crustacea from Virginia, North Carolina, and Florida, with a revision of the genera of Crangonidae and Palaemonidae. Proc Acad Nat Sci Phila 31:383–427

Knepper DA, Johnson DM, Musselman LJ (2002) *Marsilea mutica* in Virginia. Am Fern J 92:243–244

Kolar CS, Lodge DM (2002) Ecological predictions and risk assessment for alien fishes in North America. Science 298:1233–1236

Kutzbach JE, Webb T III (2001) Climate and climate history in the Chesapeake Bay region. In: Curtin PD, Brush GS, Fisher GW (eds) Discovering the Chesapeake: the history of an ecosystem. Johns Hopkins, Baltimore, pp 15–39

Light T, Grosholz E, Moyle P (2005) Delta ecological survey (phase1): nonindigenous aquatic species in the Sacramento-San Joaquin Delta, a literature review. US Fish and Wildlife Service Stockton, CA

Mann R, Harding JM (2000) Invasion of the North American Atlantic Coast by a large predatory Asian mollusc. Biol Invas 2:7–22

Maryland State Archives (2006) Maryland at a glance – aquaculture. Retrieved from http://www.msa.md.gov/msa/mdmanual/01glance/html/aqua.html

Mathieson AC, Fuller SW (1969) A preliminary investigation of the benthonic marine algae of the Chesapeake Bay region. Rhodora 71:524–534

Miller AW, Ruiz GM, Minton MS, Ambrose RF (2007) Differentiating successful and failed molluscan invaders in estuarine ecosystems. Mar Ecol Prog Ser 332:41–51

Mills EL, Leach JH, Carlton JT, Secor CL (1993) Exotic species in the Great Lakes: a history of biotic crises and anthropogenic introductions. J Great Lakes Res 19:1–54

Mills EL, Scheuerell MD, Carlton JT, Strayer D (1997) Biological invasions in the Hudson River: an inventory and historical analysis. New York State Mus Circ 57:1–51

National Research Council (2003) Non-native oysters in the Chesapeake Bay. National Academies Press, Washington DC

NEMESIS (2005) National Estuarine and Marine Exotic Species Information System. Smithsonian Environmental Research Center, Marine Invasions Laboratory. Retrieved from http://invasions.si.edu/nemesis/chesapeake.html in 2005

Occhipinti-Ambrogi A, Savini D (2003) Biological invasions as a component of global change in stressed marine ecosystems. Mar Pollut Bull 46:542–551

Orrell TM, Weigt L (2005) The Northern Snakehead *Channa argus*, a non-indigenous fish in the Potomac River, U.S.A. Proc Biol Soc Wash 118:407–415

Orris PK (1980) A revised species list and commentary on the macroalgae of the Chesapeake Bay in Maryland. Estuaries 3:200–206

Paul RW (2001) Geographical signatures of Middle Atlantic estuaries: historical layers. Estuaries 24:151–166

Paradiso JL (1969) Mammals of Maryland. U.S. Bureau of Sport Fisheries and Wildlife, Washington

Phelps HL (1994) The Asiatic clam (*Corbicula fluminea*) invasion and system-level ecological change in the Potomac. Estuaries 17:614–621

Reise K, Gollasch S, Wolff WJ (1999) Introduced marine species of the North Sea coasts. Helgol Meeresunters 52:219–234

Reveal JL (1983) Significance of pre-1753 botanical explorations in temperate North America on Linnaeus' first edition of *Species Plantarum*. Phytologia 53:1–96

Ruiz GM, Carlton JT (2003) Invasion vectors: a conceptual framework for management. In: Ruiz GM, Carlton JT (eds) Invasive species: vectors and management strategies. Island Press, Washington, pp 459–504

Ruiz GM, Hewitt CL (2002) Toward understanding patterns of coastal marine invasions: a prospectus. In: Leppäkoski E, Gollasch S, Olenin S (eds) Invasive aquatic species of Europe: distribution, impacts and management. Kluwer, Dordrecht

Ruiz GM, Fofonoff P, Hines AH (1999) Non-indigenous species as stressors in estuarine and marine communities: assessing invasion impacts and interactions. Limnol Oceanogr 44:950–972

Ruiz GM, Fofonoff PW, Carlton JT, Wonham MJ, Hines AH (2000a) Invasion of coastal marine communities in North America: apparent patterns, processes, and biases. Annu Rev Ecol Syst 31:481–531

Ruiz GM, Rawlings TK, Dobbs FC, Drake LA, Mullady T, Huq A, Colwell RR (2000b) Global spread of microorganisms by ships. Nature 408:49–50

Say T (1817) An account of the Crustacea of the United States. J Acad Nat Sci Phila 1:57–63, 65–80, 97–101

Schubel JR, Pritchard DW (1987) A brief physical description of the Chesapeake Bay. In: Majumdar SK, Hall LW Jr, Austin, HM (eds) Contaminant problems and management of living Chesapeake Bay resources. Pennsylvania Academy of Sciences, Easton, pp 1–32

Simmons SW, Dove WE (1941) Breeding places of the Stablefly or 'Dog Fly' *Stomoxys calcitrans* (L) in northwestern Florida. J Econ Entomol 34:457–462

Smith HM (1907) Our fish immigrants. Natl Geogr 18:385–400
Smith HM, Bean BA (1898) List of fishes known to inhabit the waters of the District of Columbia and vicinity. Bull US Fish Commiss 18:179–187
Smith LD, Wonham MJ, McCann LD, Ruiz GM, Hines AH, Carlton JT (1999) Invasion pressure to a ballast-flooded estuary and an assessment of inoculant survival. Biol Invas 1:67–87
Stimpson W (1859) Notes on North American Crustacea, in the Museum of the Smithsonian Institution. Ann Lyceum Nat Hist New York 7:49–93
Stimpson W (1871) Notes on North American Crustacea, in the Museum of the Smithsonian Institution, No.III. Ann Lyceum Nat Hist New York 7:92–136
Thompson ML (1993) Dynamics of an oligohaline, macrofaunal, fouling community. MS. Thesis, College of William and Mary, Williamsburg
Uhler PR, Lugger O (1876) List of the fishes of Maryland. In: Report of Commissioners of Fisheries of Maryland, pp 81–208
Wass ML (1963) Check list of the marine invertebrates of Virginia. Spec Sci Rep Virginia Inst Mar Sci 24:1–36
Wass ML (1972) A checklist of the biota of lower Chesapeake Bay. Spec Sci Rep Virginia Inst Mar Sci 65:1–20
Wasson K, Toft J, Von Holle B, Ruiz GM (2000) Detecting invasions of marine organisms: kamptozoan case histories. Biol Invas 2:59–74
Wasson K, Zabin CJ, Bedinger L, Diaz MC, Pearse JS (2001) Ecological invasions of estuaries without international shipping: the importance of intraregional transport. Biol Conserv 102:143–153
Webster HE (1879) Annelida Chaetopoda of the Virginia coast. Trans Albany Inst 9:202–269
Wennersten JR (2001) The Chesapeake: an environmental biography. Maryland Historical Society, Baltimore
Whitfield P, Gardner T, Vives SP, Gilligan MR, Courtenay WR Jr, Ray GC, Hare J (2002) Biological invasion of the Indo-Pacific lionfish *Pterois volitans*, along the Atlantic coast of North America. Mar Ecol Prog Ser 234:289–297
Williamson M (1996) Biological invasions. Chapman and Hall, London
Wonham MJ, Carlton JT (2005) Trends in marine biological invasions at local and regional scales: the Northeast Pacific Ocean as a model system. Biol Invas 7:369–392
Wulff BL, Wulff EM, Robison BH, Lowry JK, Humm HJ (1968) Summer marine algae of the jetty at Ocean City, Maryland. Chesapeake Sci 6:56–60
Zaneveld J (1966) The marine algae of the American coast between Cape May NJ and Cape Hatteras, NC. Bot Mar 9:101–128
Zaneveld J, Barnes WD (1965) Reproductive periodicities of some benthic algae in lower Chesapeake Bay. Chesapeake Sci 6:17–32

Senator WHITEHOUSE. Thank you very much, Dr. Ruiz.

Director Humphries.

STATEMENT OF REBECCA HUMPHRIES, DIRECTOR, MICHIGAN DEPARTMENT OF NATURAL RESOURCES

Ms. HUMPHRIES. Thank you, Mr. Chairman.

I am Becky Humphries, Director of the Michigan Department of Natural Resources, and I am also the Chair of the Fish and Wildlife Health Committee of the Association of Fish and Wildlife Agencies.

I appreciate the opportunity to share with you today the perspectives of State fish and wildlife agencies on the vital issue of emerging fish and wildlife disease.

All 50 States are members of the Association of Fish and Wildlife Agencies. The Association strives to enhance and facilitate cooperation and coordination among State, Federal and tribal agencies with respect to fish and wildlife conservation.

Today, I will share with you the Association's approach to this challenge through the development and implementation of the National Fish and Wildlife Health Initiative. I will characterize the national approach to managing chronic wasting disease, CWD, through the development of a State, Federal and national plan which I think was a good model. I will also briefly reflect on my experiences in Michigan, our lessons learned with several of these diseases, including bovine tuberculosis, chronic wasting disease, and viral hemorrhagic septicemia.

State fish and wildlife agencies have the statutory, and often constitutional, responsibility for the conservation of fish and wildlife within their borders for the benefits of their citizens. The Association of Fish and Wildlife Agencies developed the National Fish and Wildlife Initiative to create a system for coordination between State, Federal, tribal and private industry to ensure the early detection of pathogens and the appropriation response and management of these diseases.

The two overarching goals of the initiative are first, as you have heard, to assist States and Federal agencies in enhancing their capacity and appropriately addressing fish and wildlife health issues. And second, to facilitate close cooperation between State and Federal fish and wildlife, animal health and human health agencies with respect to fish and wildlife pathogens and diseases in order to minimize their negative effects.

The initiative is a policy framework by which all interested parties may seek both to minimize the negative impacts of disease agents in fish and wildlife and to proactively promote healthy fish and wildlife populations. A copy of the initiative is appended to my statement for your reference. It is interesting to note that we have three of the Steering Committee members here today testifying.

The growing importance of fish and wildlife health issues in natural resource management is dramatic. It makes it imperative that more resources be directed toward them in the future. Building capacity at all levels of government for early detection and the execution of coordinated response plans provides the best known strategy for successfully dealing with disease incidents.

State and Federal coordinated disease response planning is a model that has been successfully practiced in recent years. In 2002, the U.S. Department of Agriculture and the U.S. Department of Interior convened a taskforce to coordinate CWD management, which included both Federal interests and eventually State interests as well. The work of the taskforce culminated in the development of a national plan that guides surveillance and management actions.

Congress followed up by appropriating over $10 million for CWD management, part of which has been made available to the States for use in surveillance and monitoring. In Michigan, we used the national plan and the funding made available through USDA APHIS to specifically plan for and prepare a response to the potential detection of CWD in Michigan.

In the fall of 2008, in the late summer, we found CWD in Michigan. Over a period of 2 years, funds made available through USDA APHIS accounted for testing of nearly 12 percent of all cervids tested in Michigan for CWD so far. By coordinating Federal efforts and funding within State specific planning efforts, State fish and wildlife agencies have been better positioned to characterize the distribution and intensity of CWD and evaluate the risks.

These Federal funds and the flexibility of cooperative agreements between States like Michigan and the Federal Government have made it possible to conduct large scale wildlife disease surveillance, in some States for the very first time, which certainly could not have occurred without this coordinated effort.

Through our experiences with bovine TB and VHS, Michigan has learned another important lesson. Fish and wildlife disease management is not restricted to the identification of vectors, the isolation of infected individuals, and the removal from the population. Fish and wildlife bring significant economic and cultural interests to bear upon management strategies, and those interests bring political attention as well.

These juxtaposed interests have required a new paradigm in disease mitigation. Because diseases like bovine TB and VHS can be vectored through the action of hunting and angling communities, it has become essential to plan and provide for inclusion and partnership with the public.

The new cultural norm where traditions have been altered to conform to the new demands of disease on the landscape have been partially achieved, but not without concerted and consistent effort in the face of, at times, an unwilling public. Planning for cultural, social and political consequences of a disease incident should be viewed as essential.

Through our experiences with CWD, bovine TB and other diseases, we believe adequate authorities already exist. However, we need to put more resources into our work so that we can adequately expand our capacity and capabilities to respond to what we expect to be an increasing number of diseases.

We have also learned that disease planning efforts need to include the public and have their involvement and engagement.

Thank you for the opportunity to share the Association's perspectives and I would be happy to address any questions.

[The prepared statement of Ms. Humphries follows:]

TESTIMONY BEFORE THE SENATE ENVIRONMENT AND PUBLIC WORKS SUBCOMMITTEE ON WATER AND WILDLIFE, AND THE SUBCOMMITTEE ON OVERSIGHT REGARDING THREATS TO FISH AND WILDLIFE FROM DISEASES

by Rebecca Humphries, Director
Michigan Department of Natural Resources, on behalf of the Association of Fish and Wildlife Agencies
July 8, 2009

Thank you, Chairman Cardin and members of the Subcommittee. I am Becky Humphries, Director of the Michigan Department of Natural Resources, and I also chair the Fish and Wildlife Health Committee for the Association of Fish and Wildlife Agencies. I appreciate the opportunity to share with you today the perspectives of the state fish and wildlife agencies on this vital issue of emerging fish and wildlife diseases, and the need to manage for the health and sustainability of our fish and wildlife resources in the face of these disease and pathogen challenges. All 50 states are members of the Association, and among other missions, the Association strives to enhance and facilitate cooperation and coordination among state, federal and tribal agencies with respect to fish and wildlife conservation. This approach is particularly critical in the issue of fish and wildlife diseases as chronic wasting disease (CWD), bovine tuberculosis (TB), viral hemorrhagic septicemia (VHS), and the potential for highly pathogenic avian influenza (HPAI), all of which are of growing and significant concern to fish and wildlife, animal health and human health officials, and the public that they serve. Today I will share with you the Association's approach to this challenge through the development and implementation of a "National Fish and Wildlife Health Initiative"; I will briefly characterize as a model the national approach to managing CWD through the development of a state–federal national plan; and, I will also reflect on my experiences in Michigan with several of these diseases including bovine TB, CWD, and VHS.

National Fish and Wildlife Health Initiative

State fish and wildlife agencies have the statutory, and often constitutional, responsibility for the conservation of fish and wildlife within their borders for the benefit of their citizens. Where Congress has given federal agencies certain conservation responsibilities for fish and wildlife, such as migratory birds and listed threatened and endangered species, Congress has recognized that the states retain concurrent jurisdiction also for those species. Thus, states are the front-line managers of fish and wildlife, and consequently, fish and wildlife diseases. The Association of Fish and Wildlife Agencies embarked on the development of a National Fish and Wildlife Health Initiative to create a system for coordination between state, federal, tribal and local governments, and private industry to ensure the early detection of pathogens, and the appropriate response to and management of diseases. The two overarching goals of the Initiative are first, to assist the states and federal agencies in enhancing their capacity to appropriately address fish and wildlife health issues; and, second, facilitate close cooperation between state and federal fish and wildlife, animal health, and human health agencies with respect to fish and wildlife pathogens and diseases in order to minimize their negative effects. The Initiative was approved and adopted by the assembled state fish and wildlife directors in September 2006, and has also been endorsed by the U.S. Animal Health Association. A copy of the Initiative is appended to my statement. A

state–federal steering committee has also been established to oversee the Initiative; I will speak to that shortly.

The importance of maintaining healthy fish and wildlife populations has long been recognized by fish and wildlife managers, and several disease issues are a growing concern to fish and wildlife, domestic animal, and public health professionals and the publics they serve. Significant diseases, such as plague, hemorrhagic disease, pasteurellosis, CWD, botulism, VHS, West Nile virus, whirling disease, and others have been found in both free-ranging wild, and farmed, fish or wildlife populations in North America, and can have significant biological and economic effects on state and federal public trust resources. Reservoirs of economically important diseases including bovine brucellosis and bovine TB have inadvertently become established in native wildlife and threaten livestock industries in some areas. Foreign animal diseases eradicated from the continent decades ago, such as foot and mouth disease and classical swine fever, and those historically not reported in North American wildlife, such as HPAI, are a constant concern. Human activities (alteration of ecosystems, movement of pathogens, hosts or vectors, etc.), as well as improved recognition through advances in diagnostics and epidemiology, continually provide occasions for the discovery, emergence and resurgence of diseases at the interface of wildlife, domestic animals, and humans. The potential effects of climate change to both ecosystems and the species that they support has great significance to the presence and prevalence of pathogens, diseases, and their vectors. The intentional or accidental introduction of new disease agents could have a significant impact on fish, wildlife, domestic animals or human populations and will necessitate a coordinated multi-agency response.

The dramatically growing importance of fish and wildlife health issues in natural resource management makes it imperative that more human, financial, and technological resources be directed toward them in the future. Responsibility and authority issues warrant greater state, federal, tribal, and territorial fish and wildlife management agency attention, as does the increasing recognition that disease agents in free-ranging fish and wildlife have implications for domestic animals and humans. In addition to more traditional fish and wildlife health issues, state, federal, tribal, and territorial natural resource management agencies must also face emerging issues, including the threats of bio- and agro-terrorism, and unintentional introduction of disease agents, such as HPAI virus. As stewards in trust of priceless public resources, state and federal fish and wildlife management agencies must proactively take on such issues. Failure to do so invites the risk that issues of fish and wildlife health will be addressed haphazardly, inadequately, or not at all; none of these consequences is acceptable.

Responsibility and authority for conserving fish and wildlife resources rest in state and federal natural resource management agencies. Public trust stewardship is the very cornerstone of North American natural resource management as fish and wildlife are common property of the citizens of each state. Thus, successful fish and wildlife health programs must necessarily be centered in the states as well. However, there is no "one size fits all" approach to fish and wildlife health programs. Several states have had strong programs with full-time fish and wildlife health professionals for decades. Others have instituted new programs in recent years. Still others have pooled resources to create regional wildlife health cooperatives.

Regardless of the structure of a state's fish and wildlife health program, cooperation among local, state, tribal, territorial, and federal public health, domestic animal health, and natural resources agencies will invariably be essential because of overarching issues, shared regulatory authority, and limited resources. The greatest opportunities for addressing significant local health issues will be in programs where the state fish and wildlife management agency prioritizes the issues and collaborates with other governmental and nongovernmental organizations to address them. Through this approach, state fish and wildlife management agencies will improve their understanding and management of diseases, develop and share data useful to others, and maximize the financial, technological, and human resources that inevitably will be limited.

To accomplish these goals, the Association developed and is implementing the National Fish and Wildlife Health Initiative (NFWHI) by a multi-disciplinary consortium of state, tribal, territorial, federal, university, corporate, and nonprofit organizations under the leadership of the Association. Although national in scope, the NFWHI will not mandate programs at the state, federal, tribal, or local level. The NFWHI is dedicated to advancing the science, awareness, and fostering cooperation related to all aspects of fish and wildlife health. It is a policy framework by which all interested parties may seek both to minimize the negative impacts of disease agents in fish and wildlife, and to proactively promote healthy fish and wildlife populations.

The mission of the NFWHI is to conserve, restore, and enhance the fish and wildlife resources of the United States by providing a cooperative platform to empower fish and wildlife managers to set priorities and to manage fish and wildlife health issues of local, national and international scope. This mission will be achieved by six principal strategies:

1. Identify, characterize, respect, and integrate the authorities and capabilities of cooperating partners in complementary fashion.

2. Identify state, federal and other fiscal and staff resources for state, federal, and territorial fish and wildlife health programs and facilitate their optimal use and allocation.

3. Conduct proactive, coordinated and sustained surveillance for pathogens in fish and wildlife, and respond to findings according to risk.

4. Support applied research pertinent to fish and wildlife health, and development of integrated disease management strategies, and improved technology for fish and wildlife health management.

5. Establish and maintain a fish and wildlife disease Web site, uniform training for critical staff of cooperating partners, and communication plans and networks to inform policymakers and citizens about fish and wildlife health.

6. Establish a NFWHI Steering Committee to facilitate, oversee, and coordinate interactions among partners and provide the support necessary for effective implementation of the Initiative.

The goals of the NFWHI are exquisitely simple:

1. Facilitate establishment and enhancement of state, federal, and territorial fish and wildlife management agency capability to effectively address health issues involving free-ranging fish and wildlife.

2. Minimize the negative impacts of health issues affecting free-ranging fish and wildlife through surveillance, management, and research.

The Initiative details an implementation strategy which you can reference in the document so I won't go into detail. However, I would like to observe that there has been a steering committee established to oversee the Initiative, which is comprised of the following partners in this endeavor.

- Chairperson of the AFWA Fish and Wildlife Health Committee (1), Chair;
- Directors from each of the four Regional Fish and Wildlife Associations (Northeast, Midwest, Southeast and Western) (4);
- Director of the U.S. Fish and Wildlife Service (USFWS) (1);
- Associate Director of Biology, U.S. Geological Survey (1);
- Deputy Administrator of USDA, Animal Plant Health Inspection Service (APHIS), Veterinary Services (1);
- Deputy Administrator of USDA, APHIS, Wildlife Services (1);
- State Veterinarian (1);
- Academic Institution (1);
- Tribal fish and wildlife management entity (1).

Chronic Wasting Disease National Plan

Let me briefly describe the coordinated federal-state response to the detection of CWD east of the Mississippi River earlier this decade. In early 2002, the U.S. Department of Agriculture (USDA) and U.S. Department of the Interior (USDI) convened a federal task force to coordinate CWD management. Under the chairmanship of the Administrator, APHIS, and, Director, U.S. Fish and Wildlife Service, they quickly recognized the need for and utility of adding state fish and wildlife agency representatives to the task force. That was expeditiously done and six working groups each comprised of federal, state and university representatives, ultimately drafted the national plan that the task force released to the public (A Plan for Assisting States, Federal Agencies, and Tribes in Managing Chronic Wasting Disease in Wildlife and Captive Cervids) on June 26, 2002. The plan proposed goals and actions and served as a blueprint for future activities to identify the extent of the disease and management actions needed to eliminate it or prevent its spread.

Subsequently, an Implementation Document for said plan was produced on October 11, 2002, by a team of three state fish and wildlife agency representatives, four USDA, and four USDI representatives, working with input from a myriad of wildlife management and animal health professionals from across the nation. The Implementation Document steps down the goals in the national plan to action items, assigns agency responsibilities, and identifies timelines and budgets for each of six categories of diagnostics, disease

management, communications, research, surveillance, and information dissemination. The Implementation Plan represented the best and most current thinking with respect to what is necessary to successfully manage this disease.

Subsequent to the development of the National Plan and Implementation Document, the USDA APHIS has each year requested in the President's Budget, and Congress has appropriated, from $10-$16 million per year to APHIS-VS for CWD management. Approximately 25 percent has been made available as grants to the state fish and wildlife agencies for surveillance and response to CWD in free-ranging cervid (deer, elk, and moose) populations, and Veterinary Services uses another approximately 25% for its wild cervid work. The remaining approximately 50 percent is used for the management of CWD in captive cervid herds. The Association sincerely appreciates both the national approach to management of this disease, and the provision of federal grants to the states to enhance their management of CWD. We believe this is a good model of state–federal approaches to fish and wildlife diseases that should be emulated in other disease circumstances.

In Michigan, we utilized the national plan and the funding made available through USDA-APHIS to specifically plan for and prepare a response to the potential detection of CWD. Over a period of two years, funds made available by USDA-APHIS accounted for testing nearly 12 percent of all cervids tested in Michigan for CWD. Coordinating federal efforts and funding within state specific planning efforts, state fish and wildlife agencies have been better positioned to characterize the distribution and intensity of CWD and evaluate the attendant risks. These federal funds and the flexibility of cooperative agreements between states like Michigan and the federal government have made it possible to conduct large-scale wildlife disease surveillance, in some states for the very first time—which certainly could not have occurred without a coordinated effort across many jurisdictional lines.

As you might expect, we view full funding of these efforts as essential to their success but I understand that appropriations is the purview of a different committee. Suffice it to say, successful disease monitoring and assessment programs require both operational and financial consistency.

Based upon our experiences with bovine TB and VHS, Michigan has learned another important lesson: fish and wildlife disease management is not restricted to the identification of vectors, isolation of infected individuals, and their removal from the population. Fish and wildlife bring significant economic and cultural interests to bear upon management strategies, and those interests necessarily confer political attention as well.

When creating fish and wildlife disease strategies, it is especially important to be thoughtful, deliberate, and consistent. The public has very strong opinions about their resources, how we manage them, and how they use them.

The detection of bovine TB in Michigan brought together the sometimes juxtaposed elements of wildlife management, agricultural practices, outdoor recreation, and commerce. Because of the complexity of the parties involved, a new paradigm for disease risk mitigation was needed to adequately ensure the protection of both wildlife and livestock.

The new cultural norm where hunting traditions and traditional agricultural practices were altered to conform to the new demands of disease on the landscape, have been partially achieved, but not without concerted and consistent effort in the face of an unwilling public. Planning for the cultural, social, and political consequences of disease incidents should be viewed as an essential and primary outcome.

Similarly, and more recently, we have learned that lesson again through the detection of VHS in our waters. There are no practical methods for eliminating a pathogen from wild fish populations. The most important vectors for moving a pathogen such as viral hemorrhagic septicemia virus (VHSv) is the movement of infected fish and fish parts, the discharge of infected water from recreational boats, and infected ballast water discharge.

Notably, two of the three most important vectors I just mentioned are actions taken by our public. Recognizing this, the Michigan Department of Natural Resources created an information campaign backed by regulation changes that were designed to increase angler and boater awareness of pathogens like VHSv. Similar efforts engaged the commercial bait industry and operators of boat launch sites.

These education and outreach efforts have sparked independent citizen driven efforts to develop voluntary boat disinfection stations. It is our opinion that the combination of education, outreach, and regulation changes has in part slowed the spread of VHSv and reduced fish losses.

Amphibian Chytrid Fungus

Pathogens and diseases have the potential to affect all fish and wildlife, including some taxa that the public may not consider as charismatic as white-tailed deer or trout. Worldwide, approximately one-third of amphibians are threatened; we may be witnessing the 6th major extinction event the Earth has experienced, as described recently in the scientific and popular literature. Across the globe, and in the US, amphibian die-offs and extinctions have been attributed to the amphibian chytrid fungus (*Batrachochytrium dendrobatidis*; hereafter *Bd*), which results in chytridiomycosis, a recently-described fungal disease. Records of *Bd* occur as early as 1930 in specimens of the African clawed frog native to South Africa; the pathogen now appears to be invasive in many parts of the world causing extinctions of native species that have not evolved defenses against this novel disease. Not all amphibians are susceptible to *Bd*; some individuals survive the initial epidemic and serve as reservoirs and vectors capable of spreading the disease if they move or are translocated between sites. The highly infectious nature and devastating repercussions of *Bd* led to a proposal in the United Kingdom to ban the sale of African Clawed Frogs and the designation of chytridiomycosis as a notifiable disease by the World Organization of Animal Health (OIE). In the US, *Bd* is thought to have spread through commercial trade activities, such as through amphibian pets, food (e.g., frog legs), and bait (e.g., tadpoles, etc.). It has impacted native US species including federally endangered mountain yellow-legged frogs, federally threatened California red-legged frogs, western toads, and Wyoming toads, and has been implicated in the extinction of two species in the US territory of Puerto Rico, web-footed and golden coquis.

White-Nose Syndrome (WNS) in Bats

With acknowledgement to Scott Darling, Vermont Fish and Wildlife Department, who is at the epicenter of response to WNS, let me share a few of his observations that can inform the development of a response to this particular outbreak.

Understanding the role of state fish and wildlife agencies in addressing WNS is essential to working toward a comprehensive, collaborative resolution to the crisis. Unless otherwise federally listed, the conservation of all bat species is the authority and responsibility of state fish and wildlife agencies. For example, of Vermont's nine species of bats, only the federally endangered Indiana bat is eligible for federal protection and oversight. The remaining eight species are the sole authority of the Vermont Fish and Wildlife Department. The distinction of state and federal authorities is appropriate under most conservation efforts; however, such distinctions add complexity for species such as bats that migrate across state boundaries, if not regions, and for highly infectious wildlife diseases such as WNS that can sweep across the country in a matter of a few years.

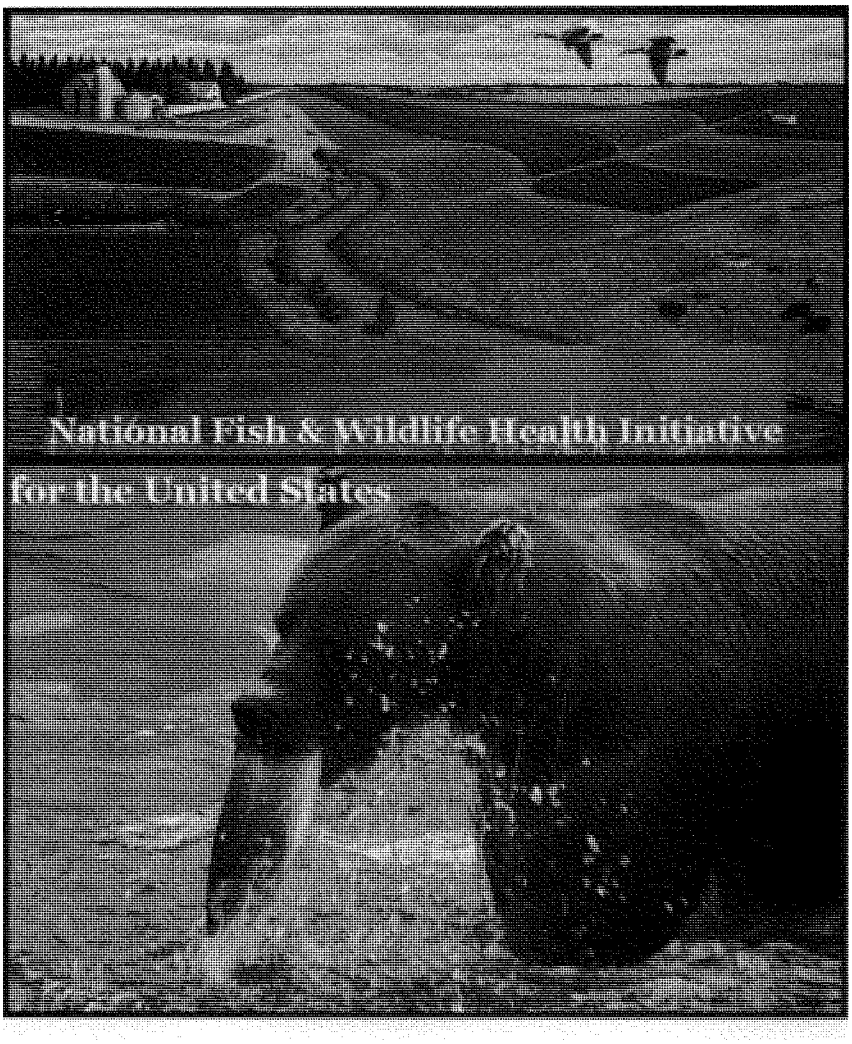
It is the state fish and wildlife agencies that provide on-the-ground local knowledge of bat populations, historic survey results, locations of caves and mines where bats hibernate, and information on key summer colony habitats. State fish and wildlife agencies are often the most credible, familiar voice in providing public outreach and education. In addition, state wildlife biologists play a role in implementing or assisting in much of the research activities associated with WNS. Therefore, any strategies to contain WNS or slow its progression across the country will require an increased level of effort from state fish and wildlife agencies.

We commend the USFWS for its initiative in assuming WNS coordination responsibilities when that niche clearly needed filling. In particular, regional staff in the USFWS New England and New York field offices was instrumental in such critical components as multi-state coordination, the development of WNS protocols, and assistance in conducting WNS surveillance. The USGS staff at the National Wildlife Health Center in Madison, Wisconsin, also availed their expertise, their lab, and themselves in the efforts to determine what was killing the bats.

White nose syndrome demonstrates that a high level of coordination, mutual commitment, open access to expertise, and responsiveness by the state and federal agencies will absolutely be required to successfully respond to emerging fish and wildlife disease issues.

Like our experience with CWD, TB and other diseases, in the case of WNS, we believe that adequate authorities already and sufficiently exist at state and federal levels. Using and coordinating the strengths of these existing authorities is a challenge, but one that is achievable. What is most needed is adequate funding in the disciplines of fish and wildlife, animal health, and public health, to enhance the respective agencies capacity and capabilities to respond to what is likely to be an increasing number of disease outbreaks that threaten not only fish and wildlife health, but domestic animal health, and potentially human health.

Thank you for the opportunity to share the Association's perspectives, and I would be pleased to address any questions from the Subcommittee.


National Fish & Wildlife Health Initiative
for the United States

April 2007

National Fish & Wildlife Health Initiative

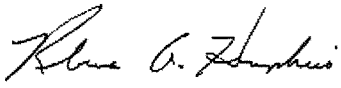
for the United States

April 2007

Emerging fish and wildlife diseases, such as Chronic Wasting Disease, West Nile Virus, Highly Pathogenic Avian Influenza, and others have recently become of growing and significant concern to fish and wildlife, animal health and public health professionals, and the public that they serve. There are indications that some factors in the spread of disease will tend to expand the range of disease vectors in the future, leading wildlife managers to conclude that they need to better monitor their spread and be prepared to take coordinated action to prevent or contain such outbreaks in the future.

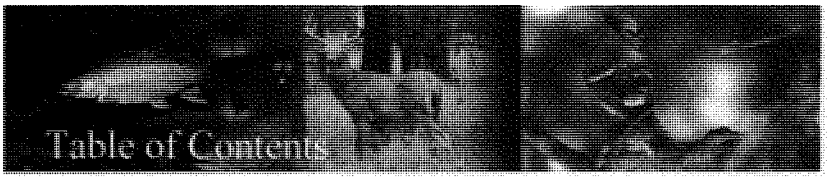
State fish and wildlife agencies have the statutory, and often constitutional, responsibility for the conservation of fish and wildlife within their borders for the benefit of their citizens. Thus, they are the front-line managers of fish and wildlife and fish and wildlife diseases. The Association of Fish and Wildlife Agencies, which represents the 50 state fish and wildlife agencies, embarked on the development of a National Fish and Wildlife Health Initiative to create a system for coordination between state, federal, and local governments and private industry to ensure early detection of pathogens and appropriate response and management of diseases.

We gratefully acknowledge our debt to those organizations that have blazed the trail for broad multidisciplinary partnerships in environmental health such as this one. In particular, we thank the Canadian Cooperative Wildlife Health Centre for its seminal Canada's National Wildlife Disease Strategy and the National Fish Habitat Initiative Core Team for its Action Plan, both of which served ably as models for this document.
We endorse the National Fish and Wildlife Health Initiative and commit to playing an active role in its implementation.



Rebecca A. Humphries
Chair, Fish & Wildlife Health Committee
April 19, 2007

ASSOCIATION of FISH & WILDLIFE AGENCIES



Support for the development of the National Fish and Wildlife Health Initiative provided by:

The William and Flora Hewlett Foundation
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Executive Summary

Human activities, such as ecosystems alterations and the movement of pathogens, hosts or vectors, often enhance the emergence and resurgence of diseases at the interface of wildlife, domestic animals, and humans. The intentional or accidental introduction of these diseases can significantly affect fish, wildlife, domestic animals or human populations and necessitate a coordinated, multi-agency response.

The mission of the National Fish and Wildlife Health Initiative (NFWHI) is to conserve, restore, and enhance healthy fish and wildlife resources of the United States by recognizing and respecting the missions, jurisdictions, and abilities of fish and wildlife managers to address health issues. This mission will be achieved by six principal strategies:

1. Identify, characterize, respect, and integrate the authorities and capabilities of cooperating partners in complementary fashion.

2. Identify state, federal and other fiscal and staff resources for state, federal, and territorial fish and wildlife health programs and facilitate their optimal use and allocation.

3. Conduct proactive, coordinated and sustained surveillance for pathogens in fish and wildlife, and respond to findings according to risk.

4. Support applied research pertinent to fish and wildlife health, development of integrated disease management strategies, and improved technology for fish and wildlife health management.

5. Establish and maintain a fish and wildlife disease Web site, uniform training for critical staff of cooperating partners, and communication plans and networks to inform policymakers and citizens about fish and wildlife health.

6. Establish a NFWHI Steering Committee to facilitate, oversee, and coordinate interactions among partners and provide the support necessary for effective implementation of the Initiative.

The two over-arching goals of this initiative are to: facilitate establishment and enhancement of state, federal, and territorial fish and wildlife management agency capability to effectively address health issues involving free-ranging fish and wildlife; and minimize the negative impacts of health issues affecting free-ranging fish and wildlife through surveillance, management, and research.

The following objectives provide a solid course to facilitate actions needed to achieve the goals of the NFWHI:

1. Establish or augment state, federal, and territorial fish and wildlife management agency capacities (human, financial and physical) to address fish and wildlife health issues.
2. Train fish and wildlife biologists and veterinarians as cornerstones of a comprehensive network of state, federal, and territorial fish and wildlife health programs.
3. Recognize, respect, articulate and integrate the abilities and authorities of cooperating state, tribal, territorial and federal agencies and other partners.
4. Create communication strategies to build support for this Initiative via active dialogue with other agency personnel, policymakers, stakeholders and the public about fish and wildlife health issues.
5. Prevent introduction, establishment, and spread of priority pathogens in fish and wildlife populations through policy, early detection, and rapid response appropriate to risks.
6. Protect fish and wildlife population health through habitat conservation, risk analysis and adaptive management.

Beyond this written formulation of the Initiative, the next steps to be undertaken are:
1. Appoint a Steering Committee for the Initiative by May 2007, and
2. Steering Committee will work with the Fish and Wildlife Health Committee to oversee the development of the Implementation Plan.

DEFINITIONS

Health: The state of an organism when it functions optimally without evidence of disease or abnormality.

Pathogen: any agent (organism or substance) capable of inducing abnormal structural or functional changes in the body, which, in turn can lead to illness and clinical manifestations of disease.

Disease: Illness; an interaction of the affected animal (the host), the pathogen and /or processes causing illness (the agent), and the environmental factors influencing all of them.

Epidemiology : The study of the distribution of disease in populations and of the factors that determine its occurrence.

Risk analysis: A process for objectively assessing risks of disease introduction into a population, evaluating management options for diminishing or controlling those risks, and communicating information about those risks to all stakeholders.

Vector: An organism or object capable of transferring an agent from one host to another biologically or mechanically.

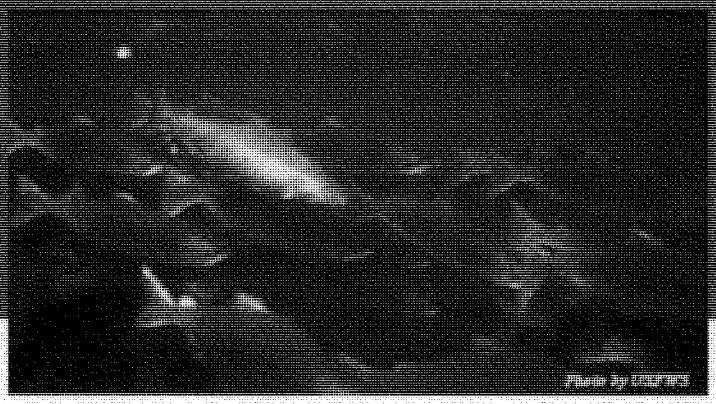
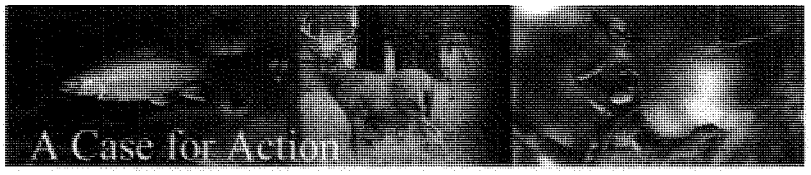


Photo by USDA



The importance of maintaining healthy populations has long been recognized by fish and wildlife managers, and several disease issues are of growing concern to fish and wildlife, domestic animal, and public health professionals and the publics they serve. Significant diseases, such as plague, hemorrhagic disease, pasteurellosis, chronic wasting disease, botulism, viral hemorrhagic septicemia, West Nile virus, whirling disease, and others have been found in wild and farmed fish or wildlife populations in North America and can have a significant biological and economic effect on state and federal public trust resources. Reservoirs of economically important diseases including bovine brucellosis and bovine tuberculosis have inadvertently become established in native wildlife and threaten livestock industries in some areas. Foreign animal diseases eradicated from the continent decades ago, such as foot and mouth disease and classical swine fever, and those historically not reported in North American wildlife, such as highly pathogenic avian influenza, are a constant concern. Human activities (alteration of ecosystems, movement of pathogens, hosts or vectors, etc.), as well as improved recognition through advances in diagnostics and epidemiology, continually provide occasions for the discovery, emergence and resurgence of diseases at the interface of wildlife, domestic animals, and humans. The intentional or accidental introduction of new disease agents could have a significant impact on fish, wildlife, domestic animals or human populations and would necessitate a coordinated multi-agency response.

The dramatically growing importance of fish and wildlife health issues in natural resource management makes it imperative that more human, financial, and technological resources be directed toward them in the future. Responsibility and authority issues warrant greater state, federal, tribal, and territorial fish and wildlife management agency attention, as does the increasing recognition that disease agents in free-ranging fish and wildlife have implications for domestic animals and humans. In addition to more traditional fish and wildlife health issues, state, federal, tribal, and territorial natural resource management agencies must also face emerging issues, including the threats of bio- and agroterrorism, and unintentional introduction of disease agents, such as highly pathogenic avian influenza (HPAI) virus. As stewards in trust of priceless public resources, state and federal fish and wildlife management agencies must proactively take on such issues; if they do not, they are being deficient in their required public trustee duties and risk the possibility that other state or federal agencies will do so without their input or consent. Alternatively, and perhaps more ominously, they run the risk that issues of fish and wildlife health will be addressed haphazardly, inadequately, or not at all.

Responsibility and authority for conserving fish and wildlife resources rest in state and federal natural resource management agencies. Public trust stewardship is the very cornerstone of North American natural resource management as fish and wildlife are common property of the citizens of each state. Thus, successful fish and wildlife health programs must necessarily be centered in the states as well. However, there is no "one size fits all" approach to fish and wildlife health programs. Several states have had strong programs with full-time fish and wildlife health professionals for decades. Others have instituted new programs in recent years. Still others have pooled resources to create regional wildlife health cooperatives (see Exhibit 1).

Regardless of the structure of a state's fish and wildlife health program, cooperation among local, state, tribal, territorial, and federal public health, domestic animal health, and natural resources agencies will invariably be essential because of overarching issues, shared regulatory authority, and limited resources. The greatest opportunities for addressing significant local health issues will be in programs where the state fish and wildlife management agency prioritizes the issues and collaborates with other governmental and nongovernmental organizations to address them. Through this approach, state fish and wildlife management agencies will improve their understanding and management of diseases, develop and share data useful to others, and maximize the financial, technological, and human resources that inevitably will be limited.

To accomplish these goals, we propose the implementation of the National Fish and Wildlife Health Initiative (NFWHI) by a multi-disciplinary consortium of state, tribal, territorial, federal, university, corporate, and nonprofit organizations under the leadership of the Association of Fish and Wildlife Agencies (AFWA). Although national in scope, NFWHI will not mandate programs at the state, federal, tribal, or local level. The NFWHI is dedicated to advancing the science, awareness, and fostering cooperation related to all aspects of fish and wildlife health. It is a policy framework by which all interested parties may seek both to minimize the negative impacts of disease agents in fish and wildlife, and to proactively promote healthy fish and wildlife populations. The United States Animal Health Association (USAHA) supports the development and implementation of the NFWHI, under AFWA leadership, and passed a resolution to that effect in 2005. To support the development and implementation of NFWHI, AFWA Guiding Principles in September 2005.

Guiding Principles

THE NATIONAL FISH AND WILDLIFE HEALTH INITIATIVE WILL:

- Support the AFWA vision for healthy fish and wildlife resources throughout North America managed by effective, well-funded resource agencies supported by informed and involved citizens;
- Support the AFWA mission to protect state authority and support territorial authority for wildlife conservation; promote sound science-based resource management; and strengthen state, territorial, federal, and private cooperation in conserving fish and wildlife resources;
- Recognize that free-ranging fish and wildlife have fundamental ecological and aesthetic value and that these resources and associated recreational activities have economic value and contribute significantly to the quality of life and the economy on a local, state, and national basis;
- Recognize that as the front-line managers, state fish and wildlife agencies are responsible for managing diseases in free-ranging fish and wildlife, and several already have in place much of the knowledge, personnel, equipment, and local public support to prevent, monitor, detect, and respond to disease issues;
- Foster development and maintenance of additional competencies, management tools, and training in fish and wildlife health management within state fish and wildlife agencies;
- Promote science-based management strategies for health issues that involve or impact free-ranging fish and wildlife and recognize that some disease agents found in fish and wildlife are of significance to domestic animal and human health, and vice versa;
- Recognize, articulate, and integrate the abilities and authorities of cooperating state, tribal, territorial, and federal agencies and other partners;
- Foster collaboration, coordination, and communication among fish and wildlife health jurisdictions, as well as with domestic animal health and public health agencies at the state and national level;
- Recognize that animals and disease agents do not observe political boundaries, necessitating interstate and international coordination of health management efforts;
- Recognize that state fish and wildlife management agencies are a key component in local response to biosecurity and bioterrorism threats and incidents and emphasize the importance of involvement, support, training, and planning for key agency personnel;
- Recognize fish and wildlife health management as an essential component of any fish and wildlife conservation program and emphasize the importance and efficacy of prevention, as opposed to control or eradication efforts, as a strategy for managing diseases in free-ranging fish and wildlife;
- Recognize the need to develop and disseminate science-based information to educate the public about the significance of diseases in fish and wildlife populations and the value of integrated prevention and management programs; and
- Recognize that free-ranging fish and wildlife are publicly-owned resources, and that effective guardianship of their health must necessarily take human dimensions of wildlife management into account.

Mission, Goals, and Objectives

The mission of the NFWHI is to conserve, restore, and enhance the fish and wildlife resources of the United States by providing a cooperative platform to empower fish and wildlife managers to set priorities and to manage fish and wildlife health issues of local, national and international scope. This mission will be achieved by six principal strategies:

1. Identify, characterize, respect, and integrate the authorities and capabilities of cooperating partners in complementary fashion.
2. Identify state, federal and other fiscal and staff resources for state, federal, and territorial fish and wildlife health programs and facilitate their optimal use and allocation.
3. Conduct proactive, coordinated and sustained surveillance for pathogens in fish and wildlife, and respond to findings according to risk.
4. Support applied research pertinent to fish and wildlife health, and development of integrated disease management strategies, and improved technologies for fish and wildlife health management.
5. Establish and maintain a fish and wildlife disease Web site, uniform training for critical staff of cooperating partners, and communication plans and networks to inform policymakers and citizens about fish and wildlife health.
6. Establish a NFWHI Steering Committee to facilitate, oversee, and coordinate interactions among partners and provide the support necessary for effective implementation of the Initiative.

GOALS:

1. Facilitate establishment and enhancement of state, federal, and territorial fish and wildlife management agency capability to effectively address health issues involving free-ranging fish and wildlife.

2. Minimize the negative impacts of health issues affecting free-ranging fish and wildlife through management, surveillance, and research.

OBJECTIVES:

1. Establish or augment state, federal, and territorial fish and wildlife management agency capacities (human, financial and physical) to address fish and wildlife health issues.

2. Train fish and wildlife biologists and veterinarians as cornerstones of a comprehensive network of state, federal, and territorial fish and wildlife health programs.

3. Recognize, respect, articulate and integrate the abilities and authorities of cooperating state, tribal, territorial and federal agencies and other partners.

4. Create communication strategies to build support for this Initiative via active dialogue with other agency personnel, policymakers, stakeholders and the public about fish and wildlife health issues.

5. Prevent introduction, establishment, and spread of priority pathogens in fish and wildlife populations through policy, early detection, and rapid response appropriate to risks.

6. Protect fish and wildlife population health through habitat conservation, risk analysis and adaptive management.

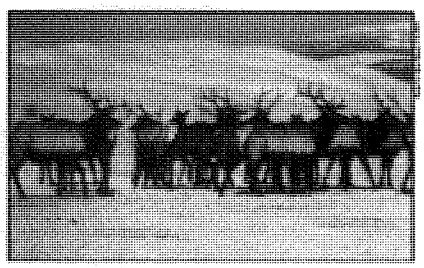


Photo by Glen Smart, US FWS

Implementation Strategy

1. Identify, characterize, respect, and integrate the authorities and capabilities of all cooperating partners in complementary fashion.

⇒ Conduct a comprehensive survey of all partners to ascertain their current authorities, capabilities and spheres of influence. Make this information available to all partners, with periodic updates over time.

⇒ Identify policies needed to fill gaps in authority and capabilities and to increase efficiency of existing policies.

⇒ Identify the benefits derived by fish and wildlife resources and the public from new policies.

⇒ Work with partners to advance a legislative agenda at both the state and federal level that:

- Ensures each state fish and wildlife management agency has the legally mandated responsibility for fish and wildlife health issues within the state or territory;

- Implements necessary protective legislation and regulations to prevent pathogen importation, establishment, and/ or dispersal in fish and wildlife, and controls human activities that increase opportunities for those outcomes.

Measures of progress: Periodic reviews of national, state, tribal, and territorial health program capabilities and legal authorities; report of survey findings.

2. Identify state, federal and other (e.g., non-governmental organization, university, etc.) fiscal and staff resources for state, federal, and territorial fish and wildlife health programs and facilitate their optimal use and allocation.

⇒ Identify federal and other resources for fish and wildlife health to enhance the capabilities of federal, state, tribal, and territorial fish and wildlife agencies.

⇒ Make recommendations and provide coordination for allocation of these resources to ensure adequate capabilities in all states and efficiently address national priority issues, based on their risk.

⇒ Develop new funding options for fish and wildlife health research and to implement the Initiative.

Measures of progress: Accounts of resources committed and their distribution; development of new funding opportunities and options.

3. Conduct proactive, coordinated and sustained surveillance for pathogens in fish and wildlife, and respond to findings according to risk.

⇒ Develop an integrated infrastructure necessary to ensure rapid, accurate collection, analysis and dissemination of pathogen and disease surveillance information. Tasks include:

- Establish an integrated national surveillance network, with potential for international expansion, by connecting existing state, federal, and territorial surveillance programs and diagnostic laboratories, and promoting complementary growth.

- Implement a secure, standardized reporting system for state, federal, and territorial fish and wildlife agencies (perhaps linked to the fish and wildlife disease Web site), to increase the availability of timely, comprehensive information, and improve the efficacy of their limited resources.

- Incorporate information from human and domestic animal disease surveillance systems to monitor risk of pathogen movement between these species and free-ranging fish and wildlife.

⇒ Proactively develop contingency plans for emergency disease events, including decision and communications processes, coordinated among agencies and political jurisdictions.

⇒ Promote and facilitate the development of standardized surveillance systems for free-ranging fish and wildlife pathogens.

⇒ Develop and maintain adequate capacity for highly effective field response to pathogen introductions and disease outbreaks in free-ranging fish and wildlife.

Measures of progress: Number of states and territories implementing standardized fish and wildlife disease surveillance; accounts of state and territorial field response capacities for pathogens in fish and wildlife; numbers of contingency plans for pathogens in fish and wildlife; and annual reports of number and distribution of pathogens in fish and wildlife by state and territory.

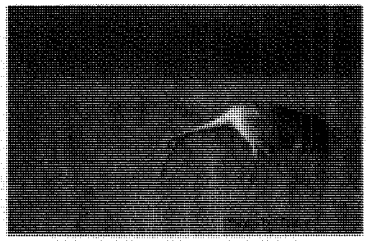
4. Support applied research to improve technologies and strategies for detecting and managing health issues in fish and wildlife.

⇒ Consult with partners to identify priority areas of multidisciplinary fish and wildlife health research, including:

• Prevention: Manage fish and wildlife habitat and populations for optimal population health;
• Risk analysis: Quantify fish and wildlife population health risks, develop appropriate risk analysis methodology, enumerate decision support and risk management options, and identify methods for effective risk communication;
• Surveillance support: Epidemiology, pathogenesis, new rapid detection equipment and methods, and development of specific and sensitive standardized and validated fish and wildlife health diagnostic techniques, procedures, and tests;
• Disease management: Specifically identify objectives and limits, and critically evaluate available integrated | disease management methods; and
• Human dimensions: Understand factors affecting stakeholder beliefs and attitudes about fish and wildlife health and how those beliefs and attitudes influence effective disease management.

⇒ Maintain an ongoing dialogue with decision makers in government, academia and stakeholder groups to make certain fish and wildlife health priorities are included in research programs.

⇒ Apply research findings to develop improved health management options, and compile a depository of those options as reference case studies via the fish and wildlife disease Web site.



Measures of progress: Annual reports identifying priority research topics; annual reports of number of priority research \projects proposed, funded and completed; annual reports of science-based management interventions undertaken, with outcomes over time; annual summaries of publications and technology transfers resulting from priority research projects; annual milestones to development of the depository of fish and wildlife health management options, territorial surveillance programs and diagnostic laboratories, and promoting complementary growth.

5. Establish and maintain a fish and wildlife disease Web site, uniform training for critical staff of cooperating partners, and communication plans and networks to inform policymakers and citizens about fish and wildlife health.

⇒ Expedite systematic communication, education, and coordination among partners through a fish and wildlife disease Web site, to:

- Archive accurate, science-based disease agent information for significant diseases;
- Incorporate existing infrastructure and (hyper)link partners to the Web site and to each other.
- Inform state, federal, and territorial fish and wildlife agency personnel, including field staff, administrators and policymakers, of health resources and expertise currently available and how to access them; and
- Inform partners, stakeholders and the public of impending threats and other significant developments in fish and wildlife health.

⇒ Train state and territorial fish and wildlife health specialists to build capacity, using a standardized program that provides uniform, basic training with special emphasis on regional issues.

⇒ Create, implement and evaluate standardized communication plans to inform varied audiences about general fish and wildlife population biology, ecology and health, as well as specific pathogen and disease topics. These plans must be appropriate for varied audiences to include agency staff, policymakers, stakeholders, media, and the public. The plan will ensure common, consistent, and science-based messages among state, territorial, federal and tribal agencies. Notably, communication planning will be an ongoing priority, receiving sustained attention as issues emerge, peak and wane. Specific tasks include:
- Conduct human dimensions research to better identify what target audiences think, feel and understand about fish and wildlife health issues;
- Define goals, set measurable objectives, and develop and test messages based on this research;
- Gather existing case studies and example communication plans in an easily accessible web-based location for education;
- Assemble researchers and communicators from partner organizations to develop the plans and education materials to communicate the messages successfully, and enact the plans; and
- Subject the plans to progressive evaluation and revision until research confirms desired outcomes are achieved.

Measures of progress: Milestones to development of the fish and wildlife disease Web site; annual number of fish and wildlife health specialists trained; number of communication plans developed, implemented and re-evaluated each year.

6. Establish a NFWHI Steering Committee to facilitate, oversee, and coordinate interactions among partners and provide the support necessary for effective implementation of the Initiative.

⇒ The Steering Committee will be assembled with representation from government partner groups (see Governance section) and strive for consensus. Among its specific roles:
- Define needs based on current and emerging fish and wildlife health issues;
- Establish fish and wildlife health policies based on prioritized needs;
- Coalition building;
- Promote necessary interagency agreements to define partner responsibilities in order to effectively address fish and wildlife health issues in a particular state or territory; and
- Conflict resolution.

Measures of progress: Establishment of the Steering Committee by May 2007; establishment of Steering Committee bylaws and structure for reporting milestones; proceedings of Steering Committee meetings.

Governance

Given the diversity of the state and territorial fish and wildlife management agencies that have spearheaded development of the NFWHI, as well as the scope and complexity of fish and wildlife health issues they face, a central structure for coordination at the national level is essential. A National Fish and Wildlife Health Steering Committee (NFWHSC) and a small support staff will be established to provide this foundation.

STEERING COMMITTEE. The NFWHSC will bear responsibility to facilitate, oversee and coordinate interactions between partners and provide the support structure necessary for effective implementation of the Initiative. The Committee will be comprised of 12 representatives drawn from the partner groups as follows:

- Chairperson of the AFWA Fish and Wildlife Health Committee (1), Chair;
- Directors from each of the four Regional AFWA Associations (Northeast, Midwest, Southeast and Western) (4);
- Director of US Fish and Wildlife Service (1);
- Associate Director of Biology, USGS (1);
- Deputy Administrator of USDA APHIS VS (1);
- Deputy Administrator of USDA APHIS WS (1);
- State Veterinarian (1);
- Academic Institution (1);
- Tribal fish and wildlife management entity (1);

Initially, the Steering Committee will be named by AFWA from nominations submitted by AFWA members and partners. A Charter specifying bylaws, terms of service, procedural rules, specific responsibilities of membership and other matters will be developed by the NFWHSC. In addition, the Steering Committee will also be charged with selecting the appropriate entities from non-government organizations, associations, industry, and other private organizations to serve on a Non Governmental Organization Caucus.

Core administrative support will initially be provided by the states, through AFWA. Minimal permanent staff positions will be filled as needed during implementation of the Initiative. Funding for these staff positions will be provided by a combination of federal appropriations, intergovernmental personnel agreements, and partner contributions.

FEDERAL CAUCUS. A Federal Caucus will be named as a key advisory body to the Steering Committee. The Caucus will provide a vehicle through which federal partners can (1) jointly identify strategies and resources to support actions under the NFWHI, (2) ensure that the Initiative reflects the priorities of federal agencies, and (3) provide a communication link among cooperating federal partners. The Caucus will work to promote federal agency policy consistent with the NFWHI. The Caucus will effectively serve as a forum for articulation and refinement of federal perspectives concerning fish and wildlife health issues, and a channel for information flow between federal partners and the NFWHSC.

The Caucus will be comprised of all federal agencies interested in fish and wildlife health issues and willing to facilitate the implementation and maintenance of the Initiative. In order to obtain comprehensive and varied input, the number of members participating in the Federal Caucus will not be limited. Initially, the Caucus will be comprised of representatives from the following U.S. Departments: Agriculture (Animal and Plant Health Inspection Service - Veterinary Services [APHIS-VS] and Wildlife Services [APHIS-WS], Agricultural Research Service, Forest Service), Commerce (National Oceanic and Atmospheric Administration - National Marine Fisheries Service), Health and Human Services (Centers for Disease Control and Prevention, Public Health Service, Food and Drug Administration), Interior (Bureau of Land Management, Fish and Wildlife Service, Geological Survey, National Park Service, Bureau of Indian Affairs), and Environmental Protection Agency. Affiliates of the U.S Departments of Defense and Homeland Security will also be invited to participate. One representative from the Department of the Interior and one representative from the Department of Agriculture will serve as Federal Caucus Co-Chairs and will function as liaisons to the Steering Committee.

Exhibits

1. **EXAMPLES OF SUCCESSFUL FISH AND WILDLIFE HEALTH PROGRAMS:**

   State Fish and Wildlife Health Programs,
   Regional Fish and Wildlife Health Cooperatives,
   The Great Lakes Fish Health Committee,
   The Epizootic Hemorrhagic Disease Project, and
   Federal Support of State Fish and Wildlife Health Programs

2. **SAMPLE OF INITIATIVE PARTNERS**

3. **NATIONAL FISH AND WILDLIFE HEALTH INITIATIVE MILESTONES**

4. **NATIONAL FISH AND WILDLIFE HEALTH INITIATIVE LEADERSHIP**

EXHIBIT 1: EXAMPLES OF SUCCESSFUL FISH & WILDLIFE HEALTH PARTNERSHIPS

Currently, the ability of state and territorial fish and wildlife management agencies to prevent, detect, monitor, and manage disease and other health problems impacting free-ranging wild animals is highly variable. To progress towards the NFWHI's goal of adequate capacity in each and every state and territory (capacity under state and territorial control), improvement in funding, cooperation and outreach are all necessary. While building capacity is a common need, the numerous and diverse examples of flourishing fish and wildlife health programs shows that a variety of routes can be taken to arrive at the same successful programmatic outcome.

STATE FISH AND WILDLIFE HEALTH PROGRAMS

A cornerstone of the research and management of wildlife health is strong programs under the authority of state and territorial fish and wildlife management agencies. Such programs have been established and maintained over time in a number of states, including Alaska, California, Colorado, Michigan, New York, Wisconsin and Wyoming, among others. In 1927, the increases, and as the deliberate manage- groundwork was laid for the pioneering U.S. program in Michigan:

> As the value of our wild life resources increases, and as the deliberate management of those resources is intensified, we shall no doubt parallel the previous experience with domestic birds and mammals, and shall have to contend with an unending series of diseases and parasites. Under these circumstances it is highly desirable that Michigan should develop at home, first class facilities for research in connection with the pests, parasites and diseases of ... wild life forms. It should not be necessary for us to depend upon Washington, or upon laboratories in other states, for the service of this sort.
>
> *(Michigan Department of Conservation, Game Division, Fourth Biennial Report, 1927-1928, pp. 265-267).*

With that independent vision, the Michigan Department of Conservation's Wildlife Disease Laboratory (WDL) was established in 1933, the first of its kind. Its initial stated role was to study starvation, nutrition and diseases of Michigan wildlife. And for over seven decades the WDL has trained veterinary and wildlife biology students at Michigan State University, monitored causes of death and illness for the multitude of game and non-game Michigan wildlife species, and carried out research and management of several significant animal diseases including bovine tuberculosis, Type E botulism, and epizootic hemorrhagic disease. This success story was possible in large measure because of substantial and sustained funding from both state (hunting and fishing license fees, State Building Authority bond funds, and general fund monies) and federal (Pittman-Robertson grants) sources. The Michigan Department of Natural Resources (MDNR) WDL is an example of how strong state wildlife health programs can benefit not only wildlife, but domestic animal and public health as well.

REGIONAL FISH AND WILDLIFE HEALTH COOPERATIVES

Several states and Canadian provinces have pooled their resources to form cooperatives. Wildlife management agencies in the Midwestern, Southeastern, and Western Associations of Fish and Wildlife Agencies have formed regional wildlife health cooperatives. The Midwestern and Western Wildlife Health Cooperatives are consortia of individual state wildlife health programs, several of which have long invested in staff positions and other dedicated infrastructure. In a similar fashion, the veterinary colleges and several governmental and non-governmental organizations in Canada have formed and support the Canadian Cooperative Wildlife Health Center. As exemplified by the Great Lakes Fish Health Committee, described below, these co-ops may bridge not only agency, but national boundaries.

The oldest of the cooperative programs is the Southeastern Cooperative Wildlife Disease Study (SCWDS). The SCWDS program began in response to a number of severe white-tailed deer mortality events in the 1950s, eventually determined to be due to hemorrhagic disease. The SCWDS program was founded at the University of Georgia, College of Veterinary Medicine by the Southeastern Association of Fish and Wildlife Agencies in 1957, with eleven original state members. Through a cooperative approach, the funds of individual SCWDS member states, which currently number sixteen plus the Commonwealth of Puerto Rico, are leveraged with dollars from each other, from the U.S. Departments of Interior (USDI) and Agriculture (USDA), and grants obtained by SCWDS faculty, to develop and disseminate wildlife health information of use to all partners. This approach allows the individual agencies supporting SCWDS to obtain much more for their investments than would otherwise be possible if working independently.

All of the above cooperatives, whatever their structure, allow for better information sharing and, in many cases, have promoted a more uniform approach to common disease problems affecting a number of different states or provinces.

THE GREAT LAKES FISH HEALTH COMMITTEE

Established in 1973 under Article VI of the Great Lakes Fishery Commission (GLFC) Convention between the United States and Canada (1955), the Great Lakes Fish Health Committee serves as the instrument of the Commission in coordinating regional efforts in the Great Lakes basin to prevent introduction and dissemination of communicable fish diseases. The Committee carries out this role by: recommending and fostering conduct of research and studies related to fish health and disease control; recommending and coordinating measures among member agencies which minimize risk of introduction and dissemination of communicable fish disease; and preparing for publication scientific and other information related to fish health protection.

The Committee consists of two representatives appointed by each agency formally cooperating with the Great Lakes Fishery Commission. Currently, these agencies represent the eight Great Lakes states, the Province of Ontario, the American and Canadian federal governments, and the tribal authorities. All positions and policies are adopted by the consensus of the member agencies. Technical advisors approved by the Committee are periodically invited to provide specialist expertise as required to enhance the conduct of the Committee's work.

In the past two decades, the Committee has made considerable progress in improving fish health management in the Great Lakes basin. Some of the achievements include:

- Development and publication of policies and protocols to reduce the risk of introducing or transferring serious disease agents into or within the Great Lakes basin (e.g. the "Great Lakes Fish Disease Control Policy and Model Program" and "Protocol to Minimize the Risk of Introducing Emergency Disease Agents with Importation of Salmonid Fishes from Enzootic Areas");

- Providing a forum for member agencies to discuss and recommend ways to manage serious disease outbreaks and associated fisheries management decisions (e.g., where and if to stock or destroy infected hatchery fish) along with providing support for these actions;

- Increasing awareness of the importance of fish health in both wild and cultured fish through participation at GLFC and Lake Committee meetings, and through development of educational tools such as the publication "A Guide to Integrated Fish Health Management in the Great Lakes Basin" and information sheets for such pathogens as *Heterosporis* sp.; and

- Providing a focus for the development and transfer of new fish health science and technology that is in turn used to update Committee policies and protocols, as well as in the development or revision of member agency legislation and policies.

The Great Lakes Fishery Commission operates a Science Transfer Program to promote partnerships through the communication of information about Great Lakes ecosystems and their fish communities, sea lamprey control, and emerging ecological concepts and technologies to fishery researchers and managers, to governments, and to the public. The program provides a source of funding to support the Joint Strategic Plan for Management of Great Lakes Fisheries, which includes support for the Committee's research priorities. In addition, the Committee formulates a priority list of research and information needs annually and achieves increased awareness and understanding of fish health issues through extension and education efforts.

THE HEMORRHAGIC DISEASE SURVEILLANCE PROJECT: A LONG-TERM NATIONAL DATABASE

Bluetongue and epizootic hemorrhagic disease are the most important viral diseases of white-tailed deer in the United States. Clinically indistinguishable from each other in deer, they are often collectively referred to as hemorrhagic disease (HD). The importance of HD was realized in the 1950s, when focally extensive mortalities of free-ranging deer jeopardized deer restoration programs in which wildlife agencies had invested significant financial and human resources. Since first recognized, HD has caused focal but severe mortality across much of the whitetail's range in the U.S. However, understanding HD epidemiology was complicated by underreporting, inconsistent diagnostic criteria, and lack of coordinated communication between states experiencing die-offs.

Since 1980, the Southeastern Cooperative Wildlife Disease Study has sent questionnaires every year to administrators and biologists of fish and wildlife management agencies, as well as veterinary diagnosticians, in all U.S. states. The questionnaires solicited information on HD occurrence, based on four consistent diagnostic criteria, at the country level. Preliminary results were complied, and follow-up contact was made when clarification was necessary and with non-respondents to obtain nationally complete information. Each year, an interim report was prepared and sent to participating states for review and corrections, with the final annual report later delivered to all participants. The major advantages of this system were its simplicity, continuity over a long period of time, and its national scope. Above all, the benefits that participants received were greater than their contributions to the project.

Through this surveillance project, 1608 HD cases in 880 counties in 31 states were independently recorded by more than 380 state wildlife biologists in the first ten years. The data accumulated in the 25 years since inception have elucidated the geographic and temporal distribution HD across the entire nation and facilitated the identification of variable clinical response to infection first on a geographic basis and later as a function of the frequency of viral exposure and the development of resistance. In addition, HD Project surveillance has provided data for disease modeling, focused research, and efficient resource allocation. Perhaps most importantly, the Project provided opportunities for cooperative interactions among states to address a common wildlife health problem, resulting in improved training, communications, and a template for regional and national collaboration for other diseases involving wildlife.

FEDERAL SUPPORT FOR STATE FISH AND WILDLIFE HEALTH PROGRAMS

First, since the passage of the Federal Aid in Wildlife Restoration (Pittman-Robertson) Act of 1937, billions of dollars generated by an eleven percent excise tax on sporting firearms, ammunition, and archery equipment have been collected by the federal government and distributed as grants to state fish and wildlife agencies to fund wildlife conservation programs. A similar program, the Federal Aid in Sport Fish Restoration (Dingell-Johnson) Act of 1950, has generated federal grants for wild fish conservation through an excise tax on fishing equipment and small boat fuels, and import duties on fishing tackle, yachts and pleasure craft. Management and research of fish and wildlife health issues form a fundamental component within the framework of conservation. Dingell-Johnson and Pittman-Robertson monies have been put to good use in many states to supplement state funds, or to leverage state funds and allow their application to other needs.

Another excellent example of federal financial support for state wildlife management agencies to conduct disease surveillance and management has come through the USDA's Animal and Plant Health Inspection Services - Veterinary Services (APHISVS). Beginning in fiscal year 2003 and continuing to date, APHIS-VS has provided $4 to 5 million each year in direct support of state activities related to chronic wasting disease (CWD). Additionally, APHIS-VS dramatically increased the number of approved laboratories and their testing capacity for transmissible spongiform encephalopathy (TSE) in 2002 by providing equipment, reagents, training, consultation, and quality control and assurance to a total of 26 facilities. The provision of federal funds through APHIS-VS for CWD surveillance and management activities directed and conducted by state wildlife management agencies should serve as a model for cooperative federal support of state wildlife health programs.

The provision of federal personnel to assist state fish and wildlife management staff in times of peak need provides a third example. Beginning in 2004, USDA's APHIS-WS hired several wildlife disease biologists with the primary mission of assisting the states with disease surveillance. The MDNR WDL incorporated fifteen of these biologists into its bovine tuberculosis and CWD testing programs in November 2004. That help was in addition to services provided by four APHISVS veterinarians and technicians as part of a cooperative program in place now for nearly a decade. The capable assistance of these federal personnel saved MDNR an estimated $120,000 in labor costs.

EXHIBIT 2 : SAMPLE OF INITIATIVE PARTNERS (AS OF MARCH 2007)‡

FEDERAL/TRIBAL

Bureau of Land Management

Centers for Disease Control and Prevention

Department of Homeland Security

Great Lakes Fishery Commission

Great Lakes Fish Health Committee

National Park Service

U.S. Department of Agriculture, Animal and Plant Health Inspection Service, Veterinary Services

U.S. Department of Agriculture, Animal and Plant Health Inspection Service, Wildlife Services

U.S. Fish and Wildlife Service

U.S. Geological Survey

NON GOVERNMENTAL

American Association of Wildlife Veterinarians

American Fisheries Society

American Sportfishing Association

Association of State and Territorial Health Officials

National Assoc. of State Public Health Veterinarians

National Wildlife Federation

Native American Fish and Wildlife Society

Quality Deer Management Association

Rocky Mountain Elk Foundation

U.S. Animal Health Association

The Wildlife Society

Wildlife Conservation Society

Wildlife Disease Association

STATE/UNIVERSITY

Alabama Wildlife and Freshwater Fisheries

Arizona Game and Fish Department

Arkansas Game and Fish Commission

Association of Fish and Wildlife Agencies

Clemson University

Colorado Division of Wildlife

Connecticut Department of Environmental Protection, Wildlife Division

Florida Department of Health, Department of Agriculture, and Fish & Wildlife Conservation Commission

Georgia Department of Agriculture, Division of Public Health, and Wildlife Resources

Idaho State Department of Agriculture, Department of Fish and Game

Indiana State Board of Animal Health

Iowa Department of Natural Resources

Kansas Department of Wildlife and Parks

Kentucky Department of Fish and Wildlife Resources

Louisiana Department of Wildlife and Fisheries

Maryland Department of Natural Resources, and Department of Health and Mental Hygiene

Massachusetts Department of Fish and Game

Michigan Departments of Agriculture, Community Health , and Natural Resources

Michigan State University

Mississippi Department of Wildlife

Montana Department of Fish, Wildlife and Parks

Nebraska Department of Agriculture, and Game & Parks Commission

Nevada Department of Wildlife

New Hampshire Departments of Health and Human Services, and Fish and Game

New Mexico Departments of Game and Fish, and Health

New York State Department of Environmental Conservation

North Carolina Wildlife Resources Commission

North Dakota Departments of Health, and Game and Fish Department

Pennsylvania Game Commission

South Carolina Department of Natural Resources

South Dakota Department of Game, Fish and Parks

State Environmental Health Directors

Tennessee Wildlife Resources Agency

Texas Animal Health Commission, Parks and Wildlife Department

University of Georgia, Southeast Cooperative Wildlife Disease Study

Utah Division of Wildlife Resources

Utah State University, Jack H. Berryman Institute

Vermont Departments of Fish & Wildlife, and Department of Health

Virginia Department of Game & Inland Fisheries

West Virginia Division of Natural Resources

Wisconsin Departments of Agriculture, Natural Resources, and Division of Public Health

Wyoming Department of Health, Game and Fish Commission, and Livestock Board

‡ Partners list is incomplete and provided here as an illustration of the breadth of partners who have participated in the regional Initiative meetings or have provided written comments on the Initiative.

EXHIBIT 3: NATIONAL FISH & WILDLIFE HEALTH INITIATIVE MILESTONES

In view of the increasing need for fish and wildlife managers to effectively address disease issues, a National Fish and Wildlife Health Initiative (NFWHI) was developed under the leadership of the Association of Fish and Wildlife Agencies (AFWA) and in cooperation with governmental agencies and non-governmental organizations. The NFWHI is nested within AFWA's infrastructure and process and is under the formal direction of the AFWA.

Development of the National Fish and Wildlife Health Initiative began in 2005 when an ad hoc group met to discuss the Initiative's core concepts. The Guiding Principles presented earlier were devised from these core concepts. During fall 2005, resolutions were passed by the AFWA and USAHA supporting development and implementation of a National Fish and Wildlife Health Initiative under AFWA leadership. The AFWA also adopted the Guiding Principles for the NFWHI. In January 2006, a core work group met in Lansing, Michigan to develop a framework for the Health Initiative. In an effort to gather input on the draft Initiative, add content, and build a collaborative process, a series of four regional meetings were held during spring and summer 2006. Professionals from federal and state agriculture, public health, and fish and wildlife management agencies were invited to attend these meetings and provide comments on the Initiative. A fifth meeting was held in Washington, D.C. to gather input from various non-governmental organizations. During January 2007, a small work gathered in Washington, DC to further refine the Initiative specifically focusing on the Governance section.

EXHIBIT 4: NATIONAL FISH & WILDLIFE HEALTH INITIATIVE LEADERSHIP

Core Work Group

Gregg Arthur, Wyoming Game and Fish Commission

Jordan Burroughs, Michigan State University

David Cobb, North Carolina Wildlife Resources Commission

John Fischer, Southeastern Cooperative Wildlife Disease Study

Dan Forster, Georgia Department of Natural Resources, Wildlife Resources Division

Rebecca Humphries, Michigan Department of Natural Resources

Terry Mansfield, Idaho Department of Fish and Game

Mike Miller, Colorado Division of Wildlife

Bruce Morrison, Nebraska Game and Parks Commission

Dan O'Brien, Michigan Department of Natural Resources

Steve Schmitt, Michigan Department of Natural Resources

Gary Taylor, Association of Fish and Wildlife Agencies

Gary Whelan, Michigan Department of Natural Resources

ASSOCIATION *of*
FISH & WILDLIFE
AGENCIES

The Association of Fish and Wildlife Agencies—the organization that represents all of North America's fish and wildlife agencies—promotes sound management and conservation, and speaks with a unified voice on important fish and wildlife issues.

Senator WHITEHOUSE. Thank you very much, Director. I appreciate your bringing your views.

Next is Baykeeper Torgan.

STATEMENT OF JOHN TORGAN, NARRAGANSETT BAYKEEPER, SAVE THE BAY, INC.

Mr. TORGAN. Thank you, Mr. Chairman. It is really an honor to be here.

The problem of invasive species poses serious economic and environmental risks to rivers, bays and coastal systems nationally. According to recent estimates, the United States spends in excess of $138 billion annually on control measures.

While this problem itself is not new, changing environmental factors and new species introductions have contributed to dramatic shifts in the types of plants and animals we see in our region and across the country and have opened the door for non-native species to take hold.

In Narragansett Bay and Southern New England, we have observed fundamental changes in the fish and shellfish populations as water temperatures have warmed over the past 30 years.

The extent of low-oxygen dead zones on the bottom has spread as warmer water and pollution contribute to massive algae blooms. The populations of classic cold water New England fish and shellfish species, like lobster, cod, winter flounder, river herring and scallops, are all down as jellyfish, algae, and other warm water-tolerant fish like striped bass and menhaden have recently increased.

You mentioned Dr. Whitehouse's dissertation work on winter flounder. That is very much on point here. That looked at a kind of shrimp that used to be excluded in cold winters in Narragansett Bay, but in warmer winters it can now get in, called the crangonshrimp or seven spine shrimp, and eat the baby winter flounder. So, this is an example of, not an invasive species, but a changing condition that opens the door to more problems from invasions.

Invasive plants and animals thrive under these warmer conditions. They are causing some negative, but mostly unknown, impacts on the broader coastal ecosystem. Asian shore crabs, which we first observed in the mid-1990s, are now the most common species of crab, the most prolific in front of our main offices in Providence. You cannot turn over a rock there without finding one. We do not know if they have driven out the native crabs or what the extent of the damage is yet, but that is something that we need to study.

Certain shellfish diseases like dermo, MSX and juvenile oyster disease, once much more common in Mid-Atlantic waters, have nearly wiped out our native oyster populations. Lobster diseases further weaken an already struggling industry in Southern New England. Commercial fisheries and the historic seafood industry of the region are facing unprecedented challenges from these and other changes.

The same changes can be observed in avian, other fish populations, mosquitoes with West Nile, and EEE, these may also be related to temperature.

Understanding biological invasions requires knowledge of past and present populations. We are only just beginning to get a clear picture of what is in our ecosystem today. Doing comprehensive baseline assessments in States helps us understand what is really new and what has been there and what is a threat.

Rhode Island has just established a citizen-based environmental monitoring program for aquatic invasive species which is an interagency and university effort. We participate in that.

The National Invasive Species Act has enabled all of this progress to date. Since its passage, Congress has appropriated $1.7 million per year for States to develop invasive species management plans. Individual States' shares of that money have been declining though as more States receive approval for their plans from the Federal Aquatic Nuisance Species Task Force. Rhode Island's share, for example, dropped from $45,000 to $35,00 in the past year. So, it would help States a great deal if Congress were to appropriate the additional $3 million authorized in that Act.

While my organization is focused primarily on coastal waters and estuaries, invasive species on land affect our environment significantly, especially where land and water interface. I will use the example of phragmites, the giant reed grass. I took the train from Providence, and you can see vast acres of it as you go through coastal Rhode Island, Connecticut, New York, New Jersey, all the way down here. We have an invasive species, phragmites, which takes over and transforms wetlands into a monoculture.

But we have identified some feasible control measures for it. Habitat restoration, allowing tidal water and salt water from the tide, where that is feasible, can knock out phragmites. Where that is not possible with some of the other aquatic plants species, you can treat them using a combination of approved herbicides, cutting and treating over the course of several seasons. But that is expensive and is labor intensive.

Forests, as some of the other witnesses have pointed out, are also at risk with things like the Asian longhorn beetle. By managing those, by clearing forests, that has an impact on water quality through increased runoff.

We know that prevention, as Senator Cardin had said earlier, is the best and most cost-effective control measure. But investing in screening and other controls at ports, airports and other points of entry would help. Once they are established, it is very difficult to get them out.

Another important role for non-profit organizations like mine is in education, in public communication and in outreach, to directly involve people in understanding the problem and the solution.

Finally, we believe that regional management is the most effective approach to these issues and this approach needs to engage multiple States because the species do not respect borders. In New England, the Northeast Aquatic Nuisance Species Panel of the Federal Task Force helps to coordinate regional efforts and maintain frequent communications with the public. We view this as an effective model.

Thank you for this opportunity to testify. I would be happy to answer any questions.

[The prepared statement of Mr. Torgan follows:]

July 8th, 2009

Testimony of John Torgan, Narragansett Baykeeper, Save The Bay, Rhode Island

To: The Honorable United States Senate
Committee on Environment and Public Works

On: Invasive Species Management

Madam Chair and Members of the Committee,

The problem of invasive species poses serious environmental and economic risks to rivers, bays, and coastal systems nationally. According to recent estimates, the U.S. spends in excess of $138 billion annually on control measures[1]. While the problem itself isn't new, changing environmental factors and new species introductions have contributed to dramatic shifts in the types of plants and animals we see in our region and across the country, and have opened the door for non-native species to take hold.

In Narragansett Bay and Southern New England, we have observed fundamental changes in the fish and shellfish populations as water temperatures have warmed over the past 30 years. The extent of low-oxygen "dead zones" of the bottom has spread as warmer water and pollution contribute to massive algae blooms. The populations of many classic cold water New England fish and shellfish species like lobster, cod, winter flounder, and scallops are down as jellyfish, algae, and other warm water-tolerant fish like striped bass and menhaden have recently increased[2].

Invasive plants and animals are thriving under these warmer conditions and causing some negative but mostly unknown impacts on the broader coastal ecosystem. Asian shore crabs, first observed in our area in the mid 1990's, are now the most common species of crab on the shoreline by our main office in Providence. Whether they have driven out the native crabs or how they have affected other species is not yet known.

Certain shellfish diseases like Dermo, MSX, and Juvenile oyster disease, once much more common in southern or mid-Atlantic waters, have nearly wiped out the native oyster populations[3]. Lobster disease has further weakened an already struggling industry in Southern New England[4]. Commercial fisheries and the historic seafood industry of the region are now facing unprecedented challenges from these and other changes.

Understanding biological invasions requires knowledge of present and past populations. We are only just beginning to get a clear picture of what lives in our ecosystem today. To adequately begin to address these issues, states need to conduct comprehensive environmental monitoring and perform detailed analyses of natural history records. Many of the non-native species living in our region have been established for many years. Others have recently been introduced and are spreading rapidly. Still others are potential invaders that have not yet been established in the region. Different states and regions

have made varying levels of progress in these baseline assessments and in efforts to prevent and control non-indigenous species.

Rhode Island has just established a citizen-based environmental monitoring program for aquatic invasive species. The monitoring is coordinated between the state's coastal zone management agency, the Rhode Island Coastal Resources Management Council, the Department of Environmental Management, and the University of Rhode Island, which also provides public education and outreach on these issues. My organization participates in this and will use the results and materials in our environmental education and community outreach efforts.

The Rhode Island program has identified seven potential marine invasive species[56] that are not yet established locally and published materials about these and an additional 13 species for a total of 20 "ID cards" to be distributed to the user communities.

The National Invasive Species Act has enabled all of this progress to date. Since its passage, Congress has appropriated $1.7 million per year for states to develop invasive species management plans. Individual states' shares of that money has been declining as more states receive approval for their management plans by the Federal Aquatic Nuisance Species Task Force. Rhode Island's share dropped from $45 thousand to $35 thousand in this past year. It would help states a great deal if Congress were to appropriate the additional $3 million authorized in the Act.

While my organization is primarily focused on coastal waters and estuaries, invasive species on land affect our environment significantly, especially where land and water interface. Coastal wetlands and marshes, among our most valuable habitats, are severely threatened by invasive weeds. In Rhode Island, for example, the majority of our coastal wetlands have already been lost to filling, and much of what remains is being taken over by *Phragmites*, the giant reed with the feathery tops. This invasive *Phragmites* out-competes native grasses and marsh vegetation and converts vast areas into a monoculture that is a less diverse, lower quality habitat and is subject to brush fires, mosquitoes and other hazards.

In the case of *Phragmites*, Save The Bay and our agency and non-profit restoration partners have proven that *Phragmites*-impacted wetlands can be restored and improved using a variety of techniques. In some salt water coastal systems, this may be achieved by restoring natural tidal flow through dredging, changing drainage elevations, and allowing the sea water to knock out the *Phragmites*. Where tidal restoration is not possible, successful techniques involve cutting the plants and treating the roots with approved herbicides over several growing seasons.

Forests in our region are also at risk from invasive species. The clearing of forests impacts water quality. As acres of forests are removed to control the spread of diseases, we lose the buffering, stormwater control, and habitat value of those forested lands. One important local example of that is the case of the Asian longhorned beetle in Worcester, Massachusetts, part of Narragansett Bay's watershed. This beetle, native to Asia, infects

hardwood trees like maples and will kill adult trees. Management requires removal of all known contaminated trees, which can threaten vast forest resources[7].

We know that prevention is the best and most cost-effective management tool for invasive species. An investment in import screening and other controls at ports, airports, and other likely points of entry would help prevent expensive future control efforts.

Once an invader has established itself, eradication, management, or control may be infeasible or even impossible in some cases. In other cases, there are practical, safe, and effective management measures that benefit people and the environment as well as addressing the problem. Active habitat restoration, such as in the *Phragmites* example, is one of the best ways to give a natural system the tools it needs to stay healthy, balanced, and resilient to a wide range of threats.

Another important role for non-governmental organizations in combating invasive species is in public communication, education, and outreach. By directly involving people in the monitoring and response to invasive species, we build a broader network of support and awareness to assist in management and control efforts.

Finally, we believe regional management is the most effective approach to these issues, as this approach engages multiple states. In New England, the Northeast Aquatic Nuisance Species Panel of the Federal Task Force helps to coordinate regional efforts and maintains frequent communications via an e-mail list-serve. We view this as an effective model.

Thank you for this opportunity to testify. I am happy to answer any questions.

[1] NOAA's National Centers for Coastal and Ocean Science, June, 2008
http://coastalscience.noaa.gov/stressors/invasivespecies/welcome.html

[2] Gibson and Oviatt, "Narragansett Bay Turns into the Chesapeake" Profidence Journal, August 1, 2008, Rhode Island Bay Windows, http://www.projo.com/opinion/contributors/content/CT_bay1_08-01-08_QHAV3V3_v50.4126909.html

[3] "Managing Diseases in Shellfish Aquaculture Farms in Rhode Island", Marta Gomez-Chiarri and Dale Leavitt, RI Sea Grant 41N, volume 4, #2

[4] "A Mysterious Disease Afflicts Lobster Shells" WHOI Oceanus, Sara Pratt, 2007

[5] Publications of The Rhode Island Coastal Resources Management Council on Aquatic Invasive Species, 2009. The seven species include *Corella eumyota* (a tunicate), the Chinese Mitten Crab, *Undaria pinnatifidia* (a species of kelp), *Sargassum muticum* (another seaweed), the Veined Rapa Whelk, *Synidotes laevidorsalis* (an isopod), and *Hemigrapsis takenoi*, a species of crab. The Chinese Mitten Crab is particularly feared as it was found in the Hudson River estuary in 2007 and it may be a short matter of time before it arrives in Rhode Island. The Veined Rapa Whelk could have a significant impact on the state's commercial shellfish and aquaculture industries as it is a voracious shellfish predator.

[4] USDA Animal and Plant Health Inspection Service, 2009
http://www.aphis.usda.gov/plant_health/plant_pest_info/asian_lhb/index.shtml

Senator WHITEHOUSE. Thank you very much, John, and once again, welcome. It is wonderful to see you here.

Our last witness is Professor Jeffrey Hill from the University of Florida.

STATEMENT OF JEFFREY E. HILL, ASSISTANT PROFESSOR, DEPARTMENT OF FISHERIES AND AQUATIC SCIENCES, UNIVERSITY OF FLORIDA

Mr. HILL. Mr. Chairman, thank you for the opportunity to testify concerning the threats of invasive species to native wildlife.

I am Dr. Jeffrey Hill, Assistant Professor of Fisheries and Aquatic Sciences at the University of Florida. My teaching, research and extension programs involve ecology and management of non-native aquatic species. I teach a course in invasion ecology, conduct field laboratory research, and apply ecological theory and practical experience to risk analysis. I have conducted and reviewed risk analysis efforts for sports fish, aquaculture species and ornamental species at State, Federal and international levels.

I am the President-Elect of the Introduced Fish Section of the American Fisheries Society and a member of State and national non-native species scientific advisory committees, including the Research Committee and the Detection and Monitoring Committee of the Aquatic Nuisance Species Task Force.

Invasive species threaten native species and ecosystems, economic values and human health in every State and U.S. Territory. Invasive species arrive in the United States through a variety of pathways, including intentional importation and interstate trade, as well as via unintentional pathways such as ballast water.

The negative effects of many invasive species, such as zebra mussels and brown tree snakes, as well as wildlife diseases such as VHS, are well known. I will not discuss them further, except to say that some invasive species are ecologically devastating or economically important and costly pests.

Few would argue that invasive species are not a problem in the United States. It is imperative for Federal and State agencies to provide effective, reasonable regulation of pathways and problematic species to reduce the frequency and negative effects of species invasions.

Invasive species or a small subset of non-native species, specifically non-natives that threaten ecological or economic harm, or human health. All invasive species must go through a series of steps to become invasive. They must be introduced into the environment, established, spread and then some will become invasive.

Although these steps sound simple, you may be surprised to learn that the process is fraught with difficulty and that most introductions fail. Literally millions of individual animals and thousands of species are moved across State lines or imported annually. Some of these get introduced into the environment. Of these introductions, only a small percentage make it to the establishment or spread phase, and only a few established species have important negative effects.

The primary Federal regulatory tool for non-native species is the Lacey Act. Unfortunately, this system, as currently implemented, is not as effective as it should be. An effective system needs to

focus limited resources on problematic species, address gaps in authority, for example diseases that primarily impact wildlife, be timely reducing listing time to months rather than years, be open, transparent and stakeholder inclusive, use science-based credible risk analysis, allow for a regional approach to managing risk, be centralized and adequately supported with resources.

These recommendations could be accommodated within the current system. Invasive species prevention and management hinges on risk. Risk is a function of the probability of an event occurring and the consequences if the event occurs. Risk analysis is a complex scientific and sociological exercise that seeks to identify risks, estimate their magnitude and reduce risks to acceptable levels.

Risk assessment should be transparent, repeatable, scientifically credible and defensible. It must also be acknowledged that there is scientific uncertainty in all methods. Risk assessments are expensive and time consuming, usually requiring months to complete. Data needs for assessing risks are considerable. Data is lacking for many species, and most current data bases are inadequate for the task.

Risk management can seldom reduce risks to zero. Non-zero levels of risk must be considered for any use of non-native species. Decisions on acceptable risk levels should be based on scientific information, on probable, not possible effects, cost-benefit analysis, conservation analysis and cultural factors.

It would be a Herculean task to assist thousands of species with hundreds of interest groups with these species. It is my expert opinion, based on having done risk analysis, that it is impractical to conduct thorough, defensible risk analysis of thousands of species in a timely manner given any reasonable level of research allocation.

The focus should be on highly problematic species. States have broad authority to manage fish and wildlife resources and have considerable experience and expertise related to the regional nature of pathways, ecosystems and risk.

Important roles for the Federal Government would be to coordinate the efforts of State, especially States with common pathways and ecosystems, facilitate State-based programs, bridge important gaps where States lack sufficient authority, and help resolve differences between States.

Working with States would provide a mechanism for reducing risk on a regional basis. The Federal Government could considerably leverage resources by sharing the burden of risk analysis, regulation and enforcement with States.

In conclusion, my recommendations are to thoroughly revisit the Lacey Act with extensive input from scientific experts and interested stakeholders, provide substantially increased resources of staff and funding to the Fish and Wildlife Service, use appropriate screening methods followed by risk analysis if needed for any nonnative species newly proposed for importation, and begin a risk based process for those species currently in trade that are identified as problematic or likely to become problematic.

Many of these recommendations are already contained in the National Invasive Species Management Plan developed by the National Invasive Species Counsel.

Thank you for the opportunity to present my views. I look forward to working with you on these issues.

[The prepared statement of Mr. Hill follows:]

TESTIMONY OF JEFFREY HILL, UNIVERSITY OF FLORIDA, BEFORE THE SENATE COMMITTEE ON ENVIRONMENT AND PUBLIC WORKS, SUBCOMMITTEE ON WATER AND WILDLIFE AND SUBCOMMITTEE ON OVERSIGHT, REGARDING THREATS TO NATIVE WILDLIFE SPECIES

8 July 2009

Dear Chair and Members of the Subcommittees, thank you for the opportunity to testify concerning the threats of invasive species to native wildlife. I am Dr. Jeffrey Hill, Assistant Professor in Fisheries and Aquatic Sciences at the University of Florida. My main teaching, research, and extension programs are in the ecology and management of non-native aquatic species. I teach a course in Invasion Ecology, conduct field and laboratory research, and apply ecological theory and practical experience to risk analysis. I am the President-Elect of the Introduced Fish Section of the American Fisheries Society, the largest international professional fisheries organization, and member of a number of state and national scientific advisory committees involving non-native species, including the Research Committee and the Detection and Monitoring Committee of the Aquatic Nuisance Species Task Force.

My program at the University of Florida is unique and I will bring this perspective to my testimony. Florida is one of the most heavily-invaded regions in the U.S., with a long history of established non-native plants, insects, fish, reptiles, birds, mammals, and other taxa. Although some species are damaging pests, non-native species are vital to the economy and cultural fabric of Florida (and the rest of the U.S.). Florida has a comprehensive set of regulations and policy developed through extensive experience with this issue. I specifically work closely with natural resource and agricultural agencies and industries, including aquaculture, to help reduce the occurrence and impacts of non-native species invasions and to evaluate risks associated with non-native species.

Invasive species threaten native species and ecosystems, economic values, and human health in every State and Territory in the U.S. Invasive species arrive in the U.S. through a variety of pathways including intentional importation and interstate trade as well as via unintentional pathways such as ballast water. The negative effects of many invasive species such as zebra mussels and brown tree snakes are well known, so I will not discuss them further except to say that some invasive species are ecologically devastating or economically costly pests. Few would argue that the invasive species problem in the U.S. is not critical. Few would also argue that current regulations, policy, and implementation at the federal level do not need an extensive overhaul. It is imperative for federal and state agencies to provide effective, reasonable regulation of pathways and problematic species to reduce the frequency and negative effects of species invasions.

What are invasive species?

Not all non-native species are invasive. Invasive species are a subset of non-native species, specifically those non-native species that cause harm (ecological, economic, or human health). Unfortunately, this is not a good definition for a scientist. The term is

subjective and open to broad interpretation of what is meant by harm and how much harm it takes to make a species invasive. Also, as an ecologist, I use the terms "invade" and "invasion" to refer to species that move to a new area without any consideration of whether the species is problematic, beneficial, or benign. What makes a species invasive? Its presence? Its abundance? Or does a species have to cause a decline in native species or an economic loss to an industry? Is it the potential to carry a pathogen or the actual transmission of disease? What about off-setting benefits? Is a species with minor negative effects but substantial benefits truly an invasive species? There has been a great deal of debate in the scientific literature on the definitions and use of this and other terms.

A good example of the difficulty in defining an invasive species is the butterfly peacock bass, a sport fish from South America stocked by a state agency into South Florida to create a recreational fishery. I have studied this species in the field, ponds, and laboratory and have evaluated this species in a risk assessment. Some scientists and agencies have called peacock bass invasive because they eat individual native fish and occasionally turn up in waters just inside the Everglades National Park. Nevertheless, data show that peacock bass have not caused declines in native fishes, including a potential native competitor, the largemouth bass. Moreover, this introduced sport fish contributes many millions of dollars annually to the South Florida economy. Is the peacock bass an invasive species? Some would argue that it must be called invasive because it causes some level of harm, albeit relatively little harm. Similar examples are common in the history of stocking non-native sport fish by federal and state agencies throughout the country.

Regardless of how invasive species are defined, all must go through a series of steps to become invasive—introduced, established, spreading, invasive. Although these steps sound simple, many conditional events have to occur at each stage for a species to become invasive. For example, a species that is introduced must arrive in a location that has all the requirements to complete its life cycle; survive predators, competitors, weather, and other environmental factors; reproduce; successfully recruit new individuals; and spread to new areas. You may be surprised to learn that this process is fraught with difficulty and that most introductions fail. Literally millions of individual animals of thousands of species are imported and moved across state lines annually by industries, agencies, research institutions, zoos and aquaria, and the public. Some of these get introduced into the environment. Of the introductions, only a small percentage makes it to the establishment or spread phase. Only a few established species have important negative effects. Scientists have estimated the percentages for each step for some taxonomic groups and often use a value of 10%. This is a very rough estimate with some taxonomic groups or stages lower and others higher. As an example, assuming 10% is close to correct, if 1000 species are introduced, then 100 will become established, 10 will spread, and 1 will become invasive. As a word of caution, this "tens rule" should not be considered a quantitative tool for predicting risk; however, it serves well to illustrate the point that there are far fewer species at each stage.

Current System

The primary federal regulatory tool for non-native fish and wildlife is the Lacey Act through the injurious wildlife provisions. Unfortunately, there are a number of problems with current implementation. Some of the issues that have been identified by a broad range of critics include:

- The injurious wildlife list has relatively few species and clearly does not list all problematic species.
- It is a slow, cumbersome process to add new species.
- It is typically applied in a reactive manner only for species already present and a problem.
- There is limited flexibility with a "one-size-fits-all" blanket coverage of the entire U.S. and Territories. Listing bans importation or interstate transport throughout all of the U.S. without regard to regional differences in risk.
- The USFWS lacks adequate resources to enforce existing provisions and to list new species in a timely manner.
- It is a dirty list rather than a clean list approach.

The system does not work as currently implemented and needs to be fixed. The question—Revise the existing system or create an entirely new approach? I will address some of the issues that bear on this difficult question, emphasizing the processes that will have to be implemented in a new system and their practicality. Keep in mind that most solutions will still require integration with the current or a modified version of the Lacey Act, broad legislation that encompasses many topics besides injurious wildlife.

Clean vs. Dirty Lists; Proactive vs. Reactive

Two important criticisms of the Lacey Act are that it is a dirty list and is reactive. A dirty list prohibits those species that have been identified as problematic whereas a clean list allows those species that have been identified as safe. Both systems require some method of categorizing the species as either safe or problematic; I will discuss this further under risk analysis. In a reactive system, species are evaluated only after they have been introduced and become problematic, in essence, too late to do very much about them. Conversely, a clean list is a proactive system because it explicitly examines a species before it becomes a problem.

There are pros and cons for each system. A dirty list keeps the focus on species that are, or are likely to become, problematic. On the other hand, species not on the list are allowed, so in essence the vast majority of species are *de facto* "approved." This is an important weakness of dirty lists only if the list is truly reactive, awaiting an invasion before potentially banning a species for importation. There are many recent proponents of clean lists. Clean lists have the advantage that the species included are those that should represent low risk. All species must go through a risk-based process to get on the approved list; otherwise trade in the species must cease. The clean-list philosophy is that listed species are safe (some schemes would include invasive species that are widespread already on clean or approved lists). What happens if some of these "safe" species later prove problematic? Does this call the entire list, and the science-based process that informs listing decisions, into question? For many species, perhaps most, there may be

(1) not enough information to determine risk or (2) disagreement over the risk categorization. With 1000s of species imported or moved across state lines annually, formally assessing risk is an expensive, daunting task.

Are dirty lists truly reactive? Often, but they do not have to be. There is no reason that potentially problematic species cannot be assessed and placed on a dirty list in a proactive manner. This has been done previously, for example, in Florida where a panel of scientists and industry representatives was asked to suggest a list of fish species to be evaluated for placement on conditional and prohibited lists (a two-tiered dirty list system). Seemingly there is nothing inherent in the Lacey Act that prevents proactive screening as called for in the National Invasive Species Management Plan.

Interestingly, most schemes are really combinations of list types. Clean list schemes also include a dirty list of species that have been evaluated and found to be of unacceptably high risk. There is also a "gray" list of species that have not yet been evaluated (or lack sufficient data to evaluate). Gray list species are functionally unapproved. This gray list may be the fate of many non-native species if a clean list approach is adopted.

Developing, implementing, and enforcing lists of any kind require resources. Resources for invasive species prevention and management are scarce and it is impossible to allocate sufficient resources to address all invasive species. Therefore a practical system should focus most resources on species likely to become problematic rather than spread effort across all species, most of which are unlikely to be problematic. A dirty list approach with proactive screening of species proposed for trade for the first time, followed by taxon-specific screening of species already in trade that are identified by experts or a rapid screening tool as potentially invasive, seems to be the better use resources.

Risk Analysis

Much of invasive species prevention and management hinges on risk. Risk is a function of the probability of an event occurring and the consequences if the event occurs. Current and proposed systems use some version of risk analysis (often an incomplete version). Risk analysis is a complex scientific and sociological exercise that seeks to identify risks, estimate their magnitude, and reduce risks to acceptable levels.

- Risk analysis = risk assessment + risk management + risk communication

I address this topic after having led and participated in risk analysis efforts for sport fish, aquaculture species, and ornamental species. Moreover, I have provided critical review for risk assessments conducted by the U.S. Geological Survey (USGS) and the Center for Environmental Cooperation and I am quite familiar with the efforts of my colleagues and collaborators at the USGS and the European Union on assessing risks of invasive aquatic species.

Risk assessment—Risk assessment is a process for determining the nature, severity, and probability of risks. All parts of risk analysis are important, but assessment is usually given the bulk of attention and resources, often to the detriment of managing and communicating risks. Risk assessments are usually conducted by scientists, but should have stakeholder input. There are numerous qualitative or quantitative (or combined) methods for assessing risk, often specific to a taxonomic group or pathway, and little consensus on which method or methods to apply. Most federal assessments of aquatic species have followed the qualitative *Generic Nonindigenous Aquatic Organisms Risk Analysis Review Process* developed by the Aquatic Nuisance Species Task Force.

Quantitative methods are desirable, being considered most objective ("scientific"), but are taxon- and frequently location-specific, and are often expensive to develop, populate with data, and to validate. Moreover, there is some subjectivity even in many quantitative models. For example, many quantitative models use some qualitative or subjective variables such as history of invasiveness (recall the discussion about what does invasive mean?). There can also be subjectivity in the assignment of threshold values to determine what number means low risk versus high risk. Qualitative or semi-quantitative models provide considerable insight into risk while quantitative methods clarify specific questions such as predicting spread or identifying the characteristics of species that may become invasive.

Risk assessments should be transparent, repeatable, and defensible. It must also be acknowledged that there is scientific uncertainty in all methods, often uncertainty of considerable magnitude. The risk sensitivity of the assessor may lead to subjectivity and non-repeatability. Risk-averse assessors may rate species unlikely to become problematic as high risk; risk-tolerant assessors may rate species that may become problematic as low risk. Using panels or committees can help reduce bias, but the composition of the group can still influence the outcome.

The assignment of risk frequently hinges on the ability of a species to establish within the region of interest, a potential limitation to the practicality of risk assessment for a large political unit like the U.S. Many schemes rate any species that may establish as high risk regardless of likely impact. Because of the size and diversity of the U.S., nearly every species on earth can possibly establish somewhere. This could lead to the exclusion of 100s or 1000s of species that represent little risk of impact yet have a non-zero probability of establishing a population somewhere in the country.

Full risk assessments are expensive and time-consuming, requiring weeks to months to complete, even if given reasonable resources. Screening methods show some promise and can be relatively quick, but need creation or refining for most taxonomic groups; nearly all need testing and validation. Some work can be done by inexperienced scientists or non-specialists, but high levels of knowledge of the biology and effects of non-native species and the ecology and habitats of potentially invaded regions and pathways are needed to develop high quality, defensible assessments.

Data needs for assessing risk are considerable. A few key factors relate to invasion success across many taxonomic groups, specifically physiological-habitat match, propagule pressure (the number of introductions and the number of individuals introduced), and prior history of invasiveness. Nevertheless, there are numerous exceptions and more research is needed to test this relationship. Moreover, determining values for these variables for most species is difficult and has a subjective element (i.e., perception of invasiveness). In general, these factors relate more to establishment success than negative effects *per se*. Other factors statistically relate to invasion success, but these vary across groups and are often specific to certain regions. For example, small body size was found to be an important factor relating to success of freshwater fish introductions globally; however, recent data from Florida suggest that small-bodied fishes have low invasion success.

An important consideration before attempting to assess risks to large numbers of species is the adequacy of existing data and databases. Sufficient data exist for some species, but there will be gaps. Due to the vast number of species, there will be 1000s with few data. Existing databases are sufficient for a few, well-studied species, but most databases are inadequate for the task. Data quality and completeness range from good to abysmal. Data quality problems include data that are out of date, incomplete, based on anecdotes, based on non-peer-reviewed (gray) literature, inadequately referenced, and erroneous. Many of the species accounts in some databases are not reviewed by qualified scientists. Moreover, there is excessive cross-referencing among databases—it is not uncommon to have databases populated by data almost solely obtained by searching the other internet sites. For example, the Global Invasive Species Database account of the Asian swamp eel, considered an aquatic nuisance species in the U.S., references primarily a species summary from a Columbia University database, with supplemental information from FishBase, the Gulf States Marine Fisheries Commission, and the USGS Nonindigenous Aquatic Species Database. The Columbia University database is not referenced, so it is difficult to determine the origin of the information. Obviously, decisions on invasive species risk and management should be made based on information of high quality, particularly obtained from the primary, peer-reviewed literature.

Risk Management—Risk management is a process for determining if there are options for reducing risks identified in risk assessments to acceptable levels and subsequently managing those risks at acceptable levels. This component must be included in any comprehensive program to reduce the effects of invasive species. It is important to note that although there are calls for precaution and developing a more risk-averse system, risk is seldom zero, even after placing a species on an unapproved list or for species on approved lists. Non-zero levels of risk must be determined acceptable for any use of non-native species. Risk acceptability is not a scientific question, but a societal question. Decisions on acceptable risk levels should be informed by scientific information on probable (not potential) effects, cost-benefit analysis, conservation goals, and cultural factors.

Approved species are presumed safe and unapproved species are too risky. However, many species will not fit neatly into these categories for the entire country. Risk for most

species will vary regionally. Species that may establish and become problematic in Hawaii most likely will not in Alaska. Some mechanism for incorporating regionality is needed so that species that may threaten one or a few regions will not be unapproved for the entire country. Using a permit system with risk-reducing conditions is one possible way to do this in a practical manner, especially if there is a close federal-state partnership.

Risk management may allow for the transport and use of species that are otherwise of unacceptable risk. For example, control of reproduction by sterilization, hybridization, triploidy, or other mechanism may reduce the risk of establishment by some species and allow for use. Risk then is primarily associated with the production facility and is likely far easier to manage than when risk is expanded across many links in a distribution chain and with end users.

Risk Communication—It is necessary to communicate risks to agencies and stakeholders. Risk communication requires resources and expertise and is frequently ignored when developing management plans. Educational programs for industry, stakeholder groups, and the public are necessary to facilitate acceptance and compliance. The State Cooperative Extension Service, a federal-state-county partnership, can be an economical and effective partner in educational programs.

Practicality of using science-based, full risk assessments to create approved lists for all non-native species imported into or transported between states in the U.S.

This will be a herculean task requiring large investments in research, database development, risk analysis, and USFWS infrastructure and operating budgets. There are 1000s of species and hundreds of stakeholder groups with interests in these species—those interested in transporting, breeding, researching, displaying, and keeping these species; those who regulate, manage, or stock these species; and those who wish to prevent the transportation and possession of these species.

This process will be expensive. Each species assessment will take time, scientific personnel, stakeholder involvement, and money while at the same time the USFWS is woefully under-staffed and under-funded for this work. Moreover, resources will be needed to defend against litigation challenging the status (approved or unapproved) of some species. Can a "user-pay" system work in the U.S. (at least initially) with so many species already commonly moved across U.S. and state boundaries and so much dispersed economic activity? User fees will be more likely to work after the process settles on an initial approved list (likely some years following a regulatory change), when new species are proposed for importation or species on approved or unapproved lists are petitioned for status change. Until then, substantial resources will have to be made available to the USFWS to conduct their program.

Can approved lists be created in a timely manner? Currently, single species risk assessments take weeks to months, not including time for risk management. How long then will the evaluation of 100s or 1000s of species take? Timeliness will only occur

with substantial, probably unrealistic, inputs of resources to the USFWS. It is likely that there will still be NEPA and other provisions that will add time to the process.

There will be considerable uncertainty over species inclusion or exclusion during the development of clean lists. Development of lists can take several years and there is concern that there will be relatively little time (relative to pertinent economic cycles) between publishing a list and implementing it. It is difficult to conduct business based on uncertainty, a factor that will harm economic activity.

The approved list approach has been used in some countries (e.g., Australia and Israel). The U.S. is far larger in population and geographic area, has more diversity of ecosystems, and larger trade and use of non-native species than any country with a clean list. Can such a system be scaled up in an effective, practical manner to the U.S., the most complex case of any country?

It is unclear exactly what types of species would actually meet the criteria for inclusion on an approved list. Some of the most damaging invasive species are also popular pets such as the domestic house cat or domestic livestock such as the domestic hog. Both species are highly problematic as feral populations in many states yet both provide societal and economic benefits. Many problematic species will have to be excluded or exempted, contrary to the logic of a clean list (i.e., species on the clean list are safe). Some other invasive species may be already so widespread as to make listing them useless. What about the many non-native species, perhaps the majority of species, where establishment is a possibility somewhere in the U.S. (possibly only in one or a few locations) or relatively little information is known? To be precautionary, risk assessments will generally rate risks of these species as unacceptable, effectively placing them in an unapproved status and therefore eliminating their movement. In essence, will a clean list be very long or very short? As a practical manner, any proposed clean list approach must explicitly deal with this issue, preferably at the legislative stage. Uncertainty will lead to considerable resistance from stakeholder groups.

In my opinion, based on having done the species risk analysis process, it is impractical to fully evaluate (i.e., conduct a thorough, defensible risk analysis) the 1000s of species in a timely manner given any reasonable level of resource allocation or user fees. My recommendation is to thoroughly re-visit the injurious wildlife provisions of the Lacey Act with extensive input from scientific experts and interested stakeholders, increase the resources allocated to the USFWS to develop and implement existing and newly-defined authority and to evaluate screening and risk analysis methodologies, use one or more appropriate screening methods (followed by a risk analysis if needed) for any non-native species newly proposed for importation, and begin a risk-based process for those species currently in trade that are identified as problematic or likely to be problematic.

Partnership with the States

States have broad authority to manage fish and wildlife resources. Some states have comprehensive programs and have clearly specified authority given to agencies.

Considerable experience and expertise resides within state agencies, especially related to the regional nature of pathways and ecosystems. These can serve as models or test cases for various approaches to reducing the risks associated with invasive species. For example, the Florida Fish and Wildlife Conservation Commission uses a combination list approach with a two-tiered dirty list (prohibited and conditional), a clean list, and a "list" of all other non-native species. Prohibited species are deemed of unacceptable risk; conditional species may be possessed or cultured under rigorous risk-reducing conditions; species on the clean list, currently two bait species, are deemed of low risk; and all other non-native species cannot be legally released from captivity. The prohibited and conditional lists have been developed over time in a combination of reactive and proactive processes; for many taxa the lists are remarkably proactive and developed with substantial input from stakeholders.

Important roles for the federal government would be to coordinate the efforts of states, especially states with common pathways and ecosystems, facilitate state-based programs, bridge important gaps where states lack sufficient authority, and help resolve differences between states. Working with the states could provide a mechanism for reducing risk on a regional basis. The federal government could considerably leverage resources by an effective partnership with states. In essence, share the burden of risk analysis, regulation, and enforcement with the states.

Summary

Our current federal system has not been effective in preventing the establishment of several invasive animal species, invertebrates and vertebrates. These species have arrived via many pathways and there is a need for improved federal programs to address this important issue. When choosing among the regulatory options, effectiveness, defensibility, enforceability, and practicality are prominent considerations. Any system must differentiate between problematic and non-problematic non-native species, reduce the frequency and severity of establishment of invasive species, ensure that the USFWS has the time and resources to effectively implement programs, evaluate the benefits as well as costs of non-native species, and consider the effects of regulatory changes on economic activity. These goals could be attained by careful renovation of the Lacey Act, a resource infusion into the USFWS to implement existing and new programs, a clear policy of proactive assessment of species that are likely problematic, and attention to risk management as a distinct, but related process to risk assessment. Strong partnerships with the states will facilitate effective management and leverage expertise and resources. I again thank the Chair and Subcommittees for this opportunity to present information on invasive species, risk analysis, and reducing the risks of invasive species.

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19 August 2009

Follow-up Question for Written Submission, U.S. Senate Environment and Public Works Committee Hearing, 8 July 2009

Question for Dr. Hill

Senator David Vitter

1. Can you explain the primary contributing factors behind the successful return of healthy crocodile populations in Florida?

Senator Vitter,

The rebound of American crocodile (*Crocodylus acutus*) abundance in South Florida is largely due to a combination of protection of habitat, reduction in adult mortality, and the inherent life history characteristics of crocodiles. The two primary pressures on crocodiles in South Florida historically were (1) loss of habitat, especially for nesting and hatchlings, due to development and freshwater diversion and (2) mortality of adults when crossing roads or when killed as nuisance wildlife or poached. Crocodilian populations have tremendous capacity to recover if habitat is available and sufficient adults remain to repopulate the habitat.

South Florida crocodile populations increased as nesting habitat improved in quality and quantity. Female crocodiles construct nests along water courses. Good nesting habitat is high enough to avoid flooding yet moist enough to prevent desiccation of the eggs, while also providing protection from predators (also accomplished by the guarding female) and seclusion from human activity. Although adult crocodiles frequent saltwater or brackish habitats, hatchlings require access to freshwater. The core area of nesting when crocodile abundance was at its lowest was in northeastern Florida Bay and northern Key Largo. Although crocodiles recruited from this region, this nesting area has the disadvantage of being somewhat distant from freshwaters needed for hatchlings, partly due to freshwater diversion. Nesting and hatchling habitat has improved in the last 20 years with the management of cooling canals and associated freshwater ponds at the Florida Power and Light Turkey Point Nuclear Power Plant near Homestead/Florida City. Other nursery habitat improvement occurred when East Cape Canal in the Everglades National Park near Flamingo/Cape Sable was plugged to retain freshwater and prevent saltwater intrusion. Additional nesting is occurring in the Crocodile Lake National Wildlife Refuge on Key Largo and a few other regions of South and Southwest Florida. Further nursery habitat improvements could be made by increasing freshwater flows into eastern portions of Florida Bay during the historic wet season.

Crocodiles are late-maturing organisms but have long reproductive life-spans. Many long-lived species are vulnerable to over-exploitation; however, many of these species also have relatively low survival throughout the early life stages. Although often assumed that crocodiles have low reproductive output and low hatchling/juvenile survival, recent research shows these parameters to be similar to other reptiles. High juvenile survival is an important aspect of recovery. For crocodile numbers to increase, a female only needs to produce two or more female offspring during her two or three decades of reproductive life. High juvenile survival especially occurs at low adult densities due to the fact that large crocodiles often kill small crocodiles. These life history characteristics allow crocodiles to increase population density over relatively short time frames and recover from low abundance if there is adequate nesting and nursery habitat that is also protected from excessive human disturbance.

A parallel example is the American alligator (*Alligator mississippiensis*), one of the conservation success stories in the United States. Alligators suffered from over-exploitation and habitat loss and declined dramatically in numbers. After effective protection and management, alligators today are highly abundant throughout much of their native range.

Please let me know if I can provide additional information.

Sincerely,

Jeffrey E. Hill, Ph.D.

Senator CARDIN [presiding]. Let me thank all of our witnesses for their testimony, their contribution to this hearing.

Dr. Ruiz, first I want to welcome you to the panel. As a person who lives in Maryland, we are very honored that you are here with us and the work that you do. I thank all of the members of the panel, but I have to certainly acknowledge my Marylander who is on the panel.

I want to talk about the Chesapeake Bay for a moment. As you point out, there is over a hundred invasive species in the Chesapeake Bay. I do not know if that is the Chinese mitten crab that you have there or not. Is that what you have in front of you?

Mr. RUIZ. Yes, it is a Chinese mitten crab that has been showing up in the Chesapeake Bay and to the north.

Senator CARDIN. That has me greatly concerned. The crab industry is synonymous with Maryland and the Chesapeake Bay, and particularly in the month of July we all very much think about our delicacy that we have given to the world. What danger do we have that this crab could become a significant part of the population and effect the blue crab, the Maryland blue crab? Is this a risk factor that we do not know about yet?

I ask that because one of the questions, one of the points, that all of you have been raising, is do a risk assessment early so you do not have to try to clean up the mess later, which becomes much more difficult.

Mr. RUIZ. I think the mitten crab is a concern. It underscores exactly the point that you are making, I think, and also that Professor Hill made, that there is a lot of uncertainty about what will happen when a non-native species shows up in one of our ecosystems like the Chesapeake Bay and that it is a species that transported from one part of the world and moved to another one with a different community, a different suite of organisms. And so, we really have a very poor understanding of how it is going to interact and what will play out.

The mitten crab is of concern because it is a species that goes through massive outbreaks, kind of like cicadas do seasonally here, but on a much longer time scale. There was an outbreak that occurred in San Francisco Bay that damaged some of the water supply system in the San Francisco delta.

In the Chesapeake region, I do not think we really know what the impact is going to be of this crab if it is established, what effect it might have on infrastructure, water supply in particular, and how it might interact with the blue crab in terms of competition for resources or even as a predator on juvenile blue crab that it may interact with as it moves down into salt water.

Senator CARDIN. We already have a problem with the survival of juvenile crabs, the blue crabs. The protective grasses are being affected by pollution and global climate change. So we already are finding it a challenge to preserve the food stock basically for the mature crabs. In some cases, they eat their own. And now, if the Chinese mitten crab is going to be competing with that, if could complicate the survival of the blue crab in Maryland.

Mr. RUIZ. I think that is exactly right. As we are struggling to recover the commercial fishery and the blue crab population in Chesapeake, the arrival of new non-native species is one more

stressor, one more factor, which makes it even more challenging to recover a fishery like the blue crab.

We do not, of course, know what the impact of Mitten crabs will likely be if it is established and becomes abundant. It is a point of concern, and it is something that I think we need to take very seriously.

Senator CARDIN. Do we know how this was introduced into the Bay?

Mr. RUIZ. The mitten crab is also an interesting example in that it underscores some of the uncertainty there. There are two likely ways in which it could have come. One is through the ballast water of ships. What we know from specimens that we have collected so far is that the genetics tell us it is likely coming from Europe where the mitten crab is also established. It has been there for over 100 years now. So, it could have well come from ships delivering ballast into the Chesapeake or the Mid-Atlantic region.

The other possibility is that it could have come as live trade in that it is a commercially important crab, particularly in Asia. It is also eaten in Europe. So it is possible that someone brought it in. It is illegal to do that now under the Lacey Act. Whether it could have been brought in when it was still legal, or whether it could have been brought in illegally, we do not know.

So, there is some uncertainty. But those are the two pathways or mechanisms by which it could have arrived.

Senator CARDIN. And, of course, the related issue is that there is an intentional introduction of an invasive species, the Asian oyster, and it certainly has its controversy when we intentionally introduce a new species into the Bay. That is being done because of the real concern of the loss of oysters, which are not only a commercial crop but are a filtering agent for clean water. I know there is a lot of work being done to monitor the Asian oyster. Are there adequate resources to monitor the mitten crab?

Mr. RUIZ. At the present time, I would say no. The approach that we have taken has been to develop an alert system and a reporting system across the Mid-Atlantic region by having watermen and fisherman, as well as citizens, report records as they come across them, taking advantage of the rather large commercial fishing effort and recreational fishing that occurs in the Chesapeake and Delaware and the Hudson River. By doing that, we have learned of over 80 crabs that have been caught and confirmed.

At the present time I would say that is the extent of the effort that is being——

Senator CARDIN. Well, what worries me is that, if you are correct, that this all of a sudden you see a huge increase because of the seasonal aspects to it, we might be faced with a crisis in the Chesapeake Bay.

Senator Barrasso.

Senator BARRASSO. Thank you very much, Mr. Chairman.

Professor Hill, if I could. There is criticism out there of the existing fish and wildlife framework and that it utilizes a dirty list. Some say that this approach is too reactive because it only addresses species after they have been introduced as harmful. Dr. Ruiz talked about the Lacey Act. Is there any reason why we cannot work within the Lacey Act to initiate proactive screening?

Mr. HILL. Senator, there is no reason that the Lacey Act could not be used to proactively screen species. The screening of species, I think, is an excellent way of identifying some of the more potentially problematic species that are out there, and I think that it could be accommodated in the current system.

Senator BARRASSO. Many of the proposals that address the threat of invasive species suggest that, aside from those few species that are exempted like pets and farm animals, there are thousands of perfectly safe non-native species and they are going to be blacklisted until a thorough scientific assessment can prove that they have no impact on the ecology of the United States. Is this the most prudent course of action?

Mr. HILL. Well, one point is that it is very difficult to prove that a species will not have some impact onto a system. There is a lot of scientific uncertainty in this estimation. So that is one issue that plays into this.

A blacklist approach, or a dirty list approach, seeks to really focus on those species that are problematic or likely to be problematic. They do not have to already be a problem to list a species. And we certainly have those. The State of Florida, for instance, uses an approach similar to this where species have been identified as potentially problematic. These are not species which are already introduced into Florida, these are species that may be in trade, or have been in trade in years past, but are not in the environment. And they been prohibited or placed on a conditional species list. So it is a workable type of solution.

Senator BARRASSO. Let me ask a question about an approved list and how that would play into this, because some of what might be some of the most damaging invasive species in the country are also popular pets. I am not talking about the boa constrictor that we saw, but popular house pets. How do you view that whole thing working out?

Mr. HILL. Well, I tend to look at this from terms of risk and a risk analysis standpoint. When you go through a risk analysis, you assess risk and what are the bad things that these organisms may do. But then you also balance those risks during the management process to determine, do you still want to have those organisms and do you balance that risk against the benefits.

There are a number of species that, from a purely scientific risk assessment standpoint, are clearly problematic. I am a dog person, but the domestic house cat is probably one of the No. 1 species in probably all the States, as being an invasive species when it is in the environment. Obviously, people love cats and they have societal and economic benefits. From a purely risk standpoint, cats are problematic. But when you put the management side to that, then cats would obviously be a banned species.

Senator BARRASSO. Director Humphries, if I could. We had Senator Levin here who gave great testimony, and he listed you as the expert from Michigan. He also said that his position in Michigan was the exact opposite of the position of, I think, the Michigan legislature. So, as the expert, can you tell all of us who is right and who is wrong?

[Laughter.]

Ms. HUMPHRIES. They are both right.

[Laughter.]

Senator BARRASSO. Well, then we have a seat for you right up here.

[Laughter.]

Ms. HUMPHRIES. But I would like to respond that it is very, very difficult to screen risk, to screen organisms by risk, and rely on that solely. So, I caution all of us that, when we look at this, we also need to be nimble, to be able to address when one of these species or diseases crops up unexpectedly. Because it is going to go through a filter at some point in time, and we will have the unexpected. That is one to the things that the Fish and Wildlife Association has been trying to address, is making sure that we have both capacities and authorities across the United States to address these issues adequately.

Senator BARRASSO. Thank you, Mr. Chairman. No further questions.

Senator CARDIN. Well, thank you.

Let me, if I could, Mr. Torgan, you talked about regional cooperation during your testimony. I think about our efforts on the Chesapeake Bay, which has been regional. We have been able to get all of the regional governments to work together on a strategy on the Bay and we could easily bring this subject into the debate and we have. It has been, I think, an effective way to deal with it.

As I have listened to the testimony, I see an effort made by the Federal Government, working with the States on specific issue problems. I just really want to get your view, and perhaps others on the panel, as to whether we need to do more to empower regional approaches to dealing with these issues. Not just on a crisis basis, or not just where there is a popular effort that has been supported over a long period of time, such as the Chesapeake Bay, which has its challenges, but whether we need to try to institutionalize this in a more effective way.

Mr. TORGAN. Thank you, Senator. I think so. The Chesapeake's situation and the recent move by EPA to create a multi-State restoration and protection framework are unique to the Chesapeake. There is a similar effort now for the Great Lakes. And we have thought a lot about whether such an approach would work, for example, for New England or for the Mid-Atlantic States.

There are a lot of lessons that we could learn in Rhode Island from what you have accomplished in Maryland and in the Chesapeake Bay and many of these issues have parallel there. So, it does make sense to cooperate, collaborate and have synergy on that. Rhode Island is a small State, obviously, so our ability to manage and communicate on the State-wide level is good.

The regional cooperation, the challenges of that have always had to do with the teeth of whatever regulations compel interstate partnerships. But we really believe, because these species do not respect State boundaries, and the issues are, if not national, then at least regional, that a regional approach that brings together States, Federal agencies and people involved on the ground in the universities and in the non-profit, non-government community who are engaged in this, to work together for a solution. I think that is the only way to crack it.

Senator CARDIN. We, in this region, look at the Chesapeake Bay partnership with the Federal Government as an area of major national priority, but also a model that could be used in other parts of the country where you have multi-jurisdictional issues.

Now the Great Lakes is the other area that is frequently mentioned as where you need to have multiple jurisdictional impact if you are going to be able to have effective results. And ,of course, you are also dealing with another country. How do the Great Lakes manage the governmental challenges of multiple levels?

Ms. HUMPHRIES. Well, the Great Lakes certainly is a difficult situation because, as you say, you have a number of political boundaries in there and countries. But, nonetheless, we get scientists together, as well as policymakers, through the Great Lakes Commission, the Great Lakes Fisheries Commission, to set priorities and help address these issues, including the science on those issues with research priorities. It has worked very well for us.

There are a number of other models when you look around the country with this regional approach. The Southeast Disease Cooperative was established back in the 1950s, where Southeastern States in the United States banded together in order to develop a scientific approach to address deer population problems that were occurring in that area. That model is still in place.

So, I think there are a number of different models and I have appended some of those within the Initiative that I attached to my testimony. They will give you some ideas of some these regional approaches. They are, I think, the most effective in the fact that you have partners coming together and talking about the specific risks in those areas. And also some of the cultural things that you need to change with your citizens to address the risk out there.

Senator CARDIN. I know that Senator Levin is working on a reauthorization under the Clean Water Act of the Great Lakes. We are working on the Chesapeake Bay reauthorization, looking for more effective ways to enforce the goals that are established by the local governments. Because we want to make sure there is not only a partnership with the Federal Government, but that there is reasonable expectation that we can achieve the goals that we set. We will be working with all of you in that regard.

Senator Barrasso, anything further?

Senator BARRASSO. No.

Senator CARDIN. Well, let me thank our witnesses again for their testimony and for their participation at this hearing. This has been a very interesting hearing for, I think, the members as well as an educational one for the Chairman.

Thank you all very much.

[Whereupon, at 12:08 p.m., the subcommittees were adjourned.]

[Additional statements submitted for the record follow:]

STATEMENT OF HON. JAMES M. INHOFE,
U.S. SENATOR FROM THE STATE OF OKLAHOMA

Good morning. I would like to first welcome Senators Levin and Nelson, who I know care greatly about the topic of this hearing this morning. I think that the protection of our native wildlife from harmful invasive species should receive increased Federal attention. I would like to thank the subcommittee Chairmen for holding this important hearing on potential threats non-native species pose to native wildlife in this country. However, as we chart a course of action we must be prudent and avoid prematurely banning species that pose no threat to the environment.

I understand that the House of Representatives had a similar hearing on this topic in April, in which a specific legislative proposal—H.R. 669—was examined to address the threats of invasive species. It is also my understanding that this legislation received widespread criticism for casting too wide a net on pets, sports fishing and other species that generate billions of dollars in our economy with no demonstrated threat to the environment. I realize that this hearing will not be examining a specific piece of legislation, which I must say makes me skeptical, considering this committee's habit of marking up bills without a legislative hearing on the specific proposal—especially one that could put in place a new, cumbersome bureaucratic process for examining the threats without consideration of effective laws already on the books.

Common sense reforms are needed to prevent the importation or breeding of species that would be harmful to our ecosystem; however, these reforms must avoid placing burdensome requirements on the retail and agriculture industries and sportsmen. I appreciate the efforts of environmental groups, mainly the Defenders of Wildlife, in attempting to address the threat posed by non-native species, but I am concerned that their proposal could harm important sectors of our economy.

Any policy that Congress considers should include a reasonable risk analysis process that would take into consideration risk management options for controlling non-native species. It should not adopt a policy that automatically bans species until proven safe. Acknowledging similar risk management processes that are used elsewhere in Federal agencies would effectively address the issue at hand. We don't need legislation that bans species that we know are safe. Invasives legislation should use existing scientific evidence without requiring industries to unnecessarily spend resources and time completing scientific testing that tells us what we already know: the vast majority of non-native species in the United States are safe and present little or no harm to their surroundings.

Thank you. I look forward to hearing from our witnesses.

STATEMENT OF HON. BERNARD SANDERS,
U.S. SENATOR FROM THE STATE OF VERMONT

I am pleased that the Environment and Public Works Subcommittees on Oversight and Water and Wildlife are holding today's hearing to discuss threats to native species. In Vermont we face several such threats, and two in particular I want to highlight.

Our bats, and bats across the Northeast, are increasingly susceptible to death from white-nose syndrome. White-nose syndrome appears to be a fungus that turns their noses and bodies white and kills with a mortality rate of between 90 and 100 percent in some caves. More than 1 million hibernating bats have died over the past 2 years. Bats prey on harmful insects such as mosquitoes which spread disease, and moths and beetles which damage crops. Bats reduce the need for pesticide use and are beneficial for the environment.

On May 5th of this year I signed a letter along with 24 of my colleagues in the Senate and the House asking the Department of the Interior to provide emergency fiscal year 2009 funding to respond to this crisis. Summer research is critical to stop the spread of this disease and develop a cure.

In addition I want to highlight another invasive species threat that deserves the attention of scientists and the Administration. That is the threat from the Asian longhorned beetle. This beetle uses maple trees as a host. Vermont leads all States in maple syrup production, producing 920,000 gallons in 2009 and creating millions of dollars in value for Vermont's economy. I ask that the Administration work with State and local officials in Vermont and put the appropriate resources into finding solutions to the spread of Asian longhorned beetles.

[Additional material submitted for the record follows:]

BOBBY JINDAL
GOVERNOR

State of Louisiana

DEPARTMENT OF WILDLIFE AND FISHERIES
OFFICE OF SECRETARY

ROBERT J. BARHAM
SECRETARY

July 29, 2009

Senator Ben Cardin
Chairman
Subcommittee on Water and Wildlife
Committee on Environment and Public Works
Washington, DC 20510

Senator Sheldon Whitehouse
Chairman
Subcommittee on Oversight
Committee on Environment and Public Works
Washington, DC 20510

Dear Chairmen Cardin and Whitehouse:

The Louisiana Department of Wildlife & Fisheries (LDWF) sincerely appreciates the opportunity to submit this testimony for the record of your recent joint Subcommittee hearing on July 8, 2009, regarding "Threats to Native Wildlife Species".

The LDWF has a very long and active history of addressing the destructive impacts of invasive species on our wetland ecosystems. In the 1930's, nutria imported from South American fur farms escaped into the marshes of Louisiana. They quickly established feral populations which by the 1950's had soared to 20 million animals causing widespread damage to marshes, rice and sugarcane fields and flood control levees throughout coastal Louisiana and Texas. Vast areas of coastal marshes denuded by nutria grazing have contributed substantially to permanent wetland loss and substantially increased our State's vulnerability to damage and loss of life from hurricanes.

Initial efforts by LDWF to address the nutria problem through the promotion of nutria as a natural resource for the trapping industry to supply global fur markets were successful. From 1962 to 1982, 1.3 million nutria were harvested annually and wetland damage was significantly reduced. Subsequently, however, global demand for fur decreased sharply and along with it the harvest of nutria. By the beginning of the millennia, over 100,000 acres of Louisiana wetland were impacted by nutria and Louisiana was losing over 40 square miles of coastal wetlands annually.

Enacted in 2000, the Coastal Wetlands Planning Protection and Restoration Act (CWPPRA), also known as the Breaux Act, has provided grant funding for coastal restoration and conservation. In 2002, a CWPPRA-funded report on Nutria Control Methods concluded that a trapper incentive payment program proposed by LDWF was the best option for coastwide control. Also funded under CWPPRA, this Coastwide Nutria Control Program (CNCP) was put in place when the trapping season opened in November 2002.

The CNCP has proven to be very successful during the past seven years of its implementation, having reduced nutria population densities and their impacts to coastal wetlands from 100,000 acres to 20,000 acres today. More information about the program can be found at www.nutria.com.

Due in part to uncertainties in the ability to secure continued funding for CNCP under CWPPRA, in 2003 the LDWF and the Louisiana Congressional Delegation worked very closely with the Maryland Department of Natural Resources and the Maryland Congressional Delegation to enact the Nutria Eradication and Control Act of 2003 (P.L. 108-16). Funding secured pursuant to this legislation has allowed critical ancillary research to develop more efficient nutria control techniques that could not be funded under CWPPRA. This very beneficial work has provided for a better understanding of the problem and alternative methodologies to increase the efficiency of the CNCP program.

With this in mind, the LDWF is very pleased that Chairman Cardin and our Louisiana Senators Mary Landrieu and David Vitter have sponsored a new bill (S. 1519) to both expand and reauthorize the Nutria Eradication and Control Act. We look forward to working with you in strong support of its enactment.

Unfortunately, the impacts of invasive species on Louisiana's wetland resources do not end with nutria. Recent aerial surveys are now documenting feral hog populations impacting increasing areas along our coast, including those previously restored under the CWPPRA/Coastwide Nutria Control Program. Wetland damage caused by feral hogs is very similar to that caused by nutria and, in fact, in most situations it tends to be even more severe. Feral hogs are apparently filling the ecological niche of wetland herbivores previously dominated by nutria and, in time, the impacts to the integrity of our coastline may be even greater.

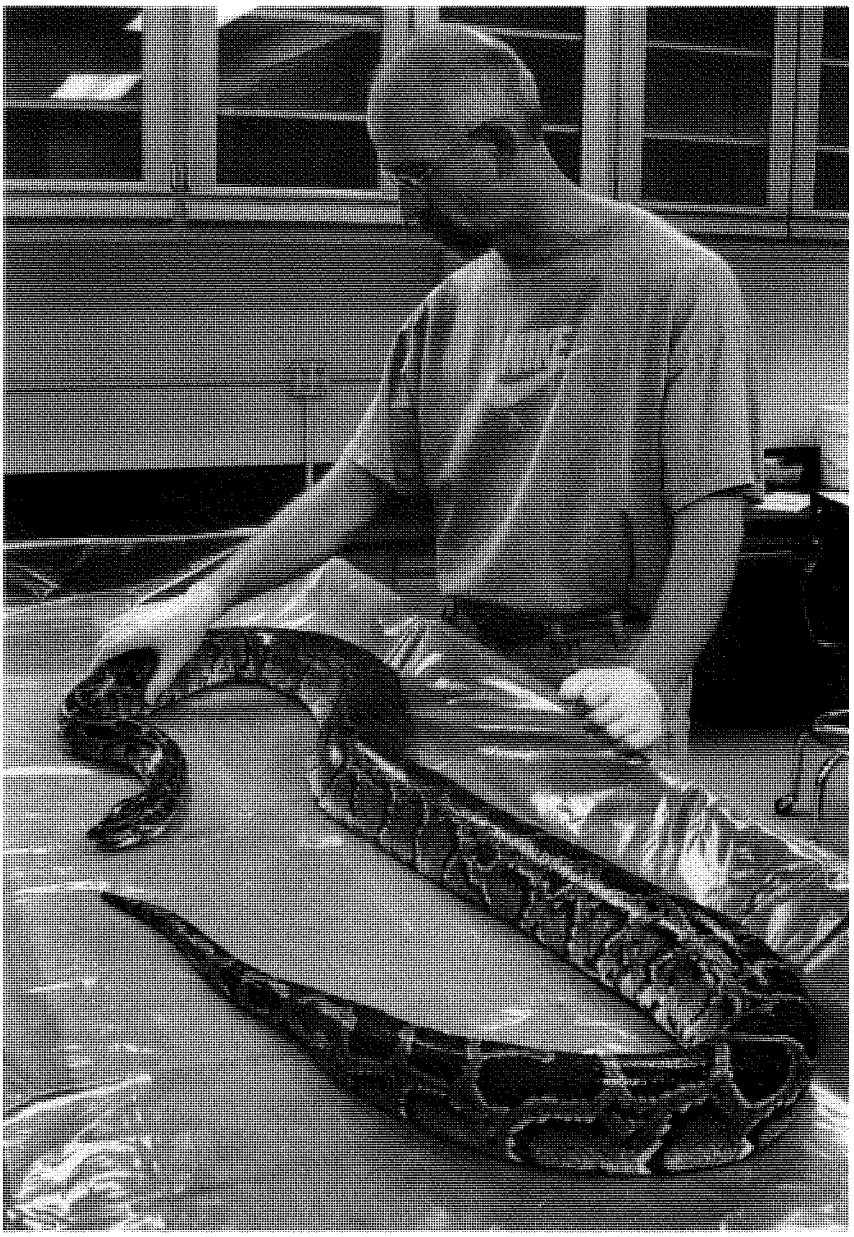
Like nutria, feral swine are a non-native (introduced), invasive species. They pose a number of threats to humans, livestock and wildlife. In addition to severe damage to critical wetland habitat, feral swine harbor a variety of zoonotic pathogens that are federally regulated and whose presence would result in severe economic loss to livestock industries. Feral swine have established populations in 38 states and are spreading rapidly. The World Conservation Union (IUCN) lists feral swine (and nutria) among the top 100 invasive species in the world.

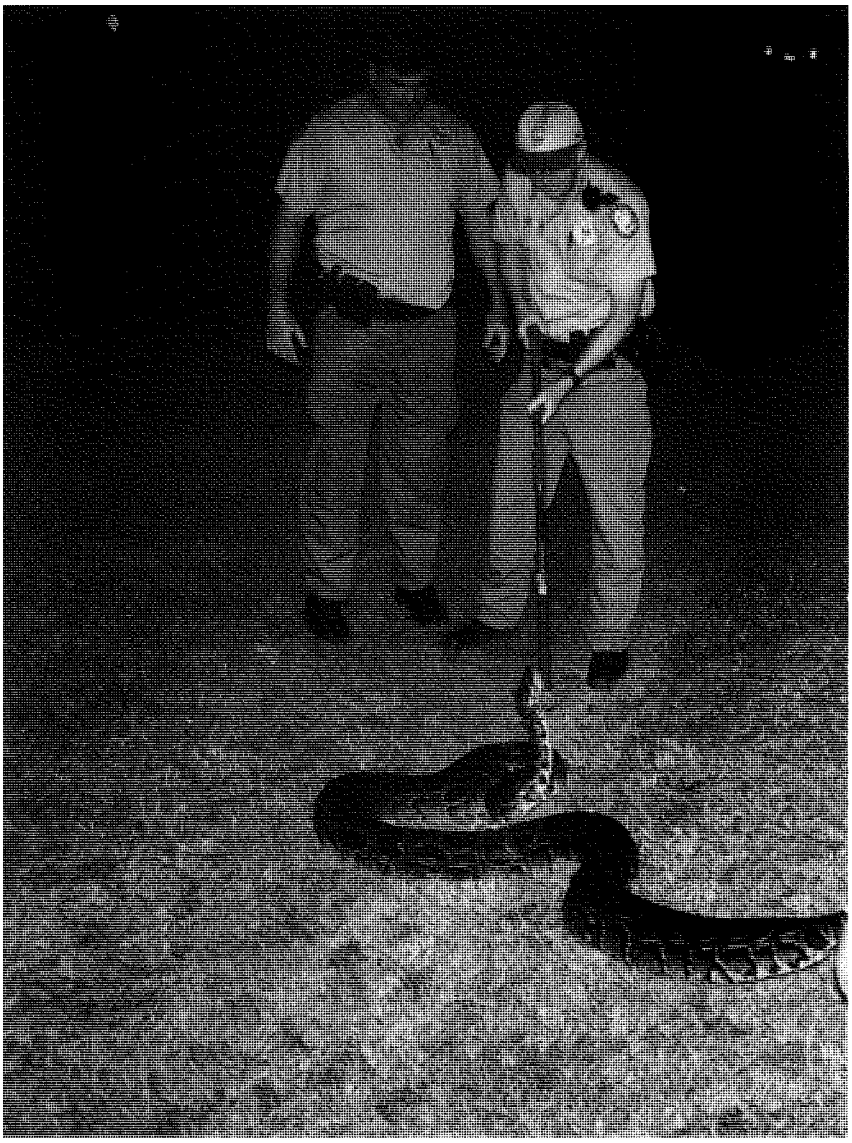
LDWF must move quickly to respond to this new threat to our wetlands which simply cannot sustain further damage in the face of hurricanes and other threats to our ecology and the safety of our people. Thus, with your consideration, we hope to work with the Committee and our colleagues in Maryland and other states to develop a timely legislative strategy to help us in this effort. One alternative is to provide LDWF with some reasonable latitude to begin immediately its efforts to address the feral swine problem under a reauthorized Nutria Eradication and Control Act (S. 1519). In the field, our nutria and feral swine control efforts go hand-in-hand. Another complimentary strategy would be to develop a separate piece of legislation devoted to controlling the feral swine problem. We would be very grateful for your consideration in working with our Senators on this initiative.

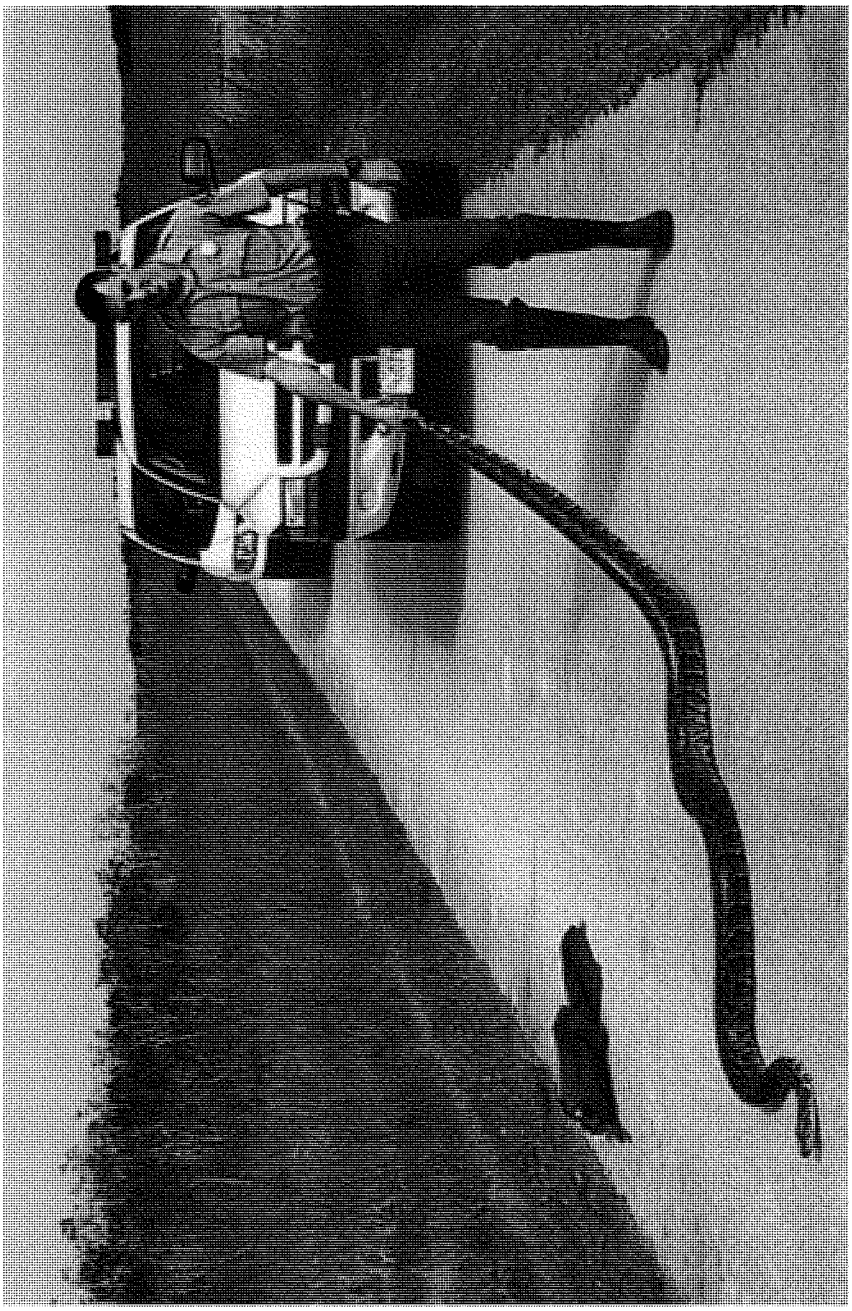
Thank you again for the opportunity to submit this testimony for the record of your hearing. We look forward to working with you on these important issues.

Sincerely,

Robert L. Barham
Secretary





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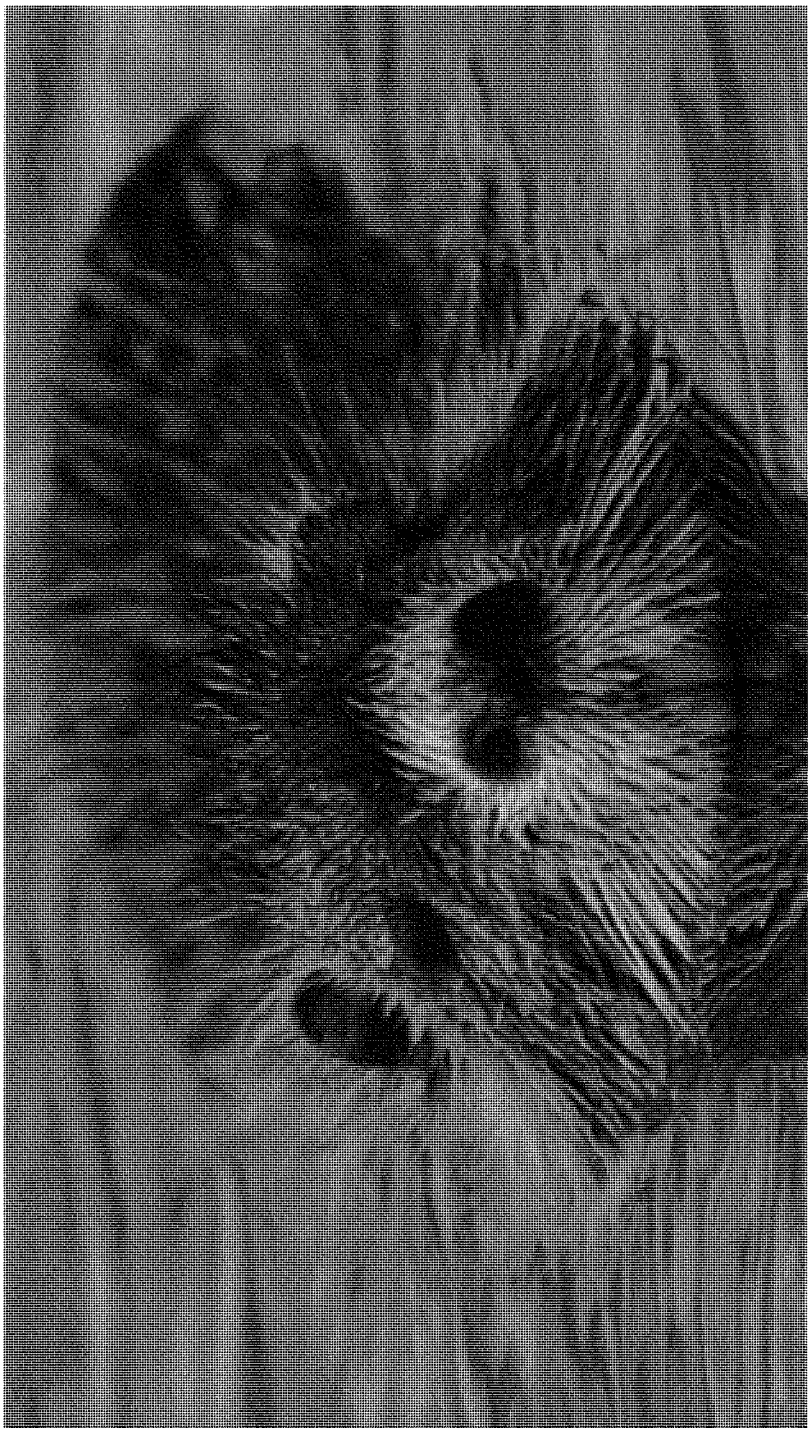
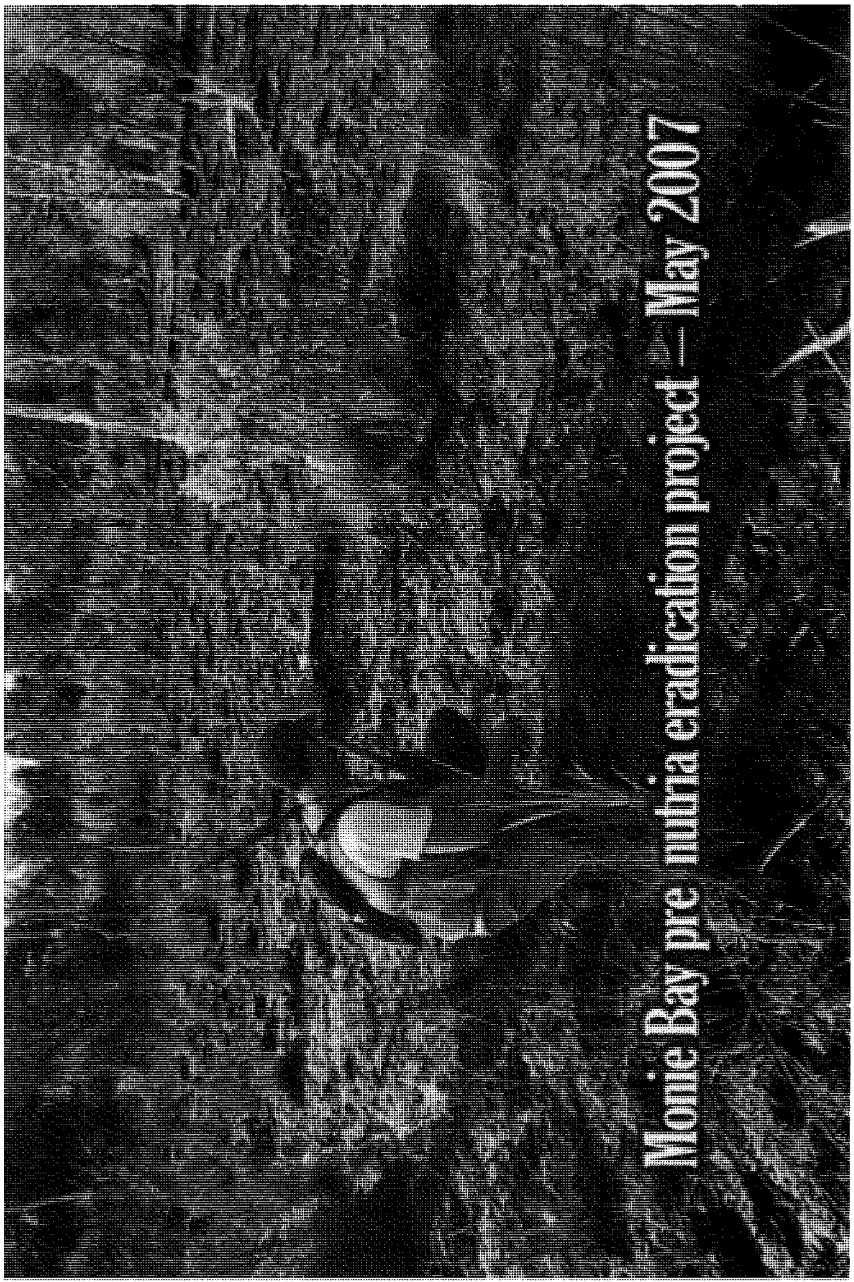
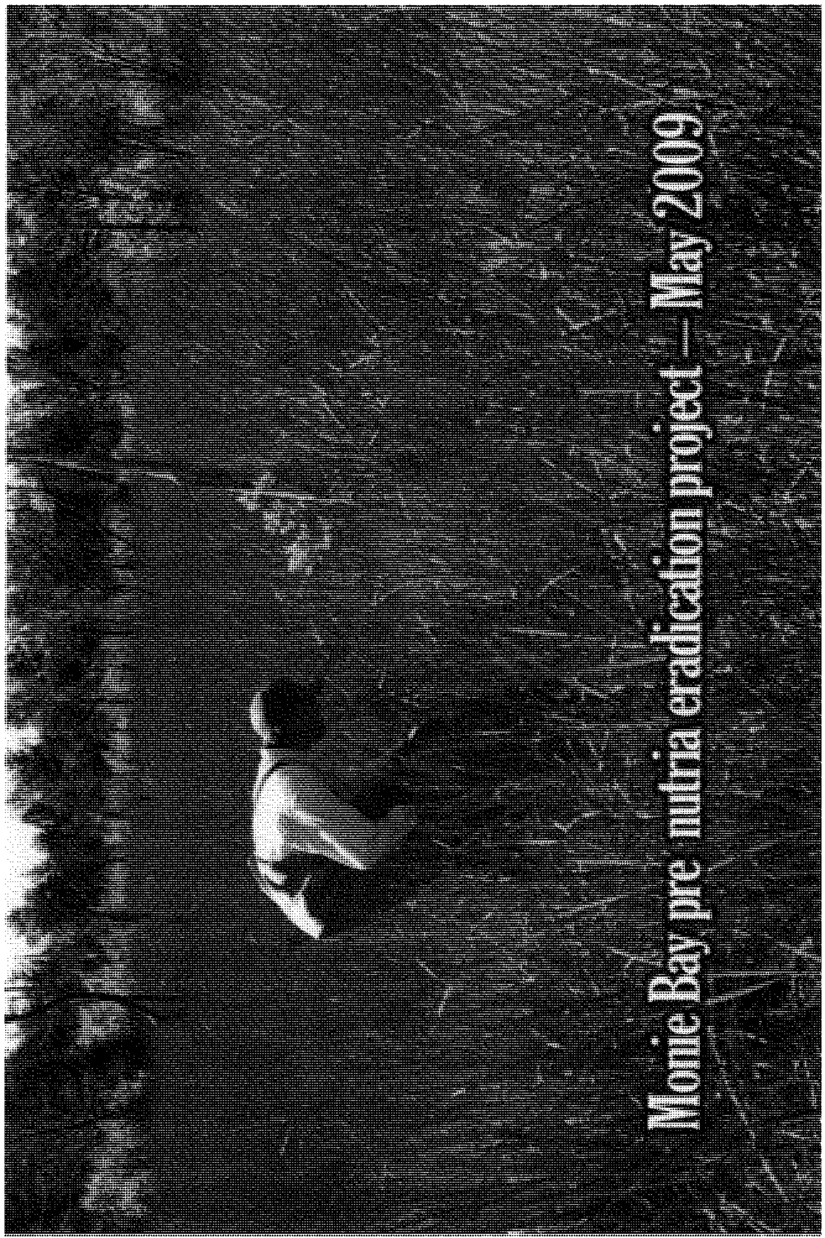



Monie Bay pre nutria eradication project — May 2007


Monie Bay pre nutria eradication project — May 2009