

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

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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 matter, 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.