Scientists' statement of reasons for a class-wide moratorium of amphibians in USA import trade to prevent entry of *Batrachochytrium salamandrivorans* (*Bsal*)

In light of new evidence about the risk of *Batrachochytrium salamandrivorans* (Bsal) to salamander species and the very recent finding of Bsal on frogs in trade in Germany[1,2], we, the scientists named below or representing the undersigned groups, call for an urgent, class-wide suspension of all amphibian imports to the USA, whether native or non-native species, *until such time as a clean trade program is feasible*. We ask the US Fish and Wildlife Service to please consider this full request or alternative policy options as outlined below such as an import restriction of known-affected amphibian genera and/or genera from regions where Bsal occurs in the wild (Europe and Southeast Asia).

We appreciated the prompt action from, and open communications with, the USFWS in response to a similar letter in 2015 leading to the 2016 rule. We ask now for prompt action again in light of this additional evidence in order to protect native amphibian species and amphibians in zoos and in personal collections.

A recent paper in the journal Nature[2] describes the fungal pathogen *Batrachochytrium salamandrivorans* (Bsal) as operating in a **"perfect storm" of infection**. New information in that paper includes the discovery of a second type of fungal spore that encysts and can remain viable and infective at the water-air interface for 30 days. These spores are less readily consumed by aquatic micropredators than the flagellated spore. Alarmingly, Bsal encysting spores can remain viable on the feet of waterfowl and can infect non-susceptible amphibians, including several frog species. These discoveries help to explain how Bsal can spread across landscapes and suggest that it will be extremely difficult to eradicate it since non-susceptible species act as reservoir species. Finally, there was no immune response in fire salamanders to Bsal, leading to mortality. So far, data suggest that species in the newt family (Salamandridae) are lethally affected. For example, the fire salamander in Europe can be rapidly extirpated from ponds by Bsal in part because lethality falls on adults. We know from earlier work[3] that North American newts are lethally affected. A species in the family Plethodontidae also was lethally affected. The authors of the Nature paper conclude that

> for regions that are currently considered free of *B. salamandrivorans*, such as the Americas, prevention of introduction in naïve environments should be considered the sole effective control measure available (p. 356)[2].

This conclusion was reiterated in a recent Perspective in the journal Science, which states "comparatively cheap measures, such as lobbying for protective legislation to avoid introduction of wildlife diseases and strategically developing early response plans, will be more effective than post hoc attempts at species salvation"[4].

It is important to note that the eastern newt *Notophthalmus viridescens* is a wide-ranging, keystone species in pond communities[5] so that if it is extirpated, it is likely that the weakly-competitive frog species will decline as a consequence. This will be analogous to the decline of competitively-weaker shellfish species in intertidal areas if the predatory seastar *Pisaster* is removed.

Given that newts are lethally affected by Bsal and that Bsal has several documented environmental reservoirs (non-susceptible amphibian species including a frog species, feet of waterfowl, pond water) that would make eradication once introduced difficult or impossible, we now know that the grim scenario seen in Europe seems likely to be played out in North American should Bsal arrive. **The priority is to keep Bsal out of North America**.

The current moratorium imposed on imports of 201 salamander species by the USFWS and the voluntary ban on importation of firebelly (*Cynops orientalis*) and paddletailed (*Pachytriton labiatus*) newts recommended by Pet Industry Joint Advisory Council are welcome steps. However, the rapid extirpation of fire salamanders seen in Europe and the documentation of Bsal as a lethal pathogen capable of rapid spread raise new concerns. In addition, unpublished research in preparation for publication indicates that additional genera of salamanders and frogs found in the US can be infected by and are vulnerable to Bsal. As noted in the recent Nature paper, **prevention of introduction is the only effective control measure currently available**.

We note that the Canadian government has recently implemented a ban on all salamander imports. [6]

Thus, for maximum protection of native species, and to protect US commercial amphibian interests, including captive species in zoos, hobbyist collections and private pet collections, we recommend that the best course of action is to **suspend all amphibian (salamander and frog) imports** *until such time as a clean trade program is feasible*.

If this level of protection is not possible, we offer the following alternatives, alone or in combination:

1) Suspend all imports of amphibians (salamanders and frogs) in shipments originating in **areas of the world where Bsal has been detected in the wild** (such as Belgium, Netherlands, Germany, Vietnam, Thailand, Japan), **regardless of genus**.
2) Suspend all imports of amphibians (salamanders and frogs) **regardless of country of origin of shipment** representing either or both of the following:

    a. All genera that occur in areas of the world where Bsal has been detected in the wild
    b. All genera on which Bsal has been found (such as *Bombina* and *Alytes*)

For reference, we include below updates to the original statement from 2015 of reasons for an order-wide moratorium on salamander imports.

1. **Evolutionary reasons:** A member of the family Hynobiidae, *Salamandrella*, was found to be a carrier of *Bsal*.[3] This is an ancient family, strongly suggesting that the ability to carry Bsal is an early-evolved, primitive trait, and therefore it is expected to occur in all species in all salamander families unless it is shown not to.

2. **Statistical reasons:** There are ten families of salamanders of which five have been minimally tested for ability to be infected. Four of the five families had members that can be infected (carriers). [3]

Importantly, a positive result with minimal sampling *does indicate* members of the family can be infected, while a negative result with minimal sampling does *not* provide strong evidence that all species in the family cannot be infected. In laboratory testing, only one family (the Ambystomatidae) out of five was found to be "not infectable". However, it is important to note that this result is based on minimal sampling: ten individuals of two species in this family. With such a small sample size, it is *impossible* to make a definitive conclusion about whether members of this family can carry infection, and it would be inaccurate to generalize this to all species in this family. Therefore, the best evidence is that species in four of four families can be infected, and we are *not sure* about the other six families because testing has not been completed or has not begun.

The statistical argument for order-level regulation is that we are sure that species in four tested families can be infected and act as carriers, including a species in an ancient lineage (Hynobiidae). Thus, it is highly probable that the other six families for which testing is not complete will include species that can be infected and act as carriers.

An analogous example: Ten airliners arrive in the United States on the same day from the same country that is experiencing an outbreak of a lethal and highly contagious disease (such as Ebola). Minimal testing is conducted of passengers on five of the planes, and Ebola is found on four of those five planes. Would a Federal health official be comfortable allowing all the passengers on all ten planes to enter without further measures to ensure they did not have Ebola, even from the untested planes?

3. **Immunology**: Traded salamanders are often transported in high densities (hundreds per container) and under poor sanitary conditions and sub-optimal temperatures, which are likely to cause stress-induced immunosuppression and lower a species' *Bsal* tolerance. Thus, results from lab exposure trials that identify certain species as "*Bsal*-resistant" are not necessarily applicable to the context of the salamander trade, where these animals are not maintained under the same optimal husbandry conditions as those held in the laboratory. It is not feasible to test a diversity of species' responses to *Bsal* under a potentially wide spectrum of poor husbandry conditions, and thus *all salamander species may be susceptible to Bsal under some set of conditions*. The best

approach to avoid this experimental limitation and pitfall is order-wide regulation applicable across the import trade to prevent exclusion of *Bsal*-susceptible species that may appear resistant in a laboratory setting.

4. **Cross contamination**: Multiple salamander species are often maintained together at foreign facilities where Bsal cross-contamination is likely to occur through water exchange prior to exportation. Whether different species are housed together or separately but on a continuous water system, a shipment of a non-prohibited species could become contaminated with Bsal-positive water. *So even if the species to be imported was not classified as a carrier of Bsal, it can still facilitate the importation of Bsal through contamination*. Thus, without being able to confirm the absence of exposure to confirmed Bsal-carrier species prior to export to the USA, all salamander importation currently poses either a direct or indirect threat of Bsal introduction to the USA.

5. Additional practical considerations: Inconsistent taxonomy and frequent inaccurate identification and labeling of salamanders in the trade indicate that caution is needed in parsing out those species that should be regulated from those that should not. Inconsistent scientific and common names are used. Several species are cryptic and hard to distinguish. Given the frequent misidentification and mislabeling (purposeful or inadvertent) of salamander imports, it would place tremendous pressure on Government port inspectors to determine the correct species and would lead to risks of imported species evading needed regulatory measures to prevent *Bsal* introduction.

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[1]Nguyen, T. T., Van Nguyen, T., Ziegler, T., Pasmans, F., Martel, A. 2017. Trade in wild anurans vectors the urodelan pathogen *Batrachochytrium salamandrivorans* into Europe. *Amphibia-Reptilia* https://doi.org/10.1163/15685381-00003125.

[2]Stegen, G., Pasmans, F., Schmidt, B.R., Rouffaer, L.O., Van Praet, S., Schaub, M., Canessa, S., Laudelout, A., Kinet, T., Adriaensen, C. and Haesebrouck, F. 2017. Drivers of salamander extirpation mediated by *Batrachochytrium salamandrivorans*. *Nature* 544: 353-356.

[3]Martel, A., Blooi, M., Adriaensen, C., Van Rooij, P., Beukema, W., Fisher, M. C., ... & Pasmans, F. (2014) Recent introduction of a chytrid fungus endangers Western Palearctic salamanders. *Science* 346: 630-631.

[4]Bower, D.S., Lips, K.R., Schwarzkopf, L., Georges, A., and Clulow, S.(2017 Amphibians on the brink. Science 357: 454-455.

[5]Morin, P.J., 1983. Predation, competition, and the composition of larval anuran guilds. *Ecological Monographs* 53: 119-138.

[6]http://www.cbsa-asfc.gc.ca/publications/cn-ad/cn17-17-eng.html [accessed 03 October 2017]