

*Bsal* Task Force

# 2018 Annual Report

January 2019



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# 2017-2018 *Bsal* TAC Annual Report

## Background

*Batrachochytrium salamandrivorans* (*Bsal*) is an emerging fungal pathogen that infects amphibian skin. It was discovered in 2013 in Europe, following the discovery of ongoing mortality of Fire Salamanders (Martel et al. 2013). It appears to be expanding in distribution (Spitzen-van der Sluijs et al. 2016). A 2014 experiment (Martel et al. 2014) revealed susceptibility of salamanders from around the world to the pathogen, including some North American species. At a 2015 workshop in Colorado, researchers and managers discussed approaches to learn more about the *Bsal* and the related emerging infectious disease caused by it and to forestall potential biodiversity losses in the Americas where it was not known to occur (Grant et al. 2016).

The *Bsal* Task Force was initiated in June 2015 (Figure A, below). Seven interactive Working Groups (Figure B) were formed: 1) Surveillance/Monitoring, 2) Diagnostics, 3) Data Management, 4) Response, 5) Outreach/Communication, 6) Research and 7) Decision Support.

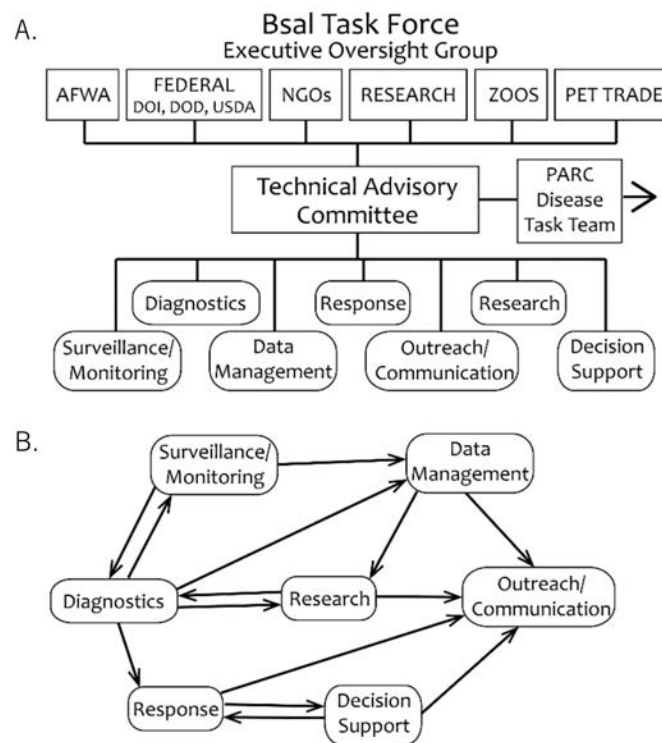


Figure A (top), Structure of the *Bsal* Task Force. Figure B, Interactive Working Groups within the task force.

Working Group leads serve on the Technical Advisory Committee, which also includes representatives from concerned partner groups such as the Pet Industry Joint Advisory Council (PIJAC), Amphibian Survival Alliance, and US federal agencies. An Executive Oversight Group was envisioned for consultation. Related tasks have been taken up by the Disease Task Team founded by Partners in Amphibian and Reptile Conservation (PARC), and an independent

working group in Canada, the Canadian Herpetological Health Working Group. National amphibian disease contacts in Mexico have been identified.

Actions to forestall *Bsal* transmission have been undertaken by three key partners. In 2015, the PIJAC instituted a moratorium on Asian salamander imports. In early 2016, the US Fish and Wildlife Service implemented an Interim Rule of the Lacey Act, naming 201 salamanders as injurious. They used an evidence-based approach prohibiting importation of any salamander genus whose members were shown to be carriers or to be lethally affected by *Bsal* in published papers. In the summer of 2017, Canada implemented import restrictions on all salamanders (Customs Notice 17-17; <http://www.cbsa-asfc.gc.ca/publications/cn-ad/cn17-17-eng.html>).

This report compiles activities conducted by the *Bsal* Task Force and their partners from September 2017 to August 2018.

## Key Accomplishments in 2017-2018

- A Strategic Plan for the containment of a *Bsal* discovery in North America has been written and is in final review before posting on the salamanderfungus.org website
- A Response Plan for the discovery of *Bsal* in North America has been finalized and posted on [salamanderfungus.org](http://salamanderfungus.org).
- Three million dollars in grant funding have been secured to addresses research questions related to *Bsal* and its disease ecology, and 18 papers by working group members have been published. A list is given at the end of this report.
- A list of laboratories throughout the world are set up to test for amphibian pathogens, including *Bsal*, and this list will be updated and maintained based on input from the Diagnostics Working Group.
- Progress was made in adding *Bsal* project data to the amphibian chytrid disease portal ([amphibiandisease.org](http://amphibiandisease.org)), transferring historical *Bd* data from *Bd*-maps.net, and updating the portal with both *Bsal* and *Bd* reports from the literature.
- A Management working group was formed. Its mission is to facilitate and improve a natural resource agency's ability to take proactive and reactive actions to prevent introduction and spread of *Bsal*.
- Communication and outreach have been successful by several measures including data that indicate that the *Bsal* website ([salamanderfungus.org](http://salamanderfungus.org)) has had more international exposure than in previous years, an increase in followers on Twitter and the production of a public service video, which has had over 2400 views to date.

## *Bsal* Task Force Organization

The *Bsal* Task Force is an ad hoc group of scientists, managers, and citizens who are helping to understand and forestall the threat of *Bsal* in North America. Although a central focus is to coordinate strategic planning and efforts in the USA, there is participation from both Canada and Mexico, and also with European and Australian scientists.

### Organizational Progress:

Working Groups were initially formed in June 2015. Since then, they have met via conference calls on a regular basis to outline new tasks and discuss progress on existing efforts. Group membership is open and inclusive, but was initially founded with persons involved with disease research, natural resource management in state and federal agencies, environmental or conservation groups, non-governmental organizations, and the pet industry. Each group has one to three leads, who help to coordinate personnel, manage the workload, and report to the Technical Advisory Committee.

The Technical Advisory Committee (TAC) is populated by the Working Group leads and representatives from selected partner groups including federal agencies, the IUCN Amphibian Survival Alliance (ASA), and the Pet Industry Joint Advisory Council (PIJAC). The TAC meets by conference call monthly, with a focus on new items and round-robin reporting by participants. New items have included tasks to be assigned or delegated to others, opportunities for products and grant proposals, and communication-outreach and networking needs. Monthly meeting notes are routed to TAC members, then to their working group members, to ensure communication. A lead for the TAC is determined by the TAC and is rotated each year. The incoming and outgoing leads serve as co-leads. Decisions of the TAC are made by consensus. *Bsal* products with oversight by TAC members were: 1) a paper by Adams et al. (2018) encouraging release of provisional findings when wildlife health is at stake, such as discovery of a *Bsal*-caused die-off in North America by researchers – publication would not be at risk due to early release of information; 2) a paper by Hopkins et al. (2018) outlining strategic responses if *Bsal* were to be detected in a US National Park, National Forest, or on neighboring Tribal lands; and 3) the journal *Herpetological Review* has expedited publication of 5 *Bsal* surveillance reports in North America, where *Bsal* was not detected in wild and/or captive animals.

An Executive Oversight Group (EOG) was originally envisioned to be created as a mechanism to inform managers or leaders of new *Bsal* information or emerging *Bsal* topics at higher organizational levels, potentially including US Department staff, the Association of Fish and Wildlife Agencies (AFWA), and PIJAC. The initiation of the *Bsal* Task Force EOG was proposed to national leaders at the North American Wildlife and Natural Resources Conference in March 2016. Discussion there expanded the need for such an oversight body not just for *Bsal*, but for other non-agricultural wildlife diseases with analogous task forces such as White-nose Syndrome in bats, as well as wildlife diseases without formalized task forces such as Sea-star Wasting Disease. An EOG for non-agricultural wildlife diseases is the topic of continued discussion. This topic segues to that of a recognized gap in US laws for wildlife health. Whereas the US Animal Health Protection Act (7 USC 109) covers agricultural wildlife health, there is no companion legislation for non-agricultural wildlife. This topic is an example of what the EOG could address. The proposal of an EOG and ensuing discussions of gaps in oversight of wildlife diseases have raised significant awareness of *Bsal* among a new cadre of US Department and State personnel, and has resulted in a growing awareness of *Bsal* knowledge developments among relevant industries and authorities.

## Working Group Reports



Southern Dusky Salamander, *Desmognathus auriculatus*. Photo: Alberto López

### Research Working Group

#### Leads

Matthew Gray, University of Tennessee  
Douglas Woodhams, University of Massachusetts Boston

#### Members

Molly Bletz, Cherie Briggs, Jessie Brunner, Davis Carter, Alessandro Catenazzi, Joseph Cussac, Maria Forzan, Lilian Fritz-Laylin, Evan Grant, Emily Hall, Reid Harris, Tatum Katz, Brandon LaBumbard, Karen Lips, Ana Longo, An Martel, Cait McDonald, Debra Miller, Kevin Minbiole, Oz Ossiboff, Gabriela Parra, Josh Parrott, Frank Pasmans, Angie Peace, Kenzie Pereira, Jonah Piovita-Scott, Louise Rollins-Smith, John Romansic, Julia Tasca, Jamie Voyles, Vance Vredenburg, Ross Whetstone, Doug Woodhams, Sarah Woodley

### *Bsal* Research Working Group Accomplishments

1. Extramural Funding Secured for *Bsal* Research
  - a. Secured

- i. National Science Foundation, Transmission pathways and immunological factors driving invasion potential of the recently discovered pathogen, *Batrachochytrium salamandrivorans*. \$2,494,511
- ii. BAND Foundation – total of approximately \$168,000 over two years
- iii. Tennessee Wildlife Resources Agency = \$19,320
- iv. Tennessee Fellowship for Graduate Excellence = \$110,000
- v. University of Tennessee Access and Diversity Fellowship = \$34,000
- vi. Liquid Spark = \$7,000
- vii. NSF EDGE: Genetic transformation of chytrid fungi. (Total costs: \$778,390.00)- This grant provides funding for development of genetic transformation of two species of chytrid fungi: *Batrachochytrium dendrobatidis* and *Allomyces macrogynus*. We will be extending these basic molecular genetic tools for use with *Bsal* as they become available.
- viii. Amphibian Survival Alliance (\$7,500)
- ix. David H. Smith Conservation Fellowship (\$150,000)
- x. Foundation for the Conservation of Salamanders (5,000)
- xi. Mohamed bin Zayed Species Conservation Fund (not funded)
- xii. U.S. Fish and Wildlife Service, Competitive State Wildlife Grant (in collaboration with Tennessee Wildlife Resources Agency), The threat of *Batrachochytrium salamandrivorans* (*Bsal*) to species of greatest conservation need and proactive development of disease management strategies = \$500,000

## 2. Research Activities

- a. Completed susceptibility trials on 16 additional species = 44 total (see table) – NOTE: This number is for ALL labs.
- b. Optimized use of flow cytometry to enumerate live and dead *Bsal* zoospores.
- c. Completed experiments evaluating differences in methodologies for *Bsal* experimental challenges.
- d. Initiated experiments evaluating the influence of temperature on *Bsal* invasion probability.
- e. Established a Pacific Northwest regional *Bsal* working group: Dr. Piovio-Scott established and coordinate a regional *Bsal* working group for the Pacific Northwest. This group has a membership of 50, including individuals representing organizations in both Canada and the US.

- f. Cultured, tested an identified *Bsal*-inhibiting skin microbiota from eastern newts and two-lined salamanders.
- g. Initiated experiments testing the ability of VOC-producing bacteria to clear *Bsal* infection and minimize disease in Fire salamanders and eastern newts.
- h. Completed a probiotic treatment trial with eastern newts.
- i. Initiated collaborations to develop nanoparticle vaccination strategies.
- j. Developed a viability assay for mucosome function testing.
- k. Tested Panamanian amphibians for *Bsal* (all negative).
- l. More sensitive LC-MS chemical analysis method for TTX developed

### 3. Delivered Research Presentations on *Bsal*

Bohanon, M., D. A. Malagon, J. P. Cusaac, E. D. Carter, C. Sheets, B. Gleaves, R. Kumar, L. K. Reinert, L. Rollins-Smith, D. L. Miller, and M. J. Gray. 2018. Refinement of methodologies for susceptibility challenges with the emerging fungal pathogen *Batrachochytrium salamandrivorans*. International Conference of the Wildlife Disease Association. St. Augustine, FL. *Oral Presentation*.

Carter, E. D., J. P. Cusaac, D. L. Miller, J. A. Spatz, L. Rollins-Smith, L. K., Reinert, L. A. Williams, A. English, M. Bohanon, and M. J. Gray. 2018. Susceptibility of species in the subfamily Spelerpinae to *Batrachochytrium salamandrivorans*. International Conference of the Wildlife Disease Association. St. Augustine, FL. *Oral Presentation*.

Gray, M. J., J. P. Cusaac, M. C. Bletz, E. D. Carter, D. C. Woodhams, M. L. Bohanon, L. K., Reinert, L. Rollins-Smith, P. Nanjappa, and D. L. Miller. 2018. Susceptibility of North American newt species to *Batrachochytrium salamandrivorans*. International Conference of the Wildlife Disease Association. St. Augustine, FL. *Oral Presentation*.

Miller, D. L., J. P. W. Cusaac, E. D. Carter, R. H. Hardman, M. L. Bohanon, L. Rollins-Smith, L. K., Reinert, D. C. Woodhams, and M. J. Gray. 2018. Pathology in *Notophthalmus viridescens* co-infected with *Batrachochytrium dendrobatidis* and *B. salamandrivorans*. International Conference of the Wildlife Disease Association. St. Augustine, FL. *Oral Presentation*.

Carter, E. D., J. P. Cusaac, D. L. Miller, L. Rollins-Smith, L. K., Reinert, M. Bohanon, D. A. Malagon, C. N. Sheets, L. A. Williams, A. English, P. Nanjappa, and M. J. Gray. 2018. Evaluating the threat of *Batrachochytrium salamandrivorans* (*Bsal*) to North American amphibian species including unknown anuran hosts. International Conference of the Wildlife Disease Association. St. Augustine, FL. *Poster Presentation*.

Cusaac, J. P. W., E. D. Carter, M. C. Bletz, D. C. Woodhams, M. L. Bohanon, L. K., Reinert, L. Rollins-Smith, A. Peace, L. A. Williams, A. English, P. Nanjappa, R. N. Harris, D.

- L. Miller, and M. J. Gray. 2018. Susceptibility of North American newt species to *Batrachochytrium salamandrivorans* (*Bsal*). Annual Meeting of the Ecological Society of America. New Orleans, LA. *Oral Presentation*.
- Gray, M. J., J. P. Cusaac, M. Bletz, E. D. Carter, D. Woodhams, L. K., Reinert, L. Rollins-Smith, G. Parra Olea, L. Williams, A. English, P. Nanjappa, and D. L. Miller. 2018. Quantifying the threat of a novel fungal pathogen (*Batrachochytrium salamandrivorans*) to amphibians of conservation concern in North Carolina (and beyond). Annual Meeting of the North Carolina Herpetological Society. Asheboro, NC. *Oral Presentation*.
- Cusaac, J. P., E. D. Carter, J. A. Spatz, L. K., Reinert, L. Rollins-Smith, L. Williams, D. L. Miller, and M. J. Gray. 2018. Susceptibility of species in the subfamily Spelerpinae to *Batrachochytrium salamandrivorans*. Annual Meeting of the Southeastern Partners in Amphibian and Reptile Conservation. Helen, GA. *Oral Presentation*.
- Malagon, D. A., J. P. Cusaac, E. D. Carter, L. Rollins-Smith, L. Reinert, D. C. Woodhams, D. L. Miller, and M. J. Gray. 2018. Evaluating the susceptibility of *Notophthalmus viridescens* to *Batrachochytrium salamandrivorans* (*Bsal*). Annual Meeting of the Southeastern Partners in Amphibian and Reptile Conservation. Helen, GA. *Poster Presentation*.
- Sheets, C. N., E. D. Carter, J. P. Cusaac, C. Yarber, A. Towe, M. J. Gray, and D. L. Miller. 2018. Enumerating and differentiating spore types of *Batrachochytrium salamandrivorans* by flow cytometry. Annual Meeting of the Southeastern Partners in Amphibian and Reptile Conservation. Helen, GA. *Poster Presentation*.
- Islam, R., A. Peace, M. J. Gray, and J. P. Cusaac. 2017. Dynamics of the emerging fungal pathogen, *Batrachochytrium salamandrivorans*, on the eastern newt. Twentieth International Conference of the Bangladesh Mathematical Society, Dhaka, Bangladesh. *Oral Presentation*.
- Gray, M. J., J. P. W. Cusaac, E. D. Carter, J. A. Spatz, D. C. Woodhams, L. Rollins-Smith, L. Reinert, L. A. Williams, B. Reeves, P. Nanjappa, and D. L. Miller. 2017. A newly discovered pathogen threatens amphibian biodiversity in the USA. 71<sup>st</sup> Annual Conference of the Southeastern Association of Fish and Wildlife Agencies, Louisville, KY. *Oral Presentation*.
- Cusaac, J. P. W., E. D. Carter, D. C. Woodhams, A. Peace, L. Rollins-Smith, L. Reinert, L. A. Williams, B. Reeves, P. Nanjappa, C. Richards-Zawacki, D. L. Miller, and M. J. Gray. 2017. Susceptibility of North American Newt Species to *Batrachochytrium salamandrivorans*. 71<sup>st</sup> Annual Conference of the Southeastern Association of Fish and Wildlife Agencies, Louisville, KY. *Oral Presentation*.
- Jonah Piovio-Scott, Deanna Olson, Matt Gray, Michael Adams, Priya Nanjappa, Reid Harris. 2018. *Bsal*: An emerging threat to amphibians in the Pacific Northwest? Society for Northwest Vertebrate Biology Annual Meeting in Portland Oregon. *Oral Presentation*.



Isam Adam, Brandon LaBumbard, Douglas Woodhams. May 2018. The Effect of Volatile Organic Compounds Produced by Bacteria on Pathogenic Fungal Inhibition. Sanofi Oracle Research Fellowship Symposium, Boston MA. *Poster Presentation*

Kathleen Conroy, Brandon LaBumbard, Douglas Woodhams. April 2018. Using Probiotic Therapy to Experimentally Treat Eastern Newts Exposed to an Emerging Fungal Pathogen, UMass Boston SFE Environmental Research Colloquium. *Poster Presentation*.

Kathleen Conroy, Brandon LaBumbard, Douglas Woodhams. April 2018. Using Probiotic Therapy to Experimentally Treat Eastern Newts Exposed to an Emerging Fungal Pathogen. Massachusetts Undergraduate Research Conference at UMass Amherst. *Poster Presentation*.

4. Delivered 8 Outreach Presentations on *Bsal*

- a. University of Tennessee-Knoxville: Life history of amphibians and their declines. Clayton Bradley STEM Academy, Alcoa, TN. 21 August 2018.
- b. University of Tennessee-Knoxville: The threat of *Batrachochytrium salamandrivorans* (*Bsal*) to North American biodiversity. U.S. National Park Service, Great Smoky Mountains National Park, Gatlinburg, TN. 14 September 2017.
- c. North American Wildlife and Natural Resources Conference. Updates and Discussion: *Bsal* Research, Needs and Potential Actions; Salamander Chytrid Fungal Disease Update, March 2018.
- d. Massachusetts Partners in Amphibian and Reptile Conservation Meeting, "Proactive conservation: curbing the threat of the salamander-eating fungus" Amherst, MA. August 2018.
- e. University of Massachusetts Boston, "It's not easy being green": Disease ecology principles of amphibian chytridiomycosis. Boston, MA (Guest Lecture in Population Biology). December 2017.
- f. Texas State University, "Ecology and Evolution on Amphibian Skin: Responding to Disease Emergence with Microbial Therapy" *Guest Lecture*. March 2018, Austin, TX.
- g. University of South Dakota, "Ecology and Evolution on Amphibian Skin: Responding to Disease Emergence with Microbial Therapy" *Guest Lecture*. April 2018, Vermillion, SD.
- h. University of Tennessee Knoxville. *Guest Lecture* for Amphibian Ecology and Conservation course: <http://fwf.ag.utk.edu/mgray/wfs493/493home.htm> May, 2018.
- i. Presentation to state agencies on *Bsal* biology and management. <https://itunes.apple.com/us/itunes-u/id1202403649> Feb., 2018.

## 5. Multimedia

- a. Maintained UTIA *Bsal* Project Website: <https://ag.tennessee.edu/fwf/bsalproject/>
- b. Created website for *Bsal* NSF Project #1814520: <https://ag.tennessee.edu/fwf/NSF/>
- c. Created 3-min *Bsal* Rap Video: <https://tiny.utk.edu/bsal>

## 6. Peer-refereed Publications

- a. Published:
  - i. Adams, M. J., R. N. Harris, E. H. C. Grant, M. J. Gray, M. C. Hopkins, S. A. Iverson, R. Likens, M. Mandica, D. H. Olson, A. Shepack, and H. Waddle. 2018. Prepublication communication of research results. *EcoHealth* doi: 10.1007/s10393-018-1352-3.
  - ii. Gray, M. J., M. C. Allender, K. H. Haman, R. N. Harris and D. H. Olson. 2018. Facilitating early detection and rapid response. *Wildlife Professional* 12:33-35.
  - iii. Cook, K.J., J. Voyles, H.V. Kenny, K.L. Pope, J. Piovita-Scott. 2018. Non-lethal isolation of the fungal pathogen *Batrachochytrium dendrobatidis* (*Bd*) from amphibians. *Diseases of Aquatic Organisms* 129: 159-164. doi: 10.3354/dao03238.
  - iv. Woodhams DC, Barnhart KL, Bletz MC, Campos AJ, Ganem SJ, Hertz A, LaBumbard BC, Nanjappa P, Tokash-Peters AG. *Batrachochytrium: Biology and Management of Amphibian Chytridiomycosis*. eLS.:1-8.
  - v. MC Bletz, M Kelly, J Sabino-Pinto, E Bales, S Van Praet, W Bert, F Boyen, M Vences, S Steinfartz, F Pasmans, A Martel. 2018. Disruption of skin microbiota contributes to salamander disease. 2018. *Proc. of the Royal Society B*.
  - vi. DC Woodhams, BC LaBumbard, KL Barnhart, MH Becker, MC Bletz, LA Escobar, SV Flechas, ME Forman, AA Iannetta, MD Joyce, F Rabemananjara, B Gratwicke, M Vences, KPC Minbiole. 2018. Prodigiosin, violacein, and volatile organic compounds produced by widespread cutaneous bacteria of amphibians can inhibit two *Batrachochytrium* fungal pathogens. *Microbial Ecology*. 75: 1049-1062.
  - vii. MC Bletz, BC. LaBumbard, AY. Basco Martínez, RN Harris, DC Woodhams. *In review*. Fighting microbes with microbes: First steps in developing probiotic mitigation tools to combat salamander chytridiomycosis in eastern newts. *SSAR Book: Strategies for Conservation Success in Herpetology*.
  - viii. K Barnhart, MC Bletz, B LaBumbard, A Tokash-Peters, C Gabor, DC Woodhams. *In review*. *Batrachochytrium salamandrivorans* elicits stress

response in spotted salamanders but not mortality. *Animal Conservation*.

ix. Voyles *et al.* *In review*. Quantifying *Batrachochytrium dendrobatidis* and *Batrachochytrium salamandrivorans* viability. *EcoHealth*.

7. Participated in 3 Interviews on *Bsal*

- a. Mongabay (1): <https://news.mongabay.com/2018/09/on-the-hunt-for-a-silent-salamander-killer/>
- b. Smithsonian online: <https://www.smithsonianmag.com/science-nature/how-american-scientists-are-planning-thwart-salamander-apocalypse-180969809/>
- c. National Geographic (1) – not released yet.

8. Contributed to Research Working Group and Management Working Group sections of the Strategic Plan of the North American *Bsal* Task Force.



Spotted Newt, *Notophthalmus viridescens*. Photo: Alberto López

## Data Management Working Group

### Leads

Michelle Koo (UC Berkeley and AmphibiaWeb)  
Deanna Olson (US Forest Service, Pacific Northwest Research Station)

### Members

Philip Kahn (website developer, UC Berkeley); John Deck (programmer consultant, Berkeley Natural History Museums); David Wake (AmphibiaWeb director, UC Berkeley); Kathryn Ronnenberg (US Forest Service, Pacific Northwest Research Station).

### Summary statement

The chytrid data management portal, Amphibian Disease (<https://amphibiandisease.org>), is fully operational, and has not had major developments in the past year. Database and dashboard maintenance updates have occurred throughout the period. A focus now is to upload *Bsal* project data to the portal, transfer historical Bd data from Bd-maps.net, and update the portal with both *Bsal* and *Bd* reports from the literature. For the latter, changes to the template and validation code were implemented.

### Key Points

Coordination with the *Bsal* Surveillance Working Group continues, and in particular incorporation of the USGS national surveillance results in the web portal database is pending.

- 1) Ongoing discussions at the monthly *Bsal* Technical Advisory Committee conference calls have led to general agreement for increased coordination and cooperation with the other *Bsal* Task team working group activities, and the potential benefits of merging some of the working groups. The idea of restructuring the Data Management and Surveillance Working Groups into one unit, and expanding the scope to include aspects of monitoring is gaining momentum.
- 2) For the Amphibian Disease portal, focused attention is needed to build support and user base, generate funding, and help guide future development.

#### 3) **Amphibian Disease portal summary statistics:**

Total projects-- 42 projects (13 public)  
Total samples—17,985 (15,408 public)  
Total species sampled-- 353 species from 25 countries

- 4) Bd-maps database integration into the Amphibian Disease portal is still on the docket to accomplish but is an increasingly more complicated task with ongoing literature entries. Dede Olson oversees the Bd-maps database, and Bd information requests can be sent directly to her ([dedeolson@fs.fed.us](mailto:dedeolson@fs.fed.us)) until the merging with the Amphibian

Disease portal is completed. The Bd-maps.net link was broken in 2013, and export functions failed at that time. Kathryn Ronnenberg (US Forest Service, Pacific Northwest Research Station) has restored and updated the database through 2014 (wild and captive data: 19,915 records from 8,247 sites; Order summary below; Family summary available upon request) and is continuing with a literature review and database additions from 2015 to present. *Note: the database represents Bd detections and no-detections by geographic and taxonomic factors with limited quality assurance of reports; limited captive data are included; there is no database record of Bd strain, zoospore load, or disease incidence although associated references may include such additional information.*

**Bd-maps Order summary:**

<b>Order</b>	<b>No. species with Bd detected</b>	<b>No. species tested</b>	<b>Spp. Prev. (%)</b>	<b>Total species</b>
Anura	761	1469	51.8	6980
Caudata	100	200	50.0	718
Gymnophiona	8	24	33.3	205
<b>Total</b>	<b>869</b>	<b>1693</b>	<b>51.3</b>	<b>7903</b>

<b>Order</b>	<b>No. families w/ Bd detected</b>	<b>No. families tested</b>	<b>Family prevalence (%)</b>	<b>Total families</b>
Anura	49	54	90.7	57
Caudata	8	8	100.0	9
Gymnophiona	5	9	55.6	10
<b>Total</b>	<b>62</b>	<b>71</b>	<b>87.3</b>	<b>76</b>

**Outcomes or impacts (including products and contribution to Strategic Plan) from workgroup activities**

- a) Presentations and demonstrations of the Disease Portal:

Koo, M., D.C. Cannatella, A. Catenazzi, A.T. Chang, J. Gross, P.Kahn, D.H. Olson, C. Spencer, V.T. Vredenburg, and D.B. Wake. 2018. AmphibiaWeb Innovations to Address the Global Crisis in Amphibians.

- a. iDigBio (NSF) Digital Data Conference, Berkeley, CA, 5 June 2018. (Michelle Koo, presenter)
  - b. Joint Meeting of Ichthyologist and Herpetologists Annual Meeting, Rochester, NY. July 12, 2018, Lightning talk (Carol Spencer, presenter).
- b)** New links to the Amphibian Disease portal on AmphibiaWeb.org (home page, [pending] disease information and *Bsal* pages)



Three-lined Salamander, *Eurycea guttolineata*. Photo: Alberto López

## Response Working Group

### Lead

Priya Nanjappa, Conservation Science Partners (CSP)

### Participants

Michael Adams (USGS ARMI); Jenn Ballard (USFWS); Jeremy Coleman (USFWS, White-nose Syndrome National Coordinator); Evan Grant (USGS ARMI); Matt Gray (Univ of Tennessee – Knoxville); Camille Harris (USGS, Wildlife Disease Coordinator); Blake Hossack (USGS ARMI), Jonathan Kolby (James Cook University); Robert Lovich (Dept of Defense/Navy); Joe Mendelson (Zoo Atlanta); Jenny Powers (NPS); Dede Olson (USFS); Mary Kay Watry (NPS)

### Summary

The Response Working Group intends to serve as a resource for issues related to eradication, containment, or other management response should *Bsal* be detected in North America. The group has finalized a *Bsal* Rapid Response Plan template, intended for customization by management unit or captive salamander facility, which provides guidance for suggested actions upon a salamander mortality event or confirmed *Bsal* detection. The plan is available via [www.salamanderfungus.org](http://www.salamanderfungus.org).

### Key Points

- The response team has completed a Rapid Response Plan (RRP) template document to help agencies and institutions customize it for their own capacities and resources. It is posted on [salamanderfungus.org](http://salamanderfungus.org).
- The RRP will be a living document, where guidance will continue to be refined as new treatment, mitigation, or management opportunities become available. It will also incorporate any lessons learned when or if actual *Bsal* detection scenarios occur that demonstrate new or improved approaches to be integrated into the plan.

### Outcomes

- Although the RRP is specific to *Bsal*, the guidance within is applicable to other instances of amphibian diseases, and could potentially serve as a model for responses to other fish or wildlife diseases.
- The RRP is a key component of the *Bsal* Strategic Plan.
- The RRP will be broadly distributed to relevant state and provincial officials.

### Interactions with other groups

The Response Working Group may merge with the Management Working Group.

## Management Working Group

### Leads

Laura Sprague, US Fish & Wildlife Service  
Matt Gray, University of Tennessee institute of Agriculture

### Participants and affiliations

Michael Adams, U.S. Geological Survey; Evan Grant, U.S. Geological Survey; Riley Bernard, U.S. Geological Survey; Susan Jewell, U.S. Fish & Wildlife Service; Betsy Howell, U.S. Forest Service; Douglas Woodhams, University of Massachusetts Boston; Molly Bletz, University of Massachusetts Boston; Priya Nanjappa, Conservation Science Partners; Rebecca Hill

### Summary statement

The *Bsal* Management Group (Team) was formed in May of 2018 to bridge the gap between the Research Group, the Response Group and the Decision groups and to help managers facilitate efficient and rapid response to *Bsal* invasion.

### Key Points

- 1)** Identify the Team's purpose and how it relates to the *Bsal* Strategic Plan and other groups.  
The Team spent a significant amount of time developing its mission statement and purpose, and was able to submit a section to the Strategic Plan.
- 2)** Facilitate and improve a natural resource agency's ability to take proactive and reactive actions to prevent introduction and spread of *Bsal*.  
The team started developing a list of actions using the White Nose Syndrome template. We will continue to work on completing the action items under this goal, but because the group is relatively new, we have not completed this task.
- 3)** Brief and Train (as necessary) natural resource agencies about the North American *Bsal* Task Force and available Management/Mitigation options at a Regional Level and at Headquarters level. The Team is still trying to identify stakeholders, and a chain of command to complete this task.

### Interactions with other groups

Many of our members are in other groups and help to facilitate communication between the groups. After defining the Team's purpose, we were able to contribute to the Strategic Plan.



## Diagnostics Working Group

### Leads

María Forzán, Cornell University, NY, USA (current leader)  
Jake Kerby, University of South Dakota (past leader)

### Participants and affiliations

John Wood, Pisces Molecular, USA; Julie Ellis, University of Pennsylvania, USA; Robert Ossiboff, University of Florida, USA; Steven Lloyd, Zoologix Inc., USA; Laura Sprague, US Fish & Wildlife, USA; LeAnn White, National Wildlife Health Center, USA; Jeff Lorch, National Wildlife Health Center, USA; Dan Grear, National Wildlife Health Center, USA; Heather Fenton, Government of the Northwest Territories, Canada; Deb Miller, University of Tennessee, USA; Kimberly Hamad-Schifferli, University of Massachusetts - Boston, USA; Carly Mueltz Wolz, Smithsonian Conservation Biology Institute, USA; Cherie Briggs, University of California, USA; Allan Pessier, Washington State University, USA; Matt Allender, University of Illinois, USA; An Martel, Ghent University, Belgium; Frank Passmans, Ghent University, Belgium; Leon Grayfer, George Washington University

List of participants includes members who have participated in at least one DxWG conference call, have contributed through email to the topics discussed by the group, or have expressed an interest in being included in the groups communications in the last 9 months (Jan-Sep 2018)

### Summary statement

The Diagnostics Working Group (DxWG), originally formed in 2015 as part of the North American *Bsal* Task Force, is composed of professionals with expertise in the application and interpretation of an array of diagnostic tools. Our members work in academia, diagnostic laboratories and government agencies throughout North America and are involved in detection and reporting of amphibian diseases, including the salamander chytrid fungus, *Batrachochytrium salamandrivorans* (*Bsal*).

The main goals of the DxWG are to assist with the promotion of consistent standards for diagnosis and reporting of *Bsal* among the wildlife health community. The DxWG also serve as a forum to exchange ideas and work out the challenges involved in *Bsal* detection and to provide expert advice to the rest of the *Bsal* Task Force regarding the viability and pitfalls of traditional and new tools for *Bsal* detection and diagnosis.

### Key Points

- 1)** The DxWG has served as a forum for open communication and collaboration amongst professionals involved in the area of amphibian diseases from various perspectives, including research, academia, diagnostics and wildlife management.

**2)** The DxWG considers a high priority to establish a long-term program for inter-laboratory quality control and evaluation of protocols for the detection of wildlife pathogens, particularly *Bd* and *Bsal*. This goal, set soon after the formation of the group, is included as Goal 1 of the DxWG's contribution to the Task Force's Strategic Plan currently in development. An initial round of round-robin type proficiency test (validation) was achieved in 2016, but it has been impossible to secure funding and expand the testing or establish a more permanent and long-term program.

**3)** Another goal of the DxWG is to foster the development of a network of diagnostic laboratories that can run tests to detect the presence of *Bsal* in amphibian or environmental samples in a timely manner and as participants in a voluntary proficiency testing program. Development and testing of methods that allows for comparison across studies and a reliable estimation of the presences and prevalence of *Bsal* in the wild could be done through the network of laboratories participating in the DxWG, but funding to support this initiative has been lacking.

**4)** Members of the DxWG, working at the University of Florida in collaboration with members of the Research Working Group from the University of Tennessee and University of Maryland, using their own funding, have developed and are in the process of validating an *in situ* hybridization technique on formalin-fixed paraffin-embedded tissues. The technique helps in the detection of chytrid infections and is capable of differentiating between *Bsal* and *Bd* (*Batrachochytrium dendrobatidis*), even in co-infected individuals.

#### Outcomes or impacts from the Diagnostics working group activities

**a)** A list of laboratories throughout the world that are set up to test for amphibian pathogens and, specifically, *Bsal*, has been updated and will be maintained based on input from the DxWG

**b)** Members of the DxWG have delivered lectures and other presentations at institutional, national and international meetings, in which they highlighted the significant threat *Bsal* poses to North American salamander populations.

**c)** Members of the DxWG contributed also content, expertise and suggestions to the following organizations/projects:

- Contribution to the Task Force's Strategic Plan
- Provision of information and support to the proposal for the listing of *Bsal* as a notifiable disease by the OIE (World Organization for Animal Health), a goal accomplished in 2018
- Information to the Canadian Council of Chief Veterinary Officers (Canada) about the risk of possible *Bsal* introduction into North America
- Participation in the Infectious Disease Committee of the Association of Reptile and Amphibian Veterinarians

d) Members of the group have published scientific articles regarding *Bsal* in peer-reviewed publications. E.g.:

- Klocke B, Becker M, Lewis J, Fleischer RC, **Muletz-Wolz CR**, Rockwood L, Aguirre AA, Gratwicke B. *Batrachochytrium salamandrivorans* not detected in US survey of pet salamanders. Scientific reports. 2017 Oct 13;7(1): 13132.
- Standish I, Leis E, Schmitz N, Credico J, Erickson S, Bailey J, **Kerby J**, Phillips K, Lewis T. Optimizing, validating, and field testing a multiplex qPCR for the detection of amphibian pathogens. Diseases of aquatic organisms. 2018 Jun 19;129(1):1-3.
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- Stegen G, **Pasmans F**, Schmidt BR, Rouffaer LO, Van Praet S, Schaub M, Canessa S, Laudelout A, Kinet T, Adriaensen C, Haesebrouck F. Drivers of salamander extirpation mediated by *Batrachochytrium salamandrivorans*. Nature. 2017 Apr;544(7650):353.

### Interactions with other groups

Several members of the DxWG are members of wildlife disease surveillance programs, including the National Wildlife Health Center, Cornell Wildlife Health Lab, University of Tennessee Wildlife Health Center, Northeast Wildlife Disease Cooperative, and the Canadian Wildlife Health Cooperative. A few members also participate in the Research, Management and Surveillance groups within the North American *Bsal* Task Force.

## Decision Support Working Group

### Lead

Evan Grant (USGS)

### Participants

Robin Russell, USGS); Katie Richgels, USGS; Riley Bernard, USGS/Penn State University; Rachel Katz, USFWS; Katrina Alger, USGS

### Summary

The Decision Support Working Group provides facilitation, relevant models and analyses to support management decisions regarding *Bsal*.

### Key Points

This group evaluated problems facing US protected area managers in responding to the threat of *Bsal*, and identified the decisions that can be solved via research (reduction of uncertainties) and decision analysis (e.g., tradeoff with other non-amphibian objectives). The group has been asked by three resource managers to help further refine their decision problem, to help identify possible proactive management solutions that can be implemented immediately to reduce the threat of *Bsal* invasion. This group initiated the development of a model to assess the effectiveness of importation bans of salamanders as a management strategy for *Bsal*, given the deep uncertainty in the processes leading to introduction of *Bsal* to wild and susceptible populations. The group continued to work on this objective into 2018.

### Manuscripts in preparation

- A manuscript investigating the expected effectiveness of importation bans and restrictions on salamanders is in prep.
- A manuscript characterizing the management decisions faced by practitioners.

### Progress

We are making efforts to extend the scope of the work to address emerging fungal diseases in general including white-nose syndrome (this is partially to attract greater funding sources and increase the level of interest in the project). The aim is to learn from WNS how to best prepare for proactive and preventative management for *Bsal* as well as for future wildlife diseases.

A set of questions was sent to Federal and State land managers, with the goal of helping to get a better sense of the management issues and information needs to develop a response to the salamander chytrid fungus (*Bsal*), and to better understand the context in which these decisions take place. This survey of manager issues is ongoing with a focus on state and federal natural resource management agencies, and will be summarized and compared against issues facing managers in making conservation decisions for bats under threat of WNS. Although preventing the arrival of a pathogen is most effective for controlling an emerging infectious disease, prevention is not failsafe. Additionally, resource managers often

consider multiple social, economic, and ecological objectives, and are challenged with confronting difficult trade-offs for any given disease management strategy (i.e., an optimal action for managing a wildlife disease may result in declines in recreational or economic values).

### Challenges

Challenges remain, including engaging managers when risk is low (i.e., as *Bsal* has not been detected in the US). This effectively limits the ability to identify and implement proactive management – representing a major challenge for developing management strategies for *Bsal* and other emerging infectious diseases. Specific and measurable amphibian management objectives are not common among natural resource agencies and we are working with several agencies to set objectives for amphibians in communities vulnerable to *Bsal*. In addition, there have been not treatment options identified for *Bsal* (and limited options for other fungal diseases of wildlife), which limits the alternatives available to managers.

### Outcomes

- 1) Workshops with a set of managers with ‘common’ decision problems will begin to frame these decisions, beginning with the first draft of the conceptual model developed during the June 2015 Powell Center workshop.

### Interactions with Other Working Groups

Ongoing work includes collaboration with the USFWS to frame emerging disease problems for WNS local management and treatment decisions, with the intention to use insights to inform *Bsal* decision problems. We are working with the Research and Management working groups to detail a model of the *Bsal* system so that management actions may be identified and evaluated using a shared system model. We are working with the Research working group and outside experts in amphibian disease ecology to populate a disease treatment table, which will provide options to resource managers considering actions, help to guide research priorities, and identify tradeoffs in other important objectives for resource management.



Dusky Salamander, *Desmognathus fuscus*. Photo: Alberto López

## Surveillance and Monitoring Working Group

This group has not been active over the last reporting period. It is an action item to begin to engage interested parties for continued monitoring of *Bsal* in North America.

## Communications and Outreach Working Group

### Lead

Mark Mandica, Amphibian Foundation

### Participants

Alex Shepack, Florida International University; Candace Hansen-Hendrikx, Amphibian Survival Alliance, *advisor*

### Summary

The *Bsal* Task Force Communications & Outreach Working Group manages *Bsal*-related communication and products for outreach, especially relative to providing informational materials for a myriad of interested groups and people with concern for salamander health and well-being.

### Key Points

- Website: Continued maintenance and posting to *salamanderfungus.org*. Updates are posted when new journal articles, popular press items, or other relevant *Bsal* items become available.
- Social Media: We continue to maintain and utilize Twitter (@salamanderfungi) and Facebook ([www.facebook.com/salamanderfungus/](http://www.facebook.com/salamanderfungus/)). As of Dec. 1 we have 698 followers on Twitter and 247 on Facebook. Twitter followers have increased by more than 300 since last year, while the Facebook page has only received 10 more.
- Publications: Several members of the task force authored an article discussing *Bsal* and current Task Force activities. The article, titled "*The Deadly Amphibian Bsal Disease: How a Joint Science-Management Approach is Forestalling Amphibian Biodiversity Losses*" has been accepted for publication in Science Findings.
- Public Service Video. Working with Freshwaters Illustrated, we produced a short (4:42) video, aimed at the general public, educating the viewer about the dangers of *Bsal*, including actions one can take to minimize the chance of spreading fungal disease. The video has had 2,471 views to date. <https://vimeo.com/288628617>

## Challenges

Maintaining active membership has been a challenge. The intermittent nature of the tasks of this working group make it hard to keep members involved. Additionally, increased communication is necessary between Task Force participants and the communication group so that media releases can be prepared in advance prior to the release of publications.

## Outcomes

- We had several unique Twitter posts that reached large audiences including the *Smithsonian* article tweet which had 6,329 impressions with 152 engagements. Also the PLOS article post received 4,144 impressions with 108 engagements with the post.
- On our Facebook page, all of our posts in 2018 reached at least 300 people, and had at least 35 engagements.
- There were nearly 2,865 unique page views (users viewed a unique page at least once) on the salamanderfungus.org website in 2018. The majority of the users viewing the salamanderfungus.org website within the same time period are from the United States (55.2%), followed by France (11.33%), then Canada (5.4%). Overall, these data indicate that the *Bsal* website has had more international exposure than previous years.
- As we continue to post updates, articles, and information, we are increasing our chance of engaging with individuals, groups, and organizations to make them aware of what is occurring with *Bsal*. This gives us the opportunity to share what work the *Bsal* Task Force has accomplished, and what work is currently occurring.
- The Communications Working Group streamlined the process of updating the website by collecting input from the rest of the Task Force through Google Drive and incorporating group comments into revisions and updates.

## PARC Disease Task Team

### Leads

Matthew J. Gray, Matthew C. Allender

### Key Points

- 1) Published article in The Wildlife Professional: Gray, M.J., M.C. Allender, K.H. Haman, R.N. Harris, and D.H. Olson. 2018. Facilitating early detection and rapid response. The Wildlife Professional 12(5):33-35.
- 2) Implementing the Herp Disease Alert System (HDAS): 5 reports received in last year; examining new ways to get HDAS information to potential users, possibly via iNaturalist or HerpMapper; updating contacts of state, provincial, and federal authorities. The email submission is: [herp\\_disease\\_alert@parcplace.org](mailto:herp_disease_alert@parcplace.org).
  - a. Published Reptiles Magazine article: Herp disease alert system: <http://www.reptilesmagazine.com/How-To-Use-The-Herpetofauna-Disease-Alert-System-HDAS/>. Providing information on Herpetological Disease Alert System (HDAS) for North America that allows the public to report observations of possible cases of herpetofaunal disease, including *Bsal* chytridiomycosis.
- 3) Managing the *Bsal* website: [salamanderfungus.org](http://salamanderfungus.org)
  - a. Web portal design update is being planned
- 4) Managing the PARC DTT website: <http://parcplace.org/parcplace/resources/disease-task-team.html?id=287:herpetofaunal-disease-resources>
- 5) Manuscript in prep on “dirty to clean standard operating procedures”
- 6) Provided feedback and review of Amphibian Disease Outreach Materials from Kentucky Dept. Fish and Wildlife Resources.
- 7) Provided feedback to NEPARC on Heavy Equipment Decontamination draft guidance document.
- 8) Provided feedback on Herpetological Review disease commentary for 50<sup>th</sup> anniversary issue.

### Outcomes or impacts

- a) HDAS reports continue to increase, including some unusual findings, possible Snake Fungal Disease, and amphibian die-offs in which disease has been suspected have been among the reports. HDAS continues to facilitate communication between reporting individuals and authorities in the appropriate jurisdictions.
- b) HDAS has facilitated identification of herpetofaunal health contact authorities in all states and provinces in North America but a need to keep these current is a priority for 2019.



- c) PARC DTT facilitates disease communication by reviewing draft products from various entities, and via the two websites, <http://parcplace.org/parcplace/resources/disease-task-team.html?id=287:herpetofaunal-disease-resources> and [salamanderfungus.org](http://salamanderfungus.org) web portal

Interactions with other groups: PARC DTT works with the National *Bsal* Task Force, and in particular the *Bsal* Communication and Outreach Working Group, to aid in *Bsal* messaging for North America.

#### Strategic Plan contribution

A member is working with the National Aquatic Nuisance Species Council to address inclusion of amphibian pathogens including *Bsal* to their lists, which has ramifications for US State listings of state-prohibited species. This raises the visibility of *Bsal* for US-wide management by states as an aquatic invasive species (AIS); currently, there is limited aquatic pathogen inclusion on state AIS lists. This proposal relates to both the developing *Bsal* Strategic Action Plan and the larger Wildlife Health Strategic Action Plan.

#### *Bsal* Task Force Key Points, from your perspective:

The PARC DTT is actively engaged in significant communication and outreach activities for *Bsal* developments in North America, via oral, written, and electronic products. The HDAS establishes an early-warning system for the public reporting of die-offs that could catch *Bsal* outbreaks immediately. Members are involved in a variety of significant committees addressing proactive measures to forestall disease spread through raised awareness and development of new guidelines or policy.



Red-back Salamander, *Plethodon cinereus*. Photo: Alberto López

## Canadian Herpetological Health Working Group

### Lead

Jennifer Provencher, Canadian Wildlife Service, Environment and Climate Change Canada

### Participants

Joe Crowley, Province of Ontario; Craig Stephen, Canadian Wildlife Health Cooperative; Scott Gillingwater, Upper Thames River Conservation Authority; Ariane Masse, Province of Québec; Maria Forzan, Cornell University; Lenny Shirose, Canadian Wildlife Health Cooperative; Bruce Pauli, Environment and Climate Change Canada; Danna Schock, Keyano College; Purnima Govindarajulu, Province of British Columbia; Kristiina Ovaska, IUCN Canada-Amphibian Specialist Group

### Summary

The Canadian Herpetological Health Working Group was formed in 2016 in response to the threat posed by *Bsal* to native salamanders in Canada, as well as reptile and amphibian health and disease issues more generally. The working group is chaired by Environment and Climate Change Canada and is comprised of government, academic, and non-governmental scientists. It reports to the Canadian Wildlife Directors Committee (CWDC), which is a management body comprised of federal, provincial and territorial wildlife directors responsible biodiversity policy and management in Canada.

### Key Points and Outcomes

- The Government of Canada implemented a long-term importation restriction on all *Caudata* (salamander) species in May 2018. The restriction requires that a permit be obtained for the legal importation of any specimen, including living or dead salamanders, salamander eggs, sperm, tissue culture or embryos, or any part or derivative of a salamander. Permits are issued by Environment and Climate Change Canada, which categorizes proposed imports based on risk. A proposed importation will generally be in the low risk category if the species is found on a List of species provided on the ECCC website and the specimen did not originate or transit through the Eurasia region. In addition, extracted DNA (deoxyribonucleic acid) and specimens preserved in solutions that have a concentration  $\geq 70\%$  of ethanol,  $\geq 10\%$  formalin or formalin-fixed paraffin are considered low risk irrespective of their origin. All other imports will generally be considered high risk. Separate application forms are provided for the two categories, with the high risk category application requiring a higher level of biosecurity documentation. Further details are available on the Department's website: <https://www.canada.ca/en/environment-climate-change/services/convention->

[international-trade-endangered-species/import-species-harmful-ecosystems/permit-application-form/salamander-permitting-policy.html](https://international-trade-endangered-species/import-species-harmful-ecosystems/permit-application-form/salamander-permitting-policy.html)

- Ongoing surveillance is conducted nationally through the Canadian Wildlife Health Cooperative, as well as provincial programs. One study from western Canada examining wild and captive newts show no detections of *Bsal* in the animals examined.

#### Interactions with other groups:

Canadian Herpetological Health Working Group members participate in most *Bsal* Task Force Working Groups.

#### Publications

Govindarajulu P, Matthews E, Ovaska K. 2017. Swabbing for *Batrachochytrium salamandrivorans* on Wild Rough-skinned Newts (*Taricha granulosa*) and Pet-Traded Amphibians on Southern Vancouver Island, British Columbia, Canada. *Herpetological Review* 48(3) 564-568.



Spotted Newt, *Notophthalmus viridescens* with lesions from *Bsal*. Photo: Alberto López

## Updates from Mexico

During September 2017, Dr. Gabriela Parra and her group collected three species of Plethodontid salamanders and send them to Matt Gray to be infected with *Bsal*.

Dr. Parra's student Delia wrote a paper about *Bsal* and Mexican plethodontids. This paper has been submitted to PloS One.

## Pet Industry Joint Advisory Council (PIJAC)

PIJAC's mission is to:

- PROMOTE responsible pet ownership and animal welfare
- FOSTER environmental stewardship &
- ENSURE the availability of pets

PIJAC members, as pet owners, and as an industry, believe that they have a responsibility to ensure that the animals in their care are treated with kindness and respect, and that pets do not cause environmental or human health problems. PIJAC is a pioneer in developing educational programs for pet owners, the pet industry, related industries, and governmental organizations that address these issues.

PIJAC maintains active Aquatics and Herpetological committees which fund scientific research and conservation projects, and their Zoonosis Committee has entered into a memorandum of understanding (MOU) with the Centers for Disease Control and Prevention (CDC) to share information, educate, and rapidly respond to zoonotic disease outbreaks.

## Amphibian Survival Alliance

The Amphibian Survival Alliance (ASA) promotes the conservation of amphibians and their habitats through dynamic partnerships worldwide. The ASA raises awareness of amphibians and their plight, and helps channel vital resources towards the implementation of the global Amphibian Conservation Action Plan (ACAP). The Alliance works directly with two globally-scoped amphibian networks: the IUCN SSC Amphibian Specialist Group (ASG), which provides the science to inform amphibian conservation action and Amphibian Ark, which focuses on amphibian species that cannot currently be safeguarded in their natural environments. Their leadership has continued to benefit the *Bsal* Task Force in the following ways. They created and maintain the salamanderfungus.org website for *Bsal* communication. In addition, they worked closely with the *Bsal* Data Management working group to ensure complementary information was uploaded on this informational website in comparison to the *Bsal* database web portal amphibiandisease.org, knitting the two together seamlessly. The ASA is also working to facilitate the implementation of the ASG's updated ACAP, which highlights research into and control of *Bsal*. Secretariat member Reid Harris was lead co-chair of the Technical Advisory Committee and Lead Liaison: Reid Harris (ASA and James Madison Univ.). Communication lead: Candace Hansen-Hendriks (ASA)

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List of journal articles and book chapters published or in review by members of the *Bsal* Task Force Working Groups

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3. Bletz, MC, BC. LaBumbard, AY. Basco Martínez, RN Harris, DC Woodhams. *In review*. Fighting microbes with microbes: First steps in developing probiotic mitigation tools to combat salamander chytridiomycosis in eastern newts. *SSAR Book: Strategies for Conservation Success in Herpetology*.
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