

HAWCPROJECT.ORG: A content management system for human health assessments

Andy Shapiro^{1,*}, Josh Addington², Vickie Walker¹, Kathryn Z. Guyton³, Andrew Rooney¹, Ivan Rusyn⁴
¹ National Toxicology Program, National Institute of Environmental Health Sciences, Research Triangle Park, NC, USA

* Current affiliation: Infinia ML, Durham, NC, USA

² Kelly Services, Research Triangle Park, NC, USA

³ International Agency for Research on Cancer (IARC) Monographs Programme, World Health Organization, Lyon, France

⁴ Department of Veterinary Integrative Biosciences, Texas A&M University, College Station, TX, USA

Abstract

Decision-makers and researchers frequently conduct literature-based assessments of the potential for chemicals or other exposures to pose a threat to human health. Such assessments typically consist of a critical review of a literature corpus to identify adverse health effects, to extract data for exposure-response relationship modeling, and/or to elucidate toxicity mechanisms. The systematic review methodology increases the transparency and objectivity in an evaluation by using a pre-defined, multistep process to identify, critically assess, and synthesize evidence. In addition to extraction of data, systematic review may also include an assessment of potential bias in a body of literature. A clear and detailed presentation of problem formulation, analysis and outputs, as well as properly documented search strategies and intermediate decisions, are critical to ensure transparency of the process.

We address these challenges by creating a modular, web-based content-management system to synthesize multiple data sources into overall human health assessments of chemicals. This free, open-source web-application, HAWC (Health Assessment Workspace Collaborative, <https://hawcproject.org>), integrates and documents the overall workflow from literature search, literature screening, risk of bias assessment, data extraction, dose-response analysis using EPA benchmark dose modeling software (BMDS), and data synthesis by enabling creation of customizable visualizations of evidence and risk of bias.

Each HAWC assessment can be composed of some of all of these steps, based on the goals of the assessment, and at the discretion of assessment owners. User access is assessment-specific; project-managers can create public or private assessments, and can share with their team during development and ultimately release publicly as supplemental information to final reports (e.g., the US National Toxicology Program (NTP) monograph of [immunotoxicity associated with PFOA/PFOS exposure](#), or the National Academy of Science's report on low-dose [toxicity from endocrine active chemicals](#)). All data and figures are exportable in user-friendly formats. To date, nearly 500 assessments have been created by users, and has been adopted for use by the NTP, the US EPA, TCEQ, and 34 assessments to date by the WHO IARC Monographs program.

Crucial benefits of such a system include improved integrity of the data and analysis results, greater transparency, standardization and consistency in data collection and presentation.

Assessment and permissions

Levels of access:

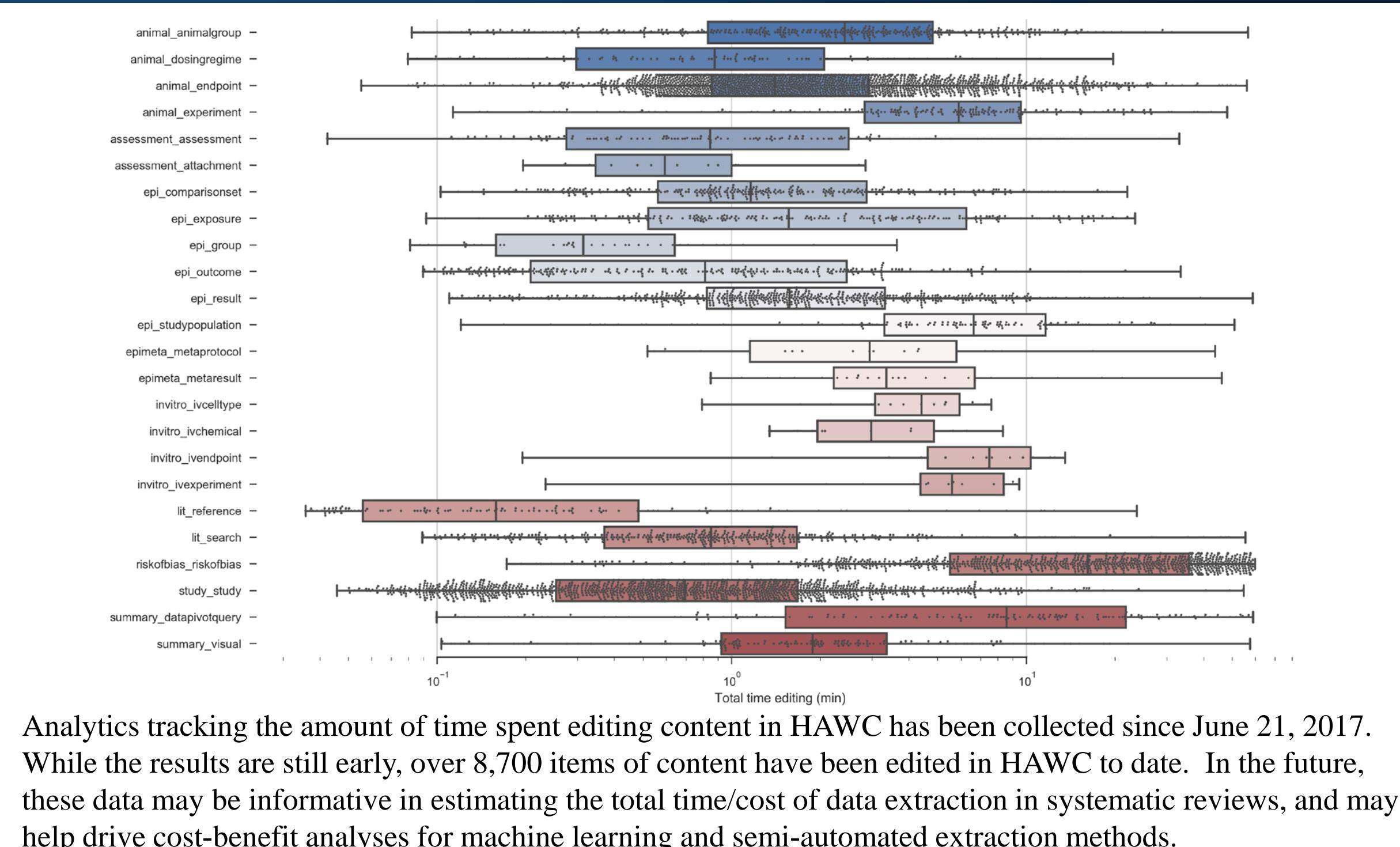
- Project managers:** change permissions settings, including who can edit assessment content and which modules are enabled
- Team members:** add, edit, and delete content
- Reviewers:** view assessment before assessment is public
- Public:** if an assessment is made public, the general-public can view

Other assessment features

- Project managers can control which modules to enable/disable, settings are project specific
- Team members can assign tasks for risk of bias assessment or data extraction tasks

HAWC is a web-based content management system to create, store, share, and display data and results in order to conduct human health assessments

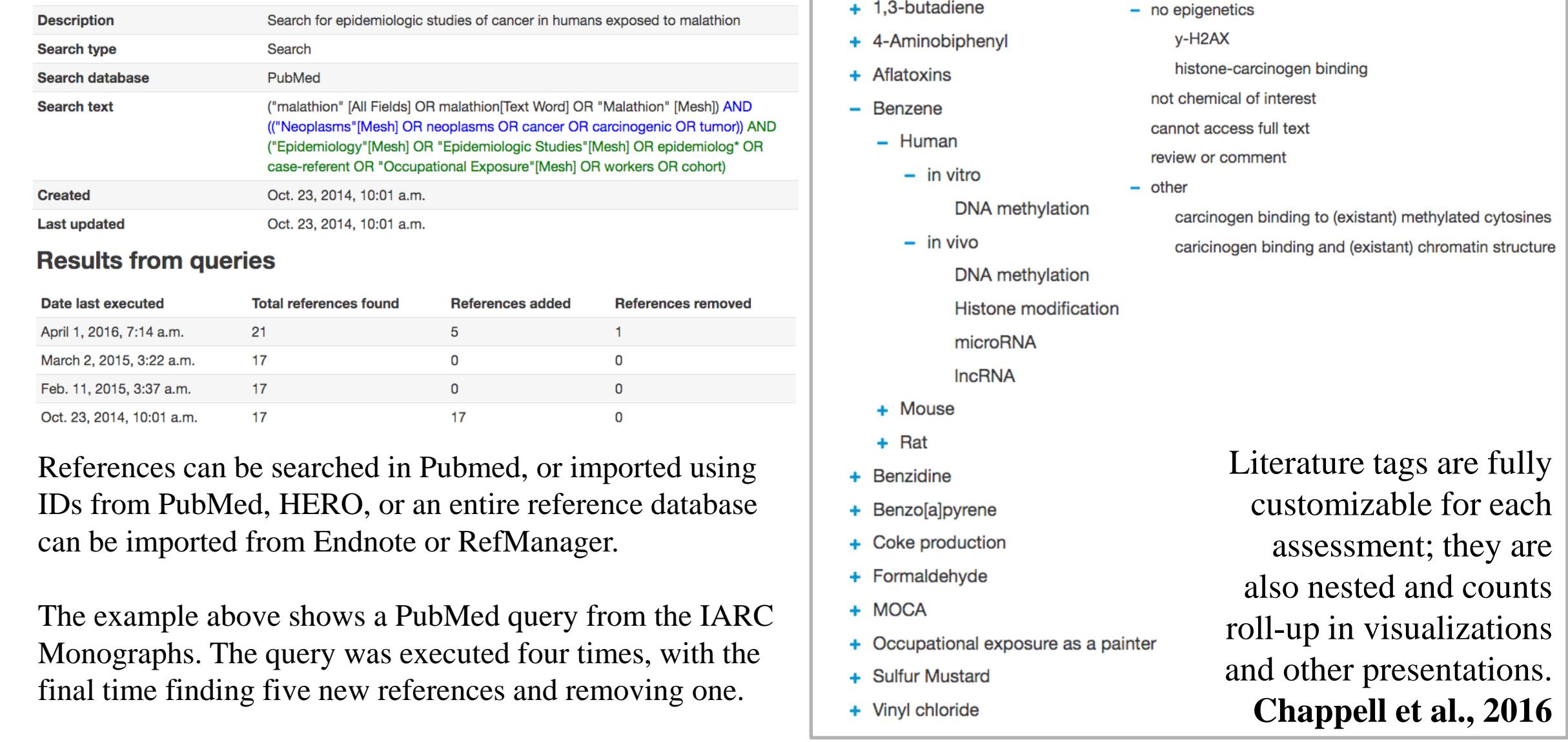
Time spent extracting data and risk of bias



Application Modules

LITERATURE REVIEW

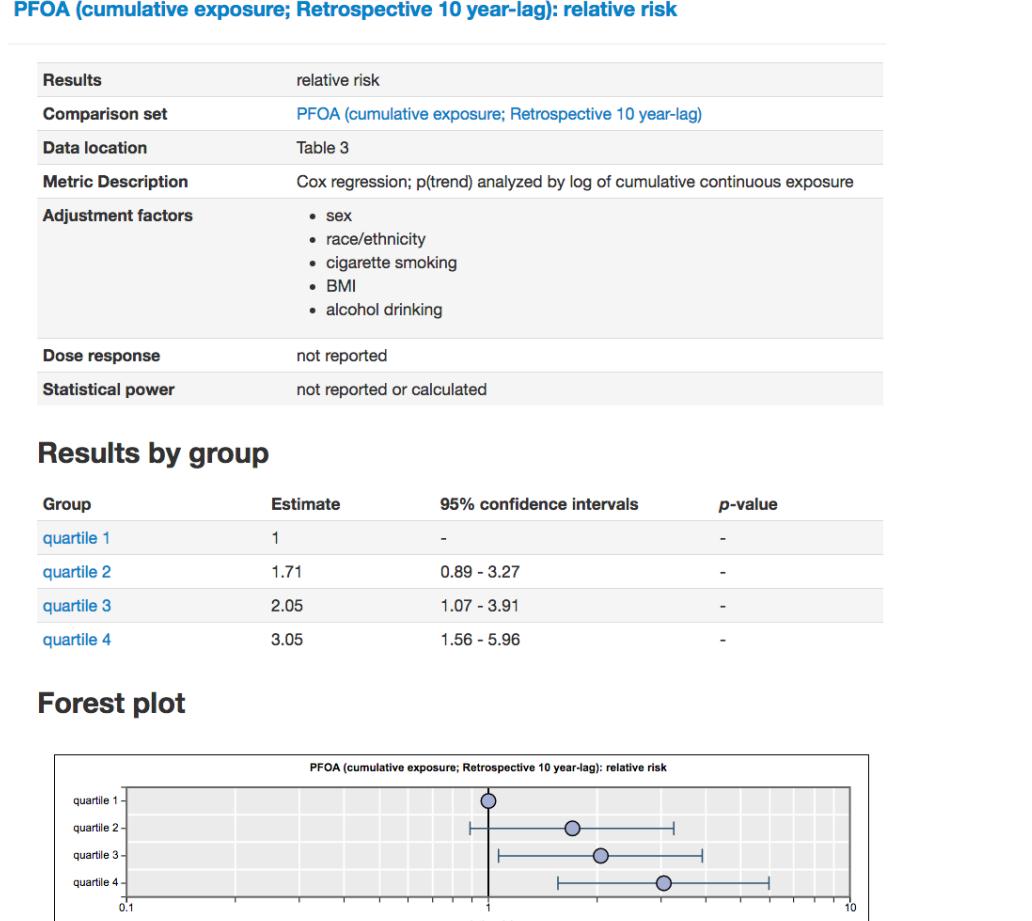
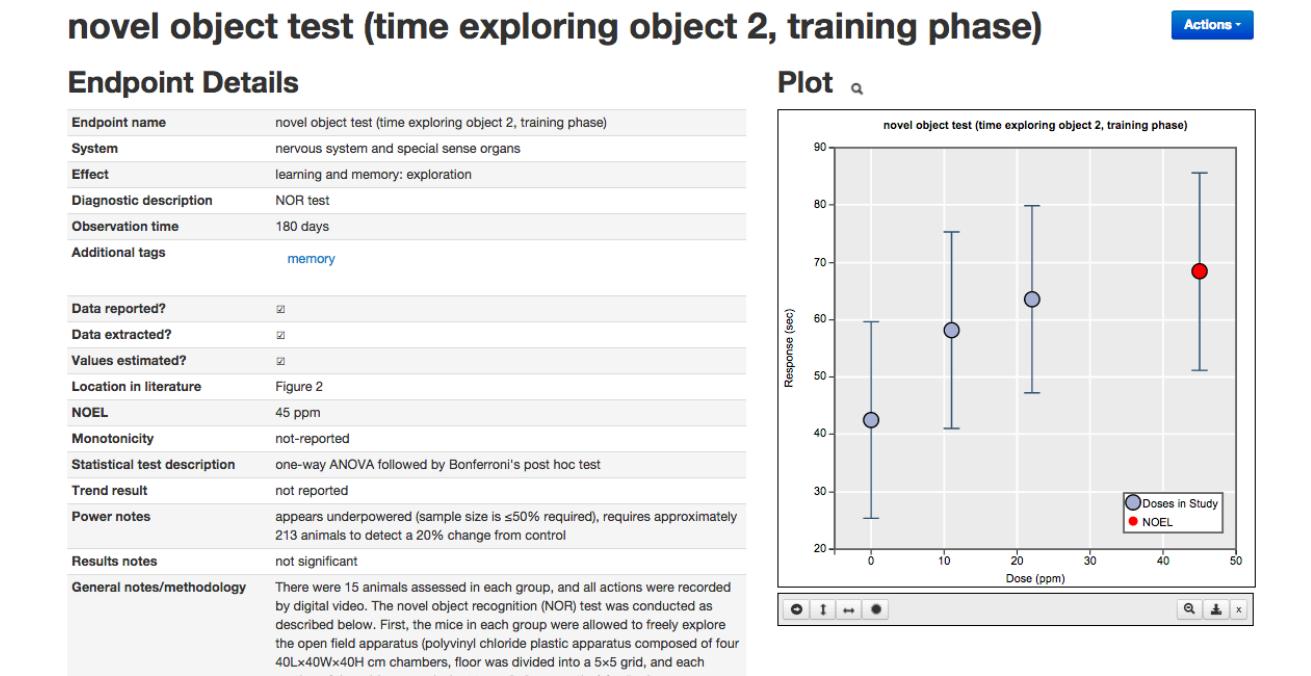
Malathion, cancer in humans



The example above shows a PubMed query from the IARC Monographs. The query was executed four times, with the final time finding five new references and removing one.

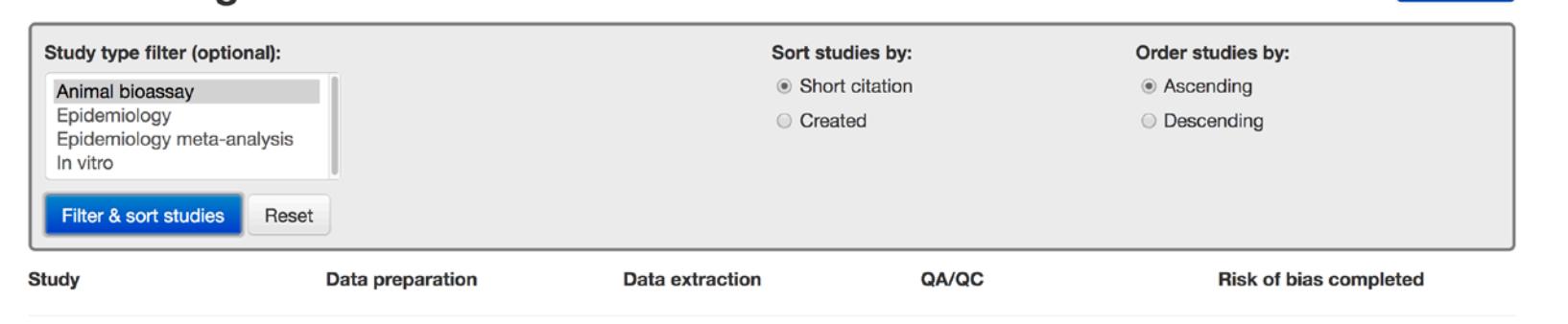
Chappell et al., 2016

ENDPOINT EXTRACTION

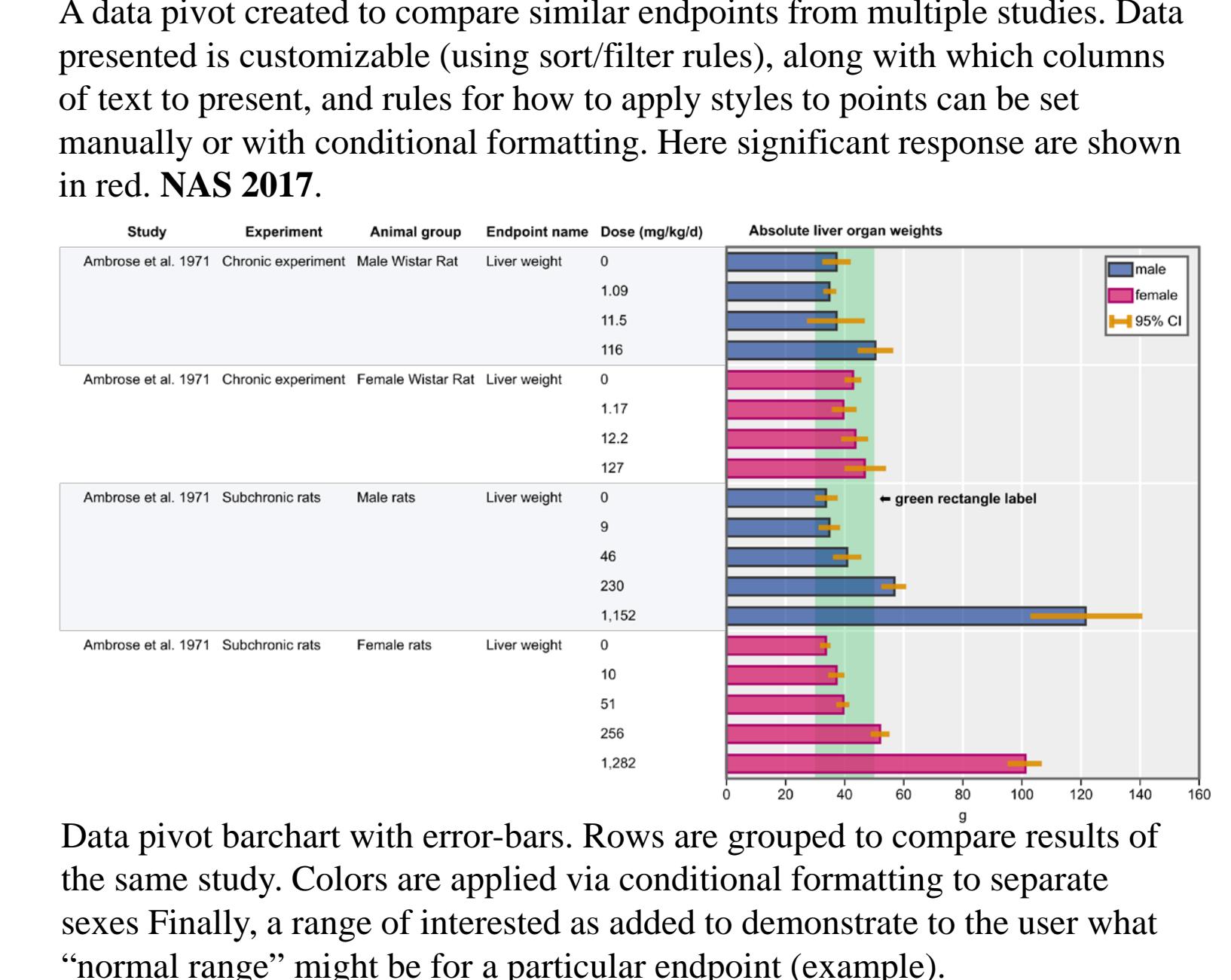
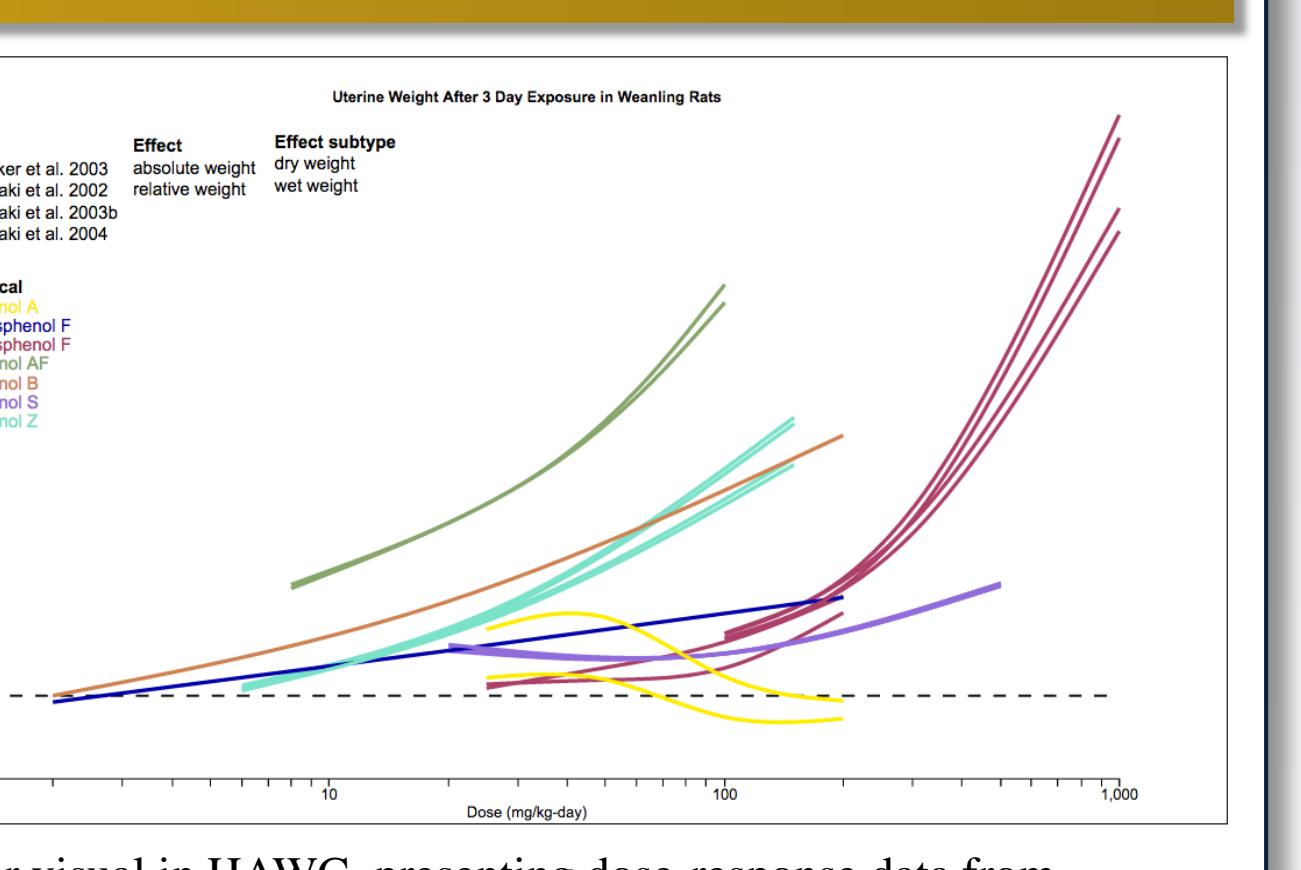
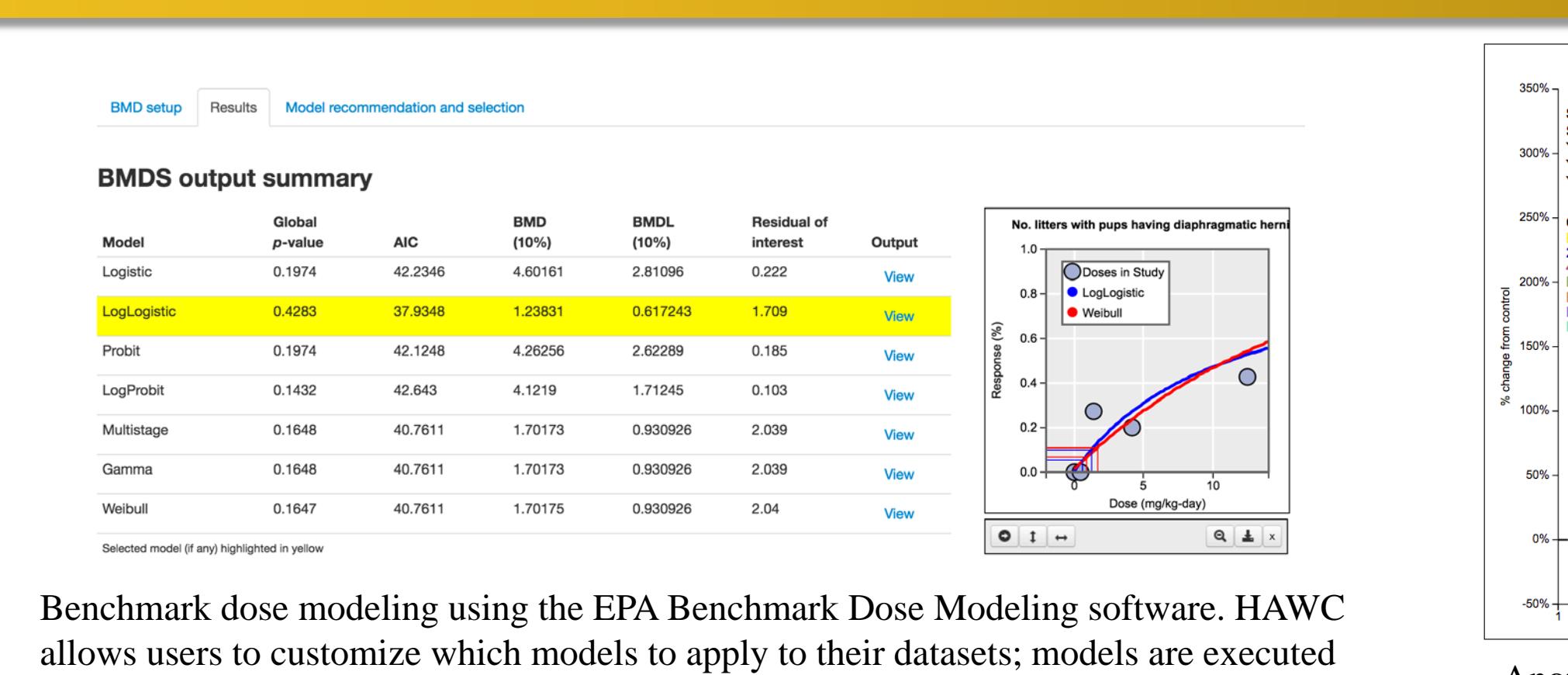
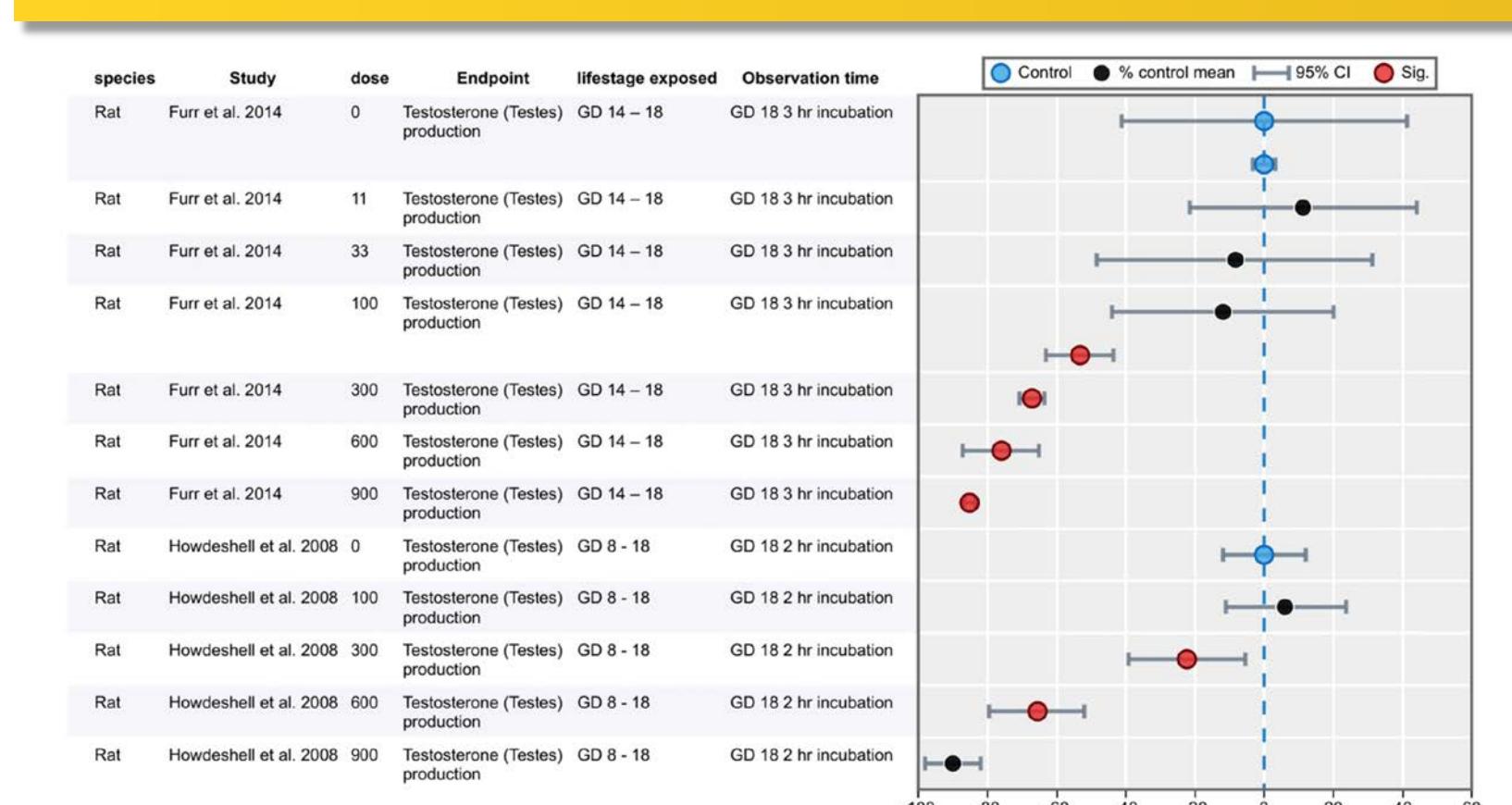


PROJECT MANAGEMENT TOOLS

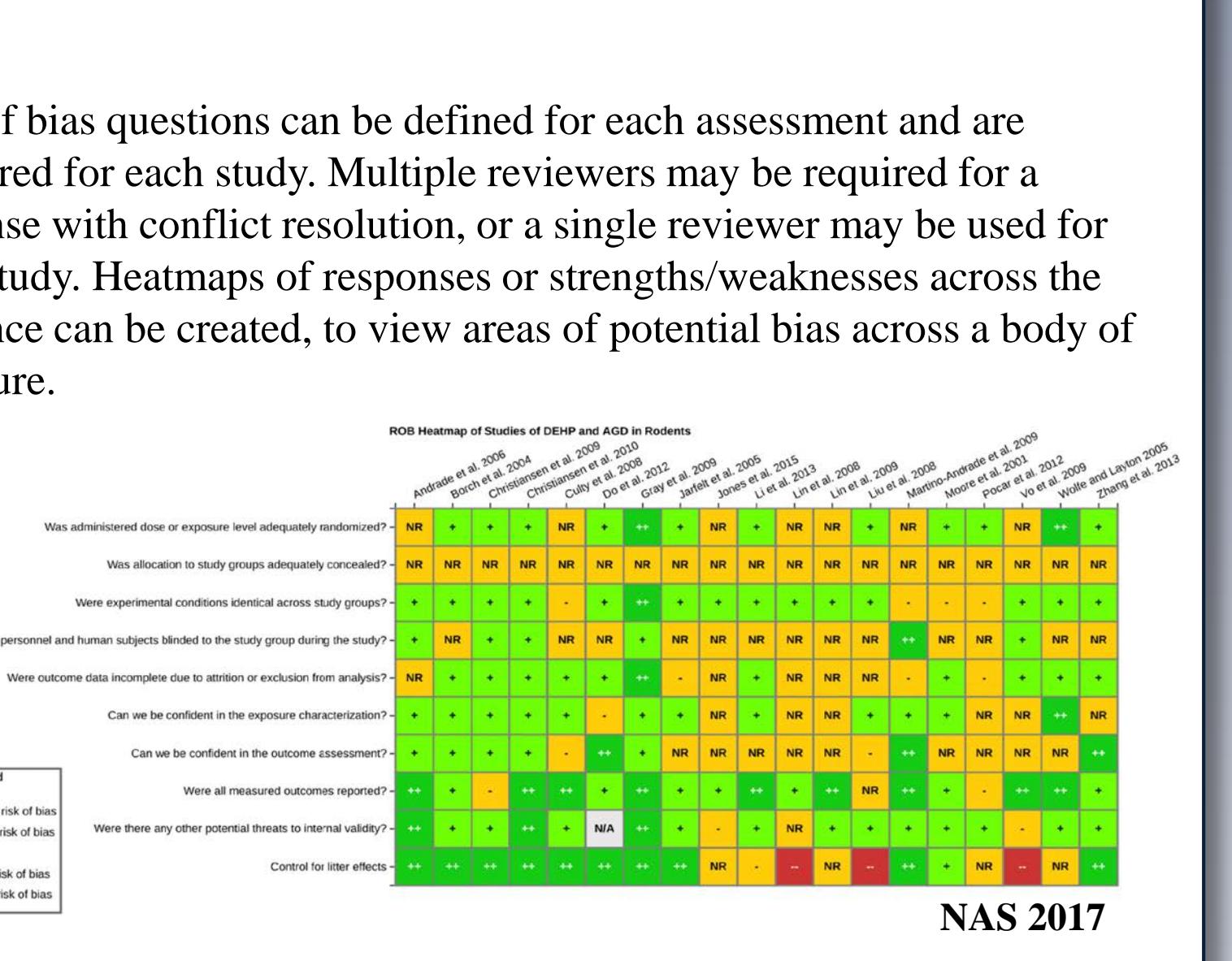
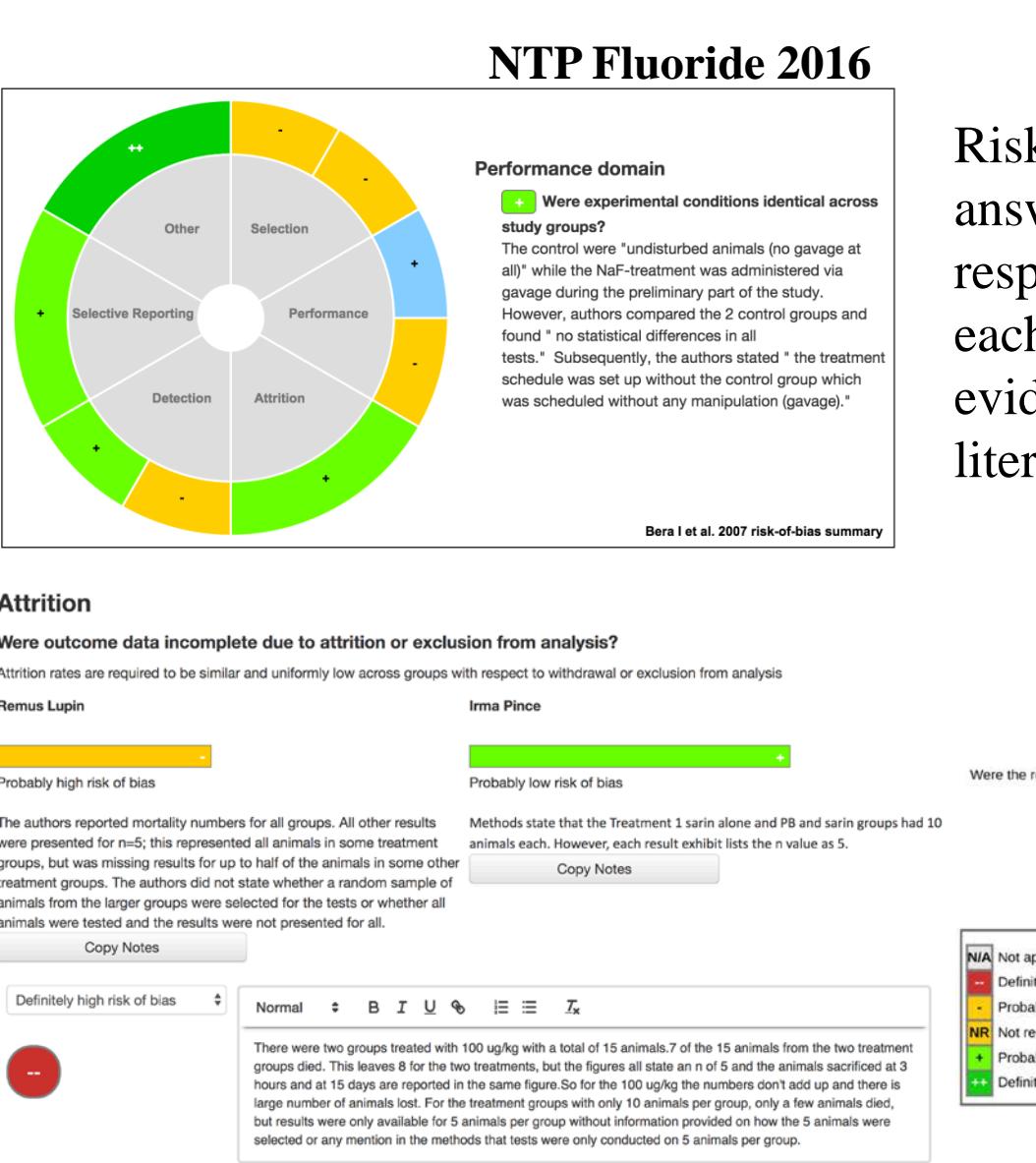
Task assignments



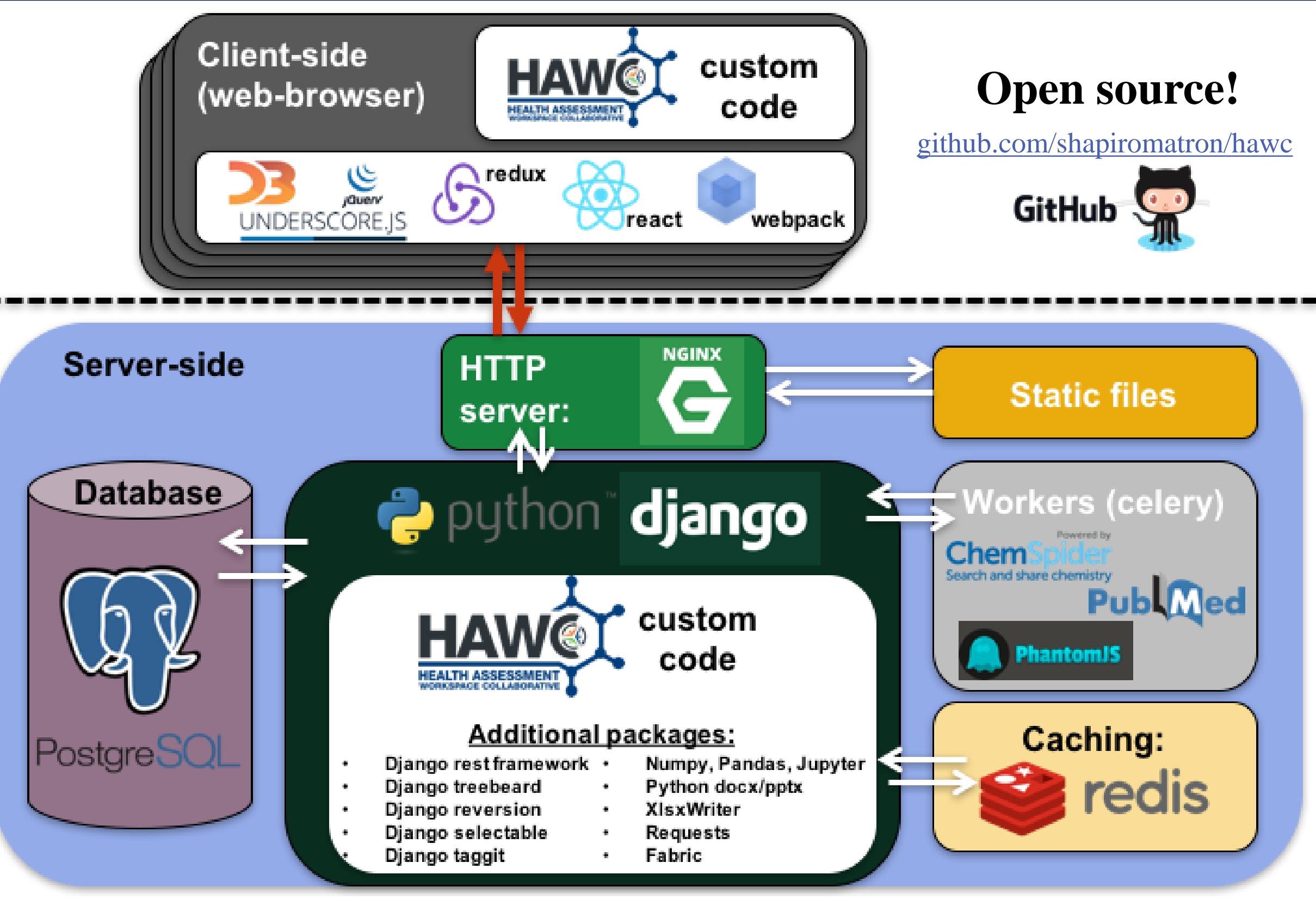
DATA ANALYSIS AND PRESENTATION



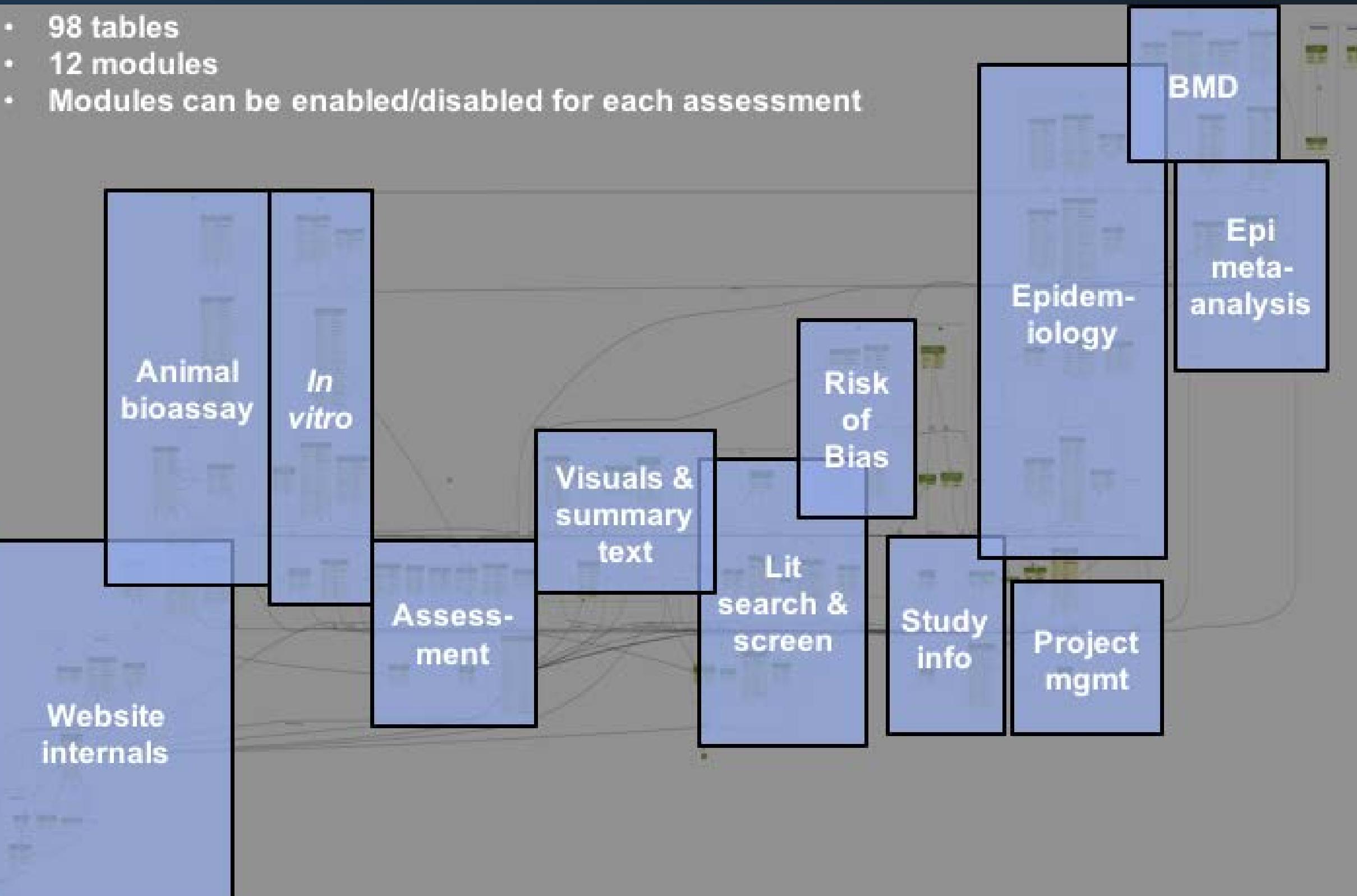
RISK OF BIAS



Technical implementation



Data model



Example published projects which used HAWC

- Projects citing HAWC include peer-reviewed publications, or final reports from organizations which indicated use of HAWC during analysis or methods guidelines and may not be a complete list:
- Boyles AL, Blain RB, Rochester JR, Avanasi R, Goldhaber SB, McComb S, Holmgren SD, Masten SA, Thayer KA. 2017. Environmental review of community health impacts of mountaintop removal mining. Environ Int. 2017;107:163-172. [10.1016/j.envint.2017.07.002](https://doi.org/10.1016/j.envint.2017.07.002)
 - Chappell G, Pogribny IP, Guyton KZ, Rusyn I. Epigenetic alterations induced by genotoxic occupational and environmental human chemical carcinogens: A systematic literature review. Mutat Res Rev Mutat Res. 2016;768:27-45. [10.1016/j.mrrev.2016.03.004](https://doi.org/10.1016/j.mrrev.2016.03.004)
 - Guh N, Guyton KZ, Loomis D, Barupal DK. Prioritizing Chemicals for Risk Assessment Using Chemoinformatics: Examples from the IARC Monographs on Pesticides. Environ Health Perspect. 2016;124(12):1823-1829. [10.1289/EHP186](https://doi.org/10.1289/EHP186)
 - IARC Monographs. 2017. Instructions to Authors for the Preparation of Drafts for IARC Monographs. http://monographs.iarc.fr/ENG/Preamble/previousInstructions_to_Authors.pdf
 - Molander L, Hanberg A, Rudén C, Åstrand M, Berzonius A. Combining web-based tools for transparent evaluation of data for risk assessment: developmental effects of bisphenol A on the mammary gland as a case study. J Appl Toxicol. 2017;37(3):319-330. [10.1002/jat.3363](https://doi.org/10.1002/jat.3363)
 - National Academies of Sciences, Engineering, and Medicine. 2017. Application of Systematic Review Methods in an Overall Strategy for Evaluating Low-Dose Toxicity from Endocrine Active Chemicals. Washington, DC: The National Academies Press. [10.17226/24758](https://doi.org/10.17226/24758)
 - National Toxicology Program. 2015. Handbook for Conducting a Literature-Based Health Assessment Using OHAT Approach for Systematic Review and Evidence Integration. https://ntp.niehs.nih.gov/nip/ohat/handbookjan2015_508.pdf
 - National Toxicology Program. 2015. Monograph on Identifying Research Needs for Assessing Safe Use of High Intakes of Folate Acid. 2015. Research Triangle Park, NC: National Toxicology Program. https://ntp.niehs.nih.gov/nip/ohat/monograph_508.pdf
 - National Toxicology Program. 2016. NTP Research Report on Systematic Literature Review on the Effects of Fluoride on Learning and Memory in Animal Studies. Research Triangle Park, NC: National Toxicology Program. https://ntp.niehs.nih.gov/nip/results/pubs/reports/01fluoride_508.pdf
 - National Toxicology Program. 2016. Monograph on Immunotoxicity Associated with Exposure to Perfluorochemicals (PFOA) and Perfluorooctanoic Sulfonate (PFOS). Research Triangle Park, NC: National Toxicology Program. https://ntp.niehs.nih.gov/nip/ohat/pfosa_pfos/pfosa_monograph_508.pdf
 - Pelch KE, Wigfall JA, Goldstone AE, Ross PK, Blain RB, Shapiro AJ, Holmgren SD, Hsieh J-H, Svoboda D, Auerbach SS, Parham FM, Masten SA, Thayer KA. 2017. NTP Research Report on Biological Activity of Bisphenol A (BPA) Structural Analogs and Functional Alternatives. NTP R-4. Research Triangle Park, NC: National Toxicology Program. (4): 1-78. https://ntp.niehs.nih.gov/nip/results/pubs/reports/r04_508.pdf
 - Smith MT, Guyton KZ, Gibbons CF, Fritz JM, Portier CJ, Rusyn I, DeMarini DM, Caldwell RC, Kavlock RJ, Lambert PF, Hecht SS, Bucher JR, Stewart BW, Baan RA, Cogliano VJ, Straif K. Key Characteristics of Carcinogens as a Basis for Organizing Data Mechanisms of Carcinogenesis. Environ Health Perspect. 2016;124(6):713-21. [10.1289/ehp.1509912](https://doi.org/10.1289/ehp.1509912)
 - Texas Commission on Environmental Quality. 2016. Ethylene Glycol Development support document. <https://www.tceq.texas.gov/assets/public/implementation/tox/dsd/whitepaper/EG.pdf>
 - Texas Commission on Environmental Quality. 2017. White Paper: TCEQ Guidelines for Systematic Review and Evidence Integration. https://www.tceq.texas.gov/assets/public/implementation/tox/dsd/whitepaper/Proposed%20_Systematic_Review.pdf

Contact information:

Andy Shapiro (shapiromaton@gmail.com)

Ivan Rusyn (irusyn@tamu.edu)
