



Technological Tools for Evidence Integration

Shane Thacker, Jennifer Nichols, Ryan Jones, Steven J. Dutton

National Center for Environmental Assessment; Office of Research and Development; US EPA

www.epa.gov/research

Shane Thacker | thacker.samuel@epa.gov | 919-541-5159

Evidence Integration

At the EPA's National Center for Environmental Assessment (NCEA), we work closely with programs throughout the EPA to integrate web-based and desktop computer tools into the assessment process, facilitating evidence integration for science assessment products. By incorporating in-house and third-party tools, both open source and commercial, activities such as the Integrated Risk Information System (IRIS) and the Integrated Science Assessments (ISA) seek to use the best tools for the job, while remaining flexible enough to improve the evidence integration process.

Current Tools

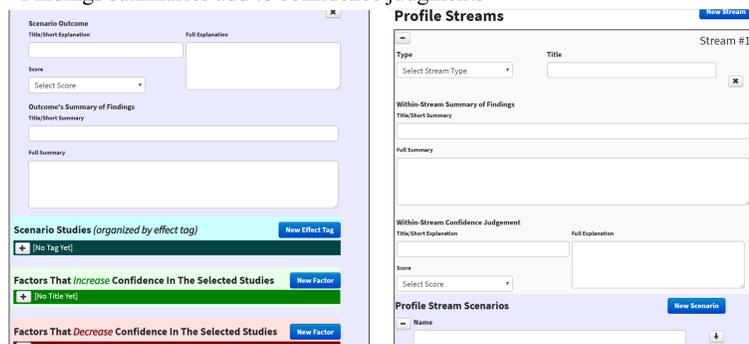
- **Health and Environmental Research Online (HERO):** Literature search, categorization, acquisition, archiving. Interoperable with HAWC, Distiller, and SWIFT.
- **Health Assessment Workplace Collaborative (HAWC):** Study evaluation, data extraction, visualization. Interoperable with HERO, BMDS, and Distiller.
- **Benchmark Dose Software (BMDS):** Dose-response modelling. Interoperable with HAWC.
- **Evidence Partners DistillerSR:** Literature screening, data extraction. Interoperable with HERO and HAWC.
- **Sciome SWIFT-Review and SWIFT-Active Screener:** Literature screening, prioritization, categorization. Interoperable with HERO and HAWC.

New Tools

Evidence Profile Table

Part of HAWC, the Evidence Profile Table offers a summary explanation of evidence integration in a chemical risk assessment. This view creates greater transparency about the body of evidence by illuminating the rationale behind the assessment findings.

- Adaptation of GRADEPro Evidence Profiles
- Create multiple rows to cover multiple evidence streams
- Select studies and endpoints added to HAWC
- Streams break down into scenarios
- Endpoints are rated within scenarios
- Confidence judgements build from individual to across-stream
- Findings summaries add to confidence judgements



New Tools, continued

Evidence Profile Table, pictured

Outcome	Studies	Factors That Increase Confidence	Factors That Decrease Confidence	Confidence Judgement and Summary of Findings for Individual Outcome	Within-Stream Confidence Judgement and Summary of Findings	Inference Across Streams	Across-Stream Confidence Judgement
test animal (Animal Bioassay)							
Test scenario	neoplastic Initial submission Title of the study (Thacker and Jones 2019)	•Consistency Relatively Low	•High Risk of Bias This is a factor that would decrease confidence.	⊕⊕⊕ Moderate test outcome This is another explanation	⊖⊖⊖ Slight test judgement This is a full explanation	*test inference this is another description	⊕⊕⊕ test total This is a test explanation
test outcome	Overall Odds Ratio Title of another study here (Thacker and Nichols 2019)	•Consistency Relatively Low	•High Risk of Bias This is another factor that would decrease confidence.	⊕⊕⊕ Robust test title test	⊕⊕⊕ test summary within test summary full		
				Title of summary And the full summary.			

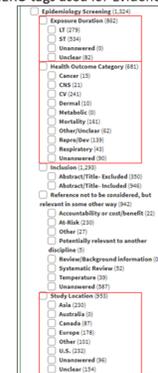
Evidence Mapping

Integrated with the Health and Environmental Research Online (HERO) database, the Evidence Mapping tool allows researchers to create heat maps to visualize and overlay characteristics (e.g., discipline, exposure, concentration, etc.) of the reviewed literature, making it easy to visualize the available evidence.

Example Evidence Map

Outcome	Location	Health Outcome Category							Total		
		Mortality	CV	Resp	Repro/Dev	Metabolic	Nervous System	Cancer		Dermal	Other
Test stream	US	16	36	18	11	2	0	0	0	0	528
	Canada	10	14	12	1	1	0	0	3	7	46
	Europe	23	36	18	6	2	5	0	1	5	116
	Asia	39	41	3	5	3	8	1	1	10	178
	Other	11	52	3	2	1	1	0	0	2	128
Test stream	US	15	8	18	44	5	4	5	0	7	106
	Canada	5	1	4	3	1	1	1	0	1	17
	Europe	5	5	11	16	6	0	2	0	1	46
	Asia	10	16	19	25	4	4	4	1	6	89
	Other	3	12	3	15	0	4	1	0	4	42
Inchbar	US	3	1	3	1	1	1	1	1	1	13
	Canada	0	0	1	0	0	0	0	0	0	1
	Europe	0	3	4	2	1	0	0	0	2	12
	Asia	0	1	8	2	0	0	0	2	0	13
	Other	0	1	2	2	0	4	0	1	1	11
Total		146	227	310	155	27	32	15	10	52	948

HERO tags used for Evidence Map



- In HERO, scientists use tags to categorize literature for possible use in chemical risk assessment projects
- Using the tool, scientists create crosstabs between sets of tags that code literature by characteristics
- The results are color-coded, creating heat maps for easy visualization of the intersection totals
- The result is a map showing the amount of possible evidence between characteristics, such as location and exposure
- Researchers can layer the characteristics into sets and subsets, adding visual organization
- Interoperable with Distiller

New Tools, continued

Evidence Inventory

The Evidence Inventory tool, hosted within HERO, facilitates data extraction and portrayal by providing researchers a template to collect and categorize data from the relevant literature and then create summary tables of the extracted information. The summary tables are then ready for export into assessment documents, allowing readers to review the evidence behind the chemical risk assessment.

From HERO				Level 2 Screening			Study Details													
HERO ID	Author	Year	Title	ISA Relevant	PECO Relevant	Reliability/Study Quality	Section	Health Endpoint	Study Design	Cohort or Study Name	Study Population Details	Sample Size	Country							
123456	Thacker, S, Jon 2016		Chemical pollutants and the	Yes	Yes	High Quality	Inf/Ox Stress/Inj/FxND	Panel			Adults with type II diabetes mellitus.	69 U.S.	69 U.S.							
123456	Thacker, S, Jon 2016		Chemical pollutants and the	Yes	Yes	High Quality	Inf/Ox Stress/Inj/FxND	Panel			Adults with type II diabetes mellitus.	69 U.S.	69 U.S.							
123456	Thacker, S, Jon 2016		Chemical pollutants and the	Yes	Yes	High Quality	ED Visit - AsEx	Time-series			All ages	611,970 U.S.	611,970 U.S.							
123456	Thacker, S, Jon 2016		Chemical pollutants and the	Yes	Yes	High Quality	ED Visit - AsEx	Time-series			All ages	611,970 U.S.	611,970 U.S.							
123456	Thacker, S, Jon 2016		Chemical pollutants and the	Yes	Yes	High Quality	ED Visit - AsEx	Time-series			All ages	611,970 U.S.	611,970 U.S.							
123457	Thacker, S, Jon 2015		Air pollution and quality of life	Yes	Yes	Adequate	ED Visit - AsEx	Time-series			Ages 5 and older	165,056 U.S.	165,056 U.S.							
123457	Thacker, S, Jon 2015		Air pollution and quality of life	Yes	Yes	Adequate	ED Visit - AsEx	Time-series			Ages 5 and older	165,056 U.S.	165,056 U.S.							
123457	Thacker, S, Jon 2015		Air pollution and quality of life	Yes	Yes	Adequate	ED Visit - AsEx	Time-series			Ages 5 and older	165,056 U.S.	165,056 U.S.							
123458	Nichols, J, Jon 2015		Solar flares and leaded gasoil	Yes	Yes	Adequate	ED Visit - AsEx	Asthma/Wheeze	Time-series		All ages	34,086 U.S.	34,086 U.S.							
123458	Nichols, J, Jon 2015		Solar flares and leaded gasoil	Yes	Yes	Adequate	ED Visit - AsEx	Asthma/Wheeze	Time-series		All ages	34,086 U.S.	34,086 U.S.							
123458	Nichols, J, Jon 2015		Solar flares and leaded gasoil	Yes	Yes	Adequate	ED Visit - AsEx	Asthma/Wheeze	Time-series		All ages	34,086 U.S.	34,086 U.S.							
123458	Nichols, J, Jon 2015		Solar flares and leaded gasoil	Yes	Yes	Adequate	ED Visit - AsEx	Asthma/Wheeze	Time-series		All ages	34,086 U.S.	34,086 U.S.							
123458	Nichols, J, Jon 2015		Solar flares and leaded gasoil	Yes	Yes	Adequate	ED Visit - AsEx	Asthma/Wheeze	Time-series		All ages	34,086 U.S.	34,086 U.S.							
123458	Nichols, J, Jon 2015		Solar flares and leaded gasoil	Yes	Yes	Adequate	ED Visit - AsEx	Asthma/Wheeze	Time-series		All ages	34,086 U.S.	34,086 U.S.							
123458	Nichols, J, Jon 2015		Solar flares and leaded gasoil	Yes	Yes	Adequate	ED Visit - AsEx	Asthma/Wheeze	Time-series		All ages	34,086 U.S.	34,086 U.S.							
123458	Nichols, J, Jon 2015		Solar flares and leaded gasoil	Yes	Yes	Adequate	ED Visit - AsEx	Asthma/Wheeze	Time-series		All ages	34,086 U.S.	34,086 U.S.							
123459	Jones, R, Dutt 2014		Transhuman influences on all	Yes	Yes	High Quality	ED Visit - AsEx	Pneumonia	Time-series		All ages	12,166 U.S.	12,166 U.S.							
123459	Jones, R, Dutt 2014		Transhuman influences on all	Yes	Yes	High Quality	ED Visit - AsEx	Pneumonia	Time-series		All ages	12,166 U.S.	12,166 U.S.							
123459	Jones, R, Dutt 2014		Transhuman influences on all	Yes	Yes	High Quality	ED Visit - AsEx	Pneumonia	Time-series		All ages	12,166 U.S.	12,166 U.S.							
123459	Jones, R, Dutt 2014		Transhuman influences on all	Yes	Yes	High Quality	ED Visit - AsEx	Pneumonia	Time-series		All ages	12,166 U.S.	12,166 U.S.							
123459	Jones, R, Dutt 2014		Transhuman influences on all	Yes	Yes	High Quality	ED Visit - AsEx	Pneumonia	Time-series		All ages	12,166 U.S.	12,166 U.S.							

- Producing a chemical risk assessment document requires extracting and reformatting the data in cited studies into tables
- Previously, this was largely a manual task without required standardization
- This new tool uses spreadsheets formatted for different disciplines to help standardize data extraction
- Once the data is extracted, the spreadsheets are transformed into sets of tables useful in the document production process

Future Development

- Store data in HERO for repeated use in assessments
- Develop search and reporting capabilities for extracted data
- Through text and concept mining tools, automate the first pass at categorization and tagging
- Visualize the results of automated categorization in Evidence Maps
- Create tighter integration between HERO and HAWC
- Create, improve, and utilize web service APIs for HERO and HAWC to ease integration with third-party software
- Allow web-based data entry for Evidence Inventory
- Integrate Tableau visualization software with HAWC, Distiller, and Evidence Inventory tools
- Integrate Evidence Prime's Pupil automated data extraction software with Distiller, HAWC, and Evidence Inventory tools
- Investigate possible standards for extracted data formats to ease data migrations
- Investigate and implement tools for automated table and graph data extraction
- Work on ontologies for data extraction to make the data more easily searchable
- Employ agile development processes to test and incorporate new and useful tools into the assessment process