Title
Environmental bodies of water as reservoirs for *Salmonella*: A Scoping Review

Registration
This protocol has not yet been officially registered. However, it will be accessible via VTechWorks (https://vtechworks.lib.vt.edu/), an openly accessible repository for Virginia Tech scholarships.

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Contributions
BC: protocol development, collection of original studies, first reviewer, data extractor, data interpretation, and article drafting. RE: first reviewer, data extractor, data interpretation, and article drafting. DW: protocol development, second reviewer, data interpretation, and article drafting. AK: protocol development, first reviewer, and article drafting. HN: first reviewer, and

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INTRODUCTION

Rationale

Salmonella enterica is a leading cause of bacterial foodborne illness in the U.S., resulting in an estimated 1.4 million illnesses each year (3). Current approaches by the USDA and FDA to regulating *Salmonella* have not achieved the desired reductions in illnesses outlined in the Healthy People 2010 and 2020 campaigns, which sought to achieve incidences of 6.8 and 11.4 infections per 100,000 people per year, respectively (4, 5); however, the incidence of salmonellosis remains at an estimated 15.3 infections per 100,000 people per year (6). Moreover, certain demographics, such as infants < 1 year old and children 1-5 years old, often experience the highest burden of salmonellosis. Exposure to *Salmonella* can occur through foodborne and non-foodborne routes, including direct contact with animals that are shedding *Salmonella* or interacting with *Salmonella* in the environment. Traditionally, non-host, 'environmental' sources of *Salmonella* were not considered as important reservoirs of infection. However, the distribution of specific genetic subtypes of *Salmonella* suggests that the environment likely plays an important role in the persistence and spread of *Salmonella* through both foodborne (e.g., contamination of ready-to-eat produce) and non-foodborne (e.g., swimming in natural bodies of water where *Salmonella* may be present) routes of exposure. The geographic distribution of select subtypes of *Salmonella* (serovars) also suggests a strong association with specific environments, particularly in the Southeastern US. The current reasons why infection with some *Salmonella* subtypes is concentrated in the Southeastern US remain unknown and are an important gap in our understanding of salmonellosis.

Although *Salmonella* is known to survive in non-host environments, and the body of literature examining these non-host environments exists, there have not been scoping or systematic reviews that synthesize this information. Given the lack of progress in achieving the ambitious reductions in salmonellosis set forth by the CDC's Healthy People 2010, 2020, and 2030 initiatives, novel approaches to reducing exposure to *Salmonella* are warranted, including a thorough understanding of the role of the non-host environment in *Salmonella* transmission. This scoping review will identify, collate, and synthesize information on the role of environmental bodies of water as reservoirs facilitating the persistence and transmission of *Salmonella*.

Objectives

1. To identify, collate, and synthesize information on the role of environmental bodies of water as reservoirs for *Salmonella*.
2. To understand:

a. What subtypes of *Salmonella* (serovars) are most commonly found in environmental sources of water?
b. What role do environmental bodies of water play in *Salmonella* transmission? This could include transmission to/from agricultural farms (i.e., run-off) or habitats for wildlife that are hosts for *Salmonella*.

METHODS

Eligibility criteria

Inclusion Criteria:

1. The study must isolate *Salmonella* sampled from environmental bodies of water defined here as any non-marine (e.g., ocean) body of surface water that is continually present (i.e., puddles or other temporary surface water is excluded) across multiple seasons, whose presence is not related to waste management nor solely for drinking water (i.e., private groundwater such as wells). Because brackish water can potentially harbor *Salmonella* as it is less saline than water from true marine environments, the term surface water is used in an attempt to be inclusive of all types of non-marine water.
2. The study must identify *Salmonella* that is not intentionally added to the natural water environment.
3. Studies must report sampling water in the 50 United States.
4. The study must be accessible to the researchers either through open-access publications, Virginia Tech Libraries subscriptions, or interlibrary loans.
5. The journal articles need to be peer reviewed

Exclusion Criteria:

1. The study reports inoculating *Salmonella* into water (i.e., artificial rather than natural contamination) to assess survival.
2. The study does not present original research (e.g., review papers).
3. Studies that do not isolate *Salmonella* from environmental bodies of water (e.g., case studies implicating water as a potential risk factor for salmonellosis).
4. Ice, iceberg, icecap, glacier, and glacial do not qualify as bodies of water as they are frozen.
5. Studies that sampled any source other than environmental bodies of water (defined above; e.g.,well water or used well water for irrigation).
6. Studies that do not list the location (ex: county, state) of where the sample was collected.
7. Studies that sampled water outside of the 50 United States (the study does not include US territories).
8. Full text is unavailable to the researchers.
9. Anything that is not peer reviewed including pre-prints and letter to the editors will be excluded

Study Records

The following databases will be searched:

1. Academic Search Complete (via EBSCOhost)

2. SocIndex (via EBSCOhost)
3. Agricola (via ProQuest)
4. Scopus
5. Web of Science Core Collection (via Web of Science)
6. BIOSIS (via Web of Science)
7. Food Science & Technology Abstracts (via EBSCOhost)
8. Cab Abstracts (via CAB Direct)
9. PubMed

Search strategy
Searches were designed collaboratively with input from all authors. Searches were peer reviewed by an expert searcher and experienced evidence synthesis information professional. Final searches were implemented by JH and CC.
Example search strategy for Scopus
Scopus: "Title, Abstract, and Keywords" for all search terms.

((TITLE-ABS-KEY (water W/5 (beck OR bourne OR bournes OR broad OR burn OR burns OR channel OR channels OR coast OR coasts OR ditch OR ditches OR gill OR gills OR harbor OR harbors OR lagoon OR lagoons OR mere OR meres OR reservoir OR reservoirs OR sound OR sounds OR seep OR seeps OR stream OR streams OR spring OR springs OR trench OR trenches))) OR (TITLE-ABS-KEY (({Allt} OR {Aquifer} OR {Aquifers} OR {Backwater} OR {Backwaters} OR {Barachoi} OR {Barachois} OR {Basin} OR {Basins} OR {Bay} OR {Bays} OR {Bayou} OR {Bayous} OR {Bight} OR {Bights} OR {Billabong} OR {Billabongs} OR {Bog} OR {Bogs} OR {Brackish} OR {Brook} OR {Brooks} OR {Canal} OR {Canals} OR {Creek} OR {Creeks} OR {Dam} OR {Dams} OR {Distributary} OR {Distributaries} OR {Dyke} OR {Dykes} OR {Estuary} OR {Estuaries} OR {Everglade} OR {Everglades} OR {Fen} OR {Fens} OR {Fiord} OR {Fiords} OR {Firth} OR {Firths} OR {Fjord} OR {Fjords} OR {Fresh water} OR {Fresh waters} OR {Freshwater} OR {Freshwaters} OR {Ghyll} OR {Ghylls} OR {Ground water} OR {Ground waters} OR {Groundwater} OR {Groundwaters} OR {Head water} OR {Head waters} OR {Headwater} OR {Headwaters} OR {Inlet} OR {Inlets} OR {Kettle} OR {Kettles} OR {Lacustrine} OR {Lacustrines} OR {Lake} OR {Lakes} OR {Loch} OR {Loches} OR {Marsh} OR {Marshes} OR {Mire} OR {Mires} OR {Moat} OR {Moats} OR {Morass} OR {Morasses} OR {Nant} OR {Nentydd} OR {Pond} OR {Ponds} OR {Plunge pool} OR {Plunge pools} OR {Quagmire} OR {Quagmires} OR {Riparian} OR {Riparians} OR {River} OR {Rivers} OR {Rivulet} OR {Rivulets} OR {Rill} OR {Rills} OR {Runoff water} OR {Runoff waters} OR {Strait} OR {Straits} OR {Salt marsh} OR {Salt marshes} OR {Saltmarsh} OR {Saltmarshes} OR {Slough} OR {Sloughs} OR {Shoal} OR {Shoals} OR {Standing water} OR {Standing waters} OR {Standingwater} OR {Standingwaters} OR {Surface water} OR {Surface waters} OR {Surfacewater} OR {Surfacewaters} OR {Swale} OR {Swales} OR {Swamp} OR {Swamps} OR {Syke} OR {Sykes} OR {Tarn} OR {Tarns} OR {Tributary} OR {Tributaries} OR {Water shed} OR {Water sheds} OR {Watershed} OR {Watersheds} OR {Wet land} OR {Wet lands} OR {Wetland} OR

{Wetlands})))) AND (TITLE-ABS-KEY ((salmonell*))) AND (LIMIT-TO (AFFILCOUNTRY , "United States"))

Study records

Data Management:
Results from the comprehensive search will be downloaded as RIS files from each database and stored in a cloud-based (Google) shared drive that requires institutional affiliation to view. Files were imported into the systematic review software, Covidence (covidence.org). Duplicate records will be identified and quarantined automatically upon importing to Covidence.

Selection process:
BC, AK, HN and RE will be the primary reviewers, and RC and DW will serve as tie-breakers to resolve conflicts. All unique results will undergo a thorough assessment for inclusion based on the title and abstract. Records included or for which a determination could not be made in the title and abstract screening will then undergo a full-text review to ensure all eligibility criteria are met. Reviewers will engage in discussions to resolve any discrepancies until a consensus is achieved. Review articles pertinent to the topics of interest will be excluded from the synthesis but will undergo forward and backward citation chasing to ensure no relevant papers were overlooked in the initial search. Citation chasing will occur after the full-text review and will be conducted on all included records as well.

Data collection process:
BC, AK, HN, and RE will extract data using a standardized extraction form, with each study reviewed independently by two team members. RC will conduct periodic spot checks to ensure accuracy.

Data items
While the exact data to be extracted from each article will depend on the articles returned during the search, we anticipate that the following information will be extracted from the included articles. The same data items will be sought from all studies, and gaps across the literature will be noted:

1. Study Identification Information (title of the article, authors' names and affiliations, publication date, journal name, DOI, or other unique identifier)
2. Objectives and all research questions of the study
3. Study Design and Methodology:
    a. Type of study (cross-sectional, longitudinal)
    b. Sampling methods (random sampling or convenience sampling)
    c. Sample size and sample source (i.e., type of water source [stream, river, etc.])
    d. *Salmonella* detection method (e.g., PCR, culture-based methods)
4. Findings of longitudinal studies: trends or changes documented in *Salmonella* serovars or sources over time
5. Physicochemical Factors
    a. Information on physicochemical factors that may influence *Salmonella* isolation from water (e.g., pH, temperature, organic matter content, turbidity)

    b. Weather conditions such as a storm/flood/hurricane/large rainfall event that lead to ‘run off’ or ‘storm run off’
6. *Salmonella* Serovars:
    a. List of *Salmonella* serovars identified in the study
    b. The method used (serological serotyping vs. PCR vs. WGS prediction, etc.)
7. Geographic and temporal information of the study (e.g., location, season)
8. Risk Factors and Transmission:
    a. Evidence of wildlife presence during sampling
    b. Evidence of agricultural farms nearby

Data synthesis

The data will be presented in tabular format, accompanied by a written narrative synthesis to expound on the findings.

Meta-bias(es)

No analyses of meta-bias will be performed for this scoping review.

References

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