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<u>Title:</u> Factors affecting sentinel behaviour in non-aquatic species
<u>Type of Review:</u> Scoping Review
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<u>Abstract</u>

Sentinel behaviour, constant vigilance of an individual over others, has been observed in many species such as birds, ground-dwelling mammals, and birds. This type of behaviour has the benefit of minimising the costs of anti-predator vigilance of individuals in a group, thereby increasing the effectiveness of other behaviours. For example, foraging efficiency is thought to be directly affected by the presence of a sentinel individual. While the effects of sentinel behaviour on individuals have been assessed before, the factors affecting sentinel behaviour are less understood. Factors such as group size, predation pressures, and resource limitations can affect social behaviour, yet there is no comprehensive assessment of these, and other factors. I will perform a systematic review on the factors modifying the propensity of terrestrial individuals to participate in sentinel behaviour. Databases such as Web of Science, Google Scholar, and Scopus will be searched using an appropriate search string, and the resulting articles will be screened using pre-established inclusion and exclusion criteria following the ROSES protocol for systematic reviews. I will synthesise and produce a comprehensive insight into how social animals might change social behaviour in response to changes in these factors and make inferences on how urbanisation can alter social behaviour in these species.

<u>Background</u> - Sentinel behaviour, where one individual in a group exhibits constant vigilance over other members in the group, is a form of social antipredator behaviour. This behaviour has been observed in numerous species including aquatic, terrestrial, and avian species. In meerkats, likely the best-known species exhibiting this behaviour, the sentinel will stand in an elevated area to better detect predators from a further distance. This, in turn, allows other members in a group to perform other behaviours with greater efficiency, such as foraging, resting, or taking care of offspring.

Whether or not species will exhibit sentinel behaviour is dependent mostly on if the species is social or not. Yet not all social species present sentinel behaviour. Recent research has identified ecological and social factors that can influence sentinel behaviour.

Ecological factors such as the habitat or presence and type of predators can alter the effectiveness and usefulness of sentinel behaviour. Access to food and the type of food available can also alter an individual's propensity to participate in sentinel behaviour since the relative costs of not foraging can be mitigated by satiation.

Social factors can make certain individuals in a group more likely to participate in sentinel behaviour than others. The likelihood of an individual to participate in sentinel behaviour has been correlated with the individual's age, sex, and status within the group (dominance and/or breeding/nonbreeding individuals in the group). Group size can also alter sentinel behaviour and interact with other factors.

A scoping review, such as the one described in this protocol, is required to effectively bring together all potential factors and determine which have the greatest impacts on sentinel behaviour on non-aquatic species.

Stakeholder Engagement: There are no stakeholders involved in this scoping review.
This scoping review will involve the participation of:
Alex Popescu - Graduate student and lead researcher of this scoping review
Dr. Kiyoko Gotanda - Assistant professor, supervisor, and principal investigator of the Gotanda lab at Brock University.
Ian D. Gordon - Science librarian and search strategy consultant at Brock University
Dr. Lucas D. Gorné - Postdoc and consultant
Albert Wu - Graduate student and consultant
Kristen Valhiotis - Undergraduate student and consultant

Objective of the Review

Objective: To determine the factors that affect an individual's decision to participate in sentinel behaviour.

Definition of the Question: Sentinel behaviour is a form of social antipredator behaviour, where one individual will be constantly vigilant over other members in the group. This scoping review seeks to comprehensively identify factors that can affect this behaviour, whether by altering the frequency of participation, duration of sentinel bouts or any other quantifiable measure of sentinel behaviour.

Methods
Searches

Search Strategy: I will search Web of Science Complete for peer-reviewed articles. I will include grey literature by searching databases such as CAB Abstracts, and Google Scholar.

Search String: Sentinel AND Behavio*

Languages - Bibliographic: English only

Languages - Grey Literature: English only

Bibliographic Databases: Web of Science Core, BIOSIS, CAB Abstracts, Zoological Records

Web-Based Search Engines: Google Scholar

Organisational Websites: N/A

Estimating the Comprehensiveness: I have made a "hit list". I expect my search string to capture at least 80% of the articles on the list. Any less will lead to modifications to the search string.

Search Update: N/A

Article Screening and Study

Screening Strategy: I will perform an initial title screening and exclude articles that do not fit the inclusion criteria. Subsequently, an abstract screening will be performed to further exclude articles based on the inclusion and exclusion criteria. Review articles will be searched forwards and backwards on Web of Science and Google Scholar for relevant articles not captured by the search string.

Consistency Checking: All articles on the hitlist should pass the title and abstract screening. Additional "screeners" will be used to ensure unbiased abstract screening when I am unsure of whether to include or exclude an article.

Inclusion Criteria: Articles must test for the effect of a factor of interest on quantitative measures of sentinel behaviour (e.g. frequency, duration, etc). Articles testing and observing the presence or coordination of sentinel behaviour in species will be kept in a separate group and used to determine how often coordination of sentinel behaviour is reported in the literature. Bednekoff (2015) identifies coordination as the defining feature of sentinel behaviour, yet the general definition of sentinel behaviour for the purposes of this scoping review is:

"a form of animal behaviour in which one member of a group watches for potential predators while others in the group forage, rest, or engage in social interactions." (APA Dictionary of Psychology, n.d.)

Model species must be terrestrial (birds, reptiles, mammals). Sentinel behaviour in aquatic environments is different than in terrestrial environments. Aquatic species will not rely on visual identification of predators as much as terrestrial or avian species and can instead rely more on the presence of olfactory signals such as chemical alarm cues and predator odours. For this reason, aquatic species will be excluded from this scoping review.

Reasons for Exclusion: Articles must be from 1970 to 2022. Model species must not be aquatic. Articles must not be theoretical (mathematical) or reviews.

Critical appraisal

Articles will be read in their entirety and tagged to identify the factors they assessed. Studies will be deemed valid if they report changes in quantitative measurements of sentinel behaviour between two or more treatment groups or states, and the effect size must either be described or be able to be calculated from their results (either standardized mean difference or correlation coefficient).

Critical Appraisal Strategy: The effect size of each factor in each model species will be compiled and used for analysis along with the measurement of sentinel behaviour used in the experiment. With this data, I will describe which factors have the greatest effects on sentinel behaviour as well as how sentinel behaviour can be altered.

Consistency Checking: All articles on the hitlist should pass the article screening. Additional "screeners" will be used to ensure unbiased screening.

Data Extraction

Meta-data Extraction and Coding: Data extracted from articles will be recorded in a table. Elements such as sample size, treatment groups, species, habitat, factor tested, and

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Commented [KG1]: ? In regular systematic reviews, yes, you have additional people screening articles, but you'll be doing this on your own, right?

Commented [KG2]: Excellent. What effect size are you thinking? Partial Eta? R^2? Cohen's D?

measurement of sentinel behaviour used will be reported in this table. From each article, the effect size of each factor tested will be recorded or calculated. The appropriate measurement of effect size will be calculated from available datasets for each factor and measurement of sentinel behaviour.

All coding will be performed in R and the script will be made publicly available for review. A list of all articles that were used for data analysis, and reasons for rejection of articles that passed the screening process but were not used for data extraction, along with a reason for their rejection, will be compiled and made available.

Data Extraction Strategy: All data will be extracted from results appearing in articles and any available data (either already available or obtained directly from the author). Data will be extracted from reported tables and figures as appropriate.

Approaches to Missing Data: Authors of articles that have missing data will be contacted and asked for any required data. If authors refuse to share their results or do not answer back, their article will be rejected.

Consistency Checking: Reasons for rejection and the screening process will be recorded and made available to ensure repeatability of the data extraction.

Potential Effect Modifiers/Reasons - Still unsure about this

Data Synthesis and Presentation

Type of synthesis: Quantitative and Qualitative

Narrative synthesis strategy: Not applicable

Quantitative synthesis strategy: Data extracted from articles will be analysed in R. Statistical tests to compare the effect sizes of each factor will be performed to assess the relative effects of each factor when compared to one another. A mixed model analysis or ANOVA of the effect size measurements, using habitat and species as factors in the model, will be performed on the effects of each factor on each measurement of sentinel behaviour. From this analysis, I seek to identify which factors have the greatest effect on sentinel behaviour and observe how these factors likely affect it.

Qualitative synthesis strategy: How each factor affects sentinel behaviour will be discussed by synthesizing findings from relevant articles used in this review. Factors will be grouped as either ecological or social in nature. How urbanisation can affect sentinel behaviour through these factors will subsequently be discussed.

Other synthesis strategies: The number of articles that report coordination of sentinel behaviour will be recorded and compared to the results of Bednekoff 's review on sentinel behaviour (2015) in order to determine the proportion of articles that use their definition compared to the broader definition of sentinel behaviour.

Assessment of risk of publication bias - Forward and backward citation searching through published and grey literature will minimize the risk of publication bias.

Knowledge gap identification strategy: A knowledge gap will be identified if there are strong effect sizes in infrequently used measurements of sentinel behaviour. Frequently

mentioned avenues of future research that were not followed up on will likewise be reported as gaps in the knowledge.

Demonstrating procedural independence: Before data extraction and analysis, screeners will be given the list of articles that will be used. They will screen this list for any articles that do not match the selection criteria for this review. Screeners will only be able to see the results from other screeners once the screening is complete. If screeners disagree on the rejection/inclusion of an article, a vote will decide the fate of the article.

A consultation with Ian D. Gordon will be required if more than 20% of articles are rejected by the screeners to identify errors in the screening procedure.

<u>**Declarations:**</u> I have no competing interests.

Bednekoff, P. A. (2015). Sentinel behavior: A review and prospectus. In *Advances in the Study of Behavior* (Vol. 47, pp. 115–145). Elsevier. https://doi.org/10.1016/bs.asb.2015.02.001