

“Despite the scarcity of data available, there are no major data gaps” — The inadequacy of assessments of effects on bats in Canadian federal impact assessments

**Submitted to:
Dr. Scott Findlay, Supervisor
Dr. Gabriel Blouin-Demers, Second Reader**

**For the Course:
Major Research Project (MRP)
(EVD6999)**

**By:
Charlie Campbell
300017975**

Institute of the Environment

**University of Ottawa
April 30, 2024**

Abstract

To investigate the capability of Canada's federal Impact Assessment (IA) process to contribute to bat conservation, this project examined Environmental Impact Statements (EISs) collected from the Impact Assessment Agency of Canada registry. 37 of the 54 EISs sampled were found to contain conclusions about bats and were therefore carried forward for analysis. The documents were searched using key words to find information on the overall conclusions reached about a project's impact on bats (regarding adverse effects, cumulative effects, and their significance), the set of potential impacts considered by a project, the strength of evidence used to support the conclusions drawn about the project's effects on bats (characterized through the presence of information gaps in the EIS, the application of precaution, the use of academic sources, and the methods used to survey for bats), and the application of bat boxes as a mitigation measure for destroyed/degraded bat habitat. Neither the effect of their project on bats, nor its contribution to cumulative effects on bats, were deemed to be significantly adverse by any of the 37 EISs that contained conclusions about effects on bats. Additionally, it was inferred based on the level of agreement between projects of the same type, that relevant impacts to a project were commonly not considered in EISs. The average strength of evidence found in the documents was low, caused primarily by high levels of uncertainty which were rarely treated with precaution. The application of bat boxes as a mitigation measure was found to be applied inconsistently, with no relationship found to the area of bat habitat loss predicted for a project. These findings suggest that in its current form, Canada's federal IA process does not consider potential effects on bats adequately.

Table of Contents

1. Introduction
 - 1.1 Project Scope and Assessment Factors
 - 1.1.1 The Consistency and Scope of Impacts Considered
 - 1.1.2 Strength of Evidence
 - 1.1.3 Use of Bat Boxes
2. Methods
 - 2.1 Project Scope and Assessment Factors
 - 2.1.1 The Consistency and Scope of Impacts Considered
 - 2.1.2 Strength of Evidence
 - 2.1.3 Use of Bat Boxes
 - 2.2 Data Collection
 - 2.2.1 Project Sample
 - 2.2.2 Document Searches
 - 2.3 Data Analysis
 - 2.3.1 Rationales
 - 2.3.2 Consistency of Impacts Considered
 - 2.3.3 Critical Information Gaps and Precaution
 - 2.3.4 Academic Sources
 - 2.3.5 Survey Methods
 - 2.3.6 Strength of Evidence Score
 - 2.3.7 Predicted Bat Habitat Loss and Bat Box Application
3. Results
 - 3.1 Types of Rationales Supporting Overall Conclusions
 - 3.2 Consideration of Impacts
 - 3.3 Secondary Research
 - 3.4 Survey Methods
 - 3.5 Critical Information Gaps and Precaution
 - 3.6 Evidence Scores
 - 3.7 Predicted Bat Habitat Loss and Bat Box Application
4. Discussion
 - 4.1 Infrequent Consideration of habitat types other than roosting habitat
 - 4.2 Bat habitat availability and significance determination
 - 4.3 Comprehensiveness of Impact Considerations
 - 4.4 Strength of Evidence
 - 4.5 Bat Boxes and Mitigation
5. Conclusions and Recommendations
 - Acknowledgements
 - Bibliography

1 – Introduction

In Canada, bat populations are threatened by multiple distinct phenomena (Spiller & Dettmers, 2019) including: disease (Cheng et al., 2021; Vanderwolf & McAlpine, 2021), wind turbine development (Frick et al., 2017; Millon et al., 2018; Zimmerling & Francis, 2016), habitat loss (Hayes & Loeb, 2007; Put et al., 2019), habitat fragmentation (Abbott et al., 2015; Claireau et al., 2019; Segers & Broders, 2014), climate change (Alston et al., 2023; Davy et al., 2022; Festa et al., 2023), and other negative effects resulting from human disturbance (Beattie et al., 2022; Seewagen et al., 2023). These threats have resulted in rapid and significant population declines for bat species across Canada (Balzer et al., 2021; Cheng et al., 2021; Davy et al., 2021; Frick et al., 2017; Rodhouse et al., 2019). Applying population trend data from Davy et al. (2021), the Committee On the Status of Endangered Wildlife In Canada (COSEWIC) estimate that some Canadian bat species could decline as much as 95% in the next 12 years due to wind-turbine-related mortality (COSEWIC, 2023, p. 31).

Given these recent and ongoing declines, any additional negative effects on remaining bat populations could have disproportionate impacts on the viability of those populations because of the tendency of threats to act synergistically with one another (Brook et al., 2008; Tyack et al., 2022) and the increased extinction risk of smaller populations (O’Grady et al., 2004). Further decreasing already depleted populations may also cause them to cross tipping points into detrimental feedback cycles which could accelerate their rate of decline (Capdevila et al., 2020; Fagan & Holmes, 2006). Additionally, recovering a population or species becomes more challenging and expensive the greater the initial decline of that population or species (Shogren et al., 1999, p. 1259–1260). These factors suggest that, in addition to addressing ongoing threats, it is critical to limit the introduction of any novel stressors to imperilled bat populations.

One of the major tools to prevent environmental damage in Canada is the Impact Assessment (IA) process. IA legislation is intended to facilitate sustainable economic development while preventing activities that are likely to cause significant adverse impacts on the environment (Impact Assessment Agency of Canada (IAAC), 2021). The primary documents upon which decisions in the IA process are based are Environmental Impact Statements (EISs). These documents are written by a proposed projects proponent (i.e., the organization seeking to undertake the project). In these documents the proponents present the methods and results of the assessments they have done to determine the environmental impact of their project. This content is then reviewed by a governmental body and used to determine whether the project will be allowed to proceed, and if any conditions are required if it does proceed.

Projects that are assessed in the IA process, such as mines, wind turbines, and other development projects are known to create impacts with the potential to negatively affect bats (Abbott et al., 2015; Claireau et al., 2019; Finch et al., 2020; Reusch et al., 2023; Theobald et al., 2020). These negative impacts may represent additional stressors to already threatened bat populations, and therefore the degree to which the IA process can effectively manage these projects and their impacts is of relevance to bat conservation efforts in Canada.

Canada’s federal IA process has been criticized for not living up to the environmental protection component of its mandate. Specifically, the federal Canadian IA process has been critiqued for:

- Approving projects “by default”, and rarely rejecting a proposed project regardless of the adequacy of the assessment conducted (Collard et al., 2020; Doebeli et al., 2021; Fonseca & Gibson, 2021);
- Not properly acknowledging or addressing scientific uncertainty present in the assessment of impacts and mitigation (Aksamit et al., 2020; Lees et al., 2016; Pavlyuk et al., 2017);
- Setting inappropriate, unscientific thresholds for determining the significance of an expected or potential impact (Ehrlich & Ross, 2015; Murray et al., 2018);
- Failing to address conflicts of interest and the risk of bias therefrom (Bernauer et al., 2023; Ray et al., 2021, pp. 1056–1057);
- Underestimating or not considering the cumulative effects resulting from multiple sources of impacts from a project or across multiple projects (Gannon, 2021, p. 7; Harker et al., 2021; Nanos, 2017, p. 11; Patterson et al., 2022, pp. 489–491); and,
- Overestimating the effectiveness of mitigation measures in offsetting environmental harm (Collard et al., 2020, p. 4; Doebeli et al., 2021; Lintott et al., 2016).

In addition to overarching studies of the IA process, more specific analyses of the contribution of Canada’s IA process to species recovery have been conducted (see: Cameron & Kennedy, 2023; Collard et al., 2020; Doebeli et al., 2021). These works have primarily focused on highly charismatic mega-fauna such as caribou and killer whales, the conservation of which is generally given increased attention relative to other, lower profile taxa such as bats (Bats are not a “priority species” in the Pan-Canadian approach to transforming species at risk conservation, as caribou are (Environment and Climate Change Canada, 2018), for example).

The purpose of this project is therefore to examine the adequacy of EISs in assessing the potential impacts of projects on bat populations, with a focus on the scope of effects assessments, the treatment of scientific uncertainty and information gaps, the quality and use of primary and secondary research, and the application of mitigation measures. By analyzing these factors, I seek to understand and characterize the capability of the current Canadian federal IA processes to address bat conservation issues.

2 – Methods

The following section details the methods employed to evaluate the treatment of bats in the Canadian federal IA process. Any use of the terms defined in Table 1 hereafter will be according to the definitions described therein.

2.1 – Assessment Factors

To support the project objectives described above, a set of assessment factors were chosen upon which EISs are evaluated in this report (Table 1). The factors chosen each roughly relate to different stages of the IA process:

- Survey Methods → Baseline Conditions Assessment
- CIGs and Academic Sources → Analysis and Effects Assessment
- Bat Boxes → Mitigation of Predicted Adverse Effects
- Precaution, Rationales, and Overall Conclusions → Decision Making

Table 1. Working definitions for terms related to the assessment factors used in this project to characterize the adequacy with which EISs assess potential effects on bats.

Term	Working Definition
Overall Conclusions	Statements made in an EIS or a relevant associated document which characterize the predicted overall net direct or cumulative effects of a project on bats as either positive or adverse and either significant or not significant.
Rationales	Statements made in an EIS or a relevant associated document which justify or explain why the overall conclusions were reached. These statements often reference or interpret the results of an EIS’s assessment of its impacts on bats.
Critical Information Gap (CIG)	A piece of information, data, or understanding which is identified in the EIS or a relevant associated document as being unknown by the proponent at the time of writing but is nonetheless necessary to make an informed decision, such that an answer that could change whether the project is predicted to have significant adverse effects on bats is contained within the range of possible answers.
Precautionary Statement	A statement in the EIS or a relevant associated document that directly relates to a CIG and which describes how the uncertainty associated with that CIG will be treated with precaution, such as by assuming a “worst-case scenario” when estimating the significance of proposed impacts, for example. General statements expressing a commitment to an overall conservative/cautious approach are not included in this definition unless they are combined with explicit statements which explain how specific uncertainties/predictions were treated in a cautious manner.
Impact Considered (or Impact Types Considered)	Possible outcomes of a project that are described in an EIS or a relevant associated document and that are considered by the EIS to potentially cause a direct or indirect adverse effect (even a negligible negative effect) on bats in the absence of mitigation. Effects that are anticipated by the EIS to be fully mitigated by the project are included in this definition.
Academic Source	A peer-reviewed source of information (such as an article published in an academic journal) cited in an EIS using an accepted referencing style that is used to directly support an EIS’s assessment of a project’s impact on bats. References to government documents (COSEWIC Reports, Recovery Strategies, Guidelines, etc.), and non-peer-reviewed sources are not included in this definition. Only Academic Sources cited in the main EIS document are considered for the purpose of this project, those found in related documents are omitted.
Survey Method	An activity carried out by the proponent of a project (or carried out on the proponent’s behalf) that is described in an EIS or a relevant associated document and which supports the assessment of the project’s effects on bats by providing information on roosts or roosting habitat in the local or regional area, hibernacula or related landscape features in the local or regional area, or the presence/absence and/or abundance of bats in the local or regional area.
Bat Box	Any artificial structure that is installed or placed into an environment with the intention that the structure be used by bats as shelter. Includes bat boxes, bat houses, bat condos, rocket boxes, and bark mimics (Holroyd et al., 2023).

Table 2. Assessment factors chosen for an evaluation of the Canadian IA process, and how each relates to GRADE assessment domains.

Assessment Factor	Related GRADE Assessment Domain(s)	Explanation
Critical Information Gaps (CIGs)	Directness, Consistency, Precision	CIGs indicate a lack of direct evidence, inconsistent or missing data, imprecision in available data, or overall lack of relevant studies.
Precautionary Statements	Directness, Consistency, Precision	In a risk assessment context, a precautionary approach can potentially mitigate the negative effects of uncertainty/CIGs when applying evidence to make decisions (Gullett, 1998; Martuzzi & Bertollini, 2004).
Academic Sources	Limitations (Risk of bias)	Studies carried out by the proponent have a higher risk of bias due to the proponent’s competing interests (Bernauer et al., 2023; Enríquez-de-Salamanca, 2018), the effect of which can be partially mitigated through the inclusion of corroboratory academic sources in the proponent’s body of evidence.
Survey Methods	Limitations, Directness, Precision	Different survey methods carry different risks of bias, levels of precision, and directness of the application of results (extrapolation).

Through the assessment of these factors, described subsequently, the adequacy of the IA process overall can be established, and the ways that each stage of the process contribute to the overall sufficiency or insufficiency of IAs can be identified.

2.1.1 – The Consistency and Scope of Impacts Considered

The effectiveness of an IA is highly dependent on its scope. To properly evaluate the significance of predicted project effects on bats, all the relevant effect pathways through which a project could impact bats must be accounted for. Therefore, an analysis of the sets of impacts considered by projects in their assessment of bats, and the comprehensiveness of those sets will inform whether IAs are properly accounting for all the pathways through which their projects could affect bats. The results of this analysis will contribute to an understanding of the capability of EISs, as they currently exist, to address bat conservation issues.

2.1.2 - Strength of Evidence

Conclusions supported by weak evidence are more likely to be incorrect than those supported by strong evidence. Therefore, if it is concluded that a project will not have a significant adverse effect on bats, but that conclusion is supported by weak evidence, there is a greater risk that the true effects of the project will be significantly adverse. To evaluate this risk, the strength of evidence used in IA must be evaluated. To accomplish this for the purposes of

this project, the Critical Information Gaps (CIGs), precautionary statements, academic sources, and survey methods identified in EISs will be analyzed.

Much of research and thought about using evidence to make decisions comes from medical science. Medicine and impact assessment are similar in the sense that they both use available evidence to make predictions about the consequences of various actions and make decisions based on those predictions, often in the face of uncertainty and incomplete information.

Developed for, and typically applied in, medical settings, GRADE is the most widely used tool for evaluating the quality of a body of evidence for the purposes of decision making (Siemieniuk & Guyatt, n.d.). A body of evidence refers to all the research that has been collected in support of or opposition to given conclusion. The GRADE framework suggests evaluating a body of evidence primarily on the limitations, directness, consistency, precision, and reporting bias of the studies within that body of evidence (Berkman et al., 2015). Table 2 demonstrates the connection between these assessment domains and the factors selected to characterize the strength of evidence of EISs.

2.1.3 – Use of Bat Boxes

Determinations of significance in IA often rely on the presumed effectiveness of chosen mitigation measures and strategies to eliminate or reduce the predicted adverse effects of a project, which is not always validated by the actual outcomes of projects (Collard et al., 2020, p. 4; Doebeli et al., 2021; Lintott et al., 2016). To be truly effective, the mitigation measures chosen for a project must be specifically tailored to address the nature of the projects predicted impacts.

A common mitigation measure employed for bat conservation specifically is the creation of bat boxes to offset losses of roosting habitat from a project (Rueegger, 2016). To understand the relationship between mitigation measures employed and the associated impacts of the project, this report will examine the use of bat boxes as described in EIS, and its relationship to the area of anticipated bat habitat loss per project. This investigation will illustrate the consistency with which bat boxes are applied as mitigation measures in EISs and thereby indicate the rate of appropriate and inappropriate use of mitigation measures in the IA process.

2.2 – Data Collection

The current federal IA legislation is the Impact Assessment Act (IAA) (2019). Due to the recency of this legislation, and the typical timelines of federal impact assessments, projects legislated under the current act are not yet advanced enough to be meaningfully evaluated. Therefore, this project will focus on projects completed under the Canadian Environmental Assessment Act (CEA) (2012), the previous Canadian federal IA legislation. While there are differences between the two acts, they are similar enough in relevant areas (Doelle & Sinclair, 2019; Gibson, 2020; Hunsberger et al., 2020) that lessons from the previous act will still be useful in informing the application of the new act.

The following subsections detail the collection and analysis of data, encompassing the selection of project samples, extraction of relevant information from the EISs of these projects, and the application of analytical techniques to the extracted data.

Table 3. The variables used for each assessment factor in an analysis of EISs from the IAAC Registry.

Assessment Factor	Variables (for each project)
Overall Conclusions	Six categorical variables, each with options “yes”, “no”, and “not considered by the project”, representing the presence of explicit or implicit conclusions on adverse/positive effects (direct and cumulative), and the significance of predicted effects (direct and cumulative).
Impacts Considered	A set of 15 binary variables, each representing a type of impact on bats and whether that type of impact was considered in a project document.
CIGs	A discrete numeric variable representing the number of CIGs identified within the documents of a given project.
Precautionary Statements	A discrete numeric variable representing the number of critical information gaps for which an associated statement of precaution was identified.
Academic Sources	A discrete numeric variable representing the number of academic sources (see definition in Table 1) cited in a project’s EIS.
Survey Methods	A set of 11 binary variables, each representing a type of survey method and whether that method was said to be used in any project document.
Use of Bat Boxes	A continuous numeric variable representing the area (hectares) of bat habitat predicted to be destroyed or degraded by the project, taken directly or inferred from a project document, and a binary variable representing whether a statement indicating that bat boxes would be used as a mitigation measure for the project was present in any project documents.

2.2.1 – Project Sample

To collect a sample of EISs from different projects, the Impact Assessment Agency of Canada (IAAC) Registry was searched using the phrase "impact statement", with the “Additional Information” filter (as EISs are assigned to this category within the registry), and the “best match” sorting option enabled. Of the 4191 total results from this search, the first 315 were reviewed to determine whether the result corresponded to an EIS or some associated document. In the case where an associated document was found the corresponding EIS was obtained from the project’s list of documents. The search yielded 52 EISs from 52 projects and 2 substituted Application documents from British Columbia¹ (summarized in Appendix A). The document

¹ The inclusion of these documents in an analysis of Federal Impact Assessment documents is supported by section 35 of the *Canadian Environmental Assessment Act (CEAA)* (2012) which states, “[...] the assessment that results from [a] substitution is considered to be an environmental assessment under this Act and to satisfy any requirements of this Act and the regulations in respect of an environmental assessment.”

lists for each project were also reviewed to identify associated documents containing relevant information, such as technical appendices.

2.2.2 – Document Searches

EISs were searched using the "find" function to identify relevant information. A common set of search terms (Appendix C) was used in each document to locate any discussions of bats or bat habitat and determine if the document contained a conclusion about the project's overall effect on bats. Only projects with a conclusion about bats (37 out of 54) were carried forward for further analysis.

The EISs of two projects were only available in French and were therefore omitted from the CIG and precaution analysis due to the time required to translate and search the documents. However, their English summaries were used for the overall conclusions, bat box mitigation, and impacts considered analyses. Therefore, the sample size for the overall conclusions, impacts, and bat box analyses is 37 projects, while the sample size for CIG and precaution is 35.

Additional searches (Appendix C) were performed on the EISs, and any relevant associated documents, to locate information related to each chosen factor identified in Table 1. Any information located through these searches, or the initial common search, and the text surrounding the result location, were reviewed for relevance to any assessment factor. Supporting arguments justifying the overall conclusion were recorded and used to evaluate Critical Information Gaps (CIGs). Precautionary statements were assessed for relevance to CIGs and incorporated into the analysis of uncertainty and precaution.

Throughout the extraction of information on the impacts considered, rationales, and survey methods used in each project, I conducted a thematic analysis to identify and categorize similar results across projects. This involved:

- Reviewing the results for each project and noting their attributes (e.g., the type of bat habitat discussed in a consideration of potential impacts).
- Identifying and labeling categories of similar types of results for each of the three factors based on their attributes (e.g., descriptions of potential impacts across different projects which referred to the same or similar bat habitat types as one another).
- Refining the categories through an iterative process: comparing new results to existing categories and adding them to the relevant category if a match was found or creating new categories as needed to capture novel, unique results. This ensured that every relevant result was categorized, and no categories existed for which there were no relevant results.

The resultant categories and their definitions are available in Appendix B of this report.

This thematic analysis enabled the identification of patterns in how projects assess environmental impacts on bats, facilitated comparisons between projects, and contributed to characterizations of the overall sample of projects.

2.3 – Data Analysis

The following subsections describe the qualitative and quantitative techniques applied to the assessment factors to understand the significance and implications of their associated data.

2.3.1 - Rationales

To characterize the types of rationales used to justify overall conclusions about bats in EISs, the marginal frequencies of the use of each type of rationale were calculated (n = 35).

2.3.2 - Consistency of Impacts Considered

To understand the types of impacts on bats considered in impact assessment, I estimated the marginal frequencies of consideration of each type of impact (n = 37).

To determine the similarity of the sets impacts considered among projects of the same type, I calculated the Jaccard Index² (Real & Vargas, 1996) of each mining project within the sample of projects by comparing the set of impacts considered by that project with the set of all impact types considered by at least one project within the sample. Only mining projects with at least one impact type considered were included in this analysis (n = 22). The mean of the resultant Jaccard Indices represents the overall level of agreement/similarity among mining projects in terms of the impacts they consider. This process was repeated for non-mining projects within the sample (n = 13), for the sake of comparison.

2.3.3 – Critical Information Gaps and Precaution

To evaluate the presence and treatment of uncertain or unavailable information, CIGs and any associated precautionary statements identified in EISs were enumerated (see relevant entries in Table 1 and Table 3) (n = 35). The results of this process were applied according to the methods described in Table 5 to generate a CIGs and Precaution Score which contributes to the Strength of Evidence Score, discussed further in section 2.3.6.

2.3.4 – Academic Sources

To identify the number of projects within the sample that cited an insufficient number of academic sources to support their overall conclusions, I compared the number of academic sources cited by each EIS to the number of impacts considered by that EIS (n = 35).

Projects should ideally cite multiple high-quality academic sources to support each scientific claim about their impact on bats. Due to time constraints and the size of the project sample, it was not feasible to directly assess the frequency with which this ideal was met. Instead, I identified a subset of projects for which a lack of adequate academic support could be reasonably inferred according to the following logic: If each academic source relates, on average, to one impact type, projects with more impact types than academic sources cited must have at least one unsupported claim, indicating a lack of academic backing for some portion of the total claims. The number of such projects in the sample represents a minimum estimate of those with inadequate academic support.

The results of this analysis were applied according to the methods described in Table 5 to create an Academic Sources Score which contributes to the Strength of Evidence score, which is discussed further in section 2.3.6.

² $J(A, B) = \frac{|A \cap B|}{|A \cup B|}$

2.3.5 – Survey Methods

To characterize the use of survey methods in assessments of impacts on bats, the marginal frequency of the use of bat survey method types was calculated using the sample of EISs with conclusions about bats (n = 35).

Table 4. Values representing the strength of evidence, on a scale of 0 to 1, of bat survey methods used in a sample of 35 EISs for projects in the Canadian federal IA process. The values contribute to an overall score representing the quality of a project’s primary research informing its assessment of bats. The working definitions of the survey methods referenced are available in Appendix B of this report.

Survey Focus	Survey Method	Value	Explanation for Value Assigned
Roosting Habitat	Land Classification Mapping	0.5	Relies on land classification data and the associations of bat habitat with land categories. Any errors/uncertainties in the classification data, or the assumed bat habitat associations can therefore affect inferences made about roosting habitat.
	Manual Inspection of Roosts	1	Confirms the presence/absence of suspected roosts with high certainty, especially if it is combined with effective presence/abundance detection methods (Froidevaux et al., 2020). Can contribute information on demographics, abundances, habitat uses, and other matters of relevance to an IA if roosts are found.
	Tagging & Tracking	1	Directly observes where bats in the area roost. Facilitates roost inspections (see above). Does not depend on the validity of inferred/suspected roost locations.
Hibernacula	Land Classification Mapping	0.5	See explanation for Land Classification Mapping of Roosts.
	Hibernacula Survey	1	See explanation for Manual Inspection of Roosts.
Presence/Absence and/or Abundance	Acoustic Monitoring	0.5	Suggests the presence/absence of bats within a chosen area, but cannot provide reliable information on abundance, distribution, or other population features. The risk of call misidentification and differences in detectability between species adds uncertainty to inferences about species composition (Dekker et al., 2022; Russo & Voigt, 2016).
	Incidental Observations (Absence)	0	A baseline survey effort level is needed to determine the absence of bats in an area because they are hard to see and hear without specialized equipment and/or techniques. Their absence therefore cannot be inferred from a lack of incidental observations.

Incidental Observations (Presence)	0.25	Suggests some use of an area by bats, but the risk of false-positives and lack of any additional reliable information gained limit the method's value.
Mist Netting	1	Can provide significant insight about the bat population of an area, if sited correctly. Provides demographic information, and can contribute to high quality estimations of abundance, particularly if used in a mark recapture survey.
Review of Previous Field Work	0.25	Uncertainty is introduced when research conducted in a particular time and/or place is used to draw specific conclusions in a different temporal and/or geographic context, creating a significant risk of error if used as the only evidence in a project's assessment of bat presence and/or abundance within an area.
Visual Assessments	0.5	Can reliably confirm the presence, and contribute to estimations of abundance, of bats at suspected emergence, swarming, or feeding locations, but cannot provide significant insight if credible data to suggest sites worthy of investigation is unavailable.

Additionally, scores characterizing the evidentiary strength of the survey method types observed in the project sample were assigned (Table 4) and used to generate a Survey Methods Score according to the methods described in Table 5. Bat surveys are most effective when multiple survey methods are combined (Appel et al., 2021; Mancini et al., 2024), so the scores in Table 4 are divided across different domains, with each domain scored individually and the overall score representing the average of each of the three survey focus domains. The effect of this approach is that projects employing multiple different methods across different survey focus domains score better than those that use fewer methods and/or whose focus is concentrated in only one area.

The survey methods score contributes to the Strength of Evidence score, which is discussed further in section 2.3.6.

2.3.6 – Strength of Evidence Score

To represent the overall strength of the evidence used to support the assessment of potential effects on bats in an EIS, I created an evidence score for each project in the sample which contained a conclusion about its potential effects on bats (n = 35). To accomplish this, the results of the CIG and precaution analysis, the academic sources analysis and the survey methods analysis were each quantified according to the methods described in Table 5.

The methods chosen were set such that a project which satisfied the minimum acceptable standards for that assessment factor would receive a score of one. Because the overall evidence score generated from these methods is an average of the three input scores, a project would receive an overall evidence score of one if it were found to be satisfactory in all three input scores evaluated.

Table 5. Descriptions of the methods used to generate coarse, quantitative scores for assessment factors related to the strength of evidence used to support conclusions about a project's effect on bats in EIS documents.

Assessment Factor	Quantification Method
Critical Information Gaps (CIGs) and Precaution	Divide the number of CIGs identified for a given project that have been addressed through precaution (see Table 1 and Table 3) by the total number of CIGs identified for that project. CIGs with any number of relevant precautionary statements are considered to have been addressed. Projects with no CIGs identified are given a score of NA.
Academic Sources	Give a score of 1 to all projects with more identified academic sources than impacts considered. Projects with no identified considered impacts, are given a score of NA. All other projects are given a score equal to the number of identified academic sources divided by the number of identified impacts considered.
Survey Methods	Ascribe a value to each survey method employed by the project according to the rubric in Table 4. Sum the values of all the survey methods identified to a maximum of 1 for all three survey focus categories (roosting habitat, hibernacula, presence/absence and abundance). Average the scores across all three survey focus categories to generate an overall survey methods score.
Strength of Evidence	Average the CIGs and precaution, academic sources, and survey methods scores for a project. If a project has a CIG and precaution score of NA, omit it from the calculation, and instead average the academic sources and survey methods scores only. If a project has an Academic Sources Score of NA, omit it from the calculation, and instead average the CIG and precaution and survey methods scores only.

2.3.7 – Predicted Bat Habitat Loss and Bat Box Application

To investigate whether projects predicted to result in larger areas of bat habitat destruction are more likely to use bat boxes as a mitigation measure than projects with smaller areas of anticipated bat habitat destruction, I used a two-tailed Mann-Whitney U test comparing the areas of habitat loss from the sample of projects with (n = 11) and without (n = 21) bat box use because the distribution of habitat loss estimates was non-normal (Shapiro-Wilk test, $p < 0.001$). Additionally, I performed a logistic regression on the datasets to test whether there was a significant relationship between bat box applications and the area of habitat lost from a project. I repeated these analyses using the proportion of total available bat habitat in the local area predicted to be destroyed/degraded by the project rather than the absolute area of predicted bat habitat lost.

3 - Results

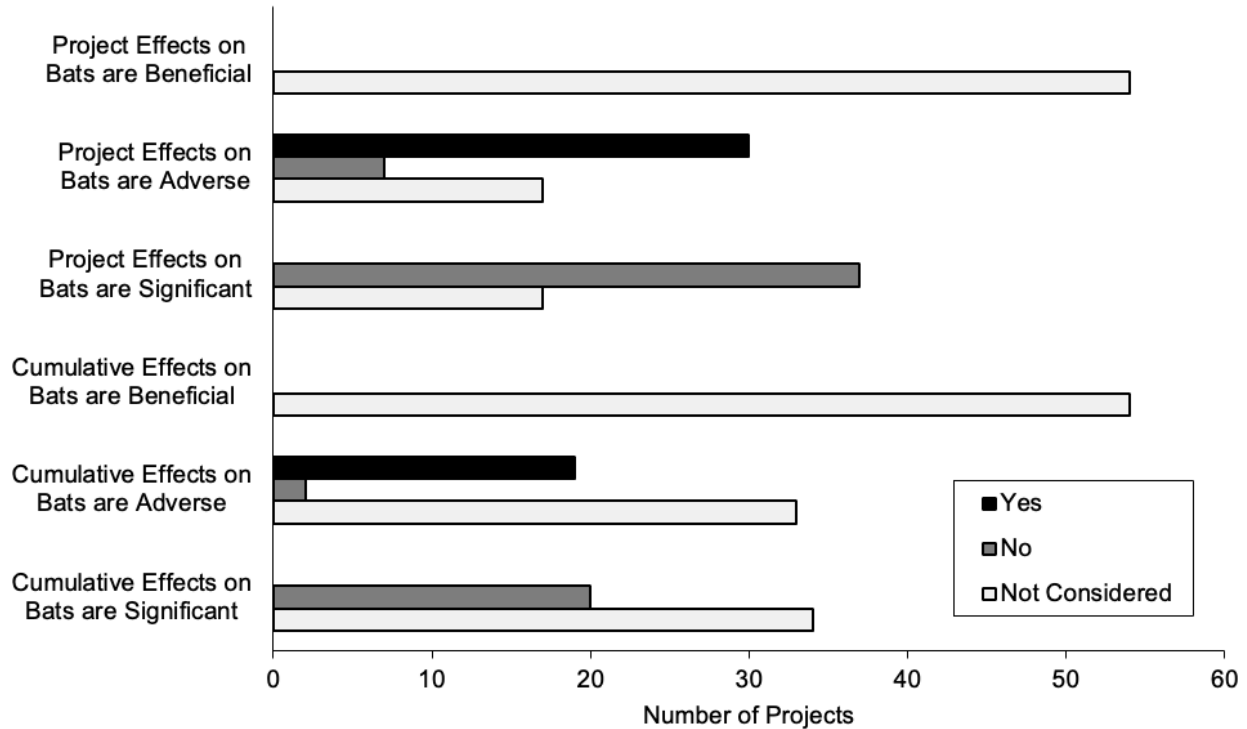


Figure 1. A summary of the general conclusions drawn in Canadian Federal EISs about a project’s overall impacts on bats based on a sample of EISs from the IAAC registry. [Yes = The conclusion was explicitly included in the EIS (or directly associated, relevant documents) or could be reasonably inferred based on information in the EIS (or directly associated documents); No = A contrary conclusion was explicitly included in the EIS (or directly associated, relevant documents) or could not be reasonably inferred based on information in the EIS (or directly associated documents); Not Considered = No conclusion on the given subject was found to be present in the EIS (or directly associated documents) and one could not be reasonably inferred based on the information in the EIS (or directly associated documents).]

Of the 54 projects sampled, 17 did not contain any conclusions about the project’s effect on bats (Figure 1). The majority (71%; 12/17) of these were related to offshore oil and gas, either offshore exploratory drillings or facility developments, whose effects are unlikely to interact with bats given their distance from land (Figure 2). The types of the other 5 projects that did not consider their impacts on bats do not preclude effects on bats in the same way that offshore activities do, so it is therefore less clear why bats were not considered by these projects.

Of the 37 projects sampled whose EIS’s contained conclusions about bats, 25 were approved, 3 were terminated by the proponent before a decision was reached, 7 are currently being assessed, and 1 was rejected.

A summary of the projects sampled is available in Appendix A of this report.

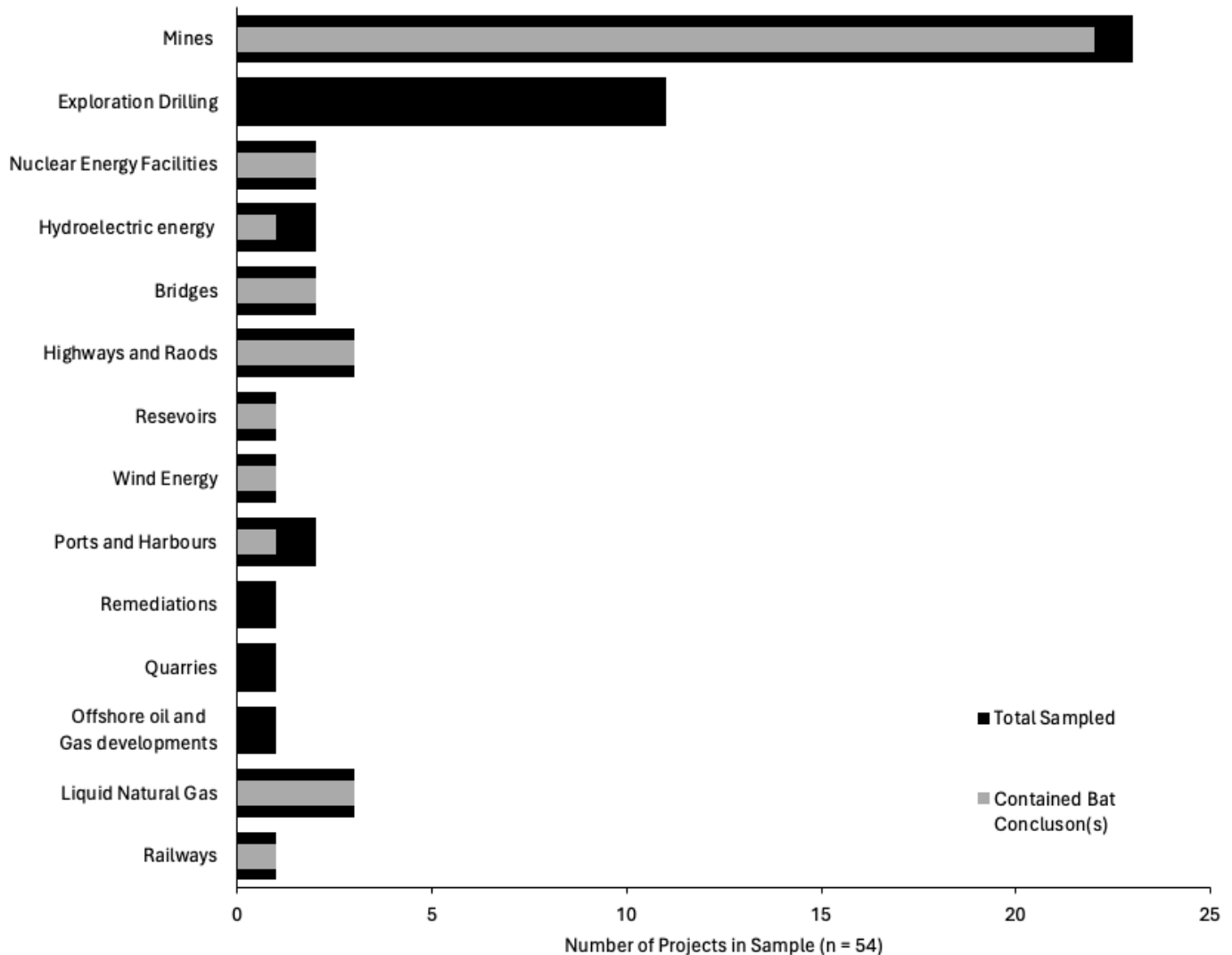


Figure 2. Types of projects identified in a sample of 54 EISs from the IAAC Registry based on the “Nature of Activity” field on their respective registry pages, and whether those EISs contained any conclusions about the project's potential effects on bats.

3.1 Types of Rationales supporting Overall Conclusions

Some of the identified rationale types share common traits with one another, such that they could be used to similar ends in supporting the conclusions of an EIS. For example, rationales based on the absence of available bat habitat, and rationales based on the low quality of available bat habitat both support the idea that a given project will not negatively impact areas of high-quality bat habitat. 49% (17/ 35) of projects in the sample used one or both of these rationales.

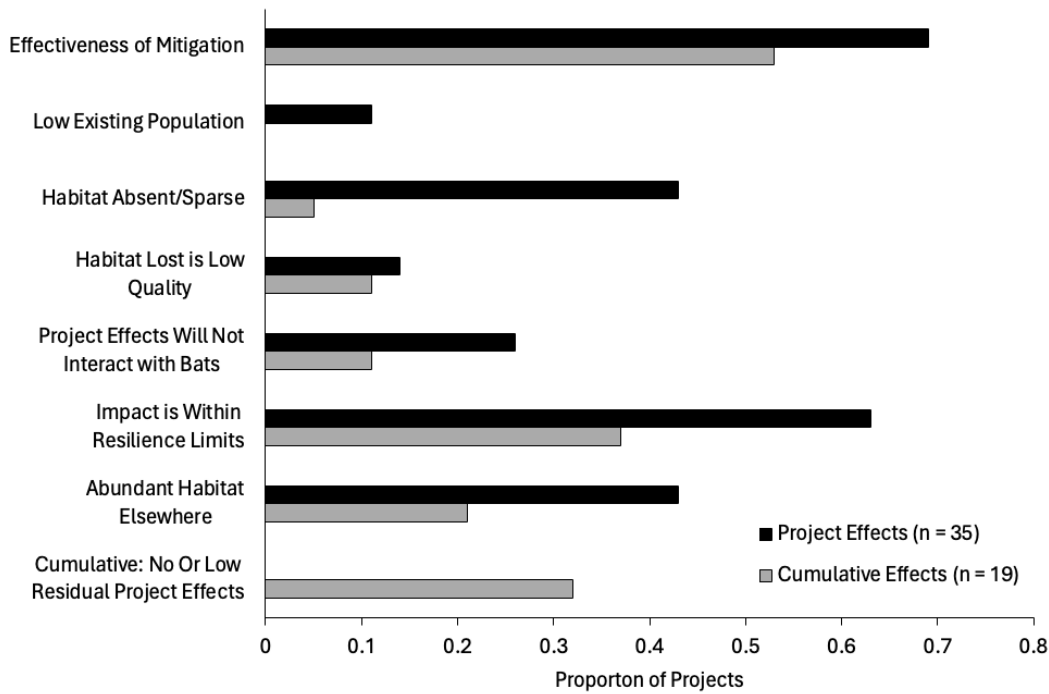


Figure 3. The use of various types of rationales in EISs to justify conclusions that the net effect of the project on bats will not be significantly adverse. Only rationales found to be present in two or more EISs are included. Definitions of the rationale types included can be found in Appendix B of this report.

3.2 Consideration of Impacts

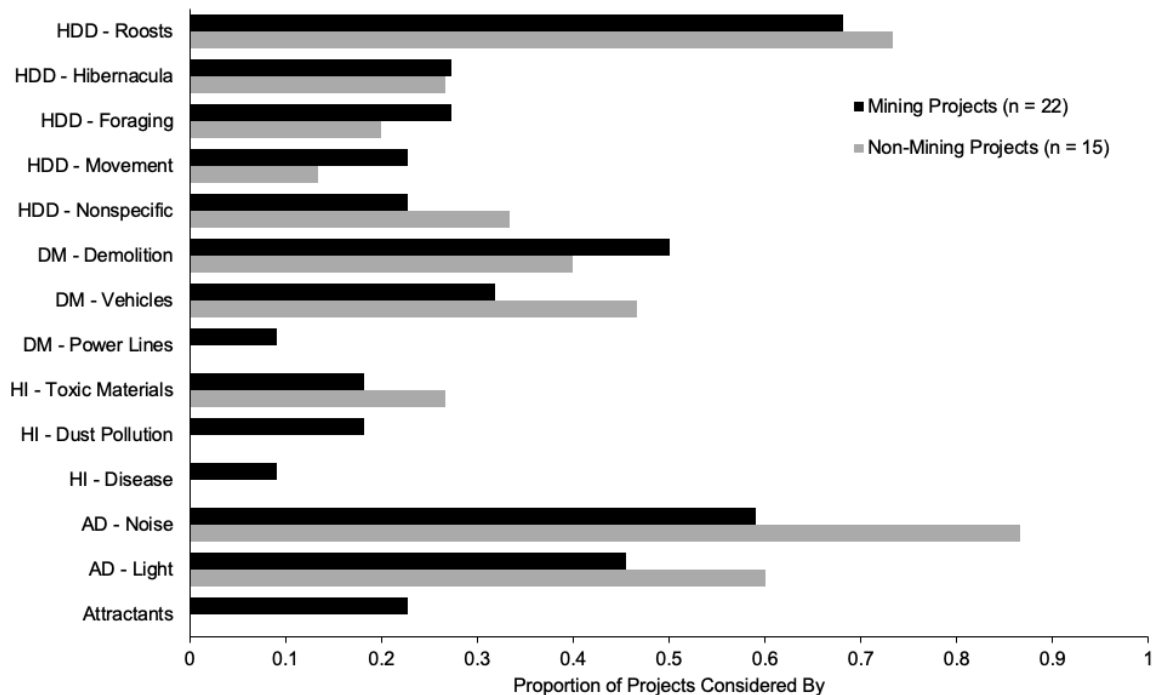


Figure 4. The potential impacts on bats considered in EISs for a sample of 22 mining projects and 15 non-mining projects in Canada's federal IA process. Only impact types that were considered by more than one project are included. (HDD = Habitat Destruction / Degradation, DM = Direct Mortality, HI = Health Impacts, AD = Anthropogenic Disturbance; Detailed Definitions of these categories are available in Appendix B)

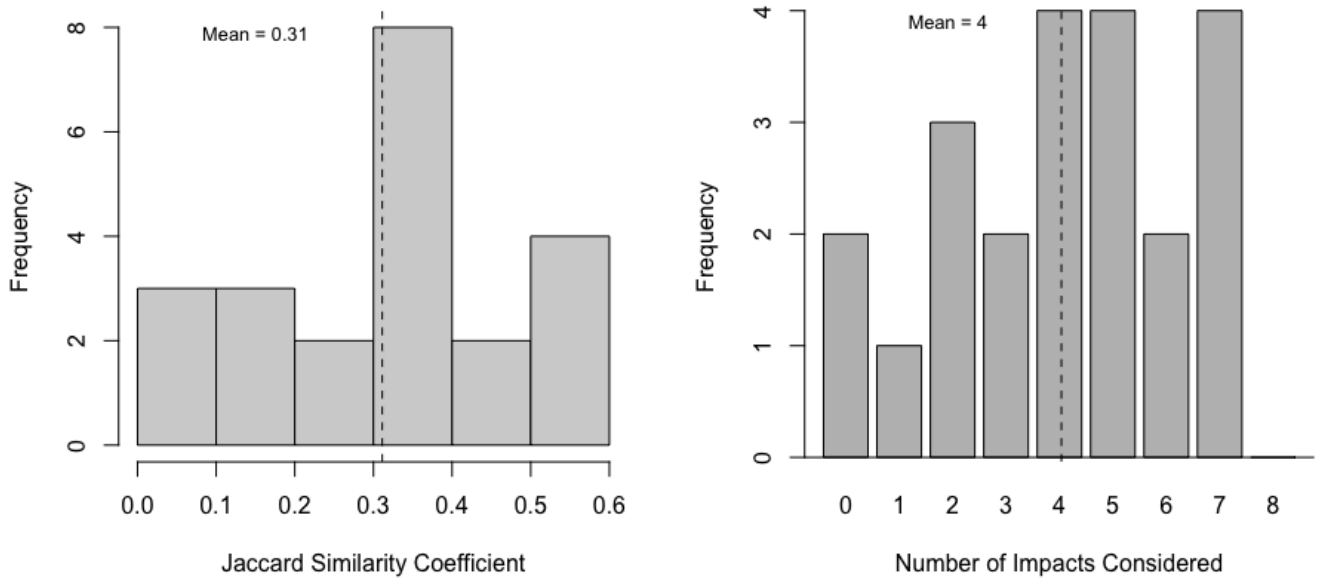


Figure 5. (Left) The distribution of Jaccard Similarity Coefficients generated by comparing the set of impact types considered in an assessment of effects on bats to a union of all impact types considered in a sample of 22 mining project EISs from the IAAC registry. (Right) The distribution of the number of impacts considered in a sample of 22 mining project EISs from the IAAC registry.

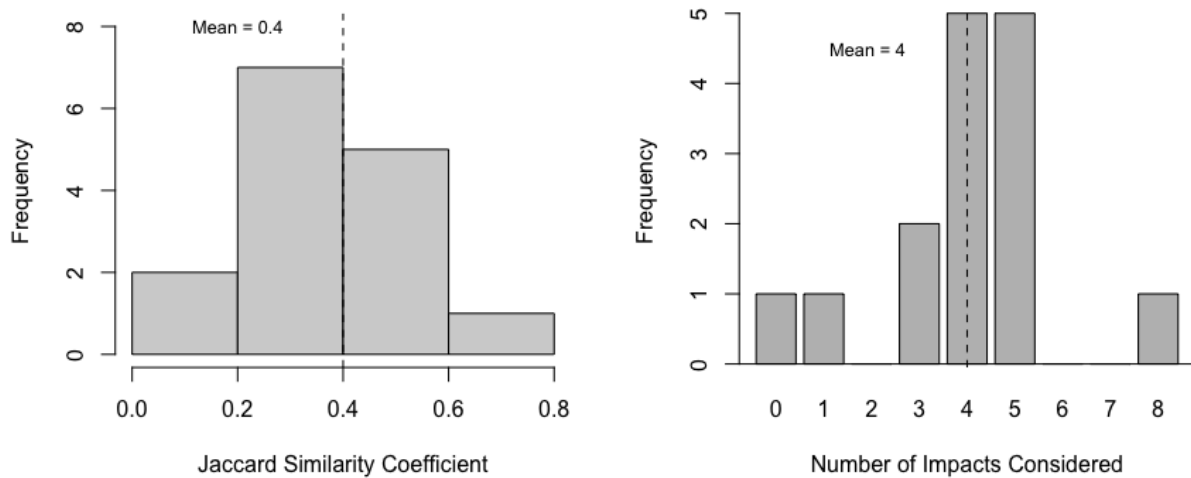


Figure 6. (Left) The distribution of Jaccard Similarity Coefficients generated by comparing the set of impact types considered in an assessment of effects on bats to a union of all impact types considered in a sample of 13 non-mining project EISs from the IAAC registry. (Right) The distribution of the number of impacts considered in a sample of 13 non-mining project EISs from the IAAC registry.

The level of agreement in the impacts considered among mining projects ($J = 0.31$), is lower than the level of agreement observed among non-mining projects ($J = 0.4$) (Figures 5 and 6). The absolute value of the score for the set of mining projects, as well as its relation to the score for non-mining projects, indicates a low level of agreement in the impacts considered by mining projects, meaning that mining projects do not typically consider the same types of impacts as one another.

3.3 – Secondary Research

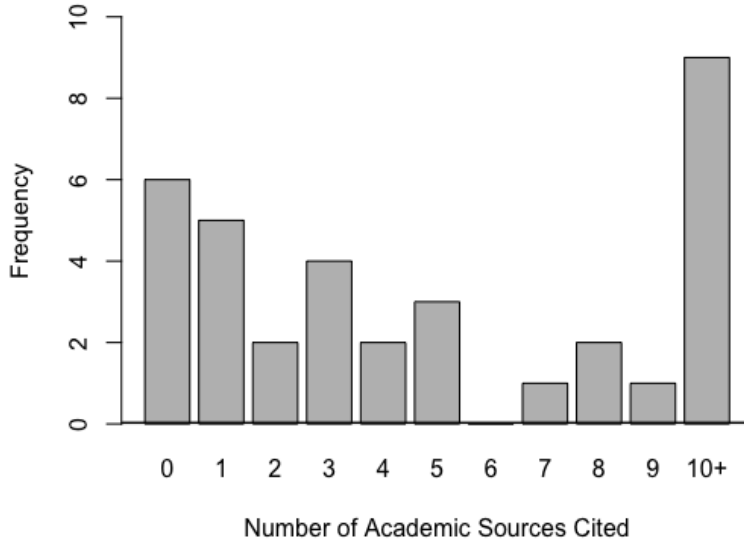


Figure 7. The distribution of the number of academic sources cited to support assessments of effects on bats in EISs. Based on a sample of 35 EISs from the IAAC registry.

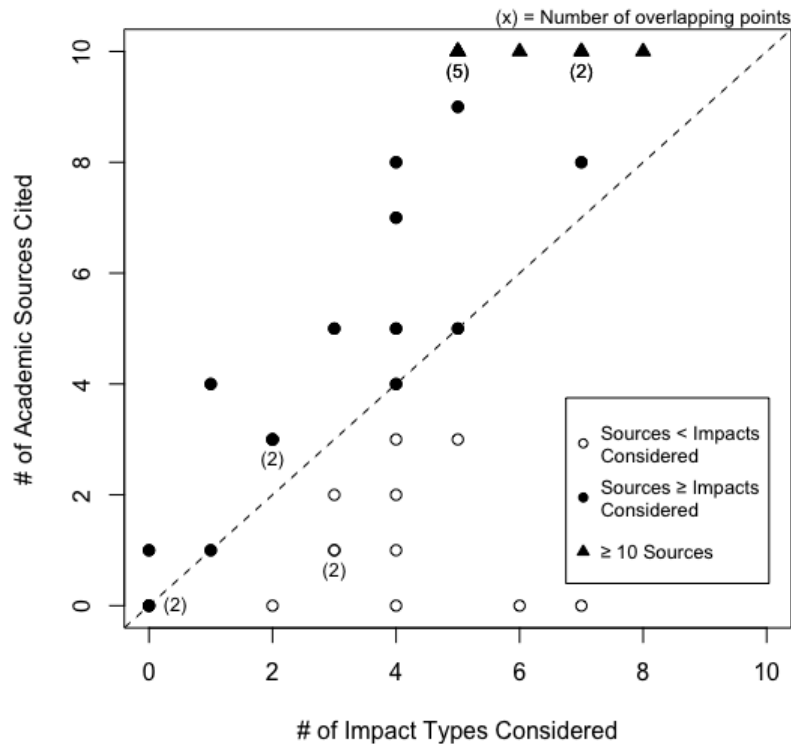


Figure 8. The relationship between the total number of the types of impacts on bats considered by a project and the number of academic sources relevant to bats cited by a project. Points below the dotted line represent those with fewer academic sources cited than impact types considered. Based on a sample of 35 EISs from the IAAC registry.

While the largest plurality of the sampled projects is of those which cited more than ten academic sources, the majority (52%) of projects have fewer than five academic sources cited in their assessment of effects on bats, with as many projects having two or fewer cited academic sources (37%; (13/35) as have more than five (37%; 13/35) (Figure 7).

Of the 33 projects with at least one impact considered, 11 cited fewer academic sources than the number of impacts they considered (Figure 8).

3.4 – Survey Methods

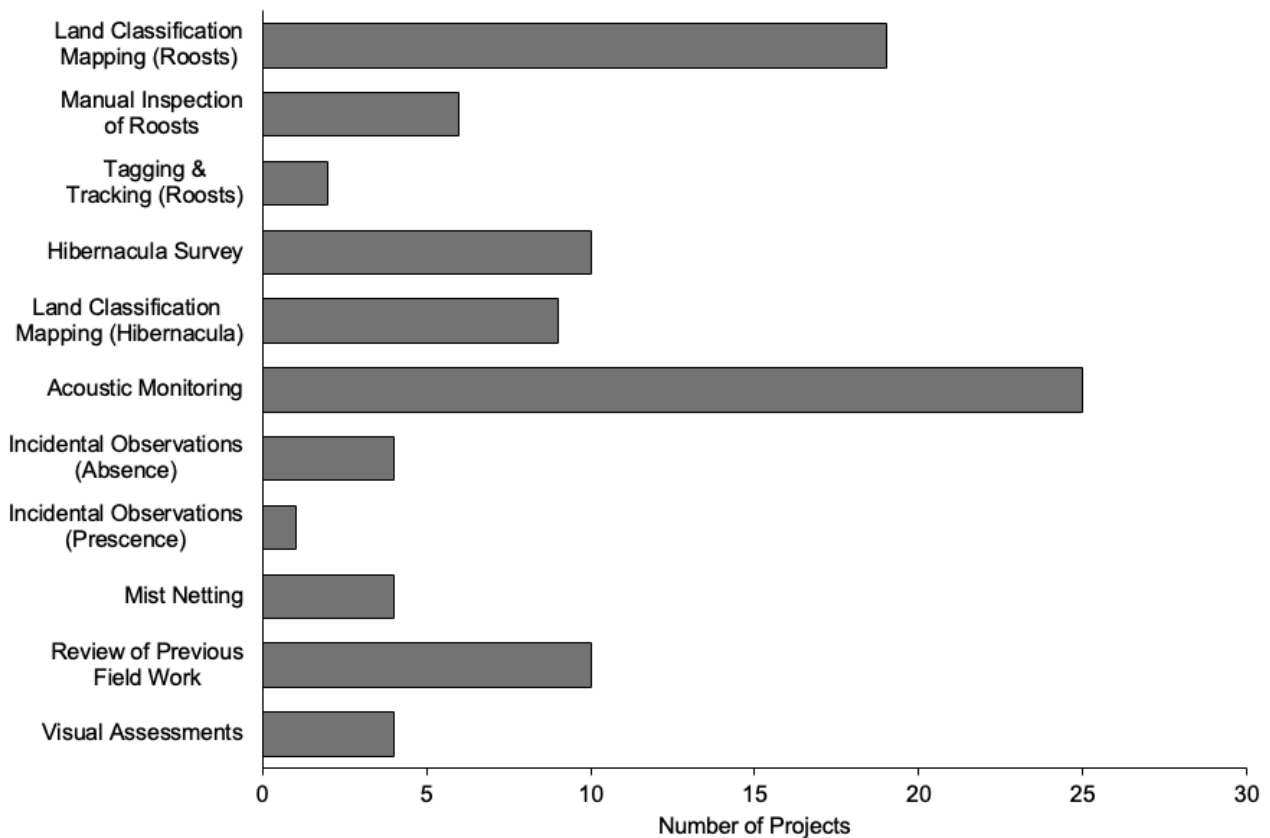


Figure 9. The number of projects that employed given survey methods based on a sample of EISs and relevant associated documents from 35 projects on the Federal Impact Assessment Registry. Definitions of each survey method included are given in Appendix B of this report.

Roosting habitat is more commonly surveyed for than hibernation habitat, with 27 observed applications of survey methods related to roosting habitat versus 19 applications of survey methods related to hibernacula (Figure 9).

3.5 - Critical Information Gaps and Precaution

Only two out of the 28 projects with at least one identified CIG addressed all of the CIGs identified with a precautionary statement (Table 6). Both projects had only one identified CIG and one precautionary statement related to that CIG (Figure 10). None of the examined projects contained more than two precautionary statements related to CIGs identified for that project.

Table 6. The level of precaution associated with projects in the Canadian federal IA process as defined by the proportion of critical information gaps identified for that project that are paired with a relevant precautionary statement (see definitions in Table 1).

Level of Precaution	# Projects (n = 35)
Full (100%)	2
Partial (>100%, <1%)	8
None (0%)	18
No CIGs (NA)	7

While it was not an intended focus of the analysis, an incidental observation was made regarding the ubiquity of CIGs related to hibernacula and/or hibernation. A CIG with explicit connections to hibernacula, hibernation, or hibernating habitat was found to be present in 50% (14/28) of the projects with at least one identified CIG.

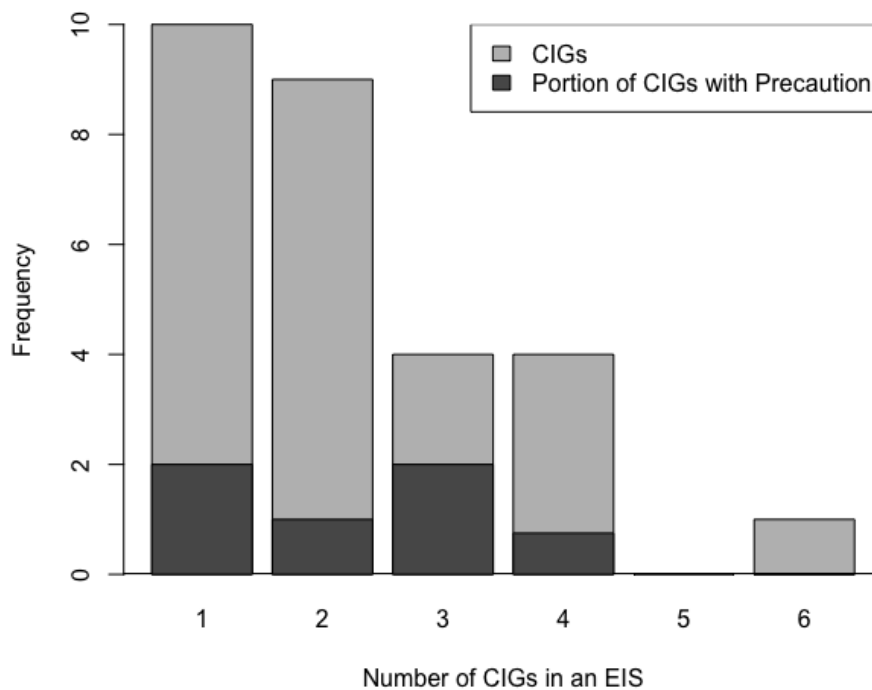


Figure 10. The distribution of the number of CIGs identified in EISs (excluding documents with zero CIGs) overlaid with the proportion of those CIGs treated with precaution, scaled by the total number of CIGs represented by each bar (n = 28). The dark grey overlaid bars represent the proportion of the CIGs in each column that were treated with precaution, multiplied by the frequency (the height of each bar), and therefore do not directly represent the distribution of the number of precautionary statements in EISs. The proportion of CIGs treated precautiously in each bar can be inferred by comparing the total height of the bar with the height of the dark grey overlaid portion.

3.6 – Evidence Scores

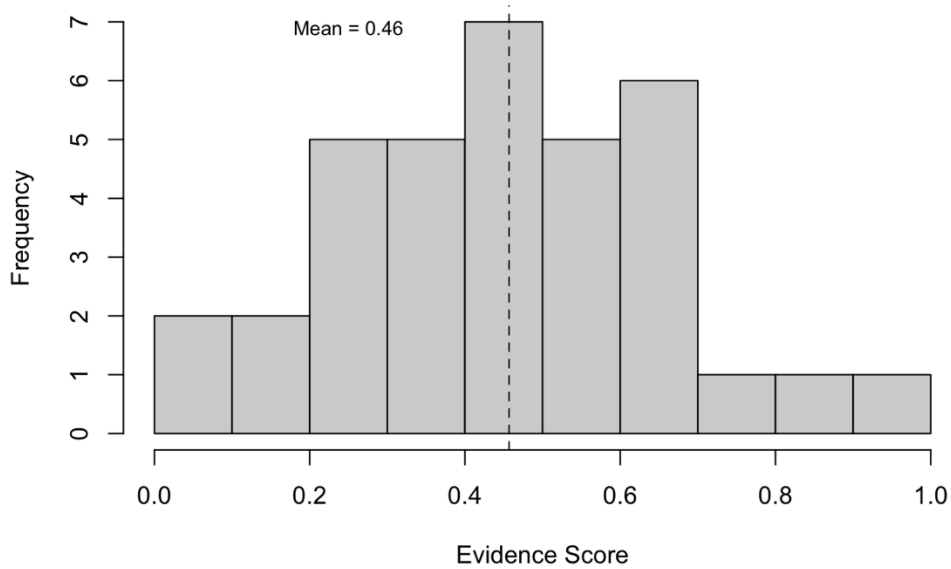


Figure 11. The distribution of evidence scores calculated for a sample of 35 EIS documents based on the primary and secondary evidence employed by the project, and the treatment of uncertain/incomplete information in the project's conclusion about its overall effect on bats.

Table 7. The average value per project of various assessment factors used to characterize the strength of evidence used to support conclusions about bats in EIS documents.

Assessment Factor	Average Value Per Project
Roosting Habitat Survey Methods Score (n = 35)	0.41
Hibernacula Survey Methods Score (n = 35)	0.34
Presence/Abundance Survey Methods Score (n=35)	0.54
Survey Methods Score (n=35)	0.43
# Of CIGs (n=35)	1.77
# Of Precautionary Statements (n=35)	0.37
CIG Score (n = 28)^a	0.21
# Of Impacts Considered (n = 35)	4.3
Rate of # Of Impacts Considered > # Academic Sources (n = 33) ^b	0.33
Academic Sources Score (n=33)	0.73
Evidence Score (n = 35)^{ab}	0.46

a. CIG Scores were only generated for projects with at least one CIG identified (n = 28). In the calculation of the Evidence Score, if no CIG Score was generated for a project, the average of the Survey Methods Score and the Academic Sources Score was used.

b. Academic Sources Scores were only generated for projects with at least one Impact Type Considered (n = 33). In the calculation of the Evidence Score, if no Academic Sources Score was generated for a project, the average of the Survey Methods Score and the CIG Score was used.

The average Evidence Score for projects within this sample is 0.46 (Figure 11), which is less than half of the satisfactory value of one (Table 5). None of the projects sampled received an overall score of one, meaning that none were found to satisfy the requirements of all three contributing factors. The highest Evidence Score achieved in the sample is 0.94, and the lowest is 0.06 (Figure 11).

The lowest contributing score to this overall value is the CIG Score, with an average value of 0.21. This score indicates that a very low proportion of identified CIGs have been addressed using precaution. The CIG Score (n = 28) and Survey Methods Score (n = 35) both only had two projects for which a score of one was given. In contrast, 21 projects received an Academic Sources Score (n = 33) of one.

3.3.4 – Predicted Bat Habitat Loss and Bat Box Application

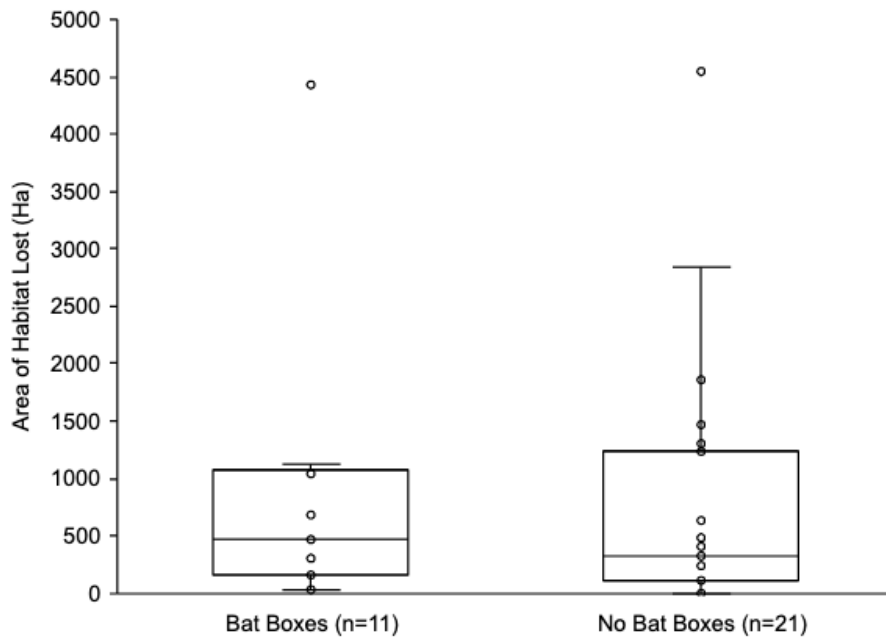


Figure 12. The area of bat habitat loss predicted in EIS documents for projects which list “bat boxes” as a mitigation measure and projects which do not. (An extreme outlier value is present in the “Bat Boxes” dataset at a value of 10,956 ha but was excluded from this plot to improve the legibility of the figure).

92% (34/37) of the projects sampled were identified as likely to result in some level of bat habitat destruction or degradation and the area of this destruction/disturbance was explicitly estimated in 27 of the EISs and could be reasonably inferred from information given in an additional 5, resulting in 32 projects with quantitative estimations of bat habitat loss for the purposes of this analysis. Bat boxes are listed as a mitigation measure for 38% (13/34) of these projects.

The median area bat habitat estimated to be destroyed/degraded because of the project is 465 ha for projects that employ bat boxes as a mitigation measure (n = 11) and 326 ha for projects that do not employ bat boxes as a mitigation measure (n=21) (Figure 12). No significant difference was found in the central tendencies of the estimates of habitat loss in projects which list bat boxes as a mitigation measure, and those that do not (p = 0.7).

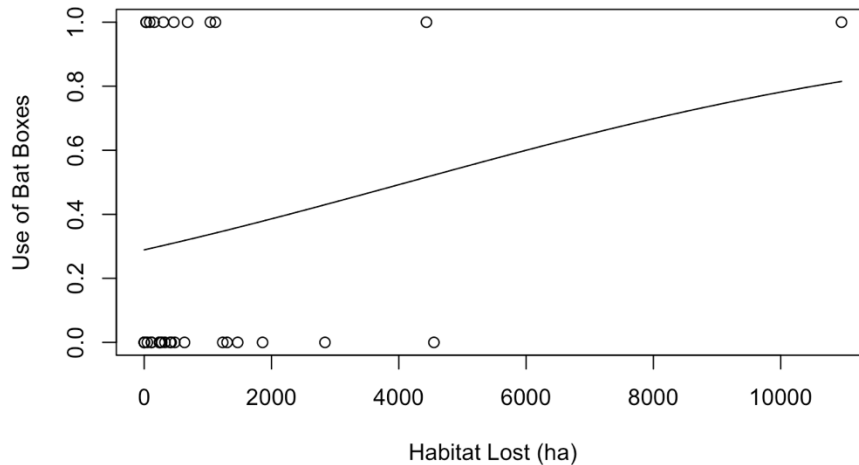


Figure 13. A logistic regression of the use of bat boxes as a mitigation measure for a project as a function of the area of bat habitat predicted to be lost by that project. (n = 32)

Furthermore, using a logistic regression of the habitat loss values, no significant association was found between the application of bat boxes as a mitigation measure and the area of habitat predicted to be lost as a result of the project (Figure 13; $p = 0.28$). Similarly non-significant results were found when measuring destroyed/degraded habitat as a proportion of the total available habitat in the local area (n = 23; $p = 0.99$).

4 - Discussion

The results of this project, presented in the preceding sections, are discussed below to assess the capability of Canada's IA process, as it currently exists, to contribute to the conservation of bats.

4.1 – Infrequent Consideration of habitat types other than roosting habitat

Across the relevant assessment factors, there is an observable tendency for roosts and roosting habitat to receive more attention in the sampled EISs than other types of bat habitat. Roosting habitat is more commonly surveyed for than hibernation habitat, with 27 observed applications of survey methods related to roosting habitat versus 19 applications of survey methods related to hibernacula (Figure 9). The difference in the survey methods used can also be observed in the average survey methods scores calculated for the two habitat types, with roosting habitat receiving a score of 0.41 and hibernating habitat receiving a score of 0.34 (Table 7). The destruction or degradation of roosting habitat was considered as a potential impact on bats by 70% of projects, whereas the destruction or degradation of hibernacula, foraging habitat, migratory corridors, were considered by 27%, 24%, and 19% of projects, respectively (Figure 4). It was also incidentally noted that a large portion of the CIGs identified relate in some way to hibernacula or hibernating habitat, indicating that information about hibernating habitat that is relevant to a project's conclusion about its effect on bats was frequently not obtained prior to EIS' publications.

This observed tendency may be because there are more effect pathways from project activities to impacts on potential roosting habitat. It may also be because potential hibernacula are more difficult to consistently and definitively identify than potential roosts because they

typically occur underground and therefore cannot be identified using remote sensing and/or land classification maps with the same ease that treed habitats can. The cause is ultimately likely to be a combination of these and other factors.

Potential implications of this observed trend on determinations of significance for projects' effects on bats are discussed in section 4.2 of this report.

4.2 – Bat habitat availability and significance determination

One of the most common rationales used to justify a project's determination of non-significant adverse effects is that the environment likely to be affected by project does not have a large quantity of bat habitat, or that available bat habitat is low quality, and therefore the destruction of that habitat will not be of consequence to bat populations (Figure 3). 49% of projects (17/35) used one or both of these types of rationales³. Another relatively common rationale is that bat habitat is abundant in the area within which the project takes place, and therefore any habitat lost because of the project will represent only a small portion of the total available habitat in the local/regional area (43% of projects; Figure 3).

The frequent use of these two rationales reveals a rhetorical strategy which may be employed in EISs to facilitate determinations of non-significance regardless of the observed state of the environment. If the project is sited in an area with minimal high quality bat habitat, this can be used as evidence that the project's impacts will not be significant. If the project is sited where bat habitat is abundant, this can be used as evidence that the project's impacts will not be significant. Within this rhetorical framework, only projects anticipated to remove an island of high-quality bat habitat, with no surrounding possible refuge habitat could be judged to have a significant impact on bats.

Additionally, given that the potential effects of a project on bat hibernating, foraging, migrating and drinking habitat are frequently not considered in an EIS (discussed further in section 4.1), it is possible that the scope of bat habitat types considered for the purposes of these rationales may be too narrow in some cases, leading to an underestimation of the ecological value that will be lost. Similarly, in cases where bat habitat is deemed to be abundant, a narrow scope of the habitat types considered can also lead to an underestimation of significance, because outside of the observed, abundant habitat type, there may be other habitat features which are limiting but which were not considered in a project's bat habitat assessment.

Both kinds of projects — those that are sited in areas of sparse bat habitat and those sited in areas of abundant bat habitat — have the potential to cause significant adverse effects on bat populations. Areas that are perceived to possess limited or no high-quality bat habitat may nevertheless support bat populations existing near the edge of their range or who are using the habitat in ways not anticipated by the assessors. Projects sited in areas of abundant bat habitat can reduce the connectivity of the habitat available, reducing its functional value, without necessarily removing a large portion of the available habitat (Abbott et al., 2015; Finch et al., 2020). Additionally, given the fidelity of certain bat species to specific roost trees (Perry, 2011), and the observed use of roost networks for thermal regulation of bats (Rensel et al., 2023; Slough & Jung, 2020), even a relatively small reduction in the total area of available bat habitat in areas where it is abundant could have disproportionate effects on the energy balance of populations,

³ As noted by Collard et al. (2020), non-significance determinations of this kind are obstacles to species recovery because they use past habitat destruction to justify future habitat destruction and further damage areas which may have otherwise been capable of restoration in the future.

who may be already existing at a marginal capacity due to white-nose syndrome (Balzer et al., 2021), declines in insect abundance (Davy et al., 2022), or other threats.

To properly assess the significance of bat habitat loss, analyses of the area lost must be combined with understandings of the characteristics of the bat populations in the area, the way they use the habitat, and the ways that use could be altered by the project. From the low score calculated for the strength of survey methods used in the project sample (0.43, $n = 35$; see Table 7), and the lack of observed consistency in the consideration of potential impacts of a project on bats (Figures 5 and 6; see sections 3.2 and 4.3), it does not appear that considerations of this kind are commonly used to reach determinations of non-significance for impacts on bats.

4.3 Comprehensiveness of Impact Considerations

The interpretation of the results presented in section 3.2 are premised on two assumptions. The first is that that projects of the same type are more likely to result in the same types of impacts. This assumption implies the existence of a set of impact types which are relevant to a significant portion of mining projects. The second assumption is that, in Canada's federal IA process, it is more likely for an EIS to overlook the consideration of a relevant type of impact than it is for an EIS to include the consideration of an irrelevant type of impact. This assumption is likely more contentious than the first, but it is supported by the fact that meaningfully considering a potential impact of a project requires both time and money, both of which project proponents are incentivized to conserve as much as possible. This incentive is theoretically offset by the risk of their proposal being rejected; however, given the low rate of project rejection in the Canadian federal IA process (Fonseca & Gibson, 2021), the level of this risk may not be sufficiently high to offset the potential benefits in cost and time. Furthermore, consideration of a potential impact may work to increase the project's risk of rejection if the resultant assessment reveals possible significant negative effects that may not have otherwise been brought to light.

Applying these assumptions to the results presented in section 3.2 suggests that relevant impacts of mining projects on bats are frequently not considered. Given the first assumption, and the implied set of impact types relevant to mining, the lack of observed consensus between mining projects in their considered impacts can be explained either by projects frequently considering impact types that are outside of the set of shared relevant impacts, or by projects frequently overlooking impact types present in the set of shared relevant impacts. The second assumption supports the conclusion that the latter explanation is more likely.

4.4 - Strength of Evidence

The low average Evidence Score found for the projects sampled indicates that the body of evidence used to support conclusions drawn about projects' effects on bats is generally weak, on average. The largest contributor to the weakness of the evidence in the examined documents is the treatment of uncertainty. At least one CIG was identified for 80% (28/35) of the projects sampled, but in only 36% (10/28) of those projects were one or more of the identified CIGs addressed using a precautionary approach, and in only 7% (2/28) of projects were all of the CIGs addressed (Table 6). The ultimate effect of this is that the vast majority (74%, 26/35) drew conclusions about the project effect on bats while critical information needed to draw that conclusion was absent and unaccounted for.

In addition to the CIGs expressly identified in an EIS, other important knowledge gaps can be inferred by comparing the current state of available knowledge, and the survey methods

employed by projects, to the rationales used to justify projects overall conclusions. The second most common rationale used to support conclusions that the projects effect on bats will not be significant, was that the predicted impacts would be within the resilience limits of the effected bat species and/or local population (present in 63% of projects examined) (Figure 3). To determine resilience at a local or species-wide level a reliable and accurate estimation of population size is necessary, in addition to other demographic factors (Capdevila et al., 2020; O’Grady et al., 2004). The low average overall Survey Methods Score observed in the project sample (0.43 out of 1) (Table 7) indicates that high-quality data of this kind are not typically produced to support this type of analysis for local populations in the project area, and species-wide population data does not exist with sufficient detail for this evaluation for most endangered bat species in Canada (COSEWIC, 2013, p. ix–xxii; Frick et al., 2017, p. 173). Therefore, conclusions that a projects effects on a species or a population will not exceed its capacity to adapt/recover are frequently made without the necessary information to determine the resilience of the species/population in question.

The tendency for projects to make definitive conclusions about their effects on bats while missing the information necessary to make those conclusions is exemplified in a statement from the Howse Property Iron Mine Project EIS regarding the data available to inform its assessment of potential effects on bats: “Despite the scarcity of data available, there are no major data gaps.” (p. 49). The high level of unaccounted uncertainty in EISs could result in significant unforeseen risk and may therefore be responsible for realized negative outcomes in a high number of projects across all IA projects within the federal Canadian IA process. These findings are in line with other analyses which have identified the disclosure, treatment, and incorporation of scientific uncertainty as a weakness in Canadian IAs (Aksamit et al., 2020; Lees et al., 2016; Pavlyuk et al., 2017).

While the CIG Score was the most significant contributor to the low average Evidence Score, the other two contributing scores, the Academic Sources Score and the Survey Methods Score, both had low average values as well, albeit higher than the average CIG Score. Even if the CIG Scores were omitted from the calculation of the Evidence Score, the overall average value would only rise from 0.46 to 0.58, which is still well below the satisfactory score of one. This indicates that the cause of the observed weakness in the evidence presented cannot be ascribed to a singular attribute in the EISs examined but is rather a more systemic issue which manifests multitudinously.

4.5 - Bat Boxes and Mitigation

The observed lack of association between the area of bat habitat anticipated to be destroyed/degraded by a project and the application of bat boxes as a mitigation measure by that project suggests that their use is not generally consistent or tied to the predicted effects of a project. While confounding factors can explain some variation in bat box application on the basis of other contextual factors, such as the health of the affected population, and their reliance on the habitat within the project’s footprint, the low average Survey Methods Score observed in the project sample (Table 7) demonstrates that most projects would likely not have access to the demographic information necessary to incorporate those factors into their assessment.

One possible explanation for the lack of observed patterns in bat box applications, is the use of bat boxes as a mitigation measure in projects whose impact on bat roosting habitat is anticipated to be small, but which are nonetheless predicted to have a negative impact on bats, through other pathways, such as by increasing mortality risks. In these cases, the application of

bat boxes would not actually mitigate the primary adverse effect but may regardless create the appearance that concerns about adverse effects on bats have been taken seriously and addressed, to satisfy decision makers and/or the public without needing to address the damaging components of the project which may be more difficult and/or expensive to mitigate. This explanation is speculative, however, and requires additional investigation to validate.

The effectiveness of mitigation measures was the most common rationale used by projects to support their determinations of non-significant effects on bats (Figure 3). The results of this bat box case study suggest that, at least this mitigation measure, is not applied consistently or logically with respect to the effect it is mitigating. This finding is in line with the existing literature on this subject which has found a tendency for mitigation measures to be applied inappropriately in IA, leading to greater residual project effects than anticipated (Enríquez-de-Salamanca, 2024; Lintott et al., 2016).

4.6 – Project Limitations and Opportunities Future Research

The analyses conducted in this report and the conclusions drawn therefrom are based on a sample of 37 EISs with conclusions about bats. The size of this sample is believed to be sufficient based on comparisons with the number of projects evaluated by other works with a similar focus. Collard et al.'s (2020) assessment of caribou in Canadian IAs was done using a sample of 29 federal IA projects. Lees et al.'s (2016) analysis of uncertainty in federal Canadian IA documents was based on a sample of 12 projects.

While the approval or rejection of each project in the sample was recorded, the reasons given by the governmental decision makers for these decisions were not examined, even though their content could be of relevance to the findings herein. For example, one project in the sample was rejected, but it is not known whether this rejection was due in any way to the project's assessment of its potential effect on bats, or whether the reasons for rejection were unrelated. It would additionally be of interest to know what kinds of conditions are placed on projects when they are approved, and whether these conditions relate to or address any of the matters discussed in this report.

Many of the analyses conducted in this report are indirect or partial measurements of an EIS's attributes. For example, the analysis of the impacts considered by EISs evaluates the comprehensiveness of the impact assessment scope through an inference based on the agreement between projects of the same type in the impact types they consider rather than a direct evaluation of the impacts on bats which ought to be considered based on the project's description. The analysis of the use of secondary research infers a baseline number of projects with insufficient academic support through a comparison between the total number of impacts a project considers and total the number of relevant academic sources that are cited by that project rather than evaluating the level of academic support provided per relevant claim in an EIS. The analysis of CIGs is also not a direct measurement of information gaps and/or uncertainty but rather a measurement of knowledge gaps that are explicitly or implicitly acknowledged in an EIS.

The directness of these measurements is sufficient for their purposes in this document, because they are employed conservatively, such as in the case of the secondary research analysis and the CIG analysis which are used to establish a lower bound of the range of possible values. The result of this approach is that can establish that things are bad but not how bad. Therefore, additional research which more directly assesses the factors described in this report could provide valuable insight into the depths of the issues identified herein.

The strength of evidence scores, and their contributing input scores, are coarse and cannot capture all the necessary complexity and nuance needed to definitively judge the quality of evidence brought to an assessment. It would therefore be inappropriate to use the methods described herein to judge the strength of evidence for individual projects without additional analysis. However, the scores can still be used, as they are in this project, to characterize general patterns in the strength of evidence averaged across several projects, based on the assumption that the influence of individual exceptional cases will sufficiently diminish in the aggregate.

5 – Conclusions & Recommendations

There is discretion built into both CEA 2012 and IAA 2019 that allows projects to proceed regardless of whether they are predicted to cause adverse significant environmental impacts if the project is deemed to be in the public interest regardless of those impacts (Canadian Environmental Assessment Act, 2012; Impact Assessment Act, 2019). While this decision will ideally be informed by scientific analysis, it is ultimately an application of normative values rather than scientific method. When this decision is made, the choice and the rationale for that choice is publicly available, allowing the public to review what was decided. The public can express the decision's alignment with their personal values in the next election. Theoretically, this is a transparent and democratic process.

This process breaks down, however, when the facts associated with a project are not accurately and comprehensively represented. When the true nature of the decisions being made are obfuscated, the voter is not able to properly assess those decisions. The criticisms of the IA process contained in this report are therefore not meant to imply that none of the projects examined should have been allowed to proceed, but rather that the implications of a project's approval should be presented in as accurate and comprehensive a manner as possible. The results presented in this report indicate that this is not the case for assessments of impacts on bats. Therefore, the current IA process is not fully capable of contributing to bat conservation efforts.

To improve the state of IA science, an enhance the ability of the IA process to contribute to bat conservation, assessments and decisions must become more discerning and more willing to reject projects that have not presented strong, comprehensive, and robust evidence in support of their conclusions. Until this is done, proponents will have limited incentives to change the way their science is conducted and presented. To aid governmental assessors in this task, and to facilitate cooperation with project proponents in achieving better outcomes, a set of specific, publicly available, and scientifically rigorous standards should be created according to which all EISs will be assessed. These standards should cover all relevant areas of IA science but should focus in particular on the proper handling of uncertain or unknown information, precaution, the scoping of effects assessments, and the appropriate application of mitigation measures.

Acknowledgements

I would like to thank my research supervisor Scott Findlay for his invaluable guidance and mentorship throughout all stages of this project. I would also like to thank my second reader Gabriel Blouin-Demers and my friend and colleague Findlay Yates-Lavery for their encouragement and input which significantly improved the quality of the project. Finally, I would like to thank Joanna Mazur, without whose support none of this would have been possible.

Bibliography

- Abbott, I. M., Berthinussen, A., Stone, E., Boonman, M., Melber, M., & Altringham, J. (2015). Bats and Roads. In *Handbook of Road Ecology* (pp. 290–299). John Wiley & Sons, Ltd. <https://doi.org/10.1002/9781118568170.ch34>
- Aksamit, C. K., Blakley, J. A., Jaeger, J. A. G., Noble, B. F., & Westman, C. N. (2020). Sources of uncertainties in environmental assessment: Lessons about uncertainty disclosure and communication from an oil sands extraction project in Northern Alberta. *Journal of Environmental Planning and Management*, *63*(2), 317–334. <https://doi.org/10.1080/09640568.2019.1579973>
- Alston, J. M., Keinath, D. A., Willis, C. K. R., Lausen, C. L., O’Keefe, J. M., Tyburec, J. D., Broders, H. G., Moosman, P. R., Carter, T. C., Chambers, C. L., Gillam, E. H., Geluso, K., Weller, T. J., Burles, D. W., Fletcher, Q. E., Norquay, K. J. O., & Goheen, J. R. (2023). Environmental drivers of body size in North American bats. *Functional Ecology*, *37*(4), 1020–1032. <https://doi.org/10.1111/1365-2435.14287>
- Appel, G., Capaverde, U. D., De Oliveira, L. Q., Do Amaral Pereira, L. G., Da Cunha Tavares, V., López-Baucells, A., Magnusson, W. E., Baccaro, F. B., & Bobrowiec, P. E. D. (2021). Use of Complementary Methods to Sample Bats in the Amazon. *Acta Chiropterologica*, *23*(2), 499–511. Scopus. <https://doi.org/10.3161/15081109ACC2021.23.2.017>
- Balzer, E. W., Grottoli, A. D., Phinney, L. J., Burns, L. E., Vanderwolf, K. J., & Broders, H. G. (2021). Capture Rate Declines of Northern Myotis in the Canadian Maritimes. *Wildlife Society Bulletin*, *45*(4), 719–724. Scopus. <https://doi.org/10.1002/wsb.1223>
- Beattie, I., Schofer, D., McGregor, G., Lee, M. J., Lee, L. K. F., Himsworth, C. G., & Byers, K. A. (2022). An investigation of bat mortality in British Columbia, Canada. *Canadian Journal of Zoology*, *100*(7), 464–473. <https://doi.org/10.1139/cjz-2021-0230>
- Berkman, N. D., Lohr, K. N., Ansari, M. T., Balk, E. M., Kane, R., McDonagh, M., Morton, S. C., Viswanathan, M., Bass, E. B., Butler, M., Gartlehner, G., Hartling, L., McPheeters, M., Morgan, L. C., Reston, J., Sista, P., Whitlock, E., & Chang, S. (2015). Grading the strength of a body of evidence when assessing health care interventions: An EPC update. *Journal of Clinical Epidemiology*, *68*(11), 1312–1324. <https://doi.org/10.1016/j.jclinepi.2014.11.023>
- Bernauer, W., Hostetler, G., Greene, E., Tester, F., Harris, R., & Tanguay, L. (2023). Undermining Assessment: EIA follow-up, stake-holder advisory groups, and extractive industries in Nunavut, Canada. *Impact Assessment and Project Appraisal*, *41*(2), 87–101. Scopus. <https://doi.org/10.1080/14615517.2022.2139469>
- Brook, B. W., Sodhi, N. S., & Bradshaw, C. J. A. (2008). Synergies among extinction drivers under global change. *Trends in Ecology and Evolution*, *23*(8), 453–460. Scopus. <https://doi.org/10.1016/j.tree.2008.03.011>
- Cameron, E., & Kennedy, S. (2023). Can Environmental Assessment Protect Caribou? Analysis of EA in Nunavut, Canada, 1999-2019. *Conservation and Society*, *21*(2), 121–132. Scopus. https://doi.org/10.4103/cs.cs_54_22

- Canadian Environmental Assessment Act, 19 C (2012). <https://laws-lois.justice.gc.ca/eng/acts/c-15.21/20170622/P1TT3xt3.html>
- Capdevila, P., Stott, I., Beger, M., & Salguero-Gómez, R. (2020). Towards a Comparative Framework of Demographic Resilience. *Trends in Ecology & Evolution*, 35(9), 776–786. <https://doi.org/10.1016/j.tree.2020.05.001>
- Cheng, T. L., Reichard, J. D., Coleman, J. T. H., Weller, T. J., Thogmartin, W. E., Reichert, B. E., Bennett, A. B., Broders, H. G., Campbell, J., Etchison, K., Feller, D. J., Geboy, R., Hemberger, T., Herzog, C., Hicks, A. C., Houghton, S., Humber, J., Kath, J. A., King, R. A., ... Frick, W. F. (2021). The scope and severity of white-nose syndrome on hibernating bats in North America. *Conservation Biology*, 35(5), 1586–1597. Scopus. <https://doi.org/10.1111/cobi.13739>
- Claireau, F., Bas, Y., Pauwels, J., Barré, K., Machon, N., Allegrini, B., Puechmaille, S. J., & Kerbiriou, C. (2019). Major roads have important negative effects on insectivorous bat activity. *Biological Conservation*, 235, 53–62. Scopus. <https://doi.org/10.1016/j.biocon.2019.04.002>
- Collard, R.-C., Dempsey, J., & Holmberg, M. (2020). Extirpation despite regulation? Environmental assessment and caribou. *Conservation Science and Practice*, 2(4). Scopus. <https://doi.org/10.1111/csp2.166>
- COSEWIC. (2023). *COSEWIC assessment and status report on the Hoary Bat (Lasiurus cinereus), Eastern Red Bat (Lasiurus borealis) and Silver-haired Bat (Lasionycteris noctivagans), in Canada*. Committee on the Status of Endangered Wildlife in Canada.
- Davy, C. M., Squires, K., & Zimmerling, J. R. (2021). Estimation of spatiotemporal trends in bat abundance from mortality data collected at wind turbines. *Conservation Biology*, 35(1), 227–238. Scopus. <https://doi.org/10.1111/cobi.13554>
- Davy, C. M., von Zuben, V., Kukka, P. M., Gerber, B. D., Slough, B. G., & Jung, T. S. (2022). Rapidly declining body size in an insectivorous bat is associated with increased precipitation and decreased survival. *Ecological Applications*, 32(7). Scopus. <https://doi.org/10.1002/eap.2639>
- Dekker, J., Steen, W., Bouman, H. B., & van der Vliet, R. E. (2022). Differences in acoustic detectability of bat species hamper Environmental Impact Assessment studies. *European Journal of Wildlife Research*, 68(2), 14. <https://doi.org/10.1007/s10344-022-01562-1>
- Doebeli, A. G., Magnuson, B., Yoon-Henderson, K., Collard, R., Dempsey, J., Walter, M. (River), Carre, M., Corrado, M., Dhaliwal, R., Giesting, A., Gonchar, K., Hsu, C., Johnson, T., Karve, U., Lam, E., Nelson, K., Teske, M., Valente, E., Wang, I., ... Yeung, C. (2021). How does the environmental state “see” endangered marine animals? *Environmental Science & Policy*, 124, 293–304. <https://doi.org/10.1016/j.envsci.2021.07.001>
- Doelle, M., & Sinclair, A. J. (2019). The new IAA in Canada: From revolutionary thoughts to reality. *Environmental Impact Assessment Review*, 79, 106292. <https://doi.org/10.1016/j.eiar.2019.106292>

- Ehrlich, A., & Ross, W. (2015). The significance spectrum and EIA significance determinations. *Impact Assessment and Project Appraisal*, 33(2), 87–97. <https://doi.org/10.1080/14615517.2014.981023>
- Enríquez-de-Salamanca, Á. (2018). Stakeholders' manipulation of Environmental Impact Assessment. *Environmental Impact Assessment Review*, 68, 10–18. <https://doi.org/10.1016/j.eiar.2017.10.003>
- Enríquez-de-Salamanca, Á. (2024). Overestimation of mitigation leads to underestimation of residual impacts. *Environmental Impact Assessment Review*, 104. Scopus. <https://doi.org/10.1016/j.eiar.2023.107340>
- Environment and Climate Change Canada. (2018, December 5). *Overview of the Pan-Canadian approach to transforming Species at Risk conservation in Canada*. <https://www.canada.ca/en/services/environment/wildlife-plants-species/species-risk/pan-canadian-approach.html>
- Fagan, W. F., & Holmes, E. E. (2006). Quantifying the extinction vortex. *Ecology Letters*, 9(1), 51–60. Scopus. <https://doi.org/10.1111/j.1461-0248.2005.00845.x>
- Festa, F., Ancillotto, L., Santini, L., Pacifici, M., Rocha, R., Toshkova, N., Amorim, F., Benítez-López, A., Domer, A., Hamidović, D., Kramer-Schadt, S., Mathews, F., Radchuk, V., Rebelo, H., Ruczynski, I., Solem, E., Tsoar, A., Russo, D., & Razgour, O. (2023). Bat responses to climate change: A systematic review. *Biological Reviews of the Cambridge Philosophical Society*, 98(1), 19–33. <https://doi.org/10.1111/brv.12893>
- Finch, D., Schofield, H., & Mathews, F. (2020). Traffic noise playback reduces the activity and feeding behaviour of free-living bats. *Environmental Pollution*, 263, 114405. <https://doi.org/10.1016/j.envpol.2020.114405>
- Fonseca, A., & Gibson, R. B. (2021). Why are projects rarely rejected in environmental impact assessments? Narratives of justifiability in Brazilian and Canadian review reports. *Journal of Environmental Planning and Management*, 64(11), 1940–1962. Scopus. <https://doi.org/10.1080/09640568.2020.1852073>
- Frick, W. F., Baerwald, E. F., Pollock, J. F., Barclay, R. M. R., Szymanski, J. A., Weller, T. J., Russell, A. L., Loeb, S. C., Medellín, R. A., & McGuire, L. P. (2017). Fatalities at wind turbines may threaten population viability of a migratory bat. *Biological Conservation*, 209, 172–177. <https://doi.org/10.1016/j.biocon.2017.02.023>
- Froidevaux, J. S. P., Boughey, K. L., Hawkins, C. L., Jones, G., & Collins, J. (2020). Evaluating survey methods for bat roost detection in ecological impact assessment. *Animal Conservation*, 23(5), 597–606. Scopus. <https://doi.org/10.1111/acv.12574>
- Gannon, P. (2021). The time is now to improve the treatment of biodiversity in Canadian environmental impact statements. *Environmental Impact Assessment Review*, 86. Scopus. <https://doi.org/10.1016/j.eiar.2020.106504>
- Gibson, R. B. (2020). An Initial Evaluation of Canada's New Sustainability-based Impact Assessment Act. *Journal Of Environmental Law and Practice*, 33(1), 1–35.

- Gullett, W. (1998). Environmental impact assessment and the precautionary principle: Legislating caution in environmental protection. *Australian Journal of Environmental Management*, 5(3), 146–158. Scopus. <https://doi.org/10.1080/14486563.1998.10648411>
- Harker, K. J., Arnold, L., Sutherland, I. J., & Gergel, S. E. (2021). Perspectives from landscape ecology can improve environmental impact assessment. *Facets*, 6(1), 358–378. <https://doi.org/10.1139/FACETS-2020-0049>
- Hayes, J. P., & Loeb, S. (2007). The influences of forest management on bats in North America. *Bats in Forests: Conservation and Management*, 207–236.
- Holroyd, S., Lausen, C., Dulc, S., De Freitas, E., Crawford, R., O’Keefe, J. O. I. U.-C., Boothe, C., & Segeres, J. (2023). *Best Management Practices for the Use of Bat Houses in the US and Canada*. <https://doi.org/10.7944/P99K4BF5>
- Hunsberger, C., Froese, S., & Hoberg, G. (2020). Toward ‘good process’ in regulatory reviews: Is Canada’s new system any better than the old? *Environmental Impact Assessment Review*, 82. <https://doi.org/10.1016/j.eiar.2020.106379>
- Impact Assessment Act, C. 28, s. 1 (2019).
- Impact Assessment Agency of Canada. (2021, July 20). *Basics of Impact Assessments*. <https://www.canada.ca/en/impact-assessment-agency/services/policy-guidance/basics-of-impact-assessments.html>
- Lees, J., Jaeger, J. A. G., Gunn, J. A. E., & Noble, B. F. (2016). Analysis of uncertainty consideration in environmental assessment: An empirical study of Canadian EA practice. *Journal of Environmental Planning and Management*, 59(11), 2024–2044. Scopus. <https://doi.org/10.1080/09640568.2015.1116980>
- Lintott, P. R., Richardson, S. M., Hosken, D. J., Fensome, S. A., & Mathews, F. (2016). Ecological impact assessments fail to reduce risk of bat casualties at wind farms. *Current Biology*, 26(21), R1135–R1136. Scopus. <https://doi.org/10.1016/j.cub.2016.10.003>
- Mancini, M. C. S., Bobrowiec, P. E. D., Oliveira, L. L., Del Sarto Oliveira, L. L., & Gregorin, R. (2024). Better together: Integrating mist-nets and bioacoustics reveals large-scale native vegetation as a key predictor of bat community conservation in a fragmented landscape. *Biodiversity and Conservation*, 33(4), 1503–1521. Scopus. <https://doi.org/10.1007/s10531-024-02813-0>
- Martuzzi, M., & Bertollini, R. (2004). The Precautionary Principle, science and human health protection. *International Journal of Occupational Medicine and Environmental Health*, 17(1), 43–46. Scopus.
- Millon, L., Colin, C., Brescia, F., & Kerbiriou, C. (2018). Wind turbines impact bat activity, leading to high losses of habitat use in a biodiversity hotspot. *Ecological Engineering*, 112, 51–54. <https://doi.org/10.1016/j.ecoleng.2017.12.024>
- Murray, C. C., Wong, J., Singh, G. G., Mach, M., Lerner, J., Ranieri, B., Peterson St-Laurent, G., Guimaraes, A., & Chan, K. M. A. (2018). The Insignificance of Thresholds in Environmental Impact Assessment: An Illustrative Case Study in Canada. *Environmental Management*, 61(6), 1062–1071. <https://doi.org/10.1007/s00267-018-1025-6>

- Nanos. (2017). *Canadians more negative than positive about energy decision-making*. University of Ottawa Positive Energy. https://www.uottawa.ca/research-innovation/sites/g/files/bhrs kd326/files/2022-11/2017-1058_positive_energy_sep_omni_-_populated_report_with_tabs.pdf
- O'Grady, J. J., Reed, D. H., Brook, B. W., & Frankham, R. (2004). What are the best correlates of predicted extinction risk? *Biological Conservation*, *118*(4), 513–520. <https://doi.org/10.1016/j.biocon.2003.10.002>
- Patterson, C., Casasanta Mostaço, F., & Jaeger, J. A. G. (2022). Lack of consideration of ecological connectivity in Canadian environmental impact assessment: Current practice and need for improvement. *Impact Assessment and Project Appraisal*, *40*(6), 481–494. <https://doi.org/10.1080/14615517.2022.2135232>
- Pavlyuk, O., Noble, B. F., Blakley, J. A. E., & Jaeger, J. A. G. (2017). Fragmentary provisions for uncertainty disclosure and consideration in EA legislation, regulations and guidelines and the need for improvement. *Environmental Impact Assessment Review*, *66*, 14–23. <https://doi.org/10.1016/j.eiar.2017.06.001>
- Perry, R. W. (2011). Fidelity of Bats to Forest Sites Revealed From Mist-Netting Recaptures. *Journal of Fish and Wildlife Management*, *2*(1), 112–116. <https://doi.org/10.3996/082010-JFWM-030>
- Put, J. E., Fahrig, L., & Mitchell, G. W. (2019). Bats respond negatively to increases in the amount and homogenization of agricultural land cover. *Landscape Ecology*, *34*(8), 1889–1903. <https://doi.org/10.1007/s10980-019-00855-2>
- Ray, J. C., Grimm, J., & Olive, A. (2021). The biodiversity crisis in Canada: Failures and challenges of federal and sub-national strategic and legal frameworks. *FACETS*, *6*, 1044–1068. <https://doi.org/10.1139/facets-2020-0075>
- Real, R., & Vargas, J. M. (1996). The Probabilistic Basis of Jaccard's Index of Similarity. *Systematic Biology*, *45*(3), 380–385. <https://doi.org/10.2307/2413572>
- Rensel, L. J., Hodges, K. E., & Lausen, C. L. (2023). Myotis Roost Use Is Influenced by Seasonal Thermal Needs. *Journal of Mammalogy*, *104*(4), 739–751. <https://doi.org/10.1093/jmammal/gyad031>
- Reusch, C., Paul, A. A., Fritze, M., Kramer-Schadt, S., & Voigt, C. C. (2023). Wind energy production in forests conflicts with tree-roosting bats. *Current Biology*, *33*(4), 737–743.e3. Scopus. <https://doi.org/10.1016/j.cub.2022.12.050>
- Rodhouse, T. J., Rodriguez, R. M., Banner, K. M., Ormsbee, P. C., Barnett, J., & Irvine, K. M. (2019). Evidence of region-wide bat population decline from long-term monitoring and Bayesian occupancy models with empirically informed priors. *Ecology and Evolution*, *9*(19), 11078–11088. Scopus. <https://doi.org/10.1002/ece3.5612>
- Ruegger, N. (2016). Bat Boxes—A Review of Their Use and Application, Past, Present and Future. *Acta Chiropterologica*, *18*(1), 279–299. <https://doi.org/10.3161/15081109ACC2016.18.1.017>

- Russo, D., & Voigt, C. C. (2016). The use of automated identification of bat echolocation calls in acoustic monitoring: A cautionary note for a sound analysis. *Ecological Indicators*, *66*, 598–602. <https://doi.org/10.1016/j.ecolind.2016.02.036>
- Seewagen, C. L., Nadeau-Gneckow, J., & Adams, A. M. (2023). Far-reaching displacement effects of artificial light at night in a North American bat community. *Global Ecology and Conservation*, *48*, e02729. <https://doi.org/10.1016/j.gecco.2023.e02729>
- Segers, J. L., & Broders, H. G. (2014). Interspecific effects of forest fragmentation on bats. *Canadian Journal of Zoology*, *92*(8), 665–673. <https://doi.org/10.1139/cjz-2014-0040>
- Shogren, J. F., Tschirhart, J., Anderson, T., Ando, A. W., Beissinger, S. R., Brookshire, D., Brown JR., G. M., Coursey, D., Innes, R., Meyer, S. M., & Polasky, S. (1999). Why Economics Matters for Endangered Species Protection. *Conservation Biology*, *13*(6), 1257–1261. <https://doi.org/10.1046/j.1523-1739.1999.98414.x>
- Siemieniuk, R., & Guyatt, G. (n.d.). *What is GRADE?* | *BMJ Best Practice*. BMJ Best Practice. Retrieved April 22, 2024, from <https://bestpractice.bmj.com/info/toolkit/learn-ebm/what-is-grade/>
- Slough, B. G., & Jung, T. S. (2020). Little brown bats utilize multiple maternity roosts within foraging areas: Implications for identifying summer habitat. *Journal of Fish and Wildlife Management*, *11*(1), 311–320. Scopus. <https://doi.org/10.3996/052019-JFWM-039>
- Spiller, K. J., & Dettmers, R. (2019). Evidence for multiple drivers of aerial insectivore declines in North America. *The Condor*, *121*(2), duz010. <https://doi.org/10.1093/condor/duz010>
- Theobald, E., Hosken, D. J., Foster, P., & Moyes, K. (2020). Mines and bats: The impact of open-pit mining on bat activity. *Acta Chiropterologica*, *22*(1), 157–166. Scopus. <https://doi.org/10.3161/15081109ACC2020.22.1.014>
- Tyack, P. L., Thomas, L., Costa, D. P., Hall, A. J., Harris, C. M., Harwood, J., Kraus, S. D., Miller, P. J. O., Moore, M., Photopoulou, T., Pirotta, E., Rolland, R. M., Schwacke, L. H., Simmons, S. E., & Southall, B. L. (2022). Managing the effects of multiple stressors on wildlife populations in their ecosystems: Developing a cumulative risk approach. *Proceedings of the Royal Society B: Biological Sciences*, *289*(1987). Scopus. <https://doi.org/10.1098/rspb.2022.2058>
- Vanderwolf, K. J., & McAlpine, D. F. (2021). Hibernacula microclimate and declines in overwintering bats during an outbreak of white-nose syndrome near the northern range limit of infection in North America. *Ecology and Evolution*, *11*(5), 2273–2288. <https://doi.org/10.1002/ece3.7195>
- Zimmerling, J. R., & Francis, C. M. (2016). Bat mortality due to wind turbines in Canada: Bats and Wind Turbines. *The Journal of Wildlife Management*, *80*(8), 1360–1369. <https://doi.org/10.1002/jwmg.21128>

Appendix A - Summary of EISs Evaluated for Claims about Bats

Project Name	Project Type	Year Published	Province	Adverse Project Effects (Y/N/NA ^a)	Significant Adverse Project Effects (Y/N/NA ^a)	Adverse Cumulative Effects (Y/N/NA ^a)	Significant Adverse Cumulative Effects (Y/N/NA ^a)
Tilt Cove Exploration Drilling Project	Exploration Drilling	2023	NL	NA	NA	NA	NA
Timiskaming Dam-Bridge of Quebec Replacement Project	Bridges Dams and reservoirs	2018	QC	Y	N	Y	N
Bekevar Wind Energy Project	Wind Energy	2021	SK	Y	N	NA	NA
Beaver Dam Mine Project	Gold Mine	2021	NS	N	N	N	N
Valentine Gold Project	Gold Mine	2019	NL	Y	N	NA	NA
Boat Harbour Remediation Project	Remediation	2021	NS	NA	NA	NA	NA
Fifteen Mile Stream Gold Project	Gold Mine	2021	NS	Y	N	Y	N
Lynn Lake Gold Project	Gold Mine	2020	MA	Y	N	Y	N
Lake Manitoba and Lake St. Martin Outlet Channels Project	Water Management Bridges	2020	MA	Y	N	Y	N
Central Ridge Exploration Drilling Program	Exploration Drilling	2020	NL	NA	NA	NA	NA
West Flemish Pass Exploration Drilling Project	Exploration Drilling	2020	NL	NA	NA	NA	NA
BHP Canada Exploration Drilling Project	Exploration Drilling	2020	NL	NA	NA	NA	NA
PROJECT 6 – ALL-SEASON ROAD	Highways and Roads	2019	MA	Y	N	Y	N
CNOOC International Flemish Pass Exploration Drilling Project	Exploration Drilling	2019	NL	NA	NA	NA	NA
Jeanne D'Arc Basin Exploration Drilling Project	Exploration Drilling	2019	NL	NA	NA	NA	NA
Newfoundland Orphan Basin Exploration Drilling Project	Exploration Drilling	2015	NL	NA	NA	NA	NA
Flemish Pass Exploration Drilling Project	Exploration Drilling	2018	NL	NA	NA	NA	NA

Eastern Newfoundland Offshore Exploration Drilling Project	Exploration Drilling	2018	NL	NA	NA	NA	NA
Blackwater Gold Project	Gold Mine	2015	BC	Y	N	Y	N
Springbank Off-Stream Reservoir Project	Highways and Roads Dams and reservoirs	2018	AL	Y	N	Y	N
Trois-Rivières Port Facilities Expansion Project (Terminal 21)	Highways and Roads Ports and Harbours	2021	QC	Y	N	NA	NA
RED MOUNTAIN UNDERGROUND GOLD PROJECT	Gold Mine	2017	BC	Y	N	Y	N
Bay du Nord Development Project	Offshore Oil and Gas Production	2021	NL	NA	NA	NA	NA
Hardrock Gold Mine Project	Gold Mine	2017	ON	Y	N	NA	NA
Hammond Reef Gold Project	Gold Mine	2018	ON	Y	N	NA	NA
BURNCO Aggregate Mine Project	Sand and Gravel Mine	2016	BC	NA	NA	NA	NA
Project 4 - All-Season Road Connecting Berens River to Poplar River First Nation	Road Construction	2016	MA	Y	N	NA	NA
Milton Logistics Hub Project	Railways	2015	ON	Y	N	NA	NA
Scotian Basin Exploration Drilling Project	Exploration Drilling	2016	NS	NA	NA	NA	NA
Magino Gold Project	Gold Mine	2017	ON	Y	N	NA	NA
Goliath Gold Project	Gold Mine	2015	ON	Y	N	NA	NA
Tazi Twé Hydroelectric Project	Hydroelectric Energy	2014	SK	NA	NA	NA	NA
Côte Gold Mine Project	Gold Mine	2014	ON	Y	N	NA	NA
Harper Creek Mine Project	Gold Mine Copper Mine Silver Mine	2015	BC	N	N	NA	NA
Pacific NorthWest LNG Project	Liquid Natural Gas Facility	2014	BC	Y	N	Y	N
Black Point Quarry Project	Quarry	2015	NS	NA	NA	NA	NA
Brucejack Gold Mine Project	Gold Mine	2014	BC	N	N	NA	NA

Shelburne Basin Venture Exploration Drilling Project	Exploration Drilling	2014	NS	NA	NA	NA	NA
James Bay Lithium Mine Project	Lithium Mine	2018	QC	Y	N	Y	N
Ajax Mine Project	Gold Mine Copper Mine	2015	BC	Y	N	Y	N
Near Surface Disposal Facility Project	Nuclear Energy	2021	ON	N	N	Y	N
Murray River Coal Project	Coal Mine	2014	BC	N	N	NA	NA
Rainy River Project	Gold Mine	2014	ON	Y	N	NA	NA
Kemess Underground Project	Gold Mine Copper Mine	2017	BC	Y	N	Y	N
Marathon Palladium Project	Palladium Mine	2017	ON	Y	N	Y	N
In Situ Decommissioning of the Whiteshell Reactor #1	Nuclear Energy	2022	MA	N	N	Y	N
Howse Property Iron Mine Project	Iron Mine	2016	NL	N	N	NA	NA
Woodfibre LNG Project	Liquid Natural Gas Facility	2017	BC	Y	N	Y	N
Roberts Bank Terminal 2 Project	Ports and Harbours	2022	BC	NA	NA	NA	NA
Énergie Saguenay Project	Liquid Natural Gas Facility	2019	QC	Y	N	Y	N
Contrecoeur Port Terminal Expansion Project	Ports and Harbours	2017	QC	Y	N	Y	NA
Grassy Mountain Coal Project	Coal Mine	2016	AL	Y	N	N	N
Rook I Project	Uranium Mine Nuclear Energy	2019	SK	Y	N	Y	N
Site C Clean Energy Project	Hydroelectric Energy	2013	BC	Y	N	NA	NA

a. NA = No statement about this feature was found to be present in the EIS or any relevant associated documents.

Appendix B – Category Definitions

Table B1. Rationale Category Descriptions

Category	Description
Effectiveness of Mitigation	There is a sufficient level of confidence that the chosen mitigation measures will reduce some or all of the adverse effects of the project on bats to an acceptable level.
Bats Absent/Sparse	Bats are deemed to not be present in the project area or are in such low numbers that there are unlikely to be any significant interactions between the project and bats.
Habitat Features Absent/Sparse	The amount of bat habitat that will be destroyed/degraded by the project is small because the baseline levels of bat habitat within the project footprint is small. Therefore, the removal of this habitat will not result in significant effects on bats and/or bat habitat.
Habitat Lost is Low Quality	The bat habitat that will be destroyed/degraded by the project is of low quality and therefore is likely providing little ecological value to local bat populations in the baseline scenario. Therefore, the removal of that habitat will not result in significant effects on bats and/or bat habitat.
Project Effects Will Not Interact with Bats	The nature of the project effects are such that bats cannot be affected by them. Therefore, the project will not have significant negative effects on bats and/or bat habitat.
Impact is Within Resilience Limits	The magnitude of the project's impact on bats is within the population's capacity to adapt or withstand such that effects will not cause meaningful, long-term changes in the population or its viability. Therefore, the project effects are not significant.
Habitat lost not Limiting in RSA or LSA	The type of habitat that will be destroyed/degraded by the project is abundant in the local/regional area and therefore the lost potential habitat resulting from the project will not prevent local bat populations from accessing that habitat type. Therefore, the removal of that habitat will not have significant effects on bats.
Cumulative: No Or Low Residual Project Effects	The project is not anticipated to result in significant adverse effects on bats or bat habitat. Therefore, its contribution to cumulative effects will also not be significant.

Table B2. Impact Considered Category Descriptions

Impact Type	Description
Habitat Destruction or Degradation - Roosts	The destruction, or degradation of roosts or potential roosting habitat. Includes maternity roosts and day roosts.
Habitat Destruction or Degradation - Hibernacula	The destruction, or degradation of hibernacula or potential hibernacula.
Habitat Destruction or Degradation - Nonspecific	The destruction, or degradation of bat habitat the type of which is not specified in the EIS.
Habitat Destruction or Degradation - Foraging	The destruction, or degradation of habitat used by bats for the foraging/hunting of insects or other food sources or the potential to be used for foraging/hunting of insects or other food sources.
Habitat Destruction or Degradation - Movement Corridors	The destruction, or degradation of habitat that facilitates the movement of bats over long distances (e.g., migration) and shorter distances (e.g., movement from roosts to foraging areas).
Direct Mortality - Incidental During Demolition	The incidental or unintentional killing of bats as a result of the demolition/destruction of a space they are currently occupying.
Direct Mortality - Vehicle Collisions	The killing of bats from collisions with high-speed vehicles such as cars or trains.
Direct Mortality - Power Line Collisions	The killing of bats from electric shock due to collisions with high energy power lines.
Health Impact - Hazardous Material Exposure	Negative impacts on the health of individual bats or a population of bats as a result of their exposure to an anthropogenic substance that is detrimental to their health such as heavy metals, pesticides, nuclear waste, etc.
Health Impact - Dust Pollution	Negative impacts on the health of individual bats or a population of bats as a result of increased anthropogenic particulate matter in the air, and its impacts on bats' ability to breathe properly.
Health Impact - Disease Risk/Exposure	Negative impacts due to the exposure, or increased risk of exposure, of bats to a harmful pathogen including viruses, bacteria, and fungi (e.g., White-nose-syndrome).
Anthropogenic Disturbance - Noise	Changes to bats behaviour that result from anthropogenic noise and which could negatively impact the fitness of the effected individuals.
Anthropogenic Disturbance - Light	Changes to bats behaviour that result from anthropogenic lights and which could negatively impact the fitness of the effected individuals.
Attractants	Negative effects on bats resulting from their reliance on or use of anthropogenic structures or activates which may be of a low quality or ephemeral in nature resulting in reduced fitness of bats using or relying on it.

Table B3. Survey Method Category Descriptions

Survey Method	Description
Land Classification Mapping (Roosts)	The use of land classification maps (such as those that identify the distributions of old growth forest) to determine the suitability of an area as roosting habitat and/or the likelihood that bats are using a given area as roosting habitat.
Manual Inspection of Roosts	Surveyors physically visiting potential roost sites and examining them to determine the nature of their use as roosts by bats.
Tagging & Tracking (Roosts)	Using telemetry or some other means to track bats to a specific location to identify the location of a roost or set of roosts and/or gain insight into the use of a roost or set of roosts. (Often combined with mist-netting)
Hibernacula Survey	Surveyors physically visiting potential hibernacula sites and examining them to determine the nature of their use as hibernacula by bats.
Land Classification Mapping (Hibernacula)	The use of land classification maps (such as those that identify distributions of karst topography) to determine the suitability of an area as roosting habitat and/or the likelihood that bats are using a given area as roosting habitat.
Tagging & Tracking (Hibernacula)	Using telemetry or some other means to track bats to a specific location to identify the location of a hibernaculum and/or gain insight into the use of a hibernaculum. (Often combined with mist-netting)
Acoustic Monitoring	The placement of an ultrasonic acoustic microphone into the environment to record ultrasonic audio and later analyze the recorded audio to identify any bat calls that were made in proximity to the ultrasonic microphone while it was recording.
Incidental Observations (Absence)	An absence of incidental observations of bats during other wildlife surveys or activities not specifically intended to identify bats, used to infer the absence of bats within a given area.
Incidental Observations (Presence)	Incidental observations of bats during other wildlife surveys or activities not specifically intended to identify bats, used to infer the presence of bats within a given area.
Mist Netting	The application of a tall net made of thin string material which bats will fly into and become caught. Once caught the bats can be extracted from the net, to be counted, tagged for subsequent recapture or with radiotracking devices, and released. Can be done multiple times to gain population estimates through capture, mark, recapture studies.
Review of Previous Field Work	The use of results from field work done in the past by other groups not associated with the project to make

	inferences about the presence or absence of bats within a given area.
Visual Assessments	Visually looking for bats or bat habitat features in the environment to determine their presence and other characteristics. Typically done in locations where bat activity is suspected, such as a potential swarming site, or emergence location.

Appendix C – Search Terms

Table C1. The search terms used to help find relevant sections and statements in EISs for a set of assessment factors.

Assessment Factor	Search Terms Used^a
Overall Conclusions	Standard set – includes: bat(s), (peri)myotis, lasi(urus/uran/onycteris), chiroptera(n), roost(s/ing), hibernacul(um/a); cumula(tive)
Impacts Considered	Standard set
Critical Information Gaps (CIGs)	Standard set; (not /un)certain(ty); (not /un)know(n/ledge); gap(s); confiden(t/ty/ce); (un)availab(le/ility); limit(ation/ed/ing); case specific terms as needed ^b
Precautionary Statements	Standard set; (pre)cauti(on/ous/ary/); conservative(ly); (over/under)estimat(e/ed/ion); worst(-case-scenario); assum(e/ption/ption); case specific terms as needed ^c
Academic Sources	Standard set
Survey Methods	Standard set; acoustic(monitoring/surveys/ transect); mist(-nets/netting)
Use of Bat Boxes	Standard set; box(es); condo(s); artificial(ly); hectares; ha ^c ; kilometer(s/s squared); km ⁽²⁾

- a. Because document searches match the given text wherever it occurs within a document, even within other words, fragments of words were used to include multiple related terms within one search. Parenthesis are used to show the additional phrase/terms included by a word or term fragment, with slashes used to delineate between multiple included prefixes or suffixes. The text outside of the parenthesis is what was actually entered into the document search.
- b. Because CIGs and precautionary statements can refer to a broad range of subjects, and because this project examines the linkages between precautionary statements, CIGs, and supporting statements on the same subjects, additional searches were conducted related to the specific subject matter discussed in an identified supporting statement, CIG, or precautionary statement, when it was determined that doing so would minimize the risk of missing a relevant CIG, or precautionary statement.
- c. Searches for this term were done twice, once with a leading space and once with a trailing space. This measure aimed to lower the rate of false positive results caused by the presence of “ha” within irrelevant words/sections.