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PERSPECTIVE

Inclusive approaches for cumulative effects assessments

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Abstract

1. The cumulative impacts of human activities and natural disturbance are leading to loss and extinction of species, ecological communities and biocultural connections people have to those ecosystems. Exclusive and extractive western science methodologies often hinder the inclusion of Indigenous knowledge holders in cumulative effects assessments (CEAs), which can lead to regional conflict and ineffective assessment and management of cumulative effects.
2. We offer our reflections on the development of a collaborative CEA process with the Kitasoo Xai'xais, Nuxalk and Wuikinuxv First Nations in what is now known as the Central Coast of British Columbia. We designed our CEA around the guiding principles of respecting Indigenous sovereignty and regional autonomy, designing for trauma-informed approaches, and prioritizing inclusivity and reciprocity. We focused our efforts on identifying current and future pressures on species of the Nations' choice.
3. We relied on expert elicitation and data-driven approaches to identify and map current and future cumulative impacts to predict their consequences for species' health. We used combinations of visualizations, numerical, oral and written materials to convey, elicit and share complex information with experts.
4. We found a diversity of elicitation processes fostered the involvement of a variety of experts (e.g. Indigenous knowledge holders and Nation staff, regional biologists, Crown managers, tenure holders). We mapped over 90+ impacts to species in the region and after conversation and facilitated elicitation processes with over 50 knowledge holders, emerged with predictions for the consequences of seven plausible scenarios of future cumulative impacts for eight species as well as broad themes for the management of cumulative impacts to the lands and waters of the Nations with whom we collaborated. Our shared lessons can support researchers, planners, proponents, and Indigenous and colonial government agencies to conduct inclusive, collaborative and accessible CEAs that inform regional land and marine use planning.

1 | INTRODUCTION

> Now today, we see so much oil-rig, roads, logging — everything they destroy in our hunting area. What about all these animals living in the bush? What do they think? I see some moose in a city and I say look at him, he come to town because he got no home, their home is all broken. I talk to other Elders. They feel very hurt about oil-rig, road, logging. It is destroying for these animals.
>
> May Apsassin, Blueberry First Nation Elder, (Penn, 2013)

> The major criticism of our current modes of planning and environmental impact prediction…is that they are piecemeal. They usually consider only one project within a region, or even one aspect of a project… With this approach, it is impossible to do a thorough job of assessing the combined effects of projects, and generally one concludes that the environmental effects of a single project are not very 'significant'. … The result is not the ecological 'disasters' which make headlines, but a process of slow attrition in which year after year, project by project, we haphazardly approach subtopia.
>
> Ian McTaggart Cowan, UBC biologist (McTaggart Cowan, 1973)

Cumulative impacts of human activities and natural disturbance on the environment are leading to the loss and extinction of species, ecosystems and biocultural diversity. We define cumulative effects here as 'changes in the environment caused by multiple interactions among human activities and natural processes that accumulate across space and time' (CCME, 2014). Unmanaged, extensive impacts from development yield 'death by a thousand cuts' which threaten ecological integrity and the interconnections communities have to those ecosystems (West Coast Environmental Law, 2021).

Contemporary project-level assessment of cumulative effects generally begins by selecting components of value, such as key species or ecosystems, where the combined consequences of past, present and future pressures are assessed (Connelly, 2011). Consequences of cumulative effects are built with data-driven and expert-informed approaches (Murray et al., 2018). The results of a cumulative effects assessment (CEA) should then be used to determine whether a proposed human activity will have significant adverse impacts on the sustainability of those valued components so that those human activities can be appropriately managed to limit adverse consequences to ecosystems and people. However, because of widespread limitations in how CEAs are conducted, particularly by colonial government agencies or project proponents, the utility of CEAs is generally hindered by lack of relevancy, applicability or trust in the process (Clogg et al., 2017; Duinker & Greig, 2006).

Positionality Statement

The team for this project was made up of women from Indigenous, Chinese and white-settler descent. We are trained as ecologists, geographers, community planners, facilitators, artists and designers. All of us have training in colonial-state universities—whether that be in science, geography, planning or art. Members of our team also have training and experience built from community-based practice with Indigenous communities in what is now known as western North America. We note here that many of our team held over a decade of experience and relationships built in co-creating various ecological and community planning projects with the First Nations in this collaboration. This meant that trust, candour and context were already relatively well established among collaborators, and between Nation staff and the communities they serve. We bring with us the lessons, responsibilities and accountabilities that stem from our relationships as the basis of our practice. We value the stewardship of the plants and animals in the lands and waters of the places we live and work, as well as the sovereignty of Indigenous Nations to govern those lands and waters. We value learning together through honest communication and engaging in challenges in supportive teams. We are committed to interrogating how we do our work through anti-white supremacist and decolonizing frameworks, and hope this offering contributes to ongoing conversations about reducing harm and improving inclusivity of our practice in our academic and professional circles.

In Canada, CEAs have been required under environmental law for the past 30 years (i.e. *Canadian Environmental Assessment Act 1992*, *Impact Assessment Act 2019*; Canada, 2012, 2019). Federal agencies which generally oversee or conduct biodiversity conservation (e.g. Environment and Climate Change Canada or Fisheries and Oceans Canada) are the same agencies who offer permitting process for economic projects that often lead to environmental impacts (Wood, 2014). The application of CEAs can therefore be limited by the general distrust generated by these conflicting internal mandates (Udofia et al., 2017). In addition, key analytical challenges include assessment processes focused on project approval instead of environmental sustainability, a general lack of understanding of ecologic impact thresholds, separation of past and future cumulative effects from project-specific impacts, and weak interpretations of cumulative effects by practitioners (Clogg et al., 2017; Connelly, 2011; Duinker et al., 2013; Duinker & Greig, 2006, 2007; Murray et al., 2018). Critics advocate that in order to address these challenges, the CEA process needs to occur prior to a proposed development project, and across a regional scale, situating the identification of impacts within locally relevant

values and regional planning and management for local human and ecological communities (Clogg et al., 2017; Connelly, 2011; Duinker & Greig, 2006; Eckert et al., 2020; Gunn & Noble, 2009; Singh, Lerner, et al., 2020).

> Elders are alarmed by the short-sighted approach to development now so prevalent. They foresee dire consequences if the approach does not change dramatically. Simply put, Elders believe we are destroying ourselves: As we see things now, our earth is dying. It is gradually being destroyed.
>
> Clarence Apsassin, Elders' Program Co-ordinator, Treaty 8 Tribal Association, Blueberry River Reserve, 1992

The failure of the CEA process to serve local communities is especially potent for Indigenous Nations and communities in Canada and beyond (Best et al., 2021; Booth & Skelton, 2011a; Clogg et al., 2017; Eckert et al., 2020). Indigenous Nations have inherent authority to govern their lands and waters. The decision-making authority of Indigenous Nations has been recognized by the Supreme Court of Canada (e.g. R. v. Sparrow, 1990; Tsilhqot'in Nation v. British Columbia, 2014), in federal government policies, and in the adoption of the *United Nations Declaration on the Rights of Indigenous Peoples* into federal legislation (United Nations Declaration on the Rights of Indigenous Peoples, 2007). In spite of this, most colonial-state or proponent-led CEA processes do not recognize the decision-making authority and jurisdiction of Indigenous Nations (Clogg et al., 2016, 2017). Broadly, by not acknowledging Indigenous Nations as decision-makers, colonial-state (i.e. 'the Crown' in a Canadian context) and proponent-driven processes undermine Indigenous governance and constructive Indigenous-Crown government-to-government relationships (Booth & Skelton, 2011b, para 1880 Yahey v. British Columbia, 2021).

Furthermore, underlying methodologies for CEAs are generally exclusive and extractive: they rely on inputs, data and tools that exclude the types of data and knowledge that exist outside of the western science paradigm. As with many other processes driven by western science, CEAs often fall short because they fail to adequately engage the values and knowledge of local people (Eckert et al., 2020), thus alienating those directly impacted by the consequences of cumulative pressures on the ground (Staples & Staples, 2021). The majority of CEAs struggle to adequately value and incorporate Indigenous knowledge if and when it is offered (Buell et al., 2020; Keats & Evans, 2020; Scott, 2022 but see Mantyka-Pringle et al., 2017). As Blueberry First Nation Elder May Apsassin, states '… they fool our family with a little of the green paper. They pay a little but then go out and do all those things… I want to go to Doig and talk with my other Elders. If we can keep barking, barking, barking about this thing maybe they can hear that this is what I was thinking' (Penn, 2013). This context is against a backdrop of general mistrust of Crown agencies, who hold enormous power over process and legislation in Canada as compared with Indigenous Nations.

Inclusive approaches that centre Indigenous decision-making and are inclusive are needed for CEAs. In many cases, Indigenous Nations and organizations are already leading such emerging processes, which centre local values, regional planning priorities and ultimately Indigenous law (Booth & Skelton, 2011b; Clogg et al., 2017; Gitanyow Hereditary Chiefs, 2020; Jolly & Thompson-Fawcett, 2021). These processes support the inclusion of multiple bodies of knowledge (i.e. Indigenous knowledge, local ecological knowledge, western science knowledge; e.g. projects implemented by Metlakatla Stewardship Society, 2019; Moorcroft et al., 2012). 'Regional Assessments' are also a promising emerging federal tool, being processes that go beyond project-focused impact assessments to understand the regional context and provide more comprehensive analyses that help inform future impact assessment decisions and the management of cumulative effects (Canada, 2019).

The continued need for novel approaches and tools for assessing cumulative impacts motivated our work. Herein, we illustrate our inclusive and values-driven process in assessing current and prospective cumulative effects on focal species in the lands and waters of the Kitasoo Xai'xais, Nuxalk and Wuikinuxv First Nations with whom we collaborated in this work, in what is now known as the Central Coast of British Columbia, Canada. At the forefront of our process was generating relevant outputs for Indigenous decision-makers and prioritizing participation of Indigenous knowledge holders; namely asking ourselves how to bring guiding principles of respect, trauma-informed practice, inclusion and reciprocity into our CEA process. Drawing on lessons from the literature and our experience, our team of academic and government researchers, artists and facilitators offers our reflections on each step of the development of a collaborative and inclusive approach to a regional CEA process.

2 | GUIDING PRINCIPLES AND PRACTICES

Our goal in this work was to re-imagine how a regional CEA could be conducted; one that served the people and ecosystems of a particular place and with a particular focus on the respect and inclusion of Indigenous peoples and their governments. We looked to four guiding principles in developing our process:

2.1 | Respect for people and place

A grounding principle in building inclusive CEAs is simply the recognition of Indigenous authority to steward their lands and waters. Broadly speaking, Indigenous peoples, their communities and their governments operate under holistic principles of respect and reciprocity for the plants and animals with whom they share their homelands, whereby interconnections in ecosystems are acknowledged and accounted for. These principles certainly stand in the region in which our work took place (see below), with Indigenous governments and knowledge holders in the territories of the Kitasoo Xai'xais,

Nuxalk, and Wuikinuxv Nations and their neighbouring Nations (Figure 1), who holistically steward biodiversity on their lands and waters through ecosystem-based approaches (Adams et al., 2021; Artelle et al., 2021; Brown & Brown, 2009; Great Bear Rainforest Order, 2016; Reid et al., 2022). As such, it was important for both the Nations and the research team that our process reflected those interconnections as much as was possible within expert elicitation and modelling methodologies which are necessarily reductionist.

We began our work by engaging first with Indigenous Nations who consented to partnering in an assessment of cumulative effects in their territory, wherein we offered Nations' Stewardship staff a rough idea of our interests and capacities and asked about their context and decision-support needs (see 'Step 1. Establish relationships and expectations'; e.g. Adams et al., 2014, 2015; Kitasoo Xai'xais Stewardship Authority, 2021; Kovach, 2010). We designed our process with Indigenous Nation staff and knowledge holders as our priority participants, after which we expanded our process to include other experts such as regional biologists, local tenure holders, academic scientists and Crown government staff. While we strove to design a process accessible to both Indigenous and western science knowledge holders who would contribute to our CEA, we were explicit in privileging and prioritizing practices that focused on inclusion of Indigenous knowledge holders.

FIGURE 1 Focal region of the cumulative effects assessment, an area now known as the Central Coast of British Columbia, Canada. We show here the communities of the collaborating First Nations (FN) including Klemtu (Kitasoo Xai'xais FN), Bella Coola (Nuxalk FN) and Kitit/Wuikinuxv village (Wuikinuxv FN).

We wanted to show collaborators and knowledge holders we respected their time and input. While there was structure to our CEA, we built in time for additional conversation and knowledge sharing that made space for conversations around interconnected ecological and anthropogenic relationships and consequences, through a variety of input options (see 'Prioritize Inclusivity'). We also considered what appropriate compensation should be for participants' time by following Nation compensation guidelines (see Supporting Information 1). We offered honoraria for time spent in the workshop as well as time they spent independently filling out workshop materials.

Respect for local context of the region was important for us to demonstrate. We structured the timing of our engagement and community visits around the seasonal needs of each Nation (e.g. avoiding key harvesting times, planning around pre-existing community events). The use of visuals strongly supported our engagement and research process (see below), so we worked with an illustrator who was familiar with the region's ecology and history. We also worked with a graphic designer and videographer who had experience communicating science to broad public audiences, and who also had worked extensively in Indigenous communities.

2.2 | Design for trauma-informed processes

We committed to operate with an ethic of care and respect that honours the broader context of collaboration with Indigenous Peoples in Canada. Identifying and assessing cumulative effects can be a sad process—territories and peoples' connections to them have changed, often drastically, following colonization and land theft, massive resource extraction by settler societies, post-contact pandemics and disruption of Indigenous family systems. This is especially true for people experiencing both knowledge loss and changing land and marine-scapes, often due to forces imposed on them by colonial Nation states.

CEAs and other environmental planning processes can incorporate trauma-informed approaches to foster feelings of safety and inclusion. 'Trauma-informed' refers to an approach that integrates an awareness of traumatic stress in the design and implementation of a practice or a system, with the goal of enhancing the quality and delivery of services provided to trauma-exposed people (Branson et al., 2017). We integrated trauma-informed approaches throughout our process when possible. For example, we designed workshops and materials to be beautiful, accessible and respectful of knowledge holders' contexts (e.g. considering residential school survivors' experiences in classroom-like settings); we considered the physical needs of workshop participants and planned for food, rest and comfort in the workshop delivery; and we designed workshop agendas and materials to be spacious and flexible for diverse knowledge to be shared through an array of inputs (written, oral, image-based, numeric, synchronous and asynchronous). There was no pressure to answer all questions and there was no one right way to contribute.

2.3 | Prioritize inclusivity and accessibility

We designed our approach, our methods and our workshop design around the core principle of inclusivity. Namely, we wanted the process to honour and respect the inclusion of Indigenous knowledge holders, in addition to other experts from the region.

We grounded our approach to communicating with knowledge holders here in 'user-centred design', wherein graphic design prioritizes the participant's point of view from the beginning, focusing on the cognitive, behavioural, social and cultural context of the participant (Bowler et al., 2011; Rodríguez Estrada & Davis, 2015). Our team included experts in visual literacy (artists, videographers and a graphic designer) as well as Indigenous planners and facilitators who created engagement materials that were accessible to all prospective participants (e.g. jargon-free text, use of illustrations alongside text and numerical elicitation approaches; Rodríguez Estrada & Davis, 2015).

Our premise on relying on visuals as a key form of communication in our CEA was that art and graphic design are highly effective at conveying ideas and concepts to diverse audiences (e.g. Best et al., 2021; Polfus et al., 2017; Roque de Oliveira & Partidário, 2020). Visual aids also support inclusion of people with varying English literacy levels and learning styles. We note that consent and sensitivity are required in visually representing Indigenous people, where assumptions or tokenization are possible and may cause sadness, anxiety or resentment in participants. When done with context and sensitivity, visuals can immediately reflect back a knowledge of the region, incorporate humour and personal anecdotes, all of which again build trust and conceptual consensus among facilitators and participants.

2.4 | Prioritize reciprocity

Contemporary western approaches to CEAs often leave local people feeling their knowledge is seen as a resource to be extracted for others' benefit, without adequate collaboration with, acknowledgement of, or compensation for knowledge holders. Our team wanted to confront this reality by prioritizing reciprocity to knowledge holders in our approach. Indeed, there has long been a call by communities for external projects to consider more reciprocity and equal access to capacity for community members where research is occurring (Wong et al., 2020).

We considered how reciprocity could factor into our process during and after the completion of the project. We strove for beauty, clarity and thoughtfulness in our approach to developing communication materials and crafting workshops. We also budgeted time and resources for hand-written invitations or follow-up notes with knowledge holders. During workshops, we budgeted generously for food and gifts in addition to honoraria (see Supplementary Information 1). When workshop participants needed extra support or time during the workshops, we strove to make them feel cared for. Time was also given, during the workshops themselves, for community members to dialogue with Nation staff who were present about issues and questions they deemed important, even though the results of this dialogue did not always feed directly into the CEA analysis. In these ways, we sought to support ongoing Nation-led stewardship efforts and relationships outside of the window of this project.

We also considered legacy impacts of our work. Our team prioritized mid-project newsletters to community members and participating knowledge holders, as well as mid-project updates with Nation staff to ensure our research products would serve their decision-making needs. We are providing territory-specific data outputs (written summaries, illustrated summaries, audio recordings, spatial data libraries and summary reports), which will be tabled with the Nation and staff and community members upon the completion of the project. Beyond these deliverables, we considered what our project's team and resources could leave in community. We note that while reciprocity was always a priority for us, the reduction in travel funds due to the pandemic allowed us to leverage even more funds towards capacity sharing with collaborating partners (e.g. training opportunities) and gifts for knowledge holders and the communities at large (Supporting Information 1).

3 | AN INCLUSIVE APPROACH TO IDENTIFYING AND PREDICTING CUMULATIVE EFFECTS FROM ALTERNATIVE DEVELOPMENT SCENARIOS

Our research goal was to develop a process for cumulative effects at a regional scale that was driven by local values and knowledge to support decision-making regarding human activities and management of the health of the focal species over the next 25 years. We defined 'health' here as the ability of a species to be self-sustaining and fulfil its ecological and cultural roles. Our CEA process is described below in eight steps (Figure 2).

Our process addresses current shortfalls with existing project-level Canadian CEA process in four main ways by (1) centring Indigenous priorities and values; (2) employing expert elicitation as a methodology for the inclusion of Indigenous knowledge and data, in addition to western scientific knowledge and data; (3) accounting for potential future pressures which were anticipated in the region, and (4) conducting an assessment of cumulative effects at a regional scale, as opposed to a small-scale project-level assessment driven by a proponent. We grounded the design of the entire project around the guiding principles described above and through the UBC Ethics Application approval H20-00874.

Our initial project design called for in-person conversations and expert elicitation workshops where we would ask knowledge holders with knowledge of focal species to estimate the current state of health for each species given the current state of cumulative effects in the region and to predict the health of focal species in 25 years under alternative development scenarios. We intended that these workshops would be held in First Nations communities for Indigenous-knowledge holders and stewardship staff and in a central location accessible to other knowledge holders. However, the COVID-19 pandemic required that we be ready to deliver some elements remotely (for more

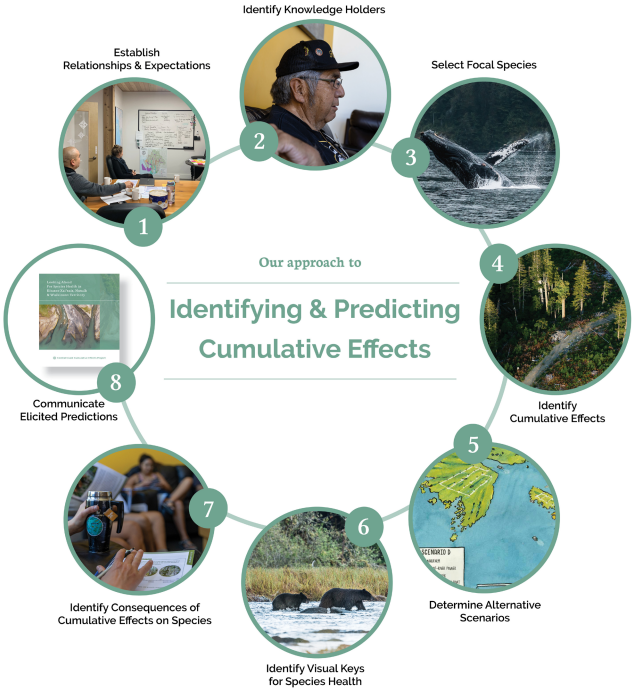

FIGURE 2 Overview of our approach to designing and implementing a regional and predictive cumulative effects assessment focused on First Nation government priorities, as supported by engaging with expert knowledge holders and spatial modelling.

details, see Supporting Information 2). Digital connectivity in remote communities can be limited, making strictly online workshop delivery inaccessible. Anticipating potential travel restrictions and lockdowns, we prioritized workshop materials that could be shared by mail and that could be followed by knowledge holders alone in their homes, with support over the phone if necessary.

3.1 | Step 1. Establish relationships and expectations

Collaborating with Indigenous Nations is relational work. This is true of any engaged environmental planning process that is driven by, or inclusive of, Indigenous Nations and their knowledge holders (Adams et al., 2014; Castleden et al., 2012; Kitasoo Xai'xais Stewardship Authority, 2021; Tobias, 2000). Establishing relationships and context before (and not during) the research or assessment process is imperative.

We were interested in how an explicitly regional scope combined with expert elicitation approaches might improve the CEA process for the Central Coast region, which has undergone recent assessment processes for major projects that have been discordant with community priorities and Nation governance processes in the region (e.g. the Joint Review Panel process for the Northern Gateway project; West Coast Environmental Law, 2015). We approached an organization that represents the joint scientific and stewardship interests in Nations' in the region (see ccirca.org) to see whether our idea of co-creating a regional CEA was of interest. The staff of the Stewardship Departments of the Kitasoo Xai'xais, Nuxalk and Wuikinuxv First Nations (hereafter 'Nations'; Figure 1) agreed to join into a research partnership with us. We invested time and resources in initial scoping meetings with each Nation before designing the CEA process, building upon years of relationships and partnerships our research team and Nation staff had from previous work in the region (Adams et al., 2021; Artelle et al., 2021; Walsh et al., 2020).

Establishing clear expectations was an important beginning step. When we began this project in the fall of 2019, the general feeling on the ground in communities in the region was one of fatigue from interviews and external research projects in general. In our initial scoping meetings, Nations identified their motivations in partnering with us, expectations of how and when we could engage in their communities, and what relevant and accessible research outputs would be. For example, just as Nation staff expected data outputs (e.g. shapefiles, summary tables), they expected accessible outputs for their knowledge holders (e.g. videos, infographics). Expectations and agreements regarding data ownership, control and possession were also clarified (note this process is iterative and ongoing; Adams et al., 2014; Kitasoo Xai'xais Stewardship Authority, 2021; Schnarch, 2004).

Once a general understanding of the process was established, we came to a consensus on the geographical and temporal scope of the project and how the Nations' stewardship staff and knowledge holders would be involved throughout the research. Where such processes existed within each Nation, we formalized these expectations in research protocols and data sharing agreements between our research team and Nation staff.

3.2 | Step 2. Identify prospective knowledge holders to participate

Bringing together knowledge from Indigenous Knowledge holders and western scientists can present methodological challenges. It is increasingly common to see Indigenous knowledge as a 'supplement' or an 'interweaving' to western science in ecological research and planning (pers. comm. J. Walkus, Wuikinuxv Nation Research Coordinator, 2022). In our project, we worked with Indigenous knowledge holders as the foundation of our process, whereby other regional experts could contribute their knowledge in addition to the foundation. We wanted to engage diverse knowledge holders, including Indigenous community members and Nation staff, regional tenure holders (e.g. fishing guides, commercial fishermen), biologists and managers from Crown governments, and academic research scientists. We ultimately worked with over 50 project participants who ranged from land-based learners to those with graduate degrees in western-science programs.

We employed a snowball approach to identify knowledge holders founded in relationships held by our research team or collaborators within each Nation. The scoping phase of the project straddled the onset of the COVID-19 pandemic, so we engaged with prospective participants in person during scoping community visits or digitally (see Supporting Information 2). We used infographics, written summaries and short videos to garner interest and share information

about the project, after which knowledge holders identified their interest to participate. We used videos for remote engagement that both explained the overall project and specifics of participating in our workshops (see Supporting Information 3).

Future-oriented planning across generations is a core tenet of Indigenous environmental management (Jojola, 2008). To this end, our CEA had a future-oriented component (see Step 5). We also prioritized youth participation where possible to help foster intergenerational knowledge transfer. This included having youth listening in on workshops or having members of our team would meet with youth groups to hear their perspectives when requested while we were in First Nation communities.

3.3 | Step 3. Select focal species to assess

CEAs focus on predicting how valued ecosystem components (VECs) will be impacted by the cumulative impacts of human activities and natural disturbances over time. The selection of VECs varies from assessment to assessment. We worked with Nation stewardship staff to select specific focal species or groups of species. In spite of VECs being commonly referred to in the literature, we chose to use the term 'focal species' because it was more descriptive and understandable to collaborators and knowledge holders.

Our approach to focal species selection was based on consensus. The Stewardship staff and community committees of each Nation identified focal species based on ecological, economic, cultural or governance/policy values. For example, some species were selected based on their ecological value, their food value for community members and/or their connection to land and marine use policy levers for Nations engaged in government-to-government negotiations. We then built a region-wide list of species based on overlap among each Nation's priorities and the capacity of our research team. Eight focal species (or in some cases, groups of species) were selected that represent species across land and sea environments in the region, including Pacific salmon *Oncorhynchus* spp., old growth forest patches, grizzly bears *Ursus arctos horribilis*, black bears *Ursus americanus*, Dungeness crab *Cancer magister*, Pacific herring *Clupea pallasii*, marbled murrelets *Brachyramphus marmoratus* and rhinoceros auklets *Cerorhinca monocerata* (Figure 3).

3.4 | Step 4. Identify cumulative effects in the region and build conceptual models

Our next step was to learn about past, present and possible future human activities and natural disturbances (hereafter 'pressures') acting on each focal species in the region. We drew on local expert knowledge from Indigenous knowledge holders, followed by knowledge from regional biologists, local tenure holders and the academic literature, to identify cumulative effects and build conceptual models of how pressures might influence the health of each focal species.

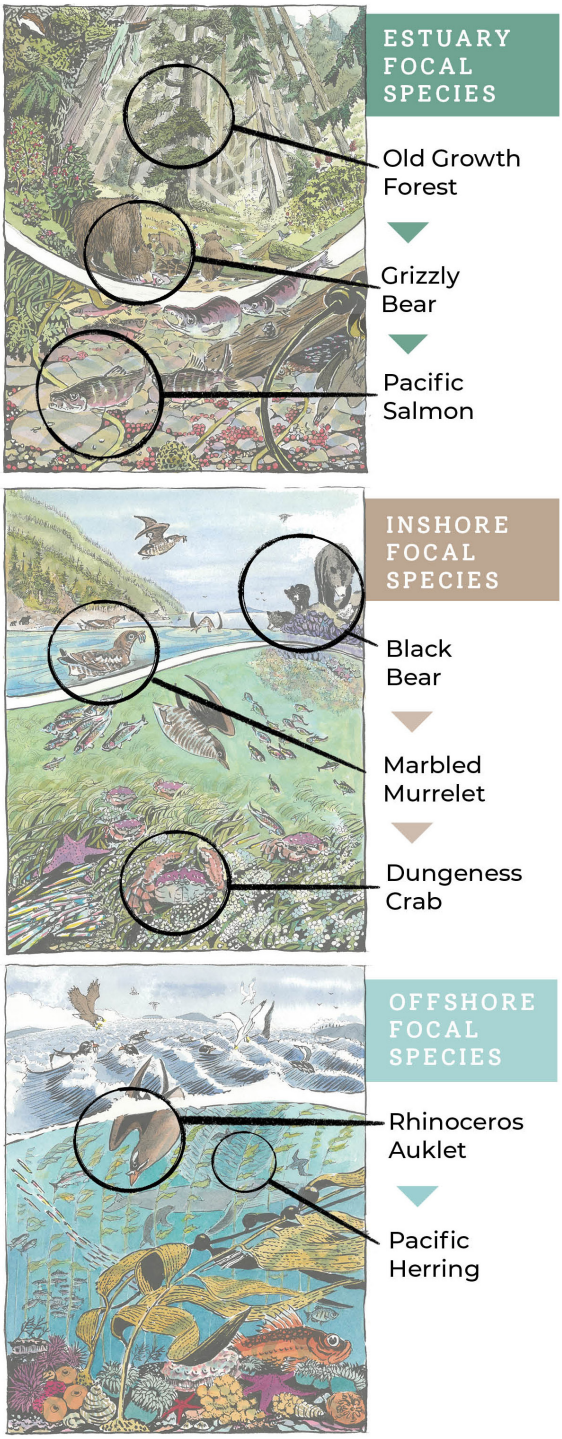

FIGURE 3 We focused on identifying, mapping, and predicting impacts to eight focal species (or groups of species) that collaborating First Nations identified as priorities for stewardship in the region of this cumulative effects assessment: grizzly bears, black bears, marbled murrelets, rhinoceros auklets, Pacific herring, Dungeness crab, Pacific salmon and remaining patches of old growth forest. In our workshop materials, we began with visuals of the focal species in their habitats as a way to acknowledge the interconnected nature of the health of species' populations, and more broadly, of coastal ecosystem.

Beginning in First Nation communities, we had conversations with Indigenous knowledge holders to learn about the history and prevalence of pressures on their lands and waters since colonization (circa 1850 for the region). Based on recommended processes from each Nation, participants gave their written informed consent to participate in these conversations. Working in small groups through semi-structured conversations over maps and other visual aids, knowledge holders identified the scale and locations of pressures in their territory and throughout the region (Tobias, 2000). These pressures ranged from wide-scale impacts of climate change on phenology or water temperature to areas of increased recreational boating activity to point locations of contaminated sites. We built conceptual models of how pressures impacted each focal species based on what was shared with us, using unweighted positive and negative relationships and linkages among pressures, food, habitat and focal species distribution (see Tulloch et al., 2022). Visual guides, such as maps and drawings of the conceptual models as they emerged, supported our conversations with knowledge holders. We created new spatial data layers by digitizing the distribution of shared information (e.g. pressure locations, focal species distribution, prey availability, critical habitat) as well as amended existing spatial information where it was deemed incomplete or incorrect.

Next, we expanded our conversations to include additional knowledge holders (e.g. regional western science biologists), using semi-structured interviews to build upon our conceptual models. We obtained informed written consent, or in some cases, oral consent for participants who joined our conversations opportunistically with their other colleagues. We conducted these semi-structured interviews in small groups of specialists who had expertise in certain focal species. We presented knowledge holders with existing models and asked them to identify if pressures needed to be added or amended, and discussed direct and indirect effects of those pressures (Tulloch et al., 2022). Western scientists also often referred us to academic literature or specific data products that could support the conceptual models and our subsequent spatial analysis (see Step 8). We combined these spatial data products with digitized layers containing information from Indigenous knowledge holders to build current cumulative pressure maps for each species.

We note that this phase of our work required energy and attention to facilitate conversations with knowledge holders that were generally open-ended and spacious. In essence, we did our best to make space for whatever people might need to say (or not say). Discussing cumulative effects post-colonization is sad and often triggering. This was at the forefront of how we conducted ourselves in communities and during our time with knowledge holders.

3.5 | Step 5. Determine alternative plausible development scenarios

Scenario development is critical to developing useful predictions as part of a CEA (Duinker et al., 2013; Duinker & Greig, 2007). To learn more about plausible future pressures from economic development in their territories, we spoke with Nation Stewardship staff. Our goal was to determine future pressures that would act on focal species over the next 25 years—a timeframe that Nation staff and our research team identified as being (a) accessible to knowledge holders and (b) relevant to Nation staff's planning processes. We focused on industries that Nations have a level of control or influence over via the provincial referral process and the region's land-use order (i.e. the Great Bear Agreement; Province of British Columbia, 2016) and/or were pursuing to support their local economic development. The human activities we increased or decreased in our alternative scenarios were forestry, energy (including both marine and land-based renewables, shipping of oil and gas) and mining, tourism, and salmon aquaculture. It was beyond the scope of this project to consider varying levels of all of the likely future pressures (e.g. off-shore fishing pressure, climate change), as this would require in an ordinate amount of effort on behalf of knowledge holders during the expert elicitation phase. Therefore, we asked knowledge holders to assume a backdrop of constant pressures identified during Step 4, with only the specified industries increasing or decreasing during alternative development scenarios as described in Step 7 (see Supporting Information 4, 'Scenario Booklet').

3.6 | Step 6. Conceptualize visual indicators of species health

Once we had established the current state of cumulative effects in the region, we wanted to understand how that current state was impacting the health of focal species currently and under alternative development scenarios. We worked with the knowledge holders from Step 4 to predict consequences of cumulative effects for species health. We structured our approach through established expert elicitation methodologies from the decision science literature (i.e. Hemming et al., 2018; Martin et al., 2012). This approach has the advantage of not solely being driven by quantitative data, which is often scarce or lacking altogether, hindering timely CEAs and decision-making (Martin et al., 2012). Typically, expert elicitation involves asking experts to predict the probability of species persistence (between 0 and 1) (Carwardine et al., 2019). To create an accessible process, we decided to contextualize 'species persistence' more broadly by considering the 'health' of a focal species within the study region as the ability of a species to be self-sustaining and fulfil its ecological and cultural roles.

To contextualize what poor, fair, good or excellent health looked like for each focal species, we asked knowledge holders during Step 4 what visual cues they might use to understand the condition of local focal species. It was important for us to draw on knowledge and stories from knowledge holders so that the visuals we used reflected their experience back to them (Roque de Oliveira & Partidário, 2020). We drew on baselines from living memory from Elder Indigenous knowledge holders (as opposed to historical baselines, especially before colonization). We found all knowledge holders shared indicators related to the condition of the species itself (e.g. body size, number of offspring), as well as the species' environment and food

availability. For example, the presence of chicks alongside adult marbled murrelets or multiple cubs alongside grizzly bear sows suggests excellent health for those species in the region. We complemented these observations with population health indicators identified in the literature. Using this information, we painted a suite of illustrations for each focal species health that corresponded from poor to excellent health (Figure 4). This way, knowledge holders could refer to contextual images when making predictions about how the focal species would respond to alternative development scenarios based on visual cues, in addition to provided numeric and written cues (Figure 4).

3.7 | Step 7. Elicit consequences of cumulative effects on species health, under current and alternative pressures

We delivered expert elicitation workshops digitally, in-person and in hybrid formats in three First Nation communities over the course of the summer of 2021. We also provided a digital survey version of our workshop booklets that knowledge holders could fill out independently, supported by instructional videos and background documents (see Supporting Information 3 and 4). Based on recommendations for consent processes from each Nation, participants gave their written informed consent to participate in digital or in-person elicitation exercises. We focused our efforts on group workshop formats for Indigenous knowledge holders who generally held interwoven expertise in multiple focal species. For experts who were more single-species focused (i.e. western scientists), we provided a digital survey in the same format as the workshop materials where experts could focus on as few or as many species that they felt confident contributing predictions for. Illustrative of the fact that one size does not fit all, some regional biologists participated in community workshops when Nations asked them to be present, and some Indigenous knowledge holders participated via the digital survey.

Regardless of the elicitation format, we invited participants to self-identify which focal species they felt comfortable making predictions about. We first asked them to predict the health of each focal species based on the current state of cumulative impacts. We then presented them with visualizations of watersheds and the nearby marine environment representing alternative development scenarios (see Supporting Information 4 for), where industries were at various combinations of high, medium or low levels and other background pressures were held constant. For each scenario, we asked them to predict the health of each focal species in 25 years.

We developed ways to communicate complex concepts using a combination of oral (videos), illustrated (printed materials and visual

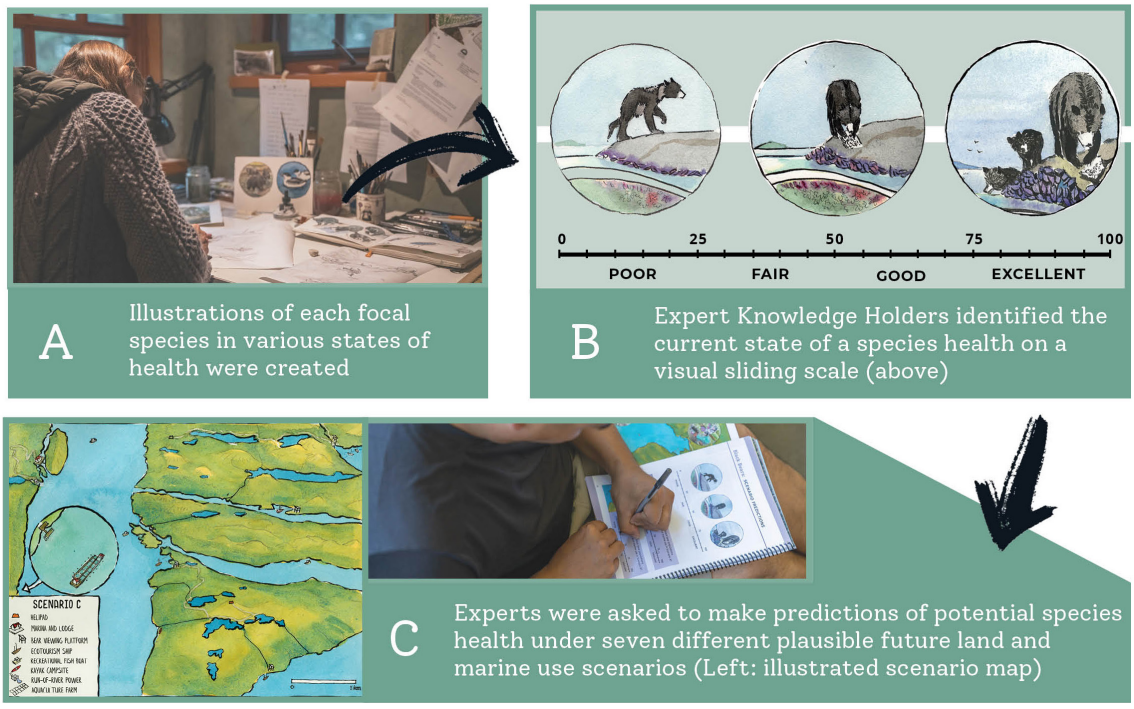

FIGURE 4 For each species, we derived illustrations of health indicators from the knowledge shared with us from experts. These illustrations represented species in various states of individual health and were built on visual indicators that experts shared with us that they said corresponded with population-level health. We built sliding scales of species health based on experts' visual indicators as well as the literature, with numerical (i.e. chance of population persistence), text (poor, fair, good, excellent) and visual prompts for experts make their prediction. Experts could select a position on the scale associated with their prediction under a given scenario. We asked experts to use the scale to first provide their prediction of the current state of each species' population health under the current state of cumulative impacts. Next, we asked experts to use the scale to predict how species' health would respond under different land and marine use scenarios which represented plausible futures in the region.

recording during workshops) and written content (workbooks, digital surveys) and we created a variety of input mechanisms for knowledge holders to use when sharing predictions (Figures 4 and 5, Supporting Information 3 and 4). For example, a prediction slider with numerical values, text and illustrated prompts was offered as a mechanism for providing estimates of focal species health, alongside opportunities for free-form written and oral submissions during our workshops (Figure 4). We used visual recording—the process of an artist listening, synthesizing and translating spoken word during workshops into real-time illustrations, also known as graphical facilitation—to build consensus and understanding among participants, demonstrate we were listening and understanding what was being shared with us, and to appeal to a diversity of learning and communicating styles (Figure 5). In particular, we found that short videos and illustrated content improved accessibility of the information we were sharing. We put similar effort into the content and readability of text in our elicitation workshop materials as we did in the placement of text and visualizations within our materials, all grounded in the goals of accessibility (see workshop materials in the Supporting Information).

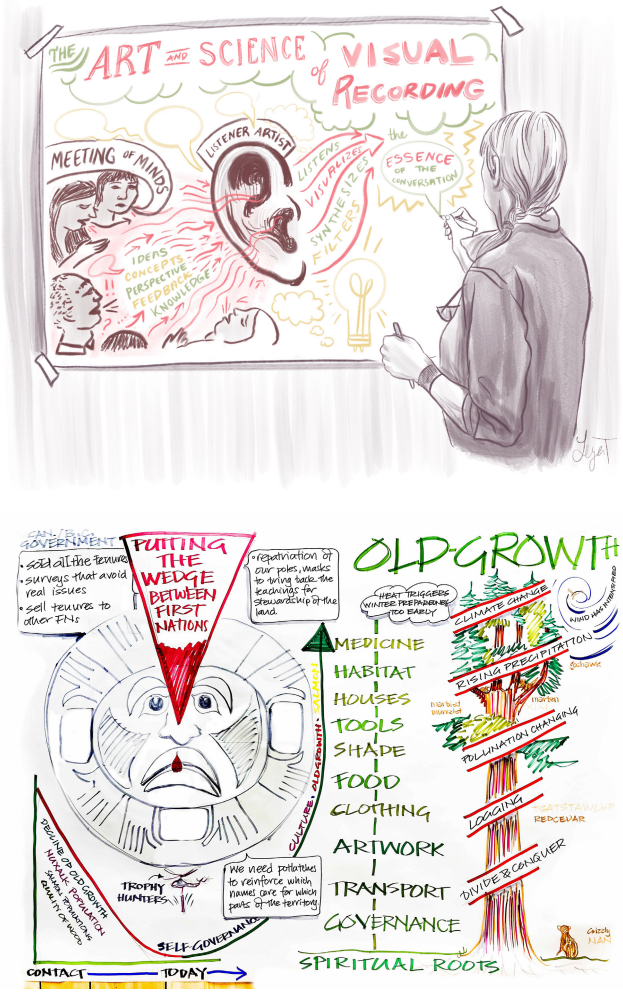

FIGURE 5 We worked with artists who had pre-existing regional expertise and community relationships to help convey concepts communicated by knowledge holders via visual recording during workshops. Visual recording (sometimes called graphic facilitation or graphical notetaking) involves an artist to listen, synthetize and translate spoken word into visuals in real time. In our case, we worked with Nation staff ahead of time to learn about locally appropriate geographic or cultural symbols and metaphors to help convey what knowledge holders were sharing with each other and our team. This works as a way to develop themes across a group without a facilitator always doing all the talking and can appeal to different types of learners and communicators.

There were four challenges where the use of art helped us to communicate with knowledge holders with more clarity:

- Acknowledging interconnections. Many Indigenous knowledge holders spoke of interconnections between individual- and population-level focal species health with the broader health of ecological communities. To ground knowledge holders in this understanding and demonstrate that while we were asking about individual species health we understood the underlying interconnections, we developed illustrations of the focal species in excellent health and within a healthy environment, as described above (Step 6). While many focal species considered in our CEA can occur in multiple ecosystems, we used three main habitat groupings to display the focal species in the context of their ecological communities: coastal rainforest and estuary, protected shoreline, and exposed shoreline (Figure 3).
- Visualizing species health consistently. To visually represent a range of focal species health along a continuum, we chose three visual states per species. These visualizations were based on body condition, habitat quality and food availability (e.g. Figure 4), as described above (Step 6).
- Visualizing land and marine use consistently. To visually represent our alternative future development scenarios (Step 5), we generated birds-eye-view visuals of scenarios of concurrent industries at varying intensities based on information shared with us by Nation staff and local experts (Figure 4). We used visualizations and written descriptions of each scenario to communicate the presence and intensity of each industry type during our expert elicitation workshops (see workshop booklets in Supporting Information 4).
- Demonstrating we were hearing and integrating knowledge shared with us. We value the conversations and knowledge shared during our elicitation workshops, as do the staff from collaborating Nations. Through visual recording, we were able to conceptualize complex cumulative effects that could not be expressed in predictions around the health of focal species alone (Figure 5). Visual recording during in-person workshops helped the project team and knowledge holders visualize information being shared and provided graphical outputs for reporting within each Nation following the workshops. We were able to work with the same artist who illustrated the workshop materials described above to do the visual recording.
- Demonstrating pre-existing local knowledge. The artist doing the visual recording (Figure 5) consulted with Elders and land managers prior to the sessions to get a sense of what the responses would be, the species of concern, and to anticipate abstract

concepts that would need to have a visual metaphor drawn from local stories and experiences. We made sure we had keywords in the different languages ready to use, key cultural symbols and stories that captured the shared heritage around difficult journeys, of working together, and of visions for the future (prosperity, restoration, health, healing, etc.). Having the ability to draw the specific local species is essential to ground the recording in the level of detail to match the local knowledge, for example, knowledge holders appreciated the artist knowing how to draw the difference between various seabirds and their preferred prey or seasonal plumage.

3.8 | Step 8. Assemble and communicate elicited predictions and knowledge

Following the elicitation workshops, we assembled predictions from all knowledge holders for each species, under the current state and each development scenario. We asked knowledge holders to identify their spatial area of expertise as either region wide or Nation territory specific and we aggregated responses based on that self-identified spatial expertise. When aggregating responses, we did not differentiate between the predictions of Indigenous and western science knowledge holders. We used summary statistics from the aggregated predictions to characterize how species health might change, in both absolute and relative predictions, as cumulative effects change into the future of the region.

Results from this process feed into a Bayesian Network model that provides probabilistic predictions of focal species health under each development scenario across the study region (e.g. Mantyka-Pringle et al., 2017). Conceptual models of connections between threats and species were used to populate the Bayesian network (see Stage 4 above). Elicited information on species persistence given various levels of human activity across the landscape were used as inputs into 'conditional probability tables'. The Bayesian Network has input nodes for pressures or human activities (e.g. 'short-term logging disturbance'), which drive the state of intermediate nodes (e.g. the intensity of forestry activity in a given area) which subsequently affect species health based on the elicited probability table generated from our elicitation process. The scenarios we elicited here allowed us minimize the number of questions asked of experts, and then interpolate a comprehensive suite of conditional probabilities of various land-use scenarios in the region (e.g. Cain, 2001; Mantyka-Pringle et al., 2016). The results from Bayesian Network modelling process are the focus of a forthcoming paper (Adams, Tulloch et al Unpublished data).

4 | CAVEATS AND CONCLUSIONS

Future land and marine use planning will require solutions for managing cumulative pressures, while still ensuring the social, cultural and ecological well-being of the socio-ecological systems in a region's lands and waters. Processes to assess, predict and inform the management of cumulative pressures, such as CEAs, must be accessible to knowledge holders and decision-makers alike if they are to be effective. In many cases, Indigenous Nations and practitioners are leading the way in developing such processes (e.g. Gitanyow Hereditary Chiefs, 2020; Metlakatla Stewardship Society, 2019). Moving forward, CEAs and other environmental planning processes must be grounded in regional values, inclusive of Indigenous and local knowledge, and ultimately acknowledge and uphold Indigenous sovereignty (Clogg et al., 2017; Yahey v. British Columbia, 2021).

Given past and present limitations of other CEA processes, whereby the inclusion of Indigenous knowledge holders and recognition of Indigenous sovereignty has been ineffective, we prioritized our efforts here with Indigenous Nations as our priority collaborators and recipients of our assessment findings. Predictions and knowledge shared with our team allowed us to learn about the current population health for each focal species, as well as how experts predicted health would change under the alternative development scenarios. These predictions may be used by the Nations to support their decision-making processes about future land and marine use. This work can also be provided by the Nations to the federal Impact Assessment Agency for consideration during any future impact assessment of any designated projects within the region that intersect with the species or industries considered herein (Canada, 2019).

While we cannot yet speak to the utility of our CEA outputs (the process is only just complete), we felt it was important and timely to share our process as an example of an inclusive CEA. While there is growing interest in federal Regional Assessments, there is also growing scrutiny around how Indigenous sovereignty and knowledge are recognized in these processes (Anselmi, 2022; Scott, 2022). While our objective with this particular project was to centre Indigenous inclusion, we note that by doing so, we also addressed previously identified shortcomings in CEA, including the need for a regional spatial scope, conducting a process proactively and within the scope of regional land and marine use planning (as opposed to reactively, during proposed developments by project proponents), and the application of plausible and relevant scenarios for forecasting of future cumulative effects (Clogg et al., 2017; Connelly, 2011; Duinker et al., 2013; Duinker & Greig, 2006, 2007). We note our approach here is limited by our scope on species or groups of species as VECs. It was beyond our scope of this study to assess impacts of cumulative effects on other valued components, such as ecosystem services or social, cultural or economic components (e.g. Metlakatla Stewardship Society, 2019; Singh, Eddy, et al., 2020).

Colonization is deeply interwoven with the western-science paradigm that informs the CEA process in Canada, a paradigm that typically refuses to acknowledge the authority, knowledge and (at times) humanity of Indigenous peoples in more than tokenized ways. Great harm has come to Indigenous Peoples at the hands of western government and science alike (National Centre for Truth and Reconciliation, 2015; National Inquiry into Missing

and Murdered Indigenous Women and Girls (Canada) et al., 2019). Harm continues to be done through degradation of ecosystem health which, in turn, impacts the well-being of Indigenous Peoples who continue to occupy and govern their lands and waters (e.g. see Figure 5: 'colonial governments driving a wedge between Nations' as it relates to impacts of old growth logging). Through our approach, we tried to avoid causing further harm by pushing back against research norms often found in settler-led research (Trisos et al., 2021; Wong et al., 2020). We continually asked each other, '*what does it mean to bring a practice of decolonizing into this CEA?*', which motivated the Nation-led pace of our process, our use of user-centred graphic design, and trauma-informed workshop planning. We centred the Nations' management priorities and managed the project to the timing and needs of their governments and communities. We approached our engagement with Indigenous knowledge holders grounded in values of respect, inclusion and reciprocity. For these reasons, our approach could tentatively be called 'decolonizing', although this word is used in so many different ways that it is hardly definitive (and sometimes problematic) (Tuck & Yang, 2012).

We want to reflect on how financial capacity and previously held relationships enabled this work to take place. Our research budget was well supported (i.e. ~200 K CAD a year, Supporting Information) and having secure funding for 3 years meant we could work over longer than normative academic timeframes and move at a pace appropriate for each Nation during the COVID-19 pandemic (see Supporting Information). We budgeted substantial funds for community meetings, which was re-allocated to support training, trauma-informed facilitation, artists, and gifts when the pandemic forced travel restrictions. While these expenses may not be considered typical in Western-driven research or assessment processes, we found that they may have improved the experience for participants and ultimately helped to create a better regional CEA (Sanderson et al., 2022; Trisos et al., 2021).

Our research team had over three decades of combined experience and relationships with the lands, waters and communities in the Central Coast region of British Columbia. Previous environmental planning processes imposed by Crown governments had resulted in conflict-ridden experiences and negative consequences for local communities. Because of our collective experience and trust with people and Indigenous Nations in the region, we propose our relationships contributed to the success of the scoping and knowledge holder engagement phase of this project, and we question whether the approach we followed would have worked as well in the absence of these long-standing relationships and connections. Researchers should consider that just as CEAs work better without the pressure of a looming development project, relationship building and project collaboration feels more genuine and reciprocal without the pressure of a looming research project, budget or publishing deadline. Without a relational underpinning and its associated accountability, research or CEA practitioners run the risk of doing harm, namely being just another process experienced as extractive or tokenizing by Nations and their knowledge holders.

There is much more work to do to build practices of anti-white supremacy and decolonizing frameworks into our research practice, our professional work and our relationships. The process described here is not a recipe for 'decolonized CEAs' nor does it proport to contribute to reconciliation in the Canadian context of Indigenous Nations and their relationships to colonial governments. That is not for us to say. We are committed to an ongoing, step-by-step, day-by-day harm-reducing version of our practice. As Canada claims to pursue a path of reconciliation, the need for researchers, Crown decision-makers and citizens to uphold Indigenous rights moves beyond an ethical imperative into a legal one. Legislation has now been passed at provincial and federal levels requiring alignment of colonial law with the articles of the United Nations Declaration on the Rights of Indigenous Peoples (*United Nations Declaration on the Rights of Indigenous Peoples-DRIPA/Bill C-41 and Bill C-15*, 2007). The implications of these laws are far-reaching and compel us all towards better respect for and inclusion of Indigenous Peoples.

> …at some point a line has to be drawn… It is a collision between constitutionally-protected rights under treaties and an attitude by the provincial government that it is allowed to take away rights on an incremental basis over time with no consequence.
>
> Chris Tollefson, West Coast Environment Law (Brend, 2017)

The assessment of cumulative effects is only made possible by the decision-makers who oversee the stewardship of lands and waters. While it is clear that regional and inclusive CEAs can contribute to building relevant stewardship tools, none of this will matter unless there is respect for the decision-making authority of Indigenous Nations. We note there are many existing models and examples where co-governance of Indigenous and colonial governments is occurring (Clogg et al., 2017). Indigenous Nations are the stewards of their territories and unless colonial government agencies begin to not only engage but also recognize Indigenous Nations as decision-makers, we predict continued conflict over how to conduct and apply CEAs in Canada, with the ultimate consequence of continued degradation of ecological and biocultural diversity.

AUTHOR CONTRIBUTIONS

Megan Adams conceived the ideas, designed and implemented the research, contributed to the data analysis, and was the primary author of the manuscript. Vivitskaia Tulloch contributed to the ideas and design of the research, led data analysis, and provided revisions to the manuscript. Jessie Hemphill contributed to the design of the research, provided crucial expertise developing elicitation materials, and provided revisions to the manuscript. Briony Penn contributed to the design of the research, provided all the artwork for the elicitation materials, built figures for the manuscript, and provided revisions to the manuscript. Leya Anderson contributed to the design of the research, provided crucial design and editing components

to all the elicitation and reporting materials, built figures for the manuscript, and provided revisions to the manuscript. Katie Davis contributed to the design of the research, provided crucial expertise developing elicitation materials and provided revisions to the manuscript. Stephanie Avery-Gomm contributed to the ideas and initial design of the research, facilitated access to funding, and provided revisions to the manuscript. Alex Harris contributed to the ideas and design of the research, provided crucial support in the conception and crafting of videos to support expert elicitation and engagement, and provided revisions to the manuscript. Tara Martin contributed to the ideas and design of the research, provided revisions to the manuscript, and was the Principal Investigator.

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CONFLICT OF INTEREST STATEMENT

We have no competing conflict of interest.

DATA AVAILABILITY STATEMENT

Specific data compiled from Indigenous knowledge holders are the property of collaborating Nations and will not be made available for public distribution. Generalized summary statistics for the entire region will be available by request (to the corresponding author) and with permission of relevant parties. We refer interested parties to our Figshare Repository or our Supplementary Information to access workshop materials, including elicitation booklets and instructional videos: figshare.com/articles/media/Central_Coast_Cumulative_Effects_Project_-_Elicitation_Workshop_Materials/21909441

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

Supporting Information 1. Budget Categories for Developing Materials and Facilitating Workshops.

Supporting Information 2. Adapting to Pandemic Challenges.

Supporting Information 3. Video Communications.

Supporting Information 4. Workshop Materials.

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