Manuscript title: Selecting indicators to track progress towards the Global Biodiversity Framework: A case study of Quebec's 2030 Nature Plan

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Abstract

Selecting biodiversity indicators to report national and subnational progress towards the Kunming-Montreal Global Biodiversity Framework (GBF) is a major challenge, one made even more urgent by the fast-approaching 2030 targets. To efficiently identify appropriate indicators, the selection process must be streamlined, while remaining transparent, effective, and with the active engagement of stakeholders from the academic, public, and private sectors. We present guidelines for the selection of biodiversity indicators to track progress towards 2030 targets in the context of the GBF, with a case study of the province-level indicator recommendation process for Quebec's 2030 Nature Plan. We outline six steps to develop a shortlist of indicators that are relevant to targets, fulfill minimum criteria of scientific quality given the province's available biodiversity data, and practical to inform decisions and on-the-ground conservation actions. We present the rationale and outcomes of this selection process, culminating in the 15 biodiversity indicators that we recommended for Quebec's 2030 Nature Plan. Going forward, we recommend continuing to build trust across sectors, developing communication guidelines to standardize indicator reporting, and testing indicator performance at national and subnational scales. Overall, this case study demonstrates that with active engagement and cooperation, we can rapidly rise to the challenge of identifying the indicators we need to track and report biodiversity change.

Introduction

Adopted by 196 countries, the Kunming-Montreal Global Biodiversity Framework (GBF) sets 23 global biodiversity targets for 2030 to progress towards four long-term goals by 2050 (CBD, 2022b). All parties must develop their strategies to meet the GBF targets, which includes implementing the Monitoring Framework of the GBF (CBD 2022a; Affinito et al. 2024). At the heart of the GBF is a biodiversity monitoring framework that relies on indicators (CBD, 2022a), which are measures of change in the state of biodiversity through time to track progress towards targets (Jones et al. 2011). A national or subnational Monitoring Framework requires the selection and reporting of a suite of biodiversity indicators that can be selected from 36 headline indicators, 71 component indicators, 266 complementary indicators, 15 binary indicators, and national indicators (Affinito et al. 2024). Many governments are now facing the challenge of quickly sorting through this extensive list to report indicators that are well-suited to their ecological and socioeconomic priorities and tailored to the available data from their own monitoring schemes, while remaining linked to global biodiversity assessments.

This challenge is particularly complex due to the urgency of choosing a shortlist of indicators within the tight timeframe set by the GBF's 2030 targets. Selecting indicators at this fast pace is particularly difficult given our uncertainty about their sensitivity at national and subnational scales, as biodiversity changes like species losses may be less perceptible at these scales. Beyond this, many proposed indicators lack the methodological detail needed to understand how their aggregation will permit an assessment of global progress. Moreover, it is still unclear how some indicators can be disaggregated to reveal progress at subnational scales accurately, given the limitations of data availability and resolution at subnational scales. Despite this lack of information, the fast-approaching 2030 deadline imposes streamlining of the

indicator selection process so that monitoring can be developed, implemented, and operationalized as quickly as possible.

To efficiently monitor biodiversity and inform policies and decisions, we need a cohesive set of indicators that are collectively informative (Noss, 1990; Sparks et al., 2011). Biodiversity change is multidimensional and scale dependent (Chase et al., 2018) and therefore must be monitored with a suite of indicators that cover multiple dimensions of biodiversity and different spatial scales (Perino et al., 2022). It is critical to assemble a balanced set of indicators that measure different aspects of biodiversity change, as well as the pressures driving these changes, nature's contributions to people, and the policy actions that are intended to halt or reverse these changes (Butchart et al., 2010; Sparks et al., 2011; Burgess et al., 2024). Taken together, a set of indicators should be composed of distinct metrics which are as independent as possible, to capture these multiple measures of progress with minimal redundancy (Martínez-Jauregui, Touza, White, & Soliño, 2021; Stevenson et al., 2024). The indicator suite must also address each target directly. While covering different measures of progress towards biodiversity targets, the indicator suite must also be parsimonious to remain cost-effective while still remaining informative (Rice & Rochet, 2005; Leung & Gonzalez 2024), particularly in contexts where data and resource constraints may be restricting (Bhatt et al., 2020).

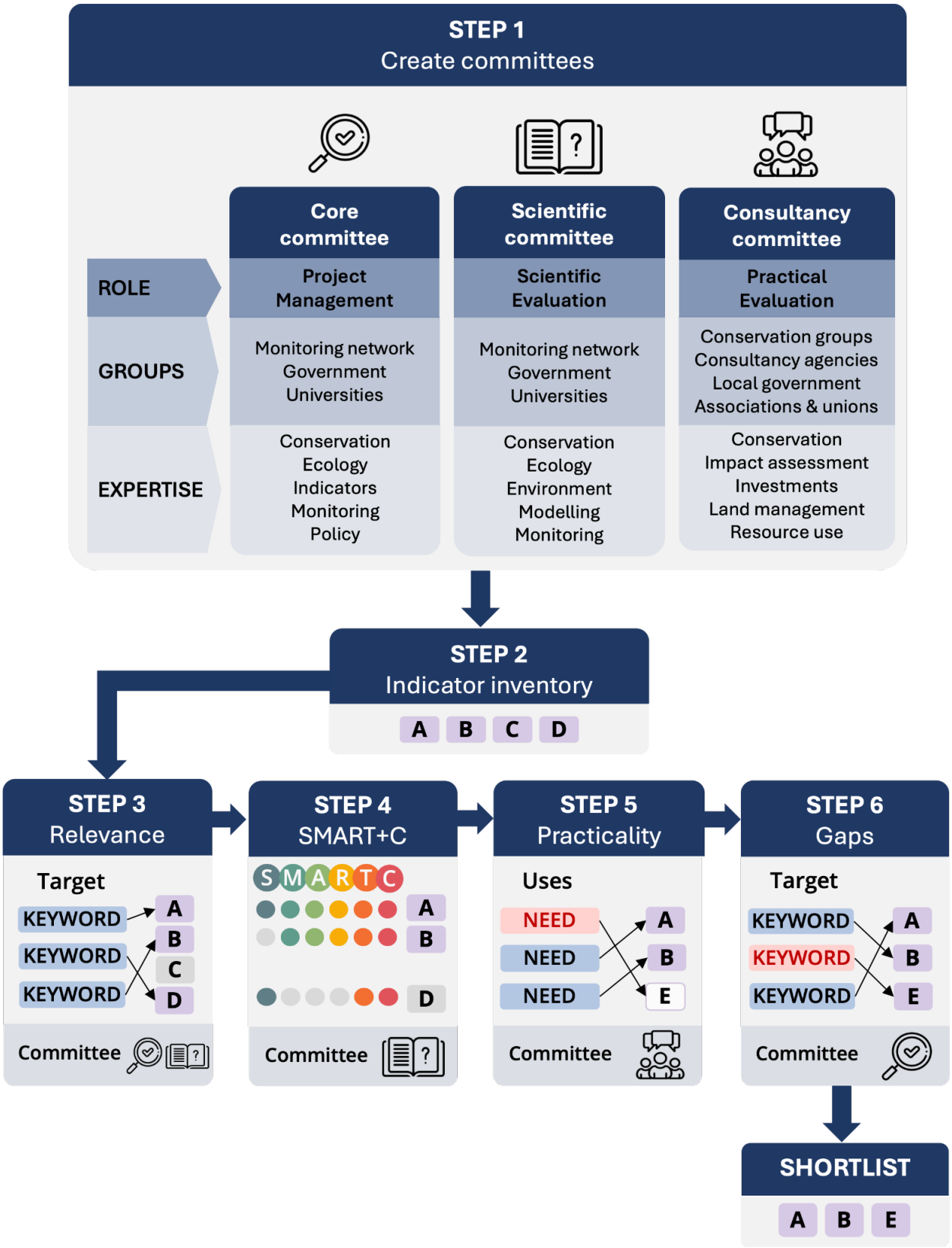
Each indicator must also be able to detect changes in the targeted variable (Noss, 1990; Heink & Kowarik, 2010). This criterion is critical, though it is often the most difficult to assess given the lack of performance testing for most metrics (Heink & Kowarik, 2010; Nicholson et al., 2021; Watermeyer et al., 2021). Given the urgency set by the GBF's 2030 deadline, it may sometimes be necessary to choose indicators based only on their known properties from the literature, without a full assessment of their power to detect trends. The selection process must

therefore include careful considerations about the minimum acceptable level of uncertainty for each biodiversity indicator as a metric of target success, given the available knowledge about its statistical power (Leung & Gonzalez, 2024). However, in many cases, indicator performance requires much more clarification through formal evaluations of statistical power to detect trends under distinct scenarios of biodiversity change, particularly at national or subnational scales with specific data constraints (Hill et al., 2016; Bundy, Gomez, & Cook, 2019).

In addition to relevance and sensitivity, indicators can only be effective if they are practical for the people and organisations who influence biodiversity policy and conservation actions. Providing policy-relevant advice is the core function of biodiversity indicators in the context of the Global Biodiversity Framework (Hill et al. 2016). The first step towards achieving policy-relevance is to understand the links between the multiple levels of organisations and institutions that influence biodiversity (Berkes 2007), which is specific to the national or subnational context. From here, it is then necessary to determine which information is most important to support conservation planning and decision processes at different scales (Wyborn & Evans 2021), both in terms of time and scales of organisation (municipality, counties, provinces, etc.). The indicators must also summarise aspects of biodiversity change in a way that fulfills stakeholder needs at these scales, notably to provide practical information for planning projects and designing policies that make progress towards biodiversity goals. They must also be able to document the effectiveness of new policies and actions taken to protect biodiversity, to make sure this progress is reported. The practicality of indicators for local stakeholders is therefore key to their successful implementation in any biodiversity monitoring program.

Here, we present guidelines to select a shortlist of biodiversity indicators, developed through our experience of engagement and collaboration between the academic, public, and

private sectors to recommend a set of biodiversity indicators for the eight targets in Goals 1 and 2 of Quebec's 2030 Nature Plan (MELCCFP, 2024), which was developed in the context of the Global Biodiversity Framework (GBF). These two goals are: (1) "Protect and restore biodiversity to ensure ecosystem resilience", and (2) "Encourage sustainable practices that foster biodiversity and enhance access to nature" (MELCCFP, 2024). We outline guidelines and key considerations used to rapidly filter the extensive catalogue of GBF indicators into a shortlist of indicators to monitor progress toward subnational biodiversity goals. We demonstrate that, with clear selection criteria and collaboration across sectors, we can rapidly integrate political, socioeconomic, and ecological priorities into a selection of indicators that are best suited to monitor biodiversity for trend detection and decision support.



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116 **Figure 1.** A step-by-step guide to streamline the selection of a recommended shortlist of

indicators to track progress towards provincial targets set in the context of the Global Biodiversity Framework. (1) Experts from the public, academic, and private sectors are convened into the Core committee, Scientific committee, and Consultancy committee, which contribute to different steps of the indicator selection process. (2) Candidate indicators are inventoried from global, national, and provincial sources, and these are completed with the committee's suggestions. To extract a shortlist of recommended indicators from this inventory, (3) indicators are first filtered by matching them to keywords of biodiversity targets (for example, protected areas, non-native species, climate change, etc.). Indicators that are linked to at least one target keyword can then (4) be evaluated in terms of their desired properties, according to SMART+C (Specific, Measurable, Achievable, Relevant, Timely, Communicable) (Fig. 2) criteria developed in collaboration with all committees. Indicators with adequate scientific quality are (5) prioritised according to their practicality for biodiversity management, conservation action and decision-making, then (6) analysed for gaps to verify that all target keywords are measured with at least one indicator. Unmeasured target keywords should be flagged, and indicators should be proposed or developed to fill this gap whenever possible (for example, Indicator E in Fig. 1).

Selecting biodiversity indicators to track regional progress

Step 1: Bring people together for the selection process as early as possible

Biodiversity indicators can only be effective if they are trusted by stakeholders (Heink & Kowarik, 2010), so it is particularly important to proactively establish confidence in the indicator suite across the sectors of society that have an influence on biodiversity. Inviting stakeholders into the indicator selection process as early as possible helps to build trust in the chosen indicators, and importantly, ensures that they can be optimally tailored to the socioeconomic context that they are intended to influence (Perino et al., 2022). As early as possible, it is vital to identify opportunities for each sector to participate in the selection, reporting, and use indicators for decision-support and biodiversity monitoring. This participation can range from observing biodiversity, developing the computational analyses that generate the indicator, reporting the indicator and communicating biodiversity change to a broad audience, to implementing the use of indicators in decisions about land use planning, financial investments, the sustainable use and management of biodiversity, and more.

To recommend biodiversity indicators for Goals 1 and 2 of Quebec's 2030 Nature Plan, we formed a core committee from the Ministère de l'Environnement, de la Lutte contre les changements climatiques, de la Faune et des Parcs, Quebec Centre for Biodiversity Science, and Biodiversité Québec. We, the core committee, then invited 65 people from academic, public (government, non-governmental organisations), and private sectors with expertise ranging from ecoinformatics, biodiversity science, sustainable development and use of biodiversity (including agriculture, forestry, hunting, and fishing), conservation, governance, policy, industry (mining, electricity), finance, private consultancy, biodiversity monitoring, and more, to participate in the indicator selection process (Fig. 1). From this group, we designated a scientific committee whose

objective was to evaluate the scientific quality of indicators, and a consultancy committee, whose objective was to review the practicality of indicators for on-the-ground conservation actions, decision-support, project design and management, and communication (Fig. 1). Importantly, committee members were not required to have any previous experience with biodiversity indicators to participate in the selection process, and were invited according to various types of expertise in conservation, biodiversity monitoring, policy, resource use, and more (Fig. 1). For each step of this process, we provided information sheets about the indicators that were discussed, including the biodiversity target it was associated with, the indicator's definition, summarised methodology and data sources, an example of a visualisation and a quantitative result, and links to more detailed information such that everyone was familiar with the indicators discussed. The committees were invited to provide feedback throughout the indicator selection process in a series of steps described below.

Step 2: Inventory candidate indicators from regional, national, and international lists

The broadest list of candidate indicators should encompass the headline, component, complementary and binary biodiversity indicators that were adopted in the Kunming-Montreal Global Biodiversity Framework (CBD, 2022b; Affinito et al. 2024). This list can then be completed with indicators that are reported at national and subnational scales to ensure that pre-existing monitoring and reporting programs can be linked or adapted to global indicators. National indicators are more likely to influence national policies, but they are not always standardized to be comparable across nations (Bhatt et al., 2020). It is therefore critical to inventory indicators that are better customized to the national or subnational context, alongside globally standardized indicators that can be compared and combined to monitor global progress (Bhatt et al., 2020).

This first inventory of candidate indicators included all headline, component, and complementary indicators from the Global Biodiversity Framework (www.gbf-indicators.org) and GEO BON (2023), national indicators (Environment and Climate Change Canada 2023), and provincial indicators (Biodiversité Québec 2023, and Ministère de l'Environnement, de la Lutte contre les changements climatiques, de la Faune et des Parcs).

We then shared a survey to all committee members asking them to: (1) narrow the candidate list by ranking proposed indicators in order of relevance to Nature Plan targets, and (2) complement the inventory with relevant metrics and/or data sources that were not yet included, but that are already applied or being developed in Quebec. The survey's first purpose, which was to rank indicators in order of relevance to Nature Plan target, was effective to reduce the inventory to a maximum of five metrics per target, in part by removing redundant metrics. The survey was also efficient at completing this reduced inventory with suggested metrics specific to Quebec. The suggested indicators notably included metrics from provincial assessments of sustainable agriculture and forestry practices and threatened and vulnerable species classifications, which are not represented in the global or national inventory. Consulting the invited committee members for their knowledge of the data and indicators that are in place, or soon-to-be in place, is a critical step to maximise the breadth of the candidate list before filtering it in subsequent steps of the selection process.

Step 3: Which indicators are relevant for the targets?

Relevance to at least one target is critical to ensure that an indicator can track the desired progress towards biodiversity goals (Heink & Kowarik, 2010; Tittensor et al., 2014; Nicholson et al., 2021). As a first filter, we asked the scientific committee to match candidate indicators with

the keywords of each target from the Monitoring Framework. The committee was divided into groups that each evaluated three targets. For each target, we asked groups to identify the target's keywords and draw links between the keywords and relevant candidate indicators (Fig. 1).

The exercise of matching indicators to target keywords generated two insights: (1) some indicators could not be directly linked to the target's keywords, and were therefore not relevant to monitor progress, and (2) some target keywords were not directly addressed by any of the proposed indicators. Indicators that lacked a direct link to the target were removed from the candidate list of recommended indicators, regardless of their scientific quality or feasibility. When targets were not adequately addressed by any of the proposed indicators, we flagged the gaps that needed to be addressed with modifications to existing indicators or by the development of new indicators. Indicators which had a direct link to at least one target element were kept in the list of candidate indicators, to be evaluated in greater detail in the next steps (Fig. 3).

Step 4: How SMART+C is each indicator?

Evaluating indicators' properties is key to prioritising them and to support the decisions and actions that drive progress towards these targets (Collen & Nicholson, 2014; Watermeyer et al., 2021). To be effective, an indicator must simplify complex information into an impactful and reliable metric that directly relates to policy and to the ecological reality it represents (Burgass, Halpern, Nicholson, & Milner-Gulland, 2017; Gregory et al., 2005; Van Strien, Soldaat, & Gregory, 2012). Indicators are expected to be regularly updated, sensitive to change while remaining robust to natural fluctuations, based on available data that is also of adequate resolution and quality, and possible to disaggregate at multiple scales of political and/or ecological organisation (Gregory et al., 2005; Nicholson et al., 2021; Van Strien et al., 2012). An

index should also perform as expected, meaning the index should show the correct magnitude and direction of change and should remain stable if there is no change (Van Strien et al., 2012; Watermeyer et al., 2021). In addition to these numerous criteria, it is important that the indicator is easy to interpret to correctly inform decisions and communication (Fischhoff & Davis, 2014; Puurtinen, Elo, & Kotiaho, 2022).

We collaborated with the consultancy committee to adapt the SMART (Specific, Measurable, Achievable, Relevant, Timely) criteria that were used to set the GBF targets (CBD, 2019; Hughes & Grumbine, 2023) to evaluate each proposed indicator in terms of some agreed-upon desirable properties (Fig. 2, Supplementary Information S1 Table S2). We expanded the SMART criteria to include a "Communicable" criterion (Specific, Measurable, Achievable, Relevant, Timely, and Communicable), as communication to relevant audiences is key to ensure that indicators can inform the management and conservation of biodiversity and the public's understanding of biodiversity change (Mace & Baillie, 2007). Each SMART+C criterion was evaluated using a series of Yes/No questions, which were reviewed in collaboration with the stakeholders to ensure the questions were complete, clearly worded, and relevant to assess the criteria. A point system was assigned to each question so that each SMART+C criterion had a weight of five points, for a total of 30 points per indicator. The resulting evaluation grid (Supplementary Information S2) could then be applied to the indicators that were the most relevant for Goals 1 and 2 of Quebec's 2030 Nature Plan targets to provide a standardized assessment of each indicator's properties.

This collaborative scientific evaluation led to several insights that were helpful to refine the candidate list. First, the scientific committee generally preferred indicators that required minimal processing of the raw data and the final indicator and assigned low measurability and

communicability scores to those built on multiple data processing or modelling pipelines, particularly when these pipelines were poorly documented. Model-based indicators from the Global Biodiversity Framework were often scored poorly, in part because they required more data processing, and were therefore more disconnected from the raw data than other relevant indicators. In some cases, their methodology was more complex while also poorly documented, and usually not yet demonstrated at a subnational scale. As such, model-based indicators were less trusted by some members of the scientific committee, who preferred a minimal processing of raw data towards the final indicator. Second, composite indicators that condense multiple metrics into a single number, such as the Agrobiodiversity Index, were also evaluated poorly in measurability and communicability, namely because it is difficult to separate the causes of changes in these indicators. Going forward, metrics with fewer data inputs were prioritised to ensure they could be interpreted and communicated transparently. Overall, the scientific committee prioritised indicators that were closer to the data. The SMART+C grids were instrumental to these insights, as they apply a standard set of evaluation criteria that can then highlight common desirable and undesirable properties across indicators.

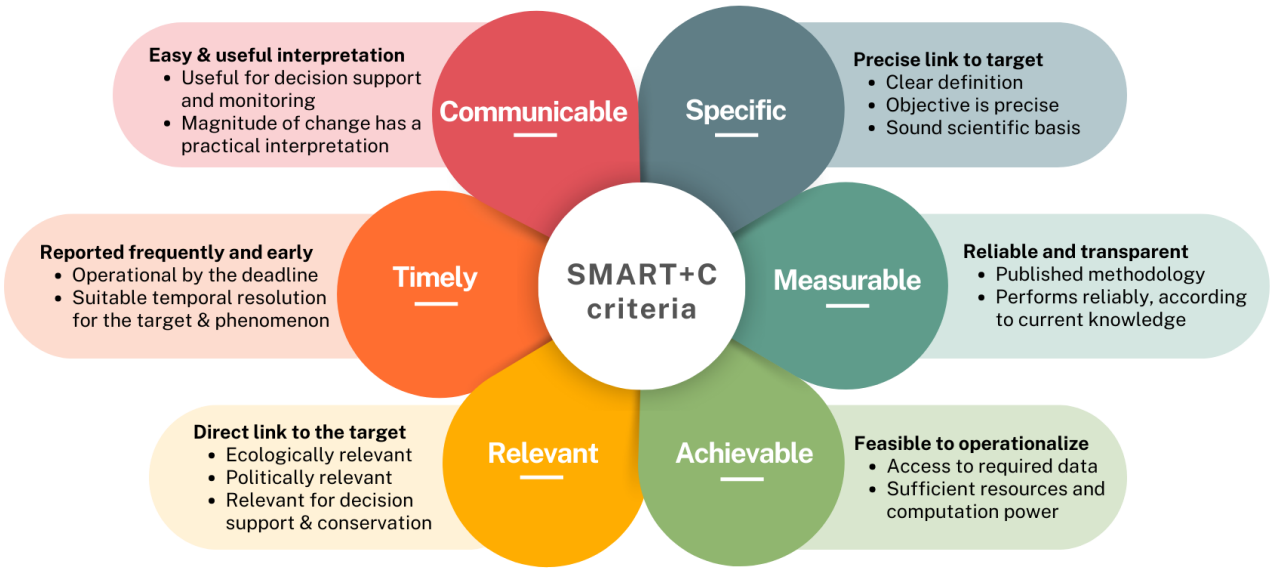

Figure 2. The SMART+C (Specific, Measurable, Achievable, Relevant, Timely, and Communicable) criteria to assess the scientific quality of each indicator. These criteria were used to build a rubric of Yes/No questions that was applied to evaluate the properties of indicators that were proposed to assess progress towards biodiversity targets (Supplementary Information S2).

Step 5: Which indicators are practical for decision support and conservation action?

Indicators must be practical for the people who make the decisions and who engage in the conservation measures that contribute to meeting biodiversity targets (Hill et al., 2016). To ensure that the selected indicators were practical and functional for their potential users, the consultancy committee was asked to identify specific needs in terms of metrics, graphics, and other tools that they require for monitoring and decision support in the context of Quebec's biodiversity strategy (Fig. 1). The consultancy committee divided into groups to propose several use cases in which they would need to monitor biodiversity in the context of a 2030 Nature Plan

target of their choice. The committee groups then designed a series of example "report cards" to evaluate biodiversity in the context of their use cases (Supplementary Information S3), which listed their information needs, some examples of practical graphics and summary statistics, and a wish-list of additional information that would be helpful though not essential.

The consultancy committee proposed a wide range of actions to make progress towards Quebec's 2030 Nature Plan targets, including restoration projects in degraded ecosystems, management of species with detrimental impacts on local ecosystems (such as overgrazers and invasive species), sustainable management and use of biodiversity (forestry, fisheries, harvesting of non-timber forest products), and improvements to connectivity and protection of natural habitats from municipal to regional scales, including within urban areas. To inform these actions, the consultancy committee requested maps and metrics to track sustainable management practices and land use planning (area of private forests with sustainable management plans, area under municipal zoning that is favourable to biodiversity, connectivity in urbanized areas), actions (proportion of degraded ecosystem area under restoration, investment in restoration projects), and the ecological outcomes of these actions (species abundance trends, number of species introduction events, changes in ecosystem integrity after restoration and conservation actions, carbon stocks, forest structure). A common thread in these requests was the need for monitoring at more practical scales, including municipalities, to update indicators and guide local biodiversity management and planning.

This exercise was critical to engage the active participation of stakeholders to prioritise indicators that directly addressed their needs, and importantly, to recommend highly practical metrics that may be lower priority according to other criteria (Fig. 1). Though this process was not intended to systematically accept or reject indicators, the consultation provided many

insights about the applicability of indicators for decision support or to inform conservation action. First, stakeholders identified specific data, summary statistics, and graphics that they depend on or lack, to select indicators that directly support and facilitate on-the-ground projects and decisions. Second, and most importantly, this consultation revealed the perception of certain indicators across stakeholders, including a distrust in indicators derived from global-scale models. It was therefore possible to highlight indicators that are already trusted by many stakeholders, and to flag indicators that are poorly trusted and therefore likely to be challenging to implement successfully in some sectors.

Step 6: Assess and address gaps and redundancies

To ensure that each target was covered by at least one indicator (Bundy et al., 2019), the core committee then revised the shortlist of indicators on a target-by-target basis. In some cases, this final screening revealed gaps in the coverage of certain targets by the proposed indicators, which we flagged as avenues for the modification of existing indicators to better suit the target's aims or for future indicator development (Fig. 1). For example, we identified a gap in the proposed set of indicators, which was a lack of sensitivity to the effects of climate change on species abundances and distributions. As Quebec's biodiversity is expected to undergo drastic changes in composition and structure as the climate warms (Berteaux et al., 2018), we recommended indicators that could be modified or developed to directly address this gap (e.g. an indicator of changing species distributions). As part of this final screening, the core committee also prioritised indicators that could apply to several targets when appropriate, to optimise monitoring, computation pipelines, and reporting. For example, a species abundance trend indicator like the Living Planet Index can be reported for specific sets of species that are

sensitive to certain pressures identified in different targets, such as agriculture, forestry, or aquaculture, while using the same calculation pipeline and reporting standards.

The shortlist of recommended biodiversity indicators for Quebec's 2030 Nature Plan

As a result of the indicator selection process, we recommended a shortlist of 15 indicators to monitor progress towards the targets in Goals 1 and 2 of Quebec's 2030 Nature Plan (Table 1). Of these 15 indicators, eight were sourced from the Global Biodiversity Framework (four headline, three component, and one complementary), three were existing provincial indicators, and three were suggested by the committee during the indicator selection process. In addition, 10 of the 15 recommended indicators (starred in Table 1) were mentioned by the consultancy committee as practical metrics for decision support and conservation actions. Almost half of these indicators were recommended to be modified for Quebec, mostly to tailor the indicators to the available monitoring network and Nature Plan targets. In some cases, none of the available indicators in the candidate inventory were appropriate, leading the committee to suggest alternative indicators throughout the process. Most notably, three indicators were suggested for Target 7 of Quebec's 2030 Nature Plan, which is: "Maintain the sustainability of forest practices, in particular through sustainable resource use and the maintenance of ecosystem services for the benefit of everyone, including the Indigenous and local communities" (MELCCFP 2024). To monitor forest practices in Quebec, it was necessary to suggest more specific metrics because forests are managed both publicly and privately by provincial laws, programs, and permits in Quebec, which requires indicators that are specific enough to be relevant and practical for provincial forestry practices.

Filtering indicators by their relevance to target keywords was an important first step to effectively reduce the pool of candidate indicators (Fig. 3). After this step, the list of 167

candidate indicators dropped to 45, and this list was further reduced to 15 indicators through the scientific evaluation of indicators with the SMART+C criteria (Fig. 3). After this step, some indicators that had been previously rejected were brought back into the candidate pool because they were practical according to the consultancy committee, and to fill gaps in the shortlist's coverage of the Nature Plan targets (Fig. 3). In some cases, these gaps could only be addressed with the development of new indicators or the development of more precise definition and methodologies for pre-existing indicators. The indicators recommended for development included changes in species distributions, cumulative pressures on ecosystems, nature's contributions to people, ecosystem integrity, and restoration.

Table 1: Recommended shortlist of biodiversity indicators for Goals 1 and 2 of Quebec's 2030 Nature Plan. Each indicator is associated with one or more 2030 Nature Plan goals and targets (listed in Supplementary material S1 Table S1). The selection, scientific, and consultation committee suggested modifications to some indicators to tailor them more closely to Quebec's ecological, scientific, and cultural context. The indicators sources include the Global Biodiversity Framework indicators (Headline, Component, and Complementary), national and provincial indicators from Environment and Climate Change Canada (ECCC), Ministère de l'Environnement, de la Lutte contre les changements climatiques, de la Faune et des Parcs (MELCCFP), Ministère de l'Agriculture, des Pêcheries et de l'Alimentation du Québec (MAPAQ), and Biodiversité Québec (BDQC), and suggested indicators from the committee members' expertises to address gaps in the candidate indicator inventory. Stars indicate that the consultancy committee specifically mentioned the indicator as a practical metric for on-the-ground conservation applications, project development, decision-support, and monitoring.

Goal and Target	Indicator	Proposed modifications to the original indicator for Quebec's 2030 Nature Plan	Source
1.1	Land-use change*		National
1.1	Species Habitat Index (SHI)	Projections under climate change scenarios	Complementary
1.2	Area under restoration*	Proportion of priority degraded ecosystems under restoration	Headline
1.3	Coverage of protected areas and OECMS	Coverage of Key Biodiversity Areas by protected areas and OECMS Connectivity of protected areas and OECMS	Headline, Provincial
1.4	Species Protection Index (SPI)	SPI of threatened and vulnerable species in Quebec	Component
1.4	Red List Index	Changes in the threat level of threatened and vulnerable species in Quebec (Rang de	Headline

		précarité S)	
1.5	Number of invasive alien species introduction events*		Component
1.5	Rate of invasive alien species spread*		Component
1.1, 2.6, 2.7, 2.8	Living Planet Index* (LPI)	1.1 All available species 2.6 Species in agricultural habitats 2.7 Species in forest habitats 2.8 Species of cultural interest	Component
2.6	Water quality in agricultural habitats*		Provincial
2.6	Proportion of agricultural habitats managed to be favorable to biodiversity*		Provincial
2.7	Forest age structure*		Suggested
2.7	Forest carbon stocks*		Suggested
2.7	Density of roads in forest habitats		Suggested
2.8	Proportion of fisheries exploited within biologically sustainable levels*	Apply to exploited species' populations (not just fisheries).	Headline

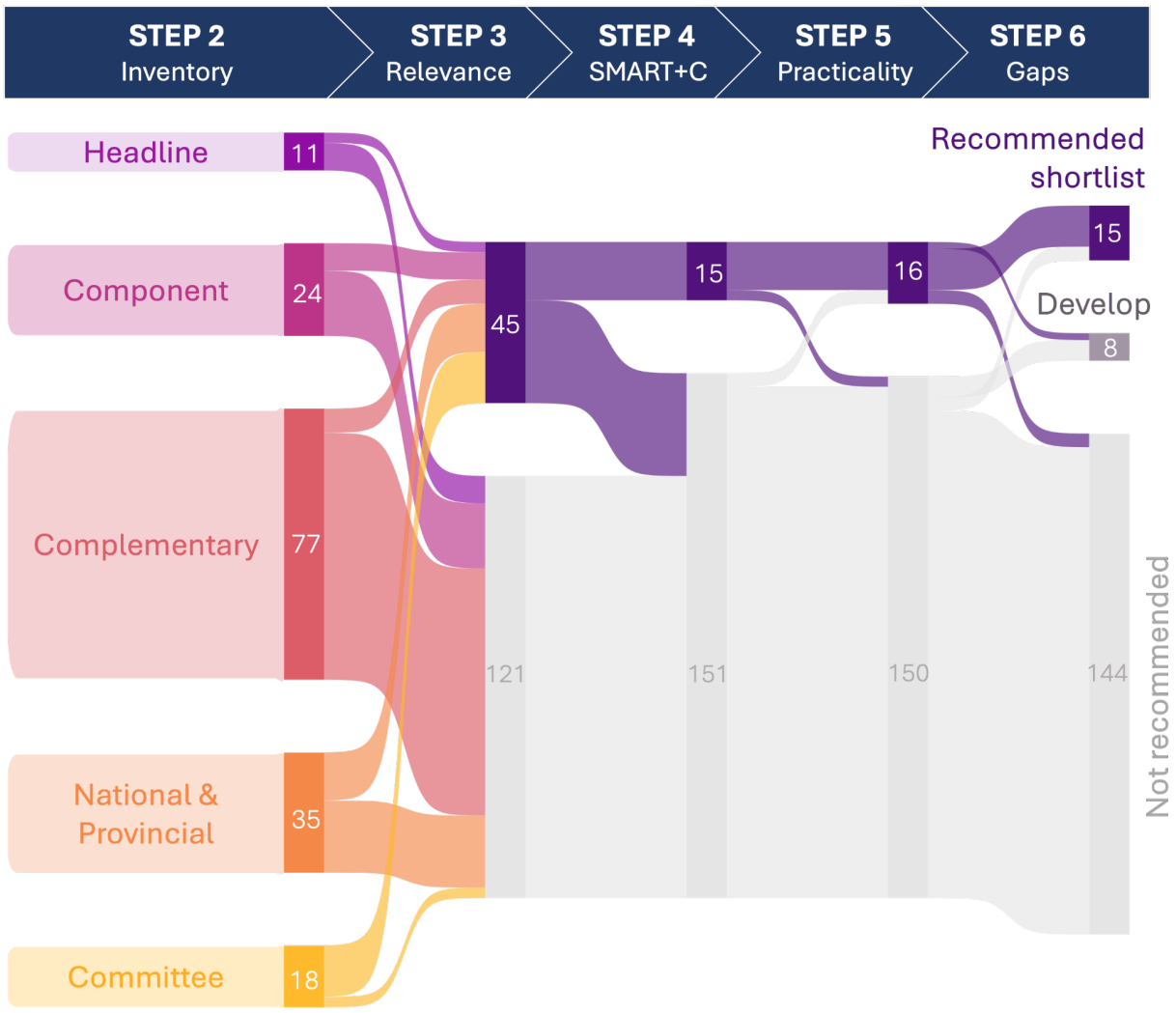

Figure 3. Steps for creating a short-list of recommended indicators. Step 1 of this process (not pictured here) is to bring people together to form the core, scientific, and consultancy committees. Step 2 is to build the inventory of candidate indicators from the Global Biodiversity Framework (Headline, Component, Complementary), national and provincial sources, and committee suggestions. These candidates are filtered by relevance (Step 3), scientific quality (Step 4) (SMART+C, Fig. 2), practicality for decisions and actions (Step 5), and this filtered list was then revised by the core committee to address gaps (Step 6). Numbers show how many indicators are in each group at the end of each step, resulting in three final groups: (1)

Recommended shortlist of 15 indicators for Goals 1 and 2 of Quebec's 2030 Nature Plan, (2) a list of eight indicators to be developed on the longer term, including indicators whose methodologies or data sources will not be ready before 2030, and (3) 144 indicators that are not recommended. All steps are illustrated in Figure 1.

Discussion

Choosing indicators that are harmonized with the Global Biodiversity Framework but tailored to national and subnational priorities is a challenge for governments worldwide. The expansive catalogue of biodiversity indicators for the GBF, along with the fast-approaching 2030 deadline, makes this task particularly complex and urgent. Here, we designed and executed a selection process to choose a set of biodiversity indicators from global, national, and subnational sources to monitor progress towards provincial targets. We found that prioritising indicators that are directly relevant to the targets, of adequate scientific quality, and practical for decision support and conservation action is key to build a shortlist of indicators that can evaluate progress towards biodiversity targets to support decision-making and conservation actions.

The steps of the selection process described here (Fig. 1) are not necessarily sequential. Rather, it is crucial that each step of the selection process can potentially add or remove indicators from the candidate list, because it is rare that an indicator will perfectly fulfill relevance, quality, and practicality requirements. In other words, the order of the steps is less important than ensuring that all steps are carried out: the consultancy committee can highlight their needs first, and the scientific committee can evaluate the scientific quality of the indicators later, and this would still result in a set of indicators that is as relevant, scientifically sound, and practical as possible. Below, we outline some recommendations to execute a similar indicator

selection process, and importantly, to build on the experience described here to improve these processes going forward.

Recommendation: Build trust through active participation and engagement across sectors

Trust in the biodiversity monitoring framework is critical to secure its influence on the decisions, actions, and policies that will lead local, subnational, national, and global progress towards the 2030 biodiversity targets. This trust should be built as early as possible, namely through the involvement of the private, public, and academic sectors in the indicator selection process, and should continue with a transparent pipeline for the preparation and reporting of the indicators (Perino et al., 2022). To achieve collaborations across sectors, some additional preparation is needed to ensure that people with different expertise have access to the same minimum information. For example, it is important to meet with the committee members as early as possible to present the biodiversity monitoring framework, the purpose of biodiversity indicators, their role in the selection process, the definitions and methodologies of each indicator, and more, to provide standard information regardless of members' expertise. With this preparation, the resulting collaboration ensures that multiple sectors shape the indicator selection process, to identify the indicators that can most effectively guide the conservation, sustainable use, and management of biodiversity.

However, trust takes time to build, and the indicator selection process presented here was designed and performed within only six months. This short time frame is not unusual given the urgency of the Global Biodiversity Framework's 2030 biodiversity targets, which leaves little time to build relationships and trust through the indicator selection process alone. To ensure that the Global Biodiversity Framework is implemented with the active participation of many stakeholders, it is ultimately most important to build partnerships prior to the indicator selection

process. Existing relationships are central to implement the Global Biodiversity Framework at national and subnational scales, and it is important to continue building on both existing and new relationships across sectors. Specifically, Indigenous expertise and leadership is crucial to protect and manage biodiversity in Quebec, and relationships must be strengthened to incorporate indigenous perspectives more effectively into the biodiversity monitoring framework and its implementation. Initiatives like the "First Nations Actions and Indicators" report (FNQLSDI 2024), which outline actions and indicators that are aligned with First Nations' needs and ambition for biodiversity conservation on their territories, must be actively incorporated into the implementation of the 2030 Nature Plan in Quebec going forward.

Recommendation: Design a communication guide for indicators and their interpretation

To successfully implement the indicator suite, communication guidelines should be developed to interpret indicator outcomes explicitly in terms of past and potential progress towards targets (Tittensor et al., 2014; McQuatters-Gollop et al., 2019). Though an indicator's methodology does not need to be understood in full detail to successfully communicate a trend, the indicator's outcome should be easily interpretable in terms of its implications for biodiversity monitoring and decision-support (Jones et al., 2011). First, the consultancy committee frequently requested training, financial support, and guidelines about how to implement projects aimed at making progress towards the provincial biodiversity targets. The selected biodiversity indicators must be linked to these practical recommendations as a tool to guide project design and to detect and attribute the contributions of these projects towards biodiversity targets. Second, uncertainty must be communicated appropriately to give an appropriate weight to the indicator for decision support (Fischhoff & Davis, 2014), which requires careful consideration about how to assess and communicate decision-relevant uncertainties in an accurate and accessible way (Rowland et al.

2021). This could be achieved by developing guidelines for translating quantitative measures of uncertainty into statements that relate to decision outcomes (McQuatters-Gollop et al., 2019), like the guide used by the Intergovernmental Panel on Climate Change (Mastrandrea et al., 2010), to ensure that communication remains consistent across indicators.

Recommendation: Test indicator performance at national and subnational scales

Assembling a suite of indicators is particularly challenging when we lack information about indicators' ability to detect trends, which varies according to data availability and quality. Assessing the performance of the selected indicators as metrics of biodiversity change is an essential task (Collen & Nicholson, 2014), which should be done prior to the selection process whenever possible (Santini et al., 2017; Watermeyer et al., 2021).

As biodiversity data are potentially biased in numerous ways (Bowler et al., 2024), it is critical to assess how well each selected indicator detects biodiversity trends given the available data and how these data are processed to generate the indicator (Johnson et al., 2024; Leung & Gonzalez, 2024). To achieve this, indicators should be systematically tested to determine their sensitivity to the modelled impacts of policy changes in a system (Costelloe et al., 2016; Nicholson et al., 2012, 2019). Additionally, the effects of the taxonomic and geographic biases in biodiversity data on the selected indicators should be evaluated, given that these biases vary nationally and subnationally (Oliver, Meyer, Ranipeta, Winner, & Jetz, 2021). The process of calculating an indicator necessarily involves many sources of uncertainty that can alter the indicator's outcome (Toszogyova, Smyčka, & Storch, 2024), which is important to consider when indicators inform decisions (Rowland, Bland, James, & Nicholson, 2021). At a minimum, an indicator's uncertainty and biases should be acknowledged, represented, and corrected if possible (McRae, Deinet, & Freeman, 2017; Rowland et al., 2021). This is an essential step to ensure that the

indicator is interpreted correctly to provide a sound basis for decisions and conservation actions (Fischhoff & Davis, 2014). Going forward, more systematic assessments of indicator performance and uncertainty in national or subnational contexts would ensure that indicators are selected based on their reliability, in addition to their availability, practicality, and relevance to track progress towards targets.

Conclusion

Biodiversity indicators are essential for guiding the decisions and actions that lead the progress towards global, national, and subnational biodiversity targets (Jones et al., 2011; Nicholson et al., 2021). However, selecting indicators that are relevant to targets, feasible to report with available resources and data, and tailored to stakeholder needs is a complex and urgent task that is currently faced by many states as they prepare to report their progress towards the Global Biodiversity Framework in 2030. Indicators must be relevant to the task at hand, they must be biologically sound, and, most of all, they must be practical to implement. To tick all these boxes, engaging with stakeholders early and often is absolutely essential. Particularly important is pairing people with a deep understanding of the data and metrics to stakeholders with a deep understanding of what will be effective in the sociopolitical landscape. While stakeholders always have diverse interests and knowledge, all parties should agree on a shared overarching goal and common terminology around that shared goal. Beyond arriving at a shortlist of indicators described here, there are, of course, many steps toward an effective biodiversity monitoring strategy that include: careful assembly of the data required to calculate indicators and guide actions and inform decisions (Gonzalez et al., 2023; Chapman et al., 2024) and transparent reporting and communication. Maintaining and building trust in the evidence they provide to guide decisions, actions, and policies that will bend the curve of biodiversity loss (Mace et al.,

2018). But ultimately, halting biodiversity loss in the coming decades will depend on the decisions we make now.

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References

Affinito, F., Williams, J. M., Campbell, J. E., Londono, M. C., & Gonzalez, A. (2024). Progress in developing and operationalizing the Monitoring Framework of the Global Biodiversity Framework. *Nature Ecology & Evolution*, 1–9.

Berkes, F. (2007). Community-based conservation in a globalized world. *Proceedings of the National Academy of Sciences*, *104*(39), 15188–15193.

Berteaux, D., Ricard, M., St-Laurent, MH. et al. (2018). Northern protected areas will become important refuges for biodiversity tracking suitable climates. Scientific Reports, *8*, 4623.

Bhatt, R., Gill, M. J., Hamilton, H., Han, X., Linden, E., & Young, B. E. (2020). Uneven use of biodiversity indicators in 5th National Reports to the Convention on Biological Diversity. *Environmental Conservation*, *47*, 15–21.

Biodiversité Québec. (2023). Biodiversity indicators. Retrieved from https://biodiversite-quebec.ca/en/indicateurs

Bowler, D. E., Boyd, R. J., Callaghan, C. T., Robinson, R. A., Isaac, N. J. B., & Pocock, M. J. O. (2024). Treating gaps and biases in biodiversity data as a missing data problem. *Biological Reviews*, 000-000.

Bundy, A., Gomez, C., & Cook, A. M. (2019). Scrupulous proxies: Defining and applying a rigorous framework for the selection and evaluation of a suite of ecological indicators. *Ecological Indicators*, *104*, 737–754.

Burgass, M. J., Halpern, B. S., Nicholson, E., & Milner-Gulland, E. J. (2017). Navigating uncertainty in environmental composite indicators. *Ecological Indicators*, *75*, 268–278.

Burgess, N., Ali, N., Bedford, J., Bhola, N., Brooks, S., Cierna, A., … Butchart, S. (2024). Global metrics for terrestrial biodiversity. *Ecoevorxiv*. Retrieved from https://ecoevorxiv.org/repository/view/7210/

Butchart, S. H. M., Walpole, M., Collen, B., Van Strien, A., Scharlemann, J. P. W., Almond, R. E. A., … Watson, R. (2010). Global biodiversity: Indicators of recent declines. *Science*, *328*, 1164–1168.

Environment and Climate Change Canada. (2023). Biodiversity indicators. Retrieved from https://www.canada.ca/en/environment-climate-change/services/environmental-indicators/biodiversity.html

CBD. (2022a). 15/5. Monitoring framework for the Kunming-Montreal Global Biodiversity

Framework. *Conference of the Parties to the Convention on Biological Diversity*. Montreal, Canada.

CBD. (2022b, December 19). COP15: Nations Adopt Four Goals, 23 Targets for 2030 In Landmark UN Biodiversity Agreement. Retrieved March 10, 2023, from Convention on Biological Diversity website: https://www.cbd.int/article/cop15-cbd-press-release-final-19dec2022

Chapman, M., Goldstein, B. R., Schell, C. J., Brashares, J. S., Carter, N. H., Ellis-Soto, D., … Boettiger, C. (2024). Biodiversity monitoring for a just planetary future. *Science*, *383*, 34–36.

Chase, J. M., McGill, B. J., McGlinn, D. J., May, F., Blowes, S. A., Xiao, X., … Gotelli, N. J. (2018). Embracing scale-dependence to achieve a deeper understanding of biodiversity and its change across communities. *Ecology Letters*, *21*, 1737–1751.

Collen, B., & Nicholson, E. (2014). Taking the measure of change. *Science*, *346*, 166–167.

Costelloe, B., Collen, B., Milner-Gulland, E. j., Craigie, I. D., McRae, L., Rondinini, C., & Nicholson, E. (2016). Global Biodiversity Indicators Reflect the Modeled Impacts of Protected Area Policy Change. *Conservation Letters*, *9*, 14–20.

Fischhoff, B., & Davis, A. L. (2014). Communicating scientific uncertainty. *Proceedings of the National Academy of Sciences*, *111*, 13664–13671.

FNQLSDI. (2024). *First Nations Actions and Indicators: Beyond the framework of the 2030 Nature Plan*. First Nations of Quebec and Labrador Sustainable Development Institute. 33p.

GEO BON. (2023). Towards a new generation of biodiversity indicators. Retrieved from https://geobon.org/ebvs/indicators/

Gonzalez, A., Vihervaara, P., Balvanera, P., Bates, A. E., Bayraktarov, E., Bellingham, P. J., …

Wright, E. (2023). A global biodiversity observing system to unite monitoring and guide action. *Nature Ecology & Evolution*. 1947-1952.

Gregory, R. D., van Strien, A., Vorisek, P., Gmelig Meyling, A. W., Noble, D. G., Foppen, R. P. B., & Gibbons, D. W. (2005). Developing indicators for European birds. *Philosophical Transactions of the Royal Society B: Biological Sciences*, *360*, 269–288.

Heink, U., & Kowarik, I. (2010). What criteria should be used to select biodiversity indicators? *Biodiversity and Conservation*, *19*, 3769–3797.

Hill, S. L. L., Harfoot, M., Purvis, A., Purves, D. W., Collen, B., Newbold, T., … Mace, G. M. (2016). Reconciling Biodiversity Indicators to Guide Understanding and Action. *Conservation Letters*, *9*, 405–412.

Johnson, T. F., Beckerman, A. P., Childs, D. Z., Webb, T. J., Evans, K. L., Griffiths, C. A., … Freckleton, R. P. (2024). Revealing uncertainty in the status of biodiversity change. *Nature*, 1–7.

Jones, J. P. G., Collen, B. E. N., Atkinson, G., Baxter, P. W. J., Bubb, P., Illian, J. B., … MCDONALD-MADDEN, E. V. E. (2011). The why, what, and how of global biodiversity indicators beyond the 2010 target. *Conservation Biology*, *25*, 450–457.

Leung, B., & Gonzalez, A. (2024). Global monitoring for biodiversity: Uncertainty, risk, and power analyses to support trend change detection. *Science Advances*, *10*, eadj1448.

Mace, G. M., & Baillie, J. E. M. (2007). The 2010 Biodiversity Indicators: Challenges for Science and Policy. *Conservation Biology*, *21*, 1406–1413.

Mace, G. M., Barrett, M., Burgess, N. D., Cornell, S. E., Freeman, R., Grooten, M., & Purvis, A. (2018). Aiming higher to bend the curve of biodiversity loss. *Nature Sustainability*, *1*, 448–451.

584 Martínez-Jauregui, M., Touza, J., White, P. C. L., & Soliño, M. (2021). Choice of biodiversity
585 indicators may affect societal support for conservation programs. *Ecological Indicators*,
586 *121*, 107203.
587 Mastrandrea, M. D., Field, C. B., Stocker, T. F., Edenhofer, O., Ebi, K. L., Frame, D. J., …
588 others. (2010). *Guidance note for lead authors of the IPCC fifth assessment report on*
589 *consistent treatment of uncertainties*.
590 McQuatters-Gollop, A., Mitchell, I., Vina-Herbon, C., Bedford, J., Addison, P. F. E., Lynam, C.
591 P., … Otto, S. A. (2019). From Science to Evidence – How Biodiversity Indicators Can
592 Be Used for Effective Marine Conservation Policy and Management. *Frontiers in Marine*
593 *Science*, *6*.
594 McRae, L., Deinet, S., & Freeman, R. (2017). The diversity-weighted living planet index:
595 Controlling for taxonomic bias in a global biodiversity indicator. *PLoS ONE*, *12*,
596 e0169156.
597 MELCCFP. (2024). *Conserving Biodiversity and Promoting Access to Nature: 2030 Nature Plan*
598 (p. 72). Québec: Gouvernement du Québec.
599 Nicholson, E., Collen, B., Barausse, A., Blanchard, J. L., Costelloe, B. T., Sullivan, K. M. E., …
600 Milner-Gulland, E. J. (2012). Making Robust Policy Decisions Using Global Biodiversity
601 Indicators. *PLoS ONE*, *7*, e41128.
602 Nicholson, E., Fulton, E. A., Brooks, T. M., Blanchard, R., Leadley, P., Metzger, J. P., …
603 Ferrier, S. (2019). Scenarios and Models to Support Global Conservation Targets. *Trends*
604 *in Ecology & Evolution*, *34*, 57–68.
605 Nicholson, E., Watermeyer, K. E., Rowland, J. A., Sato, C. F., Stevenson, S. L., Andrade, A., …
606 Watson, J. E. M. (2021). Scientific foundations for an ecosystem goal, milestones and

607 indicators for the post-2020 global biodiversity framework. *Nature Ecology & Evolution*,
608 *5*, 1338–1349.
609 Noss, R. F. (1990). Indicators for Monitoring Biodiversity: A Hierarchical Approach.
610 *Conservation Biology*, *4*, 355–364.
611 Oliver, R. Y., Meyer, C., Ranipeta, A., Winner, K., & Jetz, W. (2021). Global and national
612 trends, gaps, and opportunities in documenting and monitoring species distributions.
613 *PLOS Biology*, *19*, e3001336.
614 Perino, A., Pereira, H. M., Felipe-Lucia, M., Kim, H., Kühl, H. S., Marselle, M. R., … Bonn, A.
615 (2022). Biodiversity post-2020: Closing the gap between global targets and national-level
616 implementation. *Conservation Letters*, *15*, e12848.
617 Puurtinen, M., Elo, M., & Kotiaho, J. S. (2022). The Living Planet Index does not measure
618 abundance. *Nature*, *601*, E14–E15.
619 Rice, J. C., & Rochet, M.-J. (2005). A framework for selecting a suite of indicators for fisheries
620 management. *ICES Journal of Marine Science*, *62*, 516–527.
621 Rowland, J. A., Bland, L. M., James, S., & Nicholson, E. (2021). A guide to representing
622 variability and uncertainty in biodiversity indicators. *Conservation Biology*, *35*, 1669–
623 1682.
624 Santini, L., Belmaker, J., Costello, M. J., Pereira, H. M., Rossberg, A. G., Schipper, A. M., …
625 Rondinini, C. (2017). Assessing the suitability of diversity metrics to detect biodiversity
626 change. *Biological Conservation*, *213*, 341–350.
627 Sparks, T. H., Butchart, S. H. M., Balmford, A., Bennun, L., Stanwell-Smith, D., Walpole, M.,
628 … Green, R. E. (2011). Linked indicator sets for addressing biodiversity loss. *Oryx*, *45*,
629 411–419.

Stevenson, S. L., Watermeyer, K., Ferrier, S., Fulton, E. A., Xiao, H., & Nicholson, E. (2024). Corroboration and contradictions in global biodiversity indicators. *Biological Conservation*, *290*, 110451.

Tittensor, H. D., Dixon, M. J. R., Leadley, P. W., Galli, A., Christensen, V., Pagad, S. N., … Bellard, C. (2014). A mid-term analysis of progress toward international biodiversity targets. *Science*, *346*, 241–244.

Toszogyova, A., Smyčka, J., & Storch, D. (2024). Mathematical biases in the calculation of the Living Planet Index lead to overestimation of vertebrate population decline. *Nature Communications*, *15*, 5295.

Van Strien, A. J., Soldaat, L. L., & Gregory, R. D. (2012). Desirable mathematical properties of indicators for biodiversity change. *Ecological Indicators*, *14*, 202–208.

Watermeyer, K. E., Guillera-Arroita, G., Bal, P., Burgass, M. J., Bland, L. M., Collen, B., … Nicholson, E. (2021). Using decision science to evaluate global biodiversity indices. *Conservation Biology*, *35*, 492–501.

Wyborn, C., & Evans, M. C. (2021). Conservation needs to break free from global priority mapping. *Nature Ecology & Evolution*, *5*(10), 1322–1324.

Supplementary information S1

Table S1. Goals and targets of Quebec's 2030 Nature Plan that were addressed by the indicator selection process. Goals 1 and 2 and their targets are listed below, along with the Global Biodiversity Framework (GBF) targets associated with each target according to Quebec's Nature Plan (MELCCFP 2024).

2030 Nature Plan			GBF
Goal	Target		Targets
1. Protect and restore biodiversity to ensure ecosystem resilience.	1	Stop biodiversity loss through participatory planning and integrated development respectful of biodiversity throughout Québec, with a view to combating climate change and improving access to nature.	1, 8, 11, 12, 21
	2	Initiate restoration efforts for 30% of priority degraded ecosystems to promote biodiversity and access to nature.	2, 11, 21
	3	Preserve 30% of terrestrial and inland water areas and 30% of marine areas in Québec with a focus on effective management, representativeness and ecological connectivity of the sites preserved, while improving access to nature.	3, 11, 21
	4	Protect threatened or vulnerable species in Québec and encourage their recovery.	4, 21
	5	Avoid the introduction associated with human activity of new invasive alien species (IAS) and new pathogens in Québec, stop the spread of those already present and limit their impacts through control measures at priority sites.	6, 21
2. Encourage sustainable practices that foster biodiversity and enhance access to nature.	6	Ensure the sustainability of agriculture and aquaculture, especially through the use of biodiversity-friendly practices and a reduction of nutrient loads and risks for biodiversity linked to pesticide use.	7, 10,11, 21
	7	Maintain the sustainability of forest practices, in particular through sustainable resource use and the maintenance of ecosystem services for the benefit of everyone, including the Indigenous and local communities	10, 11, 21
	8	Strengthen sustainable management and responsible use of exploited species and natural environments to ensure the long-term survival of wildlife and plant populations, preserve the integrity of ecosystems and improve access to nature	5, 9, 10, 11, 21

Table S2. Definitions of the SMART+C criteria that were used to evaluate each candidate indicator that was matched to at least one target. Each SMART+C criterion was evaluated using a series of Yes/No/I don't know questions (Supplementary Information S2), which were developed in collaboration with the stakeholder committee to ensure that each indicator was evaluated in terms of multiple aspects of their potential use, including communication, progress assessments, and decision support.

Criteria	**Definition**
Specific	The indicator is clearly defined with a precise objective to measure one or more essential elements of the target(s).
Measurable	The indicator is a sensitive and reliable metric of progress towards the target(s).
Achievable	The indicator is already or will be operational by 2030, given the available data and resources.
Relevant	The indicator is directly linked to the target(s) and measures a signal that is ecologically and/or politically relevant for monitoring biodiversity and/or for guiding decisions.
Timely	The indicator is, or can be, reported at a frequency and temporal resolution that is suitable for detecting the targeted changes before the target deadline.
Communicable	Multiple audiences can intuitively interpret the implications of a change in the indicator (in numbers and in its visualisation) for biodiversity monitoring and decision-support, with no or minimal ecological expertise.

Supplementary information S2. SMART+C evaluation grids used to evaluate the scientific quality of indicators with the scientific committee.

Criterion 1: Specific (___ / 5)

The indicator has a precise objective and measures one or more elements essential to achieving the target with which it is associated.

Weight	Questions	Yes	No	I don't know	Notes
2	**1.** Is the indicator **objective** sufficiently specific to the target?				
1	**2.** Is the indicator **directly linked** to the component(s) it is intended to represent, or to an acceptable proxy?				
1	**3.** Is the indicator's **scientific basis** documented and validated?				
1	**4.** Are **traditional knowledge and practices** associated with the indicator taken into account in the definition and/or approach proposed for calculating the indicator? *If the indicator is not related to traditional knowledge and practices, answer "Yes".*				
0	**4a. If Question 4 = No:** How can the indicator incorporate the traditional knowledge and practices of indigenous peoples and local communities?				

Criterion 2: Measurable (____ / 5)

The indicator is a quantitative metric with a documented methodology and it is a reliable measure to evaluate the target.

Weight	Questions	Yes	No	I don't know	Notes
1	**1.** Is there a **documented methodology** to calculate this indicator?				
1	**2.** Has the indicator been **peer-reviewed**?				
1	**3.** Based on our current knowledge, is the indicator a **reliable** metric of the signal that we want it to capture?				
0	**If Question 3 = No:** **3a.** Does the indicator have any limitations (biases, uncertainty) that impact its reliability?				

1	**4.** Does the indicator include a measure of uncertainty (confidence interval, error bars, etc.)? Or, is the indicator an exact count that does not require a measure of uncertainty because it is always certain (e.g. number of protected areas)? *For example, indicators that represent counts of species or ecosystems in certain categories do not require a measure of uncertainty. But indicators that are the result of models or estimations must be accompanied by a measure of uncertainty (confidence intervals, etc.).*				
1	**5.** Has the indicator been and/or can it be validated to ensure that it represents reality (with additional data, expert opinions, etc.), or can it be otherwise diagnosed to verify the quality of the results?				
0	*(Optional)* **If Question 5 = Yes:** **6a.** If the indicator has not yet been validated or diagnosed, but you would like to suggest data or an approach for doing so, leave your comments here.				
0	*(Optional)* **7.** Do you have confidence in this indicator, based on its methodology?				

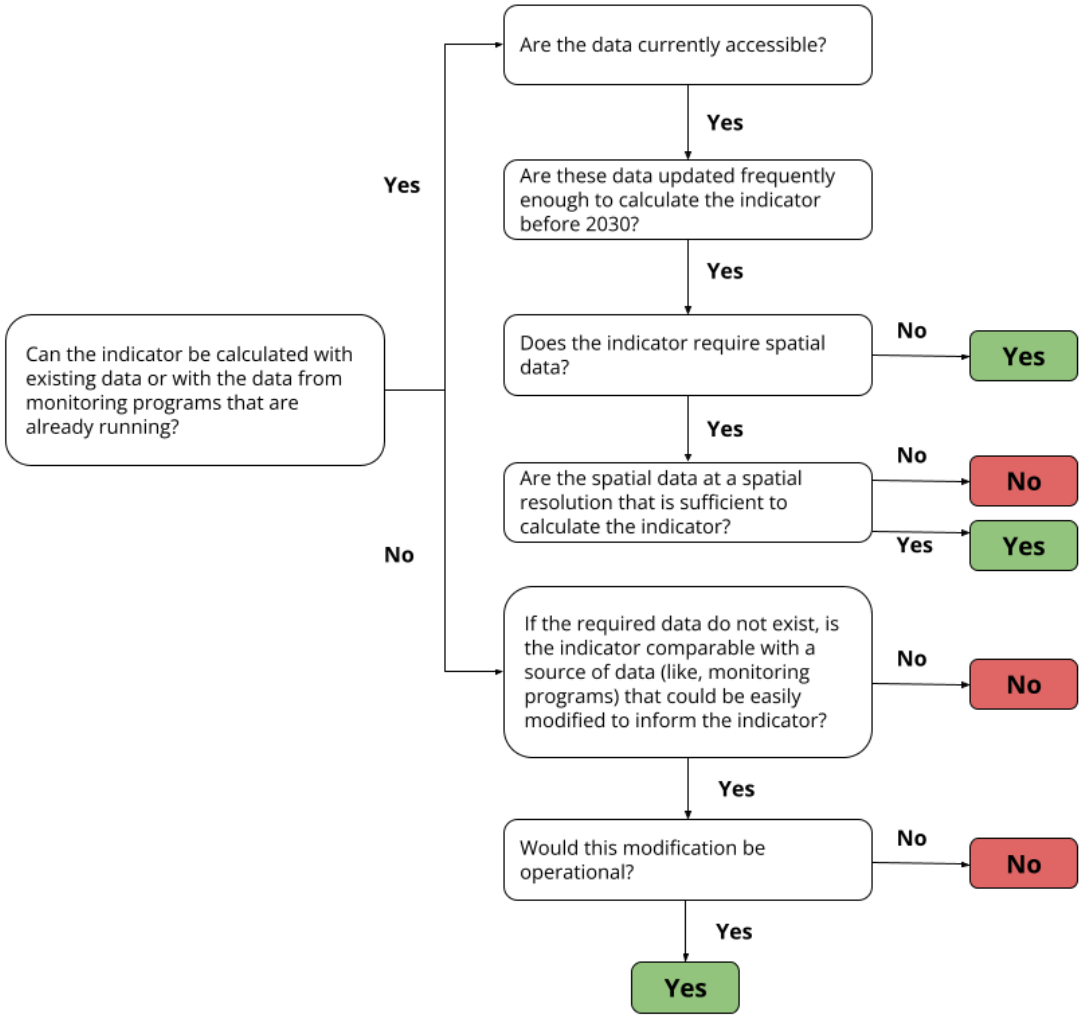
Criterion 3: Achievable (____ / 5)

The indicator is already or will be operational by 2030, depending on the resources that are currently (or potentially) available.

Weight	Questions	Yes	No	I don't know	Notes
3	**1.** Is the indicator compatible with data that already exists, or may become available in the near future? *To answer this question, complete the decision tree on the following page.*				
1	**2.** Is the indicator technically feasible (computational power, available expertise)?				
1	**3.** Is the measurement and calculation of the indicator efficient in terms of human and financial resources?				

Decision tree for Achievable: Question 1

Compatibility with existing data:



Criterion 4: Relevant (____ / 5)

The indicator's scientific, political and ecological relevance. This may mean that the indicator is sensitive to an ecological phenomenon, conservation action, or other, and that it will provide relevant information for monitoring and/or guiding decisions.

Weight	Questions	Yes	No	I don't know	Notes
1	**1.** Would the indicator be helpful to guide the decision-making process for biodiversity conservation?				
1	**2.** Does the indicator address important characteristics of conservation, the ecosystem, or key processes that threaten biodiversity?				
1	**3.** Does the indicator report biodiversity features of great cultural importance?				
1	**4.** Is the indicator measured at an organisational scale that is relevant to the target (genetic, population, community, ecosystem)?				
1	**5.** Does the indicator measure something that is likely to change by 2030?				

Criterion 5: Timely (____ / 5)

Ce critère vérifie si la fréquence et la base de référence de l'indicateur sont appropriées pour être sensible au facteur d'intérêt et pour informer des décisions.

Weight	Questions	Yes	No	I don't know	Notes
2	**1.** Can the indicator be reported within a timeframe that is appropriate for the target (e.g. at least once by 2030)?				
1	**2.** Can the indicator be measured frequently enough to detect the phenomenon that is targeted?				
1	**3.** Can the indicator be projected to anticipate long-term changes (beyond 2030)?				
1	**4.** Is the indicator compared to a baseline / reference value that is useful (or, does it not need to be compared to a baseline?				
0	**If Question 4 = Yes:** If the baseline is necessary but not established, how much time would we need to measure a baseline before the indicator would be informative?				

Criterion 6: Communication (____ / 5)

The interpretation of the indicator and the indicator result are clear and easy to communicate to non-specialists and specialists alike. Here, the focus is on the interpretation of the indicator result, rather than the details of its calculation.

Weight	Questions	Yes	No	I don't know	Notes
1	**1.** Is the indicator's objective worded in a clear and meaningful way to facilitate communication to multiple audiences? For example, will non-specialists intuitively understand what the measure means?				
1	**2.** Is the indicator result (in words) easy to understand and/or communicate?				
1	**3.** Is the indicator result visualised (or could it be visualised) in a way that is meaningful to the general public?				
1	**4.** Are the indicator's definition and methodology sufficiently transparent and/or intuitive to encourage public confidence in its results?				
1	**5.** Is a change in the indicator representative of the ecological or political significance of the change tracked by the indicator? *For example, does an extreme change in the indicator mean that there really has been an extreme change in biodiversity?*				

Supplementary information S3. Example “report card” used to evaluate the practicality of candidate indicators with the consultancy committee.

Use case: *Measuring impacts of actions on biodiversity*

Target(s): *1*

Situation:

We are planning a project to plant 10,000 trees in Montreal.

Minimum information to be reported:

More planted trees -> more green area in the city.

Wishlist of additional information to report:

- *Number of tree species within the city per year.*
- *State of the urban ecosystem according to certain key variables (temperature, species diversity, etc.)*
- *Carbon storage through time*

Example figures: