

# Opportunities for and barriers to anticipatory governance of two lake social–ecological systems in Germany and Canada

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## Abstract

1. Climate change effects are already being felt around the globe, and governance systems need to adapt to this new reality to foster greater resilience in social–ecological systems (SES). Anticipatory governance is a concept proposed for such a purpose. However, its definition remains rather vague in the literature, as is its practical use for decision makers. In this paper, we contribute to filling these two shortcomings.
2. First, we conducted a systematic literature review of the concept and derived the following main criteria: foresight, networked engagement, integration and feedback. Second, we use the identified criteria to analyse two social–ecological systems around lakes in Lower Saxony, Germany and in Quebec, Canada.
3. In both cases, data were generated using a participatory approach (interviews and workshops) with local stakeholders. We examined these data, identifying opportunities and barriers to anticipatory governance. Our findings support, with empirical data for the first time, the claim in the literature that ensemble-ization—the fact that all anticipatory governance criteria must be put forward jointly and not in isolation—is a facilitator for the emergence of anticipation.
4. Furthermore, by highlighting opportunities and barriers to anticipatory governance within two temperate lake SES cases, we illustrate how to understand a given system's limitations with respect to anticipatory governance, as well as how to engage with the concept through concrete, already existing opportunities. The proposed course of actions could help design more anticipatory governance systems to support decision-making processes that could enhance SES resilience.

## KEYWORDS

anticipatory governance, feedback, foresight, networks, social–ecological systems, systematic review, temperate lakes

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## 1 | INTRODUCTION

Governance of social–ecological systems (SES) will face an unprecedented challenge in the coming decades as climate change effects intensify. Governance entities will need to enable conditions that maintain fundamental functioning of both social and natural systems but also permit adaptation to increasingly unpredictable futures, thus promoting SES resilience (Folke et al., 2005). Although climate models project future global trends, regional climate change effects are much harder to forecast, especially when taking into account the unpredictability of climate change feedback loops and their potential cascade effects in complex SES systems (Palmer & Stevens, 2019). The need to foster greater SES resilience in a climate change context is manifest, especially for vulnerable ecosystems, including temperate freshwater ecosystems (Boltz et al., 2019). Given regional uncertainties of how climate will affect ecosystems, their complex adaptive nature and their management, for instance freshwater bodies (Vlieg & Zandvoort, 2013), governance entities cannot rely on predictive models alone for long-term planning, as such models ‘often acknowledges an easing of uncertainty’ (Foley et al., 2018, 227). This might very well lead to self-defeating policies since uncertainties might never be fully resolved, and furthermore, new uncertainties might emerge from the co-evolutionary path which is unfolding for complex adaptive SES (Haider et al., 2021; Poli, 2013; Preiser et al., 2018). While adaptive governance for ecosystem management already recognizes how multiscale, diverse actor networks create a capacity to respond to ecosystem change and new challenges (Schultz et al., 2015), this approach can be insufficient facing long-term, catastrophic change and remains reactive (Vlieg & Zandvoort, 2013). Thus, to enhance resilience, governance entities will need to shift from a reactive approach to preventive actions for SES management, achievable through anticipatory practices (Croxatto et al., 2020).

Anticipation is often associated with, and a necessity for, SES resilience in the literature (Boyd et al., 2015; Miller et al., 2013). Rosen's (2012, 313) original definition of anticipation from his classic book, first published in 1985, states that ‘[an] anticipatory system is a system containing a predictive model of itself and/or its environment, which allows it to change state at an instant in accord with the model's predictions pertaining to a later instant.’ An anticipatory SES can thus be understood as how the living and non-living system components project themselves into the future and to adapt, purposefully or not, their behaviour to maintain essential functions, based on such projections (Fuerth, 2009; Quay, 2010).

Anticipatory governance comes from the need to include the concept of anticipation into governance to enhance system resilience (Boyd et al., 2015). We understand resilience, as described by Folke (2016), as ‘the capacity of a system to absorb disturbance and reorganize while undergoing change so as to still retain essentially the same function, structure, and feedbacks, and therefore identity, that is, the capacity to change in order to sustain identity’. Despite its importance for SES resilience, the concept of anticipatory governance and studies of its implementation are fragmented, making it

difficult to grasp or implement for policy and decision makers (Boyd et al., 2015; Muiderman et al., 2020). Yet the need for such a concept to be understood and put into practice is becoming increasingly urgent. While in most publications, explicit or implicit attributes are presented for anticipatory governance, a systematic review of the concept is lacking. Yet, it remains necessary to clarify the theory of anticipatory governance and generate a comprehensive set of well-defined, specific criteria that can guide analysis of empirical data through anticipatory governance lenses.

Our paper strives to (1) identify and define the criteria of anticipatory governance and (2) connect them with concrete, practical contexts in two north temperate lake SES. By focusing on two case studies, in Lower Saxony, Germany, and in Quebec, Canada, we show how anticipatory governance criteria can be used to frame, analyse and potentially reform regional governance. Our methods are thus twofold. First, we derive criteria for anticipatory governance from a systematic literature review. Second, by jointly analysing the results from a participatory approach involving interviews, visioning and scenario planning exercises with stakeholders, we describe which aspects of the systems represent seeds of anticipatory governance, or, opportunities for anticipatory governance criteria to emerge, and which aspects are potential barriers to such emergence. We are thus not searching for anticipatory governance *per se* within the case study SES, but for opportunities for or barriers to it. We conclude by suggesting how the anticipatory governance concept can be accounted for when reforming governance to enhance SES resilience.

## 2 | CONCEPTS AND METHODS

### 2.1 | Identifying anticipatory governance criteria

Anticipatory governance is explicitly used in four different expertise spheres in the social science literature, namely (Muiderman et al., 2020): (i) social risks and acceptability of technological innovations; (ii) US national policy analysis; (iii) sustainability science, with an emphasis on social systems adaptation and resilience in the face of climate change; and (iv) environmental governance and policy. The definition of anticipatory governance varies greatly among publications, even within a same discipline, but it generally involves envisioning many different future scenarios and a diverse array of possible actions to maintain a desirable system state while actively monitoring the system to observe changes and adapt management accordingly (Fuerth, 2009; Quay, 2010). One of the most prominent definitions in futures studies tackling climate change context comes from Fuerth (2009, 29) who defines anticipatory governance as ‘a system of institutions, rules and norms that provide a way to use foresight for the purpose of reducing risk, and to increase capacity to respond to events at early rather than later stages of their development.’ Given the diversity of publications that use the concept and the lack of a common theory to frame it, a systematic literature review was necessary to identify the most

commonly used anticipatory governance criteria and frame the analysis of our case studies, as presented in the Discussion.

### 2.1.1 | Systematic literature review

We used the PRISMA method (Preferred Reporting Items for Systematic Reviews and Meta-Analyses; Moher et al., 2009) to carry out our systematic literature review. Since we wanted to explore the concept of anticipatory governance as explicitly mentioned by authors, we solely searched for the term 'anticipatory governance' in both Scopus and Web of Science, extending our search to the titles, keywords and abstracts and to all available publication types, within any limit for the year of publication. We searched all fields of social sciences, environmental science, engineering, earth and planetary sciences, energy and agricultural and biological sciences. Web of Science was searched on 10 November 2021 and Scopus on 27 October 2021. Of the retained 139 publications, we read all titles and abstracts and eliminated irrelevant publications with topics too far from SES governance or which considered anticipatory governance only superficially. The remaining 82 publications were read completely and we removed another 13 more publications that provided no definitions, nor any explicit or implicit criteria for anticipatory governance. Our analysis of anticipatory governance criteria is thus based on 69 publications.

### 2.1.2 | Criteria analysis

In each publication, we searched for the definition of anticipatory governance provided as well as for their accompanying criteria. In cases without explicit criteria, we looked for implicit criteria based on the authors' descriptions and examples of anticipatory governance. Where publications reviewed several sets of criteria based on different disciplines, we extracted only those criteria that were favoured most by the authors.

Once all criteria had been extracted, we used selective coding (see Strauss, 1987; Strauss & Corbin, 1990) to regroup similar criteria under overarching categories (see Supplementary Table S1 for a complete list of grouped terms, as well as for a complete list of publications used). Four grand criteria and one necessary condition for anticipatory governance were identified:

#### *Foresight*

Foresight is the centrepiece of the anticipatory governance concept, as it relates to the idea of imagining and anticipating possible futures and their uncertainties (Genus & Iskandarova, 2018; Vij et al., 2017). Its objective is to inform and orient decision-making and planning to reduce the possible impacts of unexpected future challenges (Conley, 2013), using tools such as scenario analysis, horizon scanning, visioning or modelling to foresee possible future challenges and pathways for solving them (Boston, 2021;

Gober, 2014; Gupta et al., 2020; Sarewitz, 2011). For some, such futuring practices are even understood as the only constituent of anticipatory governance (e.g. Adey & Anderson, 2011; Aradau & Van Munster, 2012; Aykut et al., 2019). However, those authors tend to describe futuring practices as forecasting, which attempts to predict the future state of a system, therefore failing to account for the broader, more explorative sense attributed to futuring practices in the anticipatory governance literature. Thus, in accordance with most of the literature, we understand and use the term foresight as anticipating multiple plausible pathways rather than predicting the future (Maffei et al., 2020; Muiderman et al., 2020).

#### *Networked engagement*

The networked engagement criterion refers to the importance of developing a network through which all relevant stakeholders, including politicians, scientists, entrepreneurs or the public, can express themselves and actively participate in decision-making and planning (Conley, 2013; Davies & Selin, 2012; Dotson, 2019; Gudowsky & Peissl, 2016; Guston, 2014). It is most often referred to as (public) engagement in the literature (e.g. Cummings et al., 2017; Foley et al., 2018; Muiderman et al., 2020; Wiek et al., 2012), but adding the term 'networked', as seen in Fuerth and Faber (2013), Croxatto et al. (2020) or Heo and Seo (2021), is more illustrative of the criterion's purpose and definition. Indeed, not only must stakeholders be actively engaged in planning steps and decision-making, but transparent, deliberative and horizontal communication, leading to coordinated institutions, must be maintained in the long term to perpetuate trust, allowing for this criterion to be effective (Boston, 2021; Gorman et al., 2012; Gupta, 2011; Kolliarakis, 2017; Poli, 2012).

#### *Integration*

This criterion originally relates to the importance of integrating knowledge from both the social and natural sciences to provide a more accurate and comprehensive understanding of a situation or system (Kuzma et al., 2008; Lehoux et al., 2020; Michelson, 2013a, 2013b; Wiek et al., 2012). By extension, it also relates to the integration of two different knowledge cultures such as expert and citizen knowledge (Guston, 2014; Ohta, 2020), and thus a democratization of expertise (Gupta, 2011), knowledge and information sharing (Croxatto et al., 2020; Muiderman et al., 2020; Poli, 2012) and overall transdisciplinarity of decision-making processes (Pólvora & Nascimento, 2021).

#### *Feedback*

This criterion highlights the importance of reflexivity towards the measures and actions that are taken in a system (Boettcher, 2020; Conley, 2013; Davies & Selin, 2012; Kolliarakis, 2017; Sarewitz, 2011). Numerous authors underline the importance of various feedback aspects, but only some group them into a coherent process. Feedback implies: (1) continuous surveillance and monitoring enabling observation of system evolution, dynamics and feedbacks (Barker, 2012;

Boyd et al., 2015; Gober, 2014; Jurgilevich, 2021); (2) an analysis of how measures or actions influence the system (Croxatto et al., 2020; Lawrence et al., 2020; Muiderman et al., 2020); (3) learning from observations to generate new knowledge (Boyd et al., 2015; Dotson, 2019; Poli, 2012); and (4) adjusting measures and actions accordingly to enhance flexibility and adapt decision-making to new realities that influence the system's evolution (Matthews & Baker, 2021; Quay, 2010; Serrao-Neumann et al., 2013; White et al., 2015).

### *Ensemble-ization*

Ensemble-ization, or ensemblization, represents the idea that none of the above criteria can be taken or treated in isolation (Foley et al., 2018; Fonseca & Pereira, 2014; Wender et al., 2012). Instead, all criteria must be integrated in each step of the decision-making and planning processes for full anticipatory governance. This implies a systemic approach whereby all governance processes are embedded to form an anticipatory governance system (Boston, 2019, 2021; Wiek et al., 2012). This also necessitates open-minded institutional culture and decision makers who make room for anticipation and participatory processes (Boyd et al., 2015; Maffei et al., 2020; Matthews & Baker, 2021). Heo and Seo (2021) proposed the concept of 'continuity' to describe this criterion, signifying the importance of continued anticipation efforts as well as the embedding of all anticipatory governance criteria into a coherent whole.

For this paper, we will focus on analysis of the first four criteria, leaving aside ensemble-ization for two reasons. First, because we are using data generated in participatory settings, we only have access to some aspects of each participant's social representation of the systems under scrutiny. Such data are thus poorly suited to evaluate the presence of ensemble-ization. Second, ensemble-ization represents an accomplished anticipatory governance system where all the other criteria are integrated as a whole, ongoing process. It is thus much more an overarching property of a more mature anticipatory governance process than a criterion for its development.

## 2.2 | Case studies

### 2.2.1 | Lake Dümmer

Lake Dümmer lies in North-Western Germany, in southern Lower Saxony state. The lake has a surface area of 13.5 km<sup>2</sup> and is fed by the Hunte River that runs south to north through it. The western and southern banks of the lake are a nature reserve. Around 8000 inhabitants reside in the lake's direct surrounding. In the 1950s, a dike was built around the lake, stopping natural water level fluctuations. Since then, the lake serves as a reservoir to regulate the water level of the Hunte R. downstream to protect communities from flooding. It further serves as a vacation and recreational area for many tourists throughout the year (More virtual agency, 2022).

The lake's waters belong to the administrative district of Diepholz while its western shores are in the district of Vechta. Its catchment

area, the Hunte watershed, lies within the administrative district Osnabrück. The three districts provide the institutional framework within which the municipalities operate. The authorities responsible for inland waters and for rural development are under the jurisdiction of the federal state of Lower Saxony.

### 2.2.2 | Lake Saint Charles

Lake St. Charles, in the province of Quebec, Canada, is the main drinking water reservoir of the City of Quebec, the capital of the province, 20km south of the lake. The lake watershed covers 170.1 km<sup>2</sup> while the lake itself covers 3.6 km<sup>2</sup> divided into two basins (Légaré, 1998). The southern basin is a reservoir formed after the construction of the Cyrille-Delage dam in 1934. The drinking water intake is downstream of the lake, on the St. Charles River, forming yet another watershed that covers 348km<sup>2</sup> and is shared by five municipalities (City of Quebec, Lac-Beauport, Lac-Delage, Stoneham-et-Tewkesbury, Saint-Gabriel-de-Valcartier) and an urban territory of the Huron-Wendat first nation, Wendake (APEL, 2019). Most of the riparian area directly around the lake lies in the territory of the City of Quebec, but Stoneham-et-Tewkesbury occupies the greatest extent (41%) of land within the water intake's watershed (APEL, 2019). All municipalities fall under the jurisdiction of the Metropolitan Community of Quebec (MCQ), an agglomeration created in 2002 to oversee land planning and management. While the MCQ can impose regulations over municipalities, the latter are usually accountable for land planning and management on their territory, with traditionally very little citizen participation.

## 2.3 | Assessing governance in lake social-ecological systems through a participatory process

Our study of governance in the two focal lake SES used a participatory process, and more precisely participatory modelling. The latter '(...) refers to any number of techniques by which stakeholders in a system of study are actively involved in some aspect of the creation or evaluation of models of that system.' (Penn et al., 2013, 2). Voinov and Bousquet (2010) further state two assets of participatory modelling. It: '(...) (a) enhance[s] the stakeholders' knowledge and understanding of a system and its dynamics under various conditions (...) and (b) identif[ies] and clarif[ies] the impacts of solutions to a given problem, usually related to supporting decision making, policy, regulation or management.'

Our interaction with regional stakeholders<sup>1</sup> in both case studies comprised (1) interviews with key regional stakeholders to gather data on the current SES trends; (2) a visioning exercise of future lake state in 2050; (3) a backcasting exercise to unravel the milestones and action steps needed to achieve this vision; and (4) a reflection on the information generated and on the next steps to governance transformation. Series of four workshops for the Dümmer and St. Charles cases took place between November 2019 and November

2021. In both cases, the first workshop was held in person, as was the final one in the Dümmer case. Due to the COVID-19 pandemic, other workshops were shifted into an online format (Figure 1).

Before starting the participatory process, we conducted an analysis of the regional actors involved in or affected by the lakes' management and current condition, following standard stakeholder analysis methods (see Durham et al., 2014, 40; Elias et al., 2013; Mitchell et al., 1997; Reed et al., 2009). For stakeholders to be part of the participatory process, they had to belong to a sector relevant to the lake's state<sup>2</sup> and be based either in the districts encompassing the lake and its watershed or they had to be active at the province/federal level. We further assessed regional stakeholders' interests, power and level of affectedness regarding the lake's issues. Thus, using purposive sampling (see Palys, 2008), a total of 41 individuals were invited to the participatory process in Germany, representing a diverse array of knowledgeable and key collective actors from agriculture, water management, nature conservation, administration, fishing and tourism. The sectors were equally represented throughout the workshops; however, for some sectors, the participating organizations or individuals changed. Although invited, actors from agriculture were underrepresented in the workshops with only two participants. One farmer expressed his concerns about preferring not to participate, since agriculture does not have a good image in the region; a potential explanation for their absence.

Similarly, in Canada, a total of 31 diverse stakeholders, namely municipal and civil servants from involved municipalities as well as from the MCQ, private entrepreneurs, NGOs, provincial government officers, consultancy firms and citizens, took part in the process. Although there was a rotation among them, all types of stakeholders were represented in each step of the participatory process, except for consultancy firms which only participated in the first step (defining current trends) as well as government officials who were absent from the last one (reflecting on the governance system). Also, while participants were quite varied, notably absent among them were

representatives from the Wendake Nation in the watershed who, while invited, decided not to join the process.

### 2.3.1 | Defining the current trends

We conducted a total of 18 interviews with as many stakeholders in spring and summer 2019 in Germany, and 20 interviews with 22 stakeholders in the fall 2019 in Canada.<sup>3</sup> Interviews lasted between 45 and 120 min and were recorded with notes taken during the discussions. We first discussed issues of concern regarding each lake in a broad manner, asking participants to identify the one they thought of as the main issue. We then invited them to identify: (i) the perceived causes of this main issue; (ii) the consequences for the whole system; (iii) possible causal links between consequences and causes, hence creating (iv) loops within the system, thus following the logic of causal loop diagrams (CLD) as described by Vennix (1996).

We coded the interviews using the software MaxQDA and ATLAS.ti 8 for the Dümmer and St. Charles cases respectively. We used deductive coding (see Crabtree & Miller, 1999) to identify the issues, causes, consequences, links and loops. We then transferred the data into digital visualizations, using the software Vensim (Ventana Systems Inc.). For each case, we merged all participants' social representations into a coherent whole representing the social-ecological system under study (for a complete description and representation of the current system states, see Herzog et al., 2022). This allowed us to integrate the differing points of view regarding the main issue in the systems, as well as their causes and consequences, as required for appropriate integration of knowledge in anticipatory governance.

In the St. Charles case, the current trends were further explored during the second workshop, held virtually, which involved 17 participants on 15 June 2020. This workshop allowed participants to

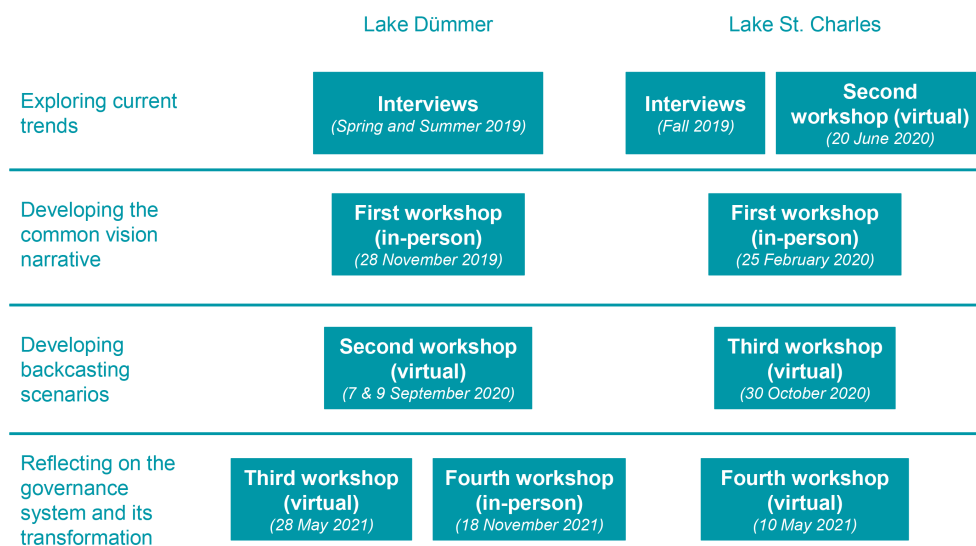


FIGURE 1 Conceptual diagram of methods used to reach specific objectives in both case studies.

further discuss the links established between all the issues identified in the interviews, their causes and consequences.

### 2.3.2 | Visioning exercise

In the initial workshops, conducted in-person, we performed a visioning exercise, having the stakeholders creating individual and collective visions of lake SES in the year 2050. We used O'Brien and Meadows (2007, 560) definition of a vision: 'a description of a desirable future', and further '(...) an exploratory and normative (i.e. value-laden) view of a possible future, that is, a scenario. Thus, a vision is a particular type of scenario.' A vision is '(...) a necessary precondition for effective strategic planning.' (O'Brien & Meadows, 2007, 557; see also Wiek & Iwaniec, 2014). Therefore, a visioning exercise can produce new insights about SES and enable actors to identify ways to adapt to social-ecological disturbances (Falardeau et al., 2019), aligning with our goals for the participatory process.

In Germany, 20 stakeholders participated in the initial workshop on 28 November 2019, while 13 people attended the first workshop in Canada on 25 February 2020. We asked participants to split into four groups, assuring that each was composed of people from different sectors. The workshop moderator read a short text to the participants to attune them to the exercise and encourage reflexivity,<sup>4</sup> after which groups were given 1 h to imagine and illustrate their desired collective future vision of the lake in 2050. After the workshop, the facilitators turned each vision illustration into a narrative stating concrete targets and goals (see Wiek & Iwaniec, 2014), and merged the four narratives for each case study into one common vision narrative for the focal lake.

An important lesson from the vision exercise, for both the research teams and participants in both countries, is that although there were differences between visions elaborated by individuals or groups, there were no divergences. That is, while some elements were mentioned by only some of the stakeholders, they were accepted by all of them once the elements had been exposed to all workshop participants, with no divergence in opinion. Although we are aware that such a process could have been subject to groupthink or to unexpressed power dynamics among stakeholders, we are assured that our methods minimized those risks. Indeed, the common vision was founded on individual visions first, then expressed in smaller groups to allow for discussions and divergences to emerge, before being presented to the whole group. In both case studies, participants were quite verbal about their surprise that the discussions were quite consensual, allowing them to construct a positive common vision outside of the daily constraints that usually oppose them to other stakeholders.

### 2.3.3 | Backcasting scenario exercise

Quist and Vergragt (2006, 1028) define backcasting as the creation of '(...) a desirable (sustainable) future vision or normative scenario,

followed by looking back at how this desirable future could be achieved, before defining and planning follow-up activities and developing strategies leading towards that desirable future.' Based on that understanding and on the common vision narratives, we conducted backcasting scenario exercises, having the participants delineate pathways to desirable future states of their respective lake system (Robinson et al., 2011, 756; Wiek & Iwaniec, 2014, 497). Participants were invited to derive the steps and measures needed to reach their 2050 vision, working backwards from the specific desired future end-point of their common vision to the present, assessing the milestones and policy instruments needed to get to that end-point (Robinson, 2003, 842).

The backcasting scenario exercise was held online. In Germany, participants were split into two groups to better facilitate the digital format: eight stakeholders met on September 7, 2020, and another 14 stakeholders joined the workshop on 9 September 2020. For the St. Charles case, 11 stakeholders, split into two groups through the use of virtual rooms, participated in the backcasting exercise on 30 October 2020. Both teams of facilitators used digital whiteboards where a pathway towards the future vision was presented. For Lake Dümmer, each group was asked to define the three elements of the vision that were most relevant, which were then used to inspire the milestones on the pathway to the vision. At Lake St. Charles, milestones were established prior to the workshop. They were 1- reach the envisioned governance system; and 2- reach one or several objectives of the participants' choosing, derived from the common vision narrative and current trends of the lake. In both regions, participants were then invited to establish the steps and processes necessary to reach the milestones to the vision.

### 2.3.4 | Reflecting on the governance system

The last phase of the participatory process consisted of reflection and discussion of the current governance systems in place, based on the insights gained from the visions and backcasting exercises. In Germany, the third workshop took place virtually on 28 May 2021, with 11 stakeholders. First, participants reflected on a concept that would extend current lake governance; second, they elaborated specific actions and aspects of such a concept. The thread was taken up in the last workshop held in person on 18 November 2021. Fourteen stakeholders were presented with a graphical visualization of the outcomes of the previous workshops and asked to reflect on them and discuss in a World Café format. Three tables were set up with two questions each. Three discussion rounds of 25 min allowed stakeholders to participate in a discussion at each table. Moderators facilitated the conversations while also supporting the participants in noting the main discussion points on a poster.

In Canada, reflection on the joint vision and the future pathways leading to it focused mainly on the envisioned governance system. This occurred on 10 May 2021, during the fourth workshop, also held online. Participants were given a list of 12 governance attributes to structure the discussion, identified in the earlier participatory

process. Two discussion groups explored the 12 attributes and discussed realistic details or possibilities necessary for the envisioned governance system to come to fruition. Here too, moderators facilitated conversations and took notes on a virtually shared platform.

## 2.4 | Analysing participatory process data through anticipatory governance lenses

We used the empirical data generated in the participatory process to observe and discuss opportunities and barriers to anticipatory governance in our case SES. We proceeded by systematically coding our interview and workshop data for hints, manifestations or mentions of processes, ideas or perceived capacities that could relate to direct or indirect opportunities and barriers to each criterion, based on our literature review. Notably, we searched for expressions or manifestations reminiscent of the vocabulary associated with each criterion and extracted from the literature, as seen in Supplementary Table S1. For instance, foresight could be associated with words such as 'scenarios', 'precaution' or 'future-oriented' practices, and it could be associated as well with an observed capacity of participants to engage in foresight exercises. Similarly, networked engagement could be associated for instance with expressions such as 'deliberative democracy' or 'dialog', and it could be deduced from examples of collaborations as well. The results of this analytical process constitute our Results section.

## 3 | RESULTS

Interpreting our data through the analytical lenses of anticipatory governance allowed us to identify opportunities or seeds for anticipatory governance, as well as barriers to its emergence.<sup>5</sup> They are presented below by criterion generally first, followed by case-specific analysis (Table 1).

Before presenting opportunities and barriers per criterion, it is worth noting that stakeholders who participated in the workshops or interviews mentioned some overarching barriers that can hamper governance shifts and management actions as a whole. These barriers relate to the higher governance levels on which participants felt that they had very little influence. Mostly, the lack of funding from the state, provincial, national or supranational levels for conservation and resource management measures was seen as the greater barrier, but could also become an opportunity if reliable funding or other incentives were made available. However, given the general perception that influencing higher level governments was too difficult, participants rather focused on regional possibilities for governance and management, as expressed below.

### 3.1 | Foresight

Foresight exercises or processes were not part of either case's current governance processes. However, the common visions

established in the first workshops, as well as the backcasting scenario exercises, certainly showed that stakeholders possess a high capacity to envision common goals and objectives for the future of the lakes, and that they are willing to shape the future using anticipatory measures, despite coming from diverse sectors, backgrounds and having different personal objectives. The expression of such foresight capacity corresponds with the motivation behind the adhesion to anticipatory governance principles (Boyd et al., 2015; Ni'mah et al., 2021). Yet, making use of the stakeholders' common visions and of the backcasting scenarios they created is the critical step that they still need to take to integrate foresight into local SES governance. But this would require more integrated networked engagement enabling these exercises to be fruitful, relevant and comprehensive, as often emphasized in the literature (e.g. Maffei et al., 2020; Michelson, 2013a, 2013b; Wiek et al., 2012). Such networked engagement was quite limited in both SES at the time of research. Furthermore, the lack of stakeholder knowledge and experience in foresight exercises also remains a notorious barrier to this criterion, as reflected in the last workshop at Lake St. Charles where participants underlined the lack of incentives to engage in such exercises, and as discussed in Milford and Wetmore (2013).

#### 3.1.1 | Lake Dümmer

One of the main measures proposed at Lake Dümmer for managing nutrient inflow into the lake is the construction of a reed polder to filter Hunte River water before it enters the lake. When the idea of a reed polder was first proposed in the 1980s, and finally conceptualized in 2012, it was a long-term planning instrument that had not yet been realized anywhere else and showed anticipatory characteristics. However, the reed polder is an end-of-pipe measure. As such it lacks foresight characteristics that would enable actors to anticipate the future state of the lake. It is instead a practical measure that would simply remove nutrients from the lake's tributary. Since it is an elaborate and still unrealized implementation, actors have focused all their attention on its construction over the last decade, precluding the development of new anticipatory tools. The institutional culture that surrounds the reed polder can be interpreted as a barrier to foresight in the context of Lake Dümmer. There is thus a palpable lack of learning and adaptation by stakeholders to new knowledge and to an evolving context at Lake Dümmer. This underscores the fact that lack of or limited feedback might be another barrier to foresight, an argument supported in the literature (e.g. Lehoux et al., 2020; Poli, 2012). It also represents a warning against over 'protocolarization' of foresight exercises without feedback to adapt to new contexts (Aykut et al., 2019).

#### 3.1.2 | Lake St. Charles

In Lake St. Charles region, after severe cyanobacteria blooms in 2006 that worried authorities, the MCQ acted to prevent a probable,

**TABLE 1** Main opportunities for and barriers to anticipatory governance criteria in Lake Dümmer and Lake St. Charles social–ecological systems.

| Criteria                    | Opportunities and seeds  | Barriers  |
|-----------------------------|--|---|
| <b>Foresight</b>            | <p><b>Common</b><br/>The capacity of stakeholders to create a common vision.</p> <p><b>Lake Dümmer</b><br/>Participants are willing to shape the future with anticipating measures.</p> <p><b>Lake St. Charles</b><br/>Participants discussed the importance of focusing on preventive measures.<br/>Opening up to communication and symbolic citizen participation.<br/>MCQ attempts at preventing further disruption through increased social acceptability of measures.</p>   | <p><b>Common</b><br/>Lack of a proper networked engagement.<br/>Lack of stakeholder knowledge and experience in foresight exercises.</p> <p><b>Lake Dümmer</b><br/>Institutional culture: focusing on one solution only has prevented alternative, forward-looking solutions from being considered.<br/>Lack of learning through feedback.<br/>Over 'protocolorization' of foresight exercise.</p> <p><b>Lake St. Charles</b><br/>Participants could hardly imagine how to implement preventive measures.<br/>Political short-termism and institutional culture.<br/>Daily priorities and limited budget.<br/>Lack of open-mindedness of institutional culture.</p>   |
| <b>Networked engagement</b> | <p><b>Common</b><br/>Recognition of the need for a networked engagement.</p> <p><b>Lake Dümmer</b><br/>Fragmented small networks already exist, creating a seed for greater networked engagement.<br/>Trust has been established already between stakeholders on the Dümmer council.</p> <p><b>Lake St. Charles</b><br/>Participants were able to imagine concrete, realistic steps to reach such a system.<br/>Political will: Openness of MCQ and municipalities to communication and citizen participation.</p>   | <p><b>Common</b><br/>A future governance entity could lack the necessary qualities (e.g. sufficient authority, legitimacy or perceived neutrality) to support a networked engagement.<br/>Contradiction between envisioned governance system and preference for fast, effective actions.</p> <p><b>Lake Dümmer</b><br/>Lack of time and opportunities for exchanges between stakeholders.</p> <p><b>Lake St. Charles</b><br/>Top-down approach from MCQ could resurface.<br/>Symbolic citizen participation.<br/>Organizational silos.<br/>Lack of adequate entity to ensure true networked engagement.<br/>Disparity between the organization responsible for encouraging collaboration and the ones that actually possess the necessary qualities to do so.</p> |
| <b>Integration</b>          | <p><b>Common</b><br/>Proper networked engagement as envisioned by participants could bring integration forward.<br/>Recognition of the need for integration in the common vision and backcasting exercises.</p> <p><b>Lake Dümmer</b><br/>Some form of information sharing already in place.</p> <p><b>Lake St. Charles</b><br/>Recent opening up of communication channels.</p>   | <p><b>Common</b><br/>Lack of proper networked engagement.<br/>Lack of experience in interdisciplinary settings and of knowledge regarding tools for integration.<br/>Power dynamics.<br/>Close-mindedness concerning what is accepted as knowledge.</p> <p><b>Lake Dümmer</b><br/>One-sided information flow on the lake's status and on progress of specific measures.<br/>Some stakeholders are cautious about poorly understood knowledge.</p> <p><b>Lake St. Charles</b><br/>Lack of formal common platforms.<br/>Non-transparency of governments and private sector.</p>   |
| <b>Feedback</b>             | <p><b>Common</b><br/>Some monitoring activities on the status of the lake and its tributary are in place.</p> <p><b>Lake Dümmer</b><br/>Dümmer council reports progress of policy measures to the state government. Based on reports, the state government revise measures if needed.<br/>Steady exchange between Chamber of Agriculture, farmers and Water Association on progress and effect of voluntary measures in agriculture.</p> <p><b>Lake St. Charles</b><br/>Recognition of need to monitor the system and adapt to new evidences.<br/>There is now more communication to help share the knowledge and learn from it.</p> | <p><b>Common</b><br/>Lack of communication and of proper networked engagement.</p> <p><b>Lake Dümmer</b><br/>Information flow too limited.</p> <p><b>Lake St. Charles</b><br/>Lack of experience or training of stakeholders in adaptive measures.<br/>The institutional culture concerning the very idea of what adaptation means.<br/>Lack of flexibility.</p>  |

undesirable future for the lake SES by restricting residential development in the lake and river watersheds through interim control by-laws. However, this represented primarily a reactive measure to prevent a short-term future and not an expression of long-term planning. Such preventive measures are similar to the concept of anticipatory governance as understood in its simplest form (e.g. Adey & Anderson, 2011; Aradau & Van Munster, 2012; Barker, 2012), but anticipatory governance, and even foresight alone, goes beyond preventive measures.

Since the MCQ board is mainly composed of officers from the City of Quebec, the imposed by-laws were perceived as interference from the City of Quebec and were unfavourably received by other municipalities, leading to low social acceptability and, eventually, legal conflicts in 2016. The situation led the MCQ to revise its position on preventing short-term futures by switching targets and attempting to prevent further disruption through increased social acceptability of measures. This was noticeable through a reopening of communication channels between the MCQ and municipalities. Workshop participants also underlined the importance of focusing on preventive measures rather than reactive ones; precisely one of the main purposes of foresight exercises (Croxtatto et al., 2020).

Nevertheless, many barriers remain for foresight to develop in Lake St. Charles governance. In the last two workshops, during the backcasting exercise and the reflection on governance, participants were unable to concretely imagine how to bring preventive measures into daily lake management. Also, a limited budget and ongoing priorities creates little to no incentive for decision makers to integrate foresight into the decision-making process. We observed a lack of openness to the idea of foresight as a planning tool from some of the municipal stakeholders who participated in the workshops. Therefore, the institutional culture can certainly prove to be an obstacle to foresight, as observed in this system. This observation is reminiscent of Fuerth's (2009) and Poli's (2017) argument about the importance of an open-minded institutional culture for foresight exercises to be realized and incorporated.

### 3.2 | Networked engagement

Networked engagement was part of the propositions raised by Lake Dümmer stakeholders, and it was the focus of many discussions at Lake St. Charles. The vision narratives showed that participants desired a much more engaged, horizontal platform in which all stakeholders could cooperate in the decision-making process, corresponding precisely with the networked engagement concept (Heo & Seo, 2021). All participants also agreed that a neutrally perceived umbrella entity would be needed to better engage all stakeholders in the decision-making process and to improve coordinated efforts in protecting the watersheds' ecosystems. However, obstacles within such an entity could arise should it lack critical necessary qualities for building trust and credibility among stakeholders, such as sufficient authority, legitimacy or perceived neutrality among stakeholders (Conca, 2019; Conley, 2013; Termini & Kalafatis, 2021). Thus, the processes and procedures that such a governance entity

would adopt to assure cooperation and deal with conflicts would very much determine its capacity to become an opportunity for networked engagement.

Another potential barrier in both case studies comes from a contradiction between the vision narratives and the backcasting scenarios. Despite inclusion of governance system restructuring to enhance coordinated efforts in the participants' visions from the first workshops, in the backcasting exercises, participants tended to favour concrete, fast actions with tangible results for reaching more specific objectives. This contradiction between the envisioned governance system and the commitment to fast, effective actions in the day-to-day tasks requiring the attention of decision makers creates a potential barrier for networked engagement to truly develop, hence for resiliency to flourish. This preference for efficiency has notably been highlighted as one of the greatest barriers to anticipatory governance (Boston, 2019; Michelson, 2013a).

#### 3.2.1 | Lake Dümmer

The Dümmer region has limited networked engagement made up of fragmented small networks. Connection between regional and state actors exists within smaller hubs of actor exchange. The Dümmer council, an organization established to supervise a redevelopment plan for the lake and to regularly report to the Lower Saxony State Agency on the progress of its implementation and effect, regroups around 24 people. They represent several municipalities, the three neighbouring districts, the Chamber of Agriculture, farmer associations, nature protection organizations, the tourism sector, the water sector, the Lower Saxony State Agency for water management, coastal and nature conservation, as well as the sailing and fishing associations. These meet three times annually to discuss the progress of measures in the Dümmer region and at the lake. Since the people participating do not change, their interaction has been consistent and led to mutual trust, which is one of the necessary pillars of networked engagement (Gupta, 2011; Kolliarakis, 2017). Furthermore, farmers, the chamber of agriculture and the regional water association have cooperated since 2012 in implementing voluntary water protection measures in agriculture to reduce nutrient input in aquatic systems. The municipalities and the Lower Saxony State Agency for water management also cooperate closely to tackle lake eutrophication.

Despite these local, specific cooperation examples, workshop participants highlighted several times that more exchanges across sectors and districts are needed. In the last workshop, they proposed establishing a platform to better connect actors from all sectors in the catchment. Current networked engagement thus remains too limited based on the point of view of participants.

#### 3.2.2 | Lake St. Charles

Participants of the backcasting exercises elaborated concrete steps to reach a governance system reminiscent of participatory

democracy, notably through a neutral entity with accessible and transparent communication channels, as well as shared responsibilities, demonstrating a true opportunity for developing a networked engagement in the Lake St. Charles SES. However, within the current SES governance, the call for a more networked governance structure ironically originated from the top-down approach favoured by the MCQ in the past and from a lack of networking. It is the social disruption and legal conflicts that resulted from previous MCQ actions that encouraged this entity, as well as municipalities, to engage in greater communication and citizen participation. Thus, political will to communicate with other stakeholders became an opportunity for networked engagement to emerge, which is not surprising given that political influence will often have a greater impact on actions than advances in technical or scientific knowledge (Serrao-Neumann et al., 2013). But depending on changes to the lake's ecological integrity, the probability that a top-down approach may re-emerge in future emergencies is not negligible, despite little success for environmental management and local implementation of measures with such approaches (Davies & Selin, 2012; Serrao-Neumann et al., 2013).

There are other inherent barriers to the actual governance system that may preclude it from reaching genuine networked engagement. The predominant one might be the fact that many powerful stakeholders may prefer to hold onto their authority and to the governance structures in place. This was observed through the expressed reluctance of some participants with more decision power to engage in anything more than symbolic citizen participation, as per Arnstein's (Arnstein, 1969) ladder of citizen participation. This trend is also observable through the way in which the City of Quebec has engaged concerned citizens, focusing thus far on information sessions. There has been no manifestation of any political will to go beyond a simply symbolic participation and to engage citizens in effective participation, even though this represents the cornerstone of networked engagement (Fuerth & Faber, 2013; Guston, 2014; Ohta, 2020; Schulz et al., 2020). The same holds true in the collaboration efforts between municipalities or between hierarchical levels of a same administrative entity, which often remain limited according to participants. Although communication channels have reopened, management occurs very much in organizational silos.

When discussing potential governance entities to orchestrate a governance restructuring, two of the most discussed possibilities were: (1) a committee established within the MCQ, but which would include democratic nominations of its members and rotation of its presidency, or (2) the watershed organization (OBV), as its actual function is precisely to regroup stakeholders around watershed-related issues. However, the MCQ structure is based on a representative democracy including elected members, while a networked structure requires participatory democracy which allows every stakeholder to share points of view. As for the OBV, although its role as an organization is to act as a consultation platform representing the point of view of all relevant stakeholders, it has no authority over municipalities and no substantial budget to carry out

necessary plans or actions. The lack of adequate entity to ensure true networked engagement, coupled with a disparity between the organization responsible for encouraging collaboration and the ones that actually possess the necessary qualities to do it, is thus another barrier to networked engagement.

### 3.3 | Integration

In both case studies, the greater opportunity for diverse knowledge type integration would come from the establishment of a networked governance structure, and thus of the envisioned governance system described by participants. Indeed, this would bring a holistic approach forward, binding different knowledge types together and leaving room for horizontal exchanges on transparent, formal, shared channels. Such channels are necessary for effective integration of knowledge, as extensively described in the literature (e.g. Gupta, 2011; Kolliarakis, 2017; Maffei et al., 2020). Therefore, the fact that participants recognized this need in the visions and in the backcasting exercises is another seed to enable integration becoming standard practice.

However, the absence of such networked engagement remains a notable barrier to integration in our case SES. And even if networked engagement was to come to fruition, the lack of experience of many stakeholders in multidisciplinary or interdisciplinary settings could certainly prove to be an obstacle to integration of different types of knowledge, as illustrated in both backcasting exercises in which participants argued in favour of integration without being able to propose tools for doing so. Such deficiencies can lead to a 'minimization of human complexity' in modelling exercises, reducing social data to simple quantitative data that cannot account for the full complexity of social realities (Bates & Saint-Pierre, 2018, 245). Furthermore, even in cases where stakeholders would possess the necessary tools and knowledge for integration, power dynamics and the level of acceptance of different knowledge types might hamper the successes of integration or the will of stakeholders to engage in such ventures.

#### 3.3.1 | Lake Dümmer

Integration of knowledge from the social and natural sciences, but also from different state sectors and from citizens, has so far been pursued to a limited degree. Ecological information about the state of the lake and its surrounding ecosystems are extensive and continuously communicated via a public forum established for the lake and discussed within the Dümmer council, as is the progress of the voluntary measures in agriculture and of the tributary's restoration. However, the interactions between human actions on the social side and dynamics within the natural system appear to be seldom identified and addressed. The interviews revealed that actors without natural sciences backgrounds were unsure and cautious regarding the ecological dynamics inherent to the lake.

### 3.3.2 | Lake St. Charles

The opening of communication channels in the last few years between different municipalities and other stakeholders prefaces a better integration of knowledge, but has not yet been attained in the Lake St. Charles system. Moreover, the lack of common, official platforms to share knowledge remains a barrier to integration, leading most stakeholders to keep working in isolation. Lack of governmental and private sector transparency remains another barrier to integration as some of the information necessary to construct a complete picture of the watershed and to make well-informed decisions remains out of reach for many stakeholders, as stated by participants in both workshops and interviews.

## 3.4 | Feedback

Again, a network structure, or a common platform could increase information flow and feedback among sectors, stakeholders and individuals for both cases; illustrated through the recurring argument that better information flow about the lake's state would help stakeholders understand how their actions can affect SES evolution. The lack of such networks and platforms creates different limitations to feedback processes of each SES.

### 3.4.1 | Lake Dümmer

The Dümmer Council provides some form of feedback, as its members report to each other about the status and progress of the policy measures, including the monitoring of the aquatic ecosystems. Members communicate the success and potential adjustments of the current measures in place to the State government. The State government in turn presumably adjusts the measures before implementing the revised or new measures. Moreover, farmers, the Chamber of Agriculture and the Water Association of the Hunte work closely together and collaboratively to exchange regularly on the progress of voluntary measures in agricultural practices and the water quality of the tributary.

We thus see two feedback processes in place, resembling their description in the literature (see for instance Gober, 2014; Jurgilevich, 2021): one across sectors at the regional level and one across sectors and different administrative levels. Stakeholders, however, have claimed that the information flow between sectors, districts and actors is too limited and should increase. Indeed, many actions aiming at further development of the region remain unknown to stakeholders.

### 3.4.2 | Lake St. Charles

In the vision and in the backcasting exercise, participants underlined the importance of constantly monitoring the lake SES to learn from

its evolution, and of adjusting or adapting measures and actions to new knowledge and scientific evidence, which is precisely one of the main purposes of feedback (Matthews & Baker, 2021; Quay, 2010). Participants also mentioned that some monitoring activities are in place and realized by several key stakeholders, which represents the first seeds of feedback processes. The reopened communication channels could help share the information thus generated to learn from it and adjust measures and actions accordingly.

That said, communication remains limited so far, as is coordination, making it virtually impossible for stakeholders to easily learn from their actions as they are less aware of which actions are responsible for which repercussions in the watershed. Yet, such learning is essential for feedback to be effective (Dotson, 2019; Poli, 2012). Furthermore, when participants were invited to elaborate on the concept of learning from new evidence, they had very little ideas on how to process. The lack of experience or training could thus again be a barrier.

When discussing adaptability of measures, most participants interpreted this as adapting each action and measure to the area of implementation. The idea of revising the entire system objectives based on its future evolution or on new evidence did not seem to be part of the institutional culture of participants. Such misinterpretation of participants concerning the concept of adaptation and the possibility of revising the very objectives of a SES also reflects a lack of flexibility, which is perceived to be a crucial element of feedback (e.g. Boettcher, 2020; Vij et al., 2017; White et al., 2015). This could represent an obstacle to feedback processes in certain circumstances, especially where greater than anticipated stress affects the SES, as a result of climate change effects for example.

## 4 | DISCUSSION

In this paper, to fulfil our first objective, we derived from the literature four criteria and one overarching property of anticipatory governance: foresight, networked engagement, integration and feedback, as well as ensemble-ization respectively. Apart from the emphasis on foresight, networked engagement, integration and feedback have also been highlighted under the concepts of polycentric (Ostrom, 2010) and adaptive governance (Folke et al., 2005). Different terms specified the criteria above like horizontal and vertical collaboration for networks, diverse knowledge systems in inter- and transdisciplinary fora for integration and social learning for feedback. The focus in preceding literature was more on how adaptive governance came into being via a crisis situation (Schultz et al., 2015) rather than long-term and purposeful-driven development of institutions. Anticipatory governance embraces both the capacity for anticipation—generating knowledge about possible futures—as well as the capacity to make use of this knowledge and respond to enhance resilience in the face of an uncertain future. Polycentric governance has a stronger focus on the response capacity rather than anticipation, while adaptive governance and management present a more prescriptive approach with steps reminiscent of the feedback criteria of anticipatory governance.

Still, in cases where social learning, or feedback, can get institutionalized (Pahl-Wostl, 2009), organisations can nurture their adaptive capacity and co-evolve with the management of and within complex SES. The remaining question is to which degree the anticipation of unfolding events, over longer time scales than those captured so far in governance and policy cycles, is possible and deemed necessary by involved actors to complement existing adaptive or polycentric governance regimes. So far, empirical attempts to identify and map adaptive (Borgström et al., 2015; Pahl-Wostl et al., 2012) and polycentric governance criteria (Galaz et al., 2012) demonstrated numerous barriers to enact collaborations matching the complexity of the respective SES challenge. Furthermore, it remains unclear to which degree crisis born institutions under the adaptive management scheme are sufficiently equipped to enhance resilience in the face of climate change (Schultz et al., 2015), hence anticipatory governance's focus on transformative rather than adaptive capacity. However, institutions that support such long-term processes are still missing, but long timescales also raise the question to which extent anticipatory governance can be established at the local level. In the end, it must be a multilevel process even when triggers may come from local or regional processes.

The second objective proposed in this paper was developed in the light of the above observations, stimulating our interest for exploring further than adaptive or polycentric governance and into anticipation processes within empirical settings. This allowed us to uncover opportunities for, and barriers to anticipatory governance in two case studies, based on the aforementioned criteria. Those opportunities and barriers highlight two observations. First, we support the claim from many authors (e.g. Fuerth, 2009; Michelson, 2013a; Wender et al., 2012) that to be successfully integrated to a governance system, anticipatory governance needs to focus on ensemble-ization of all four criteria. We do not define ensemble-ization as a criterion per se, but argue that it is an overarching property of a more mature anticipatory governance process. Second, our findings underline a potential course of action to shape governance into becoming increasingly anticipatory, which can serve as guidelines for interested decision makers. We discuss both points below.

#### 4.1 | About the need for ensemble-ization

Wender et al. (2012) consider ensemble-ization as a necessity in anticipatory governance 'to explore current socio-technical dynamics with regard to the future.' Similarly, Michelson (2013a) argues that other anticipatory governance criteria 'do not exist or play out independently of one another. Considering them together, as an ensemble, and exploring the mutually reinforcing connections among these dimensions is particularly important'. Fuerth (2009) and Poli (2017) discuss the importance of an open-minded institutional culture within a governance system, hence of enabling institutional settings which can support ensemble-ization. Our results support the arguments of those authors by going a step further and demonstrating how low ensemble-ization created barriers to anticipatory governance in our case studies.

The lack of appropriate networked engagement was perceived as a barrier to the three other criteria. Thus, without networked engagement, integration of knowledge was not possible, and neither was the development of foresight processes within the governance system nor of comprehensive feedback processes. If foresight is the centrepiece of anticipatory governance, networked engagement is one of its main catalysts. A lack of integration to permit a comprehensive understanding of the SES under study also limits the possibilities for foresight and for appropriate feedback. This is notably illustrated in the case of Lake Dümmer where the two feedback processes in place were not able to provide a complete picture of the lake system to stakeholders and which could have manifested through learning on the changing reality around the idea of the reed polder. We also saw that the absence of learning hampered further possibilities for adapting foresight exercises to the evolving context. This barrier has notably been highlighted by Segrave et al. (2016) as a paradoxical, inverse relationship between adaptive and anticipatory qualities of a system. Relying too heavily on anticipation may lead to prescriptive long-term planning, the authors argue, hampering the capacity to adapt. Adaptive capabilities are often associated with reactive measures. However, Segrave et al. (2016) also agree that both adaptation and anticipation can function in an integrative manner. If the foresight process embraces uncertainty, then adaptive capacity would be integral to the process, underlining once again the importance of ensemble-ization.

The seeds of networked engagement can also be perceived as an opportunity for some other criteria to emerge. This is notably the case with the Dümmer council which was able to support some form of system feedback. It is also the case with the reopening of communication channels between municipalities and stakeholders in the Lake St. Charles SES, leading many stakeholders to hope for more communication and integration of knowledge that might result in better adaptation of measures, hence in enhanced feedback.

In both contexts, we also saw how the institutional culture, if closed-minded to the ensemble-ization philosophy for governance, can obstruct the emergence of anticipatory governance. It was notably the case concerning the understanding of certain concepts, such as adaptation through feedback, which was often perceived as a way to adapt a given measure to a specific place, instead of adapting the course of action and objectives based on new learning. Another example comes from Lake St. Charles' institutional culture around the actual governance structure, which, we claim, could become a barrier to anticipatory governance: (i) if decision makers prefer to hold on to their authority instead of sharing some decision-making with other stakeholders and (ii) if short-term priorities keep overshadowing the need for foresight exercises to improve planning strategies.

These opportunities and barriers that directly stem from, respectively, the presence or absence of other anticipatory governance criteria, directly point to the importance of ensemble-ization. However, ensemble-ization should not be understood as an element that either does or does not exist within a governance

system. It is rather something that can manifest to a certain extent, sometimes only in certain contexts, under one or several forms. It can manifest as a formally stated principle for resource management, or as informal, cultural open-mindedness to knowledge generated or tools used in other sectors. Hence, the relevance of ensemble-ization does not lie in achieving it under all possible forms, but rather in ensuring some form of functional continuity between the different governance processes. That said, simply pointing out the relevance of ensemble-ization might appear as an austere approach for decision makers who often require more practical guidelines to take action. Therefore, based on our observations, we propose below a course of action that would facilitate proper, chronological development and evolution of anticipatory governance within a SES.

## 4.2 | Recommendations to work towards anticipatory governance

The course of action presented below to shape anticipatory governance processes is not meant to be prescriptive, nor to be set in stone. It is rather, presented as potential guidelines for interested decision makers or for researchers who would like to push this reflection further. The proposed guidelines emerged from reflections about our observations, but they must be approached with an understanding of their limits. Such limits relate mostly to each criterion's definition and sometimes misrepresentation in the literature. Most notably, foresight is sometimes understood as a prescriptive approach towards future planning, while it is in fact the opposite, promoting preventive, dynamic plans to adapt and better prepare for an uncertain future. A strictly structural approach to networks will not systematically lead to better communication without proper engagement on all sides. Integration might be hampered by personal interests and volition, even when all tools and networks exist to support it. Feedback, if emerging from crisis-born institutions, may not be adequately adapted to long-term planning. And finally, ensemble-ization, while underlined as an elementary property, represents more an idealized form of anticipatory governance and manifests in practice as many different, imperfect yet practical venues, processes or mindsets. With those limits clearly outlined, we suggest that anticipatory processes can develop through the following steps.

### 4.2.1 | Recognition and identification of actual governance limitations

The exercise carried out in this paper can serve as an example of the first step that could be taken to work towards anticipatory governance. That is, limitations of any given governance system can be recognized, and based on the criteria elaborated in this paper, opportunities for anticipatory governance and barriers to it, can be

identified. Knowing those opportunities and barriers will help decision makers to better understand how the system they govern relates to the concept of anticipatory governance. This should also help better prepare for the following steps.

### 4.2.2 | Development of networked engagement

As observed in both case studies, networked engagement is the cornerstone of anticipatory governance. Genuine networked engagement of all stakeholders in the planning and decision-making process can help better support integration, comprehensive foresight exercises, and feedback within the decision-making process. Based on the suggestions of case studies participants, networked engagement could be encouraged through the establishment of an umbrella entity ensuring development of the necessary actions to reach anticipatory governance. Horizontal and transparent communication channels, accessible to all, could also help such a network to reach its objectives. We have shown, through examples, how seeds of networked engagement can be identified within SES to help bring it to fruition.

### 4.2.3 | Integration of diverse knowledge

The development of networked engagement could open the door for integration of knowledge between disciplines and between different sectors. However, integration cannot be encouraged only through greater communication. It would need to be supported through interdisciplinary approaches and incorporate adequate multidisciplinary tools, such as modelling, to result in a comprehensive understanding of SES dynamics. Such understanding would help develop a planning process that is well-informed and would better provide stakeholders with an awareness of the many elements that constitute the issues that they are facing.

### 4.2.4 | Practice of foresight and feedback

The combination of networked engagement and integration of knowledge could support the development of foresight exercises to inform decision-making, as well as proper, well-informed feedback. Foresight exercises can be developed according to the different methods proposed in the literature (models, visioning exercises, scenarios, etc.) and would preferably be carried out regularly to keep them current. Feedback usually imply: careful monitoring of a system state and of the effects of any given measure on it; analysis of observations to learn from them; planning of appropriate adjustments needed to improve the applied measures, and; application of new or improved measures. It is usually preferable for such feedback processes to be carried out continuously, while taking into account and informing foresight exercises.

## 5 | CONCLUSION

This paper provides an overview of the concept of anticipatory governance through a systematic literature review, allowing us to redefine, in an exhaustive manner, the main four criteria brought forward to define anticipatory governance in the literature (foresight, networked engagement, integration, feedback). We also identify one facilitator for anticipatory governance to be successful (ensemble-ization). These criteria guided the analysis of our two lake SES case studies, carried out through participatory approaches, to look for opportunities for anticipatory governance, as well as barriers to it. Many of the opportunities and barriers found in our two case studies relate to the presence or absence of other anticipatory governance criteria, justifying the claim in the literature that ensemble-ization is indeed a necessary condition for anticipatory governance.

Based on our observations, we recommended a course of action to implement anticipatory governance, starting with the recognition and identification of a given governance system limitations, and followed by the development of networked engagement, integration of knowledge, and the practice of foresight and feedback. Such guidance on the development of anticipatory governance greatly improves its applicability and could arguably help many governance systems to enhance their anticipatory capabilities. We presented examples of this proposed course of action by illustrating how a governance system's limitations can be analysed through the lenses of anticipatory governance to identify opportunities and barriers to this concept. A critical review and incremental enactment of anticipatory governance criteria would favour SES resilience in the face of unpredictability associated with global climate change.

### AUTHOR CONTRIBUTIONS

Louis Tanguay and Laura M. Herzog jointly crafted the data collection process, led the fieldwork in Canada and Germany, respectively, and jointly wrote the article. They contributed equally and share first authorship. Beatrix E. Beisner edited the manuscript thoroughly. Beatrix E. Beisner, Romina Martin, René Audet and Claudia Pahl-Wostl reviewed and commented the manuscript. Romina Martin helped with specific sections regarding governance systems. Beatrix Beisner and Claudia Pahl-Wostl were lead researchers on the LimnoScenES research project and established its overall direction and objectives.

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### CONFLICT OF INTEREST STATEMENT

The authors declare no conflict of interest.

### DATA AVAILABILITY STATEMENT

The raw and processed data supporting the findings of this article at the following DOI: <https://doi.org/10.5281/zenodo.7626093>. However, some of the raw data with none-anonymized information, namely recordings of interviews and workshops, are absent from the repository in order to preserve the confidentiality of participants.

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### ENDNOTES

<sup>1</sup> In Canada, our study which involved human participants was reviewed and approved by Comité institutionnel d'éthique de la recherche avec des êtres humains at the University of Quebec at Montreal (Reference number: 3585\_e\_2019). Participants provided their written informed consent to participate in this study. In Germany, while such approval was not mandatory, the same ethical norms and methods were strictly followed.

<sup>2</sup> These are adjacent municipalities, agriculture, competent authorities, fishing, nature protection, tourism, water management and water sports.

<sup>3</sup> The interview questionnaire can be found in Supporting Information Data [S1](#).

<sup>4</sup> The text was inspired by Donella O'Meadows speech 'Envisioning a sustainable world', held at the Third Biennial Meeting of the International Society for Ecological Economics, October 24–28, 1994, San José, Costa Rica.

<sup>5</sup> A complete description of the data generated during the participatory process is available in Supplementary Data [S2](#).

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## SUPPORTING INFORMATION

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

**Supplementary Table S1.** Concepts and terms, derived from the 69 publications of the systematic review, associated with and regrouped under each of the five criteria, as well as the number of publications that discuss each criterion.

**Data S1.** Results from the participatory process.

**Data S2.** Interview Questionnaire – English version.

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