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RESEARCH NOTE

Horizon Scanning: A Process for Identifying Emerging Signals of Change Shaping the Future of Natural Resources Management

David N. Bengston[a], Tuomas Mauno[b], and Teppo Hujala[b]

[a]Northern Research Station, USDA Forest Service, St. Paul, MN, USA; [b]Faculty of Science, Forestry and Technology, School of Forest Sciences, University of Eastern Finland, Joensuu, Finland

ABSTRACT

Horizon scanning is a process to generate foresight – insight into how the future could unfold. Horizon scanning involves systematically searching a wide range of information sources for early signals of change, collecting those signals in a database, and exploring their possible implications for the future. The focus is often on external change in the broad contextual environment of a field or organization, i.e., the social, economic, technological, and governance domains. External change could be highly disruptive and is unlikely to be on the radar of decision makers. Early awareness of changes and monitoring their development over time can help natural resource planners, managers, and policymakers prepare for emerging challenges and opportunities. This paper introduces horizon scanning, characterizes different approaches and techniques, outlines the basic process, and briefly describes artificial intelligence in horizon scanning.

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Introduction

More than 100 years ago, conservation champion Theodore Roosevelt declared: "In utilizing and conserving the natural resources of the Nation, the one characteristic more essential than any other is *foresight*" (Roosevelt 1919, 548). Foresight is essential but also elusive, due to the prevalence of surprise and fundamental uncertainties about the future (Makridakis et al. 2010). Generating foresight is also problematic in a time of accelerating change (Azhar 2021).

Horizon scanning can help overcome these challenges. Since there are no data about the future, horizon scanning generates foresight – insight into how the future could unfold – by identifying emerging signals of change. This output of horizon scanning is a vital and often missing input into long-range planning in natural resources, as well as an input into other foresight methods, such as scenario planning and the futures wheel. Horizon scanning is a core tool in Futures Studies (Bell 1997) and has been applied in many fields, from business (Mühlroth and Grottke 2018) to outdoor recreation (Westphal 2022). Increasing use of horizon scanning in natural resources

CONTACT David N. Bengston david.bengston@usda.gov USDA Forest Service, Northern Research Station, 1992 Folwell Avenue, St. Paul, MN 55108 USA

and the environment in recent years has been stimulated in part by the long-running annual scans of emerging issues in biological conservation carried out by Sutherland et al. (2024).

The essence of horizon scanning is systematically searching diverse information sources for early signals of change that could affect a given field or organization, collecting those signals in a database, and exploring their possible implications. The focus is often on external change in the broad contextual environment of a field, topic of interest, or organization, i.e., the social, economic, technological, and governance contexts. External change could be highly disruptive and is unlikely to be on the radar of decision makers. Early awareness of nascent changes and monitoring their development over time can help natural resource planners, managers, and policymakers prepare for emerging challenges and opportunities.

This paper introduces horizon scanning as a process to generate foresight by identifying signals of change that could affect natural resource-related fields and organizations. The next section characterizes different approaches to horizon scanning, followed by an outline of the basic process. The increasing role for artificial intelligence in horizon scanning is then briefly described and a conclusion asserts that value of this tool is likely to grow given the accelerating pace of change and the need to prepare for an uncertain future.

Key Characteristics of Horizon Scanning

Horizon scanning encompasses a diversity of approaches and techniques. Definitions vary because of the wide range of approaches, but common to all definitions is the core objective of identifying emerging signals of change: "Horizon scanning aims to identify emerging issues and events which may present themselves as threats or opportunities for society and policy" (Amanatidou et al. 2012, 209). Beyond this basic goal, many characteristics describe the various approaches to horizon scanning. For example, horizon scanning may be:

- Exploratory or issue-centered. The goal of exploratory horizon scanning is to identify the full spectrum of signals of change that could affect a given field or organization, while issue-centered scanning focuses on monitoring a previously identified issue, driver of change, or trend, and searching for signals that confirm or disconfirm its continued emergence (Wintle, Kennicutt II, and Sutherland 2020). Both approaches may be used in a large-scale scanning project, i.e., an initial phase of broad exploratory scanning, followed by an in-depth phase of issue-centered scanning.
- Ongoing, periodic, or one-time. Ongoing horizon scanning efforts gather signals of change continuously over multiple years (e.g., Hines, Bengston, et al. 2019), and periodic scanning occurs at regular intervals, like the annual biological conservation scans of Sutherland et al. (2024). Many horizon scanning projects are one-time efforts (e.g., Spaniol and Rowland 2022).
- Automated or manual. Automated horizon scanning uses AI or text-mining to identify potential emerging signals of change (e.g., Ishigaki et al. 2022). Manual

searching relies on individuals to search for signals. Most automated scanning employs a hybrid or semi-automated approach, using automated scanning to identify signals and analysts to examine and prioritize the signals.

- Expert-based, team-based, crowd-sourced, or individual. Manual horizon scanning can be carried out by a group of experts in a Delphi-like process (e.g., Oldekop et al. 2020), a diverse and trained scanning team (e.g., Hines, Bengston, et al. 2019), a group of participants crowd-sourced from within an organization (e.g., Hiltunen 2011) or crowd-sourced through a widely distributed open call (e.g., Esmail et al. 2023), or a by single person (e.g., Coote 2011).
- In-house or purchased. Some organizations carry out their own horizon scanning efforts internally (e.g., Hines, Bengston, et al. 2019), while others purchase custom-designed scanning services from a foresight consultancy (e.g., Shaping Tomorrow 2024).
- Short- to long-term. The time horizon for scanning can vary depending on the timeframe for decision making and objectives of the scanning exercise (Cuhls, der Giessen, and Toivanen 2015). Corporate horizon scanning efforts tend to have short time horizons, often as short as few years (e.g., Mühlroth and Grottke 2018).
- Regional to global. The geographic scale of horizon scanning projects can range from regional (Spaniol and Rowland 2022) to national (e.g., van Rij 2010), to global (e.g., Sutherland et al. 2024), depending on the objectives of the project.
- Pre-defined or open. Within the field of interest for a scanning project, the specific topics scanned may be specified in advance in a "domain map" (Hines et al. 2018), or the topics and tags may be allowed to emerge inductively from the scanning process, i.e., a grounded theory approach.

Each of these characteristics represents a decision that needs to be made in setting up a horizon scanning project. Additional considerations include whether horizon scanning is requested by policymakers or other stakeholders to fulfill a specific need for foresight or is unsolicited (Wintle, Kennicutt II, and Sutherland 2020). Finally, horizon scanning may be a stand-alone activity (e.g., Coote 2011) or embedded as an early stage of a full strategic foresight project (e.g., Taylor et al. 2019).

Outline of the Horizon Scanning Process

The scanning process has been outlined in many ways, with different steps and levels of detail highlighted (e.g., Gordon and Glenn 2009, Day and Schoemaker 2006, Amanatidou et al. 2012). But four main steps are common to most scanning processes: (1) Scoping and Framing, (2) Scanning and Collecting, (3) Analyzing and Synthesizing, and (4) Communicating and Using Results (Figure 1). *Scoping and Framing* involves defining the nature of a horizon scanning project based on the characteristics described in the preceding section, i.e., should it be exploratory or centered on previously identified issues? Should it be ongoing, periodic, or one-time? A key aspect of scoping a horizon scanning project is to specify the guiding question that clearly states the overall objective (Wintle, Kennicutt II, and Sutherland 2020).

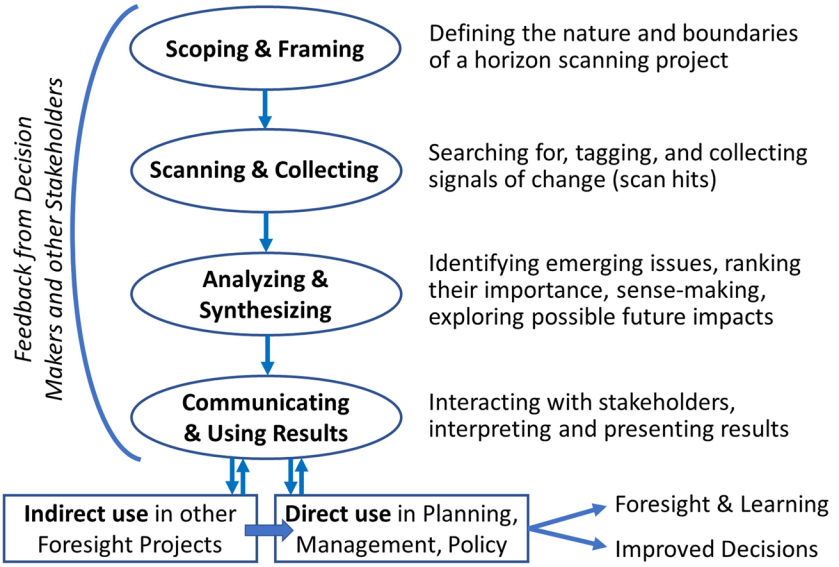

Figure 1. Horizon scanning process.

Scanning and Collecting is the core step of the horizon scanning process and consists of searching for signals of change, tagging them with descriptive terms, and collecting the signals in a searchable database. It is important to search diverse information sources, including fringe sources, because change often develops on the periphery, far from mainstream thinking (Schwartz 1996). Many types of signals that could affect the future of the area of focus are gathered, such as emerging issues and developments, trends, countertrends, broad drivers of change, "weak signals" or earliest signs of a change (Miles and Saritas 2012; Coote 2012; Cuhls, der Giessen, and Toivanen 2015) and potential wild cards (Bengston 2023). Information about each change signal is collected in a template or form (e.g., Bishop 2009). Simple templates are preferable; detailed and complex templates may impede the scanning process by placing an excessive burden on scanners (Géring, Király, and Tamássy 2021). Links to individual signals and information about them are collected and stored, usually in an online cloud-based bookmarking tool, or in a spreadsheet on a cloud-based file-sharing system.

Analyzing and Synthesizing involves various "sense-making" activities aimed at prioritizing and understanding the signals of change collected (Konnola et al. 2012). This step may involve a variety of techniques and approaches, including grouping individual signals into broader categories, ranking their importance using multiple criteria (e.g., credibility, likelihood, impact), developing hypotheses about the meaning of signals, and exploring possible direct and indirect implications using the Futures Wheel (Bengston 2015).

Finally, *Communicating and Using Results* is a vital step. To be useful, the outputs of scanning must be interpreted and presented in appropriate formats for various user groups (Hines 2019). Typical scanning outputs include periodic newsletters or articles summarizing significant emerging issues (e.g., Coote 2011), blog posts, in-depth articles, technical reports (e.g., Westphal 2022), and presentations to planners, managers, and

policymakers. Communicating horizon scanning also involves interaction with and feedback from users so that the scanning process can be adjusted to produce more appropriate and useful information.

Artificial Intelligence and the Future of Horizon Scanning

Most horizon scanning projects still use labor-intensive manual or semiautomated scanning (Mühlroth and Grottke 2022). But with recent advances in artificial intelligence (AI), horizon scanning is likely to shift toward much greater use of fully automated approaches (Hines, Bengston, et al. 2019). AI has the potential to carry out some aspects of horizon scanning with greater efficiency, thoroughness, and speed.

An important strength of AI is its ability to examine vast amounts of data rapidly and accurately – volumes of data that would not be feasible to analyze manually (Mühlroth and Grottke 2022). AI algorithms can continuously scan the internet, searching everything from the latest scientific journals to speculative blog and social media posts for emerging signals of change. AI can classify and cluster these signals and uncover patterns in this extensive array of information that would be indiscernible to a human analyst (van Belkom 2020). In addition to searching the internet, AI-based systems could also be used to query experts for their ideas about emerging signals of change, similar to the Delphi-like manual horizon scanning process used by Sutherland et al. (2024).

At its current state of development, AI also has important limitations in horizon scanning, such as dependence on vast quantities of historical data (van Belkom 2020). Another significant limitation is a lack of creativity, which is essential for identifying potential weak signals of change.

A recent application of AI in horizon scanning is Mühlroth and Grottke (2022) data mining model designed to help firms identify technological innovations and trends. The model includes components covering all aspects of the horizon scanning process and requires minimal input from human analysts while setting it up. In a retrospective analysis to test the system, the model was applied to three case studies of emerging technologies and it was able to identify these technologies early on.

Concluding Comment

The practical benefits of horizon scanning are indicated by its widespread use in public, private, and nonprofit organizations in many fields. A key benefit is to alert planners and decisionmakers to emerging risks and opportunities early enough to prepare for them (van Rij 2010). Other benefits include creating a longer-term perspective, decreasing reaction time to rapid change, and encouraging a broader view of the future. In 2009, Sutherland and Woodruff argued that horizon scanning is underutilized in environmental and natural resource practice and should become a standard tool. The increasing use of this practice in natural resource applications in recent years suggests growing recognition of its usefulness. The value and use of horizon scanning is likely to continue to grow given the accelerating pace of change and the need to prepare for an uncertain future.

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ORCID

David N. Bengston http://orcid.org/0000-0002-7358-1059
Teppo Hujala http://orcid.org/0000-0002-7905-7602

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