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Horizon Scanning for Environmental Foresight: A Review of Issues and Approaches

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Abstract

Natural resource management organizations carry out a range of activities to examine possible future conditions and trends as part of their planning process, but the distinct approach of formal horizon scanning is often a missing component of strategic thinking and strategy development in these organizations. Horizon scanning is a process for finding and interpreting early indications of change in the external environment of an organization or field. Effective horizon scanning serves as an early warning system to identify potential opportunities and threats, enable decisionmakers to plan accordingly and take timely action, and foster a culture of foresight throughout an organization. This paper reviews and discusses the key items needed to create an effective horizon scanning system: conceptual frameworks, organizational approaches, design principles, techniques to improve effectiveness, and techniques for analyzing and interpreting scanning results.

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Cover Photo

Forest ranger Bryce Ledford uses binoculars at Yellowpin lookout in Sabine National Forest, Texas. Undated photo used with permission of the Forest History Society, Durham, NC.

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INTRODUCTION

Natural resource managers and policy makers are continually working toward a desired future within the context of rapid and turbulent change in the external environment in which they operate. To be effective in a complex and changing world, decisionmakers must look ahead to anticipate emerging trends, issues, opportunities, and threats. They need to develop and apply strategic foresight, i.e., "the ability to create and maintain a high-quality, coherent and functional forward view and to use the insights arising in organisationally useful ways; for example: to detect adverse conditions, guide policy, shape strategy" (Slaughter 1999b: 287). Natural resource management agencies work to gain strategic foresight by many means. For example, the U.S. Department of Agriculture, Forest Service (USFS) carries out the Resources Planning Act Assessment every 10 years to provide a detailed look at current conditions and trends for the Nation's renewable forest resources. National forest planners are required by the 2012 USFS Planning Rule to "rapidly evaluate existing information about relevant ecological, economic, and social conditions, trends and sustainability," and to "consider and evaluate existing and possible future conditions and trends of the plan area" (USFS 2012: 21262).

These and many other existing activities for developing foresight are essential. But they may not be sufficient to meet the need for high-level strategic foresight in the present era of increasingly rapid, complex, and surprising change. Horizon scanning is one approach to help policy makers develop and maintain the broad and externally focused forward view they need. Also known as environmental scanning, external scanning, and strategic scanning, horizon scanning may be defined as "the acquisition and use of information about events, trends and relationships in an organization's external environment, the knowledge of which would assist management in planning the organization's future course of action" (Choo 2002: 84). Characteristics of horizon scanning that distinguish it from the typical activities to survey future conditions and trends carried out by forest planners include its emphasis on "weak signals" (early indicators of potential change), comprehensive scanning of all sectors, an emphasis on external trends and developments, and the inclusion of possible wild cards (low-probability, high-impact events). Horizon scanning encompasses a wide range of techniques and organizational approaches for identifying and interpreting the potential implications of weak signals of change. Ideally, horizon scanning serves as an early warning system to identify potential threats and opportunities. The goals are to find nascent indications of important future developments so decisionmakers can plan accordingly and take timely action, and more broadly to foster a culture of foresight in the organization.

Techniques for systematically gathering and analyzing information about emerging external issues and trends were originally devised by military intelligence officers to gain insights into new developments in enemy countries (Cornish 2004). Scanning has long been standard practice in the military, the intelligence community, and the business world and is a core method in futures research. In recent years, horizon scanning has been used in a growing number of fields in the public sector, such as human health (Douw and Vondeling 2006) and education (Munck and McConnell 2009). But the use of formal horizon scanning in natural resources and the environment has been limited. Rare examples include scanning exercises related to biodiversity (Sutherland et al. 2008) and global conservation issues (Sutherland et al. 2010), and the U.S. Army Environmental Policy Institute's futures scanning on environmental issues (U.S. Army Environmental Policy Institute, n.d.). The National Advisory Council for Environmental Policy and Technology recommended that the U.S. Environmental Protection Agency (EPA) create an ongoing, institutionalized scanning system (U.S. EPA 2002), but this recommendation has not been implemented. Though widely used in many fields, horizon scanning remains an underused tool for natural resource planning and decisionmaking (Sutherland and Woodroof 2009).

Although formal horizon scanning is uncommon in environmental and natural resource management organizations, all decisionmakers scan the external environment. Some scan passively and informally, keeping their antennae up and waiting to receive outside signals of change that may be significant. Others scan actively and formally. The research literature on scanning

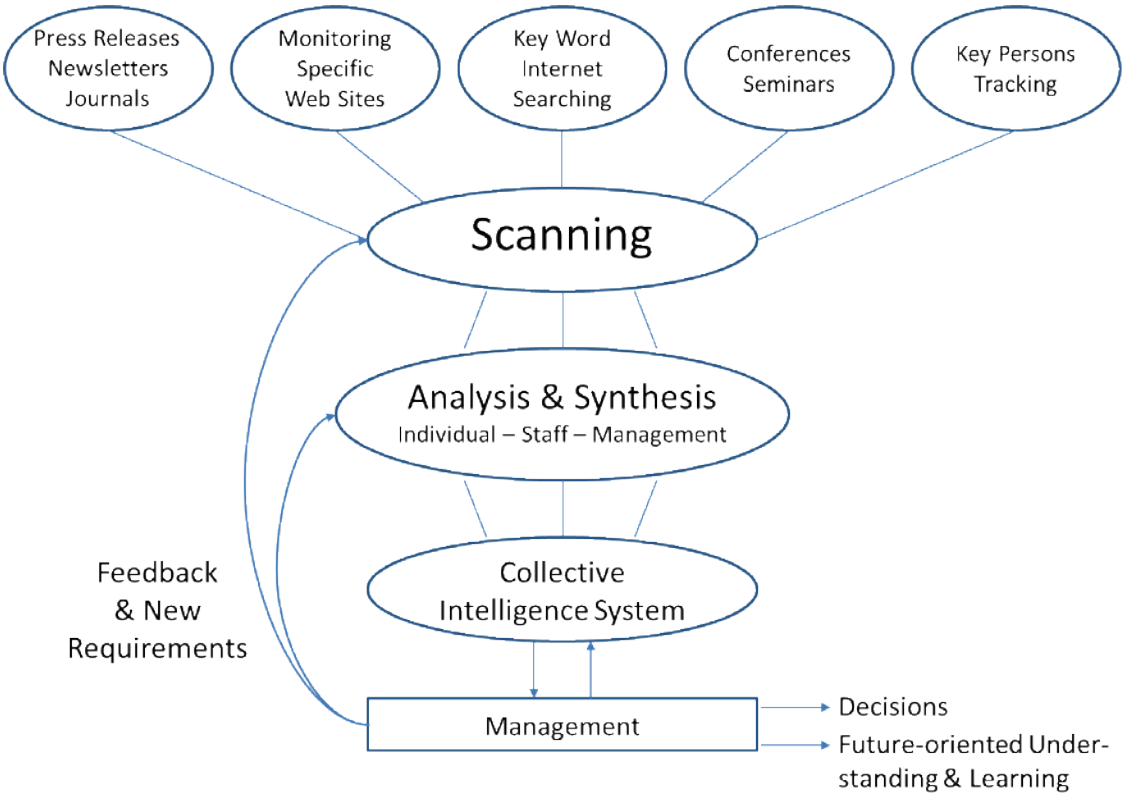

Figure 1.—Conceptual model of a horizon scanning system. (Source: Gordon and Glenn 2009).

in business clearly shows the value of active and formal scanning (Choo 2002). This paper introduces this topic to natural resource planners, managers, and policy makers, and reviews key considerations needed to create an effective horizon scanning system. The following section reviews two conceptual models of horizon scanning systems to indicate the basic elements and structure. This review is followed by discussions of the organizational approaches and design principles that need to be considered in different organizational contexts. Techniques to improve the effectiveness of scanning and to analyze and interpret scanning results are described in subsequent sections.

CONCEPTUAL MODELS OF HORIZON SCANNING SYSTEMS

Many different horizon scanning systems have been developed by futurists, business scholars, and others. These systems encompass a wide range of approaches and elements. Most include at least three main components: scanning, analysis, and interaction with decisionmakers. In this section, I describe the broad outlines of two typical horizon scanning systems, one developed by futurists Gordon and Glenn (2009) and the other by business researchers Day and Schoemaker (2006).

Figure 1 depicts a generic horizon scanning system proposed by the Millennium Project, an independent global futures research think tank (Gordon and Glenn 2009). The scanning component usually consists of a team effort to examine diverse information sources to identify potential signals of change and emerging trends, referred to as scanning hits. Examples of scanning hits could include a breakthrough in nanotechnology reported in the research literature, a surge in permit applications for sand mining for hydraulic fracturing in a region, or a decline in participation in outdoor recreation activities among youth. A few common information sources are shown at the top of Figure 1, but a large number of diverse sources should be examined.

The analysis and synthesis component involves identifying potential consequences of individual scanning hits, as well as synthesizing multiple trends or weak signals of change and looking at possible big-picture implications. A variety of techniques may be used to

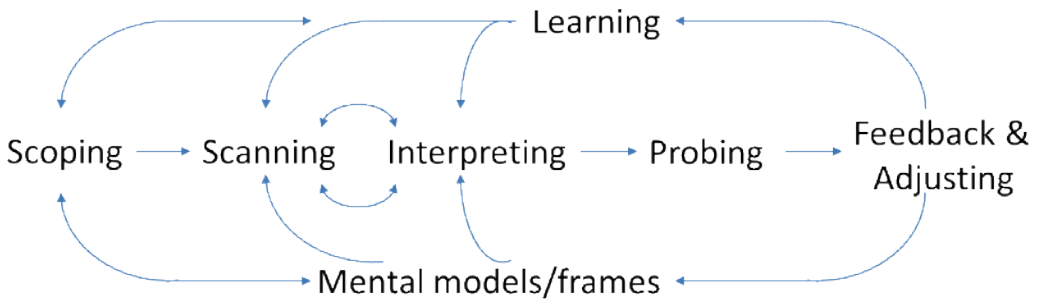

Figure 2.—Conceptual model of horizon scanning as a learning process. (Source: Day and Schoemaker 2006: 192).

facilitate analysis and synthesis of scanning hits (see the section below on techniques for analyzing, synthesizing, and interpreting). Information about raw scanning hits and the results of analysis and synthesis are entered into an interactive database or collective intelligence system that can be searched for keywords to identify patterns and generate reports on topics of interest. This database is made accessible to managers and policy makers in several ways, such as summary pages, emails of latest scanning hits, and the capability to search the database. The idea is to give decisionmakers a window into the system. Finally, interaction with and feedback from management is a key element for scanning systems, so that (1) the system "learns" how to produce information that is most relevant to decisionmakers and (2) decisionmakers understand the implications of unfamiliar trends and developments.

To facilitate the various stages in Gordon and Glenn's (2009) scanning system, they developed a template to systematically collect information about each scanning hit (i.e., an emerging trend or development of interest). The template includes the following fields for each item: (1) category or domain it falls in (e.g., technological, economic, environmental, or social), (2) leading indicator (i.e., what would indicate change in this scanning hit?), (3) source of the information and how to access it, (4) other comments about the scanning hit, (5) significance, importance, or possible consequences of the item, (6) current status, (7) actors involved in or affecting the item, and (8) date entered and name of scanner entering the item. Bishop (2009) presents a more detailed template developed by futurist Wayne Pethrick that includes subjective ratings of the impact, plausibility, novelty, and timeliness of each scanning hit.

A more detailed horizon scanning process from the business world is summarized in Figure 2 (Day and Schoemaker 2006). This model is grounded in organizational learning theory and consists of five stages: scoping, scanning, interpreting, probing/acting, and feedback/adjusting. Scoping is the process of defining how broadly an organization should scan. If the scope is too narrow, the organization risks being broadsided by external surprises; if the scope is too broad, there is a risk of being overwhelmed by unimportant signals. Day and Schoemaker (2006: 32-47) present a set of guiding questions to strike the right balance in scoping. In general, greater uncertainty in an organization's environment requires a broader scope. Given an appropriate scope, scanning is the process of searching for emerging trends and issues, and should include a balance of exploratory scanning (searching broadly in unfamiliar areas to provide a big-picture view) and "exploitation" scanning (searching in greater depth within well-defined or familiar domains). Interpreting involves developing hypotheses about the meaning of signals identified by scanning. Day and Schoemaker note that interpreting is strongly affected by incomplete and narrow frames of thinking. Confirmation bias—the tendency to favor information that confirms our existing beliefs (Nickerson 1998)—also affects our ability to accurately interpret the meaning of scanning hits. Therefore, a shift or expansion of our individual or organizational mental models may be required to appreciate potential threats or opportunities (Barker 1992).

Probing and acting is about responding to the weak signals and their anticipated implications. There are three main approaches to responding: watch and wait (a passive approach that may be appropriate when stakes

are low or there is high uncertainty), probe and learn (a more proactive response to learn more when the cost of inaction is higher), or believe and lead (a strong commitment to respond when a convergence of signals indicates that a threat is imminent or an opportunity is very promising). Finally, feedback and adjusting is the process of obtaining feedback on actions related to weak signals and making appropriate adjustments to the organization's understanding of its environment, including its mental models.

Other models of horizon scanning have been proposed, but they are fundamentally variations on the basic models. For example, futurists Slaughter (1999a), Voros (2001), and Hines (2003) focus on the importance of scanning a broad range of sources and draw on the work of integral philosopher Ken Wilber to achieve this breadth. The essence of this "integral futures" approach is a four-quadrant matrix that identifies four spheres of social life that should be incorporated in scanning to ensure the inclusion of both objective phenomena that are measurable (e.g., from the scientific and social realms) and subjective phenomena that must be interpreted (e.g., from the realms of art and morality).

ORGANIZATIONAL APPROACHES

Horizon scanning systems have been designed for many different types of organizations to accomplish an array of purposes and have used diverse approaches. They range from systems that provide a one-time or periodic scan in large corporations based mainly on the insights of top leaders, to continuous scanning processes that are tailored for public sector agencies and that use a participatory approach. Some scanning systems use a small team of full-time scanners, whereas others enlist many part-time scanners throughout an organization. Scanning may be focused on a specific set of priority issues, or it may involve broad scoping of the entire external environment. The diversity of approaches suggests that scanning systems should be designed to fit the context and information needs of decisionmakers in a particular organization. Yasai-Ardekani and Nystrom (1996) show that organizations with effective scanning systems align their approach with their specific organizational context. This section briefly describes the three main organizational approaches for horizon scanning activities: outsourcing to consultants, an in-house dedicated scanning team, and an in-house core team working with a network of part-time scanners throughout the organization.

Outsourcing to Consultants

Outsourcing scanning activities to consultants is a common approach and a large number of firms offer scanning services customized to clients' information needs. Organizations may purchase scanning services and analyses, or simply subscribe to scanning newsletters that are more or less tailored to their needs (Lesca and Caron-Fasan 2008). Using the expertise of consultants may be a quick and effective way to initiate scanning, and outside partners may provide innovative perspectives that can be difficult to obtain from internal efforts. But Day and Schoemaker (2005) note that organizations need to work hard to ensure that the scanning insights of outside consultants are relevant and incorporated into strategic planning and decisionmaking. A small in-house team typically works with the consultants to help ensure relevance, interpret scanning hits, and communicate with executives. Choudhury and Sampler (1997) suggest that scanning should be outsourced only when information specificity for the area being scanned is low, i.e., information can be acquired by individuals without specific knowledge of the area.

Dedicated In-house Team

A second approach is to form a dedicated in-house scanning team whose sole job is to search for, analyze, and communicate information about trends in the external environment. Dedicated scanning teams are widely used in corporations of all sizes (Brown 2007, Choo 2002). Such teams are sometimes referred to as a "crow's nest" because they function like the lookout in a ship, signaling information about objects on the horizon—both opportunities and potential threats—to the captain and crew. The size of these teams varies considerably depending on the size of the organization, from two or three members up to dozens. To be effective, full-time scanning teams must work to avoid the trap of becoming isolated from decisionmakers (Day and Schoemaker 2005). A potential drawback of this

organizational approach—as well as outsourcing—is that limiting scanning activities and responsibilities to a select group can make it more challenging to foster a culture of foresight throughout an organization.

Core Team with Network

The third main approach to organizing horizon scanning activities is more broadly participatory: a small in-house scanning team (or an individual) working with a much larger network of part-time scanners. Choo (1999), Day and Schoemaker (2005), and others have made the case that scanning is more effective and produces richer insights for decisionmaking when it is a widely distributed activity with many people participating. A participatory approach is based on the assumption that everyone in an organization, not just a designated scanning team or top leaders, may have valid and important insights about the changing external environment, and a scanning system should therefore facilitate gathering insights from as many people with as diverse backgrounds as possible. The core scanning unit may consist of a single half-time coordinator or a team of several members, and is supported by a network of people throughout the organization who spend a small part of their time engaged in scanning (Conference Board of Canada 2008). The scanning network may consist of volunteers or purposely selected individuals formally assigned to the duty. In public sector agencies, outside stakeholders representing diverse perspectives could be recruited and trained to actively contribute to scanning.

Other Approaches

There are many variations on these three approaches to structure scanning activities, and they may be combined in various ways: Outside consultants often design and set up in-house scanning systems, or a consultant may train an internal scanning team. Additional approaches to organize periodic or one-time scanning efforts typically involve group processes relying on external experts or internal leaders. For example, the Quick Environmental Scanning Technique (QUEST) was developed for use in relatively large organizations (Nanus 1982). An underlying assumption is that members of the top management team have valid and insightful views of the changing external environment but rarely articulate and share these views. The QUEST process provides a systematic framework to bring these views to light in order to aggregate, examine, test, and put them to use for strategic planning and decisionmaking. By tapping into top leaders' collective knowledge, QUEST also engages these leaders in the scanning process and secures their "buy-in" of the results (Slaughter 1990).

The QUEST process involves four main phases. First is the preparation phase, which focuses on creation of an initial notebook containing information about major trends and relevant issues in the organization's field and the external environment. The information is drawn from a variety of readily available sources such as trade association and government publications and recent articles speculating about the future of the field, and the notebook is distributed to a group of 10-15 top executives and managers from the organization. The second phase is a 1-day scanning workshop spent in carefully structured discussion of important issues that may affect the future of the organization. Scenario development is the third phase, in which the QUEST facilitator prepares a report analyzing all of the information generated in the preceding phase. The report also includes development of three to five scenarios describing possible future environments the organization may find itself in based on the major themes that emerged during the 1-day workshop. The report is distributed to participants 1 week before the final phase, a half-day strategic options identification workshop. Based on the report, participants identify and rank strategic options to deal with the changing organizational environment. Strategic planning teams are also formed to follow up on development of the high-priority strategies.

DESIGN PRINCIPLES

Regardless of which organizational approach is used, additional design issues must be addressed to structure scanning activities, including the degree of focus; continuous or periodic scanning; the time horizon for scanning hits; and the importance of having a diverse scanning team, information sources, and products. These design principles are discussed in the following subsections.

Focused or Broad Scanning

Day and Schoemaker (2006) emphasize that scanning activities should begin with scoping to determine how broadly to search. Horizon scanning sometimes focuses on a particular domain considered to be most important, such as emerging technologies (Douw and Vondeling 2006), competitive or competitor intelligence (Ghoshal and Westney 1991), or a particular issue or set of issues. But scanning that is too focused will fail to detect signals of change in other domains, raising the risk of being blindsided by unexpected developments (Harris 2002). The other end of the scoping spectrum is to make the scope of horizon scanning as comprehensive as possible, a full-circle sweep to detect signals of change anywhere in the external environment. Futurists generally take this comprehensive or high-level approach to scanning (e.g., Hines 2003, Slaughter 1999a) because they have found that changes in seemingly unrelated external areas can have unexpected and profound effects. For example, the automobile had a transformative effect on the use of public lands in the 20th century, including fostering the creation of the wilderness system as a way to preserve lands from widespread road building (Sutter 2002). The potential downside of comprehensive scanning is the risk of overwhelming decisionmakers with unimportant signals. Therefore, careful analysis, synthesis, and interpretation are essential if a broad approach is taken. A mixed strategy of both broad, high-level scanning and low-level scanning that homes in on specific areas and analyzes them in detail may be optimal (Choo 2002).

Several trend classification systems have been used to facilitate scanning broadly across every sector of the external environment. For example, a widely used classification system features six broad categories with the acronym DEGEST: demography, economy, government, environment, society/culture, and technology (Kotler and Keller 2008). Another commonly used acronym for sectors in the macroenvironment is STEEP: social, technological, economic, environmental, and political (Morrison 1992). Trend classifications such as these are useful starting points to ensure scanning a wide range of topics, but organizations often build on standard lists and develop their own set of categories important to their unique context and information needs. For example, horizon scanning in corporations often includes scanning for trends related to customers, suppliers, and competition (Choo 2002). The public sector equivalent would be to include the full range of an agency's stakeholders—e.g., how their attitudes, beliefs, values, demographic characteristics, and views of policy and management issues are changing and what these changes might imply—so the agency can be responsive to stakeholders' needs in the future.

Continuous or Periodic Scanning

Many horizon scanning systems are designed to provide ongoing, continuously updated information about the changing external environment, bringing weak signals of change to the attention of decisionmakers as soon as they are spotted on the horizon. Some professional scanners and futurists believe a continuous approach is essential to avoid static scans that are unresponsive and quickly become outdated (Conference Board of Canada 2008). Other scanning efforts provide periodic assessments of major emerging trends and driving forces of change. Examples of public and nonprofit sector periodic scans are the United Way of America's (1992) "What Lies Ahead" reports produced every 2 years from 1980 through 1992, the Millennium Project's annual "State of the Future" report (Glenn et al. 2012), the United Nations Environment Programme's biennial reports on emerging environmental issues (United Nations Environment Programme 2012), and the U.S. Central Intelligence Agency's quadrennial assessments of global trends (National Intelligence Council 2012). Which approach is more appropriate—continuous scanning of weak signals, periodic assessments of major trends, or some blend—depends on the purpose of the scanning system, users' information needs, and the degree of turbulence in an organization's external environment.

Time Horizon

Scanning systems sometimes incorporate multiple time horizons into the scanning framework to help planners and decisionmakers sort out and deal with a large number of trends and issues that may emerge or have an impact at different points in the future. For example, Brown (2007) describes three time horizons for different types of trends: Horizon 1 ("now") includes trends and driving forces that

are having an impact on an organization today, horizon 2 ("next") consists of emerging trends that are expected to have an impact in the near future, and horizon 3 ("new") applies to trends and driving forces that may shape an organization's environment in the longer term. The exact definitions of horizons 1, 2, and 3 are variable and will depend on the pace of internal and external change. In its quarterly horizon scans, the Centre for Environmental Risks and Futures (CERF) at Cranfield University sorts scanning hits into three time horizons: 1-3 years, 3-10 years, and 10+ years (CERF 2012).

Diverse Scanning Team

Including diverse perspectives on scanning teams is widely viewed as essential for success. Scanning team members are typically limited in their ability to scan effectively by their disciplinary backgrounds, frames of reference, and other personal factors. Specialists tend to see what they are trained to see, a phenomenon that Weiner and Brown (2005: 2) have called "educated incapacity." This limitation poses a basic challenge for horizon scanning: how to best break out of the paradigms and ways of thinking that limit our perception of potentially significant trends and developments, especially in unfamiliar areas. To help overcome these blinders, scanning teams—whether made up of a few full-time scanners or many part-timers—need to be as heterogeneous as possible, with diverse backgrounds, perspectives, and experiences (Morrison and Wilson 1997). Page (2007) documents that complex problems are solved more effectively with diverse teams than by the best individual experts. To increase diversity and effectiveness, Day and Schoemaker (2005) suggest that scanning teams include an organization's maverick employees – individuals who tend to reject conventional wisdom and think outside-the-box. The importance of diverse perspectives on scanning teams implies the need to include diverse stakeholders in public agency scanning efforts.

Diverse Information Sources

Scanning a wide range of information sources has also been shown to be critical for success. Choo (2002) recommends including both human and online (or textual) categories of information. Human sources should include individuals who are making the future or have their finger on the pulse of change, such as scientists and researchers, futurists, innovative colleagues, consultants, government officials, reporters and other media representatives, artists, and community leaders. Identifying forward-looking individuals across many domains is a challenging but crucial task in developing a network of human sources. Hiltunen (2008) found that human sources were ranked the most useful across all domain areas in a survey in which 121 futurists were asked about the best sources for identifying weak signals of change. Online sources include the Web pages of organizations and individuals, electronic databases, blogs, podcasts, discussion groups, and email newsletters, as well as traditional textual information sources such as academic and scientific journals, popular science and other periodicals, books, newspapers, fringe or underground press, doctoral dissertations, and government and non-profit sector reports.

Regardless of whether information sources are human or online, Schwartz (1996) suggests scanning nontraditional sources and seeking out potential trends on the edges of society rather than the mainstream. Some professional scanners recommend including speculative fiction, poetry, film, music, and art to develop an awareness of deeper cultural currents and changes in society (Coote 2012). Schwartz's (1996) chapter on "information hunting and gathering" is filled with tips for searching out innovative thinkers and sources of information about change, such as reading broadly outside your specialty and field, contacting the authors of challenging articles and books, cultivating relationships with people with whom you disagree but can talk cordially, and immersing yourself in unfamiliar and challenging environments and cultures through travel.

Diverse Products

Scanning may generate a variety of products, from continuously updated online databases to lengthy periodic reports. The timeframe for decisionmaking typically determines the most appropriate way of delivering scanning results. Regular electronic newsletters or concise periodic reports are viewed as useful in most planning and decisionmaking contexts according to

surveys of horizon scanning practitioners in business (Conference Board of Canada 2008) and in the public sector (Pflaum and Delmont 1987). Workshops with users to discuss and interpret findings are also widely employed. To increase the use, insights, and sense of ownership in scanning, an interactive online database is often a key product. Periodic strategic planning efforts that require knowledge of broad trends and driving forces of change may benefit most from scanning products in the form of annual or biennial comprehensive reports.

TECHNIQUES FOR IMPROVING SCANNING EFFECTIVENESS

This section reviews several techniques and resources that can increase the effectiveness or efficiency of horizon scanning: meta-scanning, lookout panels, Internet resources and tools, wide-angle vision, and techniques to explore potential wild cards (low-probability, high-impact events).

Meta-scanning

A widely practiced way to scan effectively—and simultaneously reduce labor-intensiveness and cost—is "meta-scanning" or "scanning the scanners." The idea is to take advantage of the freely available work of professional scanners in the academic, public, private, and non-profit sectors. Most scanning output is proprietary or confidential, but a surprising amount is publicly available. Table 1 contains examples of meta-scanning sources, ranging from the U.S. Army to consulting futurists, and from daily or weekly email newsletters to scanning reports issued annually or every few years. Meta-scanning is particularly appropriate for identifying global and national trends and driving forces; original scanning will likely be needed to identify emerging regional issues and trends.

Lookout Panels

Panels of experts can be a valuable technique to provide supplemental or periodic in-depth scans of issues deemed to be important. Gordon and Glenn (2009) and the Environmental Futures Committee (1995) describe an example of a "lookout panel" on African futures designed by the Millennium Project. Lookout panels generally involve identifying a diverse set of creative thinkers and querying them about (1) potential high-impact future developments that may affect the topic of interest, (2) the likelihood and impacts of these developments, and (3) policies to encourage positive developments or to deal with negative impacts. Lookout panels are often conducted in multiple, interactive rounds similar to a Delphi exercise. Bengston et al. (2012) discuss a lookout panel approach focusing on the future of wildland fire management that uses asynchronous computer conferences to gather panel members' insights. Lookout panels can also be used to analyze and interpret scanning hits.

Internet Resources

The Internet has transformed horizon scanning practice in recent decades with an ever-expanding array of information resources. Here, two examples of Internet resources for scanning are highlighted. First, innovative blogs can be a good source for early discussion of emerging trends and cutting-edge ideas. Blog search engines such as Google Blogs (http://www.google.com/blogsearch) and Technorati.com allow the user to compile a watch list or create news alerts. The search engine automatically monitors keywords provided by the user and generates periodic email updates when relevant blog postings are found. An alternative blog search strategy is to compile a list of especially innovative and broad-ranging blogs and monitor them on a regular basis. Following blogs written by subject matter experts in key areas of interest can be an effective form of meta-scanning. The bloggers continuously scour the Internet for new developments related to the topic and often add interpretations about potential implications.

Another potential resource is Web-crawler or text mining software systems that scan the Internet automatically in search of emerging innovations and trends.[1] Horizon scanning software automates a substantial part of the most labor-intensive and time-consuming aspect of

[1] In addition to sophisticated Web-crawler or text mining software, simpler—and free—tools such as Google Alerts (http://www.google.com/alerts) provide notifications of new information about relevant scanning topics as they appear on the Web.

Table 1.—Examples of meta-scanning sources and additional sources for identifying trends and driving forces of change[a]

Organization	Description	URLs for reports and archives
AEPI – Army Environmental Policy Institute (U.S. Army)	Conducts or sponsors monthly horizon scanning on environmental issues with discussion of military implications. The Millennium Project now carries out these horizon scans for the AEPI, although the latest reports are for June 2011.	http://www.aepi.army.mil/reports/ http://www.millennium-project.org/millennium/env-scanning.html
DEFRA – Department for Environment, Food and Rural Affairs (UK)	Monthly horizon scanning newsletter. The DEFRA monthly horizon scan is now conducted by the Centre for Environmental Risks and Futures (CERF), Cranfield University, UK.	http://horizonscanning.defra.gov.uk/
Future Tense podcasts (Australian Broadcasting Corporation)	Future Tense is a weekly half-hour radio broadcast that examines social, cultural, and economic issues arising from rapid change. Covers a wide range of issues.	http://www.abc.net.au/radionational/programs/futuretense/
Future Trend Report (DaVinci Institute)	Part of a free weekly newsletter from the DaVinci Institute, a nonprofit futures think tank based in Louisville, CO.	http://www.davinciinstitute.com/newsletter/
Futurewatch (Journal of Futures Studies)	Broad-ranging horizon scan that was included as the last item in each issue of the "Journal of Futures Studies" until June 2011. This journal is freely available online.	http://www.jfs.tku.edu.tw/sarticles.html
Global Foresight Books	Contains abstracts of more than 5,000 futures-relevant books and reports on all aspects of current affairs, planning, and public policy. A free email newsletter provides a complete list of new publications on the site, the Book of the Month, and other information. The director of Global Foresight Books, futurist Michael Marien, edited Future Survey for 30 years.	http://www.globalforesightbooks.org/
Global Trends (National Intelligence Council, Central Intelligence Agency)	Global Trends 2030 is the fifth installment in the National Intelligence Council-led effort to identify key trends and drivers likely to shape world events a decade or more in the future. It uses scenarios to illustrate some of the ways in which the drivers may interact to generate challenges and opportunities for future decisionmakers.	http://www.dni.gov/index.php/about/organization/national-intelligence-council-global-trends
Kurzweil Accelerating Intelligence newsletter (KurzweilAI Network)	Daily or weekly email newsletter that covers science and technology innovations. Also lists new blog posts, features, events, videos, and books.	http://www.kurzweilai.net/
Human Development Report (UN Development Programme)	Annual review of human development trends and challenges, drivers and barriers, and measurement challenges. Provides newly available data and supplementary indices weighing the effect of income inequalities, gender disparities, and household-level poverty.	http://hdr.undp.org/en/ U.N. Development Programme, ed. 2012. Human Development Report 2012. NY and UK: Palgrave Macmillan.
Outlook, Futurist Update (World Future Society)	The Outlook series is an annual roundup of forecasts, trends, and ideas drawn from articles and news stories originally appearing in "The Futurist" magazine. The Futurist Update is a free monthly email newsletter.	https://www.wfs.org/node/567

continued

Table 1.—continued

Organization	Description	URLs for reports and archives
Pew Internet & American Life Project (Pew Research Center)	One of seven projects of the Pew Research Center, a nonpartisan, nonprofit think tank that examines issues, attitudes, and trends shaping America and the world. This project has produced many reports on the impact of the Internet on families, communities, work and home, daily life, education, health care, and civic and political life.	http://www.pewinternet.org/topics/Future-of-the-Internet.aspx http://www.imaginingtheInternet.org
Pew Social & Demographic Trends Project (Pew Research Center)	Studies behaviors and attitudes of Americans in key areas of their lives, including family, community, health, finance, work, and leisure. These topics are examined by combining original public opinion survey research with social, economic, and demographic data analysis.	http://www.pewsocialtrends.org/ http://pewresearch.org/topics/socialtrends/
ScienceDaily	An award-winning Web site that covers breaking news about the latest scientific discoveries in a user-friendly format. The site covers all fields of the physical, biological, earth, and applied sciences. Stories are linked to the original articles. Users can search the site's archives of stories, topics, articles, videos, images, and books.	http://www.sciencedaily.com/
Shaping Tomorrow Newsletter (Shaping Tomorrow)	A free weekly newsletter. Shaping Tomorrow is a commercial service that scans and analyzes trends using a worldwide team. Clients can follow 75 trend topics or search for specific interests. Many custom services are offered related to foresight, strategic planning, and change management.	http://www.shapingtomorrow.com
State of the Future (Millennium Project)	Annual report providing an overview of the global situation and prospects for the future. It includes an executive summary and 2-page overviews with regional considerations of 15 global challenges such as energy, food, science and technology, ethics, development, water, and demographics.	http://www.millennium-project.org/millennium/2012SOF.html
State of the World (Worldwatch Institute)	The Worldwatch Institute's annual series on critical global issues and driving forces. Topics are covered from a global perspective, with an emphasis on how to create a more sustainable and equitable future.	http://www.worldwatch.org/stateoftheworld2012
Vital Signs, Vital Signs Online (Worldwatch Institute)	Annual report tracking 24 key trends in the environment, agriculture, energy, society, and the economy. Vital Signs Online is an interactive, subscription-based tool tracking sustainability trends.	http://www.worldwatch.org/vitalsigns2012 http://vitalsigns.worldwatch.org/
World Migration Report (International Organization for Migration)	Annual report covering international migration trends. Each year's report has a different theme. The theme of the 2010 report was "The Future of Migration: Building Capacities for Change."	http://publications.iom.int/bookstore/index.php?main_page=index&cPath=37
World Values Survey	The World Values Survey (WVS) network ("The world's most comprehensive investigation of political and sociocultural change") provides a 30-year time series for the analysis of social and political change. The WVS network carried out a new wave of surveys in 2010 - 2012 covering more than 50 countries. Data from all previous waves are available from the WVS Web site.	http://www.worldvaluessurvey.org

[a] Several of the meta-scan resources listed in Table 1 are no longer produced, but are included because the archives of past scans provide exemplars of scanning output.

scanning, allowing more time for scanners to analyze, synthesize, and interpret scanning hits. Decker et al. (2005) describe a conceptual framework for a Web-based horizon scanning process based on information foraging theory, and demonstrate the advantages of this approach in a human-machine experiment in which a prototype system outperformed a group of human experts in a typical scanning task. The Singapore government's Risk Assessment and Horizon Scanning program uses Web-crawler software to increase the efficiency of its scanning (Conference Board of Canada 2008). New developments in text mining are able to distill large volumes of text found on the Internet into highly readable summaries (e.g., Mithun 2012) or classify text into key driving forces of change (e.g., Halliman 2009). Most automated scanning software is proprietary and expensive today but offers a promising tool for increasing the effectiveness and efficiency of horizon scanning. Though a useful scanning resource, software systems and the Internet should not be relied upon as the sole means of identifying signals of change (Douw et al. 2003).

Wide-angle Vision

It is easy to get lost in detailed reading and close examination of a large number of sources and vast amounts of information, resulting in missed signals of change (Coote 2012). To avoid becoming overwhelmed and to scan more effectively, professional horizon scanners sometimes practice a technique similar to the "wide-angle vision" or "splatter vision" approach used by U.S. Secret Service agents and others (Burkan 1996, Day and Schoemaker 2004). The essence of this technique in a security context is to take in the entire scene without focusing on anyone in particular. Holding this wide-angle gaze, the agent looks for anomalies that do not fit with the rest of the scene, e.g., someone who is looking around too much or appears restless, whose clothing is not appropriate for the weather, or whose demeanor does not fit with the cheering or expectant faces in the crowd. Suspicious activity triggers closer scrutiny. An analogous wide-angle vision process can be applied to horizon scanning, in which scanners view massive amounts of information in search of incongruities that may signal future change. As in security scanning, the idea is to take in everything as a whole and not focus too much on a specific area or expected future. Focusing on one area can lead to blindness because "change usually hits us where we least expect it" (Burkan 1998: 37).

Wild Cards

Potential changes in the external environment identified by horizon scanning can be either continuous or discontinuous. The most disruptive type of discontinuous change is low-probability but high-impact events, referred to in the futures literature as wild cards (Petersen and Steinmueller 2009), black swans (Taleb 2010), or STEEP surprises (Markley 2011). In the resilience literature, discontinuous and largely unpredictable change is called "back loop" change or surprise (Walker and Salt 2006). Wild cards are often neglected in scanning in favor of more tractable continuous changes. Given the potential importance of wildcards, however, horizon scanning systems should explicitly consider identifying and exploring them.

Potential wild cards are extremely difficult to identify and interpret, but several methods have been proposed. For example, Petersen (1997) maintains that there are always early warnings of impending wild card events, but we frequently miss them because we tend not to think about such events and the precursors that might signal their approach. By identifying potential positive and negative wild cards in advance through extensive and regular brainstorming, early indicators can be identified and monitored, and plans to deal with their impacts can be developed. Petersen identifies and briefly analyzes 78 potential wild cards, including rapid climate change, a major breakthrough in nanotechnology, the development of self-aware machine intelligence, and a worldwide pandemic. Other approaches to wild card scanning often involve categorizing potential wild card events to make them easier to spot on the horizon. For example, Markley (2011) described a four-level typology of wild cards and a related method for monitoring emerging awareness of them and their credibility, and Mendonça et al. (2004) proposed a method based on the type of wild card, the subject area affected (e.g., economic, environmental, technological), and the nature and magnitude of potential impacts.

TECHNIQUES FOR ANALYZING, SYNTHESIZING, AND INTERPRETING

The weak signals identified by horizon scanning will be of little use if they are left unanalyzed. Busy planners, managers, and policy makers do not have the time or inclination to sort through and interpret large amounts of unprocessed information. This section surveys some techniques that can be used to analyze important individual trends and issues, as well as "connecting the dots" by synthesizing related scanning hits and looking for big-picture implications.

Nominal Group Technique

The nominal group technique (NGT) is a widely used structured group discussion and decisionmaking process. The "nominal" in NGT refers to the fact that participants work alone for the most part, so it involves a group in name only. One of the main advantages of NGT is that it avoids problems caused by dominant personalities in group interactions and decisionmaking. Originally developed by Delbecq and Van de Ven (1971), NGT can be used with groups of many sizes to quickly make decisions with everyone's opinions being taken into account. Although there are many variations, the standard procedure for NGT entails five stages (Potter et al. 2004, Tague 2005). First, a facilitator explains the purpose and procedure to participants. In the context of horizon scanning, the purpose might be to rank or rate the importance or likelihood of trends and issues identified by scanning. Second, participants individually generate ideas related to the purpose (e.g., ratings of the most important trends) without discussing their ideas with others. Third, participants each share their ideas, which are recorded by the facilitator. All participants should have an equal opportunity to contribute. Fourth is group discussion, in which participants can seek explanations or details about any of the ideas that have been put forward and new or hybrid ideas that arise from the discussion may be added. The final step is voting and ranking the ideas in relation to the original question, which produces the specific outcome of the process.

Sutherland et al. (2011) used a form of NGT combined with a lookout panel to both identify and rank the importance of issues related to conserving biodiversity. The purpose of this scanning exercise, which built on an earlier effort (Sutherland et al. 2010), was to identify emerging "technological advances, environmental changes, novel ecological interactions and changes in society that could have substantial impacts on the conservation of biological diversity" (Sutherland et al. 2011: 11). The 25 participants included specialists in various fields of conservation science as well as professional horizon scanners. Participants each identified and summarized up to four emerging issues they deemed to be most relevant. Seventy-one issues were identified and distributed to all contributors for scoring on a scale from 1 (well-known and relatively unimportant) to 10 (poorly known but potentially important). The issues with the highest mean scores were retained and assessed at a face-to-face workshop. After critical assessment and discussion, participants individually ranked the relative importance of the issues on a scale of 0 to 100. The result was a prioritized list of often unrecognized issues with potential importance for global conservation.

Impact/Likelihood Assessment

This technique is a simple way to identify which issues or trends may be of greatest importance to decisionmakers (Renfro and Morrison 1983). Given a long list of emerging issues identified by horizon scanning, impact/likelihood assessment begins with a subjective rating of the likelihood of each issue affecting the organization. A simple high, medium, or low scale may be used or a numerical scale ranging from 1 (low likelihood) to 10 (high likelihood). The potential impact of each issue on various areas of concern, such as environmental, economic, and social impacts, is also subjectively rated (e.g., low impact = 1, high impact = 3). The ratings can then be plotted on a graph with potential impact on one axis and probability or likelihood of occurrence on the other, creating an easy-to-grasp visual display of issues that are high in both impact and likelihood, as shown in Figure 3. A variation of this technique is used in CERF's scanning reports, which combine impact and likelihood ratings to determine "importance" and plot this value against the expected timing of a development (CERF 2012). Another variation is the EPA's (2005) system of rating the importance of scanning hits on a 5-point scale for seven criteria (novelty, scope, severity, visibility, timing, probability, and organizational relevance).

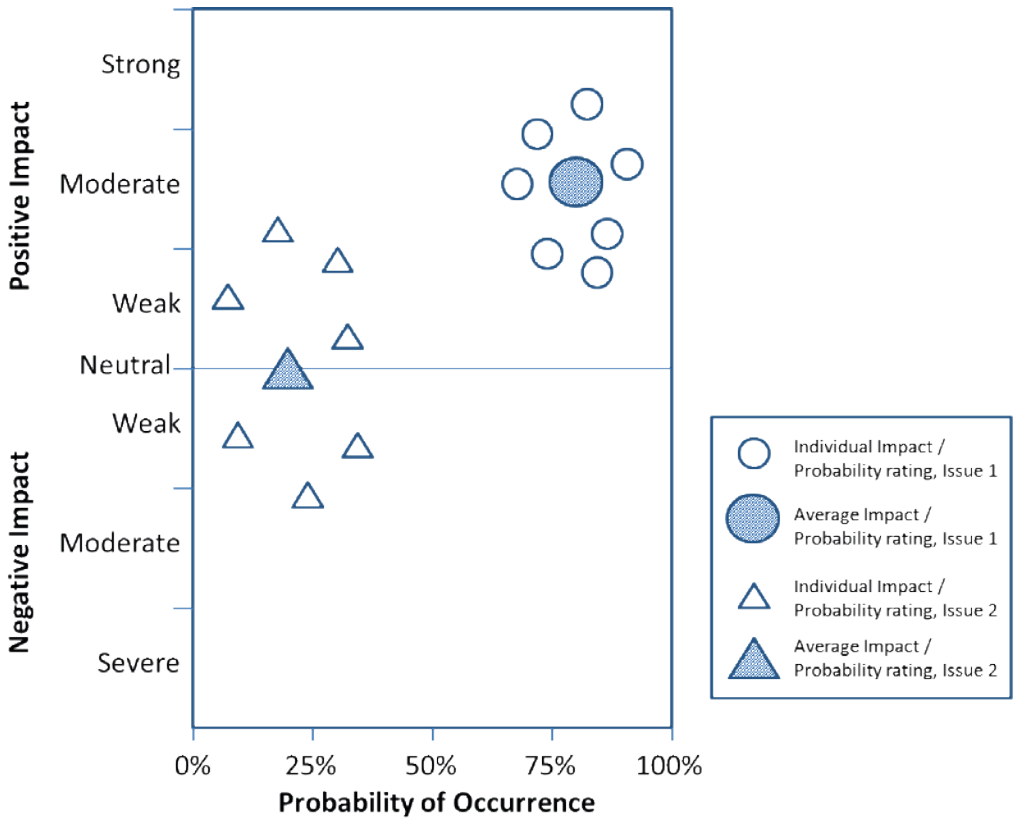

Figure 3.—Impact /Probability figure summarizing ratings for two hypothetical issues. Issue 1 (indicated by circles) shows an event with a consensus rating on probability of occurrence (high) and a consensus on moderately positive impact. Issue 2 (indicated by triangles) shows an event with a consensus on probability of occurrence (low) but not on impact. (Source: Adapted from Renfro and Morrison 1983: 16).

Futures Wheel

The direct or first-order impacts of trends and issues identified by horizon scanning may be fairly easy to discern. But the higher-order consequences are typically less obvious, often contain surprises, and may be the most important. The futures wheel, also called the Implications Wheel® or impact network, is a simple and practical tool that uses the "wisdom of crowds" (Surowiecki 2004) to explore the direct and indirect consequences of a trend, innovation, policy, or any change (Glenn 2009). The basic idea is that every change or potential change has consequences and these consequences have consequences. The futures wheel helps planners, managers, and other stakeholders identify and think through these multiple levels of consequences. Figure 4 shows the typical structure of a futures wheel.

The process of constructing a futures wheel begins by placing a short-hand description of a change or trend in the center. For example, the trend "growing hydraulic fracturing activity on private lands near national forests" could be expressed simply as "increased fracking." Next, the possible direct first-order impacts of increased fracking are identified by brainstorming and branch out from the center. Possible first-order consequences of fracking would likely include increased truck traffic, water consumption, creation of local jobs, and possible groundwater contamination. An impact categorization system such as STEEP (Morrison 1992) can be used to help identify all the first-order consequences in the near future. It is important to identify both positive and negative consequences. Next, the possible second-order consequences of each of the first-order consequences are identified by brainstorming and are added to the futures wheel. For example, increased truck traffic may result in impacts such as damage to rural roads not designed for such high levels of traffic, increased noise levels from 24-hour traffic, and safety concerns. Each of these impacts

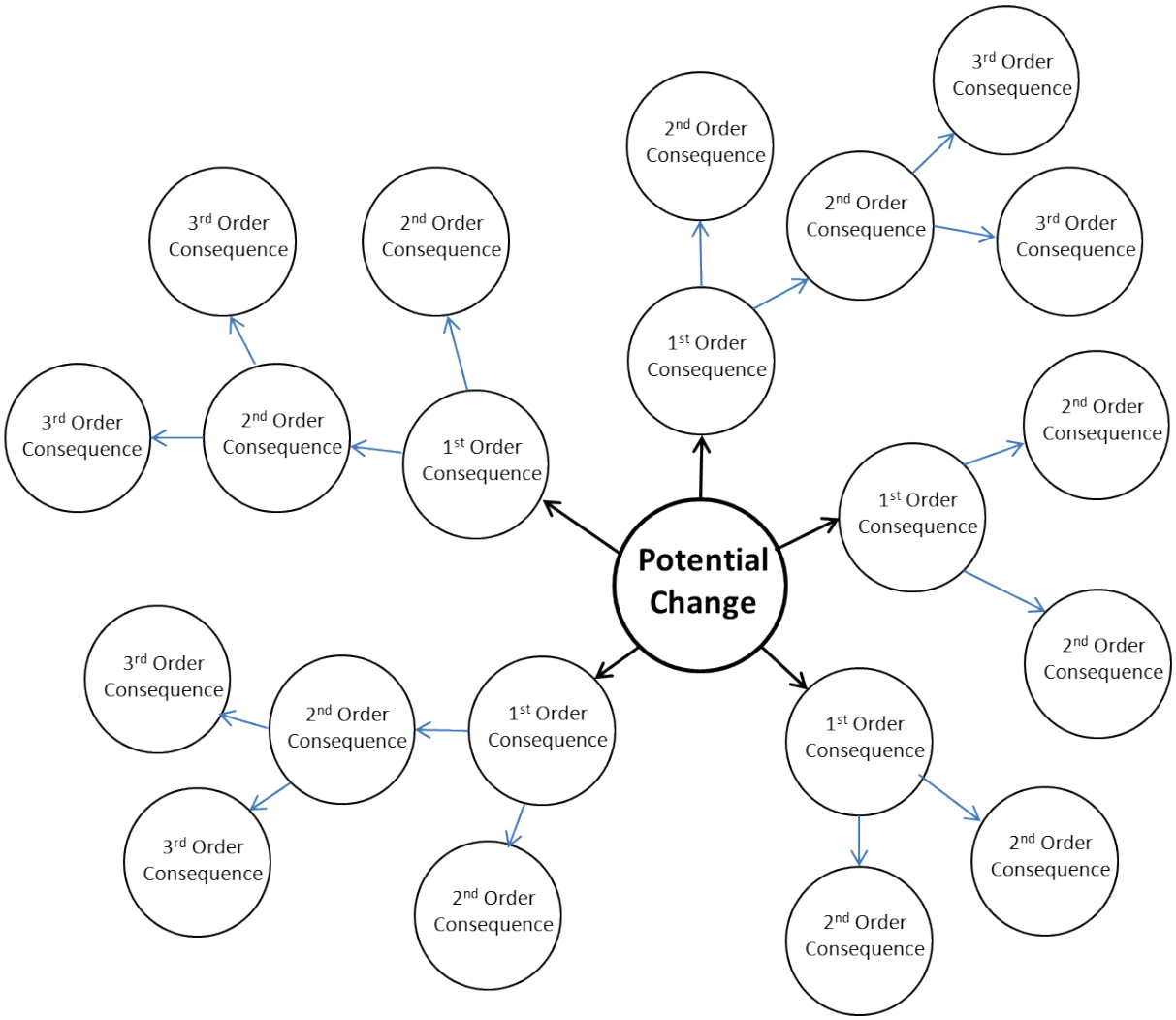

Figure 4.—Typical structure of a futures wheel.

may have third-order consequences. Once all levels of the futures wheel have been completed – typically not beyond third-order consequences – a comprehensive picture of the possible direct and indirect, positive and negative consequences emerges. Some approaches to the futures wheel include rating the desirability/undesirability and likelihood of occurrence of each implication, and comparing the ratings of different stakeholder groups. The final step is to develop strategies to manage the possible negative consequences and take advantage of or encourage the positive consequences. The construction of futures wheels and analysis of the implications identified can be greatly facilitated with computer support, such as the software developed for futurist Joel Barker's Implications Wheel® (Barker 2011).

Cross-impact Matrix

Various forms of cross-impact analysis have been used to examine how multiple trends or events might impact each other (Heuer and Pherson 2011). The many approaches to this technique are based on the premise that events do not occur in a vacuum and other forces in the surrounding environment can significantly impact them or affect their likelihood of occurrence. Chao (2008: 45) notes that the usefulness of the "cross-impact method lies in its systematic analysis of interactions among possible future developments." Some approaches to cross-impact analysis are complex, time-consuming, and expensive to implement, but a simple version of the cross-impact matrix can be useful to examine the possible interactions among selected broad trends or driving

Table 2.—Hypothetical cross-impact matrix. (Source: Adapted from Wagschall 1983)

	Trend 1	Trend 2	Trend 3	Trend 4	Trend 5	Trend 6	Sum of impacts
Trend 1	x	+ +	0	+ +	+	0	5 +
Trend 2	- -	x	0	+	+	+ +	2 +
Trend 3	0	+	x	0	+	+	3 +
Trend 4	-	- -	0	x	-	-	5 -
Trend 5	- -	-	0	- -	x	-	6 -
Trend 6	0	0	-	0	0	x	1 -
Sum of impacts	5 -	0	1 -	1 +	2 +	1 +	

forces identified through horizon scanning (Wagschall 1983). Table 2 depicts a hypothetical 6 by 6 cross-impact matrix. The same set of trends is listed across the top and on the left side of the matrix. Each cell is filled with an estimation of the positive or negative impact the trend on the left would have on each of the trends across the top. The combined judgment of a group can be used to fill in the cells by using pluses and minuses (i.e., + + = strong positive impact, + = positive impact, 0 = no impact or disagreement, - = negative impact, - - = strong negative impact). In Table 2, for example, the "+ +" in the second cell of the first row indicates a consensus judgment that trend 1 will have a strongly positive impact on trend 2. In some cases, the matrix can also be filled in based on what the research literature reveals about past relationships between similar trends. When all the cells have been filled in, the columns and rows can be aggregated to produce insights about the interactions. For example, trend 1 produces the strongest positive impact on the other trends, and trend 5 produces the greatest negative change.

Scenarios

Finally, a productive way to analyze and interpret emerging trends and developments identified by horizon scanning is to use them to create scenarios that illustrate a range of alternative plausible futures. The set of most likely and most important trends identified by the preceding techniques constitutes driving forces of change that can be used as key building blocks in scenario analysis. Glenn and the Futures Group International (2009: 2) define a scenario as "a story with plausible cause and effect links that connects a future condition with the present, while illustrating key decisions, events, and consequences throughout the narrative." The output of a scenario analysis is a set of stories or narratives. The stories are not predictions but represent a range of plausible futures intended to help decisionmakers and stakeholders build adaptive capacity to make their systems more resilient to change by preparing for a diverse set of alternatives. Dozens of scenario development methods have been created, including qualitative and quantitative approaches, expert-based and participatory approaches involving stakeholders, and inquiry-driven and strategy-driven scenario analysis (Alcamo 2008, Bishop et al. 2007). Regardless of the scenario development method used, driving forces of change identified by horizon scanning are a key input and scenarios can be a powerful technique to help decisionmakers explore and prepare for a range of plausible futures.

CONCLUSIONS

Futurist Peter Bishop (2009: 12) succinctly observed that "scanning is hard, but also necessary." It is hard for many reasons. Bringing diverse stakeholders together in participatory scanning is challenging. Identifying weak signals of change in a complex, turbulent environment is like looking for a needle in a haystack. Separating meaningful signals from all the noise requires the rare ability to see beyond prevailing mindsets and paradigms. Analyzing and correctly interpreting potential signals of change calls for creativity and insight. Acting on possible opportunities and threats presented by incipient change demands visionary leadership and careful strategy. Successfully achieving all of these requirements is indeed difficult. Some horizon scanning projects and systems fail to meet expectations or achieve goals, for a variety of reasons such as insufficient budget, lack of management support, and weak stakeholder participation (Lesca and Caron-Fasan 2008).

Despite these challenges, horizon scanning is necessary. The rapid pace of change, increasing complexity, and frequency of surprise necessitate preparing for an uncertain future by promoting a forward view throughout an organization, stimulating people to think about how emerging trends could affect their work and the mission of their agency, and preparing contingency plans. A well-designed, organizationally appropriate horizon scanning system with long-term support is needed to accomplish these objectives. Business research has repeatedly demonstrated that effective horizon scanning improves organizational performance (Choo 2002). Scanning can enhance discussion about future-oriented issues within an organization, as well as help decisionmakers anticipate and quickly respond to external change. A formal horizon scanning system is a vital but often missing component in the strategic planning process of public natural resource and environmental organizations.

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Natural resource management organizations carry out a range of activities to examine possible future conditions and trends as part of their planning process, but the distinct approach of formal horizon scanning is often a missing component of strategic thinking and strategy development in these organizations. Horizon scanning is a process for finding and interpreting early indications of change in the external environment of an organization or field. Effective horizon scanning serves as an early warning system to identify potential opportunities and threats, enable decisionmakers to plan accordingly and take timely action, and foster a culture of foresight throughout an organization. This paper reviews and discusses the key items needed to create an effective horizon scanning system: conceptual frameworks, organizational approaches, design principles, techniques to improve effectiveness, and techniques for analyzing and interpreting scanning results.

KEY WORDS: horizon scanning, environmental scanning, strategic foresight, futures research

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