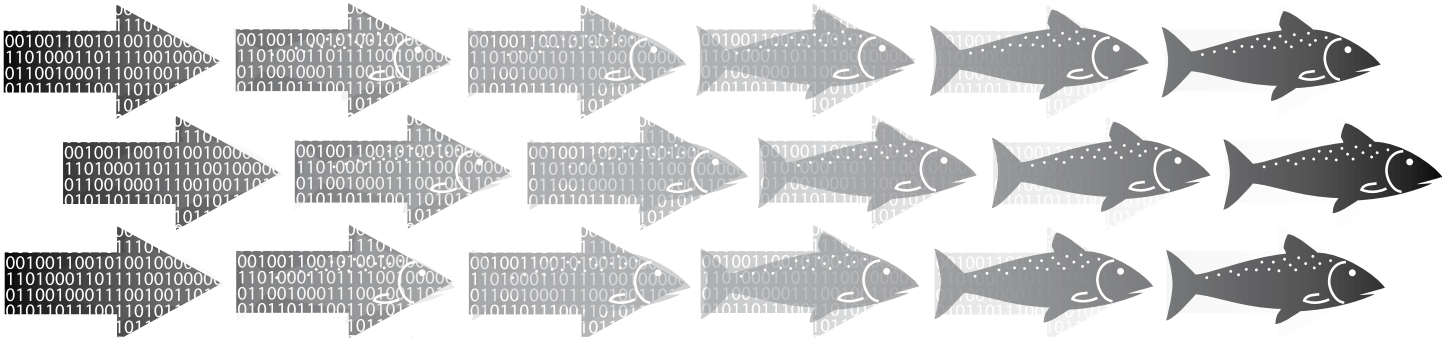
Turning Data into Fish



Introduction

Aldo Leopold never used a computer. Writing in the late 1940s, the Wisconsin woodsman preferred watching geese to that newfangled device, the television. He decried the "middlemen" and "innumerable physical gadgets" that separate people from "an intense consciousness of the land."

Leopold's moral compass, his "land ethic," has served as a guide for generations of conservationists. Yet across North America, the agencies, organizations, businesses, tribes, and citizens working on farmlands, rangelands, forestlands, and fisheries have – like many of us – become ever more dependent on spreadsheets and communications networks: tools of knowledge management.

Can this circle be squared? How might better knowledge management contribute to environmental conservation or, in contemporary thinking, bolster social-ecological resilience? If knowledge is the capacity for effective action, which capacities are worth cultivating?

Wikipedia defines knowledge management as: "the range of strategies and practices used in an organization to identify, create, represent, distribute, and enable adoption of insights and experiences." Today's organizations include far-flung digital communities, as well as traditional social, political, economic, and educational entities. In this paper, we identify opportunities to utilize knowledge management tools and practices in fostering social-ecological resilience.

The world has changed greatly in the sixty years since Leopold's *A Sand County Almanac*. While ecosystems are imperiled, opportunities for pattern recognition, true cost pricing, scalable public deliberation, and peer innovation have never been greater. Can these knowledge management practices enable the types of effective action that Aldo Leopold might appreciate? It's a challenge we call: turning data into fish.

Design for Resilience: The Role of Knowledge Management

Abstract: Two broad trends dominate the era. Human activities disrupt local and planetary ecosystems, while, aided by digital networks, the human potential for knowledge management (KM) flourishes. Digitally enabled KM tools and practices have begun to address ecological challenges, but these activities have not been systematically catalogued or described. Taking resilience to ecosystem disruptions at multiple scales as a primary social goal, we develop a set of framework propositions for inventorying physically and digitally situated KM activities. Based on this inventory, we identify opportunities in six areas and explore the role of KM in societal development.

Framework propositions

Design is an idealistic enterprise. ("Design is concerned with how things ought to be.") The design of social institutions – like, say, stock markets – shapes the nature of associated interactions – like market trading. On the Internet, for example, the types of social interactions one finds on Wikipedia, eBay, or Twitter arise from distinctions in their respective designs.

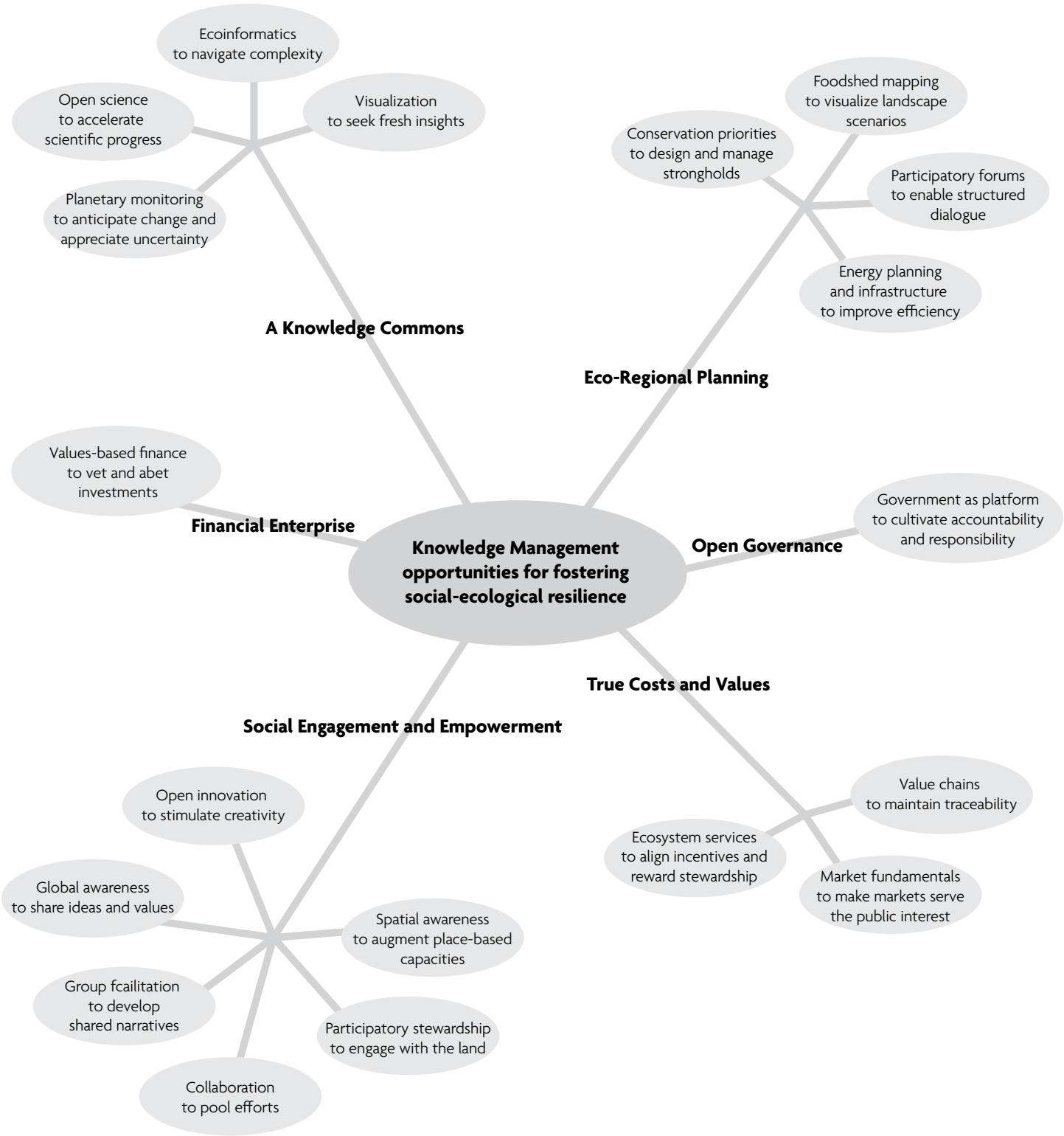
Design improvements depend in part on effective knowledge management (KM). We take knowledge to be the capacity for effective action and KM to be the systematic use of tools and practices to identify, represent, and enable knowledge creation and sharing.

Preferred design outcomes vary. Individuals and societies variously favor design for social goals that include economic growth, scientific progress, individual liberties, broad-based equity, or cultural and spiritual development. In response to environmental stresses, the goal of social-ecological resilience is gaining increasing attention (e.g., in prestigious awards for Resilience Alliance board members Buzz Holling and Elinor Ostrom).

For the purposes of this paper, we take design for resilience to ecosystem disruptions at multiple scales as a primary social goal; and we develop a two-level taxonomic tree for categorizing KM tools and practices that can be used to foster social-ecological resilience. Our taxonomy and categorization are drawn from framework propositions that include:

- Human activities are primary drivers of change in ecosystems, from local to global.
- Activities to foster social-ecological resilience include those that mitigate harmful ecosystem impacts, bolster adaptive capacity, or both.
- Adaptive capacity depends on factors such as the ability to ensure provision of basic needs and services, to anticipate and recover from breakdowns, and to organize and learn in order to act effectively.
- Individuals can mitigate and adapt, but, invariably, these activities take place within and among organizations: societies, businesses, and communities — including informal, transient, and digitally enabled communities.
- Organizations operate within institutions, the formal rules, informal norms, and enforcement mechanisms that constrain and shape social interactions.
- As organizations in physical space are constrained and shaped by institutions, organizations in digital space are further constrained by technologies ("code is law"), which partially embody and enforce rules and norms.
- The development of individual and organizational capacity to effectively mitigate or adapt may require transformation of counter-functional institutional rules or norms.
- KM tools and practices foster social-ecological resilience through activities that enable individuals and organizations to mitigate impacts, increase adaptive capacity, and transform institutions as necessary.

Utilizing this framework, we categorize and briefly describe noteworthy and illustrative examples of KM activities. In this first paper, we restrict these descriptions to opportunities in the areas of: science, governance, management, finance, markets, and society. A more complete inventory would include media, politics, education, and so on, as well as finer resolution on opportunities in all areas. We pay particular attention to digital tools and practices in order to better understand their relationships to both physical activities and each other.


Knowledge Management opportunities for fostering social-ecological resilience
A Knowledge Commons
Ecoinformatics to navigate complexity
Visualization to seek fresh insights
Open science to accelerate scientific progress
Planetary monitoring to anticipate change and appreciate uncertainty
Eco-Regional Planning
Foodshed mapping to visualize landscape scenarios
Conservation priorities to design and manage strongholds
Participatory forums to enable structured dialogue
Energy planning and infrastructure to improve efficiency
Financial Enterprise
Values-based finance to vet and abet investments
Open Governance
Government as platform to cultivate accountability and responsibility
True Costs and Values
Value chains to maintain traceability
Ecosystem services to align incentives and reward stewardship
Market fundamentals to make markets serve the public interest
Social Engagement and Empowerment
Open innovation to stimulate creativity
Global awareness to share ideas and values
Spatial awareness to augment place-based capacities
Group fcailitation to develop shared narratives
Participatory stewardship to engage with the land
Collaboration to pool efforts

Illustrative inventory of KM opportunities and activities for fostering social-ecological resilience

Cluster of activity	Opportunity area *Goal* Opportunity proposition	**KM activities:** illustrative examples of tools and practices. KEY
A Knowledge Commons	**Planetary monitoring** *To anticipate change and appreciate uncertainty* Robust and scalable applications of earth systems science can offer actionable insights.	**Monitoring systems:** GEOSS links global observation systems; NEON stations around North America detect and forecast long-term ecological change. **Water tracking:** GRACE enables remote monitoring of global aquifers. **Forest tracking:** High-resolution forest status is displayed by CLASLite through Google Earth. **Thresholds catalogue:** The Resilience Alliance and Santa Fe Institute gather examples of ecosystem regime shifts.
	Open science *To accelerate scientific progress* Accessible and rapidly disseminated data and publications can facilitate scientific progress.	**Shared access platforms:** DataONE weaves distributed data archives; BiG Grid offers infrastructure for eScience; ResaerchGate enables research collaboration. **Open access platforms:** PLoS covers bio-sciences; Encyclopedias of Life and Earth publish online. **Licensing models:** Science Commons works to facilitate data and research sharing.
	Ecoinformatics *To navigate complexity* Shared languages (ontologies) can enable machine processing of heterogeneous data.	**Threshold analysis:** In South Africa's Kruger National Park, adaptive management is informed by computational analysis of thresholds of potential concern. **Ecosystem valuation:** ARIES pilots rapid assessment of ecosystem service values.
	Visualization *To seek fresh insights* Seeing information in new ways can aid discovery and interpretation.	**Visual narratives:** The Grove offers visual approaches to planning and organizational change. **Visual feedback:** Climate Interactive offers feedback on long-term impacts of today's decisions. **Pattern recognition:** Many Eyes, Gapminder, and Tableau offer tools for finding meaning in disparate data.
Open Governance	**Government as platform** *To cultivate accountability and responsibility* Open standards and design for participation can enable agencies to better enlist and coordinate citizen participation.	**Oversight platforms:** MAPLight and They Work for You promote accountability. **Peer participation:** Peer-to-Patent invites citizen-experts to assess US patent applications. **Participatory budgeting:** Participatory budgeting empowers citizen involvement in public spending. **Collaborative writing:** The US Army invites military personnel to contribute to a wiki-based field manual revision; Future Melbourne invites citizens to wiki-edit the city's 10-year plan. **Collaborative service design:** Co-production emphasizes the shared design and delivery of services.
Eco-Regional Planning	**Conservation priorities** *To design and manage strongholds* Extended peer participation and geospatial tools can assist decision making.	**Expert survey:** The North American Salmon Stronghold Partnership identifies conservation priorities through expert knowledge survey and compilation. **Conservation catalogue:** The Conservation Registry aggregates US projects on the ground. **Spatial optimization:** Marxan optimizes design for biodiversity representation and other values. **Conservation management:** Miradi enables design and monitoring of conservation strategies.
	Energy and infrastructure planning *To improve efficiency* Planning and investment can enable managers to improve efficiency, save money, and meet carbon commitments.	**Mitigation analysis:** McKinsey greenhouse gas abatement curves describe mitigation costs and opportunities. **Energy budgeting:** Without the Hot Air explores demand-supply planning. **Emissions inventories:** ICLEI helps local governments track greenhouse gas emissions; the Carbon Disclosure Project operates a corporate emissions reporting system; Climate Smart helps small businesses. **Logistics planning:** Smart 2020 envisions 15% efficiency gains from smart buildings, grids, and transport. **Consumption feedback:** A smart meter pilot shows a 20% decline in electricity use. **Incentive programs:** Renewable Funding provides tools for residential energy financing programs. **Data brokerage:** Pachube provides a data brokerage for networked artifacts and environments.
	Foodshed mapping *To vsualize landscape scenarios* Matching regional productivity and consumption can help in planning for basic needs.	**Demand matching:** Studies assess the northeastern US capacity to meet regional food demands. **Landscape production scenarios:** Agro-ecological assessment enables analysis of foodshed capacities, alternative cropping and water-use scenarios, and projected effects of climate change. **Design for redundancy:** International food sovereignty movements prioritize food production for domestic consumption and self-sufficiency.
	Participatory forums *To enable structured dialogue* Community and eco-regional forums can enable meaningful deliberation among stakeholders.	**Design principles:** Elinor Ostrom and colleagues' principles for common resource management focus on community-ecosystem interactions. **Community planning:** The American Planning Association surveys community indicator projects. **Goal discovery and alignment:** ReAMP sets shared, multi-state targets for climate action; stakeholders in the Chesapeake Bay Program utilize online dashboards to visualize goals and measure performance. **Stakeholder roundtables:** MarineMap allows cross-validation of local and scientific knowledge.

Financial Enterprise	**Values-based finance** *To vet and abet investments* Rigorous metrics, extended expertise, and open competition can help support innovation and entrepreneurship.	**Standard setting:** IRIS seeks to define triple bottom line business standards. **Peer review:** Peer Water opens project funding proposals to transparent review and reporting. **Accountability assessment:** Keystone Accountability and The Center for Effective Philanthropy help measure and report social change. **Competitive awards:** The Buckminister Fuller and Virgin Earth Challenges foster innovation. **Investment platforms:** Kiva, SASIX, W1SD0M, and the Socent API connect investors with entrepreneurs.
True Costs and Values	**Value chains** *To maintain traceability* Traceability can enable product differentiation, verification of production practices, and design for disassembly.	**True cost labeling:** Food labels in Sweden begin to list life-cycle carbon emissions. **Best practices:** Third-party certifiers – like FSC for wood or MSC for seafood – set standards. **Chains of custody:** PacificFishTrax pilots value chain information through scannable barcodes. **Regional distribution:** FoodHub and MarketMaker pilot online trade in regional, wholesale foods. **Product stewardship:** Maine enacts framework legislation for product stewardship.
	Ecosystem services *To align incentives and reward stewardship* Best practices, market design, and landscape modeling can help account for the public benefits of good stewardship.	**Best practices:** The Lisbon Principles outline sustainable governance of natural capital; the National Resouce Conservation Service develops best management practices for land managers. **Forest offsets market:** REDD+ seeks to reduce emissions from forest deforestation and degradation. **Land use scenarios:** SWAT, InVEST and TREES offer analyses of multi-objective scenarios. **Water quality markets:** NutrientNet offers tools for improving water quality through nutrient trading.
	Market fundamentals *To make markets serve the public interest* Aligning institutions with the long term public interest can help support a more reliable prosperity.	**Social indicators:** Economists urge revising GDP to better measure long-term well being. **Pricing feedback:** Economists urge pricing to reflect externalities and uncertainties. **Corporate charters:** Corporation 20/20 seeks to revise charters to serve the public good; B Corp offers certification to companies that do; L3C defines a hybrid legal structure. **Legal structures:** Debates simmer over legal rights of corporations, as well as rights of nature and rights of communities to protect local environments. **Credit commons:** Ideas circulate for online systems to support complimentary currencies. **Personal data management:** Project VRM envisions markets as relationships.
Social Engagement and Empowerment	**Open innovation** *To stimulate creativity* Open architectures, outside expertise, and rapid dissemination can help stimulate innovation.	**Idea exchange:** Forums like TEDx and Maker Faire encourage sharing of ideas and techniques. **Scenario development:** Alternate reality games like Model UN, FishBanks, and Superstruct enable innovation. **Peer innovation:** InnoCentive and Hypios connect problems with potential solvers. **Patent catalogue:** The Global Innovation Commons shares patent information on key technologies.
	Spatial awareness *To augment place-based capacities* Networked intelligence can improve awareness of local conditions and activities.	**Sharing platforms:** Craigslist, Ridesharing, and Divvy enable shared consumption. **News platforms:** Everyblock and Outside.in pilot local news aggregation. **Transport planning:** Zipcar and TriMet reveal vehicle availability. **Spatial annotation:** OpenStreetMap, Layar, and Wikitude pilot spatial information sharing.
	Participatory stewardship *To engage with the land* Shared protocols and peer validation systems can enable citizen science; gardening skills enable food production.	**Restoration practices:** Watershed organizations engage citizens in restoration activities. **Restoration permitting:** StreamBank helps land managers navigate restoration permits and funding. **Participatory monitoring:** The Audubon Christmas Bird Count inspires citizen participation; the USA National Phenology Network enlists citizens in climate change monitoring. **Shared ontologies:** North Carolina pilots catch reports via Twitter for recreational fishermen. **Peer validation:** Data Basin pilots peer review of collected maps and data sets, including citizen-contributed ones. **Urban gardening practices:** Community gardens and edible schoolyards promote practical skills.
	Collaboration *To pool efforts* New tools assist in organization.	**Remote collaboration platforms:** Skype, Ning, and FrontlineSMS enable communities of practice. **Flash collaboration platforms:** Twitter, Ushahidi, Twilio, and Waze allow rapid intelligence circulation. **Group formation platforms:** Meetup, Upcoming, and Google Groups help people organize.
	Group facilitation *To develop shared narratives* Structured gatherings can allow collective probing of values and assumptions.	**Structured dialogue:** Group processes like Open Space and World Café enable broad participation. **Scalable deliberation:** America*Speaks* uses keypad and CoVision technologies to convene public dialog; Center for Deliberative Democracy conducts deliberative polling on national scales. **Collaborative writing:** The process of editing Wikipedia forces development of shared intelligence. **Dialogue mapping:** Climate Collaboratorium enables deliberation on climate scenarios.
	Global awareness *To share ideas and values* Diverse human interactions can enable consideration of shared goals and purposes.	**Value discovery and alignment:** Global dialogs like UN Declaration of Human Rights, Earth Charter, and Parliament of World Religions seek to foster broad agreement on social values. **Translation services:** Web and phone-based translation services ease communication. **Cultural transmission:** Social alternatives are demonstrated by stories like Balinese water management, indigenous knowledge management, and the Mondragon worker cooperative. **Discovery and alignment of purpose:** Numerous frames seek to shape a shared zeitgeist: sustainability, resilience, Wiser Earth, 350, transition, thrivability, reliable prosperity, and so on.

Discussion: KM in society

Knowledge management in societies is older than cuneiform tablets but now evolving rapidly. We inventoried KM activities in six areas with respect to defined social goals and through a set of framework propositions that describe interactions among independent human agents, acting within and among physical and digital organizations, under formal and informal institutional constraints.

As our inventory is illustrative, rather than representative or comprehensive, we refrain from evaluation of the relative performance of these activities for achieving the goals of mitigation, adaptation, and transformation. The same activities might be categorized differently, countless activities are missing or underrepresented, and given the pace of innovation, this inventory will soon be out of date. Nevertheless, the inventory opens numerous areas for exploration, and we offer brief observations.

Several distinct types of KM activities are represented across our inventory. They include: metric development (through standards, indicators, best practices), synthesis (through pattern matching, threshold and mitigation analysis, cataloguing), flow and feedback management (through logistics, distribution, pricing), knowledge community development (through open access, peer-based practices, collaboration), and collaborative intelligence development (through efforts at discovery and alignment of goals and values).

The ease of online design enables a pace of collaborative innovation in social norms seldom achieved in physical space. Online experimentation has given rise to “commons-based peer production” methods as varied as Wikipedia, Twitter, and Craigslist. In turn, these norms influence KM practices more broadly (e.g., through U.S. adoption of the Open Government Directive).

Geographic scales and locations are essential to many social-ecological activities, and the wide range of relevant KM tools and practices include: geo-location (e.g., as piloted by OpenStreetMap), assisting conservation management (e.g., as piloted by Miradi), enabling spatially specific scenario development (e.g., as in landscape production scenarios), and bounding participation to geographic communities of practice and place, such as regional value chains (e.g., as piloted by FoodHub).

Prospects for institutional transformation are shaped by symbiotic relationships among current institutions, organizations, mental models, knowledge, values, and so on. With respect to climate change, for example, the KM practice of scientific peer review has enabled a growing understanding of human influences on the global climate system. A price on carbon is similarly understood as an effective feedback mechanism for encouraging society-wide mitigation of impacts. However, the path from understanding to effective action is confounded by uncertainties of institutional transformation. These include: mitigation goals (e.g., timeline, atmospheric levels), relevant scales (e.g., national, international), price mechanisms (e.g., tax, cap-and-trade system), and relative commitments among national or other organizational actors. There are also uncertainties in the analyses and perceptions of how each of these institutional decisions may affect absolute and relative individual and organizational costs, benefits, and behaviors to emerge over various timescales.

In addition to fostering empirical understanding, KM tools and practices may be useful for enabling social learning or engaging social validation of proposed actions to mitigate, adapt, or transform. Opportunities include extending boundaries for public contribution to scientific debates (e.g., through dialogue mapping), bridging knowledge systems (e.g., as piloted by MarineMap), scalable deliberation (e.g., through deliberative polling), and facilitating goal discovery and alignment among citizens (e.g., through community planning).

Coda: From capacity to action

In the final lines of *A Sand County Almanac,* our voice of conscience, Aldo Leopold, turns to the role of knowledge management. "We are remodeling the Alhambra with a steam-shovel, and we are proud of our yardage. We shall hardly relinquish the shovel, which after all has many good points, but we are in need of gentler and more objective criteria for its successful use."

Leopold's steam-shovel could be any technology at the human-nature interface: offshore drilling rigs, nuclear energy plants, genetically engineered agriculture. The development of appropriate criteria for their successful use depends in part on knowledge management. Beyond specific technologies, our inventory described the development of criteria for community indicators, land management best practices, and triple bottom line business standards.

Inevitably, understandings of *success* have evolved since Leopold's day. Consider fisheries management. In addition to concerns that were familiar decades ago – such as catch limits and gear types – new ones like ocean acidification, caused by the human burden on the global carbon cycle, point to the influence of actions that take place far from the seashore. In order to reflect the multiple scales of activity that contribute to social-ecological resilience, our inventory included social systems as prominently as ecological ones, and urban activities along with rural ones. The trade-off may be diminished attention to the types of hands-on activities that foster Leopold's "intense consciousness of the land," certainly in our inventory and perhaps in societies as well. Opportunities for more broadly participatory stewardship practices offer notable exceptions.

For the sake of discussion and exploration, we presumed the existence of a common social goal, rather than the reality of competing goals, values, and mental models. These factors, which would likely be critical to the *gentler* criteria that Leopold seeks, appeared frequently throughout this paper, yet only indirectly – in the range of activities that seek to foster social learning and shared understandings.

In a sense, we have retraced the path that environmental scientist Donella Meadows describes in the essay, "Dancing with Systems." Recounting her experiences, Meadows begins with the optimism of systems design, only to confront a gap between understanding and implementation. "Systems thinking by itself cannot bridge that gap, but it can lead us to the edge of what analysis can do and then point beyond – to what can and must be done by the human spirit." In reflecting on this gap, biology offers a hopeful metaphor: that knowledge is not cut off from the embodied values of the human spirit, but is symbiotic with them.

Selected reading or viewing

Ackoff, R. 1989, From Data to Wisdom. Journal of Applied Systems Analysis 16: 3-9.

Benkler. Y. 2009. After Selfishness - Wikipedia 1, Hobbes 0 at Half Time. Berkman Center. Accessed at: http://www.youtube.com/watch?v=jMxz7rzwee8.

Berners-Lee, T. 2009. Tim Berners-Lee on the next Web. TED Talks. Accessed at: http://www.ted.com/index.php/talks/tim_berners_lee_on_the_next_web.html.

Bowker, G. C. 2008. Memory Practices in the Sciences. MIT Press: Cambridge, MA.

Collins, H. and R. Evans. 2009. Rethinking Expertise. University Of Chicago Press: Chicago, IL.

Daly, H. E. and J. B. Cobb. 1994. For the Common Good: Redirecting the Economy toward Community, the Environment, and a Sustainable Future. Beacon Press: Boston, MA.

Gunderson L. H. and C. S. Holling, Eds. 2001. Panarchy: Understanding Transformations in Human and Natural Systems. Island Press: Washington, D.C.

Hagel, J., Seely Brown, J. and L. Davison. 2010. The Power of Pull: How Small Moves, Smartly Made, Can Set Big Things in Motion. Basic Books: New York, NY.

Holman, P., T. Devane, and S. Cady, Eds. 2007. The Change Handbook: The Definitive Resource on Today's Best Methods for Engaging Whole Systems. Berrett-Koehler: San Francisco, CA.

Kollock, P. 1998. Social Dilemmas: The Anatomy of Cooperation. Annual Review of Sociology 24:183–214.

Lee, K. 1994. Compass and Gyroscope: Integrating Science And Politics For The Environment. Island Press: Washington, D.C.

Leopold, A. 1949. A Sand County Almanac. Oxford University Press: New York, NY.

Lessig, L. 2000. Code and Other Laws of Cyberspace. Basic Books: New York, NY.

Madin J. S., S. Bowers, M. P. Schildhauer, and M. B. Jones. 2008. Advancing ecological research with ontologies. Trends in Ecology & Evolution 23:159-68.

Maturana, H. R. and F. J. Varela. 1987. The Tree of Knowledge: The Biological Roots of Human Understanding. Shambhala: Boston, MA.

McCall, M. 2003. Seeking good governance in participatory GIS. Habitat International 27:549-573.

Meadows, D. 2008. Thinking in Systems: A Primer. Chelsea Green Publishing: White River Junction: VT.

Nelson, B. 2009. Empty archives. Nature 461:160-163.

North, D. C. 1990. Institutions, Institutional Change and Economic Performance. Cambridge University Press: New York, NY.

Orszag, P. 2009. Open Government Directive. Executive Office of the President, Director of the Office of Management and Budget. Accessed at: http://www.whitehouse.gov/open/documents/open-government-directive.

Reid, W. V., Berkes, F., Wilbanks, T. J. and D. Capistrano, Eds. 2006. Bridging Scales and Knowledge Systems: Concepts and Applications in Ecosystem Management. Island Press: Washington, D.C.

Senge, P. 2002. Reflection on a leader's new work: building learning organizations. in Morey, D., M. Maybury, and B. Thuraisingham, Eds. Knowledge Management: Classic and Contemporary Works. MIT Press: Cambridge, MA.

Simon, H. A. 1996. The Sciences of the Artificial. MIT Press: Cambridge, MA.

Smith, R. and S. Burnett. 2003. Beyond first-generation KM. Inside Knowledge 6(7).

Steffen, W., A. Sanderson, P. D. Tyson, J. Jäger, et al. 2004. Global Change and the Earth System: A Planet Under Pressure. Springer-Verlag: Berlin, Germany.

Verweij, M. and M. Thompson, Eds. 2006. Clumsy Solutions for a Complex World: Governance, Politics and Plural Perceptions. Palgrave Macmillan: Houndmills, UK.

Walker, B., Gunderson, L., Kinzig, A., et al. 2006. A handful of heuristics and some propositions for understanding resilience in social-ecological systems. Ecology and Society 11(1): 13.

Wenger, E., R. McDermott, and W. M. Snyder. 2002. Cultivating Communities of Practice: A Guide to Managing Knowledge – Seven Principles for Cultivating Communities of Practice. Harvard Business School Press: Boston, MA.

Design for Resilience: The Role of Knowledge Management (Turning Data into Fish)

This publication grows out of Ecotrust's ongoing efforts to inspire fresh thinking that creates economic opportunity, social equity, and environmental well-being. Our work includes KM activities mentioned herein and, through collaboration with Wild Salmon Center in the State of the Salmon project, a partnership with fisheries management agencies along the West Coast to assist their capacities for data management and interoperability.

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http://www.stateofthesalmon.org/agencypartnerships/portland.html

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This is a straw man draft. We welcome your thoughts on revisions or next steps: howard@ecotrust.org.

ecotrust

STATE OF THE SALMON

KNOWLEDGE ACROSS BORDERS ЗНАНИЕ СКВОЗЬ ГРАНИЦЫ 国境を超えた知識

State of the Salmon is a joint program of Wild Salmon Center and Ecotrust