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Perspective, part of a Special Feature on The Science and Practice of Ecology and Society

Social Infrastructure to Integrate Science and Practice: the Experience of the Long Tom Watershed Council

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ABSTRACT. Ecological problem solving requires a flexible social infrastructure that can incorporate scientific insights and adapt to changing conditions. As applied to watershed management, social infrastructure includes mechanisms to design, carry out, evaluate, and modify plans for resource protection or restoration. Efforts to apply the best science will not bring anticipated results without the appropriate social infrastructure. For the Long Tom Watershed Council, social infrastructure includes a management structure, membership, vision, priorities, partners, resources, and the acquisition of scientific knowledge, as well as the communication with and education of people associated with and affected by actions to protect and restore the watershed. Key to integrating science and practice is keeping science in the loop, using data collection as an outreach tool, and the Long Tom Watershed Council's subwatershed enhancement program approach. Resulting from these methods are ecological leadership, restoration projects, and partnerships that catalyze landscape-level change.

Key Words: *habitat restoration; Oregon; science and practice; social infrastructure; watershed management; water quality; watershed councils; watershed organizations*

INTRODUCTION

Watershed management that targets ecological problems requires the individual and coordinated participation of the whole suite of stakeholders. In the United States, the customary autonomy of private landowners has bred an individualistic philosophy that is often unresponsive to ecological issues that are relevant beyond the boundary of private landholdings (Dale et al. 2000). Furthermore, inspiring voluntary action by private landowners at a landscape scale is difficult. Coordinating groups of private landowners to complete projects in common may be even more problematic.

Ecologically minded management at the scale of an entire watershed crosses anthropogenic boundaries created by laws, jurisdictions, and ownership (Dale et al. 2000). In Oregon, legislators facing threatened or endangered species listings of salmon and other species developed legislation to fund grassroots organizations—watershed councils—thereby encouraging the joint participation of all stakeholders in the management of the watershed that they share (Coe-Juell 2005). The watershed councils are institutionally autonomous from the State of Oregon, are primarily governed by citizen volunteers, and have no legal authority.

For watershed-scale management to be effective, a flexible social infrastructure is needed that allows for the integration of diverse knowledge and interests in the concerted goal of watershed protection and restoration. The Long Tom Watershed Council (LTWC) developed multiple methods, including a subwatershed enhancement program to link science and practice, resulting in voluntary participation by individual landowners in watershed monitoring, inventory, enhancement, restoration, and protection. The subwatershed enhancement program is key to the LTWC's social infrastructure. This program furthers development of social infrastructures that are currently poorly understood (Daniels and Walker 2001, Kenney 2005, Sabatier et al. 2005), allowing for the

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application of available science regarding watershed protection and restoration (Williams et al. 1997, U.S. Environmental Protection Agency (EPA) 2007).

Science in Service of Action

Protection and restoration of important habitats require transdisciplinary scientific findings and insights that are adapted to the local situation. Action in social–ecological systems must be socially and ecologically viable and requires a social infrastructure that effectively educates people on how to include science in practice. Putting science into practice often requires explanation of salient principles. Often the language of science has to be translated for accurate layperson understanding. With better understanding of scientific concepts, local project participants can contribute their own experience, ideas, and observations.

Practice in landscape protection and restoration is a socially intensive process of working with landowners and system participants individually and in groups. Successful protection and restoration in social–ecological systems requires the development of promising, integrated projects that reflect the complexity of systems in which humans take part (Berkes and Folke 1998). Where land ownership is diverse, values about what and how to protect and restore differ, and actions across an entire watershed inevitably encompass many scales. This may lead to ecological protection and restoration efforts that are often fragmented and pursued opportunistically. A more holistic approach and outcome can be achieved if diverse participants are brought together. Ecologically meaningful practice requires bringing social–ecological system insights to bear with committed landowners and matching funding to create protection and restoration projects. Too often, people think about plantings, riparian improvements, upland habitat, and special places as the essence of practice. For success, practice must also include a social infrastructure that makes possible a vision that incorporates coordinated and collaborative planning for funding, monitoring, and stewardship of individual and watershed-scale projects. A flexible and adaptive social infrastructure is critical for long-term success.

BACKGROUND

In 1999, the Oregon Legislature created the Oregon Watershed Enhancement Board (OWEB) to "promote and fund voluntary actions that strive to enhance Oregon's watersheds. OWEB's programs support Oregon's efforts to restore salmon runs, improve water quality, and strengthen ecosystems that are critical to healthy watersheds and sustainable communities" (OWEB 2008). The OWEB became the funding body offering competitive grants that support watershed councils and many other entities throughout the state. A diverse group of watershed residents came together to form a watershed council for the Long Tom River Watershed in Oregon's Willamette Valley. Their charter was approved by consensus on 28 July 1998.

The Long Tom Watershed (106 000 ha) is located in Oregon's agriculturally rich Willamette Valley (Fig. 1). The Long Tom River is one of the major tributaries of the Willamette River, which is an American Heritage River (EPA 2006). Land cover (Fig. 2) and ownership (Fig. 3) mirror the complexity of the Willamette River basin. Private forest land occupies 44% of the land in the Long Tom Watershed, agriculture 31%, rural residential 9%, urban 8%, park and other lands 8%. Of the forest land, 40% is owned by large industrial companies (parcels are 160–3000 ha) and small woodland ownerships hold 60% (parcels are <160 ha). Agriculture is among the most diverse in the state, spanning 140 commodities and ranging from small organic farms to a few large conventional farms of 800 to 1600 ha. The rapidly growing towns of Veneta, Monroe, and Junction City are expanding into rural residential areas and have significant conservation opportunities to protect watershed functions before town infrastructure and development make protection more difficult. High-density urban areas are found around the city of Eugene (population 154 620 [2008]), and the Fern Ridge Reservoir is a heavily used recreation area.

The LTWC has become a model for developing and strengthening social infrastructure that translates and applies scientific and social principles. Using a neighborhood approach (Lamberson 2002), the LTWC has turned many local skeptics of science into active practitioners. In 2009, the LTWC was named a Model Watershed and awarded a 10-year grant for over US$1 million to increase the pace, scope, and effectiveness of restoration by benchmarking and monitoring progress, using

Fig. 1. Map of the Long Tom River Watershed in the Willamette River valley, Oregon.

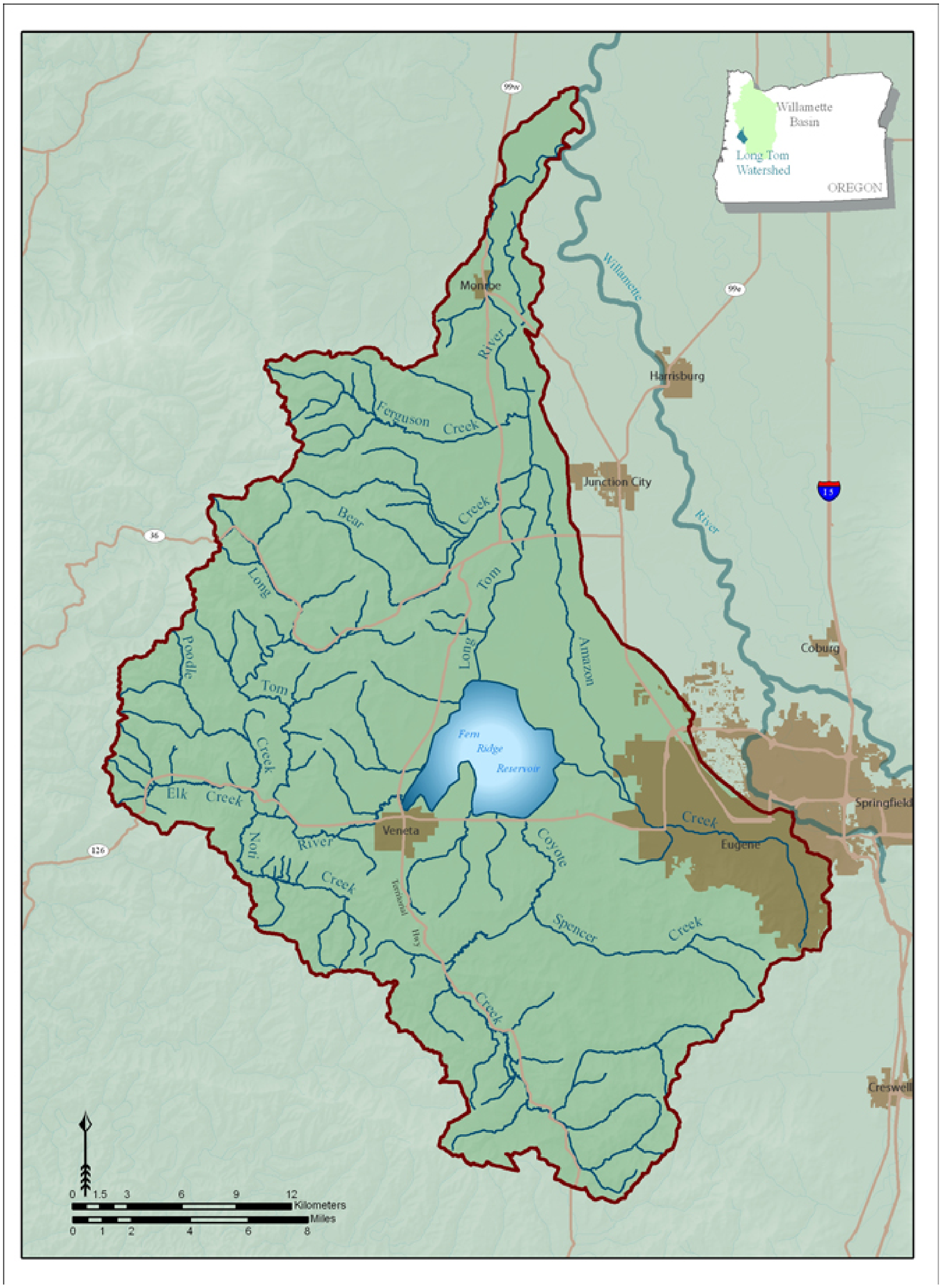


Fig. 2. Land cover for the Long Tom River Watershed and water-quality sampling locations.

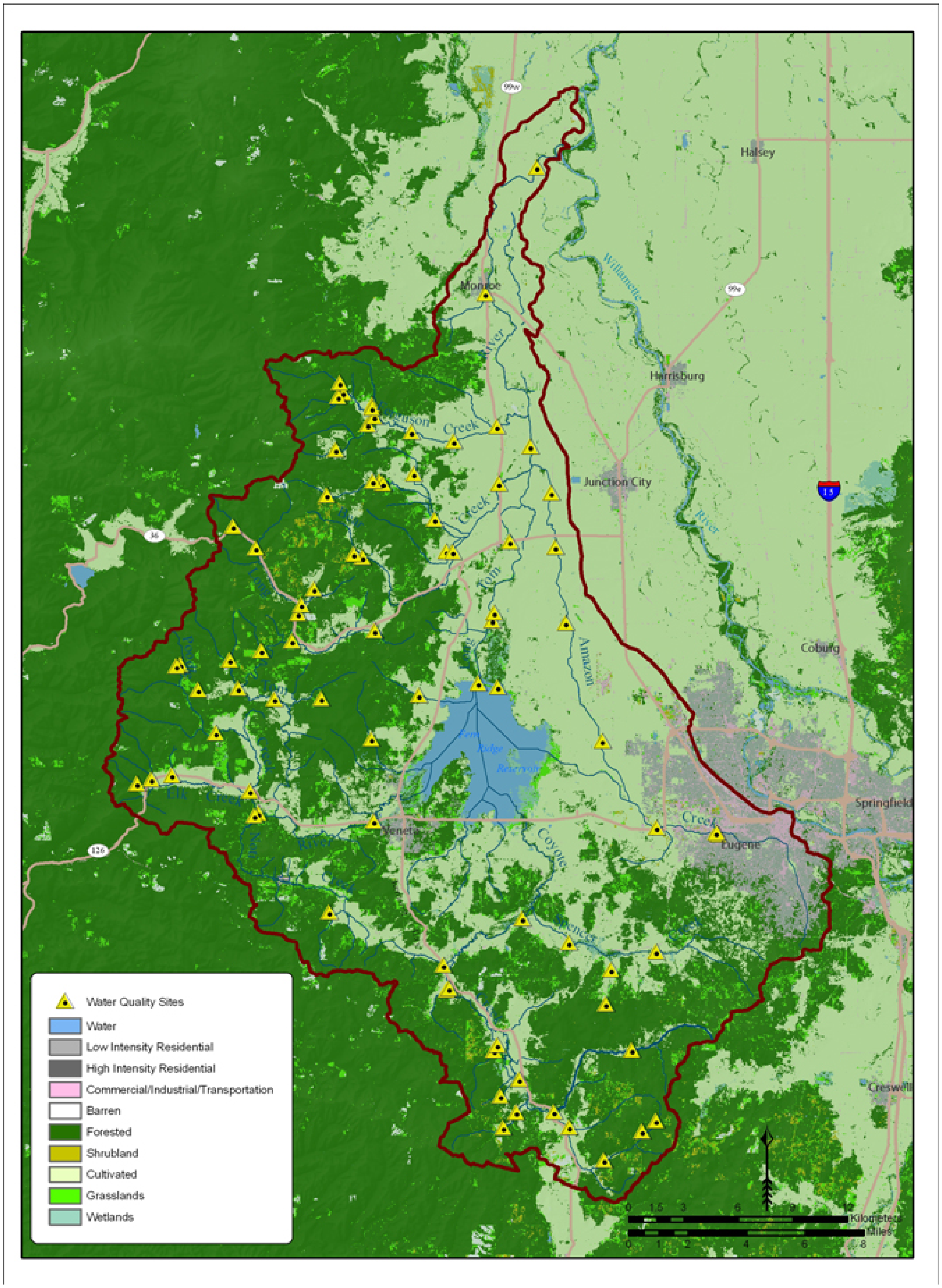
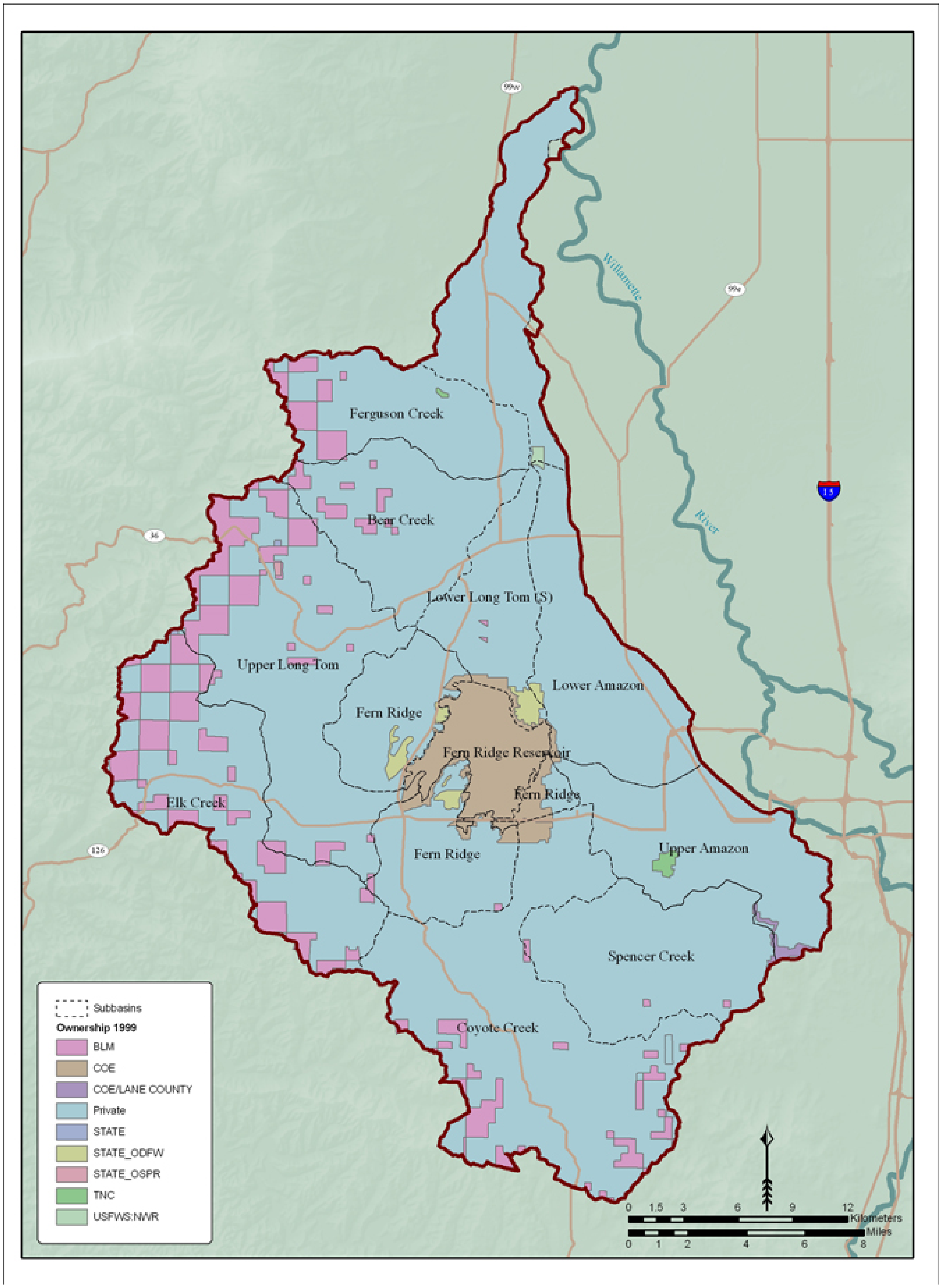


Fig. 3. Land ownership and subwatershed boundaries for the Long Tom River Watershed, Oregon.



adaptive management techniques, and collaborating further with the regional scientific community. This Meyer Memorial Trust grant is in collaboration with Bonneville Environmental Foundation, whose goals are long-term funding to achieve adaptive, science-based, monitoring-intensive management approaches (Reeve 2007, Reeve et al. 2006). Although the LTWC previously received private-sector contributions, this grant was a significant addition to the balance of private and public investment in collaborative watershed restoration, filling in significant gaps in funding a holistic approach to watershed restoration and adding capacity for learning and adaption through flexible funding rules.

In 11 years, the LTWC has implemented more than US$2.8 million worth of projects to restore or enhance portions of river, wetland, and upland habitat in all 10 subwatersheds, as well as in the floodplain of the Willamette River. Isolated projects are less effective than a coordinated program when the goal is watershed protection or restoration. By 2009, the LTWC had a catalog of more than 30 projects and a conservation strategy to guide future action. Low administrative costs (11%), and volunteer involvement from both scientists and lay persons allow for successful implementation of projects that would otherwise be impossible for individual landowners. The LTWC involves private and local funding in every grant proposal, leveraging some by a ratio of five to one.

Building a Social Infrastructure

The LTWC's social infrastructure is developed through a deliberate, transparent, and evolving process that has steadily built and strengthened trust between the Council and the public. The social infrastructure includes elements of social organization that facilitate the work of the LTWC. Individuals, landowner cooperators, volunteers, and local citizens participate in projects or cooperate with data-collection activities initiated by the LTWC. The Council also provides active learning through adult education programs and events that motivate and inform citizens and landowners. Social groups, networks of landowners, and neighbors in subwatersheds have been organized by the LTWC to approach larger-scale conservation concerns such as multiple-owner habitat restoration and protection. Integration of projects to restore ecological function in the Long Tom Watershed is accomplished by a rotating volunteer steering committee (equivalent to a non-profit organization's board of directors) that identifies and tracks the working vision, goals, objectives, and progress of the LTWC and attends to business matters.

In the early years, the LTWC had to determine who its constituency was. As the focus was on the watershed, the LTWC included "... anyone who lives, works, or plays in, derives benefit from, or is affected by the watershed and its resources... as a member of the [Long Tom Watershed] Council (LTWC 2003a)." In the interests of consistent practice over time, the LTWC developed the vision for: "A healthy watershed that ensures water quality and riparian and wetland habitat for fish, wildlife, and native plants while recognizing the importance of people's economic livelihood and quality of life" (LTWC 2003a). The LTWC quickly learned that putting science into practice was a complex social–ecological process for which an approach was not well documented. Implementing inclusivity of membership requires deliberate outreach by LTWC staff to include the most skeptical and inaccessible populations in the watershed. For example, farmers are a critical population for gaining river access and implementing stream restoration activities. Agriculture has the most extensive impact, and urban areas have the most intensive impact on habitat qualities for watershed streams and uplands. Initially, farmers were skeptical that the LTWC would exclude their interests and would instead advocate for urban and environmental interests. Council procedures and education prioritized reaching out to farmers and rural residents to engage their interest and earn their trust. Early on, as the LTWC prioritized its projects, farmers said that all actions should be voluntary. The implications are that landowners have to choose to adopt ecologically beneficial actions. Although the Council does not have any power other than to encourage voluntary action, the philosophical discussions and spoken personal commitments from LTWC organizers were an important component in forming a community approach to the shared challenge of improving ecological conditions in a degraded watershed.

METHODS FOR INTEGRATING SCIENCE AND PRACTICE

The community practice of watershed management is facilitated by the LTWC through the elements of their social infrastructure, combining collection of scientifically rigorous data for monitoring and trend detection with social outreach, and creating a subwatershed approach to share results and encourage action. Since its inception, the LTWC has been deliberate about the integration of science into everyday activities. Furthermore, priorities and work orientation have shifted or become refined by the acquisition and evolution of scientific information and discussion.

There are three core methods of social infrastructure that have evolved for the LTWC. First, the social infrastructure is founded upon science as iterative and integrative; scientists working alongside landowners as equal local citizens with different and useful talents. Second, data collection that informs scientific interpretation has become a medium for outreach and education, and the data are collected at a scale designed to answer community-generated questions. Third, the subwatershed enhancement program integrates and interprets scientific results for subwatershed residents in an open question-and-answer format with skepticism allowed and components of professional judgment clearly acknowledged, thereby building trust. The relationships with individuals that have developed through the day-to-day activities of data collection, project planning, and ecological restoration have facilitated practice by the LTWC among individuals, groups, and across the entire landscape of the Long Tom Watershed.

Science Always in the Loop (Iterative and Integrative)

The LTWC has cooperated with their scientific partners to develop statistically rigorous study designs for gathering data on macroinvertebrates (Thieman 2007), modeling of watershed processes and the effects of treatments (Lamy et al. 2002, Bolte et al. 2006), studying water and habitat quality (Thieman 2007), and understanding the behaviors and motivations of landowners and volunteers (Johnson 2007, Lurie and Hibbard 2008).

In addition to working with university and agency science partners, the LTWC took action to conduct a watershed assessment (Thieman 2000) and form a technical team. A standing LTWC committee, the technical team is composed of staff scientists from agencies, municipalities, universities, and corporations. The technical team works closely with and is supported by LTWC staff and provides broad technical support to both staff and the steering committee in reviewing study design, finding scientific information, determining ecological needs, prioritizing and planning action, reviewing restoration projects, and making educational presentations to citizens and landowners. The technical team recommends and adjusts protection and restoration priorities, reviews and prioritizes projects, provides technical assistance for projects, assesses results, and synthesizes lessons learned.

One example of how science is central to the process of watershed management for the LTWC is the process for developing their conservation strategy (Dedrick and Thieman 2005). First, the LTWC developed spatially explicit restoration priority maps and descriptions for both aquatic and terrestrial habitats based on available scientific information and expert knowledge. These priorities were published in their newsletter (circulation over 1000) with an invitation to attend LTWC's public watershed meetings. Each map and description were presented at LTWC meetings by a volunteer scientist. Then, LTWC staff described restoration prioritization and asked for feedback. This process is coordinated with the statewide Oregon Conservation Strategy (Oregon Department of Fish and Wildlife (ODFW) 2006) and the conservation action planning process for the local preserve (The Nature Conservancy 2009). Next, an overarching strategy that includes landowner comments and participation was crafted to provide descriptions of a comprehensive restoration approach for all identified watershed issues. The LTWC was then able to target required field data to supplement the plan, monitor progress, or redirect activities as conditions in the watershed change over time.

Data Collection as Outreach

The active participation of landowners and citizens from all walks of life strengthens the basis from which the LTWC can actively practice landscape-scale and coordinated restoration of an entire watershed. To this end, the LTWC has spent considerable time and energy communicating with watershed residents. The many data-collection activities that the LTWC has conducted have provided opportunities to contact watershed residents directly. The outcome of these contacts has been the development of scientifically rigorous data, and landowners and citizens who understand the questions and data and share ideas about restoration priorities. Below are four data-collection examples that highlight different goals and outcomes in terms of outreach.

Long Tom watershed assessment

The LTWC completed an inventory of the watershed through an assessment that was conducted over 18 mos. in 1998–1999 and focused on summarizing and interpreting existing data (Thieman 2000). This process involved 28 key professional and skilled citizen volunteers, in addition to a high school class, in collecting, interpreting, and mapping data. The review process included 45 professional, landowner, and layperson reviewers, and as well, a public meeting was held to present the draft findings for each of the nine chapters of the analysis. In each public meeting, a volunteer scientist presented an overview of the subject (e.g., hydrology and water use) and explained why it was important. Next, the LTWC staff reported the findings and showed draft tables and figures. The citizens and landowners in attendance questioned data and gave supporting or conflicting local knowledge. Farmers and foresters from local timber companies reviewed draft chapters of water-quality findings, riparian-zone change analyses, and fish and wildlife information. As a result, participants became invested in the accuracy of information and the phrasing that might affect its perception by landowners and stakeholders. After publishing the assessment, LTWC staff recruited an intern from the nearby University of Oregon to coordinate presentations to private stakeholder groups regarding the results of the watershed assessment. These review processes built confidence in the data, allowing questions of shared values, economic impact from restoration, and politics to be addressed.

Water-quality monitoring

Water-quality monitoring in a watershed with over 90% of the land in private ownership was daunting. Before the watershed council, data on water quality were sparse in both geographic coverage and duration of sampling. Information on potential sources of pollution was lacking. The LTWC wanted to problem solve with local landowners around known impairments based on recent, localized data. First, the LTWC staff held public watershed council meetings and outlined the questions they wanted to ask regarding water-quality differences by land use and potential pollution sources. Staff gained agreement from local residents regarding the questions of interest, obtained volunteers to help with data collection, and discussed monitoring sites. Landowners involved in “designing” the study then suggested people who would likely allow access to stream reaches that did not have public access. Unlikely partners worked together, such as a rancher and outspoken critic of government agencies learning data-collection protocols from an agency scientist and going on to collect samples. From the beginning, this process was transparent, and at key steps, the community was asked to assess goals and objectives. At each step, the community could modify the process. Ultimately, a large number of water-quality monitoring sites were distributed throughout the watershed on both public and private land (Fig. 2). A common set of water-chemistry data are now available for management that are trusted by scientists as accurate and accepted by landowners and citizens.

Macroinvertebrate sampling

The LTWC determined that inventorying an overall indicator of ecological stream health would supplement the available geomorphic and water-chemistry data. Macroinvertebrate diversity was chosen as the index, and scientists from the EPA volunteered to design an inventory study using a spatially random Centroidal Voronoi Tessellation sampling design (Larsen et al. 2001). The LTWC conducted outreach to over 350 landowners to gain survey permission for 100 sites. The study results were analyzed and presented in public council meetings, published (Thieman 2007), and are used in watershed management decisions.

Fish barrier assessment

To better prioritize instream habitat restoration, the LTWC conducted a fish barrier assessment project. Random site selection identified more than 400 sites with a goal of field sampling at least 250. Three phases of outreach were conducted to gain permission to survey. Each phase used an improved outreach letter as staff and the steering committee worked to increase the response rate: a technical, fact-filled letter, a less formal letter with fact sheet attached; then a third round, adding a color aerial photo map with desired survey locations. The increased information provided in the later contact letters led to an increased positive response from landowners (Table 1). Personal phone calls were made to further increase the response rate (Table 1). Personal contact increases the chance that a landowner will give permission for the survey and also provides an opportunity for the Council to develop a relationship with landowners who may later participate in a restoration action.

Subwatershed Enhancement Program

Bringing the results of data collection to practice, the LTWC achieved coordinated ecological restoration through a subwatershed enhancement program. This program targets ecologically significant subwatersheds and the related neighborhood of landowners. This provides a neighborhood approach and avoids the problem of uncoordinated, opportunistic projects that depend exclusively on individual landowner contacts. By using a targeted subwatershed enhancement program, the LTWC can be deliberate about where to use limited resources for the greatest social–ecological benefit.

For each subwatershed, "... the [Long Tom Watershed] Council builds a creek profile listing the special features and known impairments based on current data from the Watershed Assessment, Water Quality Monitoring Program, and local scientific knowledge" (LWTC 2003b). With the profile, maps, and photos, LTWC leaders and staff conduct outreach to identify key landowners who can co-host meetings. Together they host neighborhood meetings and tours within the subwatershed and bring farm, forest, and rural residential people living in close proximity to one another together to learn of the current state of the subwatershed. This leads to discussions of what actions are needed to restore the subwatershed. Ultimately, neighbors join together to accomplish the actions that science suggests are possible (LTWC 2003b). This process couples the social actions of outreach and trust development with scientific information. Without this pairing, a coordinated and scientifically informed restoration process would not be possible.

Five subwatershed enhancement programs are currently active, and scientific findings have been brought to bear on restoration actions in every subwatershed. The LTWC anticipates that long-term trend monitoring will indicate that this clustered restoration approach will be successful and result in measurable improvements in water quality and habitat. Project sites are identified using three criteria (in priority order): ecological priority of the location and site potential for restoration success, anticipated commitment of landowners, and social network connections in the neighborhood. Social network connections are important for long-term maintenance of project sites and also to facilitate future work in the subwatershed as neighbors speak positively to neighbors about action.

RESULTS AND DISCUSSION

The social infrastructure developed by the LTWC approaches social–ecological issues at multiple scales (Fig. 4) and through a variety of avenues. The three core methods of iterative and integrative science, data collection linked to outreach, and subwatershed enhancement programs have resulted in three major categories of results effecting watershed improvement. These categories are the development of local ecological leadership from individuals as watershed advocates and in working networks; restoration and enhancement plans and on-the-ground projects at the scale of individual or multiple sites; and partnerships and policies that effect landscape-level change.

Ecological Leadership Advocates and Networks

Peer leadership within the watershed has emerged from a variety of LTWC activities including science education and watershed data collection. Individuals who were involved in field data collection, individuals informed by that field data through science education programs, and project landowners have become leaders in their neighborhoods, subwatersheds, or areas of influence. Steering committee members and alumni provide further peer leadership and role models in translating scientific knowledge into action. Selected project landowners are listed on the LTWC's "Restoration Program" brochure, which provides references for ecological restoration work. Steering committee members and alumni have been trained in watershed issues, restoration projects, education and outreach techniques, and the business of the LTWC and are active in governing the LTWC, providing connections to landowners, speaking out to maintain the positive reputation of the LTWC, and

Table 1. Fish barrier assessment project landowner contacts through letters and response rate.

Method of Landowner Contact	Total Response (%)	Responses (%)		
		Yes	No	Other
First round of letters (*n* = 178)	28	64	30	6
Second round of letters (*n* = 171)	29	69	27	4
Third round of letters (*n* = 57)	37	76	24	0
Personal phone calls (*n* = 57)	55	46	9	45

alerting staff of any misinformation emerging in the community. The LTWC is interested in further capitalizing on informed alumni and is exploring areas for engagement such as liaison work on scientific issues and fundraising. Leaders and advocates also bring new ideas to the attention of the networks of LTWC members. For example, one landowner and steering committee alumnus proposed an alternative way to approach conservation easements and caught the attention of a scientist and land trust staff.

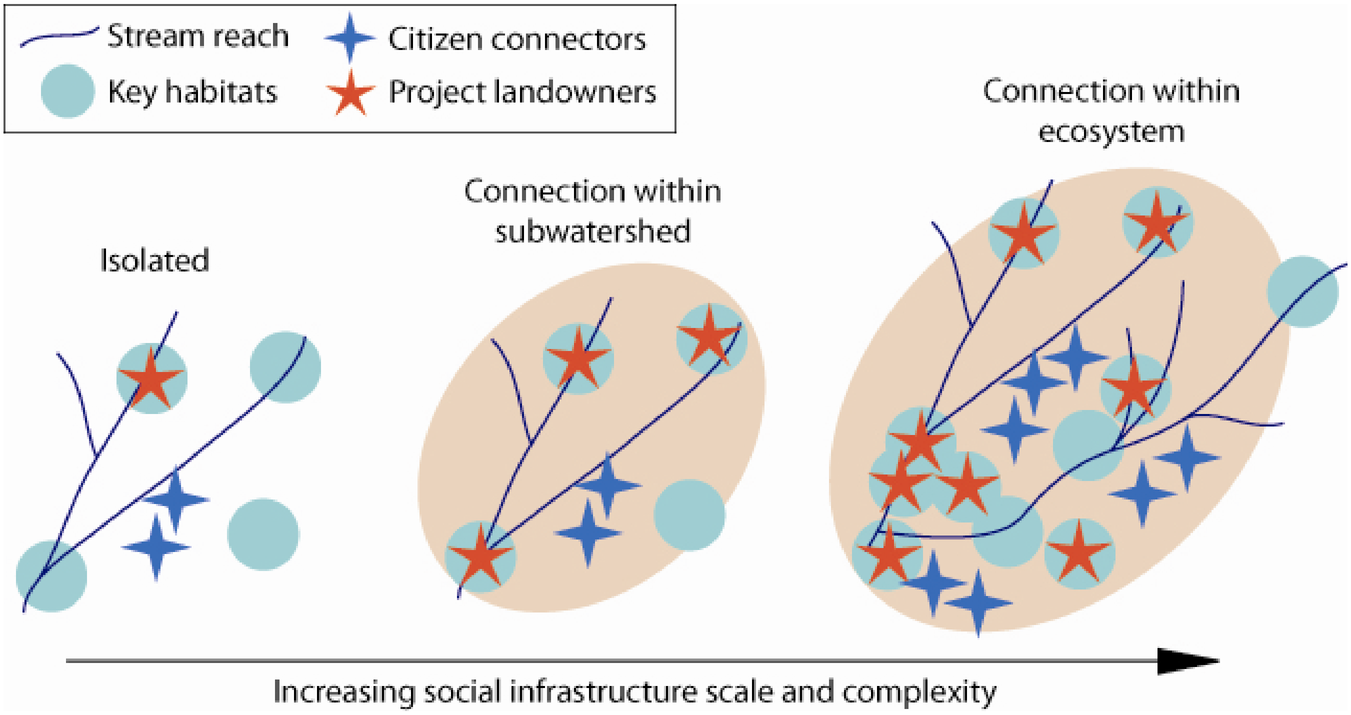
In addition to currently active watershed management participants, the LTWC built and maintains an extensive database of five key networks: people who allowed access to their land for sampling macroinvertebrates; people/landowners who allowed their culverts to be evaluated as fish barriers; volunteers who have done research, sampling, planted trees, or served on committees; people who have hosted or participated in subwatershed programs; and people who have come to LTWC meetings and tours. Due to the personal and detailed nature of the LTWC's communication and information-gathering procedures—personal letters, tour invitations, phone calls, membership interest forms, volunteer skills forms—these networks are viable ways to launch new efforts that will require extensive volunteer involvement such as invasive species management.

Restoration and Enhancement Plans and Improvements

In the early years, the focus of restoration and enhancement was on individual sites. As the interconnected web of relationships developed and trust evolved, particularly using the subwatershed enhancement program approach and data collection as outreach, the LTWC was able to expand the scope of projects to include multiple-site habitat projects at small and large spatial scales, both within the stream corridor and in the uplands. These projects involved individual landowners or groups of participants. For example, an upland restoration project encompassing several habitat improvement elements developed through collaboration with partners and regional ecological planning (Fig. 5). Another example was the removal of a culvert to open up 40 miles of habitat for trout that was identified through the macroinvertebrate sampling project (Fig. 6). An example of coordinated projects completed as part of a subwatershed planning process occurred on Ferguson Creek and focused on multiple areas of ecological habitat improvement (Fig. 7).

Data collection as outreach and peer leadership also resulted in the grouping of multiple habitat improvements. For example, one part of the water-monitoring program was an agricultural runoff pilot study of phosphorus/ortho-phosphate, nitrogen/nitrate-nitrite, and total suspended solids at seven sites. As a result of the study, the growers with identifiable detrimental effects on water quality changed their land stewardship practices. A grower with excess nitrogen entering the stream changed

Fig. 4. As relationships among landowners and the LTWC develop through the growth of social infrastructure, the focus of projects moves from isolated project location to concerted efforts among multiple landowners within the same subwatershed to large-scale projects that address issues at the scale of the ecosystems. As the social infrastructure grows, watershed residents become citizen connectors facilitating learning and projects among their neighbors, and the number of individual landowners willing to be involved in the restoration of ecologically important habitat increases.



his irrigation timing to eliminate the runoff. Two growers installed grassed waterways in three eroding fields (Fig. 8). These individual behavior changes resulted in immediate environmental benefits and updated land-management practices, and the growers themselves have the potential to spread best-management practices to their peers through project tours or LTWC meetings.

Plans developed for the watershed include science-based and community-supported priorities that can be used by anyone. The process of the LTWC Conservation Strategy described above provides maps and descriptions with spatially explicit restoration priorities for aquatic and terrestrial habitats in each subwatershed. The watershed assessment provides a summary of the ecological conditions in the watershed and subwatersheds in lay terms. The stream health report presents and interprets new local water-quality and macroinvertebrate population data by subwatershed with maps and charts. The fish barrier inventory provides maps and detailed descriptions of barriers to fish migration. These documents contain a body of common knowledge widely agreed upon by scientists, citizens, and landowners. These documents require translation of scientific language into presentations accessible by local residents. These translations meet high standards for accuracy and readability and are often referenced in plans, reports, and legal documents. Due to the networking of alumni, project landowners, and key stakeholders, advocates from diverse perspectives speak in their own terms about their trust and support for the findings in the documents to landowners and decision-makers new to the area or to the LTWC who might not have been in the approval process.

Fig. 5. Wild Iris Ridge Restoration Project. At Wild Iris Ridge, local scientists identified restoration opportunities for threatened native prairie and oak habitats. The LTWC worked with the municipal landowner to expand the scope of the project from erosion control to include 50 ha of prairie and oak habitat improvement that included blackberry removal (a and b) and scotch broom eradication (c and d).

Most subwatershed protection and restoration projects involve iterative planning and active habitat restoration. As most projects are less than 5 years old and restoration of habitat can take a half-century or longer (Kauffman et al. 1997), most current habitat measures are premature. The important outcome at this point in time is that the social infrastructure is in place and coordinated restoration actions are being planned, implemented, and monitored.

Partnerships and Catalyzing Landscape-Level Change

The collaborative and transparent data-collection approach and the quality of the data provided have led to the use of LTWC information in a variety of publicly accessible plans and documents such as federal watershed analyses, state water-quality management plans and rules, and regional long-term vision and action plans. Some examples are:

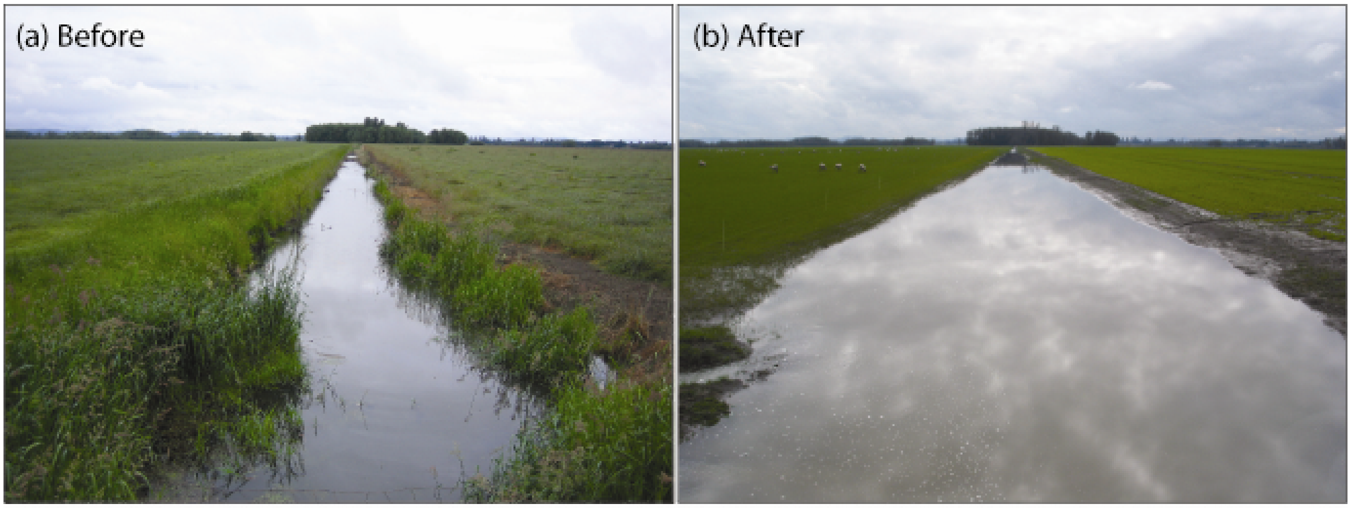
Fig. 6. Coyote Creek Culvert to Bridge Project. On Coyote Creek, a culvert-to-bridge project opened up cutthroat trout access into 74 km of upstream habitat (a and b). This site was identified through outreach to landowners with priority habitat locations found through the water-quality sampling program. This project developed into additional components that improved in-stream and riparian habitat conditions on a 160-ha ranch and is now an anchor demonstration project for a new subwatershed enhancement program in the Coyote Creek subwatershed.

water quality total maximum daily load rules for specific pollutants, the Willamette Synthesis Project, Rivers to Ridges Open Space Vision and Plan, and the West Eugene area conservation action plan.

Aside from making data, reports, and interpretations widely available, LTWC staff participate in selected planning and action efforts by other entities to achieve watershed-level impact. The data and expertise the LTWC holds and its cooperative nature make it a sought-after partner. Significant examples in addition to the plans above include: state agricultural and water-quality planning and rule creation, county planning and policy around riparian and floodway protection, and regional wetland and ridgeline partnerships for long-term waterway and habitat planning and protection. In the Agriculture Water Quality Management Plan and Rules, created by the Oregon Department of Agriculture, the LTWC was credited with creating a smoother process and a more robust rules outcome due to the Council's previous work in collecting water-quality data and educating citizens and farmers. Due to this recognized expertise and trust, the Local Area Committee formed to create and adopt the rules was composed of more knowledgeable farmers and citizens who then invited LTWC staff to serve as technical advisors. With county floodplain and riparian protection in 2009, the LTWC worked with four adjoining watershed councils and multiple agency partners to jointly report degraded floodplain and riparian conditions to Lane County Commissioners. The LTWC took a collaborative approach in offering technical services and working with county staff that resulted in the prioritization of floodplain and riparian protection in their immediate work plan. As a member of the West Eugene Wetlands Partnership, a national model for wetland protection and restoration, the Council was instrumental in the transition to its successor Rivers to Ridges Partnership, which includes a greater geography and threatened upland habitats such as oak savannah and wetland habitats. Finally, the LTWC provides landowners with connections to other organizations

Fig. 7. Ferguson Creek coordinated multiple habitat enhancement projects. On Ferguson Creek, multiple habitat enhancement projects were identified through the subwatershed enhancement program. This project targeted sites with high ecological value coupled with committed landowners. Two culverts were removed, making available several kilometers of high-quality cutthroat trout habitat. Livestock exclusions with off channel watering systems (a), riparian plantings (b), instream habitat enhancement through the addition of large wood (c), and multiple techniques were used to increase floodplain capacity including stream habitats that flood off channel terraces (d).

Fig. 8. Grassed waterway, pre- and post-project implementation. The objective was to eliminate a narrow gully and the concentrated erosion occurring due to bare soil (a). The ground was recontoured at 10:1, thereby widening the channel, erosion fabric was installed, and vegetation development is in its first year (b).



to meet their goals such as the land trust for permanent protection of land and habitats, and the U.S. Fish and Wildlife Service for restoration focused on threatened and endangered species recovery.

CONCLUSION

The Long Tom Watershed Council has created the social infrastructure for gathering, synthesizing, digesting, and translating the insights and scientific findings of local residents and the scholarly and agency community into practical applications. The LTWC's social infrastructure sets goals, gains trust, secures resources, and brings on-the-ground change in a complex rural–urban watershed. As new scientific information and theories emerge and the social–ecological system shifts, the LTWC is working to increase effectiveness in conservation and innovation and to inform and learn from other watershed protection and restoration efforts around the state.

The Council is a catalyst for starting practices that will spread through contact between individuals, targeted networking, and as a result of the use of the Council's social infrastructure. Future restoration and protection will be more secure if the practices initiated by the Council expand in location, scope, and level of protection. The LWTC is not an end point. It is the beginning of a process to improve water quality, habitat for fish and wildlife, and social–ecological relationships for stewardship in the watershed. The LTWC shows how important the social dimensions of integration and translation of science are alongside developing data collection linked to outreach and engaging neighborhoods of landowners in subwatershed enhancement programs. Through transparency and trust, the Council has reawakened land ethics and stewardship in the watershed. Through its infrastructure, Council staff, members, steering committee, and alumni continually expand the LTWC's community connection, education, and action programs.

The example of the LTWC illustrates the many elements of social infrastructure that need to be created, interwoven, and actively maintained in order to put science into practice. The transparency of the LTWC's approach to developing its social infrastructure has been an asset in building trust, encouraging communication, and increasing participation in Council-sponsored projects and events. It takes time to build an effective social infrastructure that includes leadership, vision, trust, partners, resources, education, and understandable scientific knowledge. Without this social infrastructure and its continued maintenance, science cannot be put into practice or maximally utilized as an integrated component of the practice of ecological restoration.

Responses to this article can be read online at:
http://www.ecologyandsociety.org/vol14/iss2/art36/responses/

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