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INVITED STRATEGIC ARTICLE

Communicating useful results from restoration ecology research

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Interactions between restoration ecologists and stakeholders (policy makers and decision makers, volunteers, public supporters) benefit from clear communication of research findings. Given that adaptive management (e.g. learning while restoring) already stresses frequent and effective discourse among researchers and stakeholders, it seems that a new specialty under a new term, "translational ecology," adds more confusion than clarity. Communicating technical information to nontechnical audiences benefits from simple rules—be clear and concise, retain familiar terms that serve well, and use fewer words.

Key words: adaptive management, stakeholders, translating technical information, translational ecology

Conceptual Implications

- Where a useful, understandable term already exists, any benefit of replacement might be outweighed by the cost of confusion.

In a *Science* editorial, Schlesinger (2010) characterized ecologists as "often unable to convey knowledge effectively to the public and to policy makers." *Restoration* ecologists probably fare better than average, owing to a culture of working with a broad range of stakeholders. Still, we can always improve the translation of our technical knowledge into language and formats that are understandable and attractive to nonscientists. In my opinion, those of us who accept taxpayers' money to conduct research should give some of the resulting knowledge back to the public. Schlesinger's (2010) remedy is "translational ecology" (TE, akin to "translational medicine") to help ecologists interact with stakeholders, e.g. about environmental degradation and repair. I commend Dr. Schlesinger for implementing his own advice for broad audiences (Schlesinger 2017), in addition to publishing scientific advances over a productive and highly rewarded career in ecology.

Here Is What Is Great About a New Push for More and Better Communication

Clear, concise writing and speaking are always in demand, so restoration ecologists who can convey new knowledge widely are more likely to influence policies, decisions, citizens, and future restoration efforts. An additional positive outcome is that newer faculty vying for tenure and promotion can now point to this push for understandable communications to receive credit for work that might otherwise be ignored—or worse, counted against advancement (Zedler 1997). Over five decades, I have seen professional growth assessed unfairly, with "judges" assigning less credit for applied ecology and for publications that were not peer-reviewed. Writing for broader audiences was okay *in addition to* (but not instead of) writing peer-reviewed and pure-science papers. My mode was to work directly with staff from agencies; e.g. to restore endangered species habitat in an adaptive management (AM) framework (Zedler & Callaway 2003).

UW-Madison embraced strong relationships with stakeholders in creating a Chair of Restoration Ecology, and in 1998 I rejoined the Arboretum—the birthplace of both Restoration Ecology and the practitioner journal, *Ecological Restoration*. There, I helped students and other collaborators advance restoration science and write recommendations for practitioners, policy makers, and decision makers. In 2005, we began posting Arboretum Leaflets (40 are online at https://arboretum.wisc.edu/science/research/leaflets; e.g. no. 4 on adaptive restoration). I also posted place-based research as eBooks on user's websites (1) Tijuana River National Estuarine Research Reserve and (2) Town of Dunn, Wisconsin. Both hosts provide free downloads. The Internet revolutionized communication with stakeholders. Also helpful are "Implications" in this journal and "Plain language summaries" following technical abstracts in other peer-reviewed journals (as by Myrbo et al. 2017).

So What Is My Concern?

I think something got lost "in translation," as the push to improve communication between ecologists and information-users morphed into the idea to formalize a specialty and a "comprehensive pedagogical approach for training doctoral students to be translational scientists" (Brunson &

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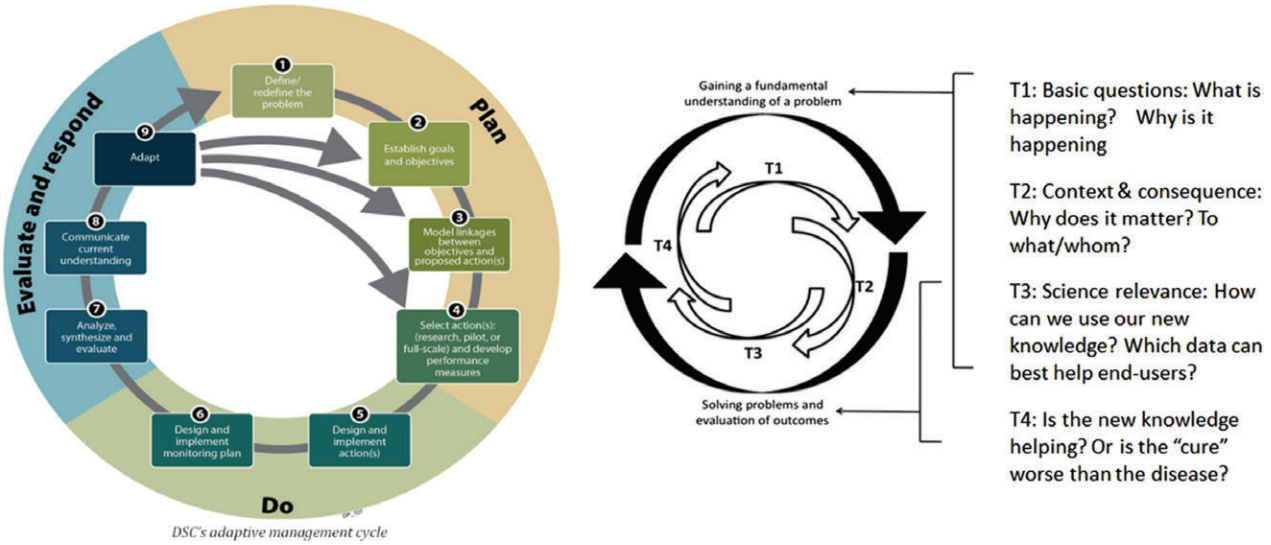

Figure 1. Concepts of AM (left) and TE (right). The many roles of scientists are implied rather than specifically identified in both diagrams. The nine steps of AM are based on research and monitoring, with arrows showing ways to address the problem or revise an action based on what is learned (from Delta Stewardship Council 2013). For California's San Francisco Bay Delta, adaptive management is mandated by state law. The diagram for TE was adapted from translational medicine, in Baker and Erwin (2016). Another drawing of TE (Hallett et al. 2017) shows more iterations between researchers and stakeholders.

Baker 2015). In a special issue of *Frontiers in Ecology and the Environment* (vol. 15[10]), "translational ecology" was presented as a new approach (or entity) needing detailed definition and rules. This followed workshops at centers for ecological synthesis. Authors tried to distinguish this entity from applied ecology, but not from AM, which espouses the same principles and seeks the same aims. Indeed, conceptual models for TE and AM are similar (Fig. 1).

The two workshops on TE were in Maryland (SYSNC, with 12 report authors; Baker & Erwin 2016) and in California (NCEAS, Enquist with 28 coauthors 2017). One author (Brunson) attended both. Attendees emerged with suggestions for formalizing a new specialization called "translational ecology"—arguing that "applied ecology" is distinctly different (Wall et al. 2017). The resulting papers (Table 1) offer definitions that also describe "adaptive management"—a term with precedence and a much larger literature (Walters & Hilborn 1976; see reviews of Wiens et al. 2017, Zedler 2017, and Leaflet 40 2016). One paper acknowledged overlap between TE and AM (Hallett et al. 2017).

As presented by authors in Table 1, translational ecologists and users are expected to interact *from beginning to end* of a project. This might be how it works for agency ecologists, but it oversimplifies restoration ecology. Restoration ecologists often help plan, implement, and monitor projects, but it is not clear if their recommendations to change course are heeded or if the same scientists are engaged to assist with new alternatives. Regardless, basic steps for TE as described above and AM are similar, namely: engage stakeholders, identify alternative approaches, conduct relevant research, observe outcomes, choose best approaches, and use results. Under any name, long-term commitments and funding are needed but difficult to achieve, even where AM is a legal requirement (as in the California Bay Delta; Wiens et al. 2017).

A new term is not likely to solve an old communication problem. I am concerned that the purpose of making ecological research understandable to stakeholders got lost as the focus became definitions. Authors present the new term, then offer examples that support it—the reverse of identifying a need for a new term for a new approach that needs a name. Let us step back and reconsider what our audience needs.

Who Will Use the Research That We Are Doing?

A new emphasis on clear concise messaging is welcome, even if much more is needed to achieve restoration targets. As a project progresses, the stakeholders shift from planners, to implementers, those who monitor outcomes, and those who decide next steps. Restoration ecologists should have greater roles in planning, implementing, and assessing restoration projects, but even early partnerships with stakeholders and continual funding will not necessarily make policy makers or decision makers *accept* science-based advice. I speak from experience. On the positive side, I have also experienced many restoration efforts that welcomed researcher participation and used results to achieve desired outcomes.

My worst experience was a contractor's refusal to heed science-based advice (rejecting scientific documentation that warned against adding topsoil to swales that were being built to trap nutrients in urban run-off). The result? As predicted from research, the swales released nitrogen and phosphorus, rather than trapping nutrients (Doherty et al. 2014; Leaflet 27 2013; Leaflet 28 2013). Nevertheless, the project was certified as a stormwater improvement system because the contract required only that swales be built as designed, not *that they would function as needed!* There is a lesson here. Ecologists need to

Table 1. Recent characterizations of a new term and references to old terms.

Source	*TE: description and proposed requirements*	*Relation to (applied ecology) or AM*
Schlesinger (2010)	Connects end-users of environmental science to field research on environmental problems. Users alert scientists to data needs; scientists synthesize data and indicate relevance to policy; stakeholders and scientists are in constant two-way communication.	Emphasizes communication with users.
Baker and Erwin (2016)	TE is boundary-spanning environmental science that leads to actionable research focused on maintaining or enhancing the resilience of social-ecological systems. Using an adaptive and iterative mode of inquiry, it extends beyond traditional scientific boundaries. It provides accessible tools and frameworks that allow exchanges of knowledge among ecologists and intended beneficiaries of their science, to promote mutual learning and a shared sense of its utility.	
Enquist et al. (2017)	An intentional approach with scientists, practitioners, and stakeholders collaborating, building trust, and developing outcomes that are accessible, actionable, shaped by all participating parties, and readily usable in decision-making. TE addresses questions from on-the-ground issues—not top-down.	AM is a structured process for decision-making; aims to reduce uncertainty; AE does not require end-users to use scientific info.
Wall et al. (2017)	Reiterates definition in Enquist et al. (2017). Also, "TE seeks to fundamentally alter the applied/basic science paradigm by explicitly engaging stakeholders in the generation and utilization of knowledge, thereby creating an alternative paradigm for ecologists to address the multilayered and complex ecological problems faced by decision and policy makers." Is "motivated by a search for outcomes that directly serve the needs of natural resource managers and decision makers." "TE could be used to inform learning-based decision processes such as adaptive management, … can be applied when a system's controllability and uncertainty are both low, … as well as in systems characterized by a combination of high controllability and high uncertainty, in which adaptive management is warranted … will help to achieve adaptive-management..."	Claims to be "[d]istinct from both basic and applied ecology, … extends research beyond theory or coincidental applications." Admits that AM stakeholders and researchers also need to agree on project outputs.
Hallett et al. (2017)	Ecologists, stakeholders, and decision makers work together to develop scientific research that informs decision-making. Reiterates Enquist et al. (2017).	TE and AE differ; in TE, end-users must share responsibility for useable research.
Lawson et al. (2017)	Priority is understanding social systems and decision contexts; identifies goals shared by stakeholders and researchers; six principles: collaboration, engagement, commitment, communication, process, and decision-framing. A long-term commitment to work directly with partners to achieve shared goals is central; results are actionable; participants have the necessary support.	

know the legal requirements and authority structure. When rules and project plans do not adequately protect the environment, we need citizen-based monitoring to catch and correct problems and new rules to prevent recurrences. In an AM approach, all would learn that the failure to accept science-based advice can cause a project outcome to be the opposite of what was intended.

Clear Communication Is Always Needed

Our communications for users are more effective when we:

Are clear and concise: State the problem or ask a question. Say what we do not know that we need to know. Say what was learned; answer questions. Say what still needs to be learned. I

admire authors who can do all that and still write in an engaging manner!

Retain familiar terms that serve well: Restoration ecologists have an advantage here, because many concepts are borrowed from the common vernacular, e.g., *restoration, disturbance*, *succession*, *competition,* food *webs*.

Use fewer words: Instead of "alternative stable states that shift from one domain of attraction to another, involving tipping points and hysteresis," a writer can tell stakeholders that "*ecosystems are easily modified but rarely restored completely*."

MTUOA: Minimize the use of acronyms.

Avoid debates over terms: Here, I ask proponents of new terms to reconsider the need for new terms, especially in the science and practice of restoration ecology. I support the need to "connect end-users of environmental science to the field research carried out by scientists who study the basis of environmental problems" (Schlesinger 2010). So it goes in AM. In those rare circumstances when a new term is needed, first consider earlier terms and provide reasons for their inadequacy before adding confusion to the literature. Restoration ecology is best approached in an AM framework following guidance, including interactions with stakeholders, as by Williams and Brown (2012) and Fischenich et al. (2012).

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