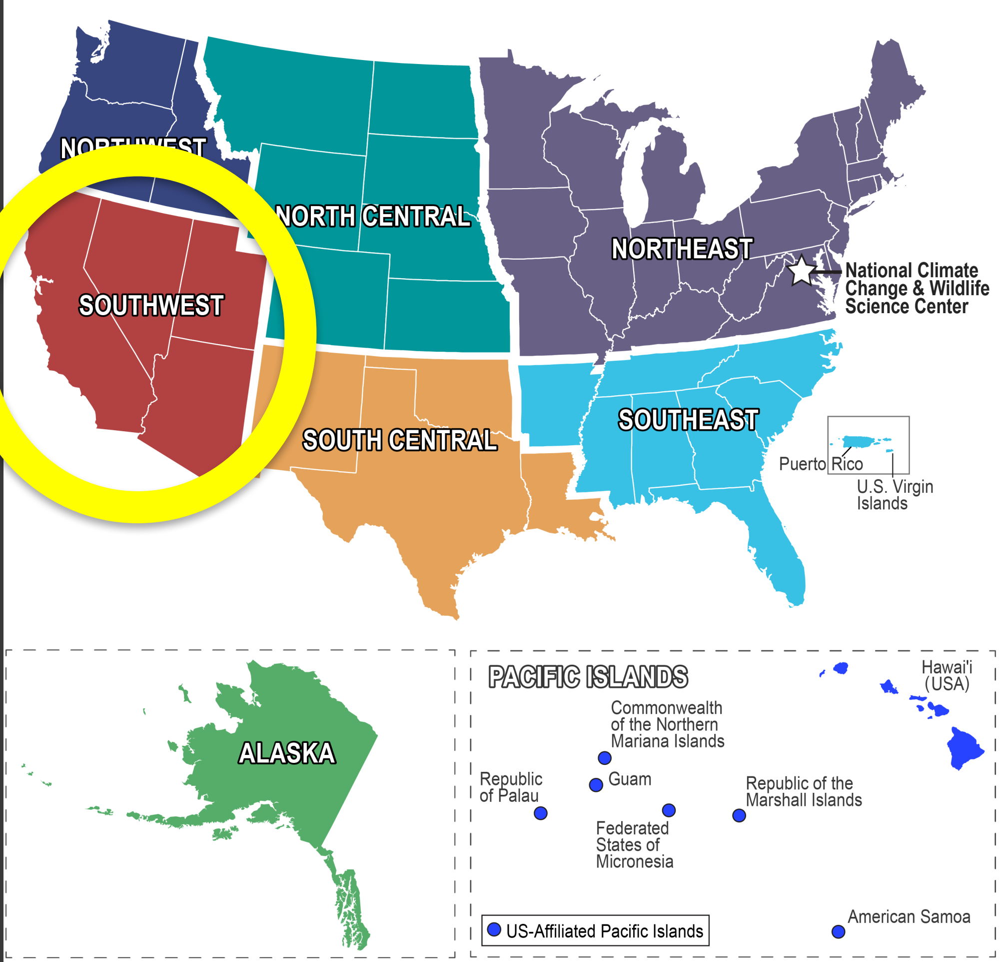
# Translational Ecology Short Course

Tucson, AZ
April 4-5, 2018

Southwest Climate Science Center
USGS science for a changing world
The University of Arizona
UC Davis University of California
Scripps Institution of Oceanography UC San Diego
UCLA
DRI
University of Colorado Boulder

Southwest Climate Science Center




Department of the Interior Climate Science Center Regions

# Mission of the Southwest Climate Science Center

The mission of the SW CSC is to work with natural and cultural resource managers to develop and deliver scientific information and techniques to anticipate, monitor, and adapt to climate change in the southwestern United States.

# Vision for the Southwest Climate Science Center

- Foster effective collaboration between scientists and resource managers in anticipating, monitoring, and adapting to climate variability and change in the Southwest

- Identify and apply best practices for translational climate and environmental sciences

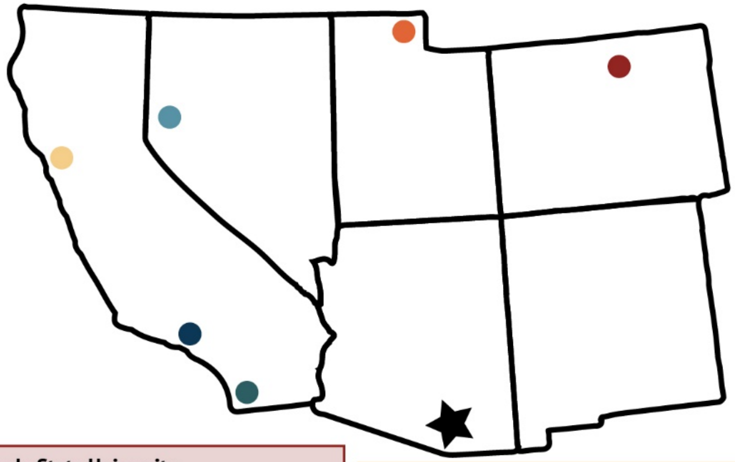
# Guiding principles:

- Focus on management outcomes and solutions
- Co-production of knowledge by practitioners and scientists
  - **Actionable Science**

# Guiding principles:

- Focus on management outcomes and solutions
- Co-production of knowledge by practitioners and scientists
  - **Actionable Science**
- Coordination of cultures and calendars of decision-making and research
- Clear communication of scientific capacities and uncertainties
- Utilization of experiential and local knowledge
- Commitment to span professional and disciplinary boundaries

# SW CSC Expertise and Institutional Connectivity



**University of Arizona**
**Gregg Garfin:** climate impacts and climate adaptation
**Alison Meadow:** anthropology, evaluating use of climate information

NOAA RISA – CLIMAS • Coop Extension • USGS AZ WSC • USGS AZ CFWRU • USGS NPN • USGS SDRS

**University of California, Davis**
**Mark Schwartz:** conservation biology and ecosystem management
**Beth Rose Middleton:** Native studies, environmental law and policy

CDFW • CA LCC • Delta Science Program • USDA California Climate Hub • UDSAFS PSRS • USGS WERC • Coop Extension

**Colorado State University**
**Erica Fleishman:** ecology and conservation biology
**Brad Udall:** water policy, climate adaptation

Colorado NHP • Colorado FS • Coop Extension • DOI NC CSC • USDAFS RMRS • USFWS NRP • USGS CO CFWRU • USGS FCSC

**Utah State University**
**Nancy Huntly:** ecology, human ecology, and climate adaptation
**Michelle Baker:** aquatic and ecosystem ecology

BLM • USDAFS RMRS • USDA NWRC • USGS UT CFWRU • Utah Climate Center • UDWR • Coop Extension

**Scripps Institution of Oceanography (University of California, San Diego)**
**Alexander Gershunov:** extreme weather and climate variability
**Dan Cayan:** meteorology, oceanography, and hydrology

NOAA RISA - CNAP • USGS CA WSC • NOAA SFSC • NWS San Diego • CDFW

**University of California, Los Angeles**
**Glen MacDonald:** long-term climate and environment dynamics
**Rich Ambrose:** restoration, environmental health, and conservation biology

NOAA Sea Grant • NPS Santa Monica NRA • Santa Monica Bay Restoration Commission

**Desert Research Institute**
**Tamara Wall:** wildfire social science, evaluating use of climate information
**Tim Brown:** wildland fire science and management

BLM • Nevada Division of Forestry • NIFC Predictive Services • NOAA RISA - CNAP • NOAA WRCC • USFWS • USGS WGSC

# Cycle 2 - Science

- Coastal Ecosystems
- Terrestrial and Aquatic Ecosystems
- Water
- Climate Extremes
- Actionable Science Practice

**Advancing Water Resource Management Across the Southwest with Cutting Edge Research**

**Effective wetland management in the California Central Valley during extreme drought.** Ongoing SW CSC work is helping Natural Wildlife Refuges and managers make better decisions on critical water allocations for wildlife and farmers.

**California's coastal marshes are vulnerable to sea-level rise.** This will negatively affect ecosystem services such as water quality, coastal protection from storms, habitat for wildlife, and the ability to store excess carbon. SW CSC research has guided the U.S. Fish & Wildlife Service to develop more resilient coastal habitats.

**Warmer spring temperatures reduce Colorado River flow.** New SW CSC research shows that warmer spring temperatures reduce flow more than previously recognized. These results help water managers determine how future warming temperatures may influence the river's flow and the region's water supply.

**Improved modeling approaches to understand current and future changes in Colorado River Basin climate and flows.** Ongoing SW CSC work indicates that dynamically downscaled global climate projections may provide more realistic estimates of future climate than those currently used by water managers.

**Science to Increase the Resilience of Southwestern Forests**

**Evaluating the vulnerability of iconic forests to extreme drought.** New SW CSC research will produce high-quality data for use in decision-support tools that forest managers can use to prioritize and implement management practices in the Southern Sierra Conservation Cooperative — a partnership of the National Park Service, the US Forest Service, the Bureau of Land Management, and the US Geological Survey.

**Prescribed fire reduces tree death from drought.** New SW CSC research shows that when prescribed fire is used to thin forests, the remaining trees are more likely to survive the stress of persistent drought.

**Increasing forest resistance to severe drought and wildfire.** Additional SW CSC work in the Sierra Nevada Mountains of California is increasing our understanding of how management practices can increase forest resilience, with utility throughout the West.

**Taking the Lead in Engaging Key Stakeholders and Tribal Communities**

**Coordination and convening of federal and other climate-adaptation entities.** The SW CSC initiated a series of discussions among regional to national climate programs, including NOAA RISAs, USDA Climate Hubs, Landscape Conservation Cooperatives (LCCs), and CSCs, to coordinate more effectively and to identify critical gaps in climate-adaptation efforts.

**Tribal Engagement Initiative.** The SW CSC collaborated with the University of Arizona's Center for Climate Adaptation Science and Solutions and the Desert LCC to organize the nation's first workshop to bring together tribes that have climate adaptation planning capacity to learn best practices. Next steps include facilitating training, grant writing, and providing other technical expertise for tribes throughout the Southwest.

**Convening Southwest Climate Summits.** The SW CSC worked with four regional LCCs, the USDA Southwest Climate Hub, the CLIMAS RISA, California state agencies, and NGOs to lead the convening of the first two Climate Summits for the region, widely attended by scientists, resource managers, and other stakeholders.

Visit us online at swcsc.arizona.edu

# Cycle 2 – Capacity Building

- Regional Partner Dialogues and Summits
- Academic Fellows
- Practitioner Fellows
- Engagement with Tribes
- Community of Practice

EDITORIAL

William H. Schlesinger is president of the Cary Institute of Ecosystem Studies in Millbrook, NY. E-mail: schlesingerw@caryinstitute.org.

# Translational Ecology

ECOLOGY IS WELL INTO ITS SECOND CENTURY AS AN ORGANIZED SCIENTIFIC DISCIPLINE, RICH WITH observations, experiments, and a general understanding of how the natural world works. Today's environmental scientists have a powerful array of tools and techniques to measure and monitor the environment and to interpret vast and diverse data. Yet despite producing an enormous amount of new information, ecologists are often unable to convey knowledge effectively to the public and to policy-makers. Unless the discoveries of ecological science are rapidly translated into meaningful actions, they will remain quietly archived while the biosphere degrades.

Global warming, the Gulf of Mexico oil disaster, invasive species—these are but a few of the issues concerning environmental scientists and, increasingly, the public. What is needed is a new partnership between scientists and advocacy groups that conveys ecological information accurately and in ways that stakeholders (including policy-makers, resource managers, public health officials, and the general public) can understand. Just as physicians use "translational medicine" to connect the patient to new basic research, "translational ecology" should connect end-users of environmental science to the field research carried out by scientists who study the basis of environmental problems. Translational ecology requires constant two-way communication between stakeholders and scientists. It should continually alert scientists to aspects of the environment in need of study to produce new data, while clearly synthesizing what is already known from field studies and its relevance to policy. The partnership's purpose should be to ensure that all stakeholders know the implications of scientific discoveries and understand their impact on alternative ecological diagnoses.

Good examples of translational ecology involve interdisciplinary teams of scientists, engineers, public health experts, and members of the end-user community. A recent study of the environmental impacts of mountain-top–removal mining involved a collaboration between ecologists and public health experts.* Earth Justice and other nonprofit groups used this material to convince the U.S. Environmental Protection Agency (EPA) to issue new guidelines that will severely limit most such mining practices. In earlier years, research by wetland ecologists helped the EPA outline how to recognize and delineate wetlands, based on soil characteristics. Other scientists are now working with advocacy groups to help policy-makers understand the implications of human perturbations of the global nitrogen cycle. And we can be sure that scientific analysis of the impacts of deep-water petroleum extraction will also be forthcoming—in this case, unfortunately, as a retrospective.

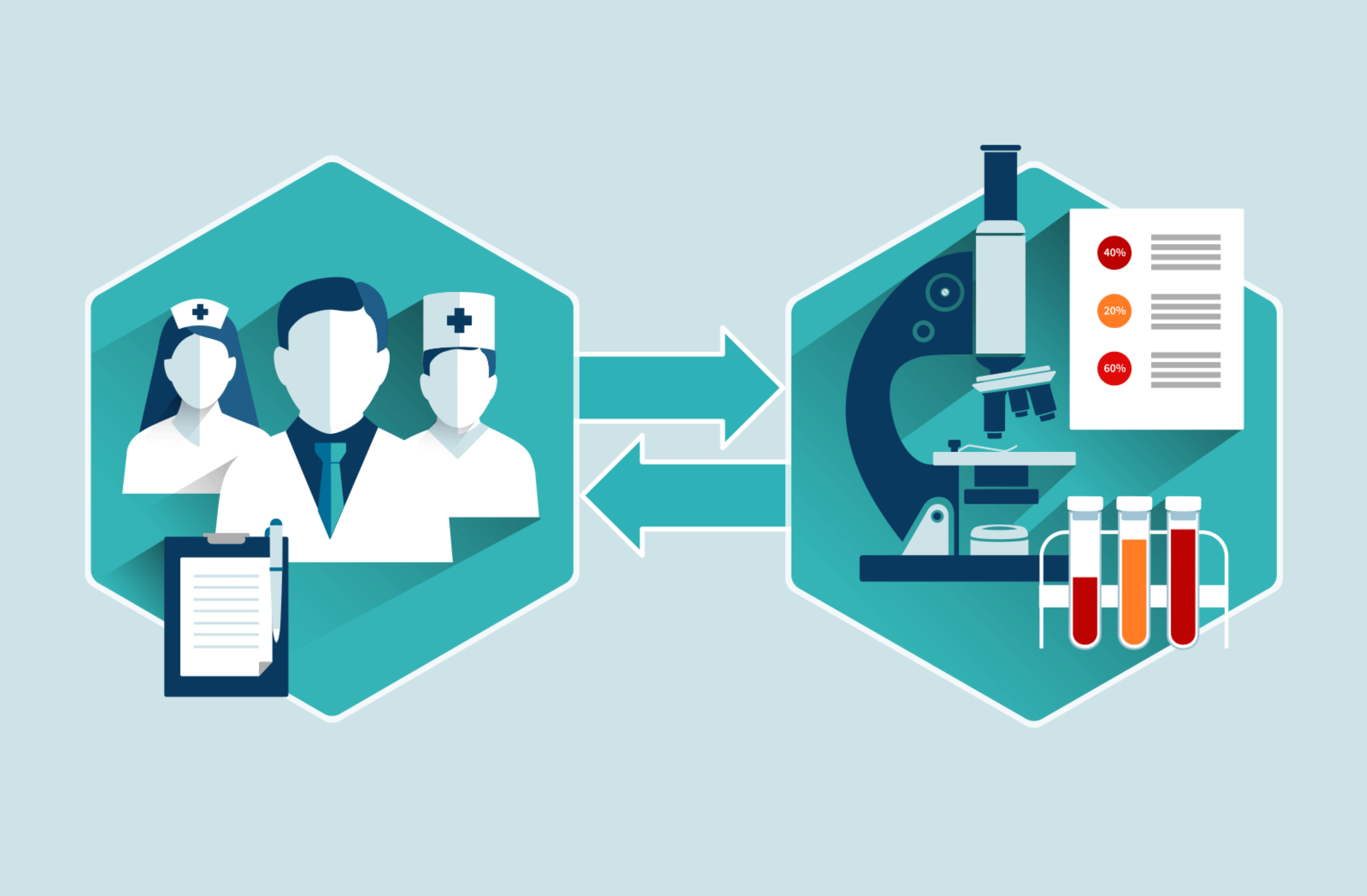
Translational medicine grew from the recognition that basic research findings were not moving effectively into the development of drugs and treatments. To overcome this problem, in 2006 the U.S. National Institutes of Health established a Consortium for Transforming Clinical and Translational Research, which grants Clinical and Translational Science Awards. These awards have recently been increased to over $250 million for the next 5 years, expanding the consortium to 55 institutions nationwide. Translational ecology should similarly connect the end-users of environmental science with the major funders of environmental research.

This week, the Ecological Society of America concludes its annual meeting in Pittsburgh. The world's largest international organization of ecologists can play a critical role in spurring translational ecology. It has drawn together more than 3000 scientists, policy-makers, and citizens to explore the causes and consequences of this year's theme, global warming. Many of the sessions call for ecologists to take charge and improve science education and literacy, so that issues related to global warming are not misunderstood. Connecting ecology to stakeholders in these and other ways should enhance the understanding and application of ecological concepts, ensuring that scientific rigor is brought to bear on the world's many environmental challenges.

**– William H. Schlesinger**

10.1126/science.1195624

*M. A. Palmer *et al.*, *Science* **327**, 148 (2010).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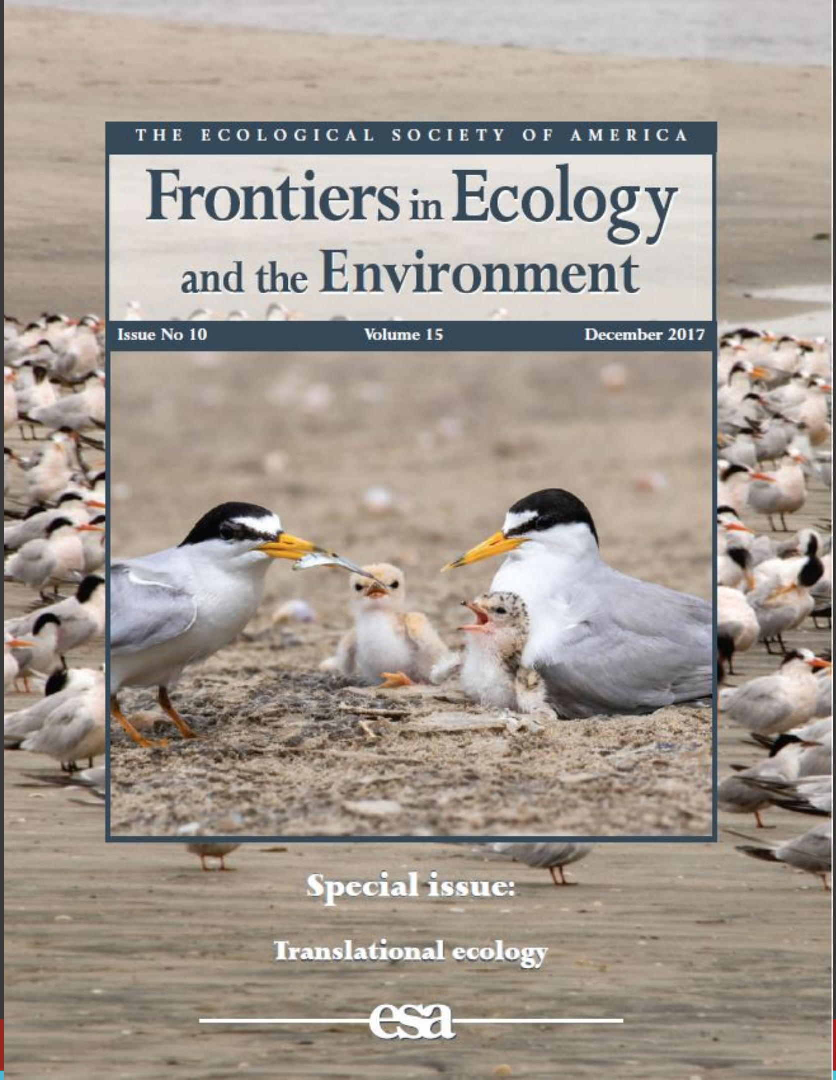
# 2015: Translational Ecology Working Group

- Ecologists
- Climate adaptation scientists
- Social scientists
- Resource managers

- Special issue of *Frontiers in Ecology and the Environment*
- ESA Symposium & special sessions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Issue No 10
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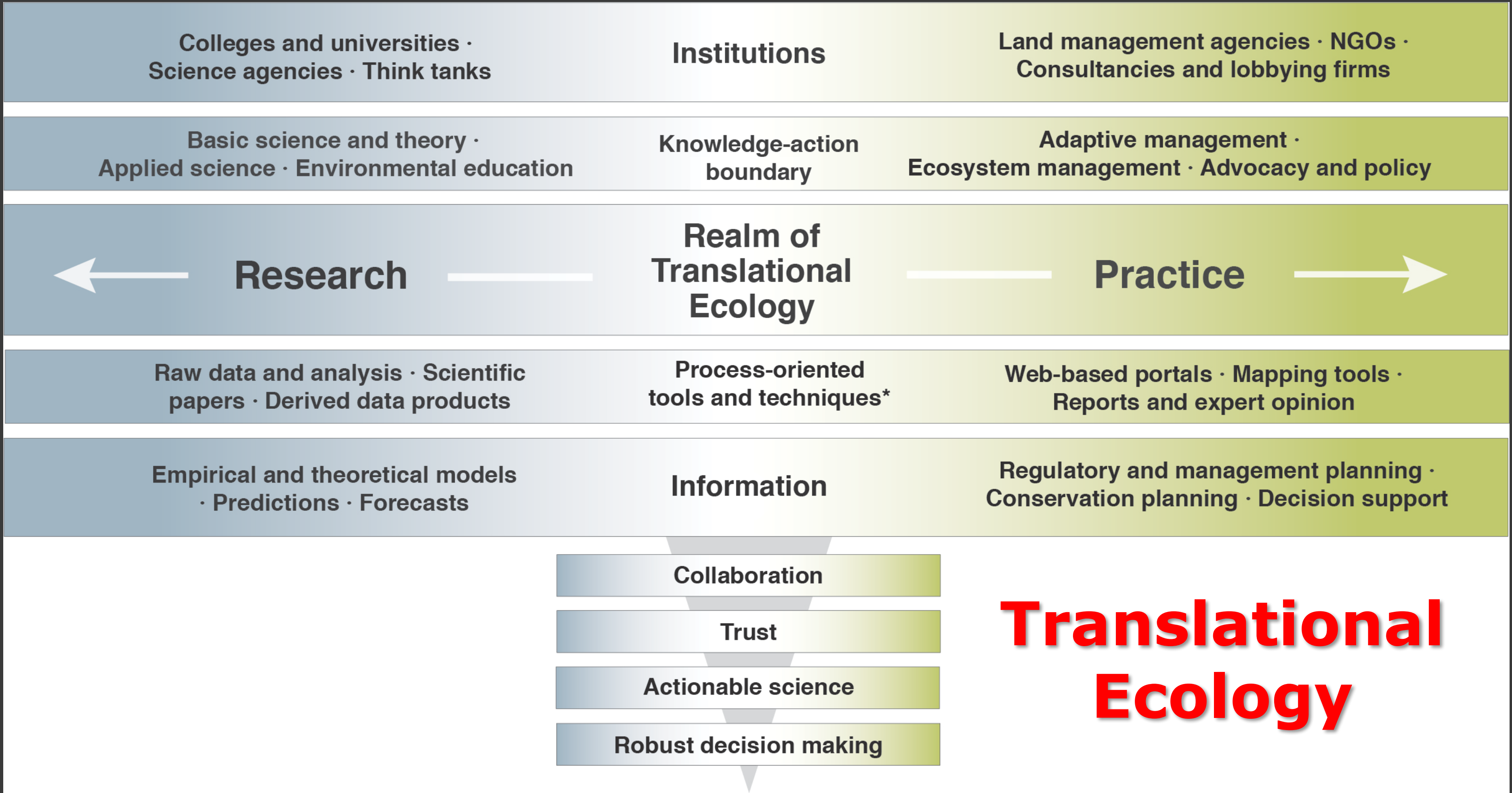

Colleges and universities · Science agencies · Think tanks
Institutions
Land management agencies · NGOs · Consultancies and lobbying firms
Basic science and theory · Applied science · Environmental education
Knowledge-action boundary
Adaptive management · Ecosystem management · Advocacy and policy
Research
Realm of Translational Ecology
Practice
Raw data and analysis · Scientific papers · Derived data products
Process-oriented tools and techniques*
Web-based portals · Mapping tools · Reports and expert opinion
Empirical and theoretical models · Predictions · Forecasts
Information
Regulatory and management planning · Conservation planning · Decision support
Collaboration
Trust
Actionable science
Robust decision making
Translational Ecology


STRONG SCIENCE FOUNDATION

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- Maggie Pitts
- Erica Fleishman
- Larry Fisher
- Kiyomi Morino
- Scott Stonum
- Ralph Marra, Jr.
- Brad Udall

# What's In the Folders?

- Agenda
- Participant list
- Speaker bios
- Co-production exercise
- Meeting facilitation scenario
- Message Box
- COMPASS Message Box Guidebook

| | Wednesday, April 4, 2018 |
|---|---|
| 830-900 | Registration |
| 900-945 | Welcome, Overview, Introductions |
| 945-1045 | Science Policy |
| 1045-1100 | Break |
| 1100-1200 | Translation and Co-production 1 |
| 1200-100 | Lunch |
| 100-245 | Translation and Co-production 2 |
| 245-300 | Break |
| 300-415 | Interpersonal skills |
| 415-430 | Break |
| 430-500 | Recap |

| | Thursday, April 5, 2018 |
|---|---|
| 830-900 | Group activity |
| 900-930 | Translational Ecology Perspectives |
| 930-1030 | Meeting facilitation 1 |
| 1030-1045 | Break |
| 1045-1145 | Meeting facilitation 2 |
| 1145-1245 | Lunch |
| 1245-215 | Science communication |
| 215-230 | Break |
| 230-415 | Translational Ecology Exercise |
| 415-430 | Break |
| 430-500 | Recap and Meeting Evaluation |

# Logistics

# Bathrooms

# INTRODUCTIONS

- Gather by date of birth
- With the person to your left
  - Who
  - Where
  - What
  - Why
  - Favorite food
- Introduce your partner to the group

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**Steve Jackson**
stjackson@usgs.gov

Southwest Climate Science Center

# Navigating translational ecology: creating opportunities for scientist participation

Lauren M Hallett, Toni Lyn Morelli, Leah R Gerber, Max A Moritz, Mark W Schwartz, Nathan L Stephenson, Jennifer L Tank, Matthew A Williamson, and Connie A Woodhouse

## Panel 1. Overcoming barriers to translational research

Translational ecology is a "cross-cultural" enterprise between scientists and stakeholders. Diverse cultures and perspectives can enhance the quality and impact of science, but can also create different barriers to scientist and stakeholder engagement. However, scientists and stakeholders also have different levels of flexibility and this may allow them to help each other to tackle challenges (green arrows in Figure 4; Tables 1 and 2).

**Table 1. Constraints on scientists (and how stakeholders can help overcome them; Figure 4a)**

| *Scientist constraint* | *Stakeholder flexibility* |
|---|---|
| Pressure to publish (academics) | Involve scientists in project design and implementation; include controls |
| Rigid timelines, such as academic calendar, degree lengths, and tenure (academics) | Adjust hiring to match academic calendar; be open to publishable sub-projects |
| Need for grants and funding (academics) | Strengthen broader impacts for traditional funding (eg NSF); expand funding options via boundary organizations |
| Mandated to avoid making direct policy recommendations (government scientists) | Shift from "should" requests and recommendations to "if, then" statements |

**Table 2. Constraints on stakeholders (and how scientists can help overcome them; Figure 4a)**

| *Stakeholder constraint* | *Scientist flexibility* |
|---|---|
| Pressure to act and move forward with available information | Provide iterative "one-pagers" as work progresses; ongoing experimentation |
| Penalized for unsuccessful trials; risk averse | Take responsibility and provide land or funding for higher-risk treatments |

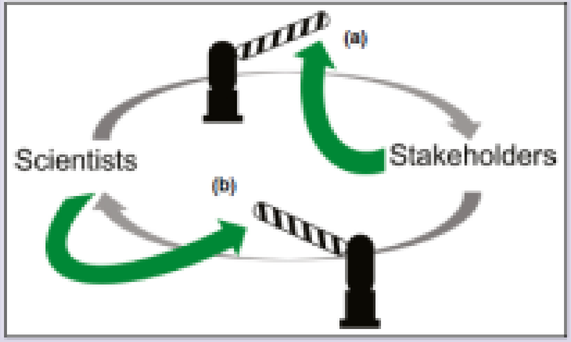


*Figure 4. Conceptual figure in which (a) stakeholders can overcome scientist-related barriers to engagement and (b) scientists can overcome stakeholder-related barriers to engagement.*

# Building translational ecology communities of practice: insights from the field

Dawn M Lawson[1*], Kimberly R Hall[2], Laurie Yung[3], and Carolyn AF Enquist[4]

Translational ecology (TE) prioritizes the understanding of social systems and decision contexts in order to address complex natural resource management issues. Although many practitioners in applied fields employ translational tactics, the body of literature addressing such approaches is limited. We present several case studies illustrating the principles of TE and the diversity of its applications. We anticipate that these examples will help others develop scientific products that decision makers can use "off the shelf" when solving critical ecological and social challenges. Our collective experience suggests that research of such immediate utility is rare. Long-term commitment to working directly with partners to develop and reach shared goals is central to successful translation. The examples discussed here highlight the benefits of translational processes, including actionable scientific results, more informed policy making, increased investment in science-driven solutions, and inspiration for partnerships. We aim to facilitate future TE-based projects and build momentum for growing this community of practice.

Front Ecol Environ 2017; 15(10): 569–577, doi:10.1002/fee.1738

Translational ecology (TE) emphasizes the social and decision-making context in which an ecological question is posed, with the goal of producing actionable science to address complex environmental problems (Enquist et al. 2017; Wall et al. 2017). Enquist et al. (2017) define TE as "an approach in which ecologists, stakeholders, and decision makers work together to develop research that addresses the sociological, ecological, and political contexts of an environmental problem", and state that TE is distinct from conventional ecological research in that it seeks "to link ecological knowledge to decision making by integrating ecological science with the full complement of social dimensions that underlie today's complex environmental issues" (Enquist et al. 2017). To succeed in helping society address the many challenges that require an understanding and application of ecological knowledge, TE-based projects must build communities of practice.

Communities of practice have a common sense of purpose and shared methods for learning and innovation (Wenger 1998). These communities are more likely to be successful over time if they develop and communicate clear mechanisms for engagement, resolution of differences, and knowledge exchange. The field of TE brings together two types of communities of practice, as identified by Amin and Roberts (2008): epistemic communities (researchers), which focus on the creation of new knowledge, and professional communities, which focus on land and natural resource management, typically in partnership with stakeholders. In the context of improving the use of sound science in environmental decision making, these two communities share a common sense of purpose, yet they work, learn, teach, and innovate differently. To fuse these groups into a common community of practice, we need to share detailed stories about TE processes, which motivate participation and provide evidence of positive outcomes (Probst and Borzillo 2008). Furthermore, the methods and goals of translation must be tangible enough that they can be understood and visualized by community members (Probst and Borzillo 2008); documenting the diverse applications and processes of TE is therefore critical. However, benefiting from lessons learned by others can be challenging due to the paucity of outlets for describing the goals, methods, and processes of translation (Clark et al. 2016). With limited resources to draw from, researchers new to TE may struggle unnecessarily rather than learning from and building on a body of shared knowledge and practice. We seek to fill this gap by examining a series of case studies

**In a nutshell:**

- Outcomes of translational ecology (TE) include establishment of key partnerships, and increased investment in effective and informed solutions to complex environmental problems
- Translational approaches are most likely to benefit conservation settings that involve high levels of ecological and social complexity
- Long-term commitments to collaborative and trust-building partnerships hold great promise for reducing barriers to the use of ecological science in decision making
- TE comprises a diverse spectrum of approaches, each characterized by the specific problem being approached and the knowledge, personnel, and resources available to address it

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# Linking knowledge to action: the role of boundary spanners in translating ecology

Hugh D Safford[1,2*], Sarah C Sawyer[1], Susan D Kocher[3], J Kevin Hiers[4], and Molly Cross[5]

One of the most effective ways to foster the co-production of ecological knowledge by producers and users, as well as encouraging dialogue between them, is to cultivate individuals or organizations working at and managing the boundary between the two groups. Such "boundary spanners" are critical to ensuring scientific salience, credibility, and legitimacy, yet they remain relatively underused in ecology. We summarize some of the major roles of boundary spanners in translational ecology, and suggest that effectiveness in translating ecological information depends on several key factors. These include organizational and individual commitment to boundary spanning over the long term; development of useful, co-produced products and tools that can subsequently assume boundary-spanning roles of their own; dual-accountability frameworks that involve both science providers and users; and identification, training, and retention of science translators who possess a suite of professional skills and individual traits that are rare in scientific circles.

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Communication between science and society has never been more vital than it is today. Modern environmental problems (eg climate change, pollution, environmental justice, non-native invasive species, extinction) are characterized by complexity, uncertainty, large temporal and spatial scales, and irreversibility, and will require innovative, participatory, and multiparty approaches to solve them (Burns et al. 2003; Bucchi and Trench 2008; Bixler et al. [2016] and accompanying papers). Translational ecology (TE) has a central role to play in tackling emerging environmental problems by facilitating (1) the dissemination of science to society, (2) the serious consideration of science by decision makers, (3) the promotion of dialogue with stakeholders, and (4) the acquisition of information essential to innovation. However, the infrastructure and business practices required to fulfill these important roles remain underdeveloped in ecology. A key question is how individuals or organizations involved in the production or use of ecological information can be organized and positioned to take advantage of new science, management practices, partnerships, and ways of thinking generated from outside their own organization or discipline.

Boundary spanners are institutions, groups, or individuals that straddle the divide between information producers and users (eg scientists and non-scientists, respectively), produce boundary products or tools ("boundary objects") that enable communication between these two groups, and are accountable in some fashion to both groups (Tushman 1977; Guston 1999, 2001; Parker and Crona 2012). Boundary spanners can have research-focused roles (where external relationships are primarily with universities, research institutions, etc) or technical-service-focused roles (where external relationships are primarily with customers), but in general their two central functions relate to information acquisition and delivery (Aldrich and Herker 1977; Ernst and Chrobot-Mason 2012). In this paper, we draw from our own experiences and those of the organizations we work with to make the case that more formal adoption of boundary-spanning principles and practices by entities that produce ecological knowledge would go far toward solving some of today's persistent environmental problems.

## Boundary-spanner roles

Boundary spanners endeavor to achieve an appropriate balance of salience (relevance of the science to users' needs), credibility (the perceived reliability and adequacy of the science employed), and legitimacy of information (the perception that the production process has been respectful of stakeholders' values and beliefs) through three main functions: communication, translation, and mediation (Cash et al. 2003, 2006). Communication is a two-way learning and teaching process that is active, ongoing, and inclusive. Cash et al. (2006) divided this procedure into "convening" and "collaboration" functions. The former (bringing relevant parties into direct contact) provides the foundation for collaboration, translation, and mediation that may come later (Figure 1), whereas the latter refers to the communication task of bringing actors (experts, decision makers, other stakeholders) together to co-produce applied knowledge or tools. Actors must be able to understand one another but different experiences and assumptions, and even language barriers,

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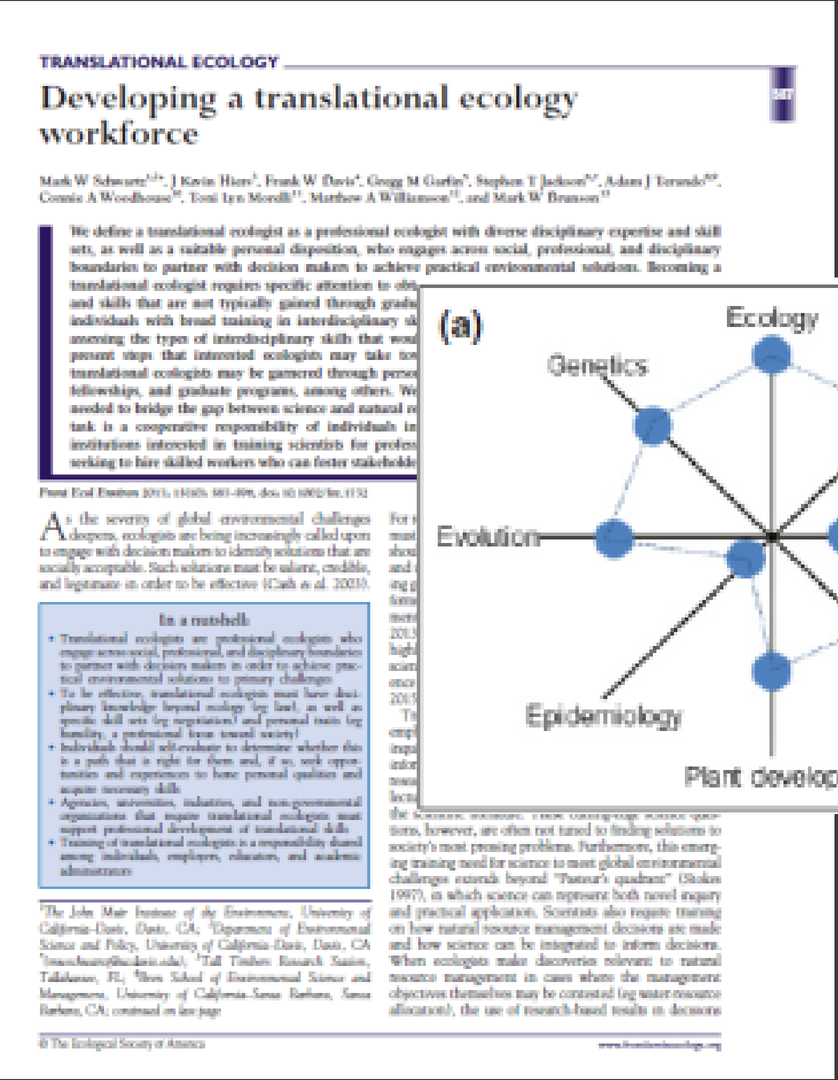

TRANSLATIONAL ECOLOGY

# Developing a translational ecology workforce

In a nutshell:

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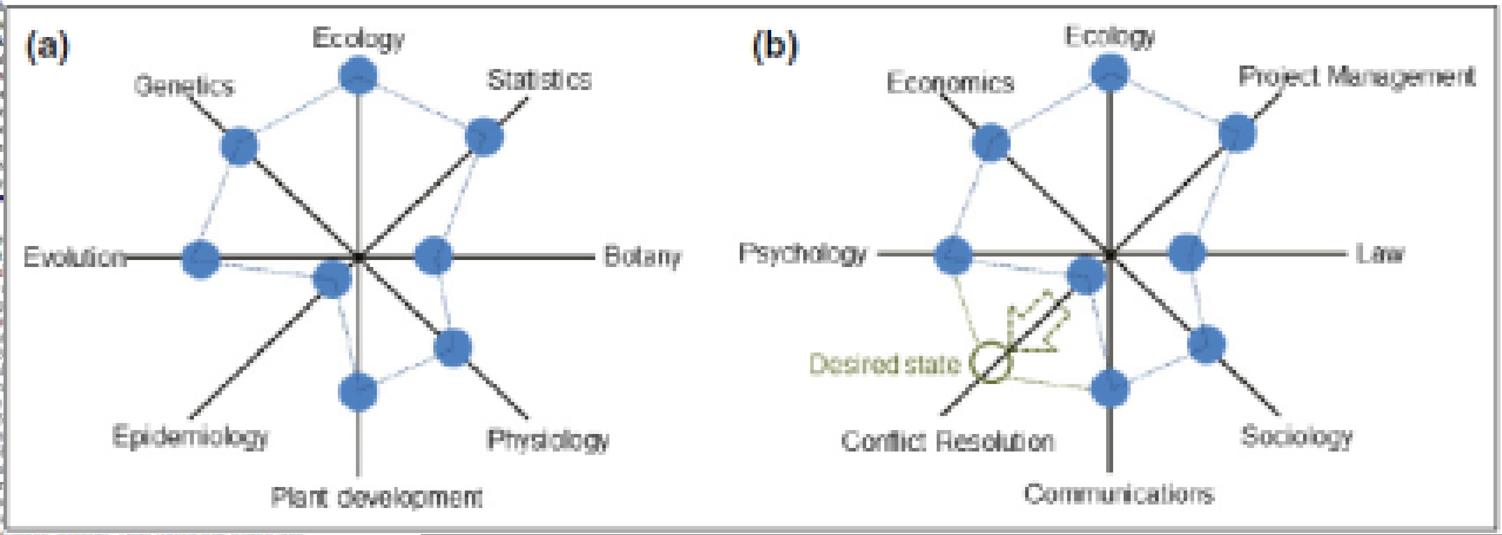

# Use-inspired science: making science usable by and useful to decision makers

Tamara U Wall[1*], Elizabeth McNie[2], and Gregg M Garfin[3]

A growing body of research in translational science provides a foundation for translational ecologists to consider the practices that show the most promise, as well as the potential pitfalls of those practices. These research approaches (eg user-inspired climate science) require deliberate engagement with end users, and an understanding of the social and cultural contexts in which a research project functions. We examine the climate science translation literature (looking at how research can inform decision making) to identify key issues related to how the social sciences have helped guide researchers engaged in user-inspired research. We focus on understanding the more intangible inputs to research projects, including the social and cultural contexts; stakeholder engagement; the role of social capital; and evaluating the outputs, outcomes, and impacts of translational science projects and initiatives. Research on return-on-investment metrics for translational science is increasingly pointing to the conclusion that intentional, structured processes, such as those found in translational sciences, boost the likelihood of science being successfully incorporated into environmental decision making and policy.

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As defined earlier in this Special Issue, translational ecology (TE) "is an approach that embodies intentional processes by which ecologists, stakeholders, and decision makers work collaboratively to develop and deliver ecological research that, ideally, results in improved environment-related decision making" (Enquist et al. 2017). TE seeks to link ecological knowledge to decision making by integrating science with the social dimensions that underlie today's complex environmental issues. Most notably, TE facilitates this linkage via interactions between decision makers, practitioners, and the public. Distinct from both basic and applied ecology, TE deliberately extends research beyond theory or coincidental applications, and is motivated by a search for outcomes that directly serve the needs of natural resource managers and decision makers. TE is part of a broader movement that aims to update and reinvigorate the social contract between science and society, to make science more useful and usable in the face of rapidly changing and pressing environmental challenges (Lubchenco 1998; National Research Council 1999) and is one of a series of approaches (end-to-end science, boundary work, co-production of science and policy, production of usable or actionable science) that embodies and puts into practice the integration of science and decision-making, through a variety of means. The purpose of this paper is to use our knowledge and awareness of usable climate science research to urge ecologists interested in TE to consider several key elements when designing a TE approach.

The ultimate goal of both the production of usable science and TE generally is for researchers – in conjunction with people who are likely use their findings – to produce scientific information that can help inform solutions to coupled human–environmental problems. Usable science has three main characteristics. First, it is *relevant* to the problem at hand, in that it fits within the decision-making framework in which the information is to be applied, and is produced in a timely manner and at an appropriate scale (Lemos and Morehouse 2005). Second, usable science is *credible*, indicating to likely users that the information was produced according to accepted

**In a nutshell:**

- Barriers to the use of scientific information in decision making can be overcome by fostering social capital among research collaborators, such as scientists, practitioners, and members of the public
- This is achieved by fostering relationships between those groups through collaborative research opportunities and outreach and engagement activities
- When researchers and stakeholders openly acknowledge differences in professional practices, expectations, and rewards, they establish a foundation for trust and increase the chances of successful collaboration
- The benefits of a well-articulated framework for managing engagement between ecologists, practitioners, and other stakeholders include an increased ability to articulate mutually desired project outcomes and to avoid misunderstandings
- Ecologists can avoid pitfalls and improve the chances of successful scientist–stakeholder collaborative project outcomes by consulting the growing body of successful case studies and examples produced by science translators in ecology, public health, and climate services

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**Panel 2. Social capital and "soft skills" in translational research**

An important but often overlooked component of the translational research process, social capital is needed to build and maintain productive relationships – based on mutual trust and respect – when creating, transferring, and utilizing usable science for decision support (Levin and Cross 2004; McNie et al. 2016; Simpson et al. 2016). Like any form of capital, social capital can be generated, spent, and lost, and so great care must be taken to manage it according to the situation. Social capital describes the relationships and "goodwill that others have toward us" (Adler and Kwon 2002) and affects how information is exchanged, how people or organizations exert influence and power, and informs perceptions of solidarity and allegiance. Research indicates that strong, trustworthy relationships increase the likelihood that people will listen to and act upon new information (Levin and Cross 2004; Lemos et al. 2012). Social capital plays a critical role in knowledge generation and sharing when there are extensive cultural, economic, or educational differences between knowledge producers (eg scientists) and knowledge users (eg individuals, organizations, tribes). When scientists interact with more marginalized populations, they often need to develop and deploy greater social capital (Figures 4 and 5). Creating social capital usually requires the use of "soft skills", such as listening, communicating, mediating, negotiating, and sharing (McNie 2007).

**Working with Native American communities**

Ferguson et al. (2016b) described a 5-year process of collaboration with the Hopi Department of Natural Resources (HDNR) to develop a local drought information system for a Native American tribe that is both isolated from major population centers and located in a region that suffers from a dearth of standard scientific data. To co-develop an effective drought plan based on local sources of information, the research team included a citizen of the Hopi Tribe, whose insider perspective and extensive social capital, developed through previous work with HDNR, facilitated improved integration and contextualization of drought information. The scientists first invested considerable effort into understanding drought from the perspectives of individuals across the spectrum of Hopi society and the institutional context into which HDNR drought advisories fit, then proceeded to cultivate relationships with the HDNR and Hopi villages, whose governance of drought ultimately dictates the effectiveness of drought preparedness and response actions, as a means of increasing engagement. The research team's commitment to a long-term, iterative process of engagement and partnership fostered social capital with key agency officials and pilot communities (Figure 1); this, in turn, engendered sufficient trust to implement a drought system that goes beyond provision of information, to facilitate dialogue about drought among managers and citizens.

Working closely with the Bishop Paiute Tribe Food Sovereignty Program, researchers at the Desert Research Institute (DRI) are using "micro-narratives" to understand how food sovereignty, climate change, and resource-management decisions are impacting tribal communities along the eastern front of the Sierra Nevada range in California. Federal resource managers in the area wanted to understand how resource-management actions affected these communities, including impacts on traditional hunting and gathering activities, whereas personnel with the Food Sovereignty program sought to understand how community members could be better engaged in traditional food consumption and crop production to foster tribal culture and healthy eating habits. Key to this project was the hiring of research assistants from the community, as well as working closely with existing tribal programs to support programmatic goals and outcomes while simultaneously developing a research design that met all of these needs. Using community members formally in the research project allowed for a greater level of participation and involvement and provided resources to the Food Sovereignty Program, allowing both to leverage resources and social capital in support of project and program goals.

**Figure 4.** *Overlooking the Hopi and Navajo Nation Reservations in Arizona.*


**Figure 5.** *Postcard created and mailed to all enrolled tribal members for project outreach.*

# Translational ecology in my own backyard: an opportunity for innovative graduate training

Jennifer L Tank

It all started a decade ago with a simple "yes". I'd been asked by a senior colleague to take a call from The Nature Conservancy (TNC); they needed someone to "put numbers to an emerging conservation practice" in agricultural streams and ditches. Since I was a stream ecologist, they wanted to know if I could help. I admit that my knee-jerk reaction was to slam the door on the request and tell my colleague that I didn't do consulting contracts. But he encouraged me to take the call, and to be open to the opportunities that could develop by partnering with a large conservation organization. "You never know what might happen", he said. So I got off my high horse, heeded his advice, and began my journey into translational ecology, which has led to some of the most challenging and rewarding science of my career.

Midwestern croplands play a crucial role in feeding the country and the world, but runoff of excess nitrogen, phosphorus, and sediments can compromise both local and downstream water quality, resulting in algal blooms and subsequent hypoxic "dead zones" often occurring far from the nutrient source. TNC needed help quantifying the effects of two-stage ditches, which restore mini-floodplains alongside agricultural ditches in order to promote nutrient retention and removal before they are exported to sensitive downstream ecosystems like the Gulf of Mexico. At the time TNC called, implementation of two-stage ditches had not been quantitatively linked to improved water quality, and the task of my lab (and my graduate students) was to determine whether floodplain restoration could reduce stream nutrient export from agricultural watersheds.

Ten years later, our small partnership has grown into the Indiana Watershed Initiative (IWI), which involves not only university graduate students and faculty but also a diverse group of partners including the Soil and Water Conservation Districts (SWCD) from multiple counties, 50 or more local farmers in two demonstration watersheds, staff from the USDA Natural Resources Conservation Service, and TNC scientists and managers. Our ongoing studies of conservation practices implemented in the streams and surrounding watersheds have revealed complex and unexpected ecological and biogeochemical results at the interface between terrestrial and aquatic ecosystems. The shared goal of the interdisciplinary team, which includes the graduate students conducting their dissertation research in this setting, is that results from our translational research will lead to novel management solutions that benefit both farmers and the environment. A further goal is that the successful outcomes highlighted through demonstration projects, which are really watershed-scale experiments, will facilitate widespread adoption of conservation practices to improve water quality in agricultural lands. Translational ecology is fundamentally shaping the research experience of the students trained in my lab: they are honing skills that allow them to think critically, communicate effectively, build collaborations, and place their research in a broader context, all of which supports their professional development and future academic achievements.

My students have learned that the results from their research must reach partners and stakeholders on a faster timeline than that of a peer-reviewed publication. They are now keenly aware of the challenges faced by resource managers, who are pressed to implement environmental solutions on the shorter time frame required by policy and budgets. Most of us have experienced the anxiety of sharing preliminary data, with worries about being scooped or (more likely) that research conclusions will change after additional data collection and analyses. While this concern is warranted, students soon discover that the iterative sharing and open discussion of preliminary data lead to unanticipated opportunities and new research directions. Moreover, feedback from partners with critical on-the-ground knowledge has improved the research questions we ask.

Now, for my students, presenting preliminary data to our partners is considered an opportunity rather than a cost. Nevertheless, these interactions and the non-traditional research products (eg one-pagers, reports, videos, even tweets!) are not always valued in traditional metrics of training success, and the time commitment required of the iterative process can be viewed as time away from "real research". Yet the effective communication skills learned and practiced in this translational setting are serving graduate students in multiple ways as they move forward in their careers. Among these benefits are better presentations, more compelling grant proposals, mastery of job interviews, and improved teaching skills.

Listening creates challenges and opportunities. Our translational research has been guided by the principle of OPV ("other points-of-view"), a communication tool that I

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