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Epistemic Mediation: Aligning Expertise across Boundaries within an Endangered Species Habitat Conservation Plan

BRUCE EVAN GOLDSTEIN

Department of Planning and Design, University of Colorado, Denver, Colorado, USA

ABSTRACT *This paper uses videotaping and discourse analysis to study participants' dialogue and conduct during preparation of the Coachella Valley habitat conservation plan in southern California. The research uses social worlds analysis to reveal that the plan's technical advisors did not find facts through the collective discovery of scientific truths with unitary meanings, but instead constructed facts by aligning professional visions of space, time, and agency. The validity of the resulting plan relied on its ability to be a "boundary object", meaning different things to different groups, while simultaneously laying claim to universality and objectivity. However, its subsequent failure to satisfy an unexpected scientific peer review demonstrates the importance of anticipating downstream reception and use when developing such documents. This case study shows that planners can be epistemic mediators, creating and stabilizing technical knowledge claims that project authority by showing a responsive face to many audiences.*

Keywords: Boundary object; endangered species; joint fact-finding; collaborative planning; habitat conservation plan

Are Lizards Everywhere?

In October 2000, a scientific advisory committee (SAC) agreed to adopt a map projecting that fringe-toed lizards would continue to accompany shifting sand dunes across the floor of Coachella Valley, California for millennia (see Figures 1 and 2). The mapping criteria employed were different from those that the SAC had applied to other species included in the multi-species habitat conservation plan (MSHCP) for the rapidly developing valley 100 miles east of Los Angeles (Figure 3). Other species were mapped by using a combination of observed sightings and present habitat affinities, resulting in a much more constrained distribution than that which might have resulted had scientists also considered the reworking of the landscape by geophysical processes over a geological time scale.

A few months later, two participants in a prestigious scientific review panel convened to evaluate the Coachella Valley MSHCP and commented on the species models assembled by the SAC:

> SCIENTIST 1: They used different standards to evaluate these species, and I don't think that's scientifically defensible.

Correspondence Address: Bruce Evan Goldstein, University of Colorado, Denver, Department of Planning and Design, Denver, Colorado, USA. Email: brugomail@yahoo.com

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Figure 1. The Coachella Valley fringe-toed lizard, a federally listed endangered species. Photo courtesy of Cameron Barrows.

SCIENTIST 2: They probably didn't have data.

In their formal report, the panel concluded:

> Some of the credibility of the ARD [administrative review draft of the MSHCP] is damaged by seemingly incongruous information presented in map form or omissions from the documentation.

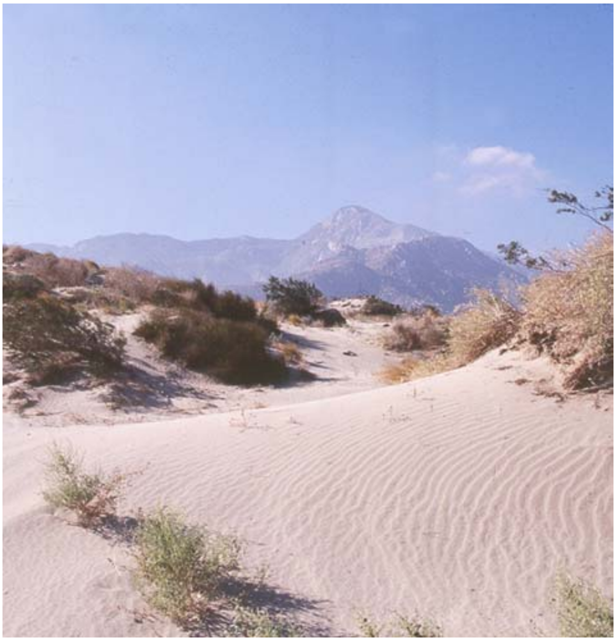

Figure 2. Active sand dune that a Coachella Valley fringe-toed lizard might use as habitat. The quality, geographic distribution, and dynamic history of sandy habitat was a sharply contested issue in this habitat conservation plan. Photo courtesy of CVAG.

Figure 3. Locational map of the Coachella Valley Multispecies Habitat Conservation Plan area, prepared by the Coachella Valley Association of Governments (CVAG).

Why did the SAC designate a species model for the fringe-toed lizard that projected species movement over geologic time, rather than using projections of its current habitat, the standard employed for the other species in the plan? The answer is not a lack of data, because there was an abundance of information available for mapping its present distribution; indeed, far more data than was available for any other species included within the MSHCP. If this wasn't just shoddy science in action, can this episode teach us about how to assemble credible, legitimate, and authoritative knowledge claims, an increasingly common challenge in high-stakes collaborative planning efforts?

The answer to these questions begins with a description of how analysis of social worlds can inform technical claims in the absence of intersubjective understanding, and an explanation of why collaborative planning researchers have not previously adopted this methodological line of inquiry. Then follows a description of the history of conservation planning in the Coachella Valley leading up to the MSHCP planning effort, tracing the ways in which a potentially volatile disagreement among technical advisors was contained by a decision to adopt a distribution model whose virtue lay in its ability to avoid opening what one of them called a "Pandora's box" of contradictory interests. It is argued that this lizard model is a boundary object (Star & Griesemer, 1989), a shared resource that is understood differently within each community of biologists, while maintaining enough features in common to provide a basis for coordinated action. I subsequently describe how, despite meeting the needs of SAC members and local landowners, the lizard model failed to meet the credibility standards of the scientists who peer reviewed the work of the plan's technical advisers. I discuss ways in which the tension between these different criteria for technical sufficiency can be accommodated, and suggest how this account informs the practice of epistemic mediation.

Bridging the Post-Positivist Divide

Disenchantment with comprehensive rational planning began with Altshuler's (1965) argument that modeling, cost-benefit calculations, and other systematic analytical methods were too removed from the hurly-burly of politics. Rittel and Webber (1973) went further, questioning the possibility that scientific rationality could identify reliable and objective truths that would allow the identification of optimal planning solutions. Planning problems were increasingly regarded as "wicked", subject to changing definitions and associated with divergent values. Collaborative planning's response to this dilemma was joint fact-finding, whereby stakeholders gain trust, mutual understanding, and scientific and political consensus by participating in the selection of experts, the scoping of technical issues, and the generation and analysis of information (Karl & Susskind, 2007).

Post-positivism challenged core assumptions in this approach to joint fact-finding. Ozawa (1991) questioned the possibility of resolving even relatively straightforward technical differences through tests and experiments whose validity could be established using universal scientific principles. Science was no longer seen as a unified knowledge practice because scientists from different disciplines were guided by incommensurable paradigms (Kuhn, 1970). Ozawa argued that joint fact-finding should promote the understanding that scientific disagreement will never be eliminated through discovery of definitive evidence. Instead, through careful mediation, adaptive and flexible agreements could be grounded in an acceptance of this enduring uncertainty.

This attention to the difference among disciplinary paradigms was broadened in the 1990s by research on how knowledge was "situated" (Haraway, 1996) within cultural perspectives, societal positions, and embodied practice. Situated knowledge breached the divide that Kuhn maintained between science and society. Expertise could be rooted in intimate and prolonged place-based interaction (Corburn, 2003; Fischer, 1993), and science was responsive to more than disciplinary imperatives. For example, Jasanoff (1990) claimed that regulatory scientists rely on statistics and published citations to establish the validity of their claims under adversarial legal scrutiny, as opposed to relying on informal credibility markers within university-affiliated disciplines such as an individual's reputation for scientific integrity.

This situated perspective on expertise posed an even greater barrier to technical consensus, since experts had radically different credentials and proposed and defended claims in mutually incomprehensible ways. Again, planners developed new approaches to joint fact-finding to bridge these divides. Rather than seek to unify understanding or to understand paradigmatic differences, they suggested that dialogue could focus on the social context of knowledge and its relationship to power, with particular emphasis on incorporating marginal or subordinated groups who were left out of scientific knowledge production (Harding, 1996). While this kind of conversation was difficult to organize and facilitate, it held more than the promise of expanding the knowledge base available to achieve consensus. Joint fact-finding could also democratize planning by enhancing the social equity of agreements (Corburn, 2003; Innes & Booher, 2010), and by changing professional discourse and identity, thus making it possible to challenge dominant cultural assumptions (Goldstein & Butler, 2009).

Understanding how science and other knowledge practices are culturally situated has enabled development of new approaches to joint fact-finding that bring to life new discursive frameworks and catalyze new institutional relationships, addressing the root causes of conflict (Booher & Innes, 2002; Healey, 1997). Yet these efforts to foster a more collaborative governance should be accompanied by ideas about the ways in which planners can craft technical agreements that are credible among the many competing actors and institutional venues of representative democracy, where plans are assembled, approved, litigated, and implemented. As Booher and Innes (2010) recently wrote, "both approaches to governance will be with us for some time and those engaged in governance will have to learn to live in two worlds."

A post-positivist framework called "social worlds analysis" can help us to understand how technical agreement can be reached without resolving culturally situated differences among experts or embracing the possibility of finding a single, objective truth. Social worlds analysis emerged from the symbolic interactionist tradition of "Chicago School" sociology (Strauss, 1991) and explores the ways in which social worlds are organized around shared meanings and concerns, and are "not bounded by geography or formal membership but by the limits of effective communication" (Clarke, 1990, p. 19). Social worlds communicate with other social worlds through "boundary objects", defined as shared resources (e.g. maps, databases, concepts) that enable collaborators to reach agreements that are defined differently within each social world, yet maintain enough features in common to provide a basis for coordinated action between social worlds with different interests, needs, and accountabilities (Star & Griesemer, 1989).

Boundary objects are useful because they satisfy the informational requirements of intersecting social worlds; they are "both plastic enough to adapt to local needs and constraints of the several parties employing them, yet robust enough to maintain a common identity across sites" (Star & Griesemer, 1989, p. 46). This idea has some similarity with "epistemic communities" (Haas, 1989), although rather than emphasizing a shared narrative, boundary objects carry multiple meanings. Boundary objects may provide a way to forge agreement that is much less thorough and time-consuming than co-production through network collaboration—like a "pidgin" language, boundary objects permit communication and exchange in the "trading zones" (Galison, 1997) between experts who have neither the time nor inclination to invent a common language or learn one another's mother tongue.

Boundary objects are a widely appreciated conceptual tool for understanding how collective efforts are possible across a wide range of disciplinary practices and areas of expertise (Carlile, 2002; Harvey & Chrisman, 1998; Shackley & Wynne, 1996). To note three recent examples in ecological planning and management, Eden (2009) described how the Forest Stewardship Council created certification standards for sustainably produced forest products that were credible to ecologists and foresters, Turnhout *et al.* (2007) noted how ecological indicators adjust to accommodate different knowledge and expertise in different places, and Goldman (2009) described how conservation corridors are boundary objects between the fields of conservation biology, landscape ecology, landscape and urban planning, and wildlife management. Yet collaborative planners have not explored this capacity to develop and maintain coherence across intersecting social worlds engaged in discussion, negotiation, and decision making. In the following section I connect this neglect to limits of collaborative research methodology.

Opening the Black Box of Collaborative Expertise

In order to understand how boundary objects emerge within collaborative planning processes, researchers have to adopt new observational techniques to examine "science in the making" (Shapin, 1992). Reconstructing scientific deliberation through interviews is difficult because participating scientists tend to describe their finished work as a product of the scientific method, erasing the contingent quality of science as ideas progress from conjecture to narrowly circulated research findings, to published scientific facts, to taken-for-granted common knowledge (Latour, 1979). This reticence to discuss the messy process of making scientific facts is not only in accord with many scientists' positivist commitments about their own practice, it is a form of "boundary work" (Gieryn, 1983) that expert advisers perform to separate their scientific advice from mere opinion or political preference.

Even when planning researchers have gained access to technical collaborative processes and have patiently waited to see what happens there, their methods of observation and record-keeping have not typically captured the fleeting, complex, and contested moments of expert deliberation that precede agreements. These interactions are especially relevant when the purpose of technical collaboration is to construct something that synthesizes different sources of information and is spatially and temporally explicit, like a GIS-based landscape model. When so many considerations are at stake, researchers' capacities to recall, take notes, or even analyze audio recordings is overtaxed by the complexity, speed, and jargon of collective expert cognition. The outcome of collaboration is only available to the analyst as an artifact or agreement, since the moment-to-moment interaction that produced it is ephemeral, often not remembered and sometimes not consciously enacted by each participant (Becker, 1996; Goodwin & Heritage, 1990).

In this way, the "black box" of collaborative expertise has remained sealed shut within planning research because studies of expert collaboration provide an inadequate account. Ozawa's (1991) inquiry, while groundbreaking in its approach to consensus procedures, provides an example of these methodological limitations. The absence of ethnographic detail in her retrospective, interview-based account renders opaque the distribution of cognitive labor among advisers, while at the same time reifying the outcome of the technical advisory process by overlooking the contingencies, crises, and dead ends encountered during the work process. These problems of method have led planning researchers to treat technical work as a sideshow, an analytically simple adjunct to stakeholder negotiation, where the really interesting social interaction must be taking place. Through this intensive, fine-grained study of technical mediation I seek to open the "black box" in order to define the contours of a new kind of collaborative planning practice occurring within joint fact finding. This practice, which I call "epistemic mediation", assists in the formation of boundary objects among collaborating experts while anticipating how technical claims will circulate within social worlds not included in the collaborative process.

Capturing Technical Collaboration

My effort to open the black box of expert collaboration uses videotaping approaches pioneered within ethnographic and ethnomethodological studies of conversation and cognition in technical workplaces (Goodwin, 1994; Jordan & Henderson, 1995). By videotaping technical advisory meetings I was able to access details of talk, and behavior and to subject specific activities to close scrutiny, slowing down and repeatedly viewing the video and audio record where necessary. I discussed these interactions with other researchers during playback and with the experts being observed by sending them my interpretations and holding discussions during field visits, thus clarifying ambiguous interactions and identifying directions for further inquiry. I selected particular exchanges for close analysis, and transcribed and analyzed them with particular attention to their content and interactional structure. These video recordings and transcripts were augmented by interviews in order to understand experts' backgrounds, training, and perspectives.

In the following account I examine work by members of the scientific advisory committee (SAC), locating their efforts within a larger history that involves the development of a multiple-species habitat conservation plan (MSHCP) for an ecologically sensitive desert region in the southwestern United States (Goldstein, 2004). I observed and videotaped twenty scientific advisory committee meetings over about two and a half years (between June, 1999 and October, 2001), with each meeting averaging about five hours in length. I focus on a series of conversational exchanges between scientists and plan consultants in a meeting called to review additions and deletions to a habitat model for the endangered Coachella Valley fringe-toed lizard. I selected exchanges for analysis after the scientific review panel released their report, which made me curious about why the SAC had defined tasks, narrowed the set of possible choices, and selected an alternative that was roundly criticized by scientific reviewers.

A Tale of Two Habitat Conservation Plans

Table 1 shows a narrative timeline of conservation history in the Valley, encompassing the events described in this paper. A desert surrounded by mountains (Figures 3 and 4), the Coachella Valley was initially spared from large-scale land conversion and influx of exotic species that transformed other parts of California after European colonization (Event 1). Installation of a canal and water supply facilities in the late 1940s enabled a dramatic expansion of the Valley's human population, along with the conversion of sand dunes into golf courses, tennis clubs, and hotels (Event 2). Like other sand-dune dependent species, the Coachella Valley fringe-toed lizard (FTL) population decreased rapidly, and the U.S. Fish and Wildlife Service designated the FTL as a federally endangered species in the early 1980s, prohibiting any action that might directly harm the species (Event 4). Faced with the uncertain resolution of a lawsuit over a proposed golf course in FTL habitat, developers and ecological advocates formed a working group that they called the "lizard club" and began preparing a habitat conservation plan (HCP). This process allowed private landholders and local and state governments to strike a deal with the Fish and Wildlife Service by balancing the number of endangered individuals killed through deliberate human action—which is called "take"—with mitigation measures such as purchasing and setting aside prime habitat to conserve other members of the species. The fringe-toed lizard HCP was quickly drafted and approved in 1986 (Event 5).

Despite smooth implementation of the HCP, FTL numbers continued to decline in the Coachella Valley, along with numbers of other sand-dependent species not covered in the plan. Faced with the prospect of new species listings that would invoke regulatory restrictions and require time-consuming planning processes, elected officials drawn from Riverside County and the Valley's nine cities decided in the early 1990s to address the problem by preparing a multi-species HCP (MSHCP) (Event 6). Stakeholders were recruited to a steering committee composed of environmental advocacy groups, development and farming interests, and mid-level staff from local and state government. They established the goals and ground rules of the MSHCP process, hired a consulting team

Table 1. A narrative timeline of the MSHCP planning process, including events analyzed in this paper

1500s-1900	(Event 1) Mountains and desert isolate the Coachella Valley from large-scale land conversion and exotic species that were introduced in other parts of California, creating a natural preserve for endemic valley species.
1948	(Event 2) Construction of a canal makes water available for substantial development in Coachella Valley environment, and sand-dependent species go into sharp decline.
1972	(Event 3) Federal Endangered Species Act (ESA) approved, providing an unprecedented degree of protection to habitat and species.
1982	(Event 4) Congress approved amendment to ESA establishing conditions allowing endangered animals to be killed or a portion of their habitat eliminated in exchange for mitigation commitments contained with a habitat conservation plan (HCP).
1986	(Event 5) U.S. Fish and Wildlife Service (FWS) approved habitat conservation plan (HCP) for the fringe-toed lizard (FTL) in the Coachella Valley.
1990–2000	(Event 6) A multiple-species HCP (MSHCP) is initiated amidst growing uncertainty about the viability of FTLs and other species in the Coachella Valley. A scientific advisory committee (SAC) is convened in 1996.
October, 2000	(Event 7, analyzed in this paper) The SAC meets to discuss mapping lizard habitat as one component of the larger MSHCP.
February-April 2001	(Event 8, analyzed in this paper) Scientific panel convened to review the SAC's technical work and prepared report critical of SAC.
November, 2001	(Event 9) SAC disbanded by MSHCP steering committee.
2008	(Event 10) MSHCP adopted by valley jurisdictions and permit issued by FWS.

to coordinate the planning process, and convened a scientific advisory committee (SAC) to map species distributions, assess potential impacts, and develop alternative designs for a multispecies habitat preserve. Stakeholders were then to select a design for the preserve, and to devise a funding mechanism to purchase and manage these lands. Finally, consultants would draft plan documents for approval by elected bodies in each jurisdiction and for scrutiny by state and federal wildlife agencies who had the final word on whether to issue an incidental take permit for covered species. The plan would also have to withstand possible court challenge from dissatisfied landowners or environmental advocates, and to provide a clear blueprint for implementation, since the acquisition of lands might take decades, and the preserve would require monitoring and management in perpetuity.

The stakeholders relied on the SAC to provide a scientific rationale for the plan that could meet these requirements. As the influential director of the area's Building Industry Association put it:

> The reason that I've been able to keep my folks involved and satisfied is resting upon the Scientific Advisory Committee. They're doing it scientifically, "This is it, this is it, this is it", so let's ride with it. The whole understanding all along is that this would be a scientific plan, not one that was a horse trading plan. Science is science, and it should not be shaped.[1]

SAC members included regulatory and local biologists. The three principal local biologists were long-term residents of the valley, where they had acquired a reputation for scientific rigor and political pragmatism as they managed habitat preserves, conducted research on endangered species, and advised local conservation efforts and conflicts. As one stakeholder put it, they had "lived here for years, were on the ground daily, and understood everything that goes on in the valley." The three principal regulatory biologists worked for the state and federal wildlife agencies, with a longstanding focus on southern

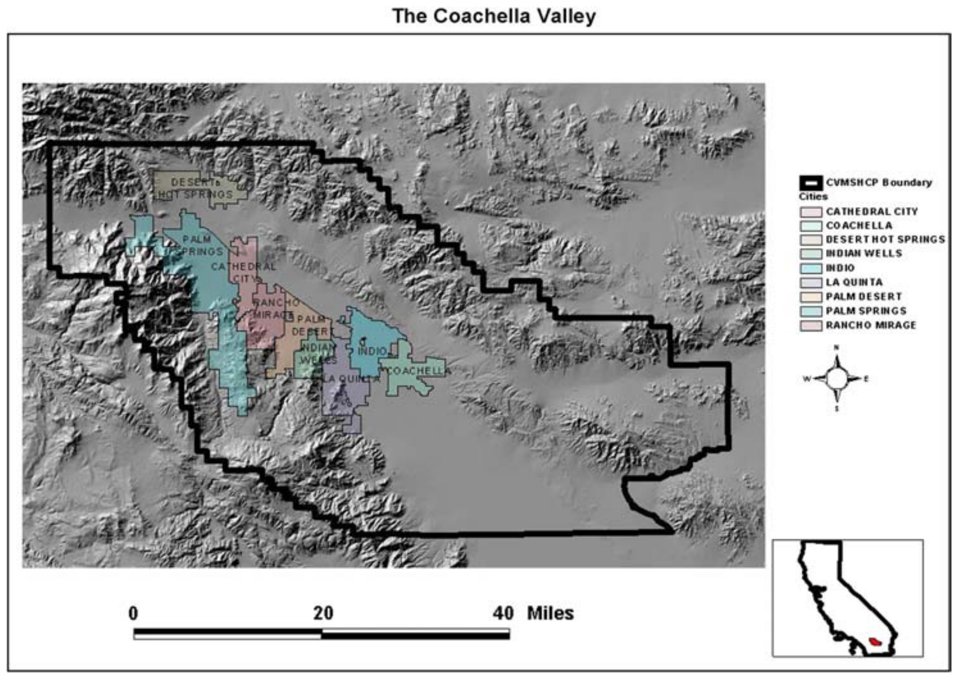

Figure 4. Relief map of the Coachella Valley Multispecies Habitat Conservation Plan area, with city boundaries (prepared by the Coachella Valley Association of Governments).

Californian desert species. While very familiar with the planning area, the regulatory biologists' expertise was not rooted in intensive fieldwork in the Coachella Valley. They had worked in different locales over their careers and were experts in assembling scientific documentation and citations and weighing the veracity of scientific claims put forward by those they regulated. For both groups of biologists the MSHCP was an unprecedented undertaking, in terms of scientific complexity, the number of organizations involved and the venues in which their scientific advice would circulate.

Over four years, the SAC met for one or two days a month, scrutinizing GIS data layers depicting soils, vegetation, and other features, and combining them to yield a habitat suitability model for each covered species. They established criteria for reserve design and connectivity, and assisted in preparation of preserve alternatives. At the time of the meeting analyzed in this paper (2000), the SAC was assembling a spatial database for many biophysical features of the valley. My analysis focuses on their attempts to construct a new distribution map for the FTL that took into account the "hydrology" of wind-blown sand across the valley and sand supply from the surrounding mountains (Event 7).

Model Construction and Deconstruction

I now examine scenes from a SAC meeting held four years after the committee was established to develop the MSHCP. The purpose of this meeting was to identify preserve areas for the fringe-toed lizard (FTL). During this meeting there was substantial disagreement between local and regulatory biologists (names of all participants are pseudonyms) over which areas of the valley should be included in the plan.

As SAC participants come to the table (Figure 5), local biologists (LB) sit together to the left (Nick, Bert, and Dave are active participants), while regulatory biologists (RB) cluster at the upper right (Linda, Randy, and Charles). Plan consultants (PC) and facilitators (including Mary and Edward) take seats that mark a boundary between local and regulatory biologists in the seating order. Land managers (LM) are distributed across the remaining seats.

Bonding Light to Lizard Habitat

Dave, a local biologist and manager of the existing FTL preserve, has worked with plan consultants to bring a new map to the meeting. The new map shows soil types by color, and Dave explains that he has developed a reasonably accurate way to identify areas in the valley that are either good or poor habitat for the lizards. Mary (a plan consultant) has already placed the new soil map at the center of the table, next to a map showing the existing FTL preserve areas. Referring to the new soil map, Dave talks[2] about what a computer can "see" when analyzing data taken from a satellite orbiting the Earth. He proposes using reflected light, measured by a satellite, to represent the grain size of soils, associating a particular reflectance range with windblown sand (colored red in the new map). Loose sand with this small grain size is good habitat for FTLs, which "swim" in the sand as part of their daily round. As a local scientist and manager of the existing lizard preserve, Dave has visited these red areas and reports they indeed possess windblown sand inhabited by FTLs.

> DAVE (LB): The hot red? Um, well, these are reflectance values that the computer sees from um, an Ekinos satellite image that's forming a resolution using color, three color infrared ... um scanning and it APPEARS based on my field checking and experience out there, that the RED areas are the areas with the most active and um LEAST compacted sand. And in areas within the

Figure 5. Seating order, participants and active map documents in SAC meeting to discuss conservation plan for an endangered lizard species in the valley. Different professional roles include plan consultants, regulatory biologists, local biologists, and land managers.

> preserve boundary that I have checked where it's red, there, it's virtually always occupied by fringe-toed lizards.

Three measures are bound together in Dave's extended utterance: (1) a remote sensing measure of light intensity is linked to the relation between (2) grain size and compaction of soils which provide habitat for (3) confirmed sightings of individuals from an endangered species. Dave speaks as an authority for lizards and the local terrain, and his work in the field and on the computer correlates light intensity and soil quality to the presence of lizards. The outcome, as proposed and resting on the table top, is a map of the valley with a colorized layer that sorts good (hot red) from poor lizard habitat (orange, yellow or brown, described below).

> DAVE (LB): And the areas that are ORANGE, it's a mix. Um there's some fairly unconsolidated or uncompacted material, but some compacted material as well. And it's sort of intermediate in character and in THOSE areas, so far anyway, I've tended to find LESS fringe toed lizards although some, but um, the flat tails are more common in that particular color type.
>
> HANK (LM): The orange?
>
> DAVE (LB): The orange. The, that's, and I'm just speaking from within the preserve cause those are the only areas I've checked. In the yellow area, it's MUCH more compacted, sometimes almost to the extent of feeling like cement, and tends to get coarser and then the brown, which there isn't much there, has got a lot of rocks and gravel and um boulders mixed in with it.

Dave's visits to the mapped areas suggest that as the sand becomes more compacted (i.e. in the areas colored orange and brown from satellite data), there are fewer FTLs and other lizard species ("flat tails") are beginning to appear. Reflectance values therefore seem to correlate with soil type and habitat species relations fairly accurately. Dave's reflectance layer could provide the SAC with a defensible way to identify current FTL habitat, including areas that have become more or less suitable for lizards since the 1986 plan was approved.

For a study of technical collaboration as a socially organized and performed interactional achievement (following Hutchins, 1995), Scene 1 looks like a moment of rapid progress by the SAC. The area and relations Dave wants to model are already captured by earlier modeling efforts (the 1986 FTL model), yet the assumptions behind those prior efforts may no longer hold. Dave proposes they displace that earlier model (and its settled agreements) with another, in a way that can be shown to be consistent with the existing preserve but that yields more accurate information. To do this, Dave proposes a new representational layer that links three measures (light intensity, soil quality, and lizard activity) by combining reflectance imagery with his own appreciation of "ground truth" in terms of soil quality and species sightings.

Regulatory Biologists Question Accuracy and Coverage for their Anticipated Use

After scrutinizing Dave's new map closely, regulatory biologists respond to this in-progress model, repeatedly distinguishing between the need to find areas to preserve, as one application of the model, and the need to determine areas that land developers might be allowed to "take", as a different application. Otherwise, they point out, FTL habitat that is good today (i.e. fluffy sand populated by lizards, see Figure 2) may disappear if developers obstruct a sand source that maintains that area.

In response, one local biologist proposes to extend the reflectance layer from a snapshot of present conditions into a representation of changes in habitat over time. A more dynamic model could show how habitat suitability changes, perhaps even addressing regulatory biologists' questions about the model's capacity to identify FTL habitats maintained by active sand sources.

A static model of current landscape conditions might then become a model of how things work over time. This will be critical if the plan is to identify existing habitat with little future value for development, to protect areas that are sustainable as lizard habitat, and to protect sand sources for those sustainable areas.

Several moments later, the regulatory biologists propose that the dynamic FTL map should rely on a sand source analysis that they have commissioned from the U.S. Geological Survey that will not be delivered for another five months. This is met with incredulity by local biologists, who feel that this sand source analysis is unnecessary because they already know where the sand is coming from, after spending decades conducting research in the valley. In their view, there is no reason to postpone a decision that could be taken in today's meeting to five months into the future.

After 40 minutes of further efforts to find a common modeling approach to account for specific preserve areas, "sand lenses" that supply fluffy sand to lizards, and human structures that act as barriers in these dynamic processes, the facilitator (Edward) tries to bring SAC members to a decision about the model's content.

> EDWARD (PC): Well, in terms of what we can accomplish uh today, are we all clear now as to what the model is going to represent when finished? [(*looking at Bert*)
>
> BERT (LB): [(*shaking head, negative*)
>
> (*general laughter*)
>
> CHARLES (RB): (*laughs, throws hands up, slumps over table*)
>
> BERT (LB): *(points to Nick and Dave)* These guys are. I'll work with them, but I'm not. (*pointing to Dave)* [Do you understand it?]
>
> DAVE (LB): [Well ...] I, I know what they want. But this is, when we put this together we had the same discussion, and it was clear that we weren't of one mind completely. And that's why we created what we did.
>
> HANK (LM): I think what you, what we really need to do is have a written statement that everyone can agree, what the model is intended to represent.

The general laughter at Bert's response suggests that SAC members are anything but clear about what will or should be represented in the model. Charles, in what looks like a show of desperation, slumps over the table.

Interlude: Enacting Professional Visions

What could account for these disagreements between local and regulatory biologists over the integrity of the proposed FTL model, after so many years of closely working together? It was not, I argue, bad will or poor communication on the part of either group of professional biologists. Nor can their disagreement be attributed to one or the other side's ignorance of HCP planning requirements, which provide little specific guidance beyond mandating that permit applicants estimate harm to each covered species and identify appropriate mitigation measures. Instead, each group participated in the SAC by performing aspects of distinctly different professional practices and these differences (along with their consequences in the plan under development) led to an inability to construct a new model that would be compatible with both groups' images of their future work requirements.

Goodwin (1994) argues that professional groups bring objects of their work into existence by orienting to the world in ways that reflect years of participation in distinct professional practices. They notice particular objects and relations and not others, highlight these in ways that enable coordinated work with others in their field, and encode what they see and talk about in conventional representational forms that (over the history of their practice) structure the intentionality of individual participants. In this sense, practitioners of a discipline actively experience their world of work through historically distinct forms of "professional vision" (Goodwin's term), even as their activity brings that professional world into existence as an ongoing technical practice.

In the previous exchanges, local biologist Dave described how to bind satellite imagery to lizard and human activity in different types of soil, making what initially appeared to be rapid progress in model construction. However, this work was soon undone, as his model was just as rapidly disassembled by the regulatory biologists, who proposed that the SAC obtain sand source information from a different group of scientists, argued that the coverage of Dave's reflectance layer was too small, and disputed his analysis on the grounds that it was not dynamic enough to identify preserve areas and to regulate what developers could "take". I suggest that differences in professional vision between local biologists and regulatory biologists led to this breakdown, both in terms of their ongoing interaction and their construction of a scientifically defensible model. Different points of view were produced in the ensuing dialogue as SAC members worked with map layers. These differences mattered as each group set model assumptions, and evaluated proposals accordingly in their search for agreement.

Regulatory Biologists: Shifting the Map and its Information into a Broader Regulatory Context

Regulatory biologists focused on whether the map's spatial coverage incorporated sand source dynamics. For example, pointing to a hypothetical development project in an area not designated as lizard habitat, one regulatory biologist considered whether the sand there could potentially reach lizard habitat:

> CHARLES (RB): If we were gonna analyze take and we had a project, like a dam up here, this is not occupiable habitat but it would still be part of the take issue.

As this suggests, the regulatory biologists' temporal horizon extended to the complexity of managing future relations between different organizations as the plan was put into practical use. Mapped plan areas were part of a complex managerial relation that balanced conservation against the need to "take" species for human use and development. The relevant terrain comprised not only soils and species, but also a social landscape of interacting and competing organizations, including the valley cities and county, environmental and development interests, the courts, and other state and federal regulatory agencies. For Charles, a lizard map with a spatial extent that excluded rocky areas was a poor representation of habitat because it didn't include potential "take" areas to guide future regulatory biologists during MSHCP implementation over the next century.

After attempting to project sand sources onto the new map, Charles and the other regulatory biologists proposed to delay map production until the U.S. Geological Survey provided a sand source analysis that would inform projections about possible obstruction of sand sources to areas downwind and downslope. They described a need to disengage claims from close association with individual scientists in order to maintain a defensible biological rationale for permitting, legal defense, and plan enforcement. They also noted that future regulatory biologists, who might not be familiar with area ecology, could rely on this well-documented and prestigious USGS study to maintain the court's deference to their scientific judgment as procedurally and administratively appropriate and thus not "arbitrary and capricious". Regulatory biologists questioned whether this deference could be maintained if "unsupported assertions" of local biologists formed the sole evidence base.

Local Biologists: Planning with Apocalyptic Dimensions

Local biologists viewed the lizard map with a greater temporal horizon and considerably less managerial complexity than their regulatory colleagues. As one described:

> DAVE (LB): We're not looking at the next ten years or the next hundred years … .we're looking at geologic processes. So people die out, buildings go away, lizards maintain what happens over the long haul. And so … we're talking thousands of years, yeah.

When Dave looks at the map, time, which was anchored to a scale that included careers and organizational life for regulatory biologists, now extends forward and backward into scenes where humans have either not yet arrived or have (for reasons not disclosed) disappeared. What currently shows as human habitat in the map could return to lizard habitat, as sand lenses bring sheets of sand over human structures, these structures crumble, and animals once threatened by human activity take center stage in an unfolding, apocalyptic narrative. Most interesting, in the point of view enacted by this local biologist, humans (including authors and users of conservation plans) disappear from the natural order.

Here, Dave enacts a version of the planning process that is built on the local biologists' decades of close personal observation and fieldwork within the desert, and on their well-established role in providing ecological expertise when scientific advice was solicited for ecological management in the Coachella Valley. During permitting, they anticipated that plan stakeholders would look to the local biologists for a personal guarantee that the proposed habitat preserve would protect imperiled species while not requiring land conservation in excess of scientific prudence or regulatory requirements. Local biologists dismissed the need to wait for the USGS sand source study, since no one could mount a successful legal challenge to their expertise. They would guide implementation of the plan just as they had done for the fringe-toed lizard HCP habitat preserve. Finally, over the longest time frame, the tensions between society and nature would diminish, as "people die out, buildings go away, and lizards maintain."

The points of view produced in (and used to produce) these exchanges show distinctively different orientations towards time, space, and agency as SAC members who inhabited different professional trajectories looked at maps, imagined their reception and use, and judged whether current efforts were adequate for varied purposes. This is not to say that Dave and the other local biologists only described landscape processes over geological time; in the exchange recounted earlier, Dave presented a map representing compact and active sand as a proxy for existing habitat conditions. Instead, both local and regulatory biologists contributed to the lizard model in ways that were consistent with a professional vision and expectations about future work. Differences across professional perspectives can help to understand how agreement is conditioned on multiple standards about what will count as adequate science, who will provide it, when it will arrive, and what purpose it will serve. The success of a model under development therefore depends on its ability to assemble shared representations that mean different things to different groups.

Finding a Coincident Boundary

Resuming the earlier chronology, the following scenes show how the tensions between professional visions of the regulatory and local biologists were resolved by an agreement to adopt a map that placed FTLs everywhere, over a geological timescale. This species distribution map was acceptable to all parties because it defined a space that had the same boundaries but different contents within each group's professional vision. The FTL map's coincident boundary contains multiple perspectives, suggesting that such technical products can possess multiple meanings depending on the circumstances in which they are constructed and invoked.

After Bert asks other local biologists if they understand what the SAC is proposing, Hank, who has consistently pointed out that his land management decisions will rest on scientific consensus, asks the committee for a written agreement. But given the circumstances, what would biologists (local or regulatory) agree to write down? Bert and Nick, both local biologists, are next to speak:

> BERT(LB): And that's got to come from them. (*points at Charles*)
>
> NICK(LB): Based on all of the models that we've done [so far.
>
> RANDY(RB): [You know maybe we should back up a little bit and ask the question whether it's worth opening this Pandora's box? It would be far easier and more expeditious to just make a simple assumption and accept the fringe-toed lizard HCP model.

Bert places responsibility for lack of agreement directly on the regulatory biologists across the table, whose efforts at this meeting so far have consisted of deconstructing model proposals and withholding agreement. Randy's proposal to "back up a little bit" sidesteps Bert's accusation and pulls the committee back from the brink of what may have turned into a heated disagreement, both at the level of interaction in this moment and in terms of their collective responsibility as advisory scientists.

"Pandora's box" here contains both the accusation about lack of co-operation made by local biologists, and the prospect of reworking the 1986 lizard HCP, which reflects both contemporary scientific opinion and a long-standing (14 year) set of agreements between local land owners, developers, and regulatory agencies.

Edward again seeks consensus from the SAC:

> EDWARD (PC): Is our ... Linda how do you react to Randy's suggestion?
>
> LINDA (RB): I like it. It's ...
>
> EDWARD (PC): (*looking at local biologists*) How about you guys?
>
> (*3 sec pause*)

RANDY (RB): I think we just need some logic. And the logic would be continuity with the past. And there's high acceptance for the existing HCP. It's probably not going to have a big result or make a big difference in the end result.

CHARLES (RB): No.

(*3 sec pause*)

EDWARD (PC): (*looking at Bert*) Given two things. Given one, that as we just said we'll take out stuff that's actually been developed. And two, recognizing that we each DO have the sand source transport, or ecological process OVERLAY, which becomes a part of this.

BERT (LB): And I think the answer to it is yes. Now the justification that, you know, it's historic continuity of the planning process, et cetera. That's not a science question, or an answer. That's political JUSTIFICATION.

DAVE (LB): But you can—

EDWARD (PC):—But you're saying it's scientifically justifiable, too.

BERT (LB): [In my opinion, yes.

DAVE (LB): [Well, all you have to do is … you look at a map like this (*holds up small map*), and you look at a map like that red orange and yellow map over there, and you can see that it's pretty defensible scientifically from that standpoint.

EDWARD (PC): Ok.

DAVE (LB): From … if you're looking at historically occupied, occupiable habitat. That's the time span you have to look at, something exceeding the last hundred years, because as everybody recognizes, things change dramatically in any ten- or twenty- or thirty-year period.

In this exchange, regulatory and local biologists make a tentative commitment to move forward with the 1986 FTL model. Facilitator Edward notes that they will be able to use a separate digital overlay to identify surrounding mountain slopes that supply sand to valley FTL habitat. Edward prompts local biologist Dave to voice a scientific rationale for the FTL model, and Dave notes that "all you have to do" is note that the FTL map includes all the area within his (currently stalled) reflectance model. Bert implicitly concurs. Using the reflectance map as a snapshot of presently occupied lizard habitat, local biologists agree that the FTL map is scientifically sound as a representation of lizard habitat that has or could be occupied over the long time period in which they situate their practice. Set aside by regulatory biologists earlier in the meeting, the reflectance model now becomes a critical part of the scientific legitimization of the 1986 FTL model, although the reflectance model is neither noted in plan documents nor carried forward in future discussion.

This exchange shows that, rather than determining behavior, the FTL model is a resource through which the facilitator guided SAC experts to organize their own behavior and interpret the behavior of others. This challenges the predominant understanding in planning research that experts resolve residual differences in favor of their financial or organizational sponsors (Ozawa, 1991) or are constrained by those with the power to limit acceptable alternatives (Flyvbjerg, 1998). These perspectives diminish the importance of interaction, the way that experts consider and apply models and other technical work in light of the contingency of practical collective action.

The SAC's local and regulatory biologists evaluated the FTL model by invoking underlying ontologies of time, space, and agency in which their work practices and organizational relationships were embedded. Collaborative technical work aligned the FTL model within their respective "professional visions", rather than attempting to find a position of compromise between the two by addressing potentially volatile differences between local and regulatory biologists enacted along sharply different professional images of the future. The FTL model provided a basis for coordinated action between communities with different interests, needs and accountabilities. As a boundary object, the FTL model was therefore "plastic enough to adapt to local needs and constraints of the several parties employing them, yet robust enough to maintain a common identity across sites" (Star & Griesemer, 1989, p. 46). In contrast to resources that help actors achieve mutual understanding in order to "make sense together" (Healey, 1992, p. 158), boundary objects like the FTL model are interfaces that allow actors from different social worlds to coordinate and cooperate without the need to fully "understand each other" (Forester, 1989, p.125).

Conducting Boundary Work

In the last exchange, regulatory biologist Randy notes that one advantage of the 1986 model is its acceptance by the many valley stakeholders, a "continuity with the past" that increases the chances for successful plan implementation. Local biologist Bert calls this rationale a "political justification" to distinguish it from a scientific justification rather than dismiss its significance, and a few minutes later in the meeting he cautions against removing habitat designation from areas covered by the FTL model since it would endanger landowner acceptance of the valley-wide development mitigation fee, noting that "The caution is I think as soon as you tweak a part of that there's gonna be somebody who says, why didn't you tweak me out over here?" The other SAC members agree, deciding to avoid actively uncovering the circumstances that influenced mapping choices made by the 1986 lizard club:

> CHARLES (RB): Well, you can either do that, you can pursue those details, or—
>
> NICK (LB): —Leave it as it is.
>
> CHARLES (RB): Leave it as it is.

Satisfied with the FTL model, the SAC moved on to other technical tasks required to assemble the MSHCP. By adopting the 1986 HCP model, the SAC was able to contain another source of trouble within the coincident boundary of the 1986 plan. At the same time that facilitator Edward aligned the FTL model within the respective biologist's professional visions, making it "scientifically justifiable", he also guided the SAC in configuring the model in anticipation of the "political justification" that would enable the model to pass through other venues during permitting, potential legal challenge, and implementation. Local biologist Dave's more selective reflectance model was discarded in part because of concerns that it could undermine the political settlement of the 1986 HCP by not maintaining a broad distribution of mitigation costs among valley landowners. The FTL model was preferred because it had underwritten that political settlement by projecting that the entire valley was lizard habitat, over geological time. SAC members also agreed that the habitat area within the FTL model should not be "tweaked" to avoid encouraging landowners to argue that their lands should be removed from the area where mitigation payments were required.

These concerns illustrate how technical problem-solving in planning applications occurs against a history of prior agreements and prior technical work. The SAC's maneuvering room for boundary object construction was constrained because new solutions displace not only old solutions but also the negotiated arrangement of the social order (Goldstein, 2008; Jasanoff, 2004). By opening the black box we can also learn about the ways that technical work can underwrite and sustain political agreement by meeting the epistemic requirements of disparate communities who may not have expert credentials or be included in technical deliberations. The SAC biologists' efforts to maintain landowner expectations of continuity with the FTL model suggest how, after a decade of serving as the basis for resolution of the "balance of terror" that existed before negotiation of the FTL HCP, the FTL model had become lizard habitat to the landowning public, floating free from association with the rationale and circumstances on which it originally depended. As Star (1994, p. 21) writes, "stripping away the contingencies of an object's creation and its situated nature" strengthens an object, because, "the more naturalized an object becomes, the more unquestioning the relationship of the community to it, the more invisible the contingent and historical circumstances of its birth."

This exchange was more than an instance of politically motivated decision making. Opening up the contingent circumstances of the FTL model's origins would not only threaten landowner consensus on mitigation fees, it would call into question the status of the FTL model as a scientific product, and the scientific authority of the SAC itself. Their reputation for scientific objectivity is worth defending, since it provides them with the means to advance their particular configuration of knowledge. While SAC biologists anticipate landowner reaction on epistemic as well as economic grounds, for the integrity of the SAC process to be maintained, scientific judgment should not be mixed with social justification. "Boundary work", the practice of ensuring the integrity of this division between science and politics, has been identified as a core practice in maintaining scientific authority and credibility in the public sphere (Gieryn, 1983). The SAC maintains the scientific integrity of the FTL model and their status as a scientific body by erasing traces of scientific contingency. These efforts to keep their science separate from mere opinion or political preference are the flipside of enhancing transparency through efforts such as joint fact-finding (Hilgartner, 2000).

External Peer Review and Its Consequences

About a year later, on February 12–13, 2001, a scientific panel was convened to review the SAC's technical work in the conference room of a small hotel in the city of Palm Desert (Figure 6, and Event 8 in Table 1). This had not been anticipated in the SAC workplan: around 50 large-scale, multi-stakeholder HCPs had been assembled contemporaneously around the country, and none of these had been submitted to scientific review, including the previous Coachella Valley HCP (Goldstein, 2004). The review had been arranged in accordance with a new state and federal emphasis on scientific oversight of HCPs, in response to rising criticism by conservation advocates and scientists that HCPs lacked scientific rigor (Luoma, 1998). The eight scientists selected for this panel were chosen both for their reputation as distinguished researchers and their independence from stakeholders in the Coachella Valley.

Interpreting their charge from the agencies, the panel adopted an approach similar to the anonymity and formality of peer review of a scientific paper or grant proposal. Panel members were provided with SAC technical documents, and then met for two days in the Coachella Valley. During the first day they listened to a series of formal presentations

Figure 6. Meeting of the scientific review panel in Palm Desert, 12 February 2001.

by SAC biologists. On the second day, the panel was sequestered without SAC members present, where they reached rough consensus on the key issues and divided up tasks to prepare a formal review document that was released a few months after this meeting, during which time the panel scientists were prohibited from speaking to anyone in the valley. As described in the introduction to this paper, during this second day the panel scientists speculated that the FTL map was different from the other species maps because the SAC didn't have enough data. In their report, they asserted that the MSHCP's credibility was damaged by including species maps constructed according to different standards.

The peer reviewer's reaction to the FTL model illustrates that while technical agreements like the FTL model may be shared among experts who crafted them and the communities that are governed by them, these boundary objects may have little legitimacy for those who were neither present nor anticipated during their creation. Despite the SAC's careful attention to future uses of the FTL model, the peer review was unanticipated, and understandably so, given the novelty of subjecting a draft HCP to such a process. Too late, SAC members realized that the plan's success depended on taking this additional external venue into account. As one regulatory biologist noted, since the report was part of the formal administrative record of the MSHCP, if they didn't address the issues it raised they risked being sued under the Administrative Procedures Act for being "arbitrary and capricious" by ignoring the best available science.[3] The FTL model was subverted by being transported to a new forum with different interactional rules and kinds of expertise, where its technical claims were destabilized.

The SAC never had the opportunity to prepare a revised FTL map, since county and city planners and other MSHCP stakeholder disbanded the SAC in the Fall of 2001 (Event 9 in Table 1). The assessment of the SAC's work by the scientific review panel figured into this decision, along with a range of other issues that I describe in another paper (Goldstein, 2010). Planning began anew with a different group of technical advisors, and the MSHCP was finally approved in 2008,[4] 18 years after planning efforts began (Event 10). This took longer than any of the 50 or so large-area HCPs approved over the past 25 years (Goldstein, 2004).

Boundary Objects and Persistent Difference

Technical agreements cannot be fully insulated from destabilization by transparency, peer review, a "public test of evidence" (Fischer, 1993, p. 3), or any other form of procedural insurance. Instead of seeking the security of objectivity, the planner has to navigate through diverse ways of knowing that are as irreducible as the variety of culture and experience. Knowledge claims are always contingent because experts cannot produce scientific truths that transcend cultural traditions, social identities, institutional relationships, and work practices.

From this premise, the fate of the FTL model can provide more than a cautionary tale of poor technical collaboration. If the peer reviewers hadn't unexpectedly appeared, the FTL might have provided a sound technical basis for agreement among the many jurisdictions of the Valley, in court, and for the diverse activities that each group of scientists anticipated in the century to come, and beyond. Breaking through the seamless surface of this settled agreement, the peer reviewers shed light on the work that is necessary to build and maintain boundary objects that serve as a foundation for shared action despite enduring and unreconciled difference. These boundary objects should be understood not as products of consensus but rather as products of persistent difference, what Haraway (1992, p. 300) described using the visual metaphor of "diffraction":

> Diffraction does not produce "the same" displaced, as reflection and refraction do. Diffraction is a mapping of interference, not of replication, reflection, or reproduction. A diffraction pattern does not map where differences appear, but rather maps where the effects of difference appear.

Within this frame of reference, peer review represents only another source of situated knowledge, not the final word. Depending on how it is brought into association with other forms of knowledge, it can undermine the credibility of regulatory scientists and agency authority (Weeks & Packard, 1997), or it can be structured to enhance the legitimacy of regulatory science (Jasanoff, 1990). By anticipating its availability and use, planners can develop more stable technical claims by constructing boundary objects that benefit from its legitimacy and high status. In the final section, which focuses on Edward, the SAC's facilitator, I describe features of this planning practice.

Planning as Epistemic Mediation

Throughout these exchanges, Edward kept the SAC focused on developing claims that were acceptable across professional visions by managing turn-taking and marking when closure had occurred or where ambiguity remained. As lead planning consultant, Edward also had the responsibility to ensure that new claims were integrated within the representational infrastructure that the SAC had spent years accumulating and to guarantee that this infrastructure—paper and digital maps, databases, spreadsheets, and more—was available and accessible to SAC members. This coordination is critical because every new agreement occurs against a history of prior agreements and prior technical work that is far too complex to maintain in individual or collective memory. Meanwhile, membership of the group may change and their assignment may shift over time. In order to maintain and expand complex technical agreements, planners like Edward must recover information and make it available in a timely way, in formats that are available for collective use and comprehensible among different participants. This infrastructure does not necessarily fit together neatly or assemble into a logical hierarchy. Some parts, such as Dave's reflectance model, may not even be a part of the official record. As Star (2002, p. 19) writes:

> Infrastructure is composed of a complex matrix of boundary objects and standards, imbricated in the way a stone wall is put together. Each stands on top of the other, supporting, but not in a smooth or seamless fashion ... Imbrication ... implies that each part may shift in character over time as the whole is edited or rearranged. Thus a keystone at one time—a rigid standard, say—may become a minor, interchangeable stone at another time.

Edward's effort to maintain awareness of prior commitments was accompanied by his efforts to write planning documents in ways that provided a unified and contingency-free explanation of the SAC's scientific reasoning in order to sustain credibility among experts in forums outside the SAC, such as the courts. Studying advisory committees of the National Academy of Sciences, Hilgartner (2000) suggests that these committees are like a theatre production in which onstage performance is made possible by backstage activities unseen by the public. Onstage, advisory reports convey a unified and authoritative scientific voice and lay out the steps the committee followed in reaching consensus. If the committee revealed the messy interplay of opinions "backstage", it would harm their scientific credibility because they would no longer speak with one voice. Yet it is only possible to speak with one voice by encouraging participants to discuss their differences and compose a mutually acceptable agreement behind closed doors. Like the SAC, Academy reports release a sanitized version of the messy work of reaching scientific consensus, meeting democratic requirements through a transparency that is procedural, rather than substantive.[5]

Sometimes more than erasure of contingencies is required to align distant forums. While surprises such as the scientific review panel's assessment of the SAC's work cannot be entirely precluded, facilitators can draw on their own professional vision as planners to anticipate how technical arguments may cross into venues that have different norms and expectations regarding reliable evidence, convincing argument, procedural fairness, and appropriate characterization of uncertainty. Anticipatory bridging between ways of knowing relies on the judgment of a boundary spanner who is familiar with the requirements of different audiences (Guston, 2001). As in this case, experts often have strong ideas about what is required to craft enduring technical claims, ideas that are conditioned by their specific experiences in situations that are probably dissimilar to unusual planning opportunities such as habitat conservation plans. An epistemic mediator can help them understand the plan's credibility requirements and anticipate potential trouble. Further, they can strengthen agreements by helping to forge technical claims that create new alliances: for example, Cussins (1997) describes the enrollment of Masai villagers in a conservation initiative through scientific demonstrations that resonated strongly with the Masai ways of knowing wildlife and demonstrating proof.

An epistemic mediator assists knowledge communities to bridge their different ways of knowing "backstage" while erasing contingencies in knowledge claims to provide a unified and authoritative scientific voice "on stage". It may seem that the purification rituals of boundary work are incompatible with the collaborative construction of boundary objects, but they are both necessary for successful practice. In this sense, epistemic mediation is itself a border practice, poised between bridging diverse ways of knowing across venues of planning practice and satisfying a commitment to objectivity and detachment. Like science itself, epistemic mediation is what Latour (1987) called "Janus-faced",[6] engaged in context-dependent, creative, and messy science-in-the-making with one face, while simultaneously presenting stable, rational, and neat settled facts about the world with the other.

Epistemic mediation's focus on creating and maintaining scientific credibility is a necessary complement to the assertion that planning legitimacy and authority depend on experiential, contemplative, artistic, and other forms of non-scientific knowledge, which together populate what Sandercock (2003) calls an "epistemology of multiplicity". Both perspectives are grounded in the idea that all knowledge practices are culturally situated, rather than placeless and neutral. However, whereas Sandercock argues that planners should oppose rather than accommodate deeply entrenched institutional preferences for agreements couched in modernist scientific terms, I argue for no absolute choice between these two perspectives, but that the interplay between them should instead remain part of what Sandercock calls the "artistry of planning". By matching the perspectives to the circumstances at hand, planners may be able to forge more credible, legitimate, and authoritative agreements, navigating the tension between persistent epistemic differences and society's unquenched modernist thirst for a unified scientific objectivity.

Conclusion

The problems of species modeling in the Coachella Valley were complex, but not unusually so. Conservation planning efforts such as the MSHCP are regularly faced with the task of cobbling together information of varied quality from heterogeneous sources, while the plans of developers proceed apace, making new claims on the landscape even as the models are being constructed. By opening the black box of technical collaboration, we can better understand why the FTL model was chosen by the SAC and then criticized as lax and incongruous by the scientific review panel. Since they could only read the documents that the SAC had carefully prepared for public scrutiny and regulatory review, the scientific reviewers could not align the FTL model with their own professional vision. The SAC's carefully constructed model was doubly inaccessible to them; first, because its imbrication among the SAC's other technical commitments was invisible beyond a screen of boundary work; and second, because the model's multiple meanings were only stable and meaningful to those who had assembled them, and those for whom the model had been assembled.

Opening the black box of technical collaboration can do more than provide insight into puzzling failures. We can learn about the ways in which planners can coordinate technical work that draws on different ways of knowing and circulates effectively in many venues beyond the stakeholder collaborative, something that is increasingly common in high-stakes planning efforts. Within the black box, facts are not jointly found during a collective discovery of hidden truths with unitary meanings. Instead, facts are jointly made, a kind of interactional achievement whose validity relies on meaning different things across different social worlds while simultaneously laying claim to universality and objectivity. While co-production (Goldstein & Butler, 2009) and the promise of a broader collaborative governance (Innes & Booher, 2010) would ground technical agreements in mutual trust and understanding within a common social order, planners still need a way to coordinate and stabilize complex technical agreements within fragmented and contested institutions (Innes & Gruber, 2005). Neither embracing epistemic diversity nor a faithful commitment to positivism provides a stable foundation for this kind of practice. Instead, planners need to be regarded as epistemic mediators who cultivate a kind of double vision by drawing on the dualistic rhetorics and practices of expertise. They create and stabilize technical claims that project authority by showing a responsive face to many audiences, a "reliable, partly shareable, trope-laced, worldly, accountable, non-innocent knowledge" (Haraway, 1997, p. 138).

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Notes

1. Interview held 19 December 2001.
2. Transcripts identify speaker (Figure 3) with professional affiliation and show contiguous talk unless otherwise noted. Extended turns are broken at thematic boundaries. EMPHATIC speech is shown in upper case, stre:::tched enunciation is shown with repeated colons, (action descriptions) are show in italics within parenthesis, and [overlapping talk is marked with [matching square brackets across speaking turns.
3. Interview held 10 May 2001.
4. See http://www.cvmshcp.org/.
5. The SAC meetings were open to the public, although as Figure 3 illustrates, in practice the only other occasional attendees were federal and state land managers, whose infrequent contribution is not described here.
6. Janus was the Roman god of doorways, usually depicted with two faces looking in opposite directions.

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