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RESEARCH ARTICLE

The business perspective in ecological restoration: issues and challenges

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Much of the practice of restoration is conducted by businesses—contractors, consultants, designers, engineers. Restoration businesses interact with a variety of stakeholders to complete projects on time and on budget, and to achieve ecological and business objectives. Our research explores the business perspective in restoration; it is based on data collected from businesses (contractors, consultants, design engineers), agencies, and nongovernmental organizations involved in a Superfund cleanup project in Montana, one of the largest river restoration efforts ever. Our findings highlight several areas restoration businesses must navigate. First, restoration businesses must juggle potentially competing goals, maintaining ecological integrity while achieving profitability objectives. Second, these businesses must manage the risk that arises from variability in the natural environment as well as individuals' risk tolerances. Third, they must navigate the disconnect between "science" and "practice," including how to best monitor restoration projects. Fourth, they must make decisions about new techniques and innovations. Fifth, on-the-ground implementation must acknowledge that personnels' motives and expertise might conflict with original plans. We discuss these findings in relation to relevant scholarly research, offering implications for theory and practice. For example, the business of ecological restoration requires learning over time to be profitable while achieving the desired ecological and social outcomes; restoration businesses leverage monitoring in pursuit of adaptive management and engage "frontline personnel" as important voices in the restoration process. Understanding the business of restoration adds an important perspective in the complex dynamics of social-ecological systems.

Key words: business of restoration, ecological restoration, restoration business, restoration economy, restoration practitioners

Implications for Practice

- Restoration businesses strive to attain ecological goals while achieving business goals.
- Explicitly recognizing how risk affects restoration decisions can help balance risk avoidance strategies with strategies to experiment with innovation and to facilitate adaptive learning.
- Project designs developed to cope with natural variability can allow restoration to be in tune with natural processes.
- Acknowledging reasons businesses typically do not rely on best-practices "science" can help identify opportunities to collaborate and to bridge the science/practice gap.
- Explicitly identifying and engaging people who do on-the-ground implementation can surface challenges and new insights.

Introduction

The business of restoration, which plays an important role in the practice of restoration, refers to "the hundreds—perhaps thousands—of firms [in the United States] engaged in ecological restoration" (Lavendel 2002, p. 174). These firms work with agencies, nongovernmental organizations (NGOs), and other stakeholders to complete needed restoration on the ground. Interestingly, despite its status as a dominant natural resource management activity, with over U.S.$1 trillion spent in the global "restoration economy" annually (Cunningham 2002, p. 3), research in restoration ecology has not explicitly addressed the business perspective.

In the United States, the business domain of ecological restoration is comprised of a wide variety of business types, roughly evenly split between the scientific/engineering/design aspects of restoration and the physical construction/earth moving aspects (BenDor et al. 2015). This business sector has shown enormous growth in jobs as more funding is available for restoration projects (BenDor et al. 2015). Indeed, BenDor et al. note that more workers are directly employed in restoration than in coal mining, logging, or steel production.

Prior research in the United States on the socioeconomic impacts of restoration has studied job creation (employment) and overall economic output on a macroscale (county, region, state, nation; e.g. Nielsen-Pincus & Moseley 2013; BenDor

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et al. 2015), such as jobs gained through ecological restoration or jobs lost through portions of the natural environment being taken out of industrial uses. Socioeconomic studies also address how stakeholders engage in restoration activities and how they value various outcomes from restoration (e.g. Petts 2007; Collier 2011; Metcalf et al. 2015). Finally, the rehabilitation of natural capital and ecosystem services (e.g. Benayas et al. 2009; Palmer & Filoso 2009; Aronson et al. 2010; Wu et al. 2011; Schultz et al. 2012) also is characterized under the "economic assessment" of restoration. However, the economic impacts of restoration do not address the practices businesses use in designing, managing, implementing, and evaluating restoration projects.

Understanding restoration business practices is important; historically, business practice has had a negative effect on the natural environment (Hart 1995). Indeed, the environmental problems the world faces today originated because businesses historically viewed the natural environment as a source of raw materials for cheap inputs, such as iron ore and wood (Shrivastava & Hart 1995, p. 154). Moreover, business activities have not accounted for negative environmental impacts arising from manufacturing, pollution, toxic waste, shipping, and transportation (e.g. greenhouse gas emissions). In fact, some have argued that the logic of business, focused on consumption of consumer goods, is inherently at odds with preserving the natural world (Mohr et al. 2016).

Given the rather dismal track record of businesses' impacts on the environment, understanding how restoration businesses navigate the many trade-offs and complexities in restoration projects to attain both ecological goals and business objectives is an important area of research inquiry. As Lavendel (2002) stated: "The for-profit side of ecological restoration has taken off … some of [these businesses] doing restoration are very good and some very poor" (p. 174).

Hence, our primary research focus is the business perspective in restoration. More specifically, we sought to understand the challenges and issues businesses face in restoration. We also sought insights into how business and ecological perspectives can be aligned in the practice of restoration. To our knowledge, no research has addressed how owners/operators/managers in these businesses make decisions about restoration projects.

Methods

Because the issues we explored have not been explicitly studied in prior research, we used a qualitative research method: in-depth, semi-structured interviews. Such methods are appropriate when the phenomenon of interest is complex and/or poorly understood (Lindlof & Taylor 2002; Glaser & Strauss 2009). More specifically, grounded theory is a systematic inductive method for conducting qualitative research aimed toward theory development. This method is used when a topic is not well understood or lacks a conceptual framework. This method elicits meaning from qualitative data through an iterative process, analyzing individual transcripts vis-à-vis the emerging understanding of the collective dataset (Patterson & Williams 2002).

Study Site

Our study focused on the Clark Fork River, the largest river by volume in Montana, and the largest Superfund complex in the United States (Superfund is a hazardous waste designation under federal law). This Superfund complex is comprised of four operable units designed to address over 100 years of contamination resulting from mining in Butte, Montana, by the Anaconda Company (subsequently purchased by ARCO in 1977). After a series of lawsuits, ARCO provided nearly $400 million for remediation and restoration on the river, including the removal of toxic mining waste *and* restoring riparian vegetation, fish populations, and a functioning floodplain on both the main stem and the tributaries. In addition to consultants and restoration businesses, the project involves multiple state agencies (e.g. Montana Department of Environmental Quality, Montana's Natural Resources Damage Program, Montana Fish Wildlife and Parks), federal agencies (e.g. Environmental Protection Agency, National Park Service), the Confederated Salish and Kootenai Tribes, NGOs (e.g. Trout Unlimited, Clark Fork Coalition), community groups (e.g. Clark Fork River Technical Advisory Committee, Watershed Restoration Council), and numerous communities and landowners.

Respondents

To identify specific research participants, we used a chain referral, purposive sampling method. Purposive sampling in qualitative research is designed to understand selected individuals' or groups' experience(s) and to develop theories and concepts; it selects individuals or groups that provide the greatest insight into the research question (Creswell 2014). Chain referral sampling involves primary contacts (or data sources) iteratively identifying others who are also members of the sample group (i.e. engaged in the restoration project) to be interviewed. Initial contacts knowledgeable about the restoration project on the Clark Fork River referred us to other key stakeholders involved in the project.

Data used in this paper were derived from a larger project studying the social dimensions of ecological restoration that interviewed a variety of stakeholders ($n = 43$, including landowners, outfitters and guides, agencies, NGOs, and restoration businesses; Metcalf et al. 2015). In this paper, we used only a portion of the full sample, focusing on business owners, consultants, engineers, contractors, NGOs, and state and federal agencies engaged in the business of ecological restoration.

Table 1 provides an overview of the 27 respondents for this project. We sought diverse perspectives to enhance our emerging understanding of the role of business in restoration. The businesses in our study included large, multinational corporations engaged in restoration globally, large national companies, medium-sized regional companies, and small local companies, as well as tribal businesses. Importantly, we also included interview data from key personnel from the agencies, NGOs, and citizen coalitions/advisory groups. These organizations collaborate with businesses in the design and implementation of restoration projects, and also allow us to validate (cross-check) the

Table 1. Respondents interviewed.

Category	*Specific Type*	*Respondent Code*
Business respondents	Design	B1
	Engineering	B2
	Engineering	B3
	Engineering	B4
	Design + Vegetation	B5
	Construction	B6
	Vegetation supplier (Tribal)	B7
	Design + Veg	B8
	Tribal business	T1
Triangulation through state/federal agencies		SA1a*
		SA1b
		FA1
		SA2a
		SA2b
		SA2c
		SA2d
		SA3
		SA4a
		SA4b
NGOs	Water/fisheries	NGO1
	Water/fisheries	NGO2
	General conservation	NGO3
	Water	NGO4
	General conservation	NGO5
Citizen advisories/collaboratives		CA1
		CA2
		CA3

*State Agency 1, respondent a; State Agency 1, respondent b; and so on.

businesses' self-reports. Our collective set of interviews provides a reasonable set of data to understand the role of these businesses—both from their perspectives as well as the perspectives of key partners—in a large restoration project.

Semi-structured, in-depth interviews typically begin with a set of general questions but allow new questions to arise during the interview (McCracken 1988). An interview guide (Appendix S1) ensured comparability across interviews; it focused on respondents' background, history with ecological restoration, restoration protocols, project objectives, success factors and hurdles/barriers to successful restoration projects, and stakeholder dynamics. Prior to the interview, participants were read a brief script to adhere to informed consent guidelines, per Institutional Review Board standards that govern research in the United States that relies on data collected from human subjects (University of Montana IRB #113-13). The interviews had a conversational quality; participants guided the flow of the discussion. We interjected questions to clarify and probe as needed. This semi-structured approach allowed us to obtain answers to queries, and provided the benefits of organization and flexibility while minimizing the risk of interviewer-induced bias (McCracken 1988). Each interview lasted about an hour, was audiotaped, professionally transcribed, and coded using NVivo 9 software.

Qualitative research explores the range of opinions and diversity of views and collects detailed information about those opinions. The number of participants required, therefore, depends on the nature of the research and how many interviews are needed to answer the research questions. The focus generally is not on sample size but rather on sample adequacy. The adequacy of sampling is usually assessed in terms of "saturation" (Bowen 2008); researchers continue interviewing until no new information or surprises emerge, that is, until saturation is reached (O'Reilly & Parker 2013). Time and resources can limit the number of interviews. However, this does not invalidate the findings; rather it means that the phenomenon has not yet been fully explored and this should be reported with the findings (O'Reilly & Parker 2013).

Data Analysis and Identification of Themes

The interview transcripts were uploaded to NVivo 9, a software tool designed to facilitate qualitative data analysis. We trained two research assistants to label the different parts of the interviews based on descriptions that corresponded to the interview guide. NVivo 9 then allowed us to retrieve all interview segments with a particular label (i.e. managing risk) and to read those segments alongside each other. By itself, NVivo 9 is not an analytical method; it is a software tool that allows qualitative researchers to be more systematic in their categorization and analysis of large amounts of data.

As noted previously, grounded theory methods elicit meaning from qualitative data through iterative analysis between the individual transcripts and the researchers' emerging understanding. Based on this iterative process, we organized the data into key themes ("thematic analysis"; Aronson 1995). We then triangulated these themes by sharing our individual interpretations, discussing discrepant views, and cross-checking themes against the transcripts. The themes that survived this validation process are discussed in the next section. Data excerpts illustrate specific findings and provide empirical evidence for the themes. In order to protect participant confidentiality, only their assigned codes (Table 1) are used as identifiers.

Results

Figure 1 provides an organizing framework for the five key themes derived from our grounded theory method. These five themes reflect the issues and challenges businesses face in managing complex restoration projects; they include: (1) balancing ecological goals vis-à-vis business goals, (2) managing the risk inherent in these projects, (3) bridging the science/practice nexus, (4) using innovative techniques, and (5) navigating on-the-ground implementation. The figure suggests that the five key themes play a role at the interface of ecological decisions and business decisions. Indeed, the interplay of these two domains suggests that both must be simultaneously considered in the process of restoration.

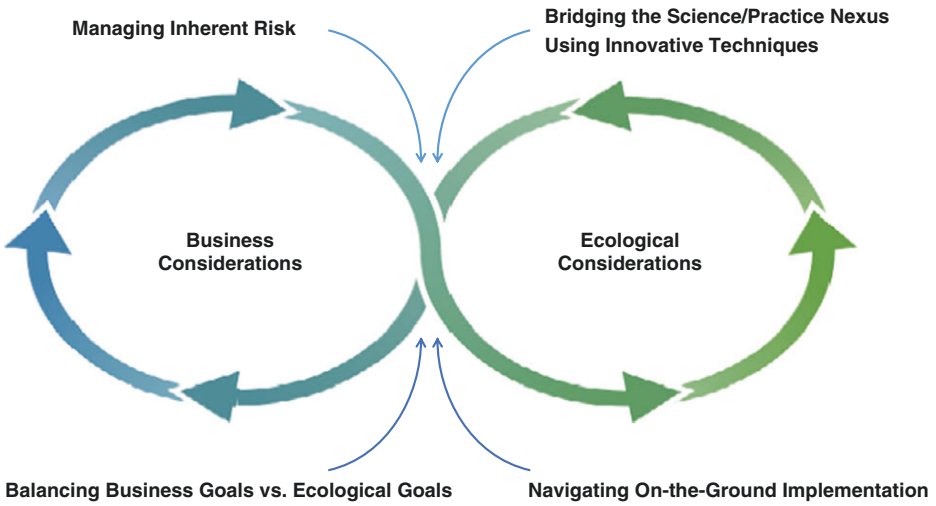

Figure 1. Challenges in the business of restoration. Consistent with social-ecological systems thinking, ecological decisions affect, and are affected by, business decisions. Hence, these two domains must be simultaneously considered in the process of restoration.

Balancing Business Goals vis-à-vis Ecological Goals

When describing goals for the restoration project, the most often-cited *ecological goals* related to restoring clean water, aquatic habitat, riparian areas, and geomorphological functioning. The *social goals* respondents mentioned included ensuring that agricultural livelihoods could continue (e.g. irrigation and agricultural needs for livestock), along with the need to manage recreation resources for the enjoyment of Montanans. One respondent stated how important it was to "keep stakeholders happy" (NGO5).

We probed further about the relationship between business goals and ecological goals specifically. When explicitly asked about how *business goals* and ecological goals were related, consultants, engineers, and contractors stated that they needed to run a profitable business while meeting ecological goals, to keep their company going, to keep people employed, and to manage overhead; these considerations affected how they engaged in various projects. For example, one respondent stated:

> Most people getting money for this work understand the commitments to achieve your [ecological] goals and objectives. But at the same time, we do have to make money. And so … (B1)

Her voice trailed off with the implication that financial aspects required commitments, too.

The need to meet business objectives while conducting meaningful restoration weighed on respondents. Our respondents overwhelmingly expressed that they entered into the restoration field because of their personal connection to the environment and their desire to restore landscapes to optimal conditions. In fact, many of them had been trained as ecologists (or in other environmental sciences) and not as business people, and so the profitability side of their businesses was often a hoped-for by-product of their projects. Hence, a commitment to ecological integrity was "the bottom line" to them—meaning it was more important than economic profitability. As one respondent stated:

> For us, not to sound cliché, it's really a passion for the resource and doing good things for Montana resources that brought us to start [our company]. That overriding philosophy is what drives us, and the business obviously does come second to that. (B8)

Additional support for this theme (balancing ecological and business goals) is provided in Appendix S2.

Managing Risk

Businesses were challenged by managing the risk inherent in restoration projects. Perceptions of risk arose from many sources. First is the context in which restoration occurs: the natural environment with an inherently high degree of variability. Some respondents indicated that managing this inherent uncertainty created tension between ecological and business considerations. Concerns about risk were often couched in terms of fear of failure, with a large impact on project design. One business respondent indicated:

> [What] really stands out is this risk averse approach to restoration. It's been a criticism of the project for many years, that it's overdesigned, the channel's too big, that the woody debris structures were ineffective, because it minimized risk. If there's a human factor involved that has changed the restoration from what it should have been ideally [i.e. from an ecological perspective], being risk averse is probably it. (B3)

This concern about risk was exacerbated, for example, when a flood destroyed some of the restoration. Due to the fear of failure arising from natural processes, some business practitioners

became even more conservative (i.e. a tendency to overengineer) in design plans for future reaches as exemplified by this quote:

> And we just saw that on [XX] Creek year before last. There was a pretty high runoff, and there was some flooding, and the stream got out of its channel, and it cut some side channels on its own, and there was a lot of criticism that this wasn't designed correctly, and we're wasting our money, we're wasting our time, now we have to go back and fix it. People just don't like to see that happen, even though that's a natural part of the process. The stream wasn't really designed badly, we just got a big flood event, which was beyond the design capacity. So the State reacted, and in the newer reaches that are being done subsequent to that, they've gone back to a slightly more conservative approach so that it doesn't happen again. (B3)

This tendency to "overengineer" projects so as not to be a poster child for failure—particularly when taxpayer dollars were funding highly visible projects—was echoed by other respondents:

> If you do a stream restoration project and it fails—and I shouldn't say fails—and you have issues with that project; say there's some banks that don't hold up to your design, or some vegetation fails or doesn't grow, it is put out there, papers are written about it: "wow, this is what so-and-so did and look what happened. They did this completely wrong." So that adds a lot of pressure, to the engineers and the scientists and the project managers working on these projects. Looking down the road … are people gonna look at this and say "wow, look what those boneheads did." (SA2a)

With respect to managing the risk inherent in restoration projects, respondents were both philosophical and pragmatic. For example, clearly defining success from the outset is crucial:

> When developing goals, you should also have a list of what we will call success but also what would make us go back and fix something. At what point do we say, if the river does something that we had not counted on, that's okay, we'll just let it go? At what point do we say, no, we will go back in there and fix it? So it is really good to define those things ahead of time. (NGO4)

Respondents also said that risk could be managed by invoking natural processes and relying on "softer, more humble" techniques:

> … take, I guess, a more humble approach, and sort of set the stage for the stream to heal itself over time, remove impediments to restoration, maybe nudge the stream gently in the right direction, but be more open about our abilities and our understanding. Taking that type of approach, rather than a more engineered approach. (B3)

Second, in addition to risk arising from the variability of nature, risk appeared at the individual level. Some individuals were inherently risk averse, and did not want to risk losing money on projects: "A. they're afraid to fail, and B. they're afraid to lose money" (NGO4). This respondent stated:

> There are definitely personalities that are more risk averse than others. Risk aversion can be simply that you don't want your project to quote, "fail." (NGO4)

Another respondent talked about people who are willing to tolerate risk and how that affects project design:

> You have to have people with the right mindset. Without [a specific individual who was willing to tolerate some risk] being there, … you [would] have someone with a different point of view, which wouldn't be good [implying that the solution would be over-engineered]. (SA2c)

Additional data on this theme of managing risk appears in Appendix S3.

Navigating the Science/Practice Nexus

Another theme that appeared in our data was the gap between science and practice. In the context of restoration, "science" generally refers to academic research using systematic methods of observation to test hypotheses. Although the disconnect between science and practice is not new to the restoration field (cf. Bernhardt et al. 2007; Cabin et al. 2010; Christian-Smith & Merenlender 2010)—nor is it unique to this field (cf. Lilien et al. 2002)—businesses attempted to navigate this disconnect in two ways.

First, many of the respondents noted the business pressures to "be successful" and "cost-effective" meant they needed to balance trying new approaches ("science") with "tried and true" practices—which they sometimes tried to portray as "best" practices. These two quotes capture the essence of this theme:

> There's a thousand different ways to build a stream bank. What's the most cost-effective that's gonna meet your performance standards in the end? (SA1b)

> … we first get our marching orders, the general purpose and scope of the project from the client. And then they're gonna look to us for advice on the best way to implement the project and to achieve their goals. They're looking for that … right balance of cost-effectiveness and, if not cutting edge, at least certainly best practices in terms of stream restoration to make that happen. (B3)

In addition, respondents acknowledged that the field of restoration is relatively new and lacked agreement on "best practices" science. This, at times, left some respondents feeling unsettled:

> Frankly, in terms of best practices, certainly in stream restoration, there isn't much of a consensus at the moment, and hasn't been since I've been involved in it. Some of those methodological debates are quite contentious. There are several schools of thought on that type of work, and they're often competing and disagreeing, sometimes in a very nasty fashion. (B3)

Despite no clear agreement on scientific "best practices," there was a general sentiment that restoration practitioners were doing the best work they could and that new science would not necessarily improve, or be better than, current practices. One respondent stated:

> I think that scientists would tell you that the science is a hurdle, but I feel like this is such an emerging thing that you could study these systems to death and it still might not change what you actually do on the ground. (B1)

Some respondents thought that closer ties with the academic community would offer new perspectives to help overcome overreliance on tried-and-true practices and incorporate more natural designs. One respondent offered an illustration to capture the role of academics in restoration:

> It was really the academic community that brought that to light, and said, the reason this stuff [tried-and-true practices] doesn't work is because you're basing this on form, and form is one consideration, but the main thing to consider is process. So, I think the level of sophistication has risen in stream restoration design. There are more engineers lookin' at sediment transport, which is good. So, that's been an improvement … perhaps more of a recognition, too, that streams can take care of themselves and form their own channels if you remove the stressors. (NGO4)

Another theme related to the science/practice nexus was the desire/need for monitoring—for both the science and practice of restoration. Issues here related to the design of the monitoring plan and the budget given to monitoring, who would do the monitoring, when the monitoring would be done, and how the monitoring data would be used. Some respondents wanted monitoring done to improve restoration practice. Rather than regarding unexpected/unanticipated outcomes as "failures," they were opportunities to learn how to improve restoration practice.

> I'm hopin' we progress and we get to where we have more … candid conversations amongst professionals about what's working and what's not working, and how to move forward together instead of this high pressure, "I don't wanna fail" type thing. (SA2a)

Additional data to support the theme of navigating the science/practice nexus appear in Appendix S4.

Using Innovative Techniques

A fourth challenge restoration businesses faced related to using novel innovations either to drive costs of a project down or simply to try something new—with an uncertain effect on business profitability. Although this area was also a source of risk, the importance of innovation in restoration practice warranted its own category. In evaluating innovative techniques, many business respondents again worried about possible failure. An unwillingness to innovate arose from both the need to be cost-effective and the need to have confidence in being successful, as illustrated by this quote:

> From a cost-effectiveness standpoint, we were not big on new innovative technology. We would rather implement something that we know will work. For the most part, we don't utilize new innovative technology, we're not reinventing the wheel with the restoration dollars. (SA2a)

The lack of innovation also came from what agencies were willing to fund. Some respondents noted that fulfilling agencies' needs prevented them from trying innovative approaches. The general concern was that if they tried something new and failed, the agency might not hire them again, ultimately influencing their financial bottom line.

> I've struggled with tryin' to use the best available technology, an example would be the XXX [agency]; they have designs that they will approve and partially fund for a project. Often those things [designs] are years out of date. So it's a struggle to say, "hey, … what you're willing to cost share really doesn't work as well as this new technology that we would like to use." (NGO3)

Additional data to support this theme in using innovations appear in Appendix S5.

Navigating on-the-Ground Implementation

A final area businesses navigated was on-the-ground implementation. Although our respondents did not mention this topic as consistently or frequently as the other themes, it has a strong impact on both business and ecological goals. We encourage future research on this area.

The dependence of the project on "guys on the ground" was clear. One respondent stated "it's the guys on the ground who implement this project, and they're the ones who are going to make it a failure or success." At the same time, some expressed the concern that "guys in the yellow machines" were just getting the job done as quickly as possible—not necessarily based on the design, particularly if it necessitated painstaking detail work (say, "planting veg in a particular way" as opposed to "just getting it in the ground").

Respondents wondered whether these people were taking advantage of the situation to maximize their own gain:

> The guys in the yellow machines doin' the work, or the guys managing the guys in the yellow machine, the contractor, that's on the low end of the skill set, low end of the intellect, that's out doing the work and is just out there to take advantage of the [project manager/agency], if they can. (B6)

However, the people on the ground perceived themselves as more knowledgeable than those who drew up the plans; they had years of experience carrying out the actual restoration and had seen both successes and failures. Indeed, on-the-ground people experienced an ethical dilemma: Do they follow the plan or do they request a change order to the plan? Or do they not follow the plan and do what they think is best? This quote exemplifies this dilemma:

> I do the labor part of it, and the plans are already done. "Here they are, do the plans, follow the plans," whether I agree with the plans or not, you don't get paid unless you follow the plans. … I understand [following the plan] enhances your revenue, so I'm going to make money and keep people employed. I've learned that if I keep my mouth quiet then we're all right, but if I see something that's so catawampus, like a dry plant going in the water, I'll say something … (B7)

Furthermore, sometimes these "guys on the ground" felt that the designers/engineers' and consultants' focus on making money meant they never came back to revisit the implementation work. If these designers had been willing to do so, perhaps the design might have been adjusted to accommodate on-the-ground learning.

> What bothers me about saving money on the back end, the guy who designs it on the front end never sees the final product. So he's already designing another project instead of going back and seeing, "Well, this worked." Or "Maybe I shouldn't call for XXX here, it doesn't work." "Maybe I should [have] ... a steeper requirement —" (B7)

Additional data excerpts on this theme are in Appendix S6. These data suggest that various stakeholders—"guys on the ground," designers, engineers, and others—have different mindsets, and mechanisms to align their various goals and perspectives would be useful. We explore this further in the Discussion section.

Discussion

Several key themes emerged from our analyses. In this section, we comment on each of the themes, situate them in the broader academic literature, and offer implications.

First, in terms of balancing business goals vis-à-vis ecological goals, a positive finding from our study is that restoration businesses were as focused on favorable ecological outcomes as on profitability outcomes. This is in contrast to much business practice, identified as negatively affecting the natural environment and "systematically ignor[ing] the constraints imposed by the biophysical (natural) environment" (Hart 1995, p. 986). To further assist in balancing these goals, agencies and stakeholders can question how a firm's business needs affect the ecological design and project implementation. Being direct in these conversations can ensure clarity regarding how firms cover their costs while making sufficient profit for the long-term.

Second, the theme of managing risk was prominent across our interviews. Rather than regarding unexpected outcomes as "failure," they should be regarded as opportunities to learn how to improve restoration practice. Risk framing and "learning from failure" are important topics in the scholarly business management literature. For example, prospect theory (also called "loss aversion theory") describes how people choose between alternatives that involve risk and uncertainty (cf. Tversky & Kahneman 1989). In particular, managers have a strong preference for certainty and are willing to sacrifice upside gains to avoid possible negative outcomes that arise from uncertainty. People tend to weight potential losses more heavily than gains (Kahneman & Tverksy 1979). This theory offers insights for restoration practitioners to become more aware of their biases and to recalibrate and de-bias decisions.

Our data are consistent with prospect theory in that restoration businesses tend to act asymmetrically when evaluating potential loss versus potential gain. An important question is whether that asymmetric behavior is good or bad. Should such asymmetry be encouraged or discouraged? If overweighting of possible losses results in overengineering of restoration structures and excessive costs, that would be undesirable. Indeed, Cunningham (2002) offers examples of these negative effects (pp. 69–76), including "overreaching," "farcical engineering blunders," to name just a few. However, if the overweighting of risks results in implementation of "safe minimum standards," for example, perhaps it is less undesirable—even positive. Agencies and those providing specifications for restoration projects can help businesses manage risk through active engagement; e.g. incentives built into specifications and contracts might be used to guide how businesses approach restoration. Another option is to promote risk neutrality, where project managers take a balanced approach to risk assessment. This presumes individuals are able to correctly evaluate risk/return trade-offs, which, in the restoration context, might be difficult.

In addition, studies of organizational culture, or the values and beliefs shared by company personnel, identify risk as a cultural value held by people in an organization. Our sample tended to be risk averse because of the nature of the projects—large, highly visible. Counteracting this risk aversion is the notion of learning from failure, considered in business to be a valuable trait in an innovation mindset (Fortune & Peters 1995). Studies of innovative organizational cultures suggest that managers must cultivate a willingness to try new practices that are unfamiliar and perhaps even at odds with a company's existing practices. Known as the "innovator's dilemma" (Christensen 1997), companies' existing competencies and routines can blind them

to new, better ways of doing things, resulting in a dated skill set that lags changing techniques (Leonard-Barton 1992). Moreover, adopting a mindset of experimentation—trying a series of smaller, low-risk experiments in order to gain important knowledge that can be built on over time—is also part of a culture of innovation (Thomke 2001; Slater et al. 2014). Trying new things and having an innovative mindset can help in managing risk and also navigating the disconnect between science and practice.

With respect to the science/practice nexus or "disconnect" (Christian-Smith & Merenlender 2010), Cabin et al.'s (2010) study of the scientist/practitioner gap at the 2009 Society for Ecological Restoration International (SERI) World Conference revealed a disconnect in restoration science versus practice. This difference in perspectives may signify that ecologists do not understand the needs of practitioners or that practitioners ignore the relevant science—or perhaps these practitioners do not let gaps in the science hold them back in their practice. Cabin et al. (2010) further state that "practitioners continue to rely on protocols that they developed themselves before the discipline of restoration ecology rose to its present prominence" (p. 784). For example, the Rosgen (1994) protocol, a seemingly straightforward classification system for river channels, provides restoration guidelines for each of the categories; it continues to be heavily utilized despite considerable research detailing its shortcomings (Kondolf 2006). Our study identified a fear of failure as a reason for using tried-and-true techniques. Moreover, our respondents indicated no real agreement on "best practices" science.

Monitoring was another area where science and practice diverge. Bernhardt et al. (2007) studied restoration practitioners' views of project success and monitoring. They noted that science plays only a minimal role in the practice of river restoration, that very few projects follow a scientific process for monitoring or evaluating success, and that scientific research is unlikely to make its way into restoration practice quickly. Acknowledging reasons practitioners do not rely on best-practices "science" can help identify opportunities to collaborate and to bridge the science/practice divide.

Collaboration between academics and practitioners also could facilitate adopting a mindset of experimentation to gain knowledge over time, consistent with adaptive management (Walters & Holling 1990; Moir & Block 2001). That mindset is important for both businesses and other stakeholders. However, as our data indicate, this mindset is hard to achieve with limited funding and a focus on near-term results.

With respect to on-the-ground implementation, the business literature refers to this group of people as "frontline service personnel" and extensive research addresses how to align their actions and behaviors with management plans and to bring their expertise into the plan (Berry 1995; Singh 2000; Bowen & Lawler 2006). Explicitly acknowledging the pressures that affect on-the-ground implementation can identify ways to mitigate those pressures.

One limitation of our research is that it is context specific. For example, because of its Superfund status, the restoration projects were highly visible, which could have increased the emphasis we found on risk. Moreover, because much of the funding came from the State of Montana, local companies did most of the work. Whether Montana-based restoration businesses are unique in some way, compared to restoration companies elsewhere in the United States, is unknown. Moreover, restoration in other areas of the world may rely on private companies differently than in the United States. Although we used care in ensuring a diverse set of businesses and a multiplicity of perspectives, replicating our study in other geographic locations and with other types of projects would be valuable. Moreover, the degree to which business goals, constraints, challenges, and issues are similar to or different from other institutions and agencies, although not part of our research question, would help delineate the unique role and perspective of business in restoration. Finally, our research hints at interesting hypotheses regarding the role of business in ecological restoration. Designing experiments and survey research methods to test some of our findings with quantitative data would be valuable.

Collectively, the findings from our research suggest that businesses have powerful impacts on ecological and social outcomes. Social-ecological systems (SES) frameworks (Folke 2006) explicitly acknowledge the impacts humans have on ecological systems. While businesses are social entities (i.e. they are comprised of people and organizations), the character and implications of business practices introduce a unique perspective in fully understanding restoration SESs. Although the interface between ecological systems and business is important and often overlooked, our study offers insight into advancing SES theory by explicitly adding the business perspective. This is consistent with Fox et al.'s (2009) framework where ecology iteratively affects and is affected by economic issues. Future studies should consider the role of businesses as a key component of the complex SES in ecological restoration.

Our research on the business perspective of restoration is the first of its kind. The qualitative, open-ended nature of our interviews allowed people to speak freely about the issues they face in managing a business. Balancing ecological and business objectives, managing risk, learning from failure, being open to innovations, engaging in monitoring to gauge project success on multiple dimensions and to improve restoration practice, and understanding the perspective of on-the-ground personnel all present business challenges. Agencies could help businesses address these challenges. For example, more active communication can flesh out stakeholders' views and perceptions of risks and tradeoffs. Businesses also respond well to incentives; agencies could build incentives into restoration contracts to guide businesses to desired outcomes. Clear responsibilities, accountability, feedback loops, and monitoring procedures, as well as education and certification (see Nelson et al. 2017) can also help restoration businesses.

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Supporting Information

The following information may be found in the online version of this article:

Appendix S1. Interview guide.
Appendix S2. Verbatim responses regarding balancing ecological and business objectives.
Appendix S3. Verbatim responses regarding managing risk.
Appendix S4. Verbatim responses regarding the science/practice nexus.
Appendix S5. Verbatim responses regarding tension in using innovative techniques.
Appendix S6. Verbatim responses regarding on-the-ground implementation.

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