Essay

Negative Off-Site Impacts of Ecological Restoration: Understanding and Addressing the Conflict

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Abstract: *Ecological restoration is a key component of biological conservation. Nevertheless, unlike protection of existing areas, restoration changes existing land use and can therefore be more controversial. Some restoration projects negatively affect surrounding landowners, creating social constraints to restoration success. Just as negative off-site impacts (i.e., negative externalities) flow from industrial areas to natural areas, restoration projects can generate negative externalities for commercial land uses, such as agriculture. Negative externalities from industry have led to government regulation to prevent human health and environmental impacts. Negative externalities from restoration projects have elicited similar legal constraint on at least one large-scale conservation project, riparian restoration in the Sacramento River Conservation Area. The negative externalities of restoration that are perceived to be the direct result of specific goals, such as endangered species management, are likely to be more contentious than externalities arising from unintended phenomena such as weed invasion. Restoration planners should give equal consideration to off-site characteristics as to on-site characteristics when choosing sites for restoration and designing projects. Efforts to control externalities can lead to off-site ecological benefits.*

Keywords: conflict, ecosystem services, externalities, landowners, land use, restoration, stakeholders

Impactos Negativos de la Restauración Ecológica: Comprendiendo y Atendiendo el Conflicto

Resumen: *La restauración ecológica es un componente clave de la conservación biológica. Sin embargo, a diferencia de la protección de áreas existentes, la restauración cambia el uso de suelo existente y por lo tanto puede ser controversial. Algunos proyectos de restauración afectan negativamente a los propietarios circunvecinos, creando restricciones sociales al éxito de la restauración. Así como fluyen impactos negativos (i.e., externalidades negativas) desde las áreas industriales hacia las áreas naturales, los proyectos de restauración pueden generar externalidades negativas para los usos de suelo comerciales, como la agricultura. Las externalidades negativas de la industria han conducido a la regulación gubernamental para prevenir impactos ambientales y sobre la salud humana. Las externalidades negativas de los proyectos de restauración han producido una restricción legal similar en por lo menos un proyecto de conservación de gran escala, la restauración ribereña del Área de Conservación Río Sacramento. Es probable que las externalidades negativas de la restauración que son percibidas como el resultado directo de metas específicas, como el manejo de especies en peligro, sean más controversiales que las externalidades resultantes de fenómenos no intencionales como la invasión de hierbas. Los planificadores de la restauración deberían de considerar de igual manera a las características ex situ e in situ al seleccionar sitios para restaurar y al diseñar proyectos. Los esfuerzos por controlar las externalidades pueden conducir a beneficios ecológicos fuera del sitio.*

Palabras Clave: conflicto, externalidades, partes interesadas, propietarios, restauración, servicios del ecosistema, uso de suelo

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Introduction

Ecological restoration reinstates the predominance of historical ecosystem services and functions into socially dominated landscapes. Scientists concerned with environmental problems have long focused on the negative effects of developed areas, such as industrial pollution, on areas supporting important ecological processes in, for example, aquatic ecosystems. Nevertheless, restoration may cause the opposite problem as well: negative effects of reestablished ecological processes on socioeconomic land uses. Unanticipated or ignored negative effects of ecological restoration projects on society, both real and perceived, can have negative consequences for restoration goals (Fig. 1). We examine this problem, drawing on our work with the large-scale restoration efforts in the Sacramento River Conservation Area (SRCA) in northern California (U.S.A.).

Arguments exist that because human impacts on the environment are ubiquitous (e.g., Goudie 1986; Sanderson et al. 2002), there cannot be a clear separation between natural and social areas (Folke 2006). Nonetheless, conflicts can arise over the process of converting areas from a socially dominated application, such as agriculture, to a primarily ecological purpose, such as providing habitat for native plants and animals or restoring hydrological dynamics.

Although restoration projects usually take place on discrete sites, ecologists now widely recognize that processes take place across land-use boundaries (e.g., Schlosser 1991; Allan et al. 1997; Sponseller et al. 2001; Colding et al. 2006). Ecological dynamics at a site influence and are influenced by the site's landscape context (Allan & Johnson 1997; Harding et al. 1998; Marzluff & Restani 1999; Marzluff & Ewing 2001). Several recent studies in restoration ecology build on this principle by identifying positive ecosystem services provided by restored sites to the surrounding landscape (e.g., Carpenter & Cottingham 1997; Lamb & Gilmour 2003). To date, ecologists have paid much less attention to the potential negative impacts of ecological restoration on surrounding landowners. We believe restoration will be more successful if negative, as well as positive, off-site impacts are explicitly acknowledged and considered in restoration planning.

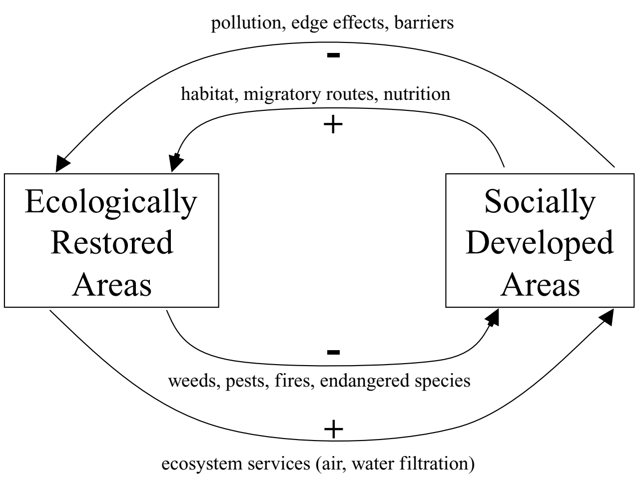

Figure 1. Interdependence of restored and developed areas. The inner effects of restoration have the potential to generate feedbacks from surrounding landowners.

Restoration of ecological processes, rather than preservation of existing ecological processes, is inherently more controversial than conservation in situations where restoration converts land from one socially beneficial use, such as agriculture, to another. In general, impacts of restoration on surrounding landowners are unlikely to directly affect ecological processes on restored sites. Nevertheless, just as physical and biological constraints limit potential restoration outcomes, so do social constraints, such as those resulting from negative attitudes and defensive actions of surrounding landowners. Ecologists often recognize the importance of social factors to restoration goals, but tend to acknowledge related decision making as extremely complex and unpredictable (e.g., Shields et al. 2003).

Social scientists argue for the incorporation of social considerations (e.g., Higgs 1997) and conflict resolution (McGinnis et al. 1999) in restoration projects. Wondolleck and Yaffee (2000) detail the difficulties and opportunities of collaborative natural resource management. Folke et al. (2005) provide a review of the literature on management of systems with social and ecological components. We provide a framework for considering how restoration affects individuals and groups and how they respond to it. A better understanding of those opposed to restoration can lead to cooperative outcomes that ultimately promote favorable ecological and social conditions.

Sacramento River Restoration Conflict

Restoration efforts for the Sacramento River demonstrate the importance of considering nearby land uses. In northern California, under mandate by the state senate (S.B. 1086), the Sacramento River Conservation Area (SRCA) was created to reestablish habitat connectivity for 160 km of the upper Sacramento River. Prior to restoration, 97% of the unforested land in the SRCA was in agriculture (SRAC 1998). The original motivation of the bill was to provide habitat sufficient to support migratory avian and salmonid species. In many ways, implementation of the restoration and conservation project in the SRCA is exemplary in terms of restoration planning with awareness of social impact, and the project is ongoing. Nongovernmental conservation organizations, such as

The Nature Conservancy (TNC) and River Partners, work closely with local, state, and federal government agencies to implement restoration projects. They also seek input from project neighbors. For example, River Partners distributes a survey to landowners adjacent to restoration areas to judge their satisfaction with restoration implementation. Committees and a management board for the SRCA formed that included government, nongovernmental organizations (NGOs), and farmers. River Partners and TNC purchase properties only from willing sellers, pay fair market price, and use local farmers for labor in the restoration activities. Both organizations seek restoration methods and management strategies that will limit the spread of weeds and pests to adjacent lands, including the use of owl and bat boxes and buffer zones, and reestablish native trees (Alpert et al. 1999).

Nevertheless, SRCA restoration activities have encountered considerable local opposition. Problems arise when farmers look at neighboring restored areas and see a landscape they associate with weed and pest production, where there had once been farmland. Local farmers are concerned restoration activities will lead to increased habitat for pests (such as squirrels, deer, or insects), spillover and establishment of endangered species onto their farmland, flooding from channel roughening and levee neglect, and the loss of farmland and farm culture (Wolf 2002; Buckley & Haddad 2006). They are also concerned with the negative effects of restoration of the Sacramento River on revenue and costs to local counties due to lost production and associated tax revenues (Adams & Gallo 2001*a*, 2001*b*). Some neighbors worry about trespassing and other security problems associated with increased recreational use of restored habitat (Jones 2005).

The SRCA Board voted in 2002 to reduce the SRCA from 86,000 ha (213,000 acres) to 32,000 ha (80,000 acres). At this meeting, over 100 landowners spoke out against the SRCA, and 4 of the 7 counties in the SRCA reduced participation (Martin 2002). Colusa County and the city of Colusa voted in 2006 to implement more stringent regulation of restoration projects to protect landowners (Hacking 2006). It appears that for the SRCA, restoration success is limited more by social concerns and the resulting laws, policies, and funding constraints than ecological knowledge and available natural resources.

Restoration and Externalities

Do our experiences in the SRCA extend to restoration in general? The concept of off-site impacts has been explicit in economics since the 19th century, with the idea of effects that are experienced "external" to markets (Marshall 1890). Negative effects are possible via markets as well, such as the situation whereby land acquisition for conservation can influence land prices in ways that might reduce ecological benefits by encouraging development (Armsworth et al. 2006). Socially undesirable outcomes resulting from market mechanisms are often called market failures. Although market effects are not technically externalities, the concept of externalities is used to describe the effects of activities on individuals not directly involved in those activities. A typical example is the effect of industrial effluent discharged into a river on downstream human health. Conservation efforts have focused on the negative externalities of industrial activities on people and ecological processes for some time. Concerns of negative effects of ecological processes on society have been around much longer. Much of the motivation for rural social institutions and behaviors comes from efforts to control the negative effects of ecological processes. Rural communities traditionally remove large predators, prevent floods and fires, and keep weeds and pests away from agricultural activities. The potential of some restoration activities to generate what they are trying to prevent is therefore highly likely to raise opposition. Local people may have personal, family, or cultural memories of these concerns and the importance of staving off their impacts.

Negative off-site impacts of ecological restoration are rarely documented or measured. This leaves surrounding landowners and restorationists to form their own opinions and to act on them accordingly. Conservationists may be hesitant to acknowledge negative off-site impacts because of their tendency to perceive a natural state as the baseline condition. Restorationists are changing a landscape that has been a part of the culture for many generations. The longer a group has historically used and managed an area in a particular way, the more they are likely to want to maintain their status and associated customary rights. The more a group has historically suppressed or removed ecological phenomena, the more likely they are to oppose restoration of those features.

Social and Ecological Compatibility of Surrounding Areas

Restoration activities can be ecologically compatible with surrounding land uses, meaning that surrounding land uses complement the targeted ecological processes. Restoration activities can also be socially compatible with surrounding land uses, meaning that the restoration activities do not impede, and may even benefit, the surrounding land use. When restoration activities are socially incompatible, they create negative social impacts. These impacts are indirect if they are unintended results of restoration activities, such as the spread of disease-carrying insects or invasive weeds. Negative social impacts can be direct if they are due to an intended outcome of restoration, such as endangered species establishment or resumption of natural flow regimes that

	Socially Compatible	Socially Incompatible
Ecologically Compatible	**mutually beneficial** • pest predation (agriculture) • native flowers (suburban) • pollination (residential, agriculture)	**conflict** • endangered species (forestry) • large predators (ranching) • natural flood/fire regimes (suburban)
Ecologically Incompatible	**inefficient/infeasible** • native vegetation (brownfields) • large mammals (suburban) • complete historical ecological assemblages (urban)	**mutually undesirable** • overexploitation/stock collapse (fisheries) • sudden novel climate changes (coastal communities) • ecological disequilibria (forestry, agriculture)

Figure 2. Ecological and social compatibility of ecological processes by land use. Each combination of ecological and social compatibility or incompatibility creates a different likelihood of conflict for a particular process given the existing land use.

involves flooding. Restoration projects that are socially and ecologically compatible with surrounding areas will be the least controversial, whereas those that are not socially compatible and create direct negative impacts will generate the most difficult conflicts to resolve (Fig. 2).

When activities are socially and ecologically compatible with surrounding areas, ecological results are typically desirable to society and the social land uses in the area support the desired outcomes of restoration. Residential areas have the potential to allow important ecological processes to occur, such as pollination (Kremen et al. 2007). Ecologically successful and socially accepted projects are often well publicized by restoration organizations (e.g., removal of the undesirable invasive species tamarisk [*Tamarix ramosissima*]; The Nature Conservancy 2003).

A more difficult situation involves restoration activities and surrounding land uses that are socially, but not ecologically, compatible. For example, reducing habitat for waterfowl is not a goal of community planners, but it might be a consequence of other priorities. Suburban residents value important ecological processes such as air purification, water filtration, and nutrient transportation, but these ecosystem services may be incompatible with socially desirable land uses such as paved roads and manicured lawns. In these situations, negative impacts of particular land uses affect ecological, not social, processes. These negative externalities are indirect in that they are not intended by the social land uses.

Restoration and surrounding land use may be ecologically, but not socially, compatible. Restoration can facilitate ecological processes in a mixed-use landscape where landowners specifically do not want these processes to occur. Efforts to restore prairie habitat in the greater metropolitan Chicago area ran into opposition over the removal of trees, increased fire risk, and loss of habitat for established fauna (Alario 2000). Restorationists must be aware that the public does not always value the amenities from ecological and physical processes deemed important by ecological theory. Certain large-scale processes such as predator activity or natural fire regimes are likely to be viewed as generating direct negative social impacts and are therefore considered undesirable for all but the most passive land uses (Merrill et al. 1999; Freilich et al. 2003; Kauffman 2004). Foresters, ranchers, and farmers want to directly prevent dispersal of insect pests, weeds, and livestock predators and the management limitations associated with endangered species establishment. Advances in agroecology led to techniques for maintaining substantial ecological function on agricultural areas, but traditional methods of agriculture emphasize control through intensive management. Farmers express a range of opinions concerning native habitat and the costs and benefits to their livelihood and personal well-being (Pease et al. 1997; Conover 1998; Hanson et al. 2004). Therefore, although some might see provision of habitat and native vegetation as benefits, others see these attributes as undesirable.

Direct and Indirect Negative Social Externalities

Restoration of processes that are ecologically compatible but not socially compatible can lead to negative externalities being borne by neighboring landowners. When the negative effects generated by restoration are also undesirable to restorationists, we consider the negative externalities indirect. For example, an increase in the mosquito (*Culicidae* spp.) population is not a goal of wetland restoration, but it is often a result (Willott 2004). In the SRCA non-native weeds are undesired by restorationists and farmers alike, but weeds are common understory species at most restoration sites (Holl & Crone 2004). For such indirect externalities, there might be technological solutions. There is room to control some undesirable ecological effects via the design of the restoration project, but it might involve higher costs, longer maintenance periods, and reductions in other desirable ecological processes (Knight et al. 2003). Presumably, if technological solutions to particular problems have not been used, the net on-site ecological benefits of the control technology do not justify the net costs. After including off-site costs and benefits, however, the control costs might be justified. If the combined damage to the restored area and other lands nearby is greater than the cost of prevention, then allowing the negative effects to continue is socially inefficient. For projects involving indirect negative externalities, restorationists are likely to improve overall success by researching mitigation techniques in advance.

When processes intended by restoration activities generate negative externalities, we consider the effect to be direct. Direct negative externalities are more difficult to resolve than indirect. In the SRCA restorationists seek to provide habitat for the valley elderberry longhorn beetle

(*Desmocerus californicus dimorphus*), a federally listed species. Farmers believe the presence of this beetle will restrict their ability to continue particular agricultural practices. Restoration projects commonly provide habitat for endangered species, whereas neighbors may want to avoid the establishment of such species on their own property.

Overall, conflict is likely to increase with increasing incompatibility of surrounding land use, with restoration activities, and with increasing social value of land displaced by restoration and land use negatively affected by restoration. Restoration of waste-disposal or industrial-activity sites is not likely to garner opposition. Unfortunately, the cost of restoration is typically inversely related to the extent of remnant ecological infrastructure. This means restoration of ecologically functional areas is less expensive than that of more developed or degraded areas. The land uses most likely to be negatively affected by restoration are those that are economically productive, such as farming, forestry, and ranching (Marzluff and Ewing 2001), and areas appropriate for these uses are also the most likely targets for restoration on the basis of an on-site cost–benefit calculation.

Keys to Restoration Planning for Off-Site Impacts

Identifying opportunities for both social and ecological gains is a smart and obvious first step that has tangible benefits. Secondary benefits include provision of test cases to reduce uncertainty about outcomes for other risk-averse landowners. Universally desirable sites for restoration projects are sites that are socially and ecologically compatible with surrounding land uses. The next most desirable sites will be those that are ecologically compatible and socially incompatible with surrounding land uses for which affordable techniques exist to mitigate negative off-site impacts with little sacrifice of restoration goals.

A more collaborative, transparent, and potentially concessionary approach becomes necessary for expensive or impossible-to-control indirect negative social effects. These requirements hold even more so for cases of direct negative social effects. Restoration planners and neighbors must openly present their beliefs and uncertainties regarding outcomes to achieve an agreeable compromise. Interviews and surveys of farmers in the SRCA revealed a wide variety of beliefs concerning restoration goals, including fear of water and land grabs for urban areas (Buckley 2004). Some farmers believe restoration is designed to impede other land uses in order to financially force them out of the region by making operations unprofitable. With uncertainty, high personal consequences, and unfamiliarity with other parties, risk-averse neighbors tend to imagine the worst intentions rather than the best. Striving for high transparency of restoration planning goals, processes, and expectations is the best route to reciprocal openness and subsequent collaboration with neighbors.

Early transparent and collaborative planning processes for environmental projects have been successful (e.g., Pfadenhauer 2001). This is because they allow honest presentation of uncertainties and provide means for learning and adaptation as cross-boundary dynamics become understood. Only with a clear understanding of the expectations and priorities of other parties are bargaining processes likely to produce stable outcomes in which no parties feel cheated. Bargaining and game theory show that stable cooperative outcomes require equitably distributed gains as measured from what would happen without cooperation (e.g., Muthoo 1999). At times these expectations of outcomes differ between restorationists and neighbors, but with uncertainty or distrust of research outcomes, accepting neighbor expectations as their measure of damage is necessary. In addition, baseline measurement differences are relevant because neighbors measure from the status quo, whereas restoration planners likely measure from an undeveloped state. The real baseline for measurement must be the state of things if no cooperative outcome can be achieved.

Typically, social planning for conservation and restoration projects is limited to cost–benefit analysis and possibly assessment of local attitudes. Cost–benefit analysis, although useful for certain efficiency tests, lumps all impacts together, regardless of their allocation, thereby ignoring distributive equity effects. By considering options among stakeholders that influence outcomes, and likely behaviors, restoration planning can better consider impacts for all parties. Techniques to identify relevant parties—such as stakeholder analysis (Grimble & Wellard 1997) and social-ecological inventories (Schultz et al. 2007)—provide systematic approaches. Because project and land-management expenditures are irreversible, a socially aware approach can generate outcomes in which all groups are better off than the high-conflict outcome.

Planning outcomes involving landowner demands have been called suboptimal compromises (Shields et al. 2003). Such language assumes a baseline with no other interests in the region and ignores influential groups with different priorities. A necessary first step is to establish trust among stakeholders and to assure them that their concerns will be factored into planning. Considering restoration goals on a continuum of priorities between the ecological and social is necessary for incorporating local concerns and impacts into restoration planning. For example, by scaling down the extent of uncontrolled vegetation permitted, neighbors who might be harmed are likely to be supportive and potentially contribute to project goals. Consequently, society can achieve more long-term, landscape-scale ecological function. Mutual recognition of differences and interdependence might also allow compromises that, while not satisfying every demand, allow all parties to benefit in some way. A better understanding of others' viewpoints might provide broad solutions to land-use problems, such as control of urban sprawl.

Action and Research Priorities

Interacting with locals as if their beliefs are those of restorationists is likely to lead to distrust and conflict, particularly if interpreted as disrespectful to local knowledge. Restorationists' beliefs, scientifically based or not, might bear little weight (if any) because local landowners generate expectations of off-site impacts. As long as the expectations of negative externalities by landowners go untested, their positions will be no less tenable than expectations that ecological restoration generally provides benefits to society. A challenge and responsibility facing biologists is to reduce the uncertainty regarding off-site impacts of restoration activities. Paying attention to negative off-site impacts of restoration might initially seem like bad marketing, giving support to opposition groups when funding and permitting is already a struggle. But openly addressing the problem is the only way to build the trust necessary for landscape-scale planning.

For site-specific recommendations restorationists must consider past actions and indicators of expectations among neighbors. Past behavioral responses to new or potential threats to productivity or livelihood are good starting points. Market and production characteristics can indicate a predisposition toward a certain type of decision making under uncertainty. Some product markets demand frequent innovation and differentiation, leading to an atmosphere conducive to trying new things. Other markets put highest priority on consistent product and delivery, with any deviation posing a potential disaster, particularly when profit margins are narrow, as for small, conventional farms in the United States. Therefore, markets driven by product differentiation and innovation are likely to be more open to experimenting with and even benefiting from incorporation of ecological processes. Actors in markets (such as conventional agriculture) with highly uniform products and little room for revenue loss would likely be less willing to undertake options that have highly uncertain expected outcomes (Kahneman & Tversky 1979; Kahneman et al. 1991).

The areas of greatest belief discrepancy between restorationists and landowners should be a primary focus of research. Differing planning time scales can also lead to seemingly inconsistent expectations because farmers must consider short-term effects of restoration projects, whereas ecologists focus on more long-term conditions that involve fewer weeds and pests.

Some beliefs about negative off-site impact are likely legitimate or at least not refutable. Control techniques might be expensive to maintain or require reductions in other priorities, but lead to better long-term, landscape-scale restoration success. Buffers successfully filter negative environmental externalities from social activities, for example, riparian vegetation strips reduced water contamination (Snyder et al. 1998). Incorporating buffers into planning to control negative social externalities from restoration has begun in the SRCA.

Conclusions

Much of the movement to establish environmental legislation has targeted reduction of negative externalities that pollute and damage ecosystems. Now some of the same private-property arguments made by polluting commercial land uses might be used in support of restoration activities to avoid the costs of prevention. Just as industrial pollution elicited regulating legislation, so have off-site impacts of restoration in the SRCA. And just as limits on negative environmental externalities are somewhat motivated out of concern for individuals in the face of large corporations, so now can the negative social externalities pit small farmers against large international conservation organizations.

Although collaborative success stories between restoration and other land uses provide important examples and reduce uncertainty, conflicts must be addressed directly. An effective approach for contested situations will involve open acknowledgment of concerns and problem solving with extensive community involvement. When direct, zero-sum conflicts occur, restorationists must be willing to compromise and recognize the legitimacy of the concerns of others. Failing to address negative off-site effects can not only inhibit the achievement of project goals but also reduce the acceptance of future efforts.

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