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Review paper

Land use planning: A potential force for retaining habitat connectivity in the Greater Yellowstone Ecosystem and Beyond

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HIGHLIGHTS

- The GYE could become an irreversible habitat island for the grizzly bear.
- Planning levels treated: national, regional, federal agency, state, and county.
- Planning tools treated: purchase, easements, zoning, incentives, boundary authority, exchanges, legislation, and annexation.
- Federal programs and initiatives supportive of regional planning are listed.
- A critical element is county zoning to protect the habitat of large carnivores.

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ABSTRACT

The grizzly bear (*Ursus arctos horribilis*) population in the Greater Yellowstone Ecosystem (GYE) is perceived to have been isolated from the population in the Northern Continental Divide Ecosystem for a century. Better land use planning is needed to thwart progressive intra- and inter-ecosystem habitat fragmentation, especially due to private land development. The dilemma of private lands being intermixed in large landscapes is addressed. This review attempts to identify some land use planning levels and tools which might facilitate dispersal by the grizzly bear and other large mammals. The planning levels discussed include national, regional, state, county and municipal, and federal land management agency. Specific potential federal tools mentioned include zoning, Landscape Conservation Cooperatives, the Endangered Species Act, beyond boundary authority, land exchanges, less-than-fee acquisition and other incentives, the Northern Rockies Ecosystem Protection Act, and federal land annexation. Besides summarizing existing recommendations, some derived observations are offered.

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> We have confidence that, because of their mutual concern, such activities [harmful land use] in the vicinity of the public lands will be appropriately regulated by state and local authorities in close cooperation with the Federal agencies. Public Land Law Review Commission (1970, p. 82)

1. Introduction

Yellowstone National Park, and indeed protected US landscapes of all types, attracts large and diverse groups of people (McGranahan, 2008). As these people decide to settle nearby, their movement towards protected landscapes increases development rates outside some protected area boundaries (McDonald et al., 2007); this is documented, for example, at Indiana Dunes National Lakeshore, Indiana (Gimmi et al., 2011). Such increasing development causes habitat fragmentation and loss, judged the most important factor in the decline of biological diversity (Vitousek et al., 1997). Since many recognize that solutions to biological problems like habitat isolation lie in the social, cultural and economic realms (Machlis, 1992), I suggest that land use planning is a key solutions. As things now stand, however, the beginning quote by the PLLRC more than 40 years ago may have been overly optimistic about the potential role of states and local governments in regulating land use adjacent to federal property.

Today, there is increasing discussion about how to conserve large landscapes (McKinney et al., 2010) and the number of different initiatives in the West is inspiring (McKinney and Johnson, 2013). We are rapidly learning that these protected areas may lose their ecological integrity, unless various negative influences outside of their boundaries are dealt with (Shafer, 1990, 2012). The Greater Yellowstone Ecosystem (GYE), a 7.3–14.5 million ha tract in Montana, Idaho and Wyoming, represents one of the fastest growing areas in the nation (Gude et al., 2006). From 1970 to 1999, human population increased by 58% and land supporting exurban development increased by 350% (Gude et al., 2006). Construction of rural homes has been the primary form of land use change in the GYE (Rasker and Hansen, 2000). In the Yellowstone PACE

(protected-area-centered-ecosystem), 68% of the natural habitat on private land has been removed (Piekielek and Hansen, 2012). Under a simulated boom scenario, all privately owned natural landscape in the GYE will be developed in 40 years (Gude et al., 2007).

There is progressive encroachment at the boundaries of many other units of the US National Park System. For 57 of the largest national parks during the 1940s to the present, outside housing density increased 329%, which was much higher than for areas without nearby national parks (Davis and Hansen, 2011). During the period from 1970 to 2030, residential housing development will have reduced the buffer zone area of US core reserves by 22% (Wade and Theobald, 2009). It is not surprising that an independent NPS advisory group consisting of land managers and environmental administrators concluded that the following was one of their top five recommended actions: "increase conservation efforts in lands that surround park units" (Hodsoll et al., 2010).

Nevertheless, the GYE still remains sparsely developed, compared to regions surrounding some other US national parks (Davis and Hansen, 2011; Piekielek and Hansen, 2012). National forests buffer many of the western US national parks to some extent. Compared to the situations of other US national parks in other regions, however, the GYE could have an advantage, since most of the land is federal (Hansen, 2006).

Some of the literature written about the GYE during the last thirty years addresses land use outside the boundaries of Yellowstone National Park. However, while researching the inter-ecosystem movements of grizzly bears (*Ursus arctos horribilis*) (Shafer, 2013), I found no up-to-date document addressing potential GYE land use planning options in a holistic fashion. Furthermore, Gude et al. (2007, p. 1016) provided a convincing argument that current growth management policies will offer meager protection for the GYE's biological diversity. Taking a broader look at the American West, Travis (2007, p. 65) maintains land use regulation in most the American West of it is "weak, fractured and uncoordinated".

My primary goal is to identify approaches to land planning that, separately or combined, may better protect the GYE's biological diversity with special emphasis on the grizzly bear. The bear represents a good example because the following characteristics give it status: being threatened, wide-ranging, and sensitive to development; having flagship status and having the potential to serve as an "area umbrella" for some other terrestrial park species (Lambeck, 1997; Noss et al., 1996).

This review must: (1) communicate with a diverse audience, (2) include pertinent law articles, (3) provide a broad look at current planning levels and approaches, and (4) identify available options regardless of the current national political climate. I also identify some factors that would thwart regional land use planning. I focus more attention on federal actions that would assist the long-term biological management goals of Yellowstone National Park. We shall not dwell on what the US Forest Service (USFS) should do to make land use in national forests more compatible with large mammals moving in and out of the two national parks.

2. The Greater Yellowstone Ecosystem

The area of the GYE, sometimes called Greater Yellowstone Area, was first delineated by Craighead (1977) as representing continuous essential habitat for the grizzly bear. Since then, documentation of the size of the GYE varies, based on the source: 7.3 million ha (Glick et al., 1991), 10.8 million ha (Noss et al., 2002) and 14.5 million ha (Gude et al., 2006). Using the 18 million ha GYE delimitation, 81.7% of the land is in federal ownership (Glick et al., 1991). The federal agencies have given the GYE *de facto* recognition (Keiter, 1989). Using the GYE 7.3 million ha spatial delineation of Glick et al. (1991) (Fig. 1), it contains two national parks (e.g. Yellowstone and Grand Teton); one national parkway (e.g. John D. Rockefeller Memorial Parkway); parts of six national forests (e.g. Bridger-Teton, Shoshone, Caribou-Targhee, Gallatin, Custer, and Beaverhead-Deerlodge); three units of the National Wildlife Refuge System (e.g. National Elk Refuge, Red Rock Lakes NWR, and Gray's Lake NWR); one Indian Reservation (e.g. Wind River), and Bureau of Land Management (BLM), Bureau of Reclamation, state, municipal, and private lands in Wyoming, Montana and Idaho.

Twenty-eight different federal, state and local government agencies administer the GYE (Clark and Harvey, 1990). Land ownership by percentage, after adopting a socio-economic GYE delimitation consisting of 20 counties at 14.5 million ha, is as follows: private 32%, USDA Forest Service 32%, USDI BLM 19%, national parks 7%, tribal lands 5%, and state lands, wildlife refuges, and other federal lands 5% (Gude et al., 2006). There were more than 370,000 permanent residents (2.54 individuals/km^2) in this area as of 2000 (Gude et al., 2006). Such a patchwork of ownership is understandable given the size of the GYE. Nevertheless, no one organization has the role of determining the ecological impact of development within the GYE or attempts to regulate it (Glick et al., 1991). From a biodiversity conservation standpoint, such an organizational plethora is problematic.

The Greater Yellowstone Coordinating Committee, a federal body now 54 years old, has the task of encouraging coordination among federal land management agencies on topics like grizzly bears, whitebark pine (*Pinus albicaulis*), aquatic ecosystems, invasive species and climate change. The Interagency Grizzly Bear Study Team has been active since 1973 (http://nrmsc.usgs.gov/research/igbst-home.htm). The Committee and Yellowstone National Park may try to influence development or management on private land but they cannot dictate what shall be done.

In the GYE, Gude et al. (2007) used existing data bases to predict that exurban development would impact bird spots, riparian areas, migration corridors and irreplaceable areas by 2020. Agricultural and home development already occurs in valley bottoms (Gude et al., 2006) used by many species. The GYE has been described by Barbee and Varley (1985) as an ecological island which, if taken literally, is not good for some dispersing large mammals. Such a situation demands our best thinking in order to thwart additional habitat loss using more effective land use planning approaches.

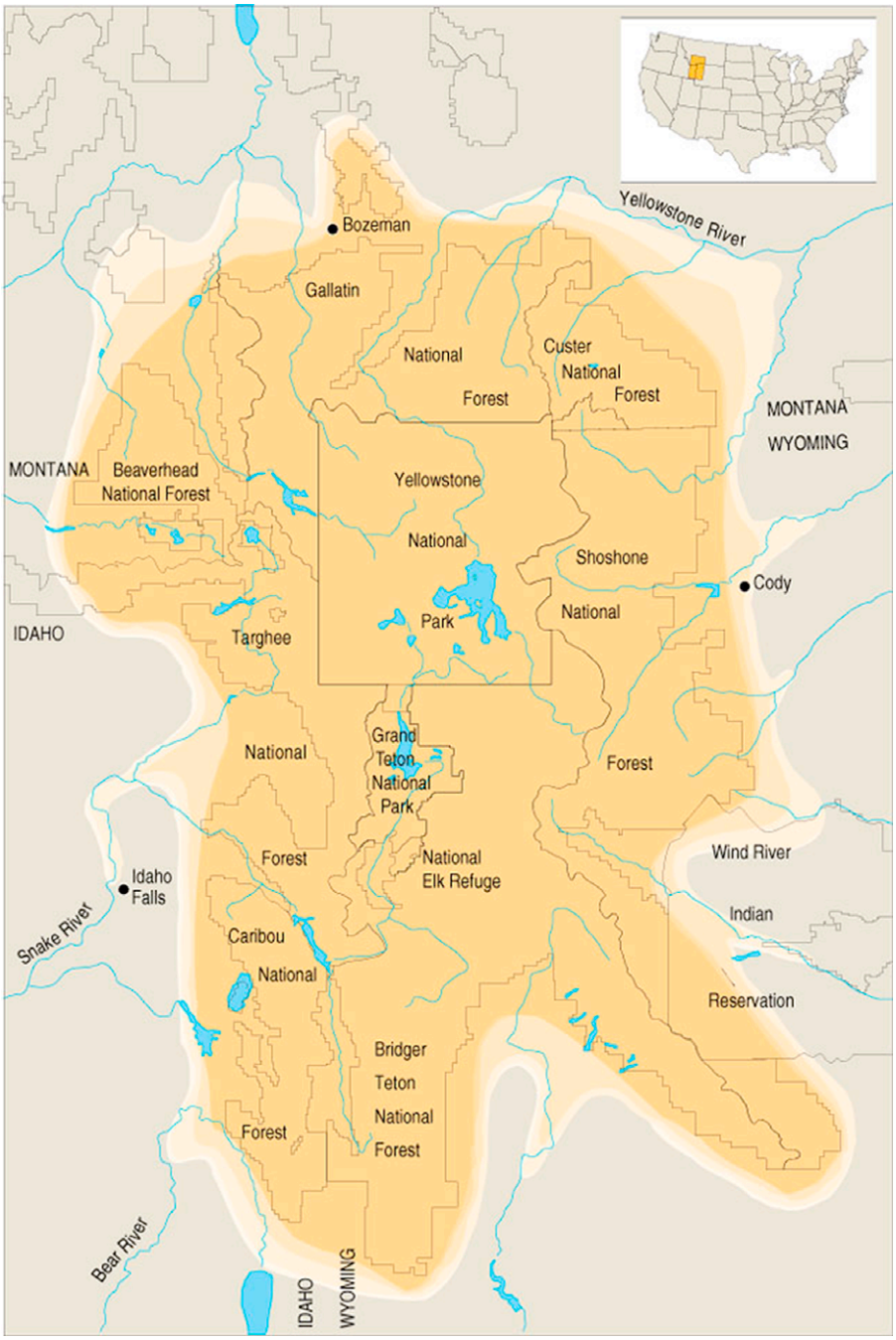

Fig. 1. The Greater Yellowstone Ecosystem.
Source: From Glick et al., 1991.

3. Land use planning

Land use planning has become an accepted area of academic study (Platt, 2004), although its practice remains a contentious topic in the US (Diamond and Noonan, 1996). Unfortunately, many land planning decisions are still made with little concern about their ecological impacts (Beatty, 2000; Dale et al., 2000). Peck (1998) provides excellent guidance on planning for preserving biological diversity. Craighead and Convis (2013) focus on modeling and GIS to implement conservation biology concepts, which they call "conservation planning". Travis (2007) thought that environmental planning had achieved little in thwarting the negative results of western growth, including exurbanization. Howe et al. (1997) and Probst and Rosen (1997), on the other hand, provide some positive outcomes. Land use planning and conservation biology have

different roots (Nassauer, 2006) but not always the same goals. Some of the following planning levels (e.g., national) should provide some perspective for the more GYE-relevant levels (county/municipal and federal) that follow.

3.1. National planning

According to Bruce Babbitt (2005), a contemporary moment in American land use planning starts with the late Senator Henry Jackson who introduced the Land Use Policy and Planning Assistance Act (S.3354) on January 29, 1970 (Daly, 1996). It passed the Senate in 1972 and 1973 while the companion House bill was defeated in 1974 (Babbitt, 2005). The original Senate bill offered a grants program to states and local governments, a national data base in land use, and an Office of Land Use Policy Administration in the Department of the Interior (Travis, 2007). President Jimmy Carter introduced a similar bill in 1971 called the National Land Use Policy Act of 1971 (S 992 and HR 4332) (Reilly, 1971). Note that S. 3354 asked the states to make sure that incompatible land use did not damage nearby federal land, like national parks and wildlife refuges (Daly, 1996). None of it became law. Senator Jackson's own words are worth repeating (Daly, 1996, p. 36):

> To a very great extent, all environmental management decisions are intimately related to land use decisions. All environmental problems are outgrowths of land use patterns. The collective land use decisions which the nation makes in the future will dictate our success in environmental management; and the land use decisions of today will shape the environment future generations will enjoy.

Some conservation biologists argue that the US is in great need of national land use planning (Baldwin and Trombulak, 2007). But according to one legal observer, the time has not yet arrived (Kayden, 2000). The 1970s legislation described above was attacked by the US Chamber of Commerce as a threat to private land rights (Wildermuth, 2005). Nevertheless, the federal government, if absolutely necessary, can "preempt most state and local land use laws" (Tarlock, 2000, p. 516). Although the federal government was responsible for many positive initiatives to both develop and conserve the West in the 1960s (Udall, 1964), it would be highly controversial whether that level of government should play a major role in thwarting the continued fragmentation of the GYE.

3.2. Regional planning

Effective regional planning in this country remains very rare (Platt, 2004). Milder and Clark (2011) observed that regional authority or coordination nationwide is weak or absent. More than 40 years ago the Public Land Law Review Commission (1970, p. 64) observed there was little comprehensive regional planning and recommended that states come together and create regional commissions to assemble state and local planning into a continuum with Federal land use planning. To have effective regional planning, local land use plans must be in place which specifies region-wide goals (Nolan, 1993). Callies (1994) reviews how ten states initiated state-wide or regional land use planning. Indeed, to have a regional plan work, there must be coordination between cities and counties (Gude et al., 2006). Travis (2007) endorses investigating using the power of Councils of Governments. These Councils of Governments are regionally-focused bodies usually serving several counties. The Greater Yellowstone Coalition (a private group created in 1983) does lobby to effect change on private land and incompatible proposed uses on federal land.

Some land trusts have a regional perspective and do their best to purchase critical private lands. Some business organizations seek to lessen direct environmental impacts (e.g., Yellowstone Business Partnership). Ideally, the federal or state government should complete an ecological assessment (see Bottrill et al., 2012) before attempting to develop land. Noss et al. (2002) mounted an assessment of the GYE which helped identify significant conservation targets needing protection. An NPS policy states that parks should "participate in local and regional scientific and planning efforts" (National Park Service 2006, p. 43) but involvement in regional land use planning in the GYE is less common than for scientific endeavors. More effective regional planning seems a possibility for the GYE, but the states, counties and municipalities should come onboard as a coordinated team.

3.3. State planning

The federal government has not embraced land use planning because it viewed private land use regulation as the domain of states and local governments (Karkkainen, 1997, p. 57). In *Kelo vs. New London (04–108) 545 US 469 (2005)*, the Supreme Court conceded that regional planning is a state issue. Sharing power with the states can potentially be achieved through federalism (e.g., Coastal Zone Management Act of 1972 (16 U.S.C. §§1451–1464); compacts (e.g., Delaware River Basin Compact) and Trust Arrangements (e.g., Valles Caldera National Preserve)) (McKinney and Harmon, 2004, pp. 189–196). States can also partner in implementing the Endangered Species Act (Arha and Thompson, 2012). However, although State governments have the authority to protect public land through public trust and wildlife trust doctrines, in practice their clout is limited (Wilkosz, 2010, p. 65). As Keiter (1993) explained, Congress rarely relies on state law to protect national parks.

In their article about controlling the ecologically destructive impacts of exurbanization, Esparza and Caruthers (2000) perceived that land use planning in the rural Mountain West would be most successful when initiated at the state level. They understand that State law is more powerful than local law unless state authority was precluded by specific statute or state constitution (Weiland, 2000). Some states conduct statewide land use planning and expect local governments to comply (Haeuber and Hobbs, 2001). Schneebeck (1986) concluded that Wyoming state legislation is inadequate to deal with

the threats facing the GYE grizzly bear because States have limited jurisdiction over what happens on federal property. One problem is that municipal and county governments often lobby against state planning, or any legislation that facilitates regional cooperation, because it reduces local control (Travis, 2007).

Western states are getting involved in land use planning to protect biological diversity. The Western Governor's Association unanimously approved a resolution (07-01) entitled *Protecting Wildlife Corridors and Crucial Habitat in the West* in 2007. The decision also instructed the Association to identify key wildlife migration corridors and crucial habitats and recommended policy options to conserve them. By June 2008, the Association had adopted a report entitled *Western Governor's Association Wildlife Corridor Initiative* (Anonymous, 2008). An MOU was signed with the Department of Interior (DOI), Department of Agriculture (DOA) and the Department of Energy (DOE).

Better state planning then may also be a possibility, but getting states to plan together remains a significant challenge. GYE state land use planning laws and county regulations has been tabulated (Greater Yellowstone Coordinating Committee, 2008, 3-1 to 3-20). However, having a state wildlife action plan, for example, is no guarantee that habitat will remain unfragmented. A review of existing state plans found that only 30% even mentioned habitat connectivity (Lacher and Wilkerson, 2014).

3.4. County and municipal planning

Any authority that allows local governments to make land use decisions usually stems from state enabling laws and is expressed in the form of zoning and growth management legislation (Breggin and George, 2003). The zoning approach spread to the county level after World War II (Kuperberg, 1978). With an origin in conservation biology, there are two types of local zoning that would benefit national parks: "corridor" zoning and "concentric" zoning (Wilkosz, 2010, p. 221). Every county bordering Yellowstone National Park has a comprehensive land use plan (Glick, 1999). This does not mean all these plans are good, enforceable, or even followed. Private land in Teton County, Wyoming, consists of only 3% of the land base, yet the County does have a comprehensive plan limiting development (Keiter, 1991, p. 9). When the county commissioners of Gallatin County, Montana, approved a plan of development along the western border of Yellowstone National Park, the Greater Yellowstone Coalition took them to court because their activities ignored the welfare of the park biota (Travis, 2007). Unfortunately, county planning is conducted largely in isolation from the activity of other GYE counties (Hernandez, 2004).

According to Gude et al. (2006, p. 148), 15 of the 20 GYE counties have no county-wide zoning plan, and four counties have no full-time staff planners. Furthermore, in 16 of the 20 counties, current zoning districts had an influence on less than 10% of the newly constructed homes (Gude et al., 2006). The NPS waded into these issues when development was within 2 km of the park and affected species like the grizzly bear (Compas, 2007). Compas (2007, p. 286) concluded that the presence of Yellowstone National Park had little influence on changing planning practices and other areas of decision making in Gallatin County. In that county, planners may have a master plan but their voice is only advisory. The County Commissioners, typically local businessmen, make the final decisions and development trends have not declined (Johnson, 2001). In other counties, decisions are also made by city councils and town boards, also usually local businessmen (Brody, 2003). On the other hand, as Travis (2007, p. 65) explained, "But a great deal of land use change in the West is occurring outside zoned areas, under the purview of very general county comprehensive plans (if any plans at all) that are only advisory, not compulsory…" In fact, "Professional planners recognize this problem and have pushed state and local governments across the West to make comprehensive plans more legally binding" (Travis, 2007, p. 220).

Some municipal governments in the GYE have taken positive initiatives in terms of preserving open space. Red Lodge, Montana, developed a town master plan and conserved thousands of acres of ranchland with conservation easements (Glick and Alexander, 2000). The town of Jackson, Wyoming, created a land use plan in 1995 that includes local regulations and financial incentives to conserve private property (Howe et al., 1997). Many national park "gateway communities" are attempting to manage their growth in more aesthetically pleasing ways (Howe et al., 1997; Probst and Rosen, 1997) and tools to do so have been identified (Steer and Chambers, 1998).

Specific policies to manage *urban growth* include regulation, (e.g., development moratoria, rate of growth controls, small-lot zoning, green belts, urban growth boundaries), and incentives, (e.g., development impact fees and taxes). Policies to protect *open space* also include regulation (i.e. subdivision exactions, cluster zoning, large lot zoning, mitigation banking, and concentrating rural development), and incentives (i.e., agricultural districts, transfer of development rights, use value tax incentives) (Bengston et al., 2004).

Since GYE county governments are in the best position to control private development, this level of government has the greatest potential to thwart damaging exurban sprawl. But private landowners in this region typically do not like regulations and the counties usually respect that viewpoint. It is a perspective tempered by needing property taxes to run the county (Fig. 2).

3.5. Federal land management agency planning

The most "highly developed" land use planning in the US, according to Culhane and Friesema (1979), is conducted by federal land management agencies. What they do is fundamentally different from planning by urban and regional political bodies. A federal plan is central to the agency mission; it represents a decision-making framework; it is decentralized and it has both technical and political elements (Culhane and Friesema, 1979). The key to a "successful" agency plan may be the degree to which it balances competing political agendas (Culhane and Friesema, 1979, pp. 73–74).

Fig. 2. GYE ranch up for subdivision. Photo by the author December 2010.

Congress did not require systemwide planning for US national forests until 1974, after the Forest and Rangeland Renewable Resources Planning Act (88 Stat. 476; P.L. 93–378) became law (Coggins, 1990). The subsequent National Forest Management Act of 1976 (NFMA) (90 Stat. 2944; P.L. 94–588) required the USFS to include "the interested public" in any planning activity (Wagner, 2006) parroting the intent of the National Environmental Policy Act of 1969 (83 Stat. 852; P.L. 91–190). BLM is required to produce plans as a result of the Federal Land Policy and Management Act of 1976 (90 Stat. 2744; P.L. 94–579). USFS and BLM plans are legally binding, while those of NPS and the USFWS are not (Coggins, 1990). As a result of NFMA, the USFS is required to coordinate its forest planning with other agencies, states, and local governments (Culhane and Friesema, 1979) but it alone retains the authority to make the final decisions (Hart, 1995). Sometimes a simple Memorandum of Understanding (MOU) can facilitate data cooperation between federal, state and county authorities (Glick and Clark, 1998). An MOU currently exists between GYE federal land management agencies and Gallatin County, Montana, to facilitate collaborative land use planning (Glick and Alexander, 2000, p. 200).

The focus of USDA USFS planning may be changing. One facet of the USFS's new *Open Space Conservation Strategy* is to "acquire and exchange lands within National Forest System boundaries to reduce islands and fingers of urban development within wildlands" (US Forest Service, 2007, p. 11). A 2012 USFS planning rule (76 Fed. Reg. 8480, 8482 Feb. 14, 2011) sought forest plans that would "protect, connect, and restore" national forests and grasslands (Nie, 2013).

One way to facilitate local citizen input into federal land management decision making is by creating place-based or community-based initiatives. Examples include the Swan Citizens' ad hoc Committee, Swan Valley, Montana; the Henry's Fork Watershed Council, Southeastern Idaho; and the Beaverhead County Community Forum, Southwestern Montana (Cestro, 1999).

Back four decades ago, the Public Land Law Review Commission (1970, 82) seemed optimistic about the prospects for regulating outside-boundary land use that could cause harm to public lands (see quote on first page). However, the Commission also said, "If cooperation is not prompt and successful (by local and state governments), the agencies should be empowered to take direct action in furtherance of the preservation of the public land environment" (p. 82). They have not been so empowered. Some ongoing federal activity listed below may offer programs that could provide assistance. Before moving to specific land management federal tools, we shall treat one critical natural resources management outlook.

4. Ecosystem management, an overriding philosophy

4.1. Definition and adoption

Cross-boundary management and land use planning together provide one aspect of ecosystem management, a vision grounded in science. It has been embraced as the new hope for managing large landscapes (e.g., Sexton et al., 1999). While there is no widely accepted definition of ecosystem management, its basic concerns include managing using an ecosystem perspective; looking beyond political and administrative boundaries; managing for the entire suite of biological diversity; data collection; monitoring; adaptive management; interagency cooperation; institutional change; management identifying humans as part of nature; and values (Grumbine, 1994). Also see Christensen et al. (1996). It can apply to any large landscape regardless of ownership. Although the concept was derived from thinking on the federal level, implementation demands action at the local level (Brody, 2003).

In his own characterization of ecosystem management, Grumbine (1994) identifies a set of goals that will ultimately overcome the weaknesses of the traditional natural resources management paradigm. Ecosystem management, a "public

policy idea" (Freemuth, 1997), was adopted in principle by 18 US federal land management agencies (Morrissey et al., 1994). The key ones (NPS, USFS, USFWS and BLM) signed an MOU in 1995 to support it (Federal Interagency Ecosystem Management Task Force, 1995). But while the Clinton Administration tried to promote it (Frampton, 1996), members of Congress never fully embraced the concept. Each agency defined the concept differently (Haeuber, 1996) (from Shafer, 2010).

4.2. Regional scale management and institutions

Regional coordination for the Yellowstone area, one aspect of ecosystem management, is not new. As early as 1917, Henry S. Graves, Chief of the USFS, spoke out in favor of better coordination between the national forests and Yellowstone National Park (Graves, 1917, p. 192). The Park, after the creation of the Greater Yellowstone Coordinating Committee, has been experimenting with regional scale management since the 1960s (Clark et al., 1991). However, one valid criticism of ecosystem management in the GYE involves the basic delineation of the park itself: "How could 'ecosystem management' work if the park is not an ecosystem?" (Chase, 1987, p. 42). The fact that the park does not contain enough space for its migratory ungulates, for example, has been recognized since 1882 (Craighead, 1991, p. 32). While some critics maintain that the legal framework for ecosystem management does not exist (Coggins, 1995). Keiter et al. (1999) argued that existing law contains considerable authority in the interim.

4.3. Vision Document

The GYE "Vision Document" represented an attempt to implement ecosystem management before the concept joined the land management lexicon. The Wyoming legislature passed a resolution in 1991, demanding that the Document, written mostly by NPS and USFS on behalf of the Greater Yellowstone Coordinating Committee, be withdrawn. Member objections to it were clearly stated in their resolution, "(the) Vision document will create a de facto Yellowstone National Park management philosophy on national forests, diminishing or totally excluding multiple use activities" (H.R.J. Res. 16, 51st Leg., Gen Sess. (Wyo. 1991), quoted in Freemuth (1997)). Basically, commercial industry representatives opposed restricting multiple use of national forests, because they fear that such regulation might limit future extraction opportunities. Other reasons for opposition are found in Pahre (2011a,b). After the Document was replaced with a bland memo, nothing surfaced to replace it (Lynch et al., 2008, p. 831). For more details about this collision of values, see Freemuth and Cawley (1998), Litchman and Clark (1994) and Clark and Harvey (1990).

However, the Vision Document was not a land use plan. And the success of another Vision Document might be doomed unless a much more aggressive approach to public outreach can be mounted (Lynch et al., 2008). The same special interest groups will likely oppose another attempt to produce such a plan. The ideal of achieving consensus (Innes, 1996) for an area with the socioeconomic diversity of the GYE may be wishful thinking. Even during the 1883 debates on extending the park's boundaries, there were protests from neighboring ranchers, miners and others (Ise, 1961, p. 4). Ecosystem management in the traditional sense may not cure the ills of the GYE (Goldstein, 1992), while land use planning, an underemphasized component, might make greater inroads.

5. Federal planning tools

5.1. Zoning

5.1.1. Buffer zone concepts

As two scholars said, "There are few studies that test the effectiveness of buffer zones, and most of those have focused on the socioeconomic as opposed to the ecological buffering functions" (Heinen and Mehta, 2000, p. 148). Buffer zones have been portrayed in an *ecologic* sense like offering land use restrictions that reduce biotic stress to a core area, e.g., thwarting outside boundary groundwater withdrawal that could lower the water level in a reserve (Schonewald-Cox, 1988). The ideal buffer zone for a developed country like the United States would guard against the potential impacts of mining, oil and gas extraction, logging, geothermal exploration, water development projects, commercial resorts and private home building. Any such expectation is unrealistic (Shafer, 1999). These threat *sources* create biotic *stresses* that result from pollution, noise, surface water diversion, groundwater depletion, habitat fragmentation, entry of exotic species, and poaching. Martino (2001) correctly pointed out that there is no current accepted definition of "buffer zone" regarding its presumed ecological stress reduction function. This may be because the buffer zone idea has thus far evaded adequate conceptualization.

The goal of an effective ecological buffer zone would be to increase the width of a protected area, so that the conditions of exterior and interior habitats are similar. A second goal would be to stop or dampen lateral fluxes generated by land use outside or adjacent to the buffer zone. In lay language, these lateral fluxes have been called the "spillover effect" (Karkkainen, 1997, p. 98). A buffer zone is not necessarily land adjacent to a reserve as portrayed by many authors (e.g., Defries et al., 2005; Zaccarelli et al., 2008) but can be a set of land use restrictions (after Schonewald, 2001). Designating a wilderness area then is creating a land use restriction.

Back before 2000, Groom et al. recognized that "buffers have not been a traditional conservation element in North America" (1999, p. 192). This was the situation for US national parks (Shafer, 1999). Indeed, the absence of buffer zones has

necessitated adding them as a sort of treatment solution after problems emerged. Examples include the eastern edge of Everglades National Park, Florida in 1989 (Ansson, 2000), and more of the watershed of Redwoods National Park, California in 1978 (Agee, 1980). In both cases, the added buffer zones were actually incorporated inside the park boundary later on. Experience until now informs us that without buffer zones, we can look forward to inevitable encroachment on our protected areas (Gascon et al., 2000).

5.1.2. Biosphere reserves

The UNESCO Man and the Biosphere (MAB) Program was initiated in 1971 as an outgrowth of the 1968 Biosphere Conference. Project 8, Biosphere Reserves, was one of the 12 major MAB research themes. In 1976, before MAB became operational, some expert panels drafted guidelines on configuring biosphere reserves (United Nations Educational, Scientific and Cultural Organization, 1974). Buffer zones and transition areas are intended to shield the core area from man's activities, to allow more space for wide-ranging mammals and larger populations of rare species, and to encourage education, tourism, and manipulative research.

Worldwide, surrounding land use often prohibits a manager from turning a protected area into a model biosphere reserve in terms of spatial configuration (Hough, 1988). Human activity in a biosphere reserve's buffer zone is usually outside of the reserve manager's authority to make land use changes (Newmark and Hough, 2000). Price (2002) reports that about half of the world's biosphere reserves have no buffer zone or transition area around the core area. Some countries do designate all three zones but 80% of the total area of post-Seville biosphere reserve land was not protected (Ishwaren and Persic, 2008). In countries like Mexico, however, the biosphere reserve model has been used to create many new protected areas with effective buffer zones (Figueroa and Sánchez-Cordero, 2008). Biosphere reserves in the US are not replicates of the model because in most instances only the core national park has been designated. Yellowstone National Park was designated a biosphere reserve in 1976 but this biosphere reserve encompasses *only* the national park and none of the adjacent land. The practice of designating US national park biosphere reserves in this manner was consistently the case except for one, Mammoth Cave National Park, Kentucky (from Shafer, 1999).

Both Brunckhorst (2000) and Karkkainen (1997, p. 100) consider the biosphere reserve model the best one for managing protected areas. The problem surfaces when trying to turn an existing protected area into a model biosphere reserve. In affect, the ultimate feasibility of making the larger GYE into a model biosphere reserve was determined by the history of what happened in that region: private land development. Towns near the boundaries of Yellowstone National Park, private development in some national forests and the explosion of private home sales on nearby one-time ranches makes serious consideration of this option seem problematic at this point in time. This model biosphere reserve approach touts cooperation as the key management tool but experience teaches us that some form of land use regulation next to the core area is needed. One IUCN land use expert argued that buffer zones should be protected by legal sanctions (Lausche, 1980). One less intimidating option would be the creation of "special nature districts" governed by private landowners for the zones outside the biosphere reserve core area (Elmendorf, 2003).

Buffer zones have a social stigma in the US. Anderson (1988) argues that imposing park buffer zones on states or private landowners would likely represent a compensatory regulatory taking and thus an improper use of federal authority. Karkkainen disagreed, arguing that if the government allows viable economic usage on any private lands in the outer concentric zones, the takings doctrine should not apply (1997, p. 103). Sustainable development in the outer biosphere reserve rings has always been a goal but meeting that expectation has been a largely unfulfilled challenge (Stoll-Kleemann et al., 2010).

5.2. Landscape conservation cooperatives and the large landscape initiative

On March 9, 2009, Department of the Interior Secretary Ken Salazar issued Secretarial Order No. 3285 on climate change. Among other things, the Order created US Fish and Wildlife Service administered "landscape conservation cooperatives" (Secretary of the Interior, 2009). These 22 Cooperatives provide a "forum for States, Tribes, Federal agencies, non-governmental organizations, universities and other groups to work together in a new way" (US Fish and Wildlife Service, 2013). They have received praise in scientific venues (e.g., Austen, 2011; Meretsky et al., 2012; Jacobson and Robertson, 2012). Their technical delineation was treated by Hansen et al. (2011). But a review of program literature does not identify land use planning as a Landscape Conservation Cooperative (LCC) function (Wood and Hawkins, 2011). The question is whether the LCCs might do more than provide professional expertise? The Great Northern LCC encompasses the GYE and a draft plan has been prepared http://greatnorthern/cc.org/.

On February 15, 2011, President Obama announced the America's Great Outdoors Initiative (America's Great Outdoors, 2011). Its LCC Initiative "focuses on catalyzing and bolstering local, community-driven efforts that conserve and connect the nation's landscapes and watersheds" (America's Great Outdoors Large Landscape Initiative, 2011). A Presidential memo signed April 16, 2010, called for "creating corridors and connectivity". The Crown of the Continent (72,000 km^2 in British Columbia, Alberta and Montana) is one demonstration site. The National Park Service later rolled out its "Scaling Up" initiative (National Park Service, 2014), a directive for units of the National Park System to engage in large landscape conservation via partnerships.

The NPS Rivers, Trails, and Conservation Assistance Program provides technical assistance to communities to plan for recreational trails and river recreation (National Park Service, 2013). Could this program be re-envisioned so it offers local

communities and states with assistance in creating biotic corridors and landscape permeability? The NPS Second Century Committee Report (Baker et al., 2009) questioned whether the Program had such authority? Rivers represent one of our best opportunities for animal corridors (Hilty et al., 2006).

By the late 1990s there were few well-designed science studies to support the corridor strategy (Beier and Noss, 1998). However, a meta-analysis more than a decade later did suggest that natural habitat corridors increase species movement (Gilbert-Norton et al., 2010). For specifics on various studies, see American Wildlands (2008, Appendix 5).

5.3. The ESA

Ecosystem management offers a valuable philosophy but may prove to be powerless for regulating private land use, based on current federal law. One exception to "toothless laws" is the 1973 Endangered Species Act (ESA) (7 U.S.C. §136, 16 U.S.C. §§1531 et seq.). ESA provisions can control land use on private land. The Act also requires Habitat Conservation Plans which is a form of land use planning. One downside to ESA implementation has been the failure to designate official critical habitat for the grizzly bear (Bader, 1992). Critical habitat designation, discretionary in Section 7 of the ESA, was mandated for all species by a 1978 amendment. Although this amendment does not demand retroactive designations, it makes them possible if the Secretary of the Interior so desires (Sellers, 1994). Due in part to political opposition, the USFWS never finalized critical habitat designation for the GYE grizzly bear, but adopted a zoning scheme instead (Primm and Murray, 2005). That scheme consists of five zones MS I–V (Servheen, 1993). According to Clark and Minta (1994), the substitution of a zoning scheme for critical habitat designations was a poor tradeoff.

5.4. Beyond-boundary NPS authority

Sax (1976) refers to US national parks as "helpless giants" due to a park superintendent's inability to control land use on adjacent private lands. Since then, many legal scholars have treated the legal aspects of dealing with external threats to national parks. Keiter (1985) and Lockhart (1997) represent comprehensive reviews. As a distinguished advisory board observed, "(there is) a mismatch between demands that park units be protected and the tools available, when the threats to park resources and values are increasingly coming from outside unit boundaries" (Franklin et al., 2001, p. 9). Park superintendents often feel helpless when attempting to deal with some external threats. Our best legal scholars do not know for sure whether or not NPS has the authority to deal with this issue because the necessary case law does not exist. Politics inhibits the development of needed case law.

Keiter often argued that while NPS has ample authority to deal with external threats derived from some land ownerships, it does not have the authority to regulate private lands (Keiter, 1985, 1996). Mantell observed the issue remains untested (Mantell, 1990, p. 240) DOI solicitors avoid the issue (Lockhart, 1997). "Congress seldom exercises it (power to control external threats), the land agencies seldom claim it, and the Department of Justice seldom asserts it in federal land litigation" (Coggins and Glicksman, 2007, p. 3:4). The same legal questions that arise for national parks also apply to wilderness areas (Glicksman and Coggins, 1999). Unfortunately, NPS sometimes does not object when development is planned outside a park boundary. One example includes oil and gas leasing on the Flathead National Forest next to Glacier National Park during the 1980s (Sax and Keiter, 1988, p. 192). From Shafer (1999, 2010).

For state and private lands, Glicksman and Coggins assert that Congress could clarify whether agencies can regulate activity on state or private land next to wilderness but is unlikely to do so because of the private lands "takings clause" of the Fifth Amendment of the US Constitution (1999, p. 410). That takings clause has been extended to state and local governments, as a result of the Fourteenth Amendment. A famous US Supreme Court decision (*Dolan v. City of Tigard (1994)*) upheld the takings protection, when a municipal government overreached its authority (Freis and Reyniak, 1996). Edgar was convinced that "grizzly bear management under the ESA does not effectuate a Fifth Amendment taking under the Lucas test (*Lucas vs. South Carolina Coastal Commission (1992)*)" (1998, p. 496). Clarification and/or supplementation of federal authority over land adjacent to federal property are a needed step for the GYE and all US national parks and wilderness areas.

5.5. Land exchanges

Employees of the USFS and BLM can perform land exchanges to create more ecologically functional park boundaries (Anderson, 1979; Beaudoin, 2000). For example, the managers of the Gallatin National Forest in Montana traded property with a private landowner to secure a private inholding close to the boundary of Yellowstone National Park (Hansen, 2006). Securing the 40,470 ha tract from the timber company required two Congressional bills to legally facilitate the transfer (Keiter, 2001, pp. 315–316). Recommendation No. 124 of the Public Land Law Review Commission (1970, p. 16) states, "General land exchange authority should be used primarily to block up existing Federal holdings…". According to Gorte and Vincent (2007, p. 7), NPS cannot exchange federal lands for state or private property. On the other hand, USFS and BLM can easily do so. The Federal Land Policy and Management Act of 1976 (FLPMA) (43 U.S.C. 1701, P.L. 94–579) explains some of the rules of land exchanges, amended by the Federal Land Exchange Facilitation Act of 1988 (102 Stat. 1086). However, land exchanges have also been used to thwart landscape preservation. For example, a land exchange was used to facilitate the construction of the Big Sky Ski Resort in Gallatin County, Montana. While environmentalists opposed the exchange, they ultimately lost that battle (Compas, 2007).

5.6. Less-than-fee acquisition and other incentives

Private land can be very valuable. For example, private property in and next to the town of Jackson, nicely situated near the National Elk Refuge in Jackson, Wyoming, can sell for $1 million per acre (Chadwick, 2000). Easements represent an alternative to fee-simple purchase (Loomis, 2002, pp. 526–528). Easements, either purchased on donated, are discussed in Baldwin (1997), Bray (2010), and McLaughlin (2011). Easements may be the most reliable tool for preserving private land, though there are some risks (Colburn, 2007). The NPS Second Century Committee recommended that NPS be given authority to purchase easements *outside* park boundaries (Baker et al., 2009). Up until July 2004, over 182,113 ha of GYE private land (which is only 5% of all GYE private land) had been conserved using easements (Copeland, 2004). The NPS Second Century Committee also thought new legislation may be needed to allow NPS to offer "technical assistance tools, grants and incentives" to private landowners (Baker et al., 2009). In most regions, assembling enough land to have large, connected reserves depends on the participation of private landowners (Colburn, 2007, p. 275). In the GYE, many NGOs have undertaken this task.

Offering financial incentives could help the landscape permeability task enormously (Karkkainen, 1997). One NGO endorses this practice for use outside national parks (National Parks and Conservation Association, 2011). Such incentives may be among our best land use planning tools (Eisner et al., 1995). Existing Federal programs that offer incentives to private landowners to preserve their property are listed in Haufler and Kernohan (2009, p. 164). Also see Greater Yellowstone Coordinating Committee (2008, pp. 7–1 to 7–39). Such incentives are included in the Farm Bill administered by the Natural Resources Conservation Service (NRCS). Specific programs of NRCS include the Wildlife Habitat Incentive Program, Environmental Quality Incentive Program, Stewardship Incentive Program, Grassland Reserve Program and Wetland Reserve Program (Locke and Rissman, 2012). Also see Scarlett (2011). The NRCS Wildlife Habitat Incentive Program issued a final November 23, 2011 rule (7 CFR 636.5) that maintains applicants must "protect, restore, develop, or enhance important migration and other movement corridors for wildlife".

Three other incentive programs are administered by the US Fish and Wildlife Service: the Private Stewardship Program, Partners Program, and Landowner Incentive Program. A promising suggestion for expanded land conservation is to utilize existing state forest tax programs to encourage private landowners to retain habitat connectivity with federal lands (Locke and Rissman, 2012). A second is continued use of the USDA Conservation Reserve Program (i.e. keeping land in agriculture to prevent residential development) (Johnson and Maxwell, 2001). Land stewardship incentive programs are also listed in Greater Yellowstone Coordinating Committee (2008, pp. 8–1 to 8–16). Looking beyond the US, direct payments have been given to landowners outside some reserves in Brazil to not cut trees in the matrix (Chomitz et al., 2006). Direct payments as incentives have also been used in Costa Rica to preserve ecosystem services (Ferraro, 2001).

5.7. Northern Rockies Ecosystem Protection Act

The Northern Rockies Ecosystem Protection Act (NREPA) has been introduced in Congress at least five times, since 1994. The bill would create more wilderness areas out of existing USFS roadless areas in Idaho, Montana, Oregon, Washington and Wyoming. NREPA would also designate more wild and scenic rivers, increase the expanse of some existing blocks of federal lands, recover landscapes through road elimination and revegetation, and connect large federal tracts of land with habitat corridors. This expansion of existing federal reserves is a good way to facilitate regional habitat connectivity (Edgar, 1998). The same bill would also reduce federal subsidies offered to the logging industry, while simultaneously creating jobs needed to rehabilitate degraded habitat and lessen any economic hardship to locals when logging is reduced. The early thinking behind the legislation is found in Bader (1991, 1992, 1999). Weinman (1995) reviewed the benefits of NREPA. The legislation was reintroduced during the 113th Congress as H.R. 1187. This legislation offers an opportunity to improve habitat protection and connectivity on federal lands in the GYE, the Northern Continental Divide Ecosystem and the Selway-Bitterroot Wilderness area, and matrix lands between them.

5.8. Federal land annexation

Another way to expand existing national parks is by using individual Congressional legislative acts to annex some adjacent federal land. Shafer (2010) outlined this option. As of 1960, 30% of the National Park System had been derived from USFS lands (Dana and Fairfax, 1979). Yet only rarely has this approach been presented as an overall strategy (one exception is Carle, 2000).

6. Other governance and coordination options

6.1. NGOs as coordinators

Another approach is to allow a non-governmental organization (NGO) to coordinate land use planning activities. This already occurs for the Yellowstone-to-Yukon (Y2Y) initiative (Merrill, 2005) and the GYE is part of that overall landscape vision. More than 160 organizations representing almost one million people have joined Y2Y thus far. Those groups include local governments, sportsmen, ranchers, and Native Americans. The USNPS and Parks Canada have signed MOUs to join Y2Y (Anderson and Jenkins, 2006, p. 135).

6.2. Mixed non-federal governance

While this review has focused on the "Yellowstone model" for protected areas (Phillips, 2003), there are other ways to protect natural areas. For example, since September 1971, Adirondack Park, New York, managed by the Adirondack Park Agency, established land use controls applicable to all non-state lands in the park and reviews any proposed development projects for the area (Booth, 1984). The Pinelands National Reserve, New Jersey, all non-federal land, is managed by the Pinelands Commission (Good and Good, 1984). Some aspects of these approaches might be applicable to the GYE. We now move from planning tools to one major planning constraint.

7. Private property rights

Multiple ownerships pose one of the greatest dilemmas facing the achievement of habitat connectivity (Breckinridge, 1994; Sample, 1994). Integrating private land into preservation oriented regional land use planning remains our "stiffest challenge" (Keiter, 1998, p. 338). "It will be difficult, and perhaps impossible, to retain ecosystems and species at the level of landscapes if private landowners do not participate in the effort" (Bachelet, 2013, p. 336). Some private land in the GYE is already managed to retain its ecological integrity, though most of it is not. For example, ranchland could be managed to be compatible with grizzly bear conservation (Brunson and Huntsinger, 2008). The 48,159 ha Flying D Ranch near Bozeman, owned by Ted Turner, is an example of a working ranch dedicated to wildlife preservation (Wilkinson, 2013). It is the largest block of private land in the GYE. Knight (2002) argued that working ranches are better for the landscape than subdivided ranchettes. A study of ten GYE counties (but excluding extensive resort development or urban development) revealed that from 1990 to 2001, 598,562 ha of ranchland changed hands as a result of 582 land sales of 162 ha or more (Gosnell et al., 2006). The land purchasers included amenity buyers 43%, traditional ranchers 25%, investors 12%, and conservation organizations 2%. Contrary to popular presumption, large ranchland tracts tended to remain intact (Gosnell et al., 2006).

Using 7.3 million ha to delimit the GYE, 25% is private land (Gosnell et al., 2006). But if one uses the 14.5 million ha delimitation (20 counties), private land increases to 32% (Gude et al., 2006). More than *one-third* of all listed threatened and endangered species in the US are confined to private property (Bean and Wilcove, 1997).

In times past, as NPS Director George Hartzog has explained, if parks were in danger from land use outside their boundaries, the park boundary was expanded after the offending land was purchased (1989, p. 17). However, times have changed, especially with regard to the GYE. "No one, it seems, wants to tackle the issue of threats to the park (or ecosystem) that arise on private lands" (Varley, 1988, p. 222). Private land rights can be a land use planning obstacle (Baldwin and Trombulak, 2007). However, many private landowners do want to manage their land for biological diversity, but may become frustrated by having to pursue multiple agency goals while harboring a fear of trusting the federal government (Haufler and Kernohan, 2009). Lack of trust towards the federal government is pervasive in the West (Nie, 2008). This is an impediment in the GYE, though not unexpected (Jobes, 1991; Reading et al., 1994). But the reception is not always negative if the approach is tempered.

A very positive example has been ongoing in the High Divide, an area between the GYE and the Selway-Bitterroot Wilderness Area. The High Divide Large Landscape Initiative coordinates cooperators and land trusts (Anonymous, 2014a,b). From 2004 to 2014, it protected 754,323 acres (305,270 ha) and invested $437.5 million on easements or fee title acquisition (Michael Whitefield, personal communication). Most of the land protected is owned by ranchers. We now shift to a more science-oriented treatment of the grizzly bear.

8. Grizzly bear

8.1. Distribution

Today there are five lower-48 United States grizzly bear populations: the GYE (20,000 km^2) with 640–797 bears; the Northern Continental Divide Ecosystem (NCDE) (25,000 km^2) with 1000 bears; the Selkirk Mountains area (5700 km^2) with 40–50 bears; the Cabinet-Yaak area (6700 km^2) with 37 bears; and the Northern Cascades area (25,000 km^2) with fewer than 20 bears based on USFWS 2011–2012 data http://www.fws.gov/mountain-prairie/species/mammals/grizzly/ and Haroldson et al. (2013).

8.2. Population trends and range expansion

The GYE grizzly bear population declined in the 1970s and early 1980s as a result of human killings stemming from Yellowstone garbage dump closure (Knight and Eberhardt, 1985). In fact, during 1980, the population went down to 183–207 individuals (Craighead, 1998). According to Boyce et al. (2001) and Harris et al. (2006), that population increased approximately 4%–7% annually from 1983 to 2002. Pease and Mattson (1999), however, believe the grizzly bear population changed little in the two decades from 1975 to 1995. The bear's range expanded by 11% during the 1980s and an additional 34% during the 1990s (Schwartz et al., 2002). Haroldson and Van Manen perceived the GYE grizzly bear population grew from 4% to 7% per year in the 1980s and 1990s, but dropped or flattened out to 0%–2% per year from 2002 to 2011 (2013:2).

The goal of the interagency *Grizzly Bear Conservation Strategy* is to "manage the Yellowstone grizzly bear population in the entire GYA at or above 500 total grizzly bears" (Interagency Conservation Strategy Team, 2007, p. 26).

8.3. Mortalities

Since the 1970s, humans caused between 70% and 90% of grizzly bear deaths in the GYE (Pease and Mattson, 1999). Numerous factors are known to be responsible, for example, agency removal (54.2%); self-defense by big-game hunters (17%); mistaken identity shootings by black bear hunters (8.5%); and malicious killing or poaching (1.7%) (Schwartz et al., 2010). Examined through a different lens, the key mortality factors for the GYE grizzly bear include bear intolerance, human distribution and the presence of firearms (Mattson et al., 1996).

Based in USFWS policy, the mortality rate for the grizzly bear in each ecosystem caused by human destruction cannot exceed 4% of the population, based on the most current 3-year sum of females. No more than 30% of this 4% threshold can consist of females and such limits cannot be exceeded for two consecutive years (Servheen, 1993). Some mortality rates follow: 48 (2008), 39 (2009), 50 (2010), 44 (2011), 54 (2012), 26 (2013) (Moody et al., 2009; Interagency Grizzly Bear Study Team, 2013). Hansen (2009a,b) concluded that private land in the GYE was a population sink for the grizzly bear.

8.4. Distance between ecosystems

Approximately 240 km separate the GYE and NCDE. The distance between the GYE and the NCDE is within the dispersal range of some wide-ranging male grizzly bears in this region (Proctor et al., 2004). One NCDE grizzly bear was found dead at Mill Creek during September 2005, about 80 km south of its main distribution (Haroldson et al., 2010). The distance between the GYE and Selway-Bitterroot–Frank Church River-of-No-Return wilderness complex is about 200 km.

8.5. Inter-ecosystem movement

The GYE and NCDE grizzly bear populations are thought to have been isolated for around a century (Miller and Waits, 2003). During a 25 year period, *none* of the 460 radio-collared grizzly bears apparently dispersed from one of the five major US lower-48 grizzly bear ecosystems to another, a distance varying from 60 to 384 km (Weaver et al., 1996, based on Servheen pers. comm., cited by Herrero in 1998). However, there has been recent discovery of some movement between these recovery areas (US Fish and Wildlife Service, 2011, p. 88). One bear moved more than 240 km from the Selkirk ecosystem to the Selway-Bitterroot Wilderness Area (Haroldson et al., 2010). Exactly where corridors should be placed is not an easy task to determine (Mawdsley et al., 2009). Fig. 3 depicts land ownership between these three grizzly bear populations.

8.6. Bear genetics

The genetic distinctiveness of grizzly bear subpopulations in the western United States and Canada has now been affirmed (Proctor et al., 2012). Interstate highways can block grizzly bear dispersal and hence gene flow (Sawaya et al., 2013). Paetkau et al. (1997) noted that the grizzly bears in the GYE had lost 15% more of their genetic variability, compared to bears in the NCDE. Miller and Waits acknowledged the genetic variation loss as having "declined slightly" (2003:4338). Miller and Waits (2003) argued that dispersal between the GYE and the NCDE was never historically robust but Craighead and Vyse (1996) perceived that lower-48 grizzly bear populations were once one metapopulation. Any bears residing between the GYE and the NCDE were likely eliminated when the land was first settled (Mattson and Merrill, 2002). After examining the DNA of 110 bears from museum collections deposited between 1912 and 1981, Miller and Waits (2003) concluded that genetic variation in the GYE population was never that diverse, due to inbreeding. "It is unlikely that genetic factors will have a substantial effect on the viability of the Yellowstone grizzly bear over the next few decades" (Miller and Waits, 2003, p. 4338). Miller and Waits (2003) offered a very low figure for grizzly bear genetic effective population size (N_e: ~80 to >100). This estimate, for "short-term" genetic fitness, is drastically different from some earlier projections for "long-term" genetic effective population size (N_e) (Harris and Allendorf, 1989; Nunney and Elam, 1994).

Miller and Waits (2003) claimed the Yellowstone grizzly bear population had an N_e of 100 bears which requires a census population of 400 bears. The USFS then adopted the position that a "viable grizzly bear population" *already* existed in the GYE (US Forest Service, 2006, p. 68).

In response to the USFWS proposal to delist the GYE grizzly bear, 269 concerned scientists signed a March 20, 2006, letter to the agency arguing that the GYE grizzly bear population needed to be between 2000 and 3000 individuals, not 400–500, before it could support genetic diversity and withstand regional-scale random events (Craighead et al., 2006). Jamieson and Allendorf (2012, pp. 581, 583) recognized that an N_e for *long term* genetic fitness was "likely to be in the thousands rather than the hundreds". Frankham et al. (2014) recommend revising the aging effective population size (N_e) rule of 50/500 to 100/1000. Using this revised rule, the GYE would require 4000 bears for long-term evolutionary genetic fitness.

Therefore some scientists assert that the long-term genetic fitness of the grizzly bears should be taken into account (Craighead et al., 2006; Jamieson and Allendorf, 2012; Frankham et al., 2014). Population isolation reduces both fitness and

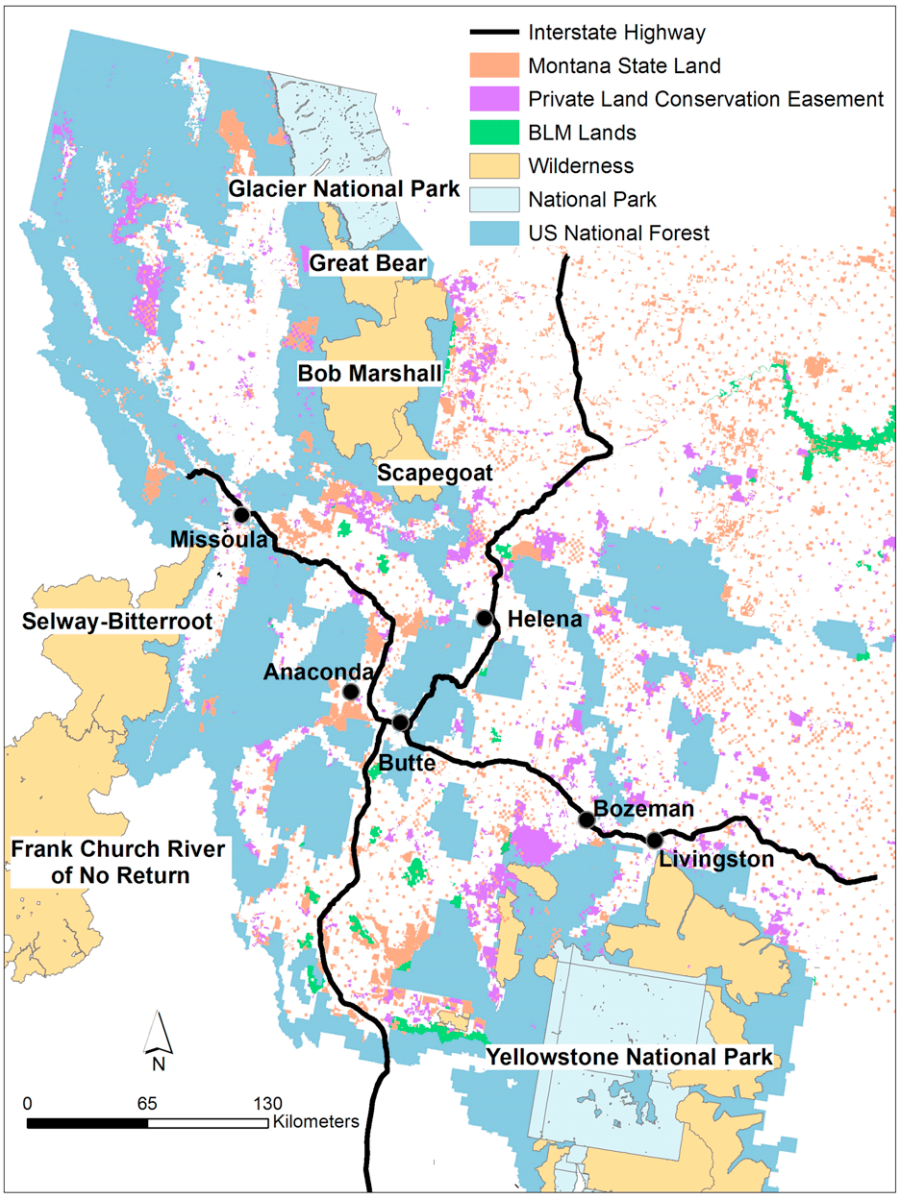

Fig. 3. Land ownership between the GYE, the NCDE, and the Selway-Bitterroot-Frank Church River-of-no-Return wilderness complex.

evolutionary potential (Reed and Frankham, 2003). The current grizzly bear population in the GYE is too small to support long-term evolutionary genetic fitness. The alternative is to do periodic grizzly bear translocations into the GYE forever. Although heroic efforts have been underway to facilitate corridor creation, the opportunity to allow for a more permeable landscape so the GYE grizzly bear population can disperse to the NCDE or the Bitterroot–Selway–Frank Church River of No Return wilderness complex, or vice versa, will not last indefinitely. Land use planning to promote habitat corridors and landscape permeability is also our most promising approach for climate change (Shafer, 2014), and may serve the needs of more species than just the grizzly bear (Noss et al., 1996).

8.7. Translocation risk

The USFWS management position on this situation is for "translocation of two or more bears from other ecosystems by 2020 if genetic analysis shows no movement into the GYE from the NCDE" (US Forest Service, 2006, p. 311; US Fish and Wildlife Service, 2007, p. 4926). However, Adams et al. (2011, cited in Hedrick et al., 2011), indicate there are fewer than 10 well documented cases of genetic rescue (i.e., a population rebounding as a result of the infusion of new genes from a species translocation).

8.8. Linkage zones and private land

In the 1990s, scientists perceived that the greatest threat to the GYE grizzly bear was private land development (Knight et al., 1999). The USFWS later made a surprising statement: "human population growth on private lands is not likely to endanger the Yellowstone (grizzly bear) DPS (distinct population segment) in all or a significant portion of its range in the foreseeable future" (2007, p. 14919). The Interagency Grizzly Bear Committee, in contrast, believes the long term future of the grizzly bear is dim, unless critical corridor connections can be secured, for example, between the GYE and the Northern Continental Divide Ecosystem (NCDE) (Thompson, 2004, p. 732).

Up to July 2004, over 182,112 ha of GYE private land (which is 5% of the total private land) has been conserved using the easement tool (US Forest Service, 2006, p. 260). The potential reconnection of some now disjunct grizzly bear populations, underway since the late 1990s, should require participation by many levels of government (Primm and Wilson, 2004). Johnson (2001, p. 8) thinks it would be difficult and even impossible to reclaim GYE habitat after it has been developed. However, in the interest of the grizzly bear, it is quite probable that some development may need to be reclaimed (e.g., failed ski resorts). Securing land for conservation is expensive near human settlements (Luck et al., 2004). Canada and the US lack the legislative authority to create terrestrial protected area networks that need functional habitat connections (Vásárhelyi and Thomas, 2006). The USFS acknowledged that, "Maintenance of linkage zones between ecosystems…is well beyond the authorities of the Forest Service to address" (2006, p. 19). The purchase of key private property is underway by members of the Y2Y coalition (Locke, 2012). To ensure safe populations of female grizzly bears in greater ecosystems and on land connecting them, USFS managers and scientists realize this will require significant changes in human use and development, mostly on private lands (2006, p. 342). Recent modeling supports the idea that private land development is a threat to the grizzly bear (Schwartz et al., 2012). Glick and Freese (2004) think the future of all biodiversity in the GYE simply hinges on the fate of its remaining private property.

9. Discussion

9.1. GYE successes

Great efforts have been made to protect the GYE and its grizzly bear population since the 1970s. Some of the results are surprising and very positive. For example, roadless areas were designated (Montana Wilderness Association, 2014); timber sales have declined and many national forest roads have been decommissioned or eliminated (US Forest Service, 2006); some mining activity has been shut down (Dykstra, 1997); the number of oil and gas leases on national forests has declined (US Forest Service, 2006); many grazing rights have been purchased or phased out (US Forest Service, 2006); a total of 202,347 ha of conservation easements have been secured (Anonymous, 2011); some geothermal extraction ceased (Steingisser and Marcus, 2009); some planned ski resorts were shelved (Willcox, 2004); much more research was conducted (National Park Service, 1997); the gray wolf (*Canis lupus*) was reintroduced (Fritts et al., 1997); the grizzly bear population increased (Haroldson and Van Manen, 2013) and its range has expanded (Schwartz et al., 2002). However, more work needs to continue if the GYE is not to become isolated habitat for the grizzly bear. Some argue that our success in preserving the GYE may be determined by our success in managing the Yellowstone grizzly bear population (Clark et al., 1991, p. 417). Now we turn to some insights about GYE land use planning.

9.2. What are the most promising land use planning options?

(1) Planning at the county level would support national park and national forest goals, provided that many of the 20 + GYE counties could plan together (Gude et al., 2006) in the best interest of park and national forest biota. If they wished to do so, counties could exert more power in controlling private land development (Glick, 1999). Easements on private land negotiated by NGOs are a critical component of any conservation strategy.
(2) Offering private landowners additional incentives is another potential approach (Eisner et al., 1995).
(3) In seeking more cooperation between federal land management agencies and other organizations, cooperative agreements or MOUs sometimes helps.
(4) NREPA could create more connections using federal land (Weinman, 1995).
(5) The USFS could reclaim more roaded or degraded national forest habitat.
(6) Some authors have discussed other systems of governance (Brunner et al., 2002; Lemos and Agrawal, 2006; Powell, 2010). Inman et al. (2006) treats the issue for the GYE wolverine (*Gulo gulo*) and grizzly bear. However, exactly what that new system of governance should or could be for the GYE represents a challenge for another author (but see McKinney and Johnson, 2009). There are many examples of NPS collaborative efforts as noted by the National Park System Advisory Board Planning Committee (2012).
(7) Comanagement of corridors is another possibility (Brown and Harris, 2005).
(8) Each national park and national forest could devote at least one staff position to dealing with outside boundary issues. It is rare for a US national park to have a staff position dedicated to interfacing with outside boundary activity and Rocky Mountain National Park, Colorado, set the example (Gamble, 1999).

(9) What about the legislative option? Keiter (2001, p. 348) concludes there would be little use "trying to craft a single 'magic bullet' biodiversity law". We would be better off, he says, relying on diverse federal, state, and local laws. Some scientists and managers associated with Yellowstone National Park concluded that retaining GYE natural processes like migration and dispersal will be "forged one issue or species at a time in the political arena, either through legislation or litigation, rather than comprehensively" (White et al., 2013, p. 178). This is one approach but a very time consuming one. See McKinney and Harmon (2004) for other approaches. Another option is supplementing existing law to facilitate wise and effective land use planning outside of national parks and other federal environmentally sensitive land.

These assimilated observations are not the only ones available. A land use planning toolkit has been developed for the GYE (Greater Yellowstone Coordinating Committee, 2008). Wilkosz (2010) also examined Federal, state and local land use protection options. Travis (2007) represents the most comprehensive account of all. As Glick and Clark (1998, p. 253) surmise, "Effective cross-boundary resource management in the GYE still is in its infancy".

9.3. Ongoing conservation activity

Thomas Lovejoy (1992, p. xviii) said that many landscapes are already so impacted by humans that opportunities to create corridors are very limited. This is true for the GYE. The Craighead Environmental Research Institute has been carefully identifying the best remaining options for the GYE since the late 1990s. The Interagency Grizzly Bear Study Team has been involved in corridor identification as well. The Heart of the Rockies Initiative is a coordinating umbrella for land trusts. It aids local and national land trust activity by combining money from several charitable foundations with state matching funds (Adams, 2006, p. 210).

Based on expert opinion, key linkage areas for grizzly bears have been mapped (American Wildlands, 2008). Where to focus efforts at averting wildlife collisions along western Montana highways have also been mapped by the same NGO (Williamson et al., 2009). Unfragmented blocks of habitat for the wolverine (*Gulo gulo*) have been located (Inman et al., 2013). High value private lands in the GYE and beyond have been identified by the Heart of the Rockies Initiative (Greater Yellowstone Coordinating Committee, 2006, map 4).

More than two decades ago, purchase of GYE private land easements was underway by the Montana Land Reliance, Trust for Public Land, Rocky Mountain Elk Foundation, American Farmland Trust, Jackson Hole Land Trust, The Nature Conservancy and others (Miller and Wright, 1991). Even more land trusts and NGOs are involved in protecting GYE land today: World Wildlife Fund (Freedom to Roam), Vital Grounds, the Conservation Fund, National Wildlife Federation, American Wildlands, Gallatin Valley Land Trust, and more. Gore et al. (2001) prioritized habitat linkages for the Northern Rockies.

10. Conclusion

10.1. Old and refined insights

My goal has been to identify planning levels and approaches that, in part or in aggregate, might be selected to better protect the GYE's biological diversity. I have used the GYE grizzly bear as an example. The following observations seem to already be well appreciated: (1) the need for regional planning for protected areas is a given (Nelson et al., 2003), (2) Federal land management agencies in the GYE need to develop a shared vision for the region (Clark et al., 1996) which will be difficult due to differing mandates (Shafer, 2010), (3) county involvement is critical for regional land use planning to succeed (Gude et al., 2006), (4) various more effective county regulations and zoning could be imposed to preserve open space (Gude et al., 2006), (5) private landowners need more or better incentives to protect their property in a natural condition (Eisner et al., 1995), which could be provided by federal agencies, states and counties, (6) passing NREPA could enhance the size and connectivity of federal protected areas (Weinman, 1995), (7) Congress could seek clarification of federal beyond boundary authority (Lockhart, 1997), (8) and seek other agency land annexation opportunities (Shafer, 2010), (9) the USFS and the BLM could look for more opportunities to trade agency lands distant from the GYE for key GYE private property (Beaudoin, 2000), (10) the USFWS could opt to designate critical habitat for the grizzly bear in accordance with the Endangered Species Act (7 U.S.C. §136, §§1531 et seq.) (Bader, 1992). Other insights evolving from this review follow:

> The federal government could play a role in managing the GYE because (1) it has the most at stake in terms of land needing regional stewardship, (2) it is best positioned to provide leadership to guide the participation of multiple user groups, and (3) it already has experience in many forms of regional planning (Babbitt, 2005). The NPS Second Century Committee recommended that NPS pursue the role of "convener of stakeholders" for large landscapes (Baker et al., 2009). This contrasts with the current political trend of decreasing the power of government in land use planning (Travis, 2007, p. 66). For example, positive things might occur using existing DOI "Large Landscape Cooperatives" providing some *potentially voluntary members* like county governments could then exert some of their land use planning authority in the best interest of wide ranging national park and national forest biota.
>
> Local fear and resentment of federal government involvement in local land use matters must be recognized and mitigated. The "old-west" mentality" in the GYE (Freemuth and Cawley, 1998; Wilson, 1997; Robbins, 2006) might be muted with education and the creation of regional advisory and decision-making groups (sensu Cestro, 1999). Participation by all stakeholders is the goal rather than rigid top down control.

The above represents a start at assimilating potential ways to better mitigate ongoing development in the GYE while promoting landscape permeability for large mammals. Guercio and Duane said, "There are no quick and easy solutions to the complex legal, cultural, economical and political problem of managing predator habitat at an ecoregional scale" (2009, p. 355). Although land use planners might prefer otherwise, "Land use planning is not, and cannot, be a purely rational technocratic and scientific exercise" (Wilson, 1997, p. 465). Redford offered this simple but not trivial insight: "We have been slow to recognize that conservation is politics" (2011, p. 1073). Indeed, "nature protection by definition is a social and political process" (Brechin et al., 2002, p. 42). The creation of viable populations of carnivores will demand unprecedented amounts of cooperation (Grumbine, 1990).

As of 1992, one-third of the conterminous US was classified as human-dominated, that is, 26 million km^2. This amount expanded to 80,800 million km^2 by 2001, and is projected to expand to an *additional* 92,200 million km^2 by 2030. As of 2000, 85,000 housing units were within 1 km of US national parks (Theobald, 2010). Some of the above insight about approaches and tools of land use planning may prove useful for other US federal national parks, wilderness areas and national wildlife refuges.

10.2. The future

As Lee Talbot (1984, p. 753) remarked, "A system of protected areas should be an integral part of the fabric of a people's or nation's well-being". The US has an opportunity to set a land use planning example focused on the GYE. As Keiter and Boyce observed, "Yellowstone is the birthplace of the world's first real experiment with wilderness preservation" (1991, p. 407).

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