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Livestock-Mediated Dispersal of *Prosopis juliflora* Imperils Grasslands and the Endangered Grevy's Zebra in Northeastern Ethiopia☆

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ABSTRACT

Prosopis juliflora (Sw.) DC is a woody plant from the Americas that has dispersed worldwide via human intervention. Typically introduced with good intentions, *Prosopis* often proliferates and degrades native ecosystems. *Prosopis* first appeared in the Allideghi Wildlife Reserve (AWR) of northeastern Ethiopia in 1997. In 2005–2006 we determined: (1) patterns of *Prosopis* dispersal and establishment using global-positioning system mapping and seed-bank assessments; (2) impacts of *Prosopis* on cover composition and species richness of grassland vegetation using transects at replicated *Prosopis* stands that varied by tree size; and (3) attitudes of local people toward *Prosopis* using focus groups and interviews. *Prosopis* seeds first arrived in the AWR after pastoral livestock consumed seedpods along the Awash River, some 50 km away. Seeds have been deposited in corrals at recently established pastoral settlements within the AWR, and saplings now sprout along livestock trails. *Prosopis* has also colonized the AWR core grassland area, a vital habitat for wild grazers. Compared with sites lacking *Prosopis*, the largest class of *Prosopis* significantly reduced understory basal cover for perennial grasses from 68% to 2%, increased soil surface exposure from 30% to 80%, and lowered the number of grass species from seven to two. Attitudes of pastoralists toward *Prosopis* have become more negative over time. Local communities use *Prosopis* via limited charcoal production with some grinding of the seedpods for livestock feed. Infested sites are cleared by hand, but control has been ineffective. Because pastoral livestock are the main vectors for *Prosopis* seed dispersal and facilitate establishment, they will help transform the core of the AWR ecosystem from open grassland to denuded *Prosopis* woodland. While this bodes ill for grazing animals in general, it has particularly negative implications for the survival of an isolated population of an endangered, grass-dependent species—Grevy's zebra *(Equus grevyi)*.

Introduction

Many plants have expanded their worldwide distribution via human activity. Some plants that have been introduced to provide beneficial goods and services have instead become invasive species that degrade native ecosystems (Richardson, 1998). African rangelands have been affected to this end; there are invasive plants, for example, that threaten rural livelihoods, biodiversity, and water supplies (Mwangi and Swallow, 2008).

Prosopis juliflora (Sw.) DC (henceforth called *Prosopis*) is a shrub or small tree originally from Central America. It has become globally dispersed, mostly for use in agroforestry. On the positive side, *Prosopis* can tolerate harsh environments and provide fuel, timber, and animal feed (Fagg and Stewart, 1994). On the negative side, *Prosopis* can suppress or eliminate native plants (Al-Humaid and Warrag, 1998; Tiedemann and Klemmedson, 2004). *Prosopis* seeds can be ingested and transported by herbivores to inoculate new locations (El-Keblawy and Al-Rawai, 2006). Management strategies are needed to efficiently use and control *Prosopis* under the typical circumstances of low-input, rangeland management. This is especially true in the developing world, where resources to combat noxious invasive species are limited. *Prosopis* has been recently recognized as an ecological threat in Kenya; rural communities there have been mobilized in attempts to control it (Mwangi and Swallow, 2008).

It was apparent during our initial visits to the Allideghi Wildlife Reserve (AWR) in northeastern Ethiopia during 2004 that *Prosopis* was a relative newcomer to the area because most of the trees were young. *Prosopis* was introduced to the nearby Awash River Valley during the 1970s when it was imported by expatriates who wanted to use it to provide shade and wind breaks at irrigated cotton plantations. *Prosopis*

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subsequently escaped from the plantations and has become regionally widespread (Shiferaw et al., 2004). Afar pastoralists first observed *Prosopis* in the AWR by 1997 (Kebede, 2009). The AWR is roughly 50 km from the vicinity of the Awash River where *Prosopis* was introduced. Mature *Prosopis* forest—with a completely denuded understory—now dominates the areas where the first plants were established (D.L. Coppock, personal observation).

Given the negative reputation of *Prosopis* and the importance of the AWR as a refuge for a local assemblage of wild grazing mammals—including an isolated population of endangered Grevy's zebra *(Equus grevyi)*—it was deemed important to assess the status of *Prosopis* at AWR to gauge the risks that the species might pose for this grassland ecosystem. Thus the research objectives were to determine: (1) patterns of *Prosopis* dispersal and establishment; (2) impacts of *Prosopis* on grassland vegetation; and (3) attitudes and actions of pastoralists and local town dwellers concerning *Prosopis* utilization and control. We hypothesized that *Prosopis* dispersal would be largely attributable to pastoral livestock and that *Prosopis* would prove detrimental to graminoid vegetation. It was less clear, however, concerning the extent that people would recognize *Prosopis* as a threat, or the degree that people would be trying to control the species.

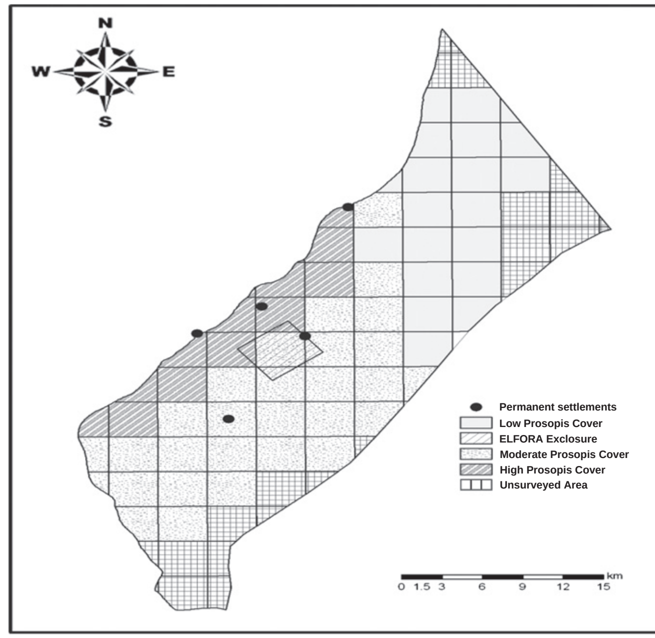

Fig. 1. Cover distribution of *Prosopsis juliflora* on the Allideghi Plain in 2005. Unsurveyed areas on the margins were either mountainous or too insecure to visit because of conflicts between pastoral groups. Source: Kebede (2009).

Methods

Study Area

Understanding the ecological and social context of this research is important, so we provide a fairly detailed description of the study area. The AWR (1 832 km^2) is in the Amibara and Oromia Districts of Ethiopia (Kebede, 2009). The AWR was established as a northern buffer zone for the smaller Awash National Park (ANP) established in 1969. The AWR has always been intended as a mixed-use area that embraces conservation, natural resource management, licensed hunting, and controlled use by livestock (Negarit Gazeta [1972] cited in Kebede, 2009). The AWR has a semiarid climate with bimodal rainfall (unpublished government data cited in Kebede, 2009). Annual precipitation ranges from 336 to 818 mm. The long rains occur during July to August, while the short rains occur during March to April. Daily maximum and minimum temperatures vary from 40°C (June) to 10°C (December).

About 35% (632 km^2) of the AWR is composed of central grassland area called the Allideghi Plain, henceforth referred to here as "the plain." The plain is rectangular (25 $\times$ 50 km; Fig. 1). The AWR has few natural sources of surface water. During wet periods the plain is crisscrossed by ephemeral streams. Natural water points outside the AWR include the perennial Awash River and thermal springs (Kebede, 2009). There are two major soil types on the plain, namely Vetic Cambisols and Calcic Cambisols. These soils are deep and alkaline with low organic matter content (WARC, 2003).

The plain provides habitat for Beisa oryx *(Oryx gazella beisa)*, Soemmering's gazelle *(Gazella soemmerringi)*, gerenuk *(Litocranius walleri)*, lesser kudu *(Tragelaphus imberbis)*, warthog *(Phacochoerus aethiopicus)*, and ostrich *(Sthruthio camelus)*. The AWR is also a vital refuge for the northernmost of three small populations of Grevy's zebra in Ethiopia, a species that inhabits just a few locations in the Greater Horn of Africa. Grevy's zebra is officially classified as endangered by the International Union for Conservation of Nature and Natural Resources (Moehlman et al., 2008). Poaching, habitat loss, and resource competition with pastoral livestock have contributed to an overall population decline for Grevy's zebra of about 70% over the past 30 years (Moehlman et al., 2008).

Perennial grasses dominate vegetation on the plain. *Chrysopogon plumulosus* Hochst., *Sporobolus ioclados* Nees, and *Cenchrus ciliaris* L. are the most common grasses. Woody vegetation is sparsely distributed and dominated by *Acacia senegal* (L.) Willd, *A. nilotica* (L.) Willd., *A. mellifera* (Vahl.) Benth, and *A. tortilis* (Forssk.) Hayne (Kebede, 2009).

Before the 1990s, local pastoral groups made little use of the AWR. This was largely because they had other places to take their livestock to forage and the plain lacked permanent water (Kebede, 2009). The Awash River Valley, however, has gradually become a region of intense competition for living space and natural resources as marginalized pastoralists have been extirpated from much of their traditional land due to annexation of key areas by government for industrial-scale agriculture starting in the 1960s (Getachew, 2001). There has also been a general expansion of the human population due to intrinsic growth, as well as immigration. As pastoralists and their herds have become displaced, they have gained access to places like the AWR because local authorities seek quick solutions for chronic problems related to the use of natural resources.

In the 1990s boreholes were thus drilled at the periphery of the plain so that pastoralists could make better use of the AWR. The abundant water allowed thousands of Afar pastoralists and their livestock to settle. Seven permanent villages occurred in or near the plain at the time of our research (Fig. 1). The livestock are now year-round residents except in December, when they go to cotton plantations along the Awash River to feed on crop residues (Kebede, 2009). The villages are also near the centers of large piospheres—denuded zones of heavy livestock impact that surround the boreholes—up to 28 ha each in size. Five temporary pastoral campsites have also been established along the southeastern edge of the plain (Fig. 1). These allow livestock to exploit forage resources deep in the plain during wet periods when the ephemeral streams are flowing. Both the villages and campsites have livestock corrals constructed with bush fencing (Kebede, 2009).

Another recent change at AWR was the arrival of livestock traders who needed to use the area as a holding ground for livestock in transit from points South and West to Djibouti in the northeast, where they are exported by ship to Middle Eastern destinations. A 2 000-ha site at the periphery of the plain and adjacent to one village was fenced by ELFORA Agro-Industries of Addis Ababa to serve as a holding ground; henceforth we refer to this site as the "exclosure" (Fig. 1). At the time of our research, the exclosure had been unused for an extended period of time. Within the exclosure was an impressive standing crop of perennial grasses that offered a marked contrast to the heavily impacted surroundings. The exclosure thus served as a control site.

Prosopis *Ecology*

Mapping

Prosopis occurrence on the plain was assessed using a global positioning system. Twenty-three parallel transects were driven three times during 2005–2006. Thirteen transects went East/West while 10 went North/South, resulting in 92 grid cells (3.66 × 3.66 km.) Each cell was visually categorized according to the relative canopy cover for *Prosopis*: low (undetected), moderate (1% to 30% of woody cover), or high (>30% of woody cover).

Soil Seed Banks

Soil seed banks for *Prosopis* were characterized following procedures of Pugnaire and Lazaro (2000). The study area was stratified into five site types on the basis of observations of *Prosopis* occurrence and forage use by livestock: (1) corrals at settlements where livestock spent the night; (2) livestock trails from settlements across the piospheres to the plain; (3) moderately grazed grassland with mature stands of *Prosopis*; (4) moderately grazed grassland lacking any woody cover; and (5) the exclosure. One location was sampled for category 5; two locations were sampled for categories 1, 2, and 3; and 10 locations were sampled for category 4 (the largest site type). At each location 10 soil samples were collected using a restricted-random protocol. Each sample was composed of the top 5 cm of soil that was enclosed by a 30 × 30 cm quadrat. The 10 samples were pooled and mixed for each location. The pooled samples were sieved using a 2-mm screen, and *Prosopis* seeds were counted, giving seed density per cubic meter. Data were compared across sites in a descriptive manner (means ± 2 standard errors). This was because of unbalanced sampling and unequal variances among mean estimates.

Influences of Prosopis *on Grassland Vegetation*

Influence of *Prosopis* on cover and species richness of herbaceous vegetation was determined. Data were collected during October 2005 following the long rains when herbaceous plants were easily identified. The research design incorporated three size-classes of *Prosopis* stands in a space-for-time substitution to quantify the progression of influence as *Prosopis* stands aged. Tree height was used as a proxy for tree size; the three classes included small (<1 m), medium (1–3 m), and large (>3 m) trees. Three replicate stands were selected, representing each size class, and were located in areas distant from current livestock activity to avoid any confounding effects of foraging; this was also a time when grazing wildlife were widely dispersed. For each stand a 200-m transect was employed. In addition, three transects were established in the fenced holding-ground that served as a control. Thirty placements of a 20 × 50 cm frame (Daubenmire, 1959) occurred along each transect in a restricted-random fashion; each site was sampled at the same level of intensity. Basal cover of each herbaceous species, as well as exposed soil surface (e.g., bare ground) and litter, was determined according to Bonham (1989). Basal cover was used given its value as an indicator of ecological change in space-for-time substitution, as well as our need to quantify the extent of exposed soil surface. Plant species rooted in each frame were counted to assess species richness. Data were averaged over the three control transects, and the resulting means were used as data in the analysis; hence the control group was represented by only one replicate in an unbalanced design.

Differences in percent cover among cover types due to *Prosopis* size class were assessed using a generalized, linear mixed-model with a beta distribution and logit link for a two-way factorial with size class (i.e., control, small, medium, and large) and cover type (i.e., grass, forb, litter, and bare ground) as fixed-effects factors. An unstructured covariance matrix was used to accommodate correlations among the four cover-type values measured on each stand, and denominator degrees of freedom were determined using a version of the Kenward-Roger method. Pairwise comparisons among means within each cover type group were adjusted for type I error using the Tukey-Kramer method. Differences due to size class in the mean numbers of grass species, forb species, and all herbaceous species were assessed using a generalized linear model with a Poisson distribution and log link for a one-way ANOVA with size class (i.e., control, small, medium, and large) as the fixed-effects factor, using Laplace estimation. Calculations were made using the GLIMMIX procedure in SAS/STAT 12.3 in the SAS System for Windows 9.4. In addition to the ANOVA, contrasts for linear trend across the ordinal levels of treatment were used to assess effects on plant species occurrence.

Human Dimensions

Information was obtained from people via focus group discussions and key informant interviews (Perecman and Curran, 2006). Nine focus groups overall were held at: (1) four pastoral settlements in or near the plain; (2) two local towns; and (3) among members of three charcoal-production associations. Thirteen key-informant interviews were conducted with representatives of international, governmental, and nongovernmental organizations. The main issues discussed concerned attitudes, practices, and plans for managing *Prosopis*. All dialogue was in English except when pastoralists were involved; for the latter a translator conversed in *Afar-aff*. The focus groups and interviews yielded consistent findings that allowed summarization in a concise descriptive format.

Results

Prosopis *Ecology*

Mapping

Fig. 1 illustrates that *Prosopis* cover was highest along the northwestern edge of the plain near most of the settlements, moderate throughout the south-central and southwestern portions of the plain, and absent elsewhere. Overall, this roughly translated into 16%, 50%, and 34% of the plain having high, moderate, or low *Prosopis* cover, respectively.

Soil Seed Banks

Seed density was highest in the corrals (122 ± 7.8 m^{-3}). Only a few seeds were detected under *Prosopis* stands (2 ± 0.8 m^{-3}) or in the open grassland (1 ± 0.6 m^{-3}). No seeds were detected on the livestock trails or in the exclosure. The trails, however, were often characterized by long lines of *Prosopis* saplings offering other evidence of livestock-mediated dispersal (see photos in Kebede, 2009).

Influences of Prosopis *on grassland vegetation*

Allocation of cover among grass, forb, litter, and bare ground varied among *Prosopis* size classes (size class by cover-type interaction, $F_{9,4.401} = 165.26$, $P < 0.001$). As size class increased, grass, forb, and litter cover decreased and bare ground increased; the cover shift from medium to large size classes of trees was not significant (Fig. 2). Forb and litter cover also trended downward as the size class of trees increased.

Although we observed a decline in the absolute number of both grass and forb species with an increase in *Prosopis* size class, the ANOVA per se provided no statistical support for these trends (Fig. 3; for grass, size-class effect $F_{3,6} = 1.93$, $P = 0.226$; for forb, size-class effect $F_{3,6} = 0.81$, $P = 0.534$; for all species, size-class effect $F_{3,6} = 1.72$, $P = 0.261$). The linear contrasts, however, revealed that a stepwise increase in the size of *Prosopis*: (1) significantly reduced the number of grass species ($P = 0.055$); (2) had no effect on the number of forb species ($P = 0.358$); and (3) only marginally affected the number of grass plus forb species ($P = 0.078$). Merging over all transects, seven grass species were observed at the control site. Of those species, six were found in the small *Prosopis* stands, three in the medium stands, and two in the large stands. Thirteen forb species were found at the control site, seven under the small *Prosopis* stands, nine under the medium

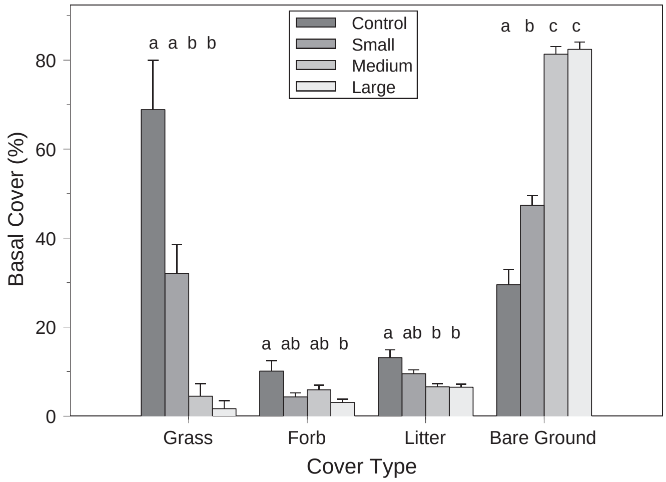

Fig. 2. Percent basal cover (mean ± SE as estimated by the statistical model) for four cover types under different size classes (small, medium, large) of *Prosopis juliflora* and in an uninvaded control area at Allideghi Wildlife Reserve, October 2005. Within a given cover type, bars with different letters have significantly different percent basal-cover means. Within any given site the basal cover totals may differ from 100% because the Daubenmire method uses midpoints of cover categories rather than exact estimates.

stands, and eight under the large stands. No species were observed in *Prosopis* stands that were not also observed at the control site.

Human Dimensions

Until the late 1990s, attitudes of pastoralists and town dwellers toward *Prosopis* were generally positive. People appreciated the benefits from *Prosopis* that included wood for fuel, fencing, and construction. Other positive attributes included forage production, provision of shade, and reduction of soil erosion in certain locales. More recently, however, pastoralists developed negative views once *Prosopis* began to dominate grazing areas and eliminate important grasses. Overconsumption of seedpods also reportedly led to livestock ailments. *Prosopis* is regarded as a major reason why pastoralists have been displaced from some traditional rangelands in the region, hence forcing Afar pastoralists to settle in the AWR. Town dwellers, in contrast to pastoralists, have tended to view the species in a more positive light overall because the benefits provided by the species in urban settings (i.e., shade, firewood, as well as fencing and building materials) outweigh the ecological costs.

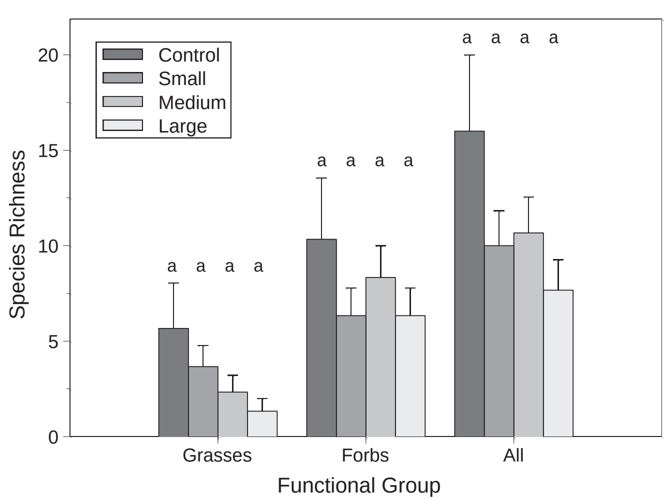

Fig. 3. Species richness (number; mean ± SE) of herbaceous vegetation under different size classes (small, medium, large) of *Prosopsis juliflora* and in an uninvaded control area (exclosure) at Allideghi Wildlife Reserve, October 2005. Within a given functional group, bars with different letters have significantly different percent basal-cover means.

Pastoralists in AWR clearly recognized that livestock disperse *Prosopis* seed. The original pathway for importing the seeds occurred when livestock traveled from the new pastoral settlements in the AWR to government cotton plantations along the Awash River. Animals were herded there each December to consume crop residues following annual cotton harvests. *Prosopis* trees planted by expatriates at the plantations for shade purposes had already spawned local groves of *Prosopis* trees at the periphery of the compounds, so livestock simply consumed *Prosopis* seedpods at these locations when traveling back and forth to the AWR.

There have been many local efforts to control *Prosopis*, officially referred to as "management through utilization." This is despite calls from pastoralists to eradicate *Prosopis*. Efforts have included licensed charcoal associations and use of hand-operated grinding mills to crush seedpods to provide livestock feed supplements without the risk of seed dissemination. Organized tree-clearing efforts (by hand) have also occurred. All approaches, however, have limited effectiveness. Charcoal production is reportedly constrained by a lack of oversight, placing valuable native trees at risk. The grinding mills are hard to acquire. Tree clearing often does not kill *Prosopis*; the stumps typically coppice and create a worse situation. No organized control efforts, however, were under way within the AWR at the time of this study.

Discussion and Conclusions

Ecology

Our results provide local confirmation of regional patterns concerning the dispersal and ecology of *Prosopis* in the Awash River valley (Shiferaw et al., 2004). Specifically, our hypotheses that livestock would be important agents of *Prosopis* dispersal—and that *Prosopis* would have negative effects on graminoid vegetation—were verified. Information collected from local people clarified the challenges associated with *Prosopis* control.

That livestock dung can contain high numbers of *Prosopis* seeds has been shown in the Awash Valley and elsewhere (Geesing et al., 2004; Shiferaw et al., 2004). The main sites for seed deposition in the AWR are thus the livestock corrals at the Afar villages. Once corrals are abandoned they could serve as epicenters of *Prosopis* recruitment because the fertile seedbeds would facilitate seedling emergence and survival. Research from Kenya supports this contention. Reid and Ellis (1995) illustrated that the seedbeds provided by pastoral corrals in arid South Turkana improved the germination rates and recruitment of young *A. tortilis* trees.

The *Prosopis* saplings that populate the livestock trails in the AWR offer the best evidence as to how livestock further disseminate seeds across the plain (see the photos in Kebede, 2009). That few *Prosopis* seeds were found in general on the plain may be most attributable to limited seed production. This hypothesis is based on verbal information from pastoralists and field observations. The relatively young trees on the plain may not have reached their maximum seed productivity whether due to age, local environment, or lack of insect-mediated pollination. For the latter, experts have noted that pioneer trees in grasslands can suffer from lack of suitable pollinators (E. Schupp, USU, personal communication). In contrast to the trees on the plain, mature *Prosopis* trees in gallery forests near the Awash River are extremely productive in terms of seed yields (D.L. Coppock, personal observation). Despite that soil seed-reserves appeared minor on the plain, the widespread occurrence of young trees suggests that recruitment will accelerate.

Scholars have noted the important role of ecological disturbance—including heavy grazing—in facilitating *Prosopis* establishment (Tiedemann and Klemmedson, 2004). This is true for *Prosopis* here, as the greatest extent of *Prosopis* cover was observed in the otherwise denuded vicinity of settlements. The negative effects of *Prosopis* on herbaceous plants have been noted in the Introduction; such effects are attributable to allelochemicals in *Prosopis* leaves that inhibit seed germination and seedling growth in grasses (Al-Humaid and Warrag, 1998), as well as the ability of *Prosopis* trees to out-compete herbaceous plants for light, water, and soil nutrients (Tiedemann and Klemmedson, 2004).

It took < 10 years for *Prosopis* to become well established in the AWR. It is realistic to assume that the grassland will be converted to *Prosopis* woodland if left unchecked. Dense *Prosopis* forests—completely devoid of understory vegetation—occur near the Awash River, illustrating a worst-case scenario. Recent mapping efforts by Wakie et al. (2014) indicate that *Prosopis* now occupies about 3 600 km^2 in the Afar region, and habitat suitability extrapolation suggests that the invasion area could expand another 140%.

Arguably, the most important and lasting implications for natural resource management of a *Prosopis* takeover of Allideghi grasslands concern direct and indirect effects of pushing already scarce wildlife to the brink of local extinction. A case in point is the endangered Grevy's zebra (Moehlman et al., 2008). The AWR is a vital refuge for this species, and chronic local threats include poaching, competition with livestock for forage and water, and habitat fragmentation (Moehlman et al., 2008; Kebede, 2009).

Prosopis must be added to the factors that could extirpate Grevy's zebra from the AWR. All zebra species highly depend on graminoid forage (Hack and Rubenstein, 1998), and grassland is the optimal habitat for Grevy's zebra in the AWR (Kebede et al., 2012). Dominant perennial grasses of high nutritional value such as *C. ciliaris* L. and *C. plumulosus* Hochst. were eventually eliminated on the study sites by *Prosopis*. This is a direct effect of *Prosopis* on reducing the zebra's food supply. That several thousand Afar and their livestock now permanently reside in AWR is primarily a consequence of their loss of other grazing lands to commercial agriculture, as well as competition with other pastoral groups (Getachew, 2001). Add to this the loss of grazing land due to *Prosopis*, and this indirectly reduces the zebra's food supply at the AWR via intensified competition from livestock. Livestock will win this struggle simply due to their greater numbers. In 2005–2006, several driving surveys enumerated 20 605 observations of large herbivorous wildlife and livestock on the plain (Kebede, 2009). Seventy-eight percent of these observations were livestock.

Human Dimensions

The shift in attitudes among pastoralists toward *Prosopis* from positive to negative over time has been reported among rural people in Kenya, and for similar reasons (Mwangi and Swallow, 2008). As observed in the Awash River valley, *Prosopis* is resilient elsewhere in response to most readily available control methods; the species also rebounds after treatment with high-tech approaches including machine harvesting and herbicides (Heady and Child, 1994). The utility of seedpod grinding has been noted before (Geesing et al., 2004). Charcoal making and other economic uses (i.e., using the wood for fuel, home construction, or furniture building—as in Kenya [D.L. Coppock, personal observation]) seems to hold the most promise in Ethiopia, as such activities could provide income and hence incentives. It also embraces the reality that *Prosopis* may never be eradicated but rather is a renewable resource that could be better managed.

Activities to systematically harvest and better use *Prosopis* by local people for income generation and resource management requires effective engagement by development agents with a strong focus on human capacity-building, benefit sharing, and local investment. The AWR, however, has been characterized by a lack of sustained engagement by officials with the local people—despite that community involvement has long been recognized as vital to achieve conservation goals (Hackel, 1999). Over the short to medium term, the way forward at AWR should include involving resident pastoralists in incentive-based conservation planning that incorporates *Prosopis* management. The longer such a process is delayed, the more costly and difficult it becomes (Grice, 2009). Over the longer term, general economic development, social change, and more effective community-based planning and resource management could lower the need for pastoralists and their livestock to occupy the AWR. This, however, requires effective policies and visionary leadership to become a reality (Abule et al., 2005).

Management Implications

Our work, in combination with that of other investigators concerning *Prosopis* in the Awash River Valley in the past decade, illustrates the potentially devastating direct and indirect effects of an invasive plant species on human land use, as well as the ecological integrity of several rangeland ecosystems—and all over a relatively short period of time. A poor, developing nation like Ethiopia has an especially difficult task in responding to such challenges given its limited financial resources and relatively weak governmental institutions. The challenge, however, could be addressed via strong, well-organized, collaborative commitments among various stakeholder groups. This includes having a spatially explicit strategy for eradication, extending technology, developing markets for *Prosopis* products, and creating policies that facilitate clearing large areas of *Prosopis* without endangering valuable woody plants in the process. The primary constraint lies in how to create a multilayered organization required for the task, and this needs—first and foremost—creative and effective leadership to build bridges and trust among various governmental and nongovernmental agencies, as well as civil society. Such organizational processes are not traditional for Ethiopia, but it is an achievable goal. Much ultimately depends on how the *Prosopis* threat ranks among other social and environmental challenges that need to be met in the Awash River Valley.

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