



CONSERVATION SCIENCE IN MEXICO'S NORTHWEST

ECOSYSTEM STATUS AND TRENDS IN THE GULF OF CALIFORNIA



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IMPACT OF RANCHING ON WILDLIFE IN BAJA CALIFORNIA

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Livestock have been present in Baja California since the 16th century when they were introduced by Spanish colonizers. However, for a long time animal husbandry remained in the form of small-scale operations. This changed in the 19th and 20th centuries when livestock numbers and areas used increased largely. In the process, burning, transhumance, harvesting of wild plants, and dry-time policies have been common practices. Despite the high numbers of cattle in Baja California, and its overall impacts on the habitat elsewhere, possible effects on Baja California rangelands have been neglected by agricultural officers and most academics, and the issue has been investigated only scantily. Overgrazing is probably widespread, but we think it is most severe, or noticeable, in the cool meadows of the northern mountains, where it has severely imperiled, or caused the extinction, of three endemic subspecies of California vole. Overgrazing is the likely cause of the disappearance of a number of meadows that were drained dry through gullies formed in particularly rainy years. Outside the grassy meadows, evidence for overgrazing is even scantier, although it has surely happened and might have impacted mule deer, pronghorn, bighorn sheep, mountain and California quails, California Bell's vireo and moles, among other species. Other likely, but poorly documented effects of animal ranching on wildlife include interference competition and the transmission of diseases and parasites from livestock to wildlife. Harvesting succulent plants to feed cattle can impair the habitat to support the native species. Grazing impacts upon wildlife habitat are probably aggravated by governmental programs that prevent cattle die-offs on the range during drought times by promoting high stocking rates, surely in excess of the range's carrying capacity at that time. In the whole, we believe livestock ranching has impacted wildlife throughout the Peninsula of Baja California, although the issue remains to be studied.

1. INTRODUCTION

In 1955, Rosarito de los Loya, a small community on the southern slope of the Sierra de San Pedro Mártir had 200 inhabitants who supported themselves with the cattle which they raised for meat, hides and cheese on the surrounding hills and, importantly, in an adjacent meadow. Things changed suddenly one morning in 1978 when, after heavy rains they woke to the unpleasant news that the meadow no longer existed: it had drained away through a gully created by the heavy runoff. Although this season was under the effect of El Niño, and rains were particularly heavy (see Figure 1), El Niño years are a common feature in northwestern Mexico, and this particular meadow had endured several such events before, although this was the rainiest year in half-a-century. Presumably, the meadow would not have disappeared if it had not been grazed so heavily as to impair the vegetation's capacity to protect the soil and retain water, and perhaps, if grazing of the upper reaches of the watershed had not lead to lower infiltration rates and higher runoff producing larger-than-normal river flow. In addition to its repercussion for the people that lived here, local populations of animals surely disappeared along with the meadow, including amphibians and, perhaps, California voles (*Microtus californicus*), whose three local subspecies are endangered (Mellink and Luévano 2005).

This is an example of how grazing by cattle can affect wildlife. However, grazing can be much more insidious, and in several places in the world its effects have been detected only after decades of research. No detailed long-term studies on rangeland conditions exist for Baja California, although one mid-term study has been carried out (Sosa-Ramírez and Franco Vizcaíno 2001), and the possibility of grazing impacts is neglected by many.

Throughout the world, grazing is the most subtle cause of habitat modification, yet the most widespread (Kelley 1990), and has damaged 80% of the streams and riparian ecosystems in arid regions of the western United States (U.S.D.I. in Belsky *et al.* 1999). Modifications result from changes in the competitive ability of plants as a result of their preferential use by grazing animals and/or the dissemination of their propagules, in what is known as "overgrazing" (Jordan 1993). This form of human dominance upon the environment is commonly unintentional, takes a long time to express itself, and is often inconspicuous, causing it to be overlooked in biological as well as administrative evaluations (Darling 1956). Despite ranching being the most widespread activity on the ranges of northwestern Mexico, and the known impacts on ranges elsewhere, its biological impacts along the Peninsula of Baja California have not been paid attention to. For example, the recent book "Del saqueo a la conservación: historia ambiental contemporánea de Baja California Sur, 1940–2003"

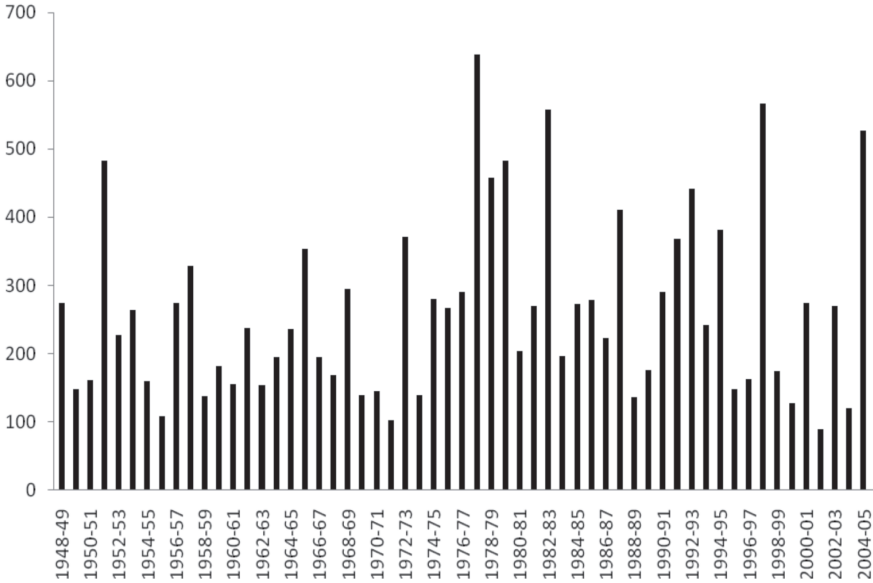


FIGURE 1. Rainfall in Ensenada, Baja California, during the rainy season (July of each year to June of the next). Data: Comisión Nacional del Agua.

(“From plundering to conservation: contemporary environmental history of Baja California Sur, 1940–2003,” Cariño and Monteforte 2008) does not include a single paragraph to analyze the impact of animal husbandry on biota in its over 700 pages of text. Likewise, in the corollary of a book on the oasis of the Peninsula (Rodríguez-Estrella and Arriaga 1997) there was no mention at all of ranching impacts on the biota. Federal agriculture officials concerned with rangelands for the state of Baja California have expressed to us their disbelief that rangelands are impacted by grazing; this feeling is, of course, reflected by the lack of governmental programs focused on range restoration.

This neglect can be due to the fact that degradation of semiarid ranges through grazing takes much longer than a human lifespan and, therefore, goes unnoticed, that it is less dramatic than, say, in grasslands, and the paucity of research on the matter. However, it is likely that ranching has impacted Baja California wildlife (Mellink 1996), and, indeed, a meticulous research of the historical sources available lead to the conclusion that there had been a severe overgrazing in the Peninsula’s northwestern ranges (Minnich and Franco-Vizcaíno 1998), particularly in and around the meadows of Sierra de San Pedro Mártir (Minnich *et al.* 1997), for

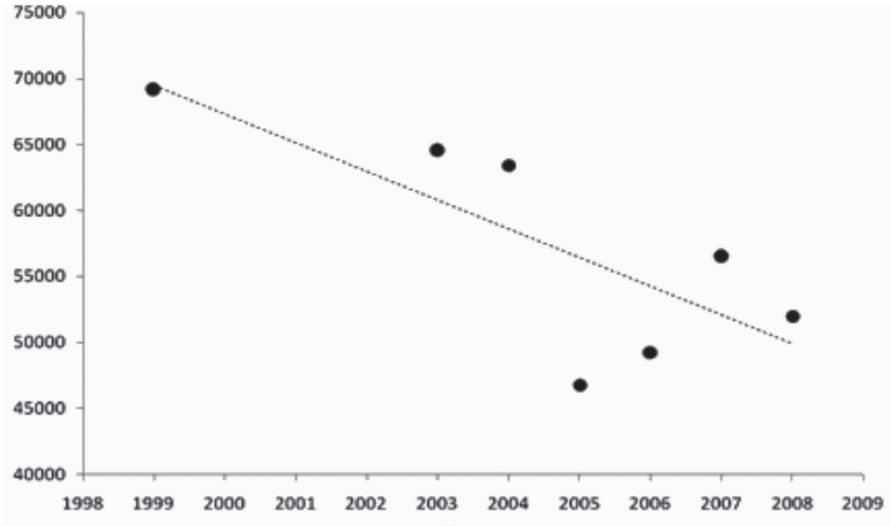


FIGURE 2. Number of heads of cattle in the Distrito de Desarrollo Rural 001, of the state of Baja California during the last 25 years. Data: DDR 001, Baja California, SAGARPA.

which Sosa-Ramírez and Franco-Vizcaíno (2001) recommended reducing grazing intensity in the Sierra's meadows "...to increase their grazing value and abundance of grasses and legumes."

The worst impacts upon native habitats come from the direct conversion of native vegetation to agriculture, but grazing can play a major role in habitat deterioration, as has been indicated for Sonora (Pérez-López 1992; López-Reyes 2006; Denogean *et al.* 2008), southwestern United States (Jordan 1993; Fleischner 1994; Noss 1994; Heffelfinger *et al.* 2006; Sommer *et al.* 2007), and the southern part of the Mexican Plateau (Mellink and Valenzuela 1992, 1995; Mellink 1994; Gonnet *et al.* 2001; Riojas-López and Mellink 2005), although some of the effects can be indirect and difficult to detect (Mellink 1989). Also, not always is grazing negative to the environment and, on the contrary, controlled grazing can be beneficial to it (Leopold 1933; Holechek 1981; Jordan 1993).

Although for the most part the overgrazing of rangelands of Baja California is neglected, the trend in number of cattle on the range suggests that such contempt is erroneous. Throughout the last 25 years the cattle herd of the Distrito de Desarrollo Rural 1 of the state of Baja California, which includes most of the state, has been diminishing despite the different governmental programs to stimulate ranching (see Figure 2). Such reduction reflects, we believe, a loss in the carrying capacity of the rangelands supporting this stock. The only other factor that could explain such

reduction is a generalized reduction in the amount of rain. Although changes in amount of rain are often invoked as causative of biotic changes, in our case they can be discarded, given that, although they exhibit large inter-annual fluctuations, there is no long-term pattern (see Figure 1).

The objective of this chapter is to review, based on the limited information available as well as our own experience in the field, the apparent or likely impacts of grazing by livestock on wildlife in Baja California. We address mostly the northern part of the Peninsula, as we are more familiar with it. However, we include scant information from the southern half (the state of Baja California Sur) when appropriate. We do not include feral grazers on islands, as they have been reviewed elsewhere (Howell and Cade 1954; Mellink 2002; León de La Luz *et al.* 2003). Here, as “wildlife” we consider terrestrial and fresh water amphibians, reptiles, birds and mammals.

2. GEOGRAPHICAL SETTING

Baja California, the second longest peninsula in the world, is a narrow peninsula of over 1,200 km, and spanning over 10° of latitude. It has a rugged texture given by a long series of mountain ranges along it. Its abrupt topography, and the influence of two very different oceanic bodies (the Gulf of California to the east, and the Pacific Ocean to the west) creates a variety of climatic conditions, broadly ranging from subtropical in the south to extreme desert in the northeast, and Mediterranean in the northwest. A fundamental characteristic of the climate, especially in the northern half of the Peninsula, is the combination of series of drought years, alternating with some very wet ones, due to El Niño Southern Oscillation events. The southern part of the Peninsula very often experiences tropical cyclones, which only rarely reach into the northern Peninsula. Both dry and wet periods, and the occasional tropical cyclone have a strong impact on ranching, although knowledge of their effect is only anecdotal. A complete description of the Peninsula and its characteristics is beyond the scope of this chapter, but a insightful account of it, along with a great map, is provided by Grismer (2002). A modern definition of its ecoregions can be found in González-Abraham *et al.* (2010).

The state of Baja California occupies the northern half of the Peninsula, and is typified by two major mountains: the Sierra de Juárez, in the north, and the Sierra de San Pedro Mártir, south of it. The second of these reaches above 3,000 m above sea level. On both sierras, but more at San Pedro Mártir, there are clear elevation vegetation patterns, from scrublands to conifer forests (Minnich *et al.* 1997). The northwestern Peninsula, under the effect of the California Current, has mediterranean

habitats. In contrast, the center and northeast are covered by variants of the Sonoran Desert, caused by latitude and orographic shade.

3. HISTORY OF RANGE USE BY LIVESTOCK

It is not possible to understand the impacts of animal husbandry on Baja California's wildlife without reviewing the history of ranching in the state. Right after colonization, cattle was ranching on open ranges, but throughout the 20th century, it was limited every time more by agrarian policies leading to a fractioning of land ownership. Although such fractioning was intended to alleviate social problems and enhance agricultural production, its results have been contradictory in terms of productivity, range conservation and impacts upon wildlife. We have divided the history of animal husbandry in the state into 4 periods. These are overlapping to some degree and surely escape the rigor of the historian, but reflect, to our best understanding, the major events in the human-environment relationship mediated by livestock.

3.1. Mission period

The first livestock arrived at the Peninsula on 3 May 1535 when Hernan Cortés disembarked some horses at the Bahía de Santa Cruz (currently La Paz). The mission of Loreto, the first permanent mission of the Peninsula, was established in 1697, and its inventory included 30 cattle, 10 sheep, 8 goats, 4 pigs and 1 horse. In 1683, Almirante Isidro Atondo y Antillón and the Jesuit priests Eusebio Kino, Matías Goñi and Juan Bautista Copart founded the mission of San Bruno (about 40 km north of Loreto), for which they received cattle from what are now the states of Sonora and Sinaloa (Martínez-Balboa 1981). This fact of receiving livestock from across the Gulf of California became common practice, as the animals raised on the local missions were employed for the northward expansion of the mission system (Del Barco 1973). So, the mission of Loreto received 8 cows and 6 horses in 1698, from Sinaloa, and father Kino sent an additional 200 cows and 170 horses from several Sonoran missions in 1700.

It is difficult, based on the information available, to determine the herd of each mission throughout time. For example, Francisco Palau reported in 1772 that there were fewer than 650 head of cattle in the missions from Santa Gertrudis to Santa María, but in 1800 the Dominican fathers reported almost 5,000 cattle at the El Rosario and San Miguel missions. In 1834 there were reportedly 3,500 head of cattle at El Descanso mission alone, while the mission of Nuestra Señora de Guadalupe reached over 5,000 cattle (Acosta 2009).

3.2. Consolidation

With the decline of the mission period of Baja California, between 1818 and 1849 (Acosta 2009), the existing agriculture all but disappeared and the ranches in the northern part of the Peninsula became the major economic endeavor of the residents. So, in 1827, between the mission of Santo Tomás and Todos Santos, the valleys and hills were “covered” by cattle, horses, and mules. In San Miguel, the mission had 3,000 horses and mules, and 30,000 sheep on the Buenas Aguas ranch (Pattie 1831). Also, on mission lands between El Rosario and Santo Tomás there were, before 1948, 60 000 cattle, 7,000 horses, 200,000 sheep, 2,000 mules, 2,000 burros, and 20,000 goats (Browne 1869).

During the first half of the 19th century several marginal ranches were established in the Central Desert, as the young married and became independent from their families. These were relatives of soldiers who now were idle in the region (Lassepas en Henderson 1964). It appears that over 150 ranches were established between Guadalupe and San Borja, but normally only a third were occupied at any time (Aschmann 1959). The climatic pattern of seasons of good, or even copious, rains punctuated by long periods of drought made ranching an hazardous activity and many ranches failed, some even before a year had elapsed. However, when a series of good years caused increases in livestock numbers, idle ranches were re-occupied or new ones established. When a new drought struck, only those in the best places survived (Aschmann 1959). Rancho Paraíso established by the Jesuits of the San Borja mission at a site explored by father Fernando Consag (1751) was abandoned in the fall of 1949 for lack of forage (Aschmann 1959). The severe, and widespread drought of 1863–1864 caused the loss of most of the sheep, horse, and cattle of the large herds of the missions (Browne 1869).

The economic activities of the region were affected by the anarchy that reigned until 1877, when the first stable government lasting a long period was established (Henderson 1964). Besides, before the late 19th century the region was not very attractive for productive enterprises (Minnich and Franco-Vizcaíno 1998), and it was until after 1850 when a large demand for meat [and surely hides and tallow as well] began to develop due to the mining boom in Upper California (Minnich and Franco-Vizcaíno 1998), and by 1857 there was already a large demand for meat leading to the development of ranching at “la frontera” (Henderson 1964). At this time there were 43 livestock ranches on 77 “sitios de ganado mayor” (“sites of large livestock;” approx. 135,000 ha) that had about 8,260 head of cattle (Lassepas en Henderson 1964). The demand of cattle-derived products by miners continued to stimulate ranching in northern Baja California and in 1911 there were 21,000 head

of cattle in association with the two northern sierras (Juárez and San Pedro Mártir; Henderson 1964). Some earlier reports speak of as many as 25,000 heads of cattle in the Sierra de San Pedro Mártir alone (Minnich and Franco-Vizcaíno 1998). Not only were animal products exported, but some California ranchers traveled south to buy live cattle, as the travels of Joseph E. Pleasants from Los Angeles, Calif., to San Telmo in 1867 and 1868 testify (Pleasants 1965).

In northwestern Baja California, during the late 19th and early 20th century cattle foraged in the lowlands until grasses were dry, after which cattle moved, reportedly of their own volition, to the higher mountains to forage on the meadows of the Sierra San Pedro Mártir, coming down again forced by the cold of autumn. Such transhumant cattle was reportedly in better condition than those that did not move to the upper meadows (Pleasants 1965). Irrespective of this, the quality of the cattle was influenced heavily by rainfall. Both of Pleasants' trips were in unusual years and cattle were in good condition, and were able to walk all the way to the "Los Nietos" ranch at a pace of 20 miles/day. However, as happened often, the following year was a bad year, in which ranchers lost most of their cattle, and Pleasants did not return south.

Although the increase in cattle numbers in the northern end of the Peninsula at the end of the 19th century has been attributed to the emergence of the California market for cattle products, we believe that it might have been favored by the presence of alien herbs. These herbs, which evolved under grazing pressure in the old world, colonized the region during mission times and could have provided much of the primary productivity of herbs and grasses (see review in Minnich and Franco-Vizcaíno 1998).

During the "Porfiriato" (the series of successive presidential terms of Porfirio Díaz in the late 19th and early 20th centuries), many of the best agricultural lands, which had been covered by grass, were plowed for farming, including the San Rafael (Ojos Negros) and San Vicente valleys which were turned over to barley (Henderson 1964).

3.3. Large livestock enterprises

During the second part of the 19th century, Mexico pushed forward a colonization strategy to increase the population and development of parts of Baja California (Walther-Meade 1983). As a part of it, land grants were given out to individuals and private companies to occupy and exploit idle lands (lands not under occupation and belonging to the Country). Such grantees were able to recruit only a few colonizers, which were left stuck on remote desert lands (Walther-Meade 1983). On the other hands, the first grantees tried to maximize their income by transferring their holdings to foreigners, or at least to associate with them. The purpose of the colonization

policy were, hence, distorted by the land winding up in the hands of companies that eventually got a hold of almost all of the current state of Baja California.

These colonization policies began at the end of the century, because as of 1870 there were no records of lands assigned to names that later reflected the existence of large companies, and all grants of land were to persons with Spanish surnames, and properties were small (Shipek 1965). Afterwards, large cattle companies under foreign (U.S.) landholders were created. For example, Robert H. Benton established one of the most famous such ranches, the Circle Bar Cattle Co., which had large tracts of land in the southern part of the Sierra de Juárez and nearby areas. From 1913 to 1920, it was administered by Robert's son Roy, who even imported shorthorn steers from Scotland to improve his herd of 10,000 head (<http://animalscience.ucdavis.edu/memorial/benton.htm>, accessed 5 January 2010). Afterwards, the company was administered by Ralph S. Benton, and it included cattle, sheep and horses which were raised on lands leased from the government, and moved according to forage availability. Between 1924 and 1930 the Circle Bar rented more than 40,000 ha on its own name, and 35,000 ha to dummy tenants, concentrated mostly on the Sierra Juárez and lands to the south (Samaniego-López 1999).

Another cattleman, Newton "Newt" House, had lived at the Rancho de [San Rafael de] Yorba, since 1894, where he worked for the Circle Bar and at the same time gathered a herd of his own and, eventually, formed his own company, under which he leased and bought large tracts of land (Samaniego-López 1999). Newt House prospered during the governorship of Abelardo Rodríguez (1923–1929) and was, in general, well supported by the system. During property conflicts, for example with the Ramonetti, the Secretaría de Agricultura y Fomento (the Ministry of Agriculture and Promotion) gave him "special treatment" (Samaniego-López 1999). Newt obtained Mexican nationality in 1924, and became safe from extraditions.

The area where these ranches were established represents a very important part of the mayor cattle and sheep producing area of Baja California, namely the northwestern part, between San Quintín and the U.S. border, and from the coast to the peninsular divide. In 1911, 12,000 cattle were reported from the Sierra de Juárez and 9,000 from that of San Pedro Mártir, along with small herds of horses (Flores and González 1913), whereas in 1918 between 18,000 and 20,000 head of cattle were calculated in the same area (Nelson 1921). There were also smaller operations and, for example, at the Rancho Los Pocitos, its Spanish proprietors raised sheep and fleece goats (Flores and González 1913).

Although large cattle companies were the major form of land administration in northwestern Baja California, they were not exclusive to it. Large cattle companies were the proprietors of most of the cattle in the Valle de Mexicali and the southern

portion of the Colorado River delta in the early 20th century, where the most common livestock was cattle, but there were also good numbers of sheep for the production of wool. At this time, it was already anticipated that agriculture would encroach upon livestock ranching in the future (Bonillas and Urbina 1913). For its part, the Magdalena Bay Co. held thousands of cattle on the Magdalena plain and nearby lava fields (Nelson 1921). The rest of the Peninsula had little cattle, whose numbers fluctuated in an abundance-scarcity cycle matching the cycle of rainy-dry years (Nelson 1921).

as in previous decades ranching in the northern portion of the Baja California Peninsula in the early 20th century was mostly for export of meat and hides, and the most important ranges were the higher parts of the sierras, especially that of San Pedro Mártir (Balse and Wittich 1913; Flores and González 1913).

The other important livestock component of northern Baja California was sheep, although they were raised in large numbers only in the northwest. During the 19th century foreign investors organized transhumance runs of sheep, mostly herded by Basque herders, which started their foraging journey near Tijuana in August, herding the sheep to the upper meadows of the Sierra San Pedro Mártir, from where they returned in October (Henderson 1964). This practice is thought to have increased in 1910, when sheep grazing in the meadows of the sierras of southern California was prohibited (Minnich 1988, Minnich et al 1997). However, by the same time, 6,000 sheep on the mesas south of Tijuana were considered a pale remembrance of times past, at least compared to the observations by James Ohio Pattie, a renowned mid-19th century trapper (Balse and Wittich 1913).

We have no record on whether sheep transhumance starting in the Tijuana mesas lasted long or not, but during the mid-20th century up to 20,000 sheep were taken annually to graze the meadows of San Pedro Mártir (Minnich *et al.* 1997; SEMARNAT 2009). This practice was prohibited in the mid-1960s following pressure by cattle growers of the area (Meling-Pompa 1991, SEMARNAT 2009). Currently, these meadows receive a variable grazing pressure, in response to resources elsewhere. In 1987, following a rainy winter, they were used little by cattle, but during the 1988–1990 drought they were heavily grazed (Minnich *et al.* 1997; SEMARNAT 2009).

3.4. Agrarian reform

One of the major transformations of modern Mexico, as far as land use goes, was that given through land re-distribution in the form of ejidos, communal land allotments that, until recent legal reforms, could not be sold. These commenced during the term of president Lázaro Cárdenas (1934–1940), and continued with ups and

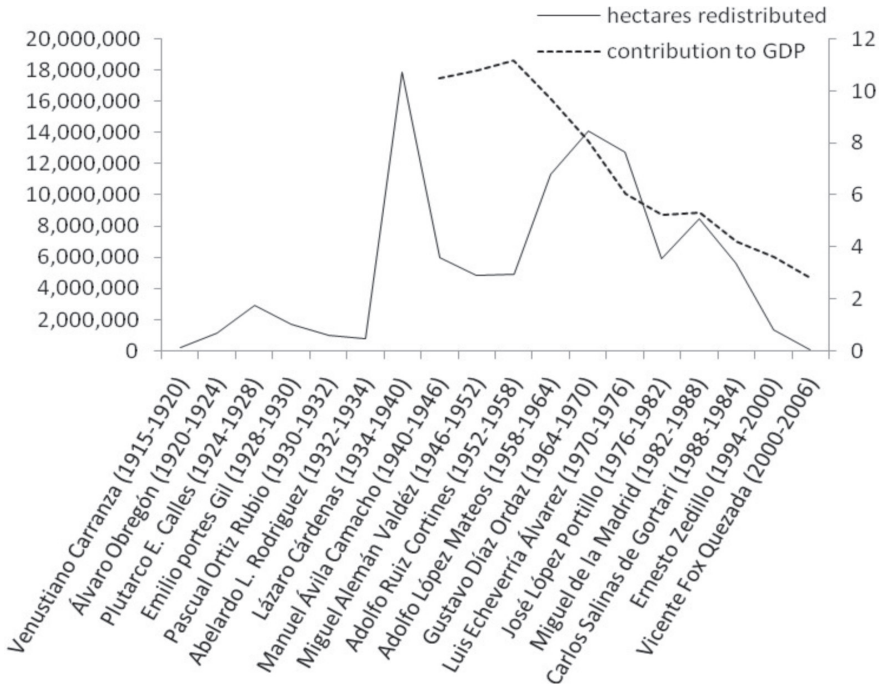


FIGURE 3. Land re-distribution and contribution of agriculture to the Gross Domestic Product (GDP) after the Mexican Revolution.

downs, until the term of Carlos Salinas de Gortari (1988–1994; see Figure 3). This re-distribution of land, which provided land to landless peasants did not significantly enhance the national economy, but had environmental effects, like soil erosion and loss of biodiversity in areas that probably should have never been converted to agriculture (Méndez 2006; FAO 2000).

This re-distribution caused fractioning of the land into smaller units, with more landowners, and a concomitant change in the patterns of livestock grazing. Gradually, the movement of livestock in search of forage was prevented by fences, and grazing pressure increased in many areas (although some ejidos, especially in the Baja California Peninsula still have large tracts of open range). Although most of the smaller properties were now fenced on the periphery, no internal fences were constructed to apply rotational grazing schemes that allow for restoration of range productivity and maintenance of biodiversity. On the other hand, during the second half of the 20th century, land leasing for grazing has been common in the northern part of the Peninsula, again leading to the creation of cattle companies. We lack

information to judge whether this has alleviated grazing pressure locally, or it has increased it.

The situation further south can be exemplified with the few data for the state of Baja California Sur (the southern half of the Peninsula). Soon after land redistribution began, that state inventoried 48,647 cattle, 5,173 horses, 4,622 goats, 3,044 mules, 2,615 pigs, 2,214 sheep, and 1,944 burros (Martínez 1947). The cattle were for local consumption, as meat, and export of hides, dried salt meat, and ranch cheese. During the second half of the 20th century, somehow favored by the re-distribution of the land, goat numbers increased notably throughout the arid portions of the Peninsula, especially in Baja California Sur. At the end of this century, goats were the main livestock in the Vizcaíno Desert area, and were the mainstay of over 200 rural communities there (Castellanos and Mendoza 1991).

4. RANCHING PRACTICES

4.1. Burning

For thousands of years, humans have intentionally burned native habitats in the Peninsula (Consag, 1751; Aschmann 1959, Biswell 1999), and not long ago this was still commonly practiced by ranchers between October and December to increase the forage value of chaparral (Melting-Pompa 1991; J. Contreras and E. Mellink, unpublished observations). This practice was, however, indicated as one of the two major problems that arboreal vegetation faced in the region (Engerrand and Paredes 1923), although it was not clear whether this opinion was backed by objective data. On the contrary, controlled burning, by rejuvenating and opening to herbaceous plants old, lignified chaparral stands, can be highly beneficial for cattle as well as for wildlife (Biswell 1999).

4.2. Transhumance

At the onset of the 20th century, as in the previous centuries, the range was essentially open for cattle to roam and graze, both in the Sierras and the desert (Acosta 2009). At this time, in northwestern Baja California cattle were not managed, but kept “in a wild state...” in which “... the animals roam around on the range and the owner does nothing else but branding them” (Flores and González 1913), which resulted in strong fluctuations resulting from the variable availability of forage. However, this view is, at least, simplistic, since as long ago as the 1790s, cattle were kept on the lower plains during most of the year and herded to the upper meadows of the Sierra de San Pedro Mártir in summer (Henderson 1964). This transhumance was the sign of animal husbandry in the northern part of the Peninsula during the 19th and 20th

centuries. Even when cattle husbandry included little more than branding, like at San Isidro del Mar in the early 20th century, they were moved to different ranges, which could include leased ones (Samaniego López 1999).

Likewise in Sierra de Juárez, livestock grazed Valle de San Rafael valley (currently Valle de Ojos Negros), Real del Castillo, and Valle de la Trinidad during most of the year, and were herded to the Laguna Hanson area for the summer. Newt House's operations eventually included up to 10,000 cattle under this scheme, between Real del Castillo and Valle de la Trinidad, and Laguna Hanson (Acosta 2009). Even in less suited areas, like ranges in Baja California Sur, Indian livestock, including horses, mules, burros, and cattle, were kept free on the range, but herded to the upper parts of the sierras during periods of drought, in the early 20th century (Diguet 1912).

Transhumance could be variable and might include areas not usually grazed, upon opportunity, as exemplified by the picturesque Antonio de los Ángeles López Meléndrez (a.k.a. "El Oso" ["The Bear"], deceased on the range in 1943), A cattleman for over 20 years at the turn of the 20th century. In good years, when there was grass and water in the desert, to the east of the Sierra San Pedro Mártir, the cattle were driven to the Colorado River (a one-month drive), and back. However, before the early 20th century, there were no known reliable watering places, as places where water occurred were known only by Indians. The discovery and enlargement of the Tres Pozos well by Edward W. Funcke, another picturesque character, created a reliable water source, allowing for such drives to the desert (Humphrey 1991; Mellink 2000).

Large-scale transhumance concluded with the agrarian reform initiated by president Lázaro Cárdenas in the 1930s. So, the creation, and allotment of land to ejido Sierra de Juárez resulted in the interruption of Newt House's transhumance ranching (Jesús José Arenivar Salgado Pers. Comm.). Although the larger-scale operations ceased, local transhumance continued to be practiced when the properties allowed for it. For example, it was so important for the ranchers of San Telmo and Santo Domingo, on the lower west slope of the Sierra de San Pedro Mártir, that "... it is impossible to raise livestock [without] grazing San Pedro Mártir" (Meling Pompa 1991), where cattle were kept from May and June to late October. This form of transhumance continued until well into the 20th century (Meling Pompa 1991, Minnich *et al.* 1997, Minnich and Franco-Vizcaíno 1998).

4.3. Harvesting of native plants for forage

Although most of the time cattle were left to survive the vagaries of climate on their own, when severe droughts struck they were fed often with wild plants harvested specifically for that purpose. These plants included cacti, like barrel cacti (*Ferocactus* spp.) and cardón (*Pachycereus pringlei*), foliage and pods of leguminous trees like

mesquite (*Prosopis* sp.) and dipua (*Parkinsonia microphylla*), and even trunks of the boojum (*Fouquieria columnaris*) and floral stalks of maguey (*Agave* sp.) (Diguet 1912, Balse and Wittich 1913). During the 1893–1894 droughts, barrel cactus near La Paz were so exhausted by harvesting that special trips were made to the nearby islands to bring more (Diguet 1912). Harvesting of native plants as emergency forage is still practiced throughout the Peninsula (J. Contreras and E. Mellink, unpublished observations). For example, although oasis-based cattle roam the ranges most of the time, during the dry part of the year they are confined to corrals where their forage includes native plants harvested from the wild, like choyas and barrel cacti (Breceda *et al.* 1997)

4.4. Ranching policies in times of drought

During strong droughts the government subsidizes ranchers with forage. Although such programs succeed in preventing the death of cattle due to lack of food, they contribute to maintain many more cattle than what the carrying capacity of the range allowed for. Another program that is often established in times of drought is that of subsidies to build large watering tanks for cattle, although their value for the production of cattle is dubious.

5. EFFECTS OF RANCHING ON RANGELANDS

Although Minnich and Franco-Vizcaíno (1998; see also Sosa-Ramírez and Franco-Vizcaíno 2001) were cautious in determining the magnitude of the impact that ranching has had on native habitats, we believe that it is possible to speculate on some of its likely effects on wildlife. Most of our inferences should be taken as propositions for investigation, rather than as proven facts.

Although we are unable to establish precisely the effects of ranching on wildlife, it would be highly unlikely, close to impossible, that there were none, given the known, strong impacts elsewhere (Noss 1994), which include "...loss of biodiversity; lowering of population densities for a wide variety of taxa; disruption of ecosystem functions, including nutrient cycling and succession; change in community organization; and change in the physical characteristics of both terrestrial and aquatic habitats" (Fleischner 1994; Belsky *et al.* 1999). In particular, grazing by cattle lowers density and structure of the vegetation and seed production; and compacts the soil, lowering water infiltration, increasing erosion, and modifying its available oxygen, chemical composition, microorganisms, and fertility (Liacos 1962; Belsky *et al.* 1999; Rauzi and Smith 1973; Gonnet *et al.* 2001; Czeglédi *et al.* 2005). However, the severity of the

impacts varies with type of ecosystem, species of domestic grazer, and the particular wildlife species of interest (Allen 1986).

5.1. Effects of overgrazing on wildlife

During the last two decades anyone visiting the meadows of the Sierra de San Pedro Mártir would have found a very short herbaceous community, which would have contrasted with the dense and tall grass cover found by Ed Griffin in 1887 and D.K. Allen in 1888 (Minnich and Franco-Vizcaíno 1998), and by L.M. Huey in the 1920s (unpublished field notes, San Diego Natural History Museum), and a paucity of wildlife that contrasts with its abundance in 1905–1906 (Nelson 1921). The change in the plant community has as its obvious cause overgrazing, which has "... reduced the diversity and abundance of native grasses... has caused soil compacting and degradation of the hydrologic and biologic systems" (SEMARNAT 2009). It has been argued that the culprit of such overgrazing of the meadows were the sheep on a transhumance scheme (Meling-Pompa 1991), although cattle herds found in them sometimes appear to exceed easily the 15–20 ha/ animal unit of recommended carrying capacity (Henderson 1964; COTECOCA 1985). Causes for the impoverishment in the wildlife of these meadows are more difficult to establish, and hunting might explain some of it. However, habitat degradation due to overgrazing is possible a major cause.

Regrettably, the issue has been investigated only scantily. A few decades ago some cattle exclusions were established in one of the meadows. After only four years, forage production was 50% higher inside the exclusions than outside them, and it was thought that longer exclusion periods appeared to lead changes in plant composition, and suggested the possibility that some plants species were eradicated due to grazing (Minnich and Franco-Vizcaíno 1998). Likewise, a 10-yr exclusion of cattle resulted in increased plant species richness and recruitment and changes in its vegetation structure, in the tropical dry forest of the tip of the Peninsula (Arriaga 2006).

If our hypothesis is correct, and we believe it is, locally, the most obvious effect of grazing appears to be the meadows, although evidence is circumstantial. Disappearance of the Rosarito de Loya meadow was a dramatic case that can be in all likelihood attributed to overgrazing, although the exact drivers, and their relative weight, are not known. This is not the only case of a 20th century disappearance of a meadow. A decade ago, the meadow of Rancho San Pablo, in the northern slope of the Sierra de San Pedro Mártir, was drying up because of the lowering of its water table due to the creation of deep erosion trenches (J. Contreras and E. Mellink, unpubl. obs.). The causes behind the formation of gullies were not clarified, but the

meadow and nearby slopes had been grazed heavily for decades. Another meadow that disappeared, although we lack knowledge on the events leading to it, was that of Rancho Tepi (in Ejido Tepi, northern San Pedro Mártir). A fourth example is provided by the grassy river-bank of Valladares. In 1996 E. Mellink and J. Luévano (Unpubl. data) searched for it in vain, and although they found its probable location, there were no traces of it. In 2013, we found its probable location, but the site was covered by shrubs, rather than grass and forbs.

The animal species most affected by the deterioration and loss of meadows is probably the California vole, which was trapped commonly in most meadows of the area in the early 20th century, and was absent at most sites in the mid 1990s (E. Mellink and J. Luévano Unpubl. data), despite it being a resilient species that can even become a pest in certain agroecosystems in California. It is our impression as well (J. Contreras, unpub. obs.), that overgrazing of the meadows has caused a reduction in forage available to mule deer.

Outside the grassy meadows, evidence for overgrazing is even more scant, although given that such effects have been documented throughout the world it would be naive to think that they did not exist in Baja California. Indeed, one author (Martínez-Balboa 1981) commented that, in general, rangelands in Baja California Sur were overgrazed, while another (Parra in Castellanos and Mendoza 1991) indicated that those in El Vizcaíno were possibly overgrazed. A brief study with cattle enclosures was inconclusive about grazing impacts on the forest range on the Sierra San Pedro Mártir (Minnich and Franco-Vizcaíno 1998), but time could have been too short.

Overgrazing of dry ranges possibly has impacted negatively some populations of mule deer, as it has done in southwestern United States (Lott, *et al.* 1991; Heffelfinger *et al.* 2006). The population of the endangered peninsular pronghorn antelopes (*Antilocapra americana peninsularis*) in the center of the Peninsula was subject to heavy hunting to supply meat to nearby mining camps (Buse and Wittich 1913). Although protected, this population has not bounced back to its historic numbers. No answer of this exists as yet, but it is possible that range degradation because of overgrazing is involved (see, for example, Schmidly 2002). Overgrazing can affect the quantity and quality of forage for pronghorns, (Howard *et al.* 1990), and the survival of their fawns (Autenrieth 1982). In some areas California quail (*Callipepla californica*) could have been affected by overgrazing, as happened in northern California (Leopold 1977).

Effects of the presence of livestock on a certain animal species can be related to the livestock species using the range. For example, Lee Grismer (Pers. Comm.; La Sierra University) did not perceive an effect of cattle upon reptiles, but where goats were present, reptile communities were very poor.

Grazing can impact wildlife without livestock being present year-long. Both, heavy periodic impacts and cattle present during critical periods like droughts, might be enough to affect wildlife. So, periods of heavy grazing in the northern sierras could negatively impact the feed or cover for mountain quail (*Oreortyx pictus*; Brennan 1994; Belding in Gutierrez and Delehanty 1999; Miller in Gutierrez and Delehanty 1999). Likewise, the yearly pulses of sheep grazing might have affected bighorn sheep (*Ovis canadensis*), and, indeed, its distribution during the 20th century could have been an artifact of previous grazing by domestic sheep. Mule deer are probably impacted more heavily when heavy grazing coincides with drought periods (Heffelfinger *et al.* 2006).

One of the habitats that might have received an especially heavy blow from grazing is the understory of riparian forests. In Baja California, this has very likely negatively impacted the California Bell's vireo (*Vireo belli pusillus*; Brown 1993). Another effect of the grazing of understory is the loss of adequate cover for the hiding of mule deer, especially the fawns (Loft *et al.* 1987). In some areas, high concentration of cattle could have affected the population of certain burrowing rodents, for example the moles *Scapanus latimanus* and *S. anthonyi* (both in the Mexican list of species at risk) in the northern sierras of the Peninsula.

5.2. Other effects of ranching on wildlife

Interference competition between livestock and wildlife can happen, although it is difficult to detect, except for selected situations. For example, feral burros have been argued to exclude bighorn sheep from waterholes (McKnight 1958), although the evidence for this is diffuse (Krasuman *et al.* 1996). Ticol Álvarez (in Mellink 1996) thought that this was the case in Baja California as well.

Besides direct competition through interference, there are a number of indirect effects of animal husbandry on wildlife. One of them is intentional burning. In addition to benefiting livestock, in California burning of an old stand of chaparral can benefit many species of mammals and birds (Longhurst 1978), including California quail and mule deer (Sommer *et al.* 2007). Although the effects of such burns in Baja California have not been studied, they are very likely similar.

One issue for which evidence is more solid is that of transmission of diseases and parasites from livestock to wildlife, whether livestock are the original carrier or that they become an effective intermediary. This has been one of the most serious conservation problems of bighorn sheep in the southwestern United States, and often the presence of pathogens is the only factor preventing the restoration of bighorn sheep populations (Goodson 1982; Berger 1990; Krausman *et al.* 1996; Schommer and Woolever 2008). In Baja California, diseases and parasites present in cattle have been found in mule deer (Contreras *et al.* 2007). Pronghorns are also susceptible to

livestock diseases (Thorne *et al.* 1988), and perhaps this has also played a role in the failure to populations in the central Peninsula to rebound, although this has not been investigated.

Some wildlife species rely on succulent plants in times of drought, including pronghorns (Funcke 1919), mule deer, bighorn sheep, and jackrabbits. Hence, the harvesting of such plants to feed cattle can impair the habitat to support the native species.

Grazing impacts upon wildlife habitat are probably aggravated by governmental programs that prevent cattle die-offs on the range during drought times by promoting high stocking rates, surely in excess of the range's carrying capacity at that time. In the long run, these programs, rather than favoring the cattle industry are probably counterproductive, as well as negative for habitat and wildlife conservation.

Finally, in addition to maintaining large stocking rates on the range, governmental programs affect the habitat through the building of large watering tanks that concentrate cattle and create high impact zones around the tanks. This results in areas which are compacted and cleared of vegetation by the cattle; with soil erosion as a possible consequence, in addition to the direct effect upon the habitat. So, even though additional water sources could benefit wildlife, these large tanks fail such purpose. If such programs call for watering tanks, it would be more appropriate to build small ones dispersed throughout the range and designed so that wildlife can benefit from them.

6. COROLLARY

The precise impacts of ranching on wildlife in the Peninsula of Baja California will never be known. It can be reasonably assumed that during the Mission period these were few and localized, whereas those by transhumance could have been heavier, especially that of sheep grazing in the northwest, at least at some habitats. Also, land re-distribution through the agrarian reform, by preventing the rotation of cattle on the range, possibly resulted in a more widespread and heavier overgrazing of the range.

It seems likely that ranching impacts have affected populations or whole subspecies, but not the entire population of a species. For example, it is possible that at one time there were voles in all meadows, perhaps as meta-populations, but by the time Huey (1964) surveyed the mammals of the Peninsula, they were already impacted by grazing and were present at only the few sites at which he documented them. In this case, although the species is nearly eradicated from the Peninsula, and apparently

two of the three subspecies described by Huey (1964) might already be extinct, the California vole as a species is not at risk; it is even a pest at many California sites. On the other hand, chaparral burning to benefit cattle is possibly beneficial for a number of wild species. The more complex relationship of grazing–soil erosion—increased runoff and its biological repercussion merits careful scrutiny and research, as it is a potential driver of future environmental degradation.

While gathering information for this chapter it became evident that there was a notorious blindness toward the possibility of grazing impacts upon the range. As a consequence, range restoration is absent from the local official programs in support of ranching or those for environmental conservation. The 2001 publication of the Mexican Official Norm that regulates range restoration (NOM-020-REC-NAT-2001), by raising the issue, gives some hope that reversal of grazing impacts will eventually permeate local programs.

Although the evidences of ranching upon wildlife and its habitat in the Peninsula of Baja California are scant, we feel that they point at a real problem, and that range degradation, including soil erosion and changes in the plant communities, should be paid attention to. We believe that an objective and careful assessment of the condition of the range is not only convenient, but imperative, both by a think tank group, and through field research. Among other things, the surveys carried out 30+ years ago by the Comisión Técnico Consultiva para la Determinación de los Coeficientes de Agostadero, COTECOCA—could be rescued and repeated now. Official programs in support of ranchers should pay much more attention to range restoration (of course with native plants) than to forage provisioning and construction of large watering tanks. Those wildlife species (and native plants, if any) likely to have been impacted by ranching should be targeted for specific conservation actions.

If ranges continue to deteriorate, the environmental as well as consequences for ranching will be severe. However, unless agriculture officers, ranchers, and scientists recognize overgrazing as a problem, little will be done to revert from the impacts that have already occurred, and prevent future land degradation from ranching. Addressing the issue of grazing impacts on the land would lead to better ranges for cattle and better habitat for wildlife.

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Exploring Mexico's northwest, the Baja California Peninsula, its surrounding oceans, its islands, its rugged mountains, and rich seamounds, one feels diminished by the vastness and the greatness of the landscape while consumed by a sense of curiosity and awe. In a great natural paradox, we see the region's harsh arid nature molded by water through deep time, and we feel that its unique lifeforms have been linked to this desert and sea for thousands of years, as they are now.

These landscapes of fantasy and adventure, this territory of surprising, often bizarre growth-forms and of immense natural beauty, has inspired a wide array of research for over two centuries and continues to inspire the search for a deeper knowledge on the functioning, trends, and conservation status of these ecosystems in both land and ocean.

This book offers a compilation of research efforts aimed at understanding this extraordinary region and preserving its complex richness. It is a synthesis of work done by some exceptional researchers, mostly from Mexico, who indefatigably explore, record, and analyze these deserts and these seas to understand their ecological processes and the role of humans in their ever-changing dynamics.

Elisabet V. Wehncke



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