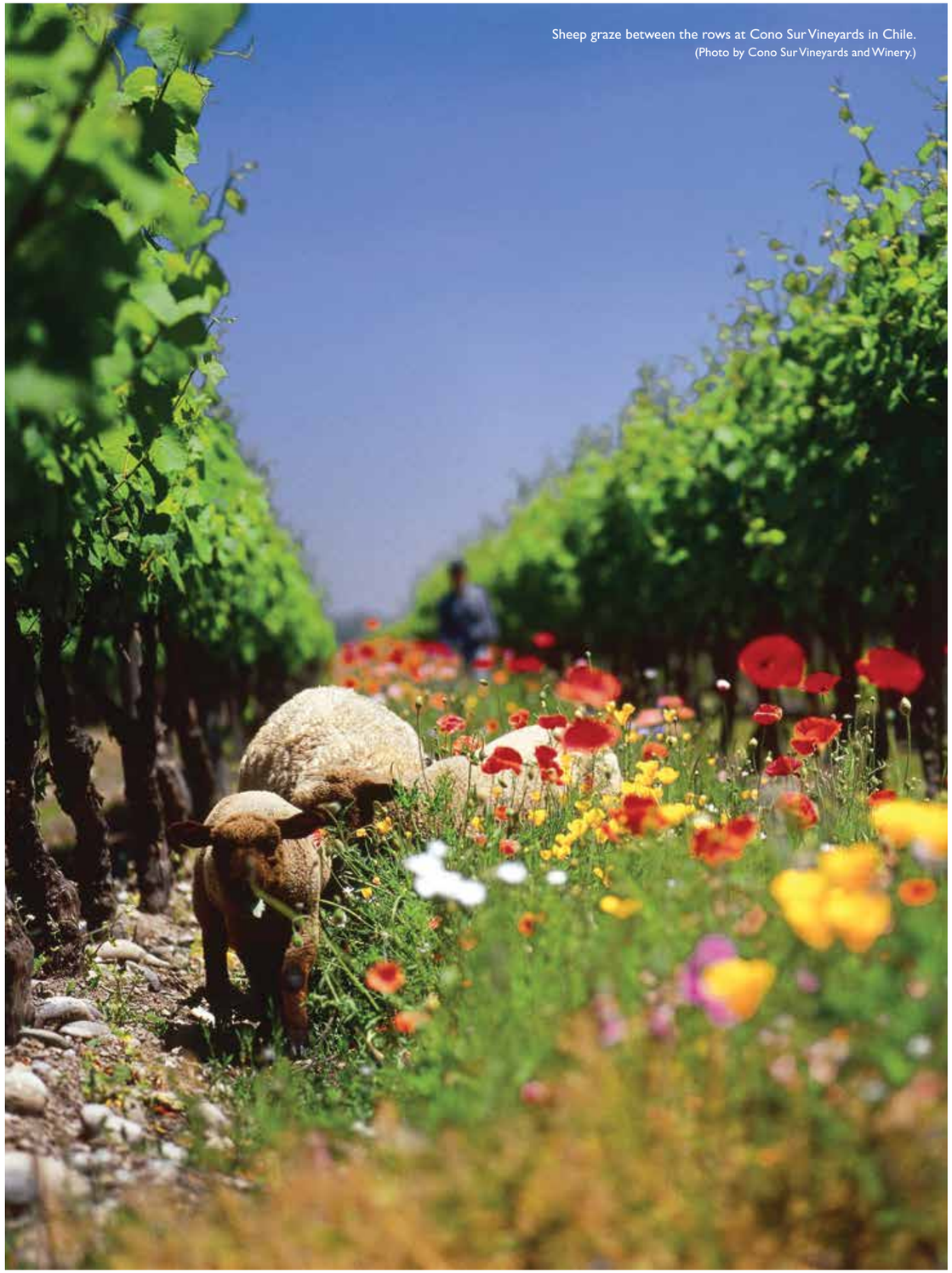

Sheep graze between the rows at Cono Sur Vineyards in Chile.
(Photo by Cono Sur Vineyards and Winery.)

CHILE AND CALIFORNIA

The Wine Is the Land

By Adina Merenlender, Miguel Altieri, Olga Barbosa, Andrés Muñoz-Sáez, Carlos Pino, and Houston Wilson

The similarity between vineyard landscapes in Chile and California is striking: both lie in mediterranean-climate ecosystems made up of twin vegetation types, and both produce some of the world's best wines. The two regions also face similar difficulties when it comes to balancing an agricultural economy and the environment.

Mediterranean-climate ecosystems — in which rainy winters are followed by long, dry summers — are rare. Despite making up just over 2 percent of the earth's terrestrial environment, they harbor 20 percent of known vascular plant species, many of which are found nowhere else. This biodiversity is threatened, however, because people also find mediterranean ecosystems to be highly desirable, and they tend to be heavily settled. In Chile and California, less than 1 percent of the mediterranean-climate regions are protected. Much of what habitat remains is at risk for continued deforestation, fragmentation, and degradation, in many cases due to the expansion of agriculture.

One way to protect native species is to restore agricultural landscapes, transforming them into semi-natural habitats that can support wildlife. Vineyards provide a unique opportunity to implement this approach because of the traditional respect for *terroir* among wine lovers. Originally a French concept, terroir is the idea that the characteristics of a specific piece of land — the soil, vegetation, slope, microclimate, etc. — impact the taste and quality of the wine grown there. To investigate the ways in which environmental concerns are compatible with the wine industry's interest in improving wine quality, we launched a collaboration among agricultural researchers, conservation ecologists, industry scientists, and wine-grape growers in both Chile and California. The ultimate goal is to provide a better understanding of ways to integrate environmental concerns into wine-grape production in order to improve conservation of biodiversity and ecosystem services.

Vineyards have expanded rapidly in both Chile and California due to a booming wine market. This change in land use, while a boon to both economies, has led to the loss of natural and agricultural diversity. Climate change may also drive vineyards to expand into new areas — farther south in Chile and farther north in California, Oregon, and Washington — to take advantage of cooler climates for wine production. The problem is not only the expansion of vineyards at the expense of natural habitat but also the degradation of the mostly unprotected natural areas adjacent to vineyards. These wildlands provide critical habitat for a number of unique mammals and bird species as well as important ecosystem services such as clean water and biological control of pests.

Preserving these habitats may be in the economic self-interest of winemakers. Currently, most of the wine that Chile exports consists of bulk and lower-priced wines, with slightly more than half coming from a few large producers. Many Chilean wine industry leaders are interested in moving upmarket so that they can increase prices and better compete in the United States. Improving wine quality is one strategy for achieving this goal, and the environmental conditions that create high-quality wine grapes are important for the Chilean industry to develop. Sustainable viticultural practices, including organic agricultural methods, can also improve vineyard market share where consumers are willing to pay a premium for wines produced using environmentally friendly practices. An added benefit to maintaining semi-natural habitats in wine-grape production areas is that more attractive vineyard landscapes are more enjoyable for tourists to visit, which can be another major contributor to the local economy.

While improving wine quality is of critical concern to the Chilean wine industry, there is also a strong commitment among many California wine-grape growers to environmental stewardship. Coupling the two presents a unique opportunity to promote the diversification of vineyard landscapes. To this end, we visited eight vineyards in Chile's four main wine regions — Maipo, Casablanca, Curico, and Maule — and nine vineyards in California's Napa, Sonoma, and Mendocino Counties. We also met with growers, members of environmental NGOs, and scientists. Based on this collective experience, we identified three main areas in need of attention: land-use and conservation planning, water resources, and increasing biodiversity in the vineyard.

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Lapostolle Vineyard in Chile is certified as both organic and biodynamic.
(Photo by Jorge León Cabello.)

Land-Use and Conservation Planning

Land-use change is the primary driver of habitat loss and ecosystem degradation, and it greatly intensifies other threats to the environment. Habitat loss and fragmentation are leading to an unprecedented rate of species extinction, which heightens the importance of conservation planning to protect biodiversity. New vineyard acreage is being planted in upland areas that support native plant and animal communities in both Chile and California. Conversion of undeveloped land to vineyards involves the clearing of native upland and riparian vegetation. This type of conversion has the potential to affect natural resources — increasing hillside erosion, degrading freshwater resources, leading to endangered species, or impeding wildlife migration. In order to be truly sustainable, agriculture needs to go beyond the farm scale and achieve no net loss of natural habitat. While farmers should be encouraged to adopt more environmentally friendly farming practices, we also need to pay attention to maintaining natural areas in and around vineyards to maintain local biodiversity.

In both Chile and California, there are strong economic incentives to clear undeveloped land for new vineyards and few regulations to protect native plant and animal communities. There is no state agency that oversees or regulates vineyard or other agricultural land conversion in California. In Chile, the Ministry of Environment and Agriculture and Animal Service does have a law regarding native forests, but this oversight has not provided sufficient protection for natural habitat. In both places, there are also a few local policies that focus mostly on preventing hillside erosion. Our visits to vineyards included discussions with growers and consultants in which we found that economic factors are the key drivers for land-use change, with little attention paid to landscape-scale conservation planning. In both regions, vineyard owners may have title to thousands of acres of natural habitat surrounding their vineyards, but the future of this habitat remains uncertain as there are no incentives to ensure its protection in perpetuity. However, some wine growers do keep this land aside for conservation, either due to their own initiative or because they are engaged in conservation programs such as the Wine, Biodiversity and Climate Change Initiative in Chile.

Odfjell Vineyards in Maipo Valley, Chile, adjoins 150 hectares of native shrublands and forest currently under a restoration program focusing on degraded slopes.

Photo courtesy of Adina Merenlender.

Photo courtesy of Adina Merenlender.

This reservoir at Husch Vineyards in Anderson Valley, California, is used to provide water during the dry season to prevent overreliance on the neighboring Navarro River.

Water Resources

In mediterranean and other water-stressed climates, water management is critical to the conservation of freshwater and terrestrial ecosystems as well as to agricultural production. Water storage and conveyance projects are often constructed at a scale and level of complexity far exceeding those in other, less seasonal climates. As a result, ecological stressors associated with natural periods of flooding and drying are compounded by impacts from water infrastructure development for agriculture and other human uses. To secure and maintain water allocations for the environment, integrated water management approaches are needed that consider ecosystem flow requirements, patterns of human water demands, and the temporal and spatial dynamics of water availability. This issue has received more attention in California coastal areas where endangered salmon species are barely surviving.

Both regions also struggle to meet the demand for vineyard irrigation and, in some cases, water-intensive frost protection, without degrading freshwater resources. In addition to having a negative impact on aquatic species, vineyard water use can deplete groundwater and lead to the accumulation of salt in the soil. Water management is only going to become more challenging in the face of climate change, yet there are few incentives to limit vineyard production in water-stressed areas or to alter management strategies to reduce reliance on surface water withdrawals during the dry season, when natural stream ecosystems are most sensitive.

In California, we met with farmers in the Alexander Valley, along the Russian River, who are monitoring groundwater to look for changes associated with groundwater pumping for vineyard irrigation and frost protection. While impacts on streams in the Alexander Valley are buffered in some places by the availability of groundwater resources, higher up in the watershed the situation is more problematic. Pumping water along smaller tributaries for springtime frost protection has led to a complete lack of stream flow during short but critical periods in salmon-bearing streams. Extensive hydrological analysis is required to estimate the trade-offs between agriculture needs and the environmental flows required to maintain salmon populations. Continued attention must be paid to how agricultural water use and freshwater natural resource conservation can coexist.

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Photo courtesy of Adina Merenlender.

Quintessa vineyard in Napa County, owned and managed by a Chilean company, manages vineyard blocks under a biodynamic program, which has improved fruit quality.

Diversifying the Vineyard: Hedgerows and Cover Crops

In addition to providing environmental benefits, enhancing biodiversity in and around the farm can reduce reliance on agricultural chemicals. In California and Chile, many wine-grape growers remove all vegetation from under the vines and between the rows, usually with herbicides or tillage, to have maximum control over vine growth. However, the lack of plant cover can reduce the number of spiders and other beneficial insects and desirable wildlife that feed on insect and mite pests. In some cases, biological control agents or nitrogen-fixing cover crops can act as partial substitutes for synthetic pesticides and fertilizers. The practical management of biodiversity in the vineyard is especially important in organic agriculture because organic growers have no recourse to synthetic nitrogen and pesticide applications. While there are many ways for a vineyard manager to maintain or enhance biodiversity to develop a more ecologically functional vineyard, we currently lack sufficient outreach programs and incentives to promote the widespread adoption of such practices.

Overwintering cover crops are widely used in vineyards to control erosion and fix nitrogen. The mixture of cover crops is important because having multiple species can provide functional redundancies and complementarities. For example, functional redundancy occurs when multiple legumes are used in a cover crop seed mix: if one species grows poorly, another may compensate, providing back-up. Functional complementarities can be obtained by seeding grasses and legumes together. Grasses are often more efficient at scavenging soil nitrate, whereas legumes fix atmospheric nitrogen.

While winter-annual cover crops may provide resources for beneficial insects that could enhance the biological control of pests, they are typically mown down in the late spring, just as grape vines begin to push out new shoots. The use of cover crops during the summer growing season is much more limited due to concerns about the cover crop competing with grape vines for soil moisture and nutrients. In some cases, such competition is actually desirable and can improve grape quality. Where this is the case, growers typically establish perennial grass covers to regulate over-vigorous grape vines, sometimes using native plants.

While more expensive, native cover crops are readily available in California; in Chile, they are just being developed. Research on the development of native cover crops is a high priority for Chilean growers, who up to now have used cover crops developed in California. The problem with importing California natives is that some species have become invasive, outcompeting Chilean native species. Finally, some growers do regularly establish flowering summer cover crops to provide habitat and resources for beneficial insects, although this is very rare and can raise production costs. Both perennial grasses and flowering summer cover crops can provide important foods for birds and other vertebrates.

Another highly desirable way to maintain biodiversity in the vineyard and to promote beneficial insects for pest control is to plant native hedgerows. The plants may need irrigation at first, but once established they can often thrive on rainfall alone. In many vineyards, hedgerows consist simply of the edges where the farmer has decided to tolerate the growth of volunteer plants, including trees, shrubs, herbs, and grasses. This type of informal hedgerow is far more common in Chile. Planted hedgerows are more readily found in California's coastal vineyards, in part due to cost-share incentives provided by the U.S. Department of Agriculture. The advantage of purposefully planted hedgerows is that farmers can avoid species that harbor pests or diseases that affect wine grapes. There are some exemplary vineyards in California that use biodynamic agriculture practices in which the surrounding native vegetation is connected to the hedgerows and the diversified planting areas to create a more balanced ecological system.

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Photo by Andrés Muñoz-Sáez.

A falcon hunts insects in a Chilean vineyard.

Future Directions

Wine-grape growers increasingly recognize the importance of the environment and the need to protect biodiversity. In part, this shift is due to buyers who want to support sustainable agriculture. While environmentally conscious consumers often rely on certification programs, current programs focus on minimizing agricultural chemical use and rarely emphasize biodiversity conservation. Similarly, some farmers and growers associations are committed to organic or biodynamic practices, but they tend to focus primarily on biological control by insects and not on biodiversity conservation or on habitat management for wildlife. Therefore, two of the central challenges in our future collaboration will be to quantify the ecosystem services that native ecosystems provide to vineyards and to collect data on the role vineyards play as a habitat for wildlife.

Climate change will likely cause growers to expand vineyards into previously uncultivated natural areas, further threatening biodiversity, and water stress will become a bigger problem in many regions. While most grape growers are aware of climate change, they do not always understand the direct influence it will have on their vineyards. In most cases, more attention to future conditions, especially water availability, would result in better climate adaptation strategies. Additional collaborative efforts between Chile and California could provide the information, technologies, and capacity building needed to protect the two countries' fragile mediterranean-climate ecosystems and to promote both regions' quality wines.

Adina Merenlender, Miguel Altieri, Olga Barbosa, Andrés Muñoz-Sáez, Carlos Pino, and Houston Wilson are part of a binational research team that received a seed grant funded by Chile's National Commission for Scientific and Technological Research (Conicyt) and administered by CLAS.

Their research will be available to wine-grape growers and managers through a bilingual website (http://ucanr.edu/sites/vec/) and continued outreach to the industry.

Attractive vineyard landscapes are more enjoyable for tourists to visit: a tasting at Quintessa in California.

Photo by M.J. Wickham Photography/Courtesy of the Wine Sisterhood.

Photo by Paolo Vescia.

A danger sign to warn of recent pesticide application in a Salinas field.

PUBLIC HEALTH

Growing Up Too Fast

By Rose Kagawa

Historically, the age at which girls begin puberty has edged younger and younger, but in the last century, the age of pubertal onset has dropped precipitously. This downward trend is troubling because early puberty among girls is linked with poor health outcomes, both during adolescence and later in life.

Girls who enter puberty early are more prone to depression, anxiety, behavior problems, substance abuse, eating disorders, and early initiation of sexual activity. Over time, they are at higher risk for illnesses such as breast cancer and cardiovascular disease.

Childhood obesity is the most frequently given explanation for the earlier onset of puberty, but social and environmental factors also seem to be important. For example, studies suggest that when a girl's biological father is absent during the early years of her life, her risk of reaching puberty before age 12 is increased. More generally, early puberty seems to be entwined with low socio-economic position and the many challenges that often accompany it, such as family instability and stress in early life.

Chemical exposures are also coming under increasing scrutiny. Animal models have shown that endocrine-disrupting chemicals can alter the timing of puberty by changing normal hormone levels. These chemicals are fairly common in our everyday environment and are present in some plastics and pesticides.

Julianna Deardorff, a clinical psychologist and an associate professor of Public Health at UC Berkeley, studies the impact of early life experiences on pubertal development, substance use, and sexual risk behaviors in her work with the Center for the Health Assessment of Mothers and Children of Salinas (or Chamacos, which also means "little kids" in Mexican Spanish).

The Chamacos study was initiated by UC Berkeley Public Health professor Brenda Eskenazi. In 1999-2000,

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