SUSTAINABLE VINICULTURE: GIVING SALMON A CHANCE TO THRIVE FOR FUTURE GENERATIONS

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ABSTRACT: Seldom are vineyards considered significant polluters to the environment or inhibitors to life. However, conventionally farmed vineyards actually use excessive amounts of water and chemicals, coupled with extravagant bottling and labeling processes. The practice of vineyard farming is responsible for harmful environmental practices, unbeknownst to the public. Their negative environmental impacts include chemical runoff and soil erosion, which kill vulnerable salmon eggs incubating in satellite streams and rivers. Salmon populations in the Salish Sea have declined dramatically since first recorded in 1984. To improve the situation, multiple international universities have identified viable agricultural techniques for creating sustainable vineyards that tread lightly on the surrounding environment and can preserve water, lessen the need for chemical pesticides, and prevent soil erosion. An additional benefit is vintners do not have to spend money on these items, thereby increasing profit margins. From an ethical standpoint, vineyards should adopt these agricultural methods particularly since recent surveys revealed consumers are willing to pay more money to buy sustainably produced wines. Thus, how might vineyards implement certain sustainable agricultural practices to protect and mitigate damage to wild salmon populations?

Introduction

Walking through an American grocery store, one is likely to stumble through a section of shelves lined with exquisite bottles of wine with artistically designed labels. Most are bottled in heavy, unrecycled, virgin glass. A huge market for wine in America exists;, however, there is a profound lack of information among consumers regarding the environmental impact of vineyards. This research essay will introduce the importance and value of salmon, which populations are staggering due to current viniculture practices. It will then discuss the differences between sustainable and conventional vineyards, before analyzing authentic and financial viability of producing sustainable wines and lastly, identifying the connection between salmon populations and soil erosion caused by vineyards. Thus, the essay will be organized in a methodological fashion: examined through the scientific and biological disciplines. Due to the practicality of producing sustainable wine, all vineyards should practice sustainable agricultural methods. Specifically, vineyards should prevent soil erosion to protect fragile wild salmon populations.

Discussion: Salmon as a Valuable Resource

The value of wild salmon cannot be quantified. To the Pacific Northwest Tribes, salmon is an essential part of their rich cultural identity and provides a spiritual livelihood. “Without salmon returning to our rivers and streams, we would cease to be Indian people” (“Tribal Salmon Culture”). This powerful statement shows how salmon is the ancient lifeblood for indigenous peoples of the Northwest. In 1915, Chief Yakima stated, “my strength is from the fish; my blood is from the fish, from the roots and berries” (“Tribal Salmon Culture”). Not only is salmon important to tribal peoples, and has been for generations, but its fisheries contribute more than $175 million to Washington’s economy

every year ("Harvest"). Thus, a healthy salmon supports multiple peoples in attaining their livelihoods.

Additionally, modern recreational salmon fishing provides the government and private sector with income. The recreational value of a single salmon has been calculated to exceed $200 when one takes into account of fishing licenses and ancillary items such as equipment, local lodging, and guides., etc. (Whitelaw 1). Unfortunately, salmon populations have been rapidly declining, and the ongoing loss of wild oceanic salmon represents an economic and environmental tragedy. In the Salish Sea, slightly less than 500,000 Chinook salmon were reported in 2010, which is a 60% reduction in the population since salmon population tracking began in 1984 ("Chinook Salmon"). This recent and drastic reduction is an outright environmental emergency which needs immediate remedial action to contain the salmon population losses. While there are multiple threats to current populations of wild salmon, those posed by neighboring conventional vineyards can be resolved quickly and inexpensively.

Discussion: Threats Posed to Salmon Populations by Current Vinicultural Practices Include Runoff

Agricultural runoff, in the form of pesticides, fertilizers, and animal waste are major threats to vulnerable salmon populations. However, farms do not necessarily need to use chemicals in order to keep their crops safe and plentiful. Farmers are beginning to move away from harmful pesticides in favor of more natural means of eliminating destructive insects, such as planting catnip between rows of crops (Schneider 1). By utilizing catnip or other natural insect repellents, harmful pesticides and herbicides will not leech into the streams or riverbeds where the nurseries for salmon eggs are located. All types of farmers are rethinking the use of pesticides due to health risks, environmental damage, and huge surpluses which drop the value of their commodities making their financial situation inviable and unprofitable (Schneider 1). Pesticidal use by large-scale commercial farming operations can also cost billions of dollars each year (Schneider 1). Refraining from the use of pesticides is no longer just limited to small farms or personal vegetable growing. In 1987, out of the United States' 2.1 million farmers, up to 100,000 of them had changed their farming methods to exclude use of pesticides (Schneider 1). Not using pesticides is becoming mainstream in America. Therefore, vintners near salmon sensitive areas can easily switch their agricultural practices to exclude the use of pesticides which is better for the environment and their pockets. From an ethical standpoint, all vineyards should reduce or not even use pesticides/herbicides in their growing practices in an effort to preserve the health of the environment and safeguard salmon from the dangers of chemical residue.

Discussion: Soil Erosion

Another danger to salmon eggs is soil erosion brought on by conventional agricultural practices. Soil erosion occurs when the top layers of agricultural soil shift and displace due to the movement of water. Soil erosion is a threat to vulnerable salmon eggs which nestle in the false safety of riverbeds. Eggs cannot survive if they are crushed and soil erosion crushes eggs nestled in sandy river bottoms, leaving streams without fish.

A stark example is found in Idaho where Chinook salmon spawning areas were severely damaged from soil erosion attributed to the logging industry (Platts 230). Agricultural soil is generally comprised of a mixture of fine and coarse sands. Sudden increases in sediment loads into river systems can induce intolerable changes by the sizes of particles settling into the salmonid spawning areas (Platts 235). Reducing soil erosion will save salmon populations because eggs will have ample time to incubate. To aid the protection of salmon populations, eggs must be viable in order to complete the reproductive cycle.

Discussion: Alleviating Threats to Salmon Populations by Use Of Mulch to Protect Soils' Water Retention Abilities

While vineyards cause high rates of soil erosion, the effects can be significantly mitigated by simple changes in the fields. A feasible and inexpensive solution was proposed by Dr. Massimo Prosdocimi, who has a Ph.D. in viniculture and is a university professor in Italy. He discovered a sustainable way to decrease agricultural runoff and soil erosion simultaneously, which poses the largest threat to salmon populations. Due to the dry and hot climate grapes must be cultivated in, water cannot penetrate the surface of the baked soil, thereby predisposing conventional vineyards to the highest rates of soil loss among all cultivated agricultural sites (Prosdocimi 323). Dr. Prosdocimi proved barley straw mulch reduced rates of soil erosion and, hence, soil runoff from vineyards into nearby salmon habitats. Dr. Prosdocimi's experiment entailed placing barley straw mulch over the vineyard plots for protection from the sun and to retain water in the earth. In the barley straw mulch experiments "the median water loss decreased to 39.27% of the total rainfall" and the "median total sediment detached from 70.34 to 15.62g" (Prosdocimi 324). Additionally, straw mulch is inexpensive and abundant, making it easily obtainable to vintners. The straw mulch will reduce the amount of water needed for their vines and the amount of water lost to evaporation. The straw mulch will lessen the need to plow and till fields because the soil will be displaced much less, saving farmers great amounts of time and money. All these factors will decrease the cost of operating the vineyard, hence allow for positive impacts on profits.

Discussion: Water Conservation

In the summer months, the expense of water increases dramatically with its scarcity. Additionally, moisture does not easily penetrate sunbaked soil, demanding a larger volume of water during these hot days when water is at its highest price. Thus, reducing the need for this limited resource will decrease operating expenses of the vintner while preserving a precious resource. Concerns of vineyard water consumption preventing successful salmon runs can be partially alleviated (Grismer 144). For example, a parched land, such as California, cannot sustain riverbeds for salmon to return to spawn and irrigate vineyards simultaneously. Unfortunately, in California the indigenous oak woodlands and savannas have increasingly been converted into vast vineyards (Grismer 144). The production of wine grapes provides a huge source of revenue for the California economy, making vineyards more financially viable than natural landscapes (Grismer 144). California notoriously suffers from parched land and vineyards fail to alleviate this condition. Paralleling this conversion of land, there are increases in rates of annual runoff by at least 50% (Grismer 144). Moisture does not soak into the soil and there is a significantly large increase in water runoff, conversely increasing rates of decline in native salmon populations. By using Dr. Prosdocimi's method of applying barley straw mulch, the rates of water runoff and soil erosion decrease. Salmon populations could thrive if every vineyard near waterways incorporated straw mulch, a sustainable method in their viniculture practices.

Discussion: Characteristics of Conventional and Sustainable Vineyards

There is a significant difference between conventional and sustainable vineyards, which are outlined in a research paper entitled "Ecological Footprint analysis applied to the production of two Italian wines" by Dr. Valentina Niccolucci, PhD. Niccolucci analyzed the difference of two vineyards, one conventional and one sustainable, located in the same region and growing the same grapes. While the wines both vineyards produced cost the same on the shelf, their production philosophies and methods were entirely different. These studied differences can be applied to all vineyards

similarly operated.

Discussion: Management Styles of Vineyards

The sustainable vineyard is denoted as being primarily run by the efforts of occasional workers, overseen by the management of a singular family; most of the work would be performed by hand stemming from local tradition (Niccolucci 163). The sustainable vineyard is starkly different than the conventional one which was portrayed in an iniquitous manner. The operation being mostly industrial and utilizing chemical fertilization and pesticides (Niccolucci 163). While the sustainable vineyard sells the wines locally, the conventional vineyard bottles their wines and ships them globally for a larger consumer market (Niccolucci 163). A bottle of wine from the conventional vineyard has an increased carbon footprint due to its long journey to its final marketplace before consumer consumption; wines from conventional vineyards are exported all over the world via plane, cargo ship, and truck. Whereas the sustainable bottle of wine is enjoyed locally with a minimal carbon footprint.

Discussion: Selective Harvesting Techniques

As with management and product transportation, sustainable vineyards also require smaller acreage than conventionally managed farms. Interestingly, conventional vineyards require 50% more land than sustainable vineyards (Niccolucci 164). This is due in part, to the conventional vineyard's assiduous and methodological selection of grapes to produce the finest wines (Niccolucci). Whereas, sustainable vineyards were not as selective in their grape harvesting, picking grapes as they become available within certain parameters (Niccolucci 165). Thus, sustainable vineyards require smaller vineyards than conventional to produce sufficient grapes for harvest. Sustainable vineyards conclusively waste fewer grapes than conventional vineyards.

Discussion: Use of Recycylable Materials

Another major difference between the two types of vineyards is observed during the packing phase when the wines are bottled and labeled. The conventional vineyard consistently uses only the foremost products available in all phases of wine production. Even the glossy bottles themselves are of heavy, nonrecycled glass (Niccolucci 165). Instead of virgin weighted bottles, the sustainable vineyard management purposely uses lighter bottles that featured recycled glass to decrease waste (Niccolucci 165). Thus, even the manufactured components of the winemaking process have different environmental impacts. The sustainable vineyard generates significantly less waste than the conventional vineyard and even reuses recycled materials, which environmentally conscious consumers appreciate.

Education of the Consumer

Expanding consumers' recognition of agriculture's environmental responsibility spurred the practice of sustainable agriculture. However, even with increased awareness of the importance of sustainable agriculture in the face of climate change, there is a large knowledge gap existing between wine production and the consumer. With the overwhelming supply of bottles in grocery stores, it is time-consuming for the consumer to navigate the quantity of products to select one aligning with their values. Gary Zucca, a viniculture expert and famed winemaker performed a survey of over 300 participants who identified as wine consumers. In Dr. Zucca's research, approximately 95% of consumers were unable to identify a single vineyard that practiced sustainable viniculture (Zucca 193). However, nearly 90% of participants in his study believed in sustainable viniculture and indicated they would purchase wine from these farms (Zucca 193). Interestingly, of these participants only 7% were able to discuss examples of sustainable agriculture practices (Zucca 193). Helping consumers identify sustainable agricultural

products, such as through a certification process which could include a final stamp of approval on labels, will create demand for sustainable wine.

Salmon Safe Certification

Recognizing the need to assist in consumer education and recognition of sustainable wines, Washington, Oregon, and British Colombia have created a private "Salmon-Safe Certification", which has certified over 350 vineyards. This certificate is proudly included on the labeling of salmon-safe wines. This program makes sure not only the vineyard is salmon-safe but also ensures the nearby water quality of the river systems and habitat are able to support and increase biodiversity around vineyards ("Salmon Safe Vineyard Certification"). The certification requires vineyards to plant trees on nearby streams to prevent soil erosion and create shade, as well as to grow cover crops, such as catnip, to control water runoff and use only sustainable methods to control pests and weeds ("Salmon Safe Vineyard Certification"). The wines sold with this label are sought out by consumers, who care about their environment and want to make ethical choices when buying wines. The wine-producing industry is taking notice of this newfound consumer demand. Due to demand, wellbeing of the environment and sacred importance of healthy salmon populations, "Salmon Safe Vineyard Certification" should be legally required of all vineyards in the proximity of salmon habitats.

Conclusion

For vineyards to truly match the public's perception of long rows of lovely greens flourishing in the sun, the winemaking industry must sacrifice its conventional methods of growing grapes and bottling its products. Conventional methods of growing grapes lead to excessive consumption of water, chemicals leeching into the water supply, and soil erosion. Soil erosion is a major factor in the decreasing population of salmon, as soil particles suffocate and crush the incubating eggs. Sustainable farming methods utilize innocuous materials, like straw mulch and cover crops, to preserve moisture levels in the soil, thus maintaining water in the root zones and preventing erosion. All of these practices eliminate or reduce the negative impact to salmonid spawning sites. Consumers have proven they are willing to be part of the solution and pay a premium for sustainably produced wines. Universities have identified practices encouraging benevolent wine production and consumers are demonstrating environmental ethics when seeking out these wines. Now that vintners have the knowledge to produce sustainable wines without increasing production costs, it remains to be seen whether they will take the ethical steps to veer towards sustainable agricultural techniques, as discussed herein, to become important contributors in remedying the wrongs wrought on our environment, including salmon populations.

Literature Review

Grismer, Mark and Caitlin Asato. "Converting oak woodland or savanna to vineyards may stress groundwater supply in summer." California Agriculture, vol. 66, no. 4, 2012.

In this research article, Grismer developed a model for ground water retention in the soil and applied it specifically to Sonoma County vineyards formerly covered with native oak trees. Grismer argues California's groundwater supply in the summer will be under more pressure than ever due to the increasing number of vineyards in the Central Valley and the corresponding deforestation of oak woodlands. Without the shade or complex root structures of oak trees, the vineyards are exposed to constant sun, which further dehydrates the land. Grismer explains the hydrologic cycle in oak woodlands as well as irrigated vineyards. Grismer utilizes graphs and mathematical calculations to explain water balance in soil.

Niccolucci, Valentina, Alessandro Galli, Justin Kitzes, Riccardo Pulselli, Stefano Borsa,

and Nadia Marchettini. "Ecological footprint analysis applied to the production of two Italian wines." Agriculture, Ecosystems and Environment, vol. 128, no. 3, 2008.

Niccolucci's paper compares the Ecological Footprint between two vastly different approaches to Italian wine making: sustainable or organic methods and the conventional. The sustainable method utilized small acreages run by family, most work done by hand and bottling in recycled lightweight glass.

Platts, William and Walter Megahan. "Time Trends in Riverbed Sediment Composition in Salmon and Steelhead is Spawning Areas: South Fork Salmon River, Idaho." Wildlife Management Institute, 1975.

This research article discusses the negative impact on salmon spawning sites resulting from soil erosion and particle loads in rivers triggered by logging and road construction. Specifically, the study is directed at the South Fork Salmon River in Idaho, with a resident Chinook salmon population, though has applicable principles to any rivers adjacent to disturbed areas. Where soil is disturbed by logging or road construction, the large amount of fine soil particles rapidly washed into the watershed created intolerable changes to salmonid spawning areas. This article relies on data collected utilizing permanent reference points at selected spawning areas, cross-sections perpendicular to the center line of the stream at 50-foot intervals, over a 9-year time span.

Prosdocimi, Massimo, Antonio Jordan, Paolo Tarolli, and Saskia Keesstra. "The immediate effectiveness of barley straw mulch in reducing soil erodibility and surface runoff generation in Mediterranean vineyards." Science of the Total Environment, vol 547, 2016.

In this 2016 article, Prosdocimi analyzes a common problem in agriculture of soil erosion and water loss. His article goes a step farther and concentrates specifically on the context of vineyard management. Prosdocimi conducted actual field studies in the arid climate of Eastern Spain. Through a series of specific calculations, he found immediate calculable benefits in the prevention of water loss and soil erosion by utilizing a covering of barley straw mulch over the bare ground. To arrive at this conclusion, Prosdocimi utilized an experiment simulating typical rainfall over 40 plots of vineyards, 20 bare ground and 20 covered with mulch. Prosdocimi also detailed his findings graphically, illustrating the dramatic decrease in the runoff of detached soil particles.

Schneider, Keith. "Farming Without Chemicals: Age-Old Technologies Becoming State of Art." The New York Times, the New York Times, 23 Aug. 1987.

This article discusses farming without chemicals and how over 2 million U.S. farmers are reducing or eliminating chemical use (either fertilizers or pesticides) and moving back to a more natural method of raising crops. Such "sustainable" methods of agriculture include the use of natural insect repellents such as planting catnip between vegetable rows, eggplants in potato fields, or marigolds in pepper crops. This article relies on farmer interviews, U.S. Department of Agriculture statistics, University of Minnesota studies, and agricultural publications.

Whitelaw, Ed, Ernie Niemi and David Lindahl. "Salmon and the Economy." Salmon Economics Handbook, 1999.

This handbook was written to summarize the ways rebuilding healthy salmon populations impacts the economies of Washington and Oregon. It discusses the potential economic benefit in salmon conservation, noting the recreational, employment, and business opportunities resulting in such efforts. The existing problems salmon face are discussed, including the impact of sediment originating from agricultural lands and running into streams, as well as the impact of diverting water from streams for irrigation. The handbook

Table 1. Literature Review Matrix.

Author and Title of Works	Publication Year and Database	Purpose
Grismer, Mark and Caitlin Asato. "Converting oak woodland or savanna to vineyards may stress groundwater supply in summer." *California Agriculture,* vol. 66, no. 4, 2012, pp 144- 152.	2012: Retrieved from Google Scholar with search terms "Soil Erosion" and "Vineyards"	The purpose of this article is to develop appropriate water use in vineyards to produce the proper characteristics of grapes desired by the wine maker. To do this, the impact of losing native woodlands to vineyards is analyzed.
Niccolucci, Valentina, et al. "Ecological footprint analysis applied to the production of two Italian wines." *Agriculture, Ecosystems and Environment* , vol. 128, no. 3, 2008.	2008: Retrieved from Google Scholar with search term "Sustainable wine"	The purpose of this article is to scientifically measure the ecological footprints of sustainable organic wine production and the commercial conventional method across the four phases of production: agricultural, winery, packing, and distribution. Other than human labor, conventional methodology of wine production consumed more enumerated resources and, hence, had a greater ecological footprint.
Platts, William and Walter Megahan. "Time Trends in Riverbed Sediment Composition in Salmon and Steelhead is Spawning Areas: South Fork Salmon River, Idaho." *Wildlife Management Institute* , 1975.	1975: Retrieved from Google Scholar with search terms "salmon" and "soil erosion"	The purpose of this article is to analyze the effect of soil erosion on the spawning areas of salmonids adjacent to disturbed land, caused by logging activity. Specifically, fine particles in the sediment suddenly deposited in a stream system can kill the salmon eggs leading to a decrease in salmon populations.
Prosdocimi, Massimo, Antonio Jordan, Paolo Tarolli, and Saskia Keesstra. "The immediate effectiveness of barley straw mulch in reducing soil erodibility and surface runoff generation in Mediterranean vineyards." *Science of the Total Environment,* vol 547, 2016.	2016: Retrieved from Google Scholar with search terms "vineyard" and "soil erosion".	The purpose of this article is to identify an immediate solution to the problems caused by soil erosion and water loss specifically encountered in the practice of viniculture in arid climates. Thereby, this article offers cost-effective solutions to increase sustainable practices in vineyard management.
Schneider, Keith. "Farming Without Chemicals: Age-Old Technologies Becoming State of Art." The New York Times, the New York Times, 23 Aug. 1987.	1987: Supplemental journal article from New York Times, retrieved from general Google search on pesticide free agricultural practices	The purpose of this article is to chronicle the movement away from chemical use in agriculture and back to more natural means of crop production. This includes the use of certain insect repellent plants such as catnip, marigold and eggplants in fields next to target crops.
Whitelaw, Ed, Ernie Niemi and David Lindahl. "Salmon and the Economy." *Salmon Economics Handbook* , 1999.	1999: Retrieved from Google Scholar with search terms "economic benefit" and "salmon"	The purpose of this handbook is to comprehensively summarize the extensive evidence of economic impacts of restoring native salmon populations in Washington and Oregon. Salmon conservation can have positive effects on the economy without being so burdensome as commonly believed; several ideas are presented to start the process of salmon habitat restoration.
Zucca, Gary, and David Smith. "Sustainable viticulture and winery practices in California: What is it, and do customers care?" *International Journal of Wine Research* , vol. 20, no. 2, 2009.	2009: Retrieved from Google Scholar with search terms "sustainable viniculture" and "consumer".	The purpose of this article is to predict the trends of sustainable wine growing and consumer awareness of this particular product. As consumer demand for sustainably produced wine grows, the wine producing industry is taking note, and even considering a certification program. Evidence shows consumers are willing to pay for sustainably produced wines, but do not know how to define the term "sustainable wine".

notes the importance of educating consumers about salmon-safe practices and stimulating demand for salmon-friendly technologies. The handbook represents a comprehensive summary of economic evidence regarding the implications of proposals to restore the salmon habitats in Washington and Oregon.

Zucca, Gary, and David Smith. "Sustainable viticulture and winery practices in California: What is it, and do customers care?" International Journal of Wine Research, vol. 20, no. 2, 2009

This article discusses the perceptions of wine consumers of sustainable practices in the wine industry against the backdrop of the need for product differentiation by the producers. Zucca defines sustainability by three overlapping principles: environmentally sound, economically feasible, and socially equitable in the production of wine. Zucca notes that while certification programs are yet to be developed by the industry, growing consumer awareness exists. While consumers are willing to pay more for sustainably produced wines, they are confused by what is meant by the term. Zucca's article relies on industry generated writings and data reports. He surveyed 300 wine customers, who underwent a structured personal interview process.

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