

The Influence of Climate Change and State Regulatory Systems on Independent Wine Production

A Case Study of the Muscadet Wine Region of Northwestern France

by

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Chapter 1: Introduction

Problem Statement

The Loire Valley of North-Western France is world renowned for its wine. From popular Sauvignon Blancs of Sancerre, dark and spicy Cabernet Francs of the Touraine, to dry, white Muscadet wines of the Pays Nantais, the wines are as variable as the climate of this French wine region. (Cadot 2012) The Pays Nantais, experiencing a static maritime weather pattern, has historically allowed local viticulture the luxury of less-variable growing seasons, and therefore, more predictable and easily managed practices. In contrast, the upper regions of Sancerre and its neighbors, Pouilly-Fume and Orleans, experience a continental climate more variable with seasonality: a climate in which only varieties that are hardy enough to withstand late frosts and large diurnal swings may yield quality fruit. (Bonnefoy 2012)

The French wine industry is systematically regulated by region: meaning the propagated varieties found in these regions are categorized and given unique value solely upon their origin of cultivation. In turn, each respective wine is characterized by regional name, and the environment from which it is cultivated. This process is upheld by the appellation labeling system of France, as well as cultural and socio-economic identity attached to these wine regions. (Barham 2004) Wine production in the Loire and the rest of France is governed by the AOP system, or the Appellations d'Origine Protégée. This system, created in 1935, outlines strict criteria specific to appellations within France that guides consumers as to where the product comes from and what characteristics and quality to expect. The system has created 4 categories to define classes of French wine: Vin de France, Vin de Pays (now IGP or "Indication de Géographie Protégée"), Vin Délimité de Qualité Supérieure or VDQS, and AOC (now AOP) itself. (Glade 2004)

This system is not solely a regulatory body for labeling requirements, but a system that geographically delineates and recognizes wine-growing regions. These viticultural areas are not only delineated by name, but by the terroir from which the wine is grown upon and given character. Terroir, a French term, has come to encompass the unique environmental elements of a specific region (such as geology, climate, topography, etc), as well as the unique viticultural customs imbibed into the wine making process, that gives each vine, and the wine produced from them, a completely unique character in look, smell, and taste. This reliance upon terroir to delineate appellations from one another may prove to be problematic in the future, as terroir within many areas may shift with the climate, leaving some appellations unsuitable for their signature varieties. (Duchene 2010) The AOP system of standards has institutionalized and reduced the definition of "quality" in French wine to the regions from which they are produced; if climate is to shift out of favor for regionally distinct varieties, there raises a question of how producers will maintain AOP standards of wine character and distinction.

As climate change continues to raise temperature averages across the globe, there are presently serious threats of economic downturn and environmental degradation that may impact

regionally characterized wine. (Pomarici 2016) Will the Pays Nantais still produce dry Muscadet? Will these regions begin to adopt new varietals and forego AOP regulation, or will producers adapt new, radical strategies to continue propagating the same varietals in their native terroirs despite changing climates? The answers to these questions not only hold implications for the future of wine in the Loire, but the global wine industry as well.

This research will ultimately address the attitudes and perceptions of independent wine producers, (those that grow, produce, and market wine from independent, personal estates) towards the prospective effects of climate change in the Pays Nantais region of the Loire Valley. This study also aims to investigate the role AOP regulations have on priority bias in viticultural management and wine production. Vines require 5-8 years to mature to the point of producing high quality grapes for winemaking, thus producers must invest time and money into the future of the crop, rather than the present. This long-term investment in turn requires the consideration of future climatic and environmental sustainability of their crops if the producer wishes to be successful, gain profit, and contribute to the viability of the wine market with their product. This study thus investigates how climate change will impact wine production in the Pays Nantais, if and how independent vignerons will adapt to shifting climates, and how the AOP regulatory system impact the ability or desire to adapt Pays Nantais vineyards to more suitable management practices.

Site and Situation

The Loire Valley, a geographic depression characterized by the Loire River and its tributaries, is situated in Northwestern France (see Figure 1.1). Stretching from the western Atlantic coast near the city of Nantes, to the city of Cevennes in the center of the country, this region is home to approximately 163,000 acres of land dedicated to viticulture. Containing over 60 recognized AOP, and over 4000 wineries, this region produces the largest volume of white wine in France as well as world-class, light-bodied red wines. (Gamble 2007) The Pays Nantais, the westernmost wine region, is particularly known for its crisp, dry Muscadet wine; one that upholds a reputation for being one of few wines available to pair well with oysters and other shellfish. (Pages 2005) To understand what makes the terroir, and the wine, of the Pays Nantais unique, we must delve into the geographic and viticultural background of the Loire Valley itself.

Figure 1.1 Wine Folly (2019)



Geography and Climate of the Loire Valley

The valley is stratified by several climatic regions: The Upper Loire (Centre), the Mid Loire, and the Lower Loire. This mosaic of climates allows the Loire Valley to uniquely produce all styles of wines: reds, whites, rose's, and sparkling wines. Each subregion specializes in distinctive varietals, creating unique wines that are characterized by a wide range of microclimates that exist in each viticultural area. These microclimates are produced by the variance in landscape and the moderating, riparian effects of the Loire River and its many tributaries that pervade the region. (Neethling 2012)

The Lower Loire, also known as Le Pays Nantais, is located on the Atlantic Coast of Western France, centered around the city of Nantes and the Loire estuary. Due to its adjacency to the Atlantic Ocean, this sub-region expresses a maritime climate pattern. Characterized as Cfb on the Koppen scale (temperate, oceanic climate) the Lower Loire experiences moist, mild winters, and hot, humid summers with the smallest range of temperature variability throughout the valley. (Rubel et al. 2017) The Mid-Loire, better known as the home to the appellations of Saumur, Touraine, and Anjou, expresses a more variable climate with mild to cold winters and warm, sunny summers. Touraine, located on the easternmost cusp of the Mid-Loire, straddles the maritime climate zone of the west and a more continental climate zone focused in the center of the country. This is a climatic-transition region that produces the majority of red wines in the Loire Valley. The Upper Loire, or Centre, expresses continentality, which express high seasonality, variable climate conditions and a large diurnal temperature range, or diurnal swing, resulting from significant distance from the ocean or other large, temperature regulating bodies of water. (Loire Valley Wines 2015) The diurnal swing, a phenomenon in which daytime and nighttime temperatures vary greatly from one another, is the dominant variable affecting viticulture in this region. (Bonnefoy 2012)

While climate plays a significant role in viticultural suitability, soil contributes greatly to the health of vines, the water and nutrients available to them, and the overall quality of the wine produced. (Halliday 2007) The soils of the Loire Valley are as diverse as the climate and the varieties grown within it, characterized by unique geology and adjacency to the Loire River. The Loire Valley stretches across three geologic formations in France: The Massif Armorican, the Parisian Basin, and the Massif Central.

The Loire River has its origins in the mountains of the Massif Central found in central and southern France. At the headwaters of the Loire River, a Jurassic limestone formation known as the Kimmeridgian ridge has eroded overtime and allowed its mineral rich composition to riddle the soils of the Centre – Loire, primarily Sancerre and Pouilly Fume, with limestone, clay, sand, and chalk. (Dolfus 1931) Vintners (or vigneron in French) believe it is this mixture of soil that gives Sancerre and Pouilly Fume wines a zesty and smoky taste. (Wilson 2012)

As the Loire River enters the Mid-Loire region, it passes into the Parisian basin where the soils shift to various levels of clay and sand dominant outcrops. This is due to once-present shallow sea that had engulfed much of central and northern France throughout the cretaceous period, which left various layers of sand and clay over chalky materials in the local crust. This coupled with the consistent deposition of silt from the Loire River and its many tributaries has left this subregion extremely fertile. Most vineyards are however situated on sloped, chalk-dominant terrain while the fertile lowlands are often populated by other crops. The Loire Valley continues through the Parisian basin until the Appellation of Anjou, where the Parisian Basin meets the Massif Armorican. (Fort 2016)

Anjou has been colloquially segregated by vintners who cite two major soil regimes: Anjou Blanc (White Anjou) and Anjou Noir (Black Anjou). The white Anjou refers to the light, chalk dominant soils found within the Parisian Basin, while the Black Anjou refers to the dark, volcanic and schist dominant soils of the Massif Armorican. The Massif Armorican was once a

region of extreme geologic uplift during the Hercynian orogeny, a collision event in the Late Paleozoic era in which two continents, Laurussia and Gondwana, conjoined to create the supercontinent of Pangea. (Carcaud 2013) The event was characterized by volcanic activity and the building of mountainous terrain in what is now modern day Brittany. Over millennia the Massif Armoricaïn has eroded significantly due to tectonic shift, followed by fluvial and marine erosion, creating a low level plain dissected by geologic ridges across much of Brittany and the Pays Nantais region of the Loire Valley. (Fort 2016)

It is in the Pays Nantais that the Loire River meets the Atlantic Ocean. The landscape is characterized by narrow valley systems and sloping hills that open to flat, delta-land at the confluence of the Loire River, its many tributaries, and the Loire Estuary. (Wilson 2012) The geology and soils of the Pays Nantais are volcanic in nature much like the Anjou Noir, with deposits of gneiss, schist, and granite. The soil drains exceptionally well, allowing potassium and magnesium rich deposits to form in the lower soil horizons below layers of silt, clay, and sand. The soil makeup of the region varies by distance of terroir from the Loire River, the Loire Estuary, or ridge outcrops of the Massif Armoricaïn. (Cacaud 2013, Fort 2016) Soils farther from the river and the estuary tend to be more dominant in schist and granite, while those near the Loire river are more silt, sand, and clay dominant. (Fort 2016) These soils of the Pays Nantais, though varied, are often praised for attributing minerality and earthen tasting notes to the locally grown Muscadet and Gros Plant varietals. (Clingeffer 2014)

Viticulture and the AOP

As previously stated, the wine in the Loire is characterized by the subregions and appellations to which they belong (see Figure 1.2). With white wines dominating the eastern and western reaches of the valley, light red wines and sparkling wines rule the mid-Loire. (Leeuwin 2006) This again, is due to the complex variability of terroir throughout the Valley, with climate and soil shifting greatly from region to region. Due to the AOP system put in place in 1937, each appellation claims the production of unique wines distinct from all others, with some that do not see production anywhere else. The Loire recognizes 85 appellations and sub-appellations, 69 of which hold the AOP designation. The AOP system designations and labeling requirements can be found in Table 1.1:

Table 1.1

AOP Designation	Regional Specificity	Strict Varietal Regulations	Labeling Specificity	Other Labeling Requirements
Vin de France	No	No	Often labeled by varietal(s) only	None
IGP	Yes; Often larger extent of a region than VDQS or AOP	No	Region and Varietals	None
VDQS (No longer in use after 2012)	Yes; Defined region and appellation	Yes	May include producer, chateau, or village. Does not specify varietals	May include signifiers of quality
AOP	Yes; Defined Appellation	Yes	Chateau, Producer, or Village information; Does not specify varietals	Grand Cru or Premier Cru designation

Until recently, the Loire Valley held all of its appellations at the AOP standard, yet in recent years we have begun to see the emergence of more IGP appellations form. This is due to the purchase and conglomeration of relatively small vineyards by larger, wholesale producers that will forego retaining an AOP designation to produce varietals that are not historically or lawfully designated to the region by AOP standards. The IGP designations are also becoming more popular due to the emergence of “eclectic” vigneronns that wish to propagate non-traditional varietals and experiment with unorthodox enological methods. (Zhao 2008)

Each subregion and appellation produce distinct varietals that correlate to each microclimate present. In the region of the Pays Nantais, dry, light, white wine varieties dominate the landscape. The primary varietal of this region is the Muscadet, or Melon de Bourgogne; a crisp, dry wine with delicate taste that excels in a cool, stable, maritime climate with limited range in temperature and little diurnal swing. Within the Pays Nantais, there are 7 distinct appellations (see Figure 1.3): Muscadet, Muscadet Cotes de Grandlieu, Muscadet Coteaux de Loire, Muscadet-Sevre et Maine, Coteaux d’Ancenis, Fiefs Vendéens, and Gros Plant du Pays Nantais, 4 of which are allowed to produce Muscadet exclusively. (Wilson 2012)

Figure 1.2 Wine Folly (2004)

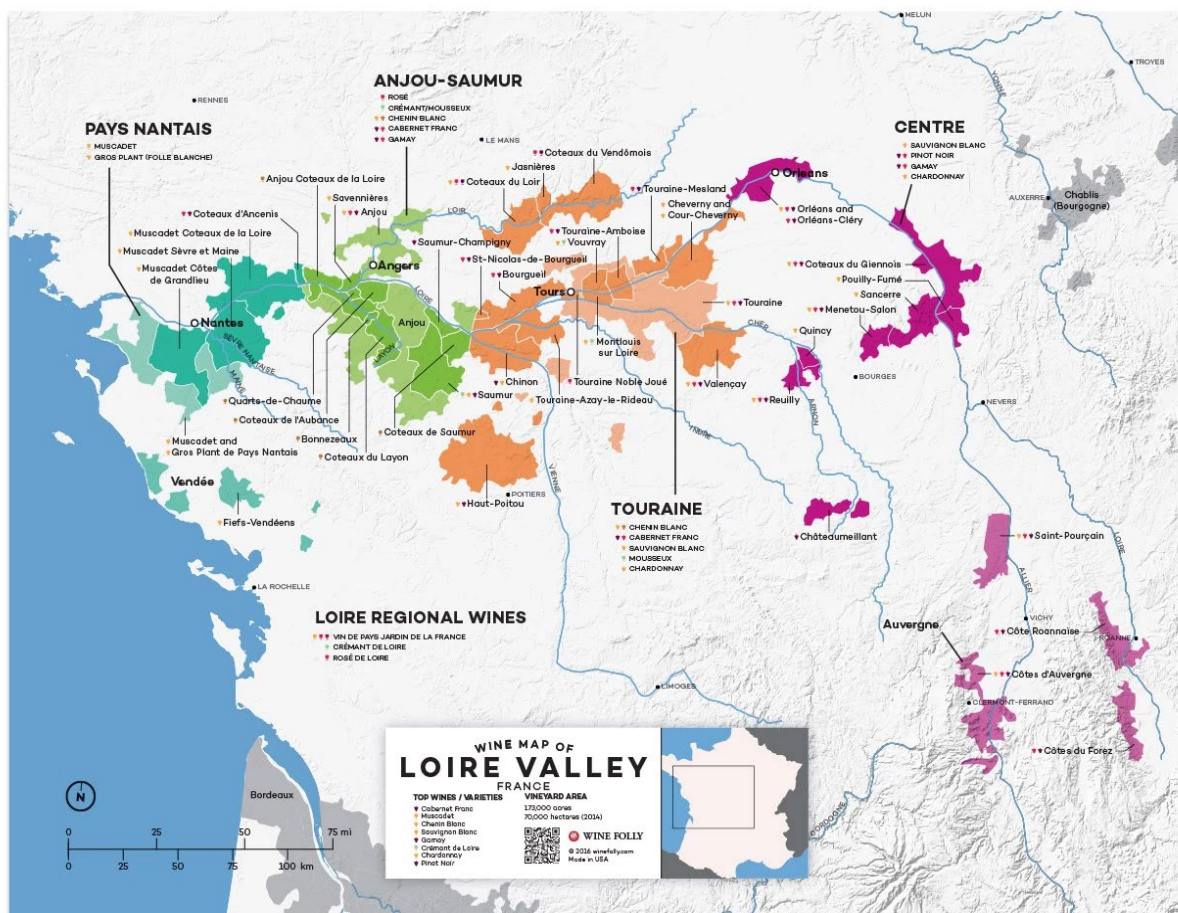
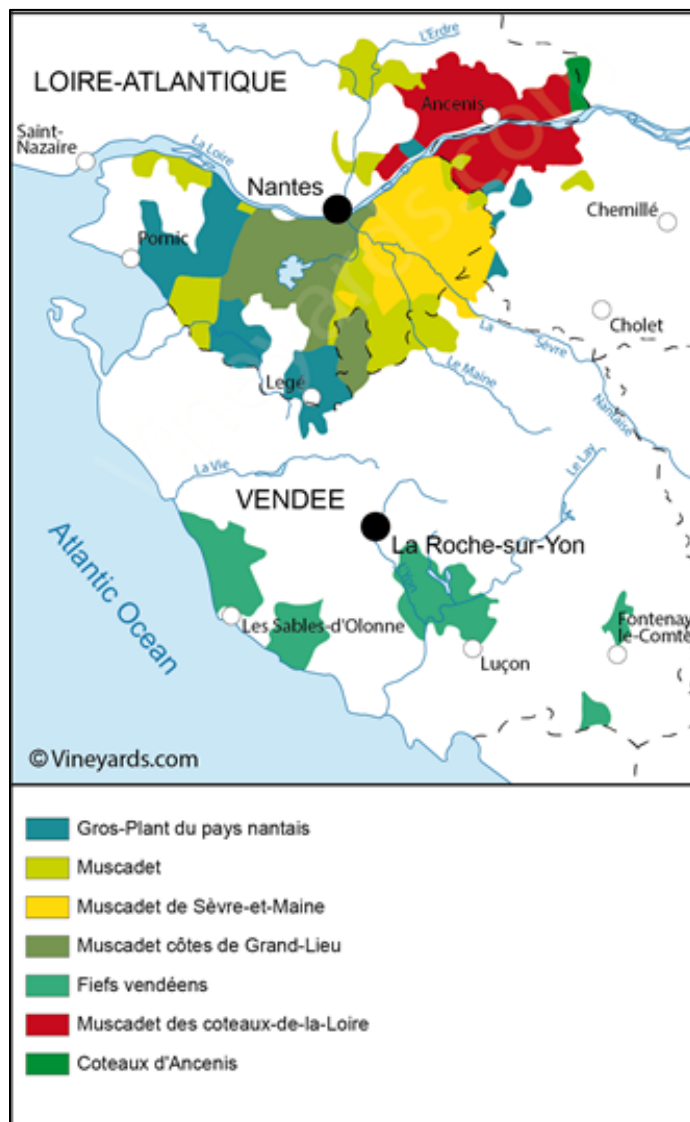


Figure 1.3 Vineyards.com (2019)



The more diverse Mid-Loire can be characterized by three primary appellations: The Anjou, Saumur, and Touraine regions. The Anjou appellation is known primarily for its sweeter, white wines made from the Chenin Blanc varietal. Gaining distance from the coast, the westernmost appellation of the Mid-Loire expresses more seasonality yet remains within a small range of temperature throughout the day, allowing this subregion to produce dry chenin blanc, quality reds such as cabernet sauvignon and cabernet franc, and off-dry rose's as well. (Goulet 2011) Saumur, a small appellation between Anjou and Touraine, is known widely as the sparkling wine capital of the Loire Valley. Three of the sub-appellations in Saumur are dedicated specifically to sparkling wine: Le Crémant de la Loire, Saumur Brut, and Saumur Brut Rose. (Wine Guide 2017) Other sub-appellations of Saumur produce dry chenin blanc much like Anjou, or cabernet franc. The Touraine appellation, the easternmost sub region of the Mid-Loire, is arguably the heart of red wine production in the Loire Valley.

This appellation is renowned for its light, dry Cabernet Francs and Malbec (Cot), most notably from the sub appellations of Chinon and Bourgeul. Gamay and Pinot Noir have quite a large presence here as well but are associated with blending rather than single-varietal wines. (Halliday 2007) Dry whites primarily made from Chenin blanc and chardonnay are also present as both are common varietals that excel throughout the Loire Valley.

In the Upper Loire or Centre, hardy sauvignon blancs have made the Sancerre and Pouilly Fume sub-appellations famous worldwide. In these two sub-appellations, Sauvignon Blanc, also referred to as Fume Blanc, is exclusively grown by strict AOP regulation. These Sauvignon Blancs are smoky and vegetative, zesty and citrus forward in nature, creating a benchmark for French Sauvignon Blancs according to the Court of Master Sommeliers. The Centre is also renowned for Pinot Noir and Gamay red wines. These reds are known to be light, jammy, and reminiscent of the same varietals that grow within the Burgundy region of Central

France. (Wine Guide 2017) This is due to the continental climate and similar geology that the two regions share. (Fort 2016)

Given the large variability of wines in each subregion of the Loire Valley, the Pays Nantais stands out as one of few that specializes in one dominant varietal. The Muscadet of the Pays Nantais, exhibiting distinctive qualities of high acidity, dry character, saline and mineral tasting notes, and propensity to pair solely with seafood, is not only unique to the region but to the global wine market. (Zhao 2004) While the Muscadet dominates the region, the Fiefs Vendéens, Coteaux d'Ancenis, and Gros Plant de Pays Nantais are also allowed to produce the varietals known as Gros Plant, Gamay, and Malvoise. While Gros Plant exhibits many similar qualities to Muscadet (Melon de Bourgogne) due to its overlapping range of the Pays Nantais, it is not given the same level of recognition, esteem, nor propagation as the Muscadet. (Wilson 2012) The AOP structured monoculture gives rise to questions concerning the economic viability and sustainability of the crop as climate change progresses.

Chapter 2: Literature Review

Viticultural Climatology

Viticulture and winemaking are critically dependent upon a multitude of climatic and environmental variables that directly impact the growth, cultivation, production, quality, and sustainability of wine. Jones (2007) makes it evident that the unique geography of wine regions and their subsequent “climatic niches” are attributes to the quality of wine, environmental suitability for varieties, and the economic potential of the region. The amalgamation of these factors is what viticulturists refer to as “terroir”. Townsend (2011) describes terroir “as the physical and cultural geographic attributes of a given location that may potentially influence the quality of a wine”; thus, making terroir central to the question of what varieties may potentially do well in any given region.

Jones (2012) identifies prime growing temperatures of *vitis vinifera* (common grape vine) and its many sub-varieties to average between 13-21°C during the growing season for optimum phenological outcomes, including high quality grapes. He admits that many varieties are grown out of this range, but mentions the product is usually of lesser quality and often used for bulk commercial processing. This optimum temperature range is based on his own analysis of “climate-maturity zoning”, or the correlation between climate variability and vine growth observed within “benchmark wine regions” across the globe. His study categorizes popular varieties by average climatic temperature. Despite comprehensive and thorough analysis, it would seem that Jones’ climate and quality index does not encompass specific micro-climates and sub-regions of wine growth such as the Pays Nantais, which has a unique coastal environment that imbues its own climatic variables and hazards upon the region. This is an unfortunate indicator of the relatively small amount of academic research dedicated to varieties and appellations outside of the larger commercial market, and how they will largely be affected by climate change.

The major hazards and impacts upon viticulture by climate change include but are not limited to abnormally early budding and ripening events in the growing season, shift of suitable climate, extreme weather variability, and even rise in sea-level. The European Environment Agency (EEA) cites a significant increase in global temperature and climatic shift in a Climate Change, Impacts, and Vulnerability Report (2016). EEA projections have shown a temperature increase in Central Europe with an average of .2 - .3 degrees Celsius per decade between 1960 and 2015. The report cites a global temperature increase of .4 to 1.6 degrees by 2046 from the IPCC (Intergovernmental Panel on Climate Change) MPI5 climate modeling projection. This level of increase will exceed a significant, global climatic threshold of a 2 degrees Celsius increase from pre-industrial times by 2042. This increase, according to the report, will affect the target region and Northwestern France by increasing the length of summer and the number of warm days while decreasing overall precipitation.

According to Neethling et al (2012), a consistent increase of length, and warmth, of growing seasons between 1960 and 2010 have already impacted the development and ripening time of the Melon de Bourgogne, or “Muscadet” grape, throughout the Pays Nantais. The Muscadet grape varietal is most suited to the cool, maritime climate of the Pays Nantais, which contributes to its unique composition and taste. Within the study, the Pays Nantais was observed to have increased daily temperatures within the growing season (April – September) by 1.4 degrees Celsius, a diurnal temperature range increase of 1.0 degrees Celsius, and a negative trend of -5.5 mm of rain lost per year. Neethling et al. (2012) included an analysis of berry composition concerning sugar and titratable acidity of key grape varieties from the regions tested between 1970 – 2010. The results showed an increase in sugar composition of Muscadet grapes in the Pays Nantais, while acidity had decreased. This is concerning as the Muscadet wines of the Pays Nantais are renowned for their dry and characteristic acidity which makes popular in the region as a pairing with local seafood. Increasing sugar content and decreased acidity changes the character of the wine, requiring much earlier harvests of already early-ripening varietals according to both Neethling and Duchene et al (2010). Duchene explains that early harvests have become necessary as the rate of veraison, or onset of ripening, is occurring earlier in Northern European white wine varietals due to the increasing brevity of cold snaps in the growing season, which allows for an early concentration of sugars within the berry to grow. If a vintner wishes to produce a dry, acidic wine, these conditions are not favorable, prompting early harvests to limit sugar concentration in the final stages of ripening (Halliday and Johnson 2007).

The impact of climate change is not limited to grape phenology and climatic variance in the Pays Nantais; projections by Rahmstorf (2007) and Climate Central (2015) within the region show a significant increase in sea level if the threshold of + 2.0 degrees Celsius is reached. This physical hazard is projected to inundate large portions of the Loire Estuary, the sub-appellations of Muscadet Cotes de Grandlieu, Gros Plant, Muscadet, and the city of Nantes. This gradual inundation puts soil in these sub-appellations at risk of erosion, salination, and extreme flooding events. The same projection, built heavily on the research of NOAA, IPCC, and various national institutions, predicts significant flooding events in these areas to occur within the next decade and inundation by 1ft of sea level rise to occur by 2050.

Terroir of the Pays Nantais

The effects of climate change are particularly concerning for the Pays Nantais viticultural region due to its near monoculture of Melon de Bourgogne (Muscadet). Originating in Burgundy, the varietal, according to Wilson (1998), had traveled to the Pays Nantais in the 17th century with Dutch traders looking for plots to produce brandy grapes. A miniature ice age in the early 18th century destroyed the red varietal crops in the region, yet the Muscadet remained. In the modern era, the Muscadet grape has all but disappeared from Burgundy, but has thrived on the Atlantic Coast amidst a population with a propensity for seafood. The physical and political landscape of the Pays Nantais has created an extremely niche terroir, one that is rooted in the Muscadet grape and those that continue to produce it.

The paradigm of terroir has been classically defined as the unique environmental factors and geology of a given wine region that affects the growth, taste, and quality of wine, but Clingeffer (2014) and Demossier, (2011) disagree. Demossier argues that the paradigm has shifted to identify the winegrower as “a mediator in the expression of terroir”, essentially the cultural aspects of a given territory to the physical. This, according to Demossier, allows terroir to act as a tool for territorial governance, and the means to maintain “homogeneity and rootedness” in a given territory as a response to globalization. Clingeffer (2014) concurs with this sentiment, arguing that the concept of terroir has been emphasized by traditionalist wine producers as a means of maintaining identity and distinction in a growing international wine market that emphasizes “varietal and brand name wines, [and] dominance of large companies”. My project is rooted heavily in this version of the terroir paradigm, allowing my research to examine the interrelational connectivity between the physical environment, human perception of environmental hazards, and viticultural practice which encompasses the problem of traditionalist growers competing within a globalized wine industry while adapting to or mitigating the effects of climate change.

Wilson (2012) identifies the Pays Nantais as a matrix of overlapping appellations, a maze of soil-types and terroir, all with a menagerie of varietals. The Muscadet grape remains dominant and the most distinctive varietal, but other AOP appellations, few they are, produce Folle Blanche, another light and acidic white varietal, while others produce light, off-dry rose or red varietals produced from Gamay, Cabernet Franc, Pinot Noir, and Grolleau. The diversity of varietals is relatively new, the Folle Blanche (Gros Plant) being an exception as it was introduced approximately the same time as the Muscadet and consequently grown side by side. The introduction of other varietals found in neighboring Anjou or Touraine, according to Wilson, is a reactionary adaptation for economic benefit and improving (warming) climate in the smaller sub-appellations of Coteaux d’Ancenis and Fiefs Vendéen. The Court of Master Sommeliers (2015) identifies the four other AOP appellations of Muscadet, Muscadet Coteaux de la Loire, Muscadet Cotes de Grandlieu, and Muscadet de Sevre et Maine as strictly Muscadet producing regions, with Muscadet de Sevre et Maine responsible for over 80% of Muscadet production in the entirety of the Pays Nantais.

Political, Economic, and Cultural Viticulture

While other wines of the Loire have gained popularity on the global market such as Sancerre, Chinon, and Anjou, Muscadet has seen a decrease in sales outside of its home range. Beckett (2014) attributes this to the abundance of other commercial varietals such as Cabernet Sauvignon and Chardonnay that saturate shelves at supermarkets and hold a more recognizable identity in foreign markets such as the USA. Beckett asserts that the Muscadet wine, made of 100% Melon de Bourgogne, is a single-varietal wine rarely known or understood in these markets which, for the most part, have been flooded in the past decade by bold, juicy, and blended wines to fit the less-experienced palates of a new generation of wine consumers. These popular varietals have not only invaded the shelf-space at retailers of Muscadet wine, but have now begun to invade the territory of the Muscadet AOP as well. Robinson (2013) claims that

Muscadet sales have declined significantly enough to reduce the total area of Muscadet AOP vineyards from 13000 hectares, to under 8000 hectares. Robinson goes on to claim that steps are being taken, partially under the pressure of merchants and wine-sellers, to allow varietals such as Chardonnay and Sauvignon Blanc into AOP appellations of the Pays Nantais and Muscadet wine, effectively changing appellation laws and essentially allowing mass-production of a mass-market wine with higher sugar levels to remove the acidic and somewhat saline taste of Muscadet. While these characteristics may not appeal to the foreign consumer, they are quintessential to Muscadet's traditional, Atlantic character and ability to pair perfectly with shellfish and seafood, most notably oysters.

Given the effect that the wine market has had upon the Pays Nantais and Muscadet wine, this project aims to identify and understand other interrelational factors that impact this wine region, emphasizing not only the economic but also the physical, political, and the cultural as these factors integrally intertwine with one another. To understand these phenomena, it is essential to first understand how the progression of climate change and shifting wine regions may affect wine economy. To put the economic weight of the wine market into perspective, Mosedale, Abernathy, Smart, Wilson, & Maclean (2016) emphasize that the international wine industry is estimated, in terms of GDP of the global market, to equal \$58,600 billion USD. As the finite isotherm niche given by Jones (2012) shifts with the changing climate, the lucrative profit margin of the wine industry inspires viticulturists to radically change their management techniques and production, often converting vineyards historically replete with a singular, traditional varietal, to rows of commercially viable varietals known to do well on the market. Mosedale et al (2016) frame the environmental impacts of climate change as an advantage for viticulturists and a potential boost in quality yield, higher sugar content, and juice complexity within varietals found in "cold regions". This same effect is responsible for crippling the quality or desired taste of varietals within "hot regions" as it increases likelihood of rot, unfavorably high sugar content, and necessity of early harvesting. Unlike Jones, Mosedale et al. offer the idea of shifting varietals into, or out of, a given viticultural area, to essentially match the shifting climate as a remedy. Unfortunately, this may not be a viable option for regional wine economies dependent upon terroir-identity, such as those in France, as the appellation system and cultural tradition stipulate that associative value is placed upon terroir, not the grapes themselves.

The federal wine-tourism site for the Loire Valley, "Vins du Val de Loire" (2017), identifies the near monoculture of the Pays Nantais with white wines comprising a staggering 98.6% of varietal growth and production within the region. With 55 million bottles from this region sold between 2015 – 2016, only 17% were exported to foreign markets while 83% of sales were conducted in France. According to Chollette (2015) this may be a small representation of a larger problem affecting the French wine industry, one that has been echoed by Clingeffer and Demossier: globalization in the form of shifting wine markets, specifically the popularization of New World wines. Between the years 2000-2003, French wine imports to the USA dropped in volume by 34%, and in revenue by 15%. Meanwhile within the same period, France's stake in the UK wine market decreased to 25% from 43%, losing out to New World wines (wines produced in the America's) which comprised 43% by 2003.

The shift to New World wines, and the decline of consumer favorability of French wine within the global wine market, is believed by Chollette and Steiner (2004) to be a product of changing attitudes towards wine labeling. Steiner argues that value in traditional AOP labeling requirements have diminished in foreign markets as New World wines, and their varietal-specific labeling, have been distributed across the globe. These labels often demarcate the exact varietal and the expected taste of the wine, unlike the place specific AOP labels required under French law. Steiner asserts that to many wine consumers outside of France, one may not find any discernable information regarding taste, value, or quality from a French label alone unless they have prior, specific knowledge of AOP labeling and French appellation geography. Zhao (2005) further questions the AOP system, positing that the “vertical classification” of French wine, or the hierarchical stratification of quality required in AOP labeling laws, creates and implies social control of wine commodities, signifies social standing, and embodies political power. Essentially, Zhao asserts that AOP laws perpetuate terroir-identity tied to hegemonic dominance of the French market by traditionalist vigneron, or wine growers, who adhere to strict, historic AOP standards. This in turn stifles access to the market by low-standard labeling, Vin de Pays producers that introduce new varietals, or new techniques, to enhance quality and marketability of their wine despite their classification.

The power-dynamic created by AOP laws, while favorable to the highest rungs of this hierarchy for the latter half of the 20th century, has backfired as French producers now struggle to push high-quality Chinon, Burgundy, Languedoc, Muscadet, etc. back onto foreign markets that do not understand their inherent value. The traditionalist vigneron of the Pays Nantais are no exception to these predicaments as they face a systemic decline in wine sales, political restriction of terroir, and physical hazards of climate change. Yet, a strong identity in terroir and localized wine culture keeps many vigneron practicing their traditionalist viticulture despite these factors.

Chapter 3: Methods and Methodology

Introduction

This research is based on the hypothesis that climate change will present a significant hazard to the wine industry, through climatic and environmental shift that may change the suitability for propagation, and quality, of particular grape varieties. With this hypothesis, this research strives to answer how climate change will directly impact the environment of the Pays Nantais region of the Loire River Valley, France in the foreseeable future. This research also recognizes that within the Pays Nantais, there is a significant element of political and economic power that the AOP system and its stipulations of viticulture, wine production, and labeling rights have over the wine industry. Thus, through this research I also strive to answer how the AOP system and its stipulations could impact or influence the ability of Muscadet vintners (vignerons) within the Pays Nantais to adapt to future climate change.

The AOP system is of particular interest as it places standards upon vignerons as to what, and where, to grow specific varietals. This system is often tied to traditionalism and place-identity in terroir as it encourages production upon historical, and often familial-linked, plots of land dedicated to Muscadet (Clingeffer 2014). If the environment of the Pays Nantais is to shift away from suitable conditions to grow Melon de Bourgogne, local AOP laws, traditionalism, and terroir identity may act as a hindrance for vintners to adapt their production to ensure terroir and climatic suitability for future Muscadet production.

The ideal climate suitability of Melon de Bourgogne to create Muscadet is characterized by consistent precipitation and temperature throughout the year and a stable, maritime climate. (Neethling 2012) With the advent of climate change, it is possible the region will experience more weather variance that may shift environmental conditions outside of the Melon's suitability. (Neethling 2016) This study highlights the potential for this climatic shift to cause a conundrum for vintners; whether adaptational management techniques can be implemented within traditionalist, AOP constraints, or whether to abandon Muscadet AOP standards to produce non-AOP Vin de France or IGP grade wines from non-traditional varietals.

The questions at hand create a problematic between environmental, cultural, political, and economic factors that can be understood by a mixed methods approach. This approach incorporates exploratory, qualitative research and climate modelling analysis to explore how climate change will affect Muscadet and how the AOP will affect implementation of adaptation or mitigation strategies.

Methods

To understand the problematic between climate change, the AOP system, and the Pays Nantais, this exploratory research paper will incorporate the coding of qualitative information, and analysis of climate modelling data. Qualitative data retrieval and analysis will be heavily rooted in Grounded Theory, using a system of Open, Axial, and Selective Coding to identify nodes of knowledge relevant to answering research questions. Climate modelling data for the target site of the Pays Nantais will be collected primarily via secondary resource models available through the French Environment & Energy Management Agency, French Public Collegiate Systems, The Scientific Counsel of the Environment of Brittany, The European Environmental Agency, International Panel on Climate Change, and NOAA.

Qualitative Data

Categorical Investigation

In order to efficiently filter, codify, and analyze qualitative data, three categories of significant information parameters have been identified to reflect common themes of analysis throughout the research process. These three categories have been identified as:

1. Terroir and Environmental Factors
2. The AOP System and Place-Identity
3. Viticultural Management Techniques

These categories were chosen as they represent key areas of analysis comprising of climate change dynamics and their impacts on culture, politics, economy, and adaptation strategies specific to the target site and research questions of this paper.

Each category of analysis garnered questions of their own to consider throughout the research process to further narrow and relate relevant information back to a common, thematic code; i.e. Terroir and Environmental Factors will inquire upon how climate change will impact production practices, the target terroir, quality of grape yield, varietal physiology etc. while Place-Identity will inquire upon how the appellation system will impact climate change mitigation strategies in the Muscadet market and how traditionalist Muscadet producers will fare within the global political-economy of wine production. Consequently, sub-categories were given to further codify qualitative data within these larger themes, delineating which data is relevant through content analysis. (See Table 3.1)

Table 3.1 Sub-Categories of Analysis

<i>Terroir and Environment</i>	<i>AOP and Place-Identity</i>	<i>Viticultural Management</i>
Climatological Reports	AOP Specific Data	Traditional Viticulture
Past Climate Data	AOP Law Structure	Conventional Viticulture
Projected Climate Data	Political Economy	Adaptational Viticulture
Climate Model	Traditional Perspective	Environmental Concern
Soil Impact	Local Muscadet Market	Melon de Bourgogne
Environmental Hazards	Global Muscadet Market	Vine Management
Terroir Specific Data	Political Impact	Soil Management
Hydrology and Precipitation	Cultural Normativity	
Wine Expression	Terroir Attachment	
	Economic Concern/Disconcern	

Resource Acquisition and Types

Qualitative resources were compiled by prevalence to research questions and target site. Using databases ranging from TSU Alkek Library, to wine trade and wine industry resources, to International climatological archives, data was collected from primary, grey, and secondary materials to create a well-informed, inferred conclusion to the questions posited by this research.

Primary data consisted of non-academic interviews of independent vigneron within the Pays Nantais. As defined by American University, (Ho 2019) these resources included blog entries, online video, and audio sources and were analyzed through transcription and open coding. If the source was determined to be significantly edited or used post-collection for analysis or discussion, it was deemed a secondary source as per Texas State University standards. (Libguides 2019)

Grey literature is defined by Texas State University as “self-published [literature] and typically comes from: Government agencies, research institutes, organizations/companies, associations”. (Libguides 2019) Grey literature was used in this research as an invaluable source of industry, NGO, and Governmental knowledge regarding the areas of analysis identified by this paper. Grey literature was obtained via government databases, international NGO websites, trade organization and wine union literature, and other formal yet non-academic sources.

Secondary sources, as defined by Texas State University, consists of peer-reviewed, academic resources, or resources written after the fact and by a person non-party to the event described. (Libguides 2019) The combination of these resources, and the data collected from them, facilitates an analysis akin to but more robust than a typical literature review.

Coding

When queried in the online databases articles matching keywords and keyword combinations including but not limited to “climate change”, “viticulural management”, “Pays Nantais”, “Muscadet”, etc. are collected and subsequently analyzed for content that maintains relevance to the Pays Nantais, or Pays Nantais-adjacent knowledge, that is characterized by the three main areas of analysis. Articles and qualitative data that do not exhibit this relevancy are discarded while the rest is codified by the sub-categories listed above (See Table 3.2). Each Sub-category is defined by key words, phrases, connotation, emotion, historical data, and other contextual identifiers as open codes, while a system of axial coding will be used to extrapolate meaning through emergent themes from open code overlap. The databases of ScienceDirect, GeoBase, GeoRef, Google Scholar, Wiley, J-Store, and the Government and NGO databases listed previously were accessed between January 2018 to October 2019, with publishing years of each reference ranging from 1935 to 2018.

Table 3.2: Guide for Open Codes & Associated Resources

<i>Resource Type</i>	<u>Terroir & Environment</u>			<u>AOP & Place Identity</u>			<u>Viticultural Management</u>		
	Primary	Grey	Secondary	Primary	Grey	Secondary	Primary	Grey	Secondary
<i>Sub Categories</i>									
Climatological Reports		8	7						
Past Climate Data		6	5						
Projected Climate Data		5	7						
Climate Model		3	3						
Soil Impact	2	5	2						
Environmental Hazards	3	2	5						
Terroir Specific Data	4	3	5						
Hydrology and Precipitation	2	3	6						
Wine Expression/Typicity				7	4	3			
AOP Specific Data				5	6	3			
AOP Law Structure				1	5	3			
Political Economy					4	3			
Traditional Perspective				8	5				
Local Muscadet Market				4	6				
Global Muscadet Market				2	6	2			
Political Impact				4	4	2			
Cultural Normativity				5	3				
Terroir Attachment				6		3			
Economic Concern				7	4	4			
Traditional Viticulture							6	5	5
Conventional Viticulture							4	10	6
Adaptational Viticulture							6	5	6
Environmental Concern							4	7	5
Melon de Bourgogne							8	6	4
Vine Management							6	8	6
Soil Management							5	7	5

While hand-coding was the default method for physical articles and non-convertible online files, the codification process was eased using the coding platform *Nvivo*. This particular program was chosen because the user-friendly software organizes data, allows the researcher to

track patterns and themes amongst data, utilize graphics and word-trees to visualize connectivity and open code repetition, and to signify an appropriate saturation of data to present a clear inference of conclusive evidence.

As repetition and connectivity of open-codes began to reveal thematic groups, axial codes, or rather these common themes or relationships between open-codes emergent in the coding program, were analyzed for core variables through selective coding that inferred a larger, if not overarching, relationship amongst the core categories and their open-codes. This in turn offered conclusive findings regarding how the AOP may impact adaptation to climate change through cultural, political, and economic influence.

Primary and Interview Resources

The sources collected as primary references and interviews were found via online blogs, industry publications, and stakeholder accounts from first-hand vineyard walks and interviews. Within these sources, 10 vigneron (Figure 3.3) were chosen to inform the qualitative research based on the availability of full and partial interviews, their status as independent vignerons, and their recognition as high-quality producers of Muscadet based on high performance rates within market publications (Decanter, Wine Enthusiast, Hachette Guide, & Wine Spectator, 2019). The sources from which these interviews were obtained were multimedia, and included the “Wineterroir” blog series of Bertrand Celce, the Louis Dressner Wine Selections blog, “Ask a Winemaker” and “Loire on Tour” YouTube channels, and the French gastronomy blog “La Boite du Fromager”. These sources were chosen as they exhibited close relationships to the vignerons in question, or offered direct interviews from industry professionals concerning management, perceptions of terroir, vintage reports, and general Muscadet production, allowing a more in-depth view of their attitudes and perceptions towards their viticultural ventures. Due to the specific parameters of the target subject population, the interviews available were biased towards an interest in high quality wine production by celebrated, independent producers that focused on historical, managerial, and terroir-specific aspects of their operations. All interviews were conducted in English, with the exception of “Loire on Tour” interviews which were conducted in French and translated into English in video production by the channel hosts, and La Boite du Fromager, which offered both French and English transcripts.

Interviews were analyzed alongside recorded vineyard walks, harvest reports, vintage comments, and estate visits made by primary and secondary source contributors to place each interview within the context of the vineyard site, the terroir, and the identity of the vigneron themselves. This context allowed for better qualitative coding within the matrices of the Nvivo program, underlining connectivity between the physical environment, the human elements of vineyard management, the enological process, and the attitudes and perceptions of vignerons. The analysis that followed resulted in the creation of thematic groupings of commonly re-occurring experiences, practices, and perceptions that fit within the 3 areas analysis outlined at the beginning of this chapter, thus revealing further conclusive evidence to either confirm or nullify the hypothesis from the perception of a stakeholder.

VIGNERON	DOMAINE	APPELLATION	CRU COMMUNAUX
<i>Jo Landron</i>	Domaines Landron	Muscadet Sevre et Maine	
<i>Benoît Landron Chartier</i>	Domaine Landron Chartier	Coteaux d'Ancenis, IGP	
<i>Marc Ollivier</i>	Domaine de la Pepiere	Muscadet Sevre et Maine, IGP	Clisson, Château-Thebaud, Monnières-Saint Fiacre, and Gorges
<i>Remi Branger</i>	Domaine de la Pepiere	Muscadet Sevre et Maine, IGP	Clisson, Château-Thebaud, Monnières-Saint Fiacre, and Gorges
<i>Pierre-Marie Luneau</i>	Domaine Pierre Luneau-Papin	Muscadet Sevre et Maine, IGP	Goulaine
<i>Phillipe Chevarin</i>	No Domaine	VDF	
<i>Fred Niger</i>	Domaine de L'Ecu	Muscadet Sevre et Maine, IGP, VDF	
<i>Phillipe Menard</i>	Domaine Menard-Gaborit	Muscadet Sevre et Maine, IGP	Monnières-Saint Fiacre
<i>Nicholas Choblet</i>	Domaine du Haut Bourg	Muscadet Cotes de Grandlieu, IGP, Gros Plant	
<i>Jean-Michel Dabin</i>	Domaine Poiron-Dabin	Muscadet Sevre et Maine, IGP, VDF	Château-Thebaud

Figure 3.3 Vignerons

Climate Study

While the qualitative analysis of primary, grey, and secondary resource materials offered insight into the more human elements of the problematic, environmental data was key in understanding how climate change could alter the production of Muscadet and the culture, politics, and economy that supports it. To better understand climate change and the affect it may have, this paper included the climatic analysis of secondary source modelling data of Earth System Models (ESM's). This analysis spanned the collection, and analysis, of data from several organizations, government entities, and academic sources that offer credible climate models of the Pays Nantais and the surrounding regions of Brittany and the Pays de Loire. These models and climate projections gave a multi-faceted view of the target area and the environmental processes that will affect local terroir over time, including factors of suitability and typicity for Muscadet production.

The expected expression of quality, or “typicity”, of Muscadet is dependent upon the environmental suitability of Melon de Bourgogne. (Robinson 2015) Before climate model analysis began, the environmental factors of Melon de Bourgogne suitability were collected and analyzed to create a “control climate”. This reference allowed the research to identify ideal conditions of precipitation, sunlight, frost, humidity, etc. necessary for quality Muscadet typicity; this was then compared to various climate models and projection scenarios within the target area to confirm whether local environmental suitability may or may not be retained in the future.

To provide a concise inference towards a sustainable or non-sustainable future environment, climate models and climate data projections were collected, analyzed, and codified by method, data criteria, control climate, etc. to ensure that all models reflect similar outcomes, target areas, and percentage of confidence. The projections and models assessed included the CLIMAT, CESER, and NASA, EEA, and IPCC Earth System Model databases due to the level of scientific validation they have received. Scientific validation is achieved through academic and scientific testimonial and peer review of the data models presented. Once it was confirmed that the models were sound and consistent in data, these models were then analyzed by the viticulture suitability parameters mentioned above such as precipitation, solar days, etc. to determine whether there is a significant shift in climate suitability for the Melon de Bourgogne variety. These results are recorded and analyzed to determine what affects may occur due to climate change, and how factors of change will affect the propagation and production of Muscadet.

The discovery of significant affective factors was used to confirm which adaptational measures would be recommended for viticulture in the Pays Nantais, as well as what forms of adaptation should be undertaken. Once confirmed, the qualitative coding process offered insight into how the AOP ultimately affects these adaptational recommendations and acted as a basis to confirm or nullify the hypothesis suggesting that AOP standards and traditionalist views may hinder appropriate adaptational practices to combat climate change.

Methods Summary

The wine industry of France is replete with distinct terroirs ruled and regulated by the constraint of the French appellation system. Vignerons and wine-producers are beholden to this system, as are the specific varieties of wine-grapes propagated amongst the many appellations within each recognized wine region. Adding more constraint to the production of wine is the threat of climate change and its symptomatic environmental hazards, which may heavily impact the quality and propagation of certain varieties that are not suited to climatic variability. The Loire Valley, and the Pays Nantais particularly, are projected to express elements of climate change such as rising temperatures, rising sea level, and other environmental hazards that threaten the sustainability of the region's distinct Muscadet crop.

Climatic and environmental impact on the terroir and producers of the Pays Nantais can be exacerbated by the negative economic implications of a diminishing market for Muscadet wine. This is troubling as the AOP restrictions on terroir have created a cultural place-identity in Muscadet and Pays Nantais, pressuring viticulturists to preserve both a traditionalist mindset and the propagation of their traditionalist varieties despite the environmental and economic constraints placed upon them. To mitigate these impacts, many vignerons must adapt to the changing markets and climate by adopting techniques and strategies to sustainably produce traditionalist varieties. Others may voluntarily sacrifice their traditionalist, AOP designation by replacing crops of Muscadet and Gros Plant with varieties from external appellations that will fare better in the changing terroir.

This research aimed to integrally understand the perceptions and attitudes of producers in the Pays Nantais towards the current state of the wine industry and the shifting climate, while analyzing their reactionary-adaptation techniques. These findings will ultimately provide new information to academia regarding wine ethnography, cultural ecology and viticulture within a research-based, geographic framework.

Chapter 4: Results and Discussion

Climate Study

Climate Typicity

To better understand the affect climate change has on the Pays Nantais region and the local Melon de Bourgogne crop, this project aimed to identify a climatic typicity that defined good crop yield, wine quality, and a mean temperature control. All climatic variables and data were obtained from Meteo France and NOAA through raw daily data and reported normals within a 43-year period (1975-2017). This data was collected from weather station Bougenais situated between Nantes and Muscadet Sevre-et-Maine. While the station is not located within target vineyards, the location was believed to give an accurate representation of the regional climate and thus identifiable trends that may affect AOP vineyards of the Pays Nantais.

Base Climate Control

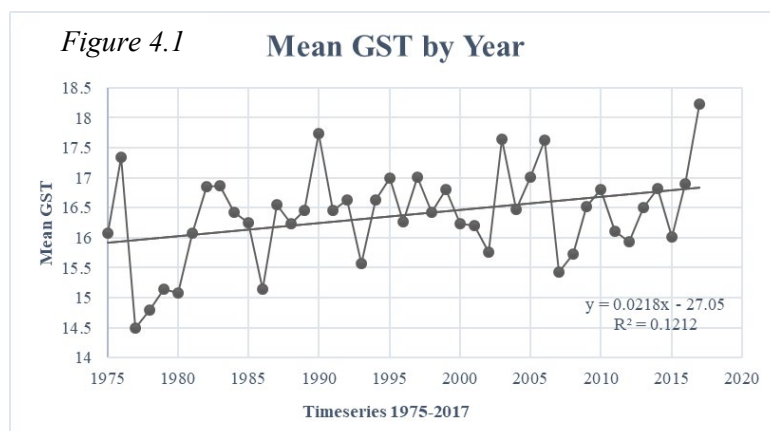
To provide a base climate typicity for the target region of the Pays Nantais and the cultivar Melon de Bourgogne, temperature and precipitation data was collected and reduced to a series falling within the typical growing season of Melon de Bourgogne (April 1 – September 31). The growing season was defined as the beginning of flowering in early April, to full ripening in late September. To best represent a base climate, average growing season temperature (GST) was reported by Meteo France and Neethling et al.(2012) as 16.2°C between 1960-2010 while daily temperature data collected from NOAA reported a GST average of 16.4° C between 1975-2017, the adjusted average falling within 16.3 degrees. Using this adjusted average as a baseline for the following levels of analysis, several bioclimatic indices were formulated from NOAA daily data, modeled and guided by previous research by Neethling et al, and Jones et al, to identify trends in climatic suitability of the Pays Nantais. Bioclimatic indices were selected based upon the ability to “define a viticultural region in relation to its climate: its ability to produce grapes, the varieties that are best adapted, as well as [suitability based upon] phenological stages” of growth (Neethling et al 2012). Indices calculated in this study from the daily data series 1975-2017 included the Mean GST, Huglin Index, Cool Night Index, Diurnal Temperature Range, Annual Growing Season Precipitation, and Frost Event Frequency.

Each of these indices were calculated for mean and standard deviation, tested for statistical significance through linear standard error and linear regression, subjected to Fischer’s test to determine 95% correlative probability, and plotted to identify significant trends within the timeline studied.

Mean GST

The GST indicates the minimum and maximum bounds of the typical growth period, calculated for the daily mean to determine an average temperature typicity within the given

region. According to Jones (2006,2010), the GST correlates with the maturity potential of cultivars across many regions. In the Pays Nantais, the GST for the daily series 1975-2017 was calculated at 16.4 degrees Celsius. To determine whether this average has fluctuated over the time series or been influenced by anomaly or significant change, the annual GST has been calculated and plotted accordingly in Figure 4.1.



The plotted graph shows a clearly positive, though varied, trend in GST with a yearly increase of .0218°C and a net 0.94 degree increase within the 43-year period.

The positive trend was indicative of an increasing climate within the Pays Nantais that has the potential to affect growth and productivity of *vitis vinifera* cultivars by prolonging the

growing season and increasing maximum daily temperatures in a historically cool region.

Huglin Index

The Huglin Index, also known as the Heliothermal Index (HI), is frequently used by academics to represent temperature suitability within a given viticultural region adjusted to give more weight to maximum daily temperatures and average length of day by latitude coefficient (Huglin 1978, Jones 2010). The weighted latitude coefficient also indicates the average length of growing season per region, with the Pays Nantais in a more northerly latitude, the growing season is calculated within a six month index of April-September, as Huglin indicated that maximum temperatures in October did not acquiesce a significant heat ratio to affect ripening and harvest dates along these latitudes in Europe. This of course may change as climate change progresses, but for this project the traditional growing season length was used within the calculation.

The formulation of the Huglin Index is as follows:

$$\Sigma \max([([Tmean - 10] + [Tmax - 10]) / 2], 0) \cdot K$$

with K equivalent to the adjusted latitude coefficient (for the Pays Nantais the coefficient is 1.05), and the value of “10” accounting for the minimum daily temperature in Celsius at which *vitis vinifera* is phenologically productive. The sum of the adjusted Huglin score can then be categorized by climate suitability regimes and used to identify the

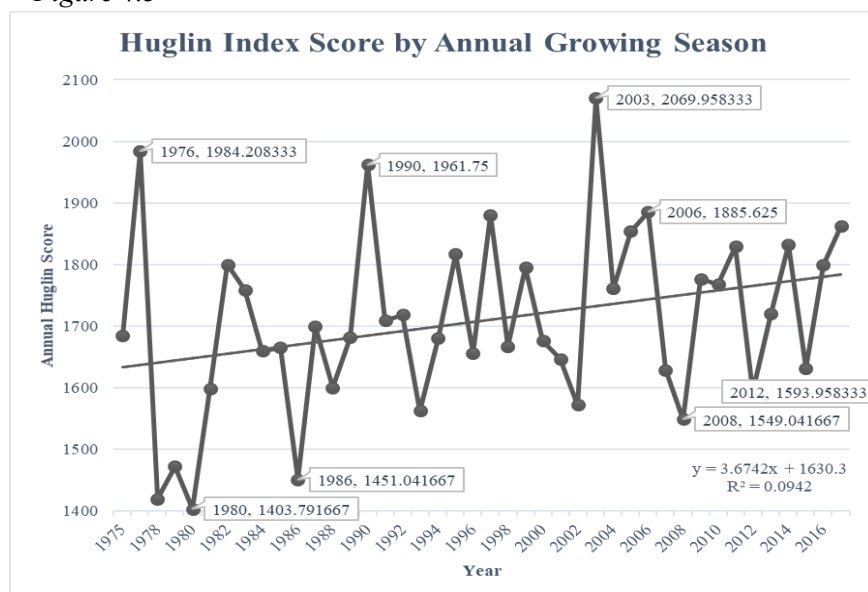
Figure 4.2

Suitability Regime	HI Score
Too cool	< 1200
Very cool	1200-1500
Cool	1500-1800
Temperate	1800-2100
Warm Temperate	2100-2400
Warm	2400-2700
Very Warm	2700-3000
Too Hot	> 3000

potential viticultural productivity of each region. The score regimes according to Huglin (1978) and Jones (2010) can be found in Figure 4.2.

The 1975-2017 data series was calculated for the Huglin Index and plotted. The results were graphed in Figure 4.3.

Figure 4.3



The plotted, annual HI scores for timeseries 1975-2017, not unlike the Mean GST, showed a clear, positive trend throughout the timeseries. The overall mean HI score is reported at 1709.3, falling within the “Cool” suitability regime, which was to be expected from a more northerly wine region. Meanwhile, the data reported a rounded 3.7 point-increase per year, ultimately accumulating 159.1 points within a 43-

year period, increasing the mean HI score significantly within the present.

The standard error regression for this data series is calculated at 21.9 points. This assumes the true mean for the data series falls within 1709.3 points +/- 21.9 at any given period. Even while assuming the lower bound of this mean, the 159.1-point accumulation throughout the timeseries has increased the suitability regime from “Cool” to “Temperate” in the Pays Nantais over a 43-year period. If this trend continues, it will increase the potential to introduce cultivars more suitable to warmer climates into the region, while simultaneously changing the potential typicity of the native Melon de Bourgogne. While the increase has been gradual, there are anomaly events within the timeseries, namely 2003, that exhibited years with HI scores in the “Warm Temperate” and “Warm” HI regimes; high enough to mature cultivars such as Cabernet Sauvignon and Merlot within a relatively short growing period. (Jones 2005) These anomalies give insight to the suitability potential that the Pays Nantais may reach if GST continues to increase.

Cool Night Index

The Cool Night Index, or CI, is calculated as a means of providing the mean nightly temperatures within a viticultural region during the period at which maturation of *vitis vinifera* occurs during the ripening period (Tonietto and Carbonneau, 2004). Maturation takes place in the later months of the ripening period; September in the Northern Hemisphere and March in the Southern Hemisphere. This index is indicative of the climatic potential for a given wine region to

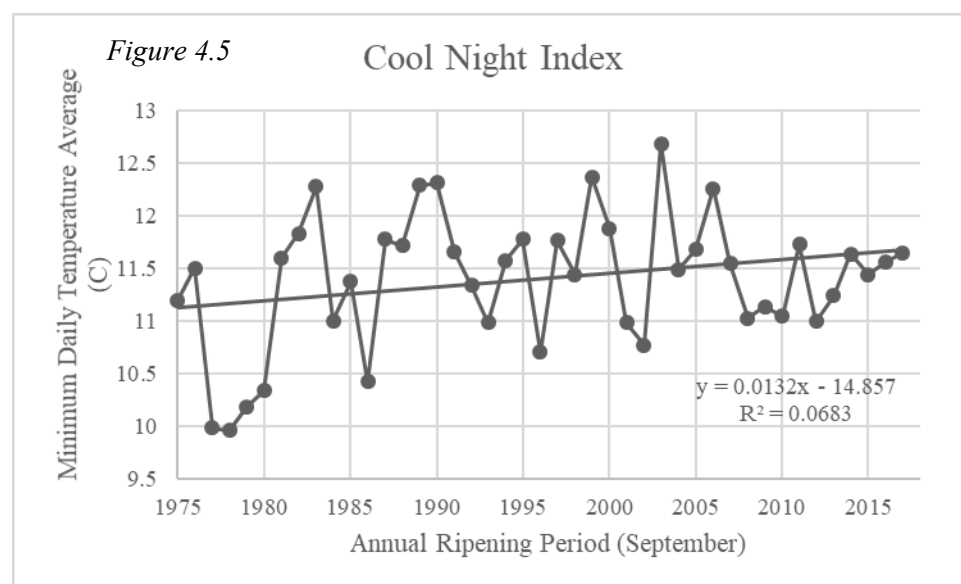
mature grapes outside of the heliothermal cycle, and thus mature secondary, qualitative characteristics of the wine grape such as aroma, color, and polyphenols. Tonietto and Carboneau (2004) assert a “threshold” of 14.2°C exists in context of “berry colour and terpenic aroma intensity”, while anything higher may result in loss of aromatic quality and colour.

Similar to the Huglin Index, the CI can be measured in terms of “Very Cool” to “Warm” dependent upon the reported mean. According to Tonietto the reported mean is measured in terms of Celsius in Figure 4.4:

Figure 4.4

Very Cool Nights	<12°C
Cool Nights	12 - 14
Temperate Nights	14 - 18
Warm Nights	>18°C

CI was calculated simply as the mean of daily temperatures throughout the month of September and the annual results were plotted in Figure 4.5.



The CI for the timeseries 1975-2017 reported a rounded mean CI of 11.4°C, falling into the “Very Cool Nights” parameter. This designation was to be expected as the Pays Nantais falls within a more northerly latitude when compared to other traditional wine growing

regions. Though the overall mean lies in the lower designation of “Very Cool Nights”, the plotted data reported a positive trend in the nightly mean temperature of the Pays Nantais that indicates a gradual surgency into a higher designation on the CI scale. The yearly increase occurred at a rate of 0.0132 degrees per year; within the 43-year interval, the mean had risen by 0.57 degrees Celsius, placing the mean CI within the “Cool Nights” designation. Tonietto and Carboneau (2004) classify productive wine regions such as Bordeaux within the “Cool Nights” designation, indicating a potential for the Pays Nantais, and climatically similar regions, to produce cultivars such as Cabernet Sauvignon, Merlot, Chardonnay, and other temperate varieties, successfully. Jones (2015) claims lower nighttime temperatures in cool climate regions slow “respiration and metabolism”, thereby producing more “delicate” and favorable sensory characteristics in the cultivar. Jones also maintains that mean nightly temperatures below 12 degrees Celsius are most favorable to these cool climate regions and the cultivars that

traditionally grow within them. Thus, the CI increase within the Pays Nantais may potentially cause typicity within the wines produced in Muscadet AOP's to change, resulting in less aromatic and less acidic wine styles.

Another observation from the plotted results include a lack of variability within a 10-year period between 2007 and 2017. The more recent plots, while still maintaining a positive trend, show a tighter cluster of data indicating that the range of nightly temperatures has become less variable and more homogenous in annual means. Whether this is a significant observation or not is unclear, but according to Giatti (2018) and Tonietto and Carboneau (2004), homogenous nighttime temperature trends may indicate a better predictability of qualitative wine characteristics, and less variability in wine complexity between vintages.

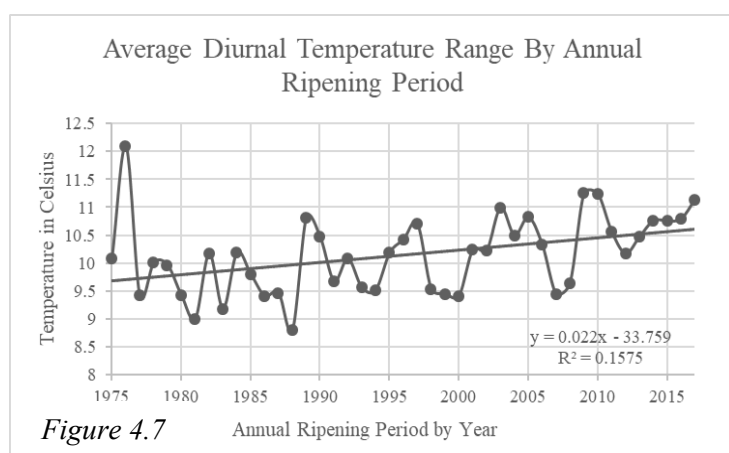
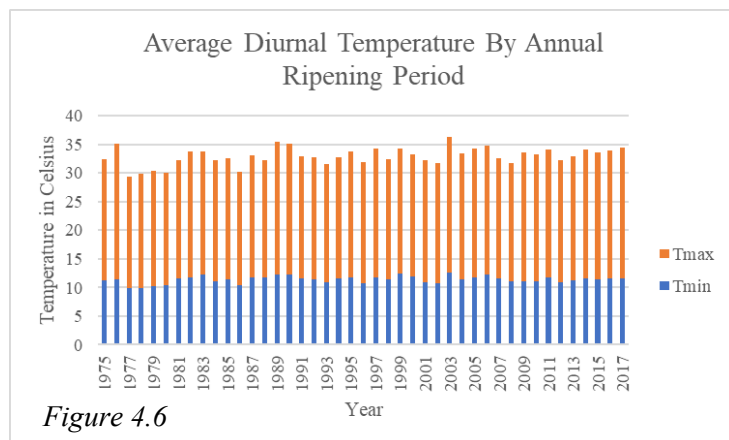
Diurnal Temperature Range

The heliothermic index and cool night index both offer insight to the maximum and minimum daily temperatures that may affect the growth, maturation, and quality of *vitis vinifera* in a given area, but do not individually offer information regarding the full daily productivity potential of a viticultural area. Jones (2006, 2015) and Neethling et al. (2012) assert that the Diurnal Temperature Range (DTR), specifically during the period of ripening, can significantly influence qualitative characteristics of *vitis vinifera* such as flavor, aroma, and acidity. The DTR is calculated by the mean variation between maximum daily temperatures and minimum nightly temperatures in the earliest stages of the maturation period through the end of ripening (August-September in the Northern Hemisphere).

Considering the maritime position and northerly latitude of the Pays Nantais, the DTR was expected to have a small and consistent range due to the stabilizing, climatic influence of the Northern Atlantic circulation of the thermohaline cycle. The currents following the thermohaline cycle transport warm sea water towards the European landmass, displacing the more frigid waters originating from the Arctic, allowing coastal Europe to enjoy a more temperate climate while stabilizing the local maritime regions due to increased Sea Surface Temperature (SST) (Appenzeller et al.). Hallmarks of this climate include mild winters, temperate summer, and consistent, frequent, precipitation, which acted as another control observation for the region of the Pays Nantais to identify anomaly events and significant trends.

Another variable of DTR that was considered for this climate study was altitude, and the plausibility that vineyards throughout the Pays Nantais would vary in climate due to altitude differences. Higher altitudes produce a high DTR comparable to more continental vineyards with large diurnal swings, allowing a more balanced or complex sugar maturation within the ripening period conducive to propagating bold and complex tasting varieties; in contrast, low altitudes and less variable landscapes often exhibit a lesser DTR, thus producing a climate more suitable to varieties with a more subtle typicity. (Jones, 2015) The topography within the Pays Nantais AOP designation areas does not exceed a maximum of 210 ft above sea level; maintaining a typically unvaried landscape with few slopes consistent with the majority of the Armorican Plain.

The DTR was calculated for maximum and minimum temperatures during the maturation and ripening periods and plotted for mean range over the 43-year period. The resultant data for these calculations can be found below in Figures 4.6 and 4.7.



The variation of diurnal temperature visually observed in Figure 4.6 was found to be in line with the expected outcome from a maritime climate. The data from Figure 4.7 shown below, revealed a more accurate, dynamic representation of DTR. The linear regression calculated for mean temperature range found a positive trend to have occurred over the observed 43-year period. This trend is indicative of a subtle increase in temperature comparable to temperature increase observed in other bioclimatic indices within the study. The data reports a mean 0.022 degree increase per year, with a total mean increase of .95 degrees. While this range increase does not constitute a large differential, the likelihood of further increase is speculated to cause a phenological change to typicity of Melon de Bourgogne and Muscadet wine within the region as rising

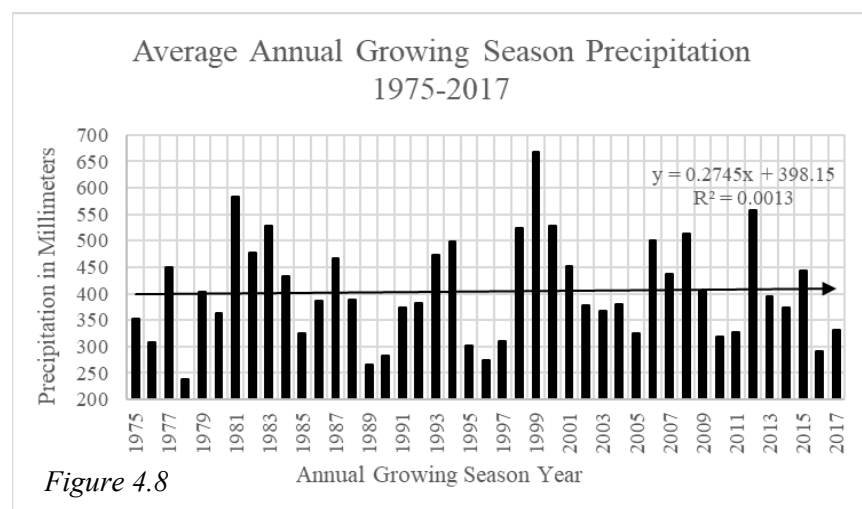
temperatures will generally cause a higher rate of metabolism, hasten harvest dates, and affect the natural acidity exhibited by this varietal.

Precipitation

Vitis vinifera naturally requires precipitation to fuel phenological processes from budbreak to ripening. According to Jones (2015) there is little research to suggest an upper boundary of precipitation for *vitis vinifera* to thrive and fruit, but Fraga et al (2013) suggest that ample precipitation can be indicative of fewer solar days within the growing season, and a more suitable environment for viticultural disease and pests such as fungal rot and mildew, which can be extremely detrimental to the overall crop. In a changing climate, the variability of precipitation, or lack thereof, can act as an environmental regulation control, limiting extreme weather events such as frost, or as a driver for environmental hazard such as disease.

The precipitation of the Pays Nantais, like the temperature, is highly regulated by the maritime climate of the North Atlantic. The seasonal atmospheric pressure systems carried across the Atlantic Ocean by the North Atlantic Oscillation or “NAO” and the East Atlantic pattern oscillation (EA), heavily influence the precipitation along Western Europe, specifically France (Wibig 1998). According to Wibig (1998), Hurrell and Dickson (2003), and Pal et al. (2004), the NAO is most influential in the winter months (December-February) surrounding the Pays Nantais and western coast of France, while the EA is most influential during the months most associated with the growing season (April-September, and October). These oscillations occur in cyclical periods between positive and negative indices, with a positive cycle resulting in low pressure systems moving towards the western coast of Europe, depositing greater amounts of precipitation compared to negative cycles. The EA and precipitation within the area is estimated by Pal et al. (2004) to decrease overall in future decades, while increasing the likelihood of anomaly precipitation or drought events, which may prove either beneficial or detrimental to local viticulture.

This study collected daily rainfall data during the April-September growing season from the Nantes weather station to determine if significant change or anomalies have occurred within the time series 1975-2017. The results can be found in Figure 4.8.



The mean precipitation occurring over the time series is recorded at 404.2 MM with a standard deviation of 94.3, rendering a calculated mean of 309.9 MM. The regression formula reveals a positive, though extremely small rate of precipitation increase over time. With a 0.2745 MM increase over 43 years, the overall increase of 11.8

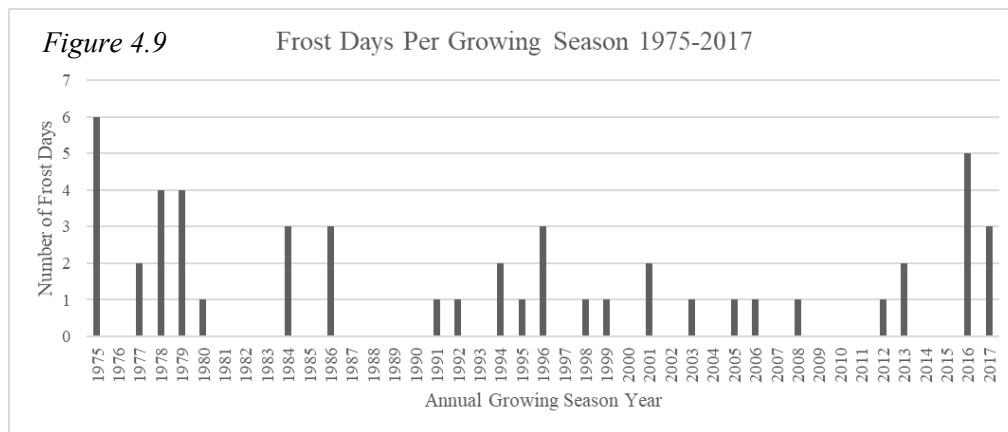
MM is non-significant. Visual observations of Figure 4.8 reveal a highly variable, almost cyclical occurrence of high precipitation years and drought years. Namely, 1989, 1990, 1996, 1997, and 2016 showed extremely low precipitation periods while 1981, 1994, 1998, 1999, 2000, 2006, 2008, and 2012 all showed signs of high precipitation anomaly. The rate of high precipitation occurrence has increased over the two-decade period between 1997-2017, skewing the data towards a positive trend despite a relatively homogenous regression.

The increase in abnormally high seasonal precipitation and narrow cyclical occurrence is predicted by Pal et al. (2004) to be indicative of warming climate zones despite maritime regulation patterns.

Frost Frequency

A seasonal climatic hazard often affecting viticulture in many regions is the onset of frost in the early and late months of the growing season. Frost is often detrimental as it can destroy large swaths of flowering buds or late season ripening grapes. The frequency of frost can be most damaging if it occurs more than once in a single season, which can lead to extremely small yield and inadvertently non-typical wines.

While the oceanic, maritime climate controls the temperature to be more suitable during the growing season, frost is not unheard of in the Pays Nantais. In this study, Frost Days were identified as days within the growing season lower than or equal to 0°C, temperature at which frost is most likely to occur. The frequency of frost days per growing season was analyzed to identify trends or anomalies in the occurrence of frost-based hazards. Results are displayed in Figure 4.9.



The raw data revealed a relatively even distribution between growing seasons with frost days and those without. The series expressed an average of 1.16 frost days per year, while the visual observation showed several high-frequency years with 3 days or more. This information is not significant on its own but coupled with qualitative data such as harvest and vintage reports, may offer insight into the regional effects of frost upon grape yield and wine typicity.

Regional Climate Change and Local Viticulture

The literature review is in consensus that anthropogenic climate change has and will have a large impact on the globe. The agricultural sector, due to the biologically climate-dependent needs of plant life, will be extremely affected as region specific climate, and subsequent weather events, will become more variable and less suitable for traditional management of crops. Viticulture is especially vulnerable due to the specific environmental needs of *vitis vinifera* to yield quality fruit in sufficient quantities. As climate change progresses, traditional viticultural regions will experience a shift in climatic suitability, resulting in a change of wine typicity, annual crop yield, or the ability to grow traditional varieties within the AOP system.

Global Temperature Increase

According to the IPCC SR15 Report, the extent of anthropogenic climate change has caused a global mean surface temperature (GMST) increase of .87°C between 2006 – 2015 and reports a likely 0.2°C increase per decade. The IPCC also reports a global increase in “Warm Days”, or rather daily temperatures sustaining a maximum above the 90th Percentile. This global increase is projected by two scenario models depicting a change from pre-industrial temperature norms by 1.5°C, and by 2°C, by the year 2055 and by year 2100, respectively. The 1.5°C increase model predicts significant impacts within a manageable context, assuming the intervention of humans reducing anthropogenic drivers of climate change (carbon and methane emissions, industrial increase, etc), while the 2°C model presents a more pessimistic view if anthropogenic drivers of climate change are not decreased. The trends expressed within the results of the time series study suggests the rate of temperature increase has fallen within the same global range reported by the IPCC, indicating a high level of confidence of a significant shift in climate suitability.

Regional Climate Impact

While global data emphasizes a largescale temperature increase, it does not account for regional impacts that may manifest differently compared to other climate regions. The IPCC SR15 and the IPCC SR Ocean and Cryosphere reports contain data that predicts a more precise model for coastal European regions like the Pays Nantais, which is heavily influenced by its maritime climate and northerly latitude. These locational features maintain a climate more precipitous and cooler than continental or southerly regions of Europe, which will in turn be affected by more unique climate change patterns in comparison.

The climate shift found to be most prominent in the Pays Nantais region by the IPCC, CESER, ADEME, and NASA within the 1.5°C predictive model includes temperature increase, increased DST, increase in extreme weather events, sea level rise, land inundation, and soil salinification. IPCC SR15, Vautard et al. (2014), Jacob et al. (2018), and Kjellstrom et al. (2018) indicate that a relatively stable precipitation pattern will exist if the 1.5°C predictive model

proves to be accurate, meanwhile other climatic factors will have increased. The EEA (2017) reported a 7-8 day/decade increase in “Warm Days” within the Pays Nantais from 1960-2015, with projected increase of “Warm Days” along the same trend well into the middle of the century. EEA (2017) models extreme heat wave events to occur more frequently in the future at a rate of 2 per 33 years, minimum. At 2°C, the effects of climate change were found to cause more dire and significant trends.

The 2°C model predicts a significant decrease in Summer-time precipitation in Western Europe, severe inundation of coastal environments, and the weakening of the AMOC and Thermohaline cycles by 2100. While mean annual precipitation is projected to decrease, incidence of heavy or extreme precipitation events and annual five-day consecutive precipitation events are projected to increase in Western Europe within the same predictive models (IPCC 2012, EEA 2017).

Glacial and Polar ice melt is predicted by the EEA (2017) to cause a sea level rise over 0.4 meters by the period 2081-2100 along the coast of Western France, meanwhile tide gauges in Brittany have shown a 3 MM/year increase between 1970-2014. The implication of a higher trend is indicative of future inundation events that will affect the Loire Estuary and the Pays Nantais. Climate Central projections based on Kopp et al. (2014), and Tebaldi et al. (2012), show significant inundation of the Pays Nantais given a 0.5 meter rise in sea level assuming current trends and “unchecked pollution, with areas falling within the Muscadet, Muscadet Sevre-et-Maine, Muscadet-Cotes de Grandlieu, and Gros Plant de Pays Nantais AOP’s completely inundated. Inundation of riparian land and lowland areas surrounding the Loire River Estuary, as well as increased tide and surge exposure, can cause the soil to become more saline as brackish water intrudes dryland, and as evapotranspiration during warmer summers may potentially leave vineyard soil with salt deposits that will potentially be absorbed, and kill vines.

For the Pays Nantais and vine-based agriculture, the greatest threats involve an unstable weather cycle, increased temperatures coupled with frequent precipitation events, and soil salinization as these factors are the most relevant to the survival of Muscadet vineyards.

Muscadet Production and Future Climate Change

Increased temperature and prolonged “Warm Days” will undoubtedly raise the GST, CI, and HI within the Pays Nantais, changing the physical environment out of range for standard Muscadet typicity which relies on cool nights and consistent DST to achieve its signature minerality and acidity. While other varietals may find more suitability in the Pays Nantais, the increasing temperature will prove to shorten the growing season for Melon de Bourgogne and affect its phenology by allowing greater sugar production, which is often associated with sweeter, bolder wines. While temperature increase will reduce the likelihood of severe frost events within the growing season, this will ultimately increase the survivability of disease and pests that will prey upon vines and grapes (EEA 2017).

Sustained precipitation rate and pest survivability will most likely increase Melon's susceptibility to fungal disease such as downy mildew, and grey rot. This is in part due to the vine trunk's low disposition to the ground, and naturally tight bunches that Melon de Bourgogne produces, where ill-managed vines with excess foliage and low hanging fruit will lock in moisture on particularly wet nights, allowing the diseases to spread rapidly. Future prolonged heat events may cause the vines to become more susceptible to an acute form of the spreading Esca fungus, which attacks the vine and kills it within several days. Vignerons have described the disease to be as dangerous as the phylloxera plague (an invasion of aphid-like insects that attack whole vines) that almost destroyed the French wine crop completely in the late 19th Century. (Clark 2015, Rego & Corio-Costett 2016) As climate change progresses, the incidence of this disease may increase with the temperatures.

Vineyards that fall within floodplain areas may be exposed to an increase in soil salinity due to estuary flood events, storm surges, or direct inundation, which would prove toxic and possibly fatal to vines. According to a phenology study by Shani and Ben-Gal (2005), the response of *vitis vinifera* to differing levels of saline conditions resulted in reduction of transpiration, vine growth, and water uptake in lower levels, while the highest levels caused vine mortality onset. The study reported that salinity level, and reduction of biomass, transpiration, and general growth, were linear in correlation to each other and duration of saline exposure. Inundation and increased flooding events may also cause excess water storage within the soil over prolonged periods, effectively drowning vines or causing excess moisture to expose root systems to disease and rot.

Climatic Study Summary

Viticulture and the natural environment are inherently linked, as *vitis vinifera* can only flourish and yield quality fruit in ideal climatic conditions. These conditions are associated with sufficient solar exposure, temperature above 10°C, high-drainage and non-saline soils, and a suitable environment lacking frost and other growing season hazards that may impede growth, destroy fruit, or cause susceptibility to disease. This study collected 43 years of daily data to analyze how the Pays Nantais has climatically evolved, and whether the suitability for Melon de Bourgogne production has changed outside of its typicity range.

Calculations for mean Growing Season Temperature, Heliothermal Index, Cool Night Index, and Diurnal Temperature Range reported a positive trend in temperature resulting in high confidence predictability of suitability regime change. In conjunction with climate modelling reports by the EEA, IPCC, and academic findings, the increase in temperature and suitability regime change within the Pays Nantais is predicted to cause significant bioclimatic hazards to increase or appear with the exception of frost. Prolonged “Warm Day” and heatwave events will change the typicity and phenology of the Melon de Bourgogne, resulting in earlier harvests and loss of acidity. Heavy and extreme precipitation events will likely cause greater susceptibility to fungal disease, while flood events and inundation may cause soil salinization and retained moisture, further exasperating disease and causing vine mortality.

While many hazards may increase within the traditional vineyard areas, the increasing temperature and predicted decrease in precipitation may offer opportunity to produce more temperate varieties of *vitis vinifera* within the Pays Nantais, and the opportunity to colonize more northerly lands in Brittany with Melon de Bourgogne to retain the typicity of wines produced from it.

Qualitative Results

Climatic variables reveal environmental factors reshaping the viticultural landscape in the Pays Nantais, but these factors are not the only elements of terroir that affect the Melon de Bourgogne grapes or the typicity of Muscadet created from them. The human element of terroir is as much of a factor to the development of quality vineyards as the climate; people manage the land and vines, create and standardize the sensory characteristics of their wine, and influence the markets and consumers that intake their product. The AOP system from which these practices have been regulated is now precociously situating producers to question the future of their crops and trade. As data reveals a climatic shift in the Pays Nantais, producers and industry experts have begun to adapt management techniques, innovate enological processes, and introduce non-traditional varietals and wine to their repertoire. To understand these adaptations and the transition to non-traditional viticulture, this study compiled and coded primary and grey sources depicting the situation of vignerons, industry stakeholders, and market experts within the Pays Nantais, and the Muscadet AOP. The resultant themes and revelations were recorded, analyzed, and discussed in this chapter in correlative terms with significant environmental data.

Coding Analysis

Following several levels of axial, blank, and blank, coding, the compilation of primary and secondary sources were found to contain corroborative information regarding vintage quality affected by environmental factors and trends, a community of vignerons adapting their lifestyle, identity, and management to more biodynamic and “natural” means, forays into non AOP standards, an opposition to change, and a market that is increasingly unstable, all amidst the changing environment that may affect the region’s most notable wine and its typicity.

Vintage and Harvest Reports

The results of the climatic investigation found an increasing temperature within the Pays Nantais and a change of suitability regime over a 43-year period. Historically, the Melon de Bourgogne has been situated in cool temperatures where it was able to develop signature minerality and acidity due to the consistent maritime weather and constant DTR. While the climatic record indicates a change in environment, primary accounts of annual vintages and harvest reports were analyzed and coded to understand the true effect of these environmental variables on crop yield. Each report was collected via the internet from prominent wine experts, bloggers, stakeholders, and vignerons themselves. The reports gave insight into the true effects of temperature variance and weather variability in the vineyard from select vineyards as well as the generalized Pays Nantais. The climatic data results were used as a guide to explore anomaly events, potential for biohazard, and harvest consistency.

Code Concentrations of Precipitation, Biohazards, and Low Yield

The Bioclimatic Indices exploration emphasized rising GST, CI, DTR, and HI within the Pays Nantais while the precipitation showed no significant trend. To understand the perception and effect of these indices on past vintages and harvests, reports were queried and coded for references regarding temperature, precipitation, biohazards, yield, and positive versus negative sentiment. These variables were chosen to identify recurring themes, correlation, and causation of harvest outcomes throughout each vintage.

The most referenced codes from 14 Muscadet harvest reports consisted of “Precipitation”, “Fungus and Rot”, “Heat Effect”, and “Low Yield” respectively. “Precipitation” was found to be the most cited factor within harvest results; however, “Precipitation” was often a precursor or causation of other hazards that affected the final crop. Precipitation events were often cited in conjunction with “Fungus and Rot”, followed by “Heat Effect” and “Low Yield”. When queried within a matrix, it was revealed that “Precipitation”, “Fungus and Rot”, and “Low Yield” were most often coded within the same reference, while “Heat Effect” remained an outlier with fewer citations within the same references, suggesting that while it was associated with the vintage, it was a more independent variable.

When analyzed on the textual level, the conjunction of precipitous events, biohazard, and low yield remained consistently correlative with concern by vignerons and independent observers about quality of yield, and negative sentiment towards the yield produced. Vintages most closely associated with these outcomes included 2000, 2006, 2007, and 2011 which were heavily referenced within the text as exhibiting “wet summers” and “heavy” precipitation events. Marc Ollivier reported to Jules Dressner and Eben Lillie in 2011 how the year’s precipitation had affected the harvest outcome:

“Because of heavy rainfall, 10 to 30% of our grapes this year are rotten. We’ve been sorting through bunches and have been forced to throw away some usable grapes because large parts of those clusters were too affected by rot.”

Heat Effect, Yield, and Acidity

“Heat Effect” was explored independently, being queried for synonymous textual references and influential patterns within the harvest and vintage reports. This revealed a consistent and frequent association with positive sentiment, “Yield”, and “Low Acidity”, followed by the codes of “Precipitation” and “Fungus and Rot”. The latter two codes, while more influential independently, were occasionally followed by a reference to “heat effect” as a relieving factor of precipitous events. For vintages lacking in “Precipitation” and “Fungus and Rot” events, cited “Heat Effects” often entailed heatwaves or warm and sunny growing seasons. These texts were most often cited positively as vine growth and “Yield” were given precedent within the same reference.

While a majority of “Heat Effect” references were found to be positive, they were often superseded by coded references of “Low Acidity”; rather, in vintages found to contain “Heat Effect” as a main contributing factor to harvest outcomes, “Low Acidity” was always cited within the same reference. “Acidity” was also found to be the 4th most frequent word found within all 14 reports, implying a weighted value towards the desired outcome of harvest and subsequent vintages of wine. Vintages citing “Low Acidity” were often found to contain “High Sugar” references, implying that heat patterns were associated with lower acidity, higher sugar content within the grapes, and therefore atypical wines. The vintages most frequently cited in this context were 1989, 1990, 1995, 2003, 2005, 2009, and 2012.

Bioclimatic Indices and Vintage years

When compared to the charted results of the Bioclimatic indices study, correlation of coded vintage year references with annual mean data observations was inconsistent. This is due to the use of annual means of data with HI, GST, and Precipitation, which did not reflect event influence but rather the growing season average.

Influential precipitation events cited within harvest and vintage reports were least likely to be identified via annual precipitation data, as regularly cited vintages for precipitation effect were not observed as particularly high in annual precipitation. An example can be found with the 2011, which Marc Ollivier lamented to be a vintage marred with fungus and rot damage due to heavy precipitation in the late season, but had an annual growing season mean 60 MM less than the average. 2006 and 2007 also saw vintages heavily impacted by precipitation induced damage, yet only received a growing season mean precipitation of 100 and 45 MM above the average respectively. In contrast, the highest precipitation means by growing season reported by this study were reported in 1999, 1981, and 2012 respectively, from which vintage reports revealed no significant influence resulting in abnormal harvest outcomes.

The most correlative outcomes were exhibited by the cited influence of “Heat Effect” in harvest reports, and Average Diurnal Temperature Range by Annual Ripening Period. With each cited vintage year, the DTR by Ripening Period spikes both in temperature and diurnal range. This phenomenon implies the last stages of maturation are highly sensitive to temperature and

DTR; when both factors are high within this period, grapes are likely to exhibit low acidity, high sugar content, and high yield. This is supported by Neethling et al. (2012), which found correlation between rising temperature in 6 Loire wine regions, titratable acidity, and sugar levels within mature grapes.

Primary and Interview Resources

To create a fully rounded understanding of how the terroir is evolving in independent Pays Nantais vineyards, the human element of terroir must be accounted for within the perception of stakeholders and vignerons themselves. As climate change threatens the environmental variables that affect vine health and wine typicity, ultimately it is the actions and management decisions made by vignerons that will determine the relative success of a vintage in order to produce quality wine. The perception and mitigation of environmental factors is often influenced, and sometimes impeded, by traditional and personal preference, as well as the AOP system that beholden vignerons to particularities of varietal propagation and wine production. To identify the perception, management strategies, and intrapersonal or traditional influences of independent vignerons, primary sources of vineyard walks and direct vigneron interviews were compiled from internet sources identified as blogs, industry journals, and stakeholder interest groups. The qualitative information found within these sources were coded and analyzed to determine which thematic variables dominate the management of independent Muscadet vineyards.

Thematic Groupings

Once coded, the interviews and primary sources revealed several key themes that producers and vignerons found to be the most important and influential aspects of Muscadet production. The repetitive and stressed referencing of thematic groupings by this study determined that prominent, independent vignerons are most concerned with organic or biodynamic viticulture, terroir, wine typicity, the AOP, and expanding production outside of the AOP system. Within these groupings, this study had found evidence of traditional focus on geology for wine typicity, adoption of unique management practices, and a growing disinterest with AOP standards amongst vignerons.

Geology and Wine Typicity

In contrast to harvest and vintage reports that suggested a heavy influence of climate on the maturation and growth of *vitis vinifera*, the majority of independent vignerons in this study cited geology or soil bedrock as the most influential environmental factor to retaining typicity of Muscadet or creating a wine with a specific flavor outcome. “Minerality” and “Acidity” were the most frequent words used to describe favorable Muscadet typicity, while “soil” and geological references such as “gneiss”, “orthogneiss”, “granite”, “schist”, “amphibolite”, and “serpentine” were all cited by vignerons as highly influential variables to impart signature taste and typicity to their Muscadet and individual cuvees. The one outlier was observed in a 2010 interview with Jo Landron of Domaines Landron, (Ask A Winemaker, 2010) who cited a balanced acidity as dependent upon weather conditions:

“With warm weather, we get in fact, very low acidity, the lowest I’ve seen for a few years, and of course, increasing degrees in the same times... the difficulty was to keep the freshness in the wine without this acidity, and I think, the wines, the Muscadet, which gets more minerality because of the vineyard is ploughing, is well done. I think it has a better freshness today, and a better structure than those that are not ploughing...”

Even with a malady caused by increased temperatures, Landron cites ploughing the soil to impart more minerality to the wine as a technique on the viticultural level to balance the lack of acidity and create a wine *“in harmony”* with itself.

The level of influence that the vigneronns believe soil to have on wine typicity and taste can be reduced to small geological faults underlying vineyard soil, with distinct flavor outcomes based on varying percentages of these geologic features. Fred Niger of Domaine L’Ecu in a 2014 interview describes the three most common bedrocks found throughout the Pays Nantais as having distinct flavor profiles from one another in Muscadet:

“Gneiss gives some very soft wines with more of the fruit, okay, very easy to drink... Orthogneiss gives some massive wine, full body with very raw, spicy often..spicy... and Granite is more like a flinty wine, very straight, linear wine, on the rock”.

When asked if the vines are managed differently, Fred Niger replies that it is all the same; *“same hill, same exposure, same ploughing, all is the same, the work in the cellar, just the bedrock simply”*. Bertrand Celce on his 2012 vineyard walk with Jo Landron in Domaines Landron further confirmed the perceived geologic effect on sensory elements of wine in describing a vineyard meant for cuvee production that contained minerals unique to the plot:

“The soil is thick with hard sandstones and other gravels and quartz, the latter giving the smoky, flintstone side in the aromatic range”.

On a separate plot of Domaine Landron, Celce (2012) reports

“Here the soil is orthogneiss and silica, some of these stones giving the flintstone/smoky aroma on the nose. The clay here is also an altered orthogneiss, which brings more of this smoky minerality”.

Wine typicity was not the only variable believed to be affected by soils and bedrock according to independent vigneronns; the geologic elements within the soil were cited by multiple producers to have a more local and phenological effect in the vineyard as well. Nicholas Choblet in a 2018 interview with LoireOnTour, expressed how the soil of Domaine du Haut Bourg is perceived to affect grape maturity:

“Here, we have quite alluvial soils. You have red sand and river-rolled quartz pebbles, which encourage early grapes, because they keep the ground warm, both day and night”.

According to Jules Dressner on his 2013 vineyard walk at Domaine Pepiere, he describes another function of the soil in conjunction with the climate ideal for vine growth and fruit maturity:

“when most of his (Marc Ollivier) estate’s vines are planted on poor, shallow soil with hard granite very close to the surface, the Clos des Briords has a much deeper top soil of clay and silica over a brittle granite subsoil: this ensures excellent drainage in wet years, and better moisture retention in dry summers. Ripening is slower, and the longer hang-time before harvest allows for optimal maturity to be reached”.

Despite the vigneron perception of correlation between soil regimes, bedrock, and sensory elements found in Muscadet, there is mixed evidence to support it. Retallack and Burns (2016) suggest that the sensory element of acidity (grape pH) most often associated with taste and typicity in cool climate Pinot Noir, was highly dependent upon the pH levels and depth within soil horizons in which *vitis vinifera* is located. Their conclusions found that shallow soils with high-pH and younger parent material produced low-pH wines with minimal complexity, while deep soils with older parent material produced more complex and acidic wines. Other sensory elements such as minerality were negligible. Alex Maltman (2018) suggests that there are only miniscule amounts of minerals and micronutrients within the soil originating from the parent material that are taken within the root systems of vines. This implies that

“the proportion of mineral nutrients in a finished wine bear only a complex, indirect, and distant relationship to the geologic minerals in a vineyard”.

Maltman (2018) pinpoints overlooked variables such as seasonal climatic variance, and the “cation exchange” of root systems. Cation Exchange is the process by which positive ionic nutrients such as potassium, magnesium, and calcium are absorbed and held within the soil by negatively charged soil surface materials, and in turn available for the absorption of plants via their root systems. (Mackenzie et al. 2004) These nutrients, or “cations” are not a result of bedrock availability but rather sourced from other soil regimes and deposited via leaching and microbial activity. (Rengasamy et al. 1999) The combination of atmospheric variables and soil cation exchange is a more likely source of sensory elements found in wine; with further research, earthen component of terroir could be redefined as localized pedological and microbial factors and not the presence of particular parent material. If soil and microbial activity within vineyards are responsible for subtle, and region-specific wine taste and aroma, wine typicity will be partially determinant upon the suitability and upkeep of the soil.

As climate change progresses, soil health and suitability may shift or deteriorate in the Pays Nantais if not managed for mitigation. Increased frequency of extreme precipitation events could cause the soil to increase leaching and loss of cation nutrients, while years of prolonged drought may cause increased soil salinization and pH shift due to moisture evaporation. According to Brinkman and Sombroek (1996) mitigation of cation leaching and pH shift can be implemented by introducing healthy and sustainable soil “fauna”, microbial ecosystems, and cover vegetation that minimize direct soil impacts from extreme climatic events. Thus, a strategy focusing on these natural elements within a vineyard may retain health of the soil, and therefore a greater cation exchange capacity to maintain wine typicity.

The Organic and Biodynamic Shift

Between the 10 independent vigneron referenced, 8 noted a preferential use of organic or biodynamic viticulture as a means of improving the terroir and caring for the vines. Within the most cited references, this management style is seen as essential to vine health and improvement of wine quality. Within organic and biodynamic viticulture, the most cited references for reasoning fell under “soil health”, “vineyard ecology”, “disease management”, and negative sentiments towards “conventional agriculture”.

Bertrand Celce (2013) in his vineyard walk with vigneron Marc Ollivier, made a point to contrast the independent vineyards with the commercial and conventional ones.

“We're speaking here of wines made from living vineyards, not from war zones like much of conventional vineyards farmed with all sort of harmful chemical products...Note the obvious difference between the appearance of couple of inter-rows on the left and the ones in the center and right, the ones on the left being alive with weeds (and worms and other insects when you dig a bit) while the rest is worryingly flat and dead still. Growers with mindsets still rooted in the 1970s' consider yet these vineyards with dead soils as "clean" (propres), and they are very proud of their job.”

Further in Celce's account, he describes neighboring vineyards as “lunar landscapes” desolate of life due to continuous spraying and machine-compacted earth. Marc Ollivier recounted to Jules Dressner in a 2012 interview that

“Muscadet stopped being interesting because it was made like a Vin de Pays. What I mean by that is the wine's relation to terroir was completely abandoned. Technology was what mattered to people, not terroir. Like any A.O.C [now A.O.P] in France, if the vines are maintained and there is a real point of interest, you can make varied, interesting wines. Another big problem is that people started planting vines everywhere to create a larger supply of Muscadet. The obvious results are that the vines are in soils not suited for viticulture. People forgot about terroir, and by doing that they forgot what makes an A.O.C: vignerons, grapes and soils”.

The sentiment of a loss in terroir and true connectivity to the natural environment is what has pushed many independent vignerons like Ollivier, to pursue organic and biodynamic viticulture.

The mention of biodynamic or organic farming is often associated as a means of returning management focus onto the terroir itself. There is a sense of pride, passion, and even community within the organic/biodynamic movement. Phillipe Chevarin, a relatively new vigneron to the region, in an interview with Jules Dressner (2017) describes his work towards becoming certified organic as necessary:

“I'm converting the vines to organics and waiting to get certified by Ecocert. Whenever I get some new land, it's immediately converted. I work the soils with a tractor. We only use copper and sulfur in the vineyards, and last year I experimented with some essential oils. This year I will try some biodynamic preparations and see how it goes”.

When asked by Dressner if it was always planned to work naturally, he replied

“I can’t envision any other way. It’s a matter of personal taste: I was drawn to wine through natural wine, and that’s what I want to drink and what I want to make. But at the same time, if I feel I need to add sulfur, I’ll do it. There is an economic reality to what we do, and as a young vigneron who suffered a very rough second vintage (2016), I can’t permit myself to have an unsellable product... However, we have mobilized with a group of like-minded growers and started an association called Pinards et Jus. We take our wines by boat from Oudon to Nantes and organize a tasting there. The goal is to promote what we are doing in the region. All of us work organically, and “naturally” in the cellar, and only one of us is in the appellation. He’s fought hard to be in the appellation and is really trying to shape the tasting panel into understanding the characteristics of our wines, particularly ones without added sulfur.”

With organizations dedicated to the organic and “natural” viticulture movement, there have become more pathways for vignerons to openly express different techniques and means of production, but many of these wines will not qualify for the AOP labeling distinction.

Pierre Marie Luneau, a prominent vigneron and partner of Domaine Luneau-Papin expresses similar sentiment concerning a return to terroir-centric management, and his personal preference of natural viticulture in an interview with Jules Dressner:

“Our distinction at Luneau-Papin is that we work parcel by parcel, terroir by terroir. You can’t claim terroir if you don’t highlight the link between the soil, the vegetal state of the vines and its surrounding environment... 40 hectares is a lot of vines, and today we surround ourselves with a team to thoroughly work on each parcel. This means working the soil so we don’t have to use herbicides anymore; to create a more natural place for the soil and the vines... This is my main challenge and goal for the estate. I want to do this so that we can best express the mineral purity of Melon de Bourgogne in our soils. I’m seeing a lot of young vignerons completely in love with their place and their terroir. I’m glad to be part of it!”

With many other independent vignerons taking suit in this fashion, their numbers are still small in comparison to the conventional growers around them. Though they produce far less than conventional vineyards, the independent vignerons are consistently given top marks by wine publications such as Wine Enthusiast, Decanter, and Wine Spectator over more commercial competitors. This dominance is credited to their unorthodox methods (aside from the soil terroir) and passion for the terroir.

The vine management by these vignerons often entails unique methods of disease and pest mitigation to fit within the standards of an organic identity. While pruning and soil tillage is often done by hand and machine much like elsewhere, many vignerons rely on less orthodox techniques to prevent biohazards and disease. Herbicide and chemical spraying is still implemented in other parts of the Muscadet, but some independent vignerons have adopted more “natural” methods such as copper and sulfur spraying, as well as the use of herbal “teas” to kill or reduce the presence of fungus and small pests within the vineyards. Marc Ollivier was

reported by Celce (2013) in his vineyard walk to stockpile plants and herbs such as horsetail and dandelion for this method.

“Horsetail is known to have medicinal properties, and in the organic/biodynamic agriculture it is used through tea preparation and sprayed on the plants as an alternative to copper-based products. Horsetail is very rich in silica. One of the staff, a young guy working at the winery is in charge of the biodynamic sprayings. They use also dandelion (pissenlit) but one of the challenges is that for a surface of about 40 hectares they need lots of herbs each time. The herb-tea preparations are sprayed on all of their vineyards but the heart of the biodynamic preparations, the [teas] are only used only on half of the surface. The herb tea is usually mixed with the mildew treatment”.

Despite the qualitative success in the market, the efficacy of organic and biodynamic hazard management is questionable. Doring et al. (2015), Doring et al. (2019), and Morrison-Whittle et al. (2017) forewent studies investigating the vine growth, health, nutrient intake, and microbial susceptibility of *vitis vinifera* in separate management conditions (conventional, organic, and biodynamic). Their respective studies concluded that vine vigor and general growth decreased under organic conditions comparably to conventional, and that the microbial communities found in *vitis vinifera* fruit clusters and bark were either unaffected by biodynamic spraying management, or in some instances, microbial communities were more present in biodynamically managed vines compared to the conventional. The negligibility of this management efficacy is concerning when put into terms of climate change, as the likelihood of increased biohazard incidence could cause future vintages to fail. The current success of these vineyards is most likely attributed to an increased attentiveness to the vines, a more nurturing approach to management, and the level of cation exchange capacity found within soils protected by vegetative cover and a thriving pedosphere. Jules Dressner (2012), reports the 2011 vintage from Domaine de la Pepiere as a nearly failed crop:

“a lot of rain and cold right before harvest [which] led to a tremendous amount of gray rot this year. Marc estimates that, depending on the parcel, 75%% to 25% of the grapes were unusable; about 30% of their total production was lost.”

While rot had destroyed a large portion of the grape clusters, Marc Ollivier makes a poignant statement in the 2012 interview in which he stresses the use of hand-picking during a terrible vintage:

“I literally had my team splitting hairs with the bunches. If some of the clusters were partly rotten but the rest was usable, be it a half or one fifth, they meticulously salvaged the quality grapes. I cringe at imagining what a machine harvested Muscadet will taste like in 2011; if they had as much rot as me -and I know a lot did!- it all went into the production”.

It would seem quality wine can be made from a disappointing vintage due to vigilant and meticulous management.

Biodynamic and organic viticulture is not meant to act as a more effective solution to management, but rather a focus on producing wine in harmony with nature. The vigneronns who practice this are seen as acolytes to the “renaissance des appellations” or rather the “return to terroir” that focuses passion and vineyard care on the soil and the relationship between vigneron and life amongst the vines. Fred Niger of Domaine de L’écu highlights this sentiment in a 2014 interview: “*We don’t believe in A.O.C [A.O.P], we believe in terroir...you have to respect your soils, you have to find what is in your terroir*”; A statement that juxtaposes the philosophies of conventional viticulture, and presents a challenge to commercial producers that neglect or purposefully work against the natural vineyard environment, and those who behold themselves to a restrictive AOP system.

New Varietals and AOP Disinterest

9 vigneronns within this study produce AOP wines labeled within the appellations of Muscadet Sevre et Maine, Muscadet Coteaux du Grandlieu, and Coteaux d’Ancenis. Several producers within these appellations have gone further by producing wines worthy of the “Cru Communaux” designation; the highest title in the Pays Nantais earned by creating wines that exhibit excellent taste, expression of singular terroir, and complex enology. Cru wines are designated by the communities from which they originate, including those of Clisson, Gorges, Chateau Thebaud, Le Pallet, and Goulaine. While the AOP and Cru designations are considered high honorific entitlements, most primary sources emphasized a present interest in producing IGP and Vin de France wines, using experimental enological techniques, and increasing production of non-Muscadet varietals; more specifically, red ones. The ability to expand operations towards non-traditional cultivars and methods is often affected by the AOP regulatory system, which many of the vigneronns cite as restrictive on terroir usage and economic viability, hindering the ability to pursue individual passion projects. Despite the challenge of AOP dominance, market research shows that IGP wine production in the Pays Nantais is growing in volume, price, and sales. AOP wine production has, in contrast, decreased in volume while growing exponentially in price. The market and vigneron interest in IGP wines and new varietals may prove to be more sustainable in the future, as many of the non-Muscadet varietals grown in the Pays Nantais and receiving new found attention are identified by Jones (2012) as temperate-climate cultivars, which would prove to be more suited to an increasing climate in the region.

Melon de Bourgogne still dominates the vineyards of the Pays Nantais, but as cited within interviews of independent producers, many more varietals have come to occupy the terroir alongside the traditional Muscadet. With the shifting climate favoring temperate-climate cultivars, it is no surprise that the region is producing quality wines from grapes of varying climate suitability regimes in both white (folle blanche, chardonnay, pinot gris, malvasie, and gewürztraminer), and red (gamay, grolleau, pinot noir, merlot, cabernet franc, côt, and cabernet sauvignon). Within the coding index, “Non-Muscadet Varietals” ranked 7th in reference frequency and had appeared in 100% of interviews and primary sources analyzed, indicating that the independent vineyards of the Pays Nantais have become a matrix of vine diversity and a laboratory for terroir experimentation.

Marc Ollivier illustrates the independent vignerons' interest in exploring possibilities outside of the Muscadet AOP in a 2012 interview with Jules Dressner:

"I've always wanted to make reds. My original plan was to make red and moelleux wines. Evidently, the Muscadet is not the best place to make moelleux; we've tried but the results have been less than satisfactory. Reds, on the other hand, are perfectly adaptable to our terroirs".

Bertrand Celce (2010) emphasizes the quality of management and care Ollivier focuses on plots of non-AOP varietals in comparison to neighboring, conventional growers:

"One interesting thing to note about Marc Ollivier's reds is that unlike other growers around, he planted the red vineyards on this qualitative, south-western exposure terroir where ripeness is particularly good. As the Muscadet Appellation is only for the white Melon de Bourgogne, the red varieties are usually given the less-interesting terroirs, as they'll not be labelled as Muscadet but as Vin de Table or Vin de Pays".

As Celce states, a necessity amongst independent growers is to label their red wines and non-AOP products as IGP Val de Loire or Vin de Pays. This lesser designation indicates a lack of appellation prerequisites in varietal and vinification, but allows for both a level of distinction and a custom label. Entering the appellation system is also voluntary, if not costly. Phillipe Chevarin in a 2017 interview with Jules Dressner clarifies his rejection of a potential appellation status with his Melon de Bourgogne and Gamay wines:

"If I were under the appellation system, the whites would fall under Muscadet des Coteaux de la Loire and the reds would be Coteaux d'Ancenis. Entering an appellation takes time and costs money. Add to that I'm making an un-sulphured Melon de Bourgogne that goes through malo, it's not even worth trying to present them."

Chevarin is joined by other vignerons who purposefully produce outside of the AOP system to work creatively both in the vineyard and in the cellar. Fred Niger of Domaine L'Ecu often uses amphorae, little to no Sulfur Dioxide, and plays hymnal music in the cellar to create unique and highly rated cuvees and red IPG wines (Ask A Winemaker 2014, winesearcher 2019), while Jo Landron, Phillipe Menard of Domaine Menard-Gaborit, and Jean-Michael Dabin of Domaine Poiron-Dabin, have both specialized in traditional-method sparkling wines made of various cultivars grown on their respective estates. (Domaine Landron 2019, Domaine Menard-Gaborit 2019, Loire on Tour 2018). In many cellars, the vignerons have adopted the biodynamic mindset and projected it onto the enological process, removing the addition of sulfur, non-native yeasts, and other traditional measures, thereby disqualifying wines further from AOP designation.

Lingering Place-Identity and Familial Tradition

Despite the independent vigneron's interest in unorthodox pursuits, their identity is still largely imprinted in a familial or traditional attachment to the land. Many of the vignerons within

the study had inherited vineyards and even the vines themselves from family or mentors and have continued the tradition of Muscadet production as their primary role. Phillipe Menard in an interview with La Boite du Fromage emphasizes the historical and familial connection he has with his vineyards:

“We are a family winery, existing since 1734, passed on from Father and Son for 5 generations, located in the Vineyard of Nantes, in the Loire Valley. The first plantations of Muscadet date from 1734. From 1914, a barrel cellar is born, a real avant-garde construction for the time”.

Pierre Marie Luneau (Dressner, 2012) emphasizes the familial association with his vineyards when speaking about his identity as a vigneron; the impact of generational vineyard work inspiring his passion for the vineyards and winemaking, and what it means to work with the terroir:

“Our cellar is in Le Landreau, where my father Pierre Luneau was born. We also have vines in Chappelle-Heulin, where my mother's family, the Papins, are from. The two estates merged together in the 90's, hence the name. I've always been cradled by the tanks and the tractors, and I often joke that my crib was a pallet case! I have such wonderful memories from my childhood, and running through the vines brings me joy to this day... Luneau-Papin is a family estate. My father was always very knowledgeable about the area, and searched far and wide for the best parcels our land could offer... We have [45] hectares of Melon de Bourgogne, at about 7000 vines per hectare... But both my grandfathers were passionate about winemaking. They were already working in the Burgundian style, fermenting and aging everything in small barrels. Parcels were vinified separately, and as I child I remember customers coming by, tasting barrique by barrique (barrel). When you came to visit my dad, you came to taste different terroirs...”

It has been observed that many independent vignerons take pride in the vineyards and old vines they care for while making Muscadet as their ancestors have. Marc Ollivier (Dressner, 2012) asserts that his reasoning for using native yeasts, rather than preselected yeasts many wine producers rely on, is in part because of his grandfather:

“My grandfather was a vigneron. At the time is was just a few hectares, spread amongst other crops (tobacco) and livestock (cows)... I decided that working with native yeasts would be an interesting way to make wine. It brought me back to the days when my grandfather made wine, and he never had any problem with his fermentations.”

Thus, there is suggested to be a blurred line between familial traditionalism and the new unorthodoxy of the natural, organic, and biodynamic movements. This implies that Melon de Bourgogne production will continue, but the methods by which it is propagated and vinified may further evolve away from the conventional methods found elsewhere. If this is the case, the Muscadet AOP will likely continue to retain its presence in the Pays Nantais but will face challenges as the climate and markets change.

Economic Viability

As Phillipe Chevarin stated, “*there is an economic reality*” to wine production; and the realities of AOP membership, commercial viticulture, and wine business includes a high cost. This is precisely why, according to Fred Niger, (Ask a Winemaker, 2014) the present biodynamic movement among independent vigneronns can be somewhat cost effective and environmentally friendly:

“..so it was very easy [before] because, [sic] the cost, the pollution cost I mean, of the wine, was under the cost of the market, the price, so it was so easy, why would you want to go into biodynamic when it was so easy to make money? Now it is a bit different, because the pollution costs are over the market prices, so it is quite hard in my area...”

The methods incorporated by these independent vigneronns can also become a financial burden by other means; Joe Dressner (2019) expands on this notion, stating that the AOP system encourages market price competition amongst neighbors, which can put a bottle of excellent, terroir-driven Muscadet at the same price of a neighbor’s conventional, mediocre wine. This market competition can also be restrictive in terms of unique methods such as hand-harvesting (as opposed to machine harvest) due to the extra time and cost it may require; as told by Pierre-Marie Luneau:

“I have nothing to hide: the rest are machine harvested, because the economic realities of Muscadet don't favor hand harvested, terroir driven bottling..”

Celce (2013) emphasizes the effect of market competition on bulk Muscadet supply, stating that

“the bulk price in 2011 for generic AOP Muscadet (obviously made for example from the couple of dead-soil plots...) [were]: 60 € per hectoliter, which makes 60 cents per liter or about 50 cents per 75 cl...”

This cheap, conventional wine often sets the price for non-conventional Muscadet lower than the value of labor met to produce it, thus creating a non-profitable market that could have independent producers concerned for the future of their natural products and financial welfare.

Market demand is often a variable that cannot be ignored by independent vigneronns, as their livelihoods are funded by direct estate sales rather than the use of “négociants” as middlemen between vigneronns and other markets. Luckily the market for these products seems to be growing in unexpected ways; Jean-Michel Dabin (Loire on Tour, 2018) claims to have accrued a market export presence abroad, specifically in Asia:

“It is true that we are well established in Asian countries, particularly Japan and China, with whom we have excellent commercial and personal relationships. It is really this that drives me to seek customers abroad”.

With growing markets in Asia and elsewhere, there is hope that independent products may become more profitable.

FranceAgriMer, the French national commission for agricultural and maritime products, produces statistical data each year for sales, production, and cost of agricultural products including wine, and measures the range of price and volume from year to year. Between 2016 and 2017, FranceAgriMer reported an 18% decrease in volume of Muscadet production, but a 59% price increase, and from 2017 to 2018 reported a 25.7% decrease in volume sold, with a 10.8% price increase. For AOP Muscadet, volumes have declined but prices are growing, giving independent vignerons an edge over competition due to better quality and consistently high scores by wine reviews. IGP wines, however, are also increasing in price, but unlike AOP wines, are increasing in sold volume. FranceAgriMer reported that IGP de Val de Loire (white, majority chardonnay) wines have increased in sales by 7% and in price by 4%.

The increase in IGP sales and price is promising to independent, eclectic vignerons that offer a variety of quality products on the global market, incentivizing the continued adaptation of vineyards to better fit their vision and the shifting climate. This movement away from AOP production and sales has not gone unnoticed; as of the 15th of November 2018, the Muscadet AOP has officially allowed the propagation and vinification of Chardonnay grapes, with Muscadet AOP wine allowed to contain up to 10% chardonnay. (Cahier des Charges INAO, 2018) While this may allow vignerons a greater level of accepted diversification, it is still a minute change that does not address the severity of future climate change, and the necessity for vignerons to adapt accordingly; adaptation most likely will necessitate growing more temperate-climate varieties instead.

Primary and Interview Resources Summary

When primary sources and vigneron interviews were compiled, coded, and analyzed, several key themes within the independent vignerons worldview and management techniques became evident:

1. The perceived influence of bedrock material, rather than climate, in creating terroir and wine typicity.
2. Increasing usage of organic or biodynamic management techniques among independent vignerons with high quality product.
3. Increasing propagation of non-AOP varieties within Muscadet appellations, prompting greater production of IGP or VDF products and a dissatisfaction with restrictive AOP regulations.
4. A common sense of familial traditionalism that influences identity rooted in terroir and Muscadet viticulture.
5. Concern for economic viability and the changing market.

These thematic groupings were identified by reference frequency, and emphasis, within each source.

According to the independent vignerons studied, wine typicity of Muscadet (both by AOP and generalized standards) was perceived to be most affected or influenced by the bedrock material found beneath vineyards. Bedrock or parent material was so greatly emphasized amongst each vigneron that it was often synonymous with the “terroir” itself, and the most influential factor in sensory aspects of their wine products. Unless observed as an extreme precipitation event or climatically unique growing season, climate was not emphasized or perceived to be an influence on wine typicity.

To further enhance the quality of their wine products, many of the vignerons studied had converted, or are actively converting, their vineyards to organic or biodynamic management systems. Those that have done so claim to have a greater respect for nature, and that “natural” management techniques have given their wine products a higher quality. As previously mentioned, the vignerons within this study were chosen in part due to the renowned quality of their Muscadet and non-AOP wines, garnering attention from the wine industry and consumer communities for their accolades, and the management strategies by which they achieve their quality product. Some studies suggest the relative success of these management strategies may be in part to the upkeep of the soil; by allowing ground cover to flourish, and microbial and faunal activity to thrive within the soil, the soil pH and vital nutrients are protected from heavy precipitation, leaching, and drought events. This retains nutrients within soil horizons where they become available to vine root uptake, potentially influencing the phenology of the vine itself.

Independent vignerons have not only adopted unconventional management techniques but have ventured into the cultivation of non-AOP varieties and production of IGP and VDF wines. The varieties growing alongside Melon de Bourgogne are vastly more suitable to temperate climates and offer a more sustainable crop if positive climate trends continue in the region. Primary source analysis revealed a high frequency of non-varietal references, as well as

negative sentiment towards AOP standards, implying a growing disinterest in the AOP while increasing production of IGP and VDF wines.

While non-AOP cultivars and IGP/VDF wines are growing in production volume, many independent vignerons felt a sense of familial and personal identity within Muscadet production and the local terroirs of the Pays Nantais. This implies that while production volume has decreased, independent vignerons will continue to cultivate Melon de Bourgogne in their vineyards.

The market for Pays Nantais wines have changed with the decreasing volume of AOP Muscadet and the growing volume of IGP and VDF wines produced. While AOP wines are more valued and more expensive, many vignerons had expressed a concern for economic viability, turning towards unconventional markets and their non-AOP products to increase income.

Chapter 5: Conclusion

The Pays Nantais of Northwestern France is a diverse matrix of wine and terroir which simultaneously contains an AOP designation that has, until very recently, only accepted the Melon de Bourgogne grape into its labeling distinction. With a unique, maritime climate allowing the cool-weather grape to thrive, the effects of climate change on this region may change the accepted, and expected, typicity of this grape and create a management dilemma for vignerons and winemakers. This study therefore collected climatic data and qualitative information to understand how climate change will impact this wine region, and how the AOP regulatory system will affect independent vignerons' ability to adapt or thrive.

According to daily climatic data of the region, a clear increase in GST, HI, CI, and DTR have been observed over a 43-year period, revealing a shift in local climate from cool to more temperate conditions. Climate models from national and international sources support these findings, reporting significant effects on the region that will likely increase extreme precipitation events, deteriorate and salinize the soil, and continue to increase temperatures. These affects prove a threat to the Melon de Bourgogne's phenology and wine typicity and will likely make the cultivar un-sustainable within the next 100 years.

The AOP system encourages the near mono-culture cultivation of Melon de Bourgogne, legally restricting vignerons to Muscadet production to qualify for AOP labeling rights. The "economic reality" is that AOP wines are generally more valued by the market but are decreasing in sales, creating interpersonal conflict over the allocation of territory and terroir, and the pursuit of new viticultural possibilities. While many vignerons have delved into production of non-AOP cultivars, the varieties of the AOP are still given primary focus, the best terroirs, and are often linked to familial tradition. As time has passed, the climate has shifted into more temperate conditions, and if climate models are correct, will prove to be less hospitable in terms of maintaining the varietal typicity expected by AOP standards in this region. A loss in typicity renders the AOP meaningless, unless regulations concerning varietal restriction, or the standard-bearing sensory notes of a terroir, are further amended to better represent the sensory outcome of grapes produced in an atypical climate. If the AOP does not adapt, then the AOP will prove to be a hinderance to viticultural adaptation. While Melon de Bourgogne is still the primary cultivar in the region, independent vignerons of the Pays Nantais are challenging the notion of AOP superiority, while working in tandem with nature and the changing climate, to produce high-quality wine.

The recommended action to retain vineyard sustainability in the region is to increase usage of "natural" management practices, as well as to increase the propagation, and marketing, of IGP wines from cultivars that are more suited to temperate climates and resistant to disease. Managing the vineyard in a "natural" setting increases microbial, faunal, and vegetative activity within the soil, creating ground cover and balanced pH that will protect the root systems and cation exchange capacity, mitigating the impacts of increased events of extreme precipitation or drought. Propagating more temperate-climate cultivars and establishing a market for them will guarantee a sustainable income from the vineyard, while simultaneously allowing the vigneron

greater enological freedom. Muscadet may find a more suitable growing region north of the Pays Nantais in Brittany, or perhaps the Melon de Bourgogne will colonize more suitable cool weather climates such as the Northwest Coast and Finger Lakes regions of North America. For the time being, Muscadet seems it still has a home with the eclectic, independent producers of the Pays Nantais.

Limitations and Future Research

This project could be improved and expanded upon by further research in several core areas, including climatic data modelling and more intensive ethnographic investigation. The study would be greatly benefitted by the collection of more diversified daily climate data that would have represented a larger area of the Pays Nantais to have a more complete understanding of regional climate change; data was limited to the Bougenais station due to daily data availability and financial cost. More intensive ethnographic research, including personal interview of a greater range of producers in the area would also greatly benefit the study by providing perceptions of conventional and AOP-specific vignerons to compare with independent vigneron interviews. More in-depth questioning concerning climate and climate change perception within interviews would create more focused and nuanced results regarding purposeful mitigative management techniques, or lack thereof, currently implemented in vineyards.

The objective of this study is to contribute to the field of wine geography and viticultural studies. Therefore, I am hopeful that further research will be inclusive of both the physical and human aspects of terroir within a given region, to create a more sustainable future for the wine industry and its stakeholders.

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Transcripts of Viable Primary Source Material

Philippe Chevarin Interview with Jules Dressner

This interview with Philippe Chevarin took place over Skype in April, 2017.

All words and transcripts are original and under copyright of Jules Dressner and Louis/Dressner Selections.

JD: You aren't from an agricultural background right?

PC: Not at all. I used to be an audio engineer. I would go on tour with bands and singers doing live sound.

No recording studio work?

I worked in studios a bit but ended up being really focused on live music.

What kind of music?

It went from noisy, dirty rock n' roll to larger acts like Vanessa Paradis.

How did you end up as an audio engineer?

I started as a musician. When I realized I wasn't good enough to ever make a living at it, I shifted my focus to the technical side of sound! I read some books and learned everything on my own.

How long did this first career last?

From 1991 to 2015.

So what made you change paths and start making wine?

I'd been around the block with my job, and growing meant doing bigger productions, stuff like Vanessa Paradis... I was really turned off by the business side of shows of this scale, and knew it wasn't for me.

So I decided it was time for a change. One idea was to open a wine bar with my wife, because I was already completely in love with it. But it just so happens she is childhood friends with Thierry Puzelat's wife Cécile. Through Thierry I was introduced to Pierre-O Bonhomme, René Mosse... It was inspiring.

Because I had a lot of down-time with work, I decided to study viticulture and oenology on the side. This placed me in a two year stage at Domaine de la Paonnerie, about 30 minutes from Nantes. After two years with Jacques and Agnès, I knew I wanted to be a vigneron. And since I'd gotten used to that area, I asked them to help me find vines close by.

Did you move from Nantes?

No, we still live in Nantes. It's about a 35 minute drive.

Tell me about the vines you were able to acquire.

It was a bit of a particular situation. The vines had been abandoned for three years. The vigneron next to them treated them once a year to make sure they wouldn't get sick and affect his own vines, but other than that not much was happening.

Basically a guy was taking care of them and disappeared overnight. He didn't pay for his rentals, there was a trial... Anyhow, when I took them over they were a little bit damaged. But by hanging out in the village, I started meeting farmers and some offered me more land.

So with how much land did you start, and where are you at today?

I started with 2.8 hectares of Melon de Bourgogne, Gamay and Cabernet. I took those over in March, 2014. That year I sold my grapes to Pierre-O Bonhomme and René Mosse. 2015 was my first vintage working the vines full time and making my own wine.

So how much land are you working now, and what is the breakdown grape-wise?

I'm at 5.3 hectares now. I'm buying 40 ares of vines this year, and the rest is in fermage; I give them some wine and they let me work their land. Essentially it's people who care about keeping their vines alive but can't work them themselves. They don't want the vines ripped out.

As far as my surface, I'm at around 2/3 in Melon, 1/3 of Gamay and a tiny bit of Cabernet and Grolleau. The soils consist principally of schist, quartz and sandstone. These are really "vineyard soils": nothing else can grow in them.

How old are the vines?

I have two mains plots. In the first, the oldest vines were planted in 1969, but most are from the 80's. For the the second plot, I've got some Gamay from the 50's. And I'm about to get some Melon de Bourgogne planted in 1948.

Can you break down the wines you make?

The Melon is called Le Souffle. It's a blend of all my parcels; I don't have enough juice or space in my cellar to do otherwise. I do a direct, slow-press with the old screw-press I own, about 4 hours. Malo happens and so far I have succeeded in not adding any sulfur. It worked my first two vintages so we'll see.

Then I have a Gamay rosé called La Goulée but I'm going to change the name because Benoit Courault also makes a wine with that name. But that's what it's called for now. It's also direct-press, and ends up as a fairly colored rosé.

My Gamay is called Les Sentinelles, which is a more ample style, with nice structure and tannin. In 2015 I made it whole-cluster, so it has a semi-carbonic profile. In 2016, I made it half whole-cluster, half de-stemmed.

Then there is a Grolleau called L'Oublie, which is in tiny quantities. Then there is a Cabernet PET NAT called Coup d'Pouce that I harvest with my friends and neighbors.

Finally there is a Gamay PET NAT called La Houle, made half with Gamay Teinturier (Gamay with red pulp) and half Gamay Noir à jus blanc. I decided to take out the Teinturier from Les Sentinelles because it gave the wine an animal quality I wasn't into. I'm really happy because having the red pulp gives the wine a great color. So I think I'll stick with this.

I'll admit that I'm really new at this and still experimenting with vinification. I don't know if the way I make wine today will always be the same.

What's the work in the vines like?

I'm converting the vines to organics, and waiting to get certified by Ecocert. Whenever I get some new land, it's immediately converted.

I work the soils with a tractor. We only use copper and sulfur in the vineyards, and last year I experimented with some essential oils. This year I will try some biodynamic preparations and see how it goes.

Was it always in your plan to work "naturally"?

I can't envision any other way. It's a matter of personal taste: I was drawn to wine through natural wine, and that's what I want to drink and what I want to make.

But at the same time, if I feel I need to add sulfur, I'll do it. There is an economic reality to what we do, and as a young vigneron who suffered a very rough second vintage (2016), I can't permit myself to have an unsellable product.

Your wines are all intentionally declassified as Vin de France. Can you elaborate on that?

If I were under the appellation system, the whites would fall under Muscadet des Coteaux de la Loire and the reds would be Coteaux D'Ancenis. Entering an appellation takes time and costs money. Add to that I'm making an un-sulphured Melon de Bourgogne that goes through malo, it's not even worth trying to present them.

My neighbor Jacques Février, who also works naturally, had approached the appellation about being more open to trying wines like ours. A woman came to his house and started criticizing the wild grass in his parcels! If it's to hear shit like that, it's not worth it for me.

However, we have mobilized with a group of like-minded growers and started an association called Pinards et Jus. We take our wines by boat from Oudon to Nantes and organize a tasting there. The goal is to promote what we are doing in the region. All of us work organically and "naturally" in the cellar, and only one of us is in the appellation. He's fought hard to be in the appellation, and is really trying to shape the tasting panel into understanding the characteristics of our wines, particularly ones without added sulfur.

So there is SOME movement. And the truth is, if we want to see change it will depend on our actions. Nothing is going to change on its own.

Are you from the Loire?

No, no, I'm from the South-West. I came to Nantes in 2002 after a 15 year stint in Bordeaux. I had been planning to move, but I met someone from there and that was a good excuse as any.

Anything you'd like to add?

I often say that my goal, at least for the time being, is to make simple wine. I'm still learning how to do this, but all I want is to do the best possible work in the vineyards, to give them as much life as possible to in turn pick beautiful grapes. I want to make a simple, approachable wine with the least amount of intervention possible.

Domaine Luneau-Papin Interview with Jules Dressner

This interview with Pierre-Marie Luneau took place at the Salons des Vins de Loire in February, 2012.

All words and transcripts are original and under copyright of Jules Dressner and Louis/Dressner Selections.

JD: Tell us about Domaine Luneau-Papin.

PML: We are vignerons in the Muscadet-Sèvre et Maine. We're to the South-East of Nantes, which is only 15 kilometers away. In Muscadet, there are 8500 hectares of vines spread over 25 communes. We're located in a small commune called Le Landreau; there are 800 hectares of Melon de Bourgogne here shared by 35 estates.

Our cellar is in Le Landreau, where my father Pierre Luneau was born. We also have vines in Chappelle-Heulin, where my mother's family, the Papins, are from. The two estates merged together in the 90's, hence the name.

You're 32 and 2011 was your first year as head vigneron for Luneau-Papin. What built up to that?

I've always been cradled by the tanks and the tractors, and I often joke that my crib was a pallet case! I have such wonderful memories from my childhood, and running through the vines brings me joy to this day.

When I turned 18, I was curious about viticulture outside of Nantes, so I took a two year B.T.S in Bordeaux. By the early 2000's I didn't feel the urge to stay in school, so I decided to do a working tour of France. I worked in Sancerre, Bordeaux for a while, then I was in the South (between Perpignan and Rivesaltes) for a good year, then back to Sancerre. I came home for a year before moving to Australia for 6 months, but that trip was mostly to learn how to speak English!

I was back for good in September 2005, and I've worked all six vintages since.

Tell us about the work in the vines.

Luneau-Papin is a family estate. My father was always very knowledgeable about the area, and searched far and wide for the best parcels our land could offer. He was able to procure many of these in the 80's, and we find ourselves today with 50 parcels spread over 10 plots. We have 50 hectares of Melon de Bourgogne, at about 7000 vines per hectare; because of the density of plantation, we average about 50 hl/h yields. Our distinction at Luneau-Papin is that we work parcel by parcel, terroir by terroir. You can't claim terroir if you don't highlight the link between the soil, the vegetal state of the vines and its surrounding environment.

40 h is a lot of vines, and today we surround ourselves with a team to thoroughly work on each parcel. This means working the soil so we don't have to use herbicides anymore; to create a more natural place for the soil and the vines. This really started in 2008, when we acquired the "Terre de Pierre" plot. Because of its rocky serpentine, I knew we had to work the soil. It was a time when we had the human and technical resources to do so, and my father and I agreed it needed to be done.

This process is parcel by parcel, and we began on five new ones last year. Also, we only use copper and sulfur in the vineyards now. In France, an entire property has to be converted to get an organic

certification. You have five years to convert, and today 15 of our hectares are completely organic. I am convinced that in 5 years we will succeed at this. It means a lot more work from us and our team, and we are in the process of figuring it out. This is my main challenge and goal for the estate. I want to do this so that we can best express the mineral purity of Melon de Bourgogne in our soils. I'm seeing a lot of young vignerons completely in love with their place and their terroir. I'm glad to be part of it!

Can you elaborate on making cuvées parcel by parcel?

Muscadet is France's largest single variety A.O.C: everything is 100% Melon de Bourgogne. We have a rich history of exporting our wine because we are very close to the ocean, and for generations Muscadet would be shipped from the Loire to England and Holland. And you can't forget that for a long time, 80% of the production was purchased locally! None of this created much of an incentive in making cuvées that highlight terroir.

But both my grandfathers were passionate about winemaking. They were already working in the Burgundian style, fermenting and aging everything in small barrels. Parcels were vinified separately, and as I child I remember customers coming by, tasting barrique by barrique. When you came to visit my dad, you came to taste different terroirs...

Muscadet is a big place and while some of our neighbors worked in a similar fashion, we were still relatively few. Today, we are lucky in that we sell the entirety of our production directly from the the estate; this permits ourselves to make as many cuvées as we do.

Today, there is a new generation that is interested by their village, by the geology, the pedology of the vines. We have so many soils and sub-soils here. It's a really beautiful region to make wine in. And Melon is a grape that really captures the minerality of a soil.

What about in the cellar?

We make white wine, and there are very few manipulations we have to worry about. With Melon de Bourgogne, you want healthy, clean grapes coming to the cellar. We spend 15 days hand harvesting from each parcel on 24 h of vines. I have nothing to hide: the rest are machine harvested, because the economic realities of Muscadet don't favor hand harvested, terroir driven bottling (editor's note: this is because prices must compete with their neighbors. Read Joe's article Appellation d'Origine Contrôlée for a more in depth exploration of this topic). (ed: as of 2017, only the young vines are still machine harvested. 30 hectares are now hand harvested, with more to come)

The grapes are slow pressed, whole-cluster and vinified parcel by parcel. We do a 36 hour débourage to get rid of the gross lees. Alcoholic fermentation averages between 3 to 6 weeks depending on the parcel. The Muscadet is known for making wine sur lies, which means we don't rack the wine after alcoholic fermentation. This creates an exchange between the clear juice and the dead yeasts and minerals. The aging on the lees lasts from winter through Spring, at which time they are typically bottled.

Can you talk about the unique characteristics of the "Terre de Pierre" plot?

Nantes is really at the very edge of France, and we are very close to the Atlantic Ocean. We are located on the very old Armorican massif, which is composed of metamorphic rocks like schist and gneiss as well as rock from magmatic eruption such as granite. We've always been fascinated by the

diversity of our terroir, and we were lucky enough to acquire an exceptional plot on a lieu-dit called "Butte de la Roche". We called our plot "Terre de Pierre"; it is unique due to its serpentine soils. This serpentine forms the hill itself, and actually comes from terrestrial crusts that broke off during a period of

tectonic movement; these crusts eventually made their way to the surface. In the 500 million years it took for this to happen, the serpentine became altered. So we have all this silicious, irony serpentine that is okra red.

Some geologists from the University of Nantes came to test it and told us we must do our best to preserve this site. They even declared it a geological landmark!

What do you like to drink?

You have to be curious. Right now we're at the Salon des Vins de la Loire, and we all know all the great wines the region has to offer. I'm a big fan of Alsacian wine: it's a place that's also really about minerality, and you find the same qualities on old Melon that I get with Riesling.

Otherwise, every wine has its story. You can't have preconceptions with wine. Every vintage is different and every time you taste it, the circumstances are different as well. Keep that in mind!

Domaine de la Pépière Interview with Jules Dressner

This interview with Marc Ollivier took place at the Salons des Vins de Loire in February, 2012.

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JD: Tell us about Domaine de la Pépière.

MO: Domaine de la Pépière is 35 hectares, and is run by my partner Rémi Branger and I. 30 of those hectares are in white, 5 in red. We are almost to the point of having the entire estate converted to organic agriculture; it's been a step by step process and currently the majority of our vines are worked this way.

Working organically has been a long term goal for you. Can we talk about this?

There are of course many factors in this decision. I think that Rémi's arrival gave me more time to sit down and really think about how I could do it. It's also a much better time to work organically from a technical standpoint.

A huge inspiration has been through you guys, through meeting all the vigneronns who were working organically. I tasted their wines and immediately felt there was something really interesting about them. I started exchanges with these guys, and through some great conversations I realized that converting isn't as hard as most people think.

Tell us your personal journey to becoming a vigneron.

My grandfather was a vigneron. At the time it was just a few hectares, spread amongst other crops (tobacco) and livestock (cows). At first, my father and uncle continued my grandfather's exploitation. But when their children were born, things had to change because the farm's production wasn't enough to feed everybody. At that point, my father became an agricultural technician, while my uncle and cousins continued the farm work.

I was going to university in Nantes at the time, studying science. I realized very quickly that these studies could only lead to a job in education, and I had no desire to be a professor. I wanted to work outside, to be in contact with nature. I also wanted to stay in the Muscadet, so I thought: "Hey, why not viticulture?" At the time I was not passionate about wine; it was just an idea. I found an oenological program for adults in Burgundy and I spent a year there. I was about 18 at the time, and I came back having found my true calling.

Can we talk about the evolution from making only the base Pépière to now producing a large amount of cuvées?

When I first started, there were only 7 hectares of vines. Everything was in Pépière, so the terroir was unified. As the estate grew and the terroirs diversified, I began doing what has always been done in the rest of France: I was already vinifying each parcel separately, so it made perfect sense to make different cuvées. I started making Clos des Briords in 88, Clos Cormerais in 92, etc.

And the reds?

I've always wanted to make reds. My original plan was to make red and moelleux wines. Evidently, the Muscadet is not the best place to make moelleux; we've tried but the results have been less than satisfactory. Reds, on the other hand, are perfectly adaptable to our terroirs. I had a tiny parcel at first. We then tore up and replanted a parcel at the bottom of a coteau, which was believed to have been used for vines a century earlier. We planted 2.5 hectares there in the 90's, and have been planting new vines bit by bit since then.

Have you always worked with native yeasts?

Not always. I used to yeast one or two tanks and let the rest ferment naturally. I quickly noticed that the native yeast wine was more interesting; the wines I made with selected yeasts always had simpler, more primary aromas. I decided that working with native yeasts would be an interesting way to make wine. It brought me back to the days when my grandfather made wine, and he never had any problem with his fermentations.

I come from a generation where you were told you had to yeast or the wine wouldn't ferment. I was never convinced by this argument, because as we all know wine has been made without preselected yeasts for millions of years. I knew it could be done in modern times.

Let's talk about Rémi. How did you meet, and how did you end up partners?

Rémi was born a kilometer from my house. I've known him since he was a little kid. A few years ago I was looking for some vines, and I knew that Rémi's father was going to retire. I approached him and asked if he had a predecessor, and when he said no I told him I was interested. Rémi was finishing up his studies at the time, and with the acquisition of these new vines I was also looking to hire an employee. I can't remember if he asked me or if I asked him, but he started working for me immediately. This was in 2006, and I very quickly told him that if he was interested, he could have a place at Pèpière.

Let's talk about the Muscadet A.O.C, which has a bit of a bad rap (at least in France).

I have a theory on this, which is worth what it's worth... The Muscadet has always been under the influence of négociants. This was originally a good thing, but the dynamic changed when the focus shifted to bulk sales, which require a simple, uniform product. Under this influence, a standardization of Muscadet occurred. This phenomenon was perpetuated and spread by agricultural technicians, who used machine harvesting, preselected yeasts and whatever technology available to make "clean" or "flawless" wines. This soon became the norm, and everyone was doing the exact same thing.

Muscadet stopped being interesting because it was made like a Vin de Pays. What I mean by that is the wine's relation to terroir was completely abandoned. Technology was what mattered to people, not terroir. Like any A.O.C in France, if the vines are maintained and there is a real point of interest, you can make varied, interesting wines.

Another big problem is that people started planting vines everywhere to create a larger supply of Muscadet. The obvious results are that the vines are in soils not suited for viticulture. People forgot about terroir, and by doing that they forgot what makes an A.O.C: vignerons, grapes and soils.

Did your grandfather sell to a négociant?

My grandfather only worked 3 hectares, and sold a large part of his production in barrel to cafés in Nantes. He would deliver them himself, barrel by barrel. He also sold a bit to the négociant. In the

60's there was very little wine being bottled.

How did you decide you wanted to bottle independently?

After my formation, I worked at my uncle's for two years. When Pépière became available, I knew I wanted to take over and I knew I wanted to bottle independently. At the time, you made a good living selling to the négociant, but bottling independently felt like the only way to meet the actual people who drank the wine. I never envisioned it any other way.

Did you always want to work in Muscadet?

When I went to school in Nantes, it was so I'd be close to home. I didn't know it would be viticulture at the time, but I did know that whatever my job ended up being, I would do it here. That's why I have a tough time traveling. Your father had to really twist my arm to come to the U.S. I refused for years!

What can I say? I'm a peasant, I've very much linked to soil and to nature. I have a hard time being anywhere else.

Let's talk about "natural wine". Where do you stand?

Rémi and I have never claimed to be part of the natural wine family. I've always been very interested by these wines, and do envision my wines to have the same qualities. But we've always used SO₂, and we don't plan on eliminating it. At the same time, I know the term "natural" is imprecise, and that many would consider me a natural winemaker even if we use a little sulfur.

There is a technical reason we use SO₂. Pépière is all about minerality, purity and freshness. We don't want any malolactic fermentation, so after alcoholic fermentation we rack the wine to a cold, temperature controlled tank and slightly sulfur it in December and January (on average 5g total). We almost never sulfur at bottling.

I don't care how people categorize me within this debate, but I must say that when I drink sulfur free wines, I notice that you really taste the grape and the terroir. I've also realized that you can make sulfur free wine and it can still age. So progressively, we have tremendously reduced the amount of sulfur in the wine over the years.

What do you like to drink?

A lot of things. I love Loire wine, and they represent about 50% of the wines I drink. I still love moelleux, and regret the Anjou and Montlouis guys make less of it because it's hard to sell. I like the Rhône and the South a lot.

La Boite du Fromager Interview with Phillipe Ménard: Winemaker at Domaine Ménard-Gaborit

Interview took place September, 2019

Interview with Mr. MÉNARD: Winemaker at Domaine Ménard-Gaborit

“Carolina”

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C: Hello Mr. MENARD, could you introduce yourself to our readers?

PM: We are a family winery, existing since 1734, passed on from Father and Son for 5 generations, located in the Vineyard of Nantes, in the Loire Valley .

Tell us about your domain MÉNARD-GABORIT. What is it's story ?

The first plantations of Muscadet date from 1734. From 1914, a barrel cellar is born, a real avant-garde construction for the time.

Then in 1947, these are the first bottled on the property. Since the Domaine MENARD-GABORIT covers an area of 73 hectares and is managed by Philippe and Thierry.

What are the characteristics of the MÉNARD-GABORIT domain (surface, soil, terroirs, grape variety ...)?

We operate 73 hectares, mainly Muscadet (80%) for the grape variety Melon de Bourgogne, but also Gros-Plant of the Pays Nantais, Cabernet (Cabernet Franc grape variety) and Gamay (Gamay grape variety). Soils are siliceous clay on gneiss.

What is your annual production? What are your wines?

We have an annual production of 3,500 hectoliters.

We have 5 cuvées : Cuvée Prestige, Cuvée Muscadet Sèvre and Maine sur Lie, Ambroise harvest of autumn, Brut traditional method, Monnières-Saint Fiacre raw communal.

When and how can our readers visit you?

We are open all year, Monday to Saturday lunch.

What emotions do you think your wine will convey to our subscribers?

The Cuvée Prestige is a selection of our best cuvées of Muscadet Sèvre and Maine sur Lie. It is representative of our know-how and the result of a daily work going from the cultivation of the vine, to the vinification of a wine.

In a bottle of Cuvée Prestige the taster finds all the pleasure of the "pearling" typical of this appellation. The first nose, fine and discreet, evokes hazelnut.

After shaking, the second nose is more expressive with floral and mineral notes and evokes spring in all its freshness.

The creamy texture of this Muscadet makes it a real moment of pleasure and discovery of a promising vintage with good aging potential.

Loire On Tour – Domaine Poiron-Dabin – Interview with Jean-Michel Dabin, owner and winemaker

Video Interview – YouTube 0:03 – 1:46

Transcript translated by Loire On Tour from French to English

March 16, 2018

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Jean-Michel Dabin :

Domaine Poiron Dabin is a family wine estate run by my brother Laurent and I.

We produce wines with the Muscadet Sevre et Maine Sur Lie appellation and the Cru Chateau Thebaud appellation, which is a village cru appellation of a very high level, where you have a rare type of bedrock composed of schist and soft, crumbly granite which gives the wine great structure, fruitiness and exceptional ageing potential.

We have also specialized ourselves in another area, the production of Traditional Method sparkling wines made entirely at the estate.

These Traditional Method sparkling wines are made from unusual varieties, like Gewurztraminer, which is of course grown on the estate, Sauvignon Fie Gris, Melon Blanc, or the famous historical variety, Berligou, which is a remarkable variety.

That is something that is really worth discovering if you ever happen to visit us.

[On the subject of exporting estate wines]:

It is true we are well established in Asian countries, particularly Japan and China, with whom we have excellent commercial and personal relationships. It is really this that drives me to seek customers abroad.

We are a long way from having conquered the whole world. We tend rather to let people come to us.

It is word of mouth that does the job for us to a certain extent.

Loire On Tour Domaine du Haut Bourg – Interview with Nicolas Choblet, owner and winemaker

Video Interview – Youtube 0:03 – 1:38

Filmed onsite of Domaine du Haut Bourg

Transcript translated by Loire On Tour from French to English

March 16, 2018

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Nicolas Choblet:

My name is Nicolas Choblet. I'm Sales Director at Domaine du Haut Bourg, in the community of Bouaye, in the heart of the Muscadet-Cotes-de Grandlieu area.

We are a family-run estate. I work with my brother, with whom I co-run the business. We are a 40-hectare estate, which produces fifty percent Muscadet-Cotes-de Grandlieu and fifty percent IGP Val de Loire wines.

Here, we have quite alluvial soils. You have red sand and river-rolled quartz pebbles, which encourage early grapes, because they keep the ground warm, both day and night.

Our Muscadet wines are aged for a long time on lees. Up to ten years for the longest aged, from a selected plot. We manage our entire vineyard on a plot-by-plot basis.

With the IGP Val de Loire, we look more to make wines that are on the fruity and fresh side. We try to make them youthful and easy-drinking wines that can be enjoyed at any occasion.

We have been exporting our wines for 15 years now. Exports account for fifty percent of our sales. We sell mostly to Europe, but we're mostly in the US and in Canada. I aim to develop a real relationship of partnership with my distributors by helping them on their market and also by taking account of their feedback which helps me to improve and make even better quality products.

Ask a Winemaker – Fred – Domaine de L’ecu; Biodynamic farming in Muscadet: Fred of Domaine de l’Ecu weighs in.

Video Interview – YouTube 0:00 – 2:57

Filmed at Rootstock, Chicago

April 28, 2014

All words and content under copyright of Ask a Winemaker and Fred Niger/Domaine de L’Ecu

Fred Niger on being biodynamic in Muscadet:

The last year, they used to, used to get the (unintelligible), it was so easy to use chemicals to get some high yields, and uhh, you know, just to have a seule machine, and then you sell the wine immediately... Meme... even before the alcoholic fermentation, get a big truck *High pitched whistle* (indicating a dumping motion), you full the truck (claps hands) its done.

So it was very easy [before] because, uhhh the cost, the pollution cost I mean, of the wine, was under the cost of the market, the price, so it was so easy, why would you want to go into biodynamic when it was so easy to make money?

Now it is a bit different, because the pollution costs are over the market prices, so it is quite hard in my area... but umm.. we only maybe 10 winegrowers to be in organic farming, and uhh only two winegrowers to be biodynamic farming.. you know, both. Jo, which is one of my best friends, and uh Domaine de L’Ecu.

So we are a bit eclectic in my area, you know, in the Bouloire and Vallet there are many biodynamic estates, and the Alsace also, in the south of France.. but in my area, you know it is so cloudy.. so it still rains. So you have to fight..its a fight every year against rot, but what I mean its not easier in the south, but its just a fact there is less rain in the south of France than my area, we are very close to the ocean and we got many many clouds, so, many many rains... and uh, you know with the Demeter certificate, we cant use more than three kilo of copper every year for (unintelligible), and usually we are more like one, one and a half, two kilo of copper, its very very few (unintelligible) because of the rain, so its very dangerous to be in biodynamic in my area.

You have to know that the last ten years its about 30 hectares for 40 hectolitres barric counts..the average... very very few.. especially for Muscadet.

You speak about St. Emilion grand cru, because St. Emilion grand cru is fifty five okay? Fifty five for St. Emilion grand cru, and I am in Muscadet, its 30.

I don’t know if it makes sense, but uhh biodynamic for me is a way of life, I don’t do anything else.

Ask a Winemaker – Fred – Domaine de L’ecu; Orthogneiss, Gneiss, and Granite: the Bedrock of Muscadet.

Video Interview – YouTube 0:13 – 1:53

Filmed at Rootstock, Chicago

April 28, 2014

All words and content under copyright of Ask a Winemaker and Fred Niger/Domaine de L’Ecu

Fred Niger on the differences of his vineyard’s bedrock:

F: One bedrock is gneiss, one is orthogneiss, and one is granite. You have to understand that they are made with the same elements: feldspathe [Feldspard], mica, and quartz, its just a difference of heat and pressure. So gneiss and Orthogneiss are metamorphic stones.

Okay, you got gneiss, you got a lot of pressure and heat so very very small small stones... the orthogneiss in the middle of the hill which are very bigger stones, very square, that’s why its called or-tho-gneiss, very, very square, very massive; and granite is granite so it’s a .. narrative stone, so you got three different stone, three different bedrocks, that gives you three different wines, simply.

Gneiss gives some very soft wines with more of the fruit, okay, very easy to drink... Othogneiss gives some massive wine, very full body with very raw, spicy often..spicy...umm from three to ten years in your cellar.. you can drink now but it ages very well. and Granite is more like a flinty wine, very straight, linear wine, on the rock. Yeah and you can age these bottles for ten year.

A: “Do you farm them differently?”

F: No, it’s the same work. Same hill, same exposure, same ploughing, all is the same, the work in the cellar, just the bedrock simply.

Ask a Winemaker – Fred – Domaine de L’ecu; What is the Renaissance des Appellations?

Video Interview – YouTube 0:05 – 1:28

Filmed at Rootstock, Chicago

April 28, 2014

All words and content under copyright of Ask a Winemaker and Fred Niger/Domaine de L’Ecu

A: If you were in charge what would you do?

F: Oh I would never be in charge, believe me. You know I belong to a group called “Return to terroir”, okay? The renaissance des appellations. We fight, and I mean, we fight against the standardization of the wine...

We don’t believe in AOC, we believe in terroir.. okay? So.. uh, believe me, I would never be the head of, you know..never never never. Because for me its just nonsense. You know? Just because you are in the area of Chinon or Muscadet, you make some Chinon.. [sic] bullshit. Bullshit. Some make some great Chinon and some other make some, some poor white.. but they are all in Chinon. This is nonsense.

You have to respect your soils, you have to try to find what is in your terroir. But some don’t have, so they make some Chinon, or some Muscadet or some... new white trends but..

AOC is uhh....AOC is uhhhh... ah. You know, as soon as I talk back I already have ten arrows in my back, so that’s enough *Laughs*

Ask a Winemaker via Candidwines.com - Jo Landron, Domaine de la Louvetrie (Domaines Landron), Muscadet

Video Interview – YouTube 0 :10 – 3 :45

December 22, 2010

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Jo Landron on the freshness of Muscadet:

When we get a good balance in the Muscadet, we are with, always, get the freshness in the wine, by the acidity. But it musn't be too high to get the freshness, to get the well balance in the wine.

In fact, there are also those factors that can balance the wine when you have less acidity, [sic]. Umm but of course its an important element to decide it, when we have to pick the grapes.

When you uh feel a very well balance, very good taste, quite good harmony in the elements in the grapes, you can say "yes, I am ready, pick the grapes tomorrow; or a pick the grapes in three days", it could be so exact, just tasting the wine.

We have two vintages which, which illustrated that very well, its two or three, with warm weather, we get in fact, very low acidity, the lowest I've seen for a few years, and of course, increasing degrees in the same times.. the difficulty was to keep the freshness in the wine without this acidity, and I think, the wines, the Muscadet, which gets more minerality because of the vineyard is ploughing, is well done. I think it has a better freshness today, and a better structure than those that are not ploughing, for example.

At the contrary, on the very cold weather, you can imagine Paris um '98, it was really cold weather; probably we could find the same thing in a little bit in 2008. You can get more acidity, and probably sometimes too much, and to balance this acidity, we need to wait a little more in the bit before harvesting, uh that the acidity was balanced in the grapes.

I want to say you have malic acidity, and you have also tartaric acidity, which is the main composant of the acidity, total acidity.

The malic acidity, is from, quite the same from green apple, and it gave sometimes in the wines a taste of green apple. And uh, normally with the sun, it's a process to burn malic acid, to convert it to tartaric acid, its met quickly when your sun. More of your son, more your balance is made quickly, and less you have sun of course, more it take time. That means that when cold weather, cold vintages, we have to wait for more longer time, just the balance is made in the grapes.

