Winegrape ideas from reading the literature

**Misc**

vanLeeuwen and Destrac-Irvine 2017 – a good general overview of how viticulture can adapt to climate change, mostly by getting vines to verase later

Ferguson et al 2014 – estimated day of bud-burst, initial hardiness and maximum hardiness were all positively correlated. More hardy varieties in winter then tend to budburst earlier in the spring.

If I have enough data, I would like to look at the variation due to root stock and clone. What capacity is there for retaining an variety but still adaptive planting?

The ideal window for harvesting grapes in teh northern hemisfer is 10th September to 10th October. Because of climate change some wines like Merlot and Sav blanc wont be so high quality in Bordeaux because their dicking dates earlier than 10th September. Van Leeuwen et al 2019. How do we adapt to this?

1. plant later ripening varieties (but European regulations and market demand)

2. Plant later ripening clones

3. Change rootstock. Data is scarce though.

4. Increase Trunk height so vines dont get as warm in the summer (how does this affect their winter hardiness?). vanLeeuwen and Destrac-Irvine 2017 talk about a special golblet growing shape that helps, but you cant mecanically harvest.

5. Reduce leaf area to fruit weight ratio. Fewer leaves mean less sugar accumilation in teh berries during verasion. More applicable for white wine than red

6. Late pruning in winter delays budburst in spring by a few days. Still quite experimental though.

Could any of the viticultural practices employed to encourage later ripening also affect teh vines ability to maintain winter hardiness? Perhaps a problem for places like teh okanagan where summer temperatures are already high

increased droubt likely because warmer and more evapotransporation. This can have positive or negative effects on wine quality, depending a lot on how extream the conditional already were. Van Leeuwen et al 2019.

How much clonal variation is there in winegrape winter hardiness? There is quite a bit for sugar accumilation dynamics (van Leeumen et al2019 fig 8) and sugar accumilation plays an important role in hardiness

what about clones? Chosing the right close is a powerful tool to deal with drought stress (V), so maybe for winter hardiness too?

**Climate Modelling**

I could frame a question around predicting species’/varaiety’s niches? Thsi might be more ecological? About how difficult it is based on a one or a few climate variables. Focus on suposed increases in where wine can be grown in teh north because winter temperatures are getting higher, but what about teh influence of increasing heatwaves, drought and false springs? Also how does considering within species variation change the answer? But what if better adapted varieties cant reach new areas? Also how much can we infer about changes in summer heat/drought from changes in winter temperatures? Do places generally increase winter and summer temperatures teh same amount? Does something weird happen in spring? Might there be more extreme fluctuations in climate?

Are more cold tolerant species more or less sensitive to heat/drought? Maybe some tradeoff? This will matter when considering new areas to grow grapes.

What about the potential affects of lack of chilling in warmer winegrape regions? See Luedeling et al 2009 about this problem in trees

Could vineyards use micro climates within regions to find the perfect balance of warmer winters without too hot summers? Maybe a slope aspect or something? I could take a look at this by seeing if there are any small scale climate patterns in which areas will be most suitable. I.e. mostly a particular facing slope or something.

Fraga et al 2016 – overview of projected changes in climate (and other stuff) and how this will change viticulture in Europe. More yield in France. Can gro grapes in UK. Spain will have lower yield.

How should i deal with climate modeling uncerainty? Deser et al 2012.

**False Springs**

Could I get at which varieties are going to be less vulnerable to false springs?

How much of a problem will false springs be? Will they be more of a problem for areas that are only just getting warm enough for planting? Will this cause problems if you need to plant a very hardy vine but then it is more susceptible to false springs? \***\**need more research on false spring modelling*\***\*

Most damage to crops occurs during spring frosts or autumn heat waves (Charrier et al). SO this is where my model need s to be most accurate?

Phenology - Do I see evidence that more cold hardy varieties budburst earlier? (see Ferguson et al 2014). If so these varieties may be MORE cold vulnerable in spring than less hardy varieties

How will earlier budburst dates interact with potentially more common false springs or late winter frosts (tardive frosts)? See Sgubin et al 2018 for more info on this. How regionally variable is this?

**Trait Plasticity**

Does the same vine reach the same hardiness each year, conditional on temperature? Does the same variety or clone? How plastic is cold hardiness?

What about how variable varieties are between sites? If I take teh same varieties, and look at how they differ relatively at different sites, will some varieties differ more? I.e. be more plastic? Or are acc/deacc rates unchanging?

**How does winter hardiness correlate with other important things?**

What would i expect it to correlate with? What is an important thing?

\* heat and/or drought tolerance. Will new areas really become available because of warmer winter temperatures, or will these areas become to extreem during teh summer?

\* Wine quality/verasion timing/phenology

\* yield

\* where does cold hardiness fit into syndromes?

\*what trade-offs are there physiologically in becoming and maintain cold hardiness?

Ferguson et al 2014 – more variation in Hc max than Hc initial between varieties. Doesn't that suggest that some varieties must get hardier quicker? How does that work physiologically, and what are the costs of this? Does microclimate affect the rate of change of hardiness in relation to temperature? Or will Riesling always get (for example) 1 degree more cold tolerant for a unit of chilling wheras Merlot only 0.5 degrees of cold tolerance? If rate does change, would I expect more variation for a hardier grape? If the rate is invariable I would expect less between site variation (if micro climates are taken into consideration).

**Modelling**

Processed based modelling – can I think of a simpler one that would still work?

Should I focus on maximum hardiness or the rate of deac/acc? (related to potential risk of False Springs vs very cold periods midwinter). Charier et al mentioned that it has been observed that maximum hardiness achieved in winter is not dependent on environment (need to take another look at this).

The Feguson 2011 model was not good at predicting late winter/spring hardiness. It tended to overestimate hardiness a lot because the model didnt understand the physiological changes taking place as vines get ready for budburst. The 2014 Ferguson model estimated hardiness based on phenological stage for the spring temperatures, and that seemed to work better. They said that LTE values derived from the lab were not correct for buds that were not dormant – something to do with water chemistry I think?

Maybe have a model that has two different rate periods, one before spring bud physiological changes move to budburst, and one after this point. But how would i estimate this pivot date?

Maybe i could include as logistic component to my regression (like Fegusson et al 2011) to stop harciness increasing linearly when it’s really cold?

Lenz et al 2016 - in trees, budburst happened a certain number of days after the last time temperatures went below the freezing tolerance of new leaves.

Could I just include a modle estimating chilling requirement and budburst (i.e. Caffera and Eccel 2010) and include that as teh dates when i expect rates of change of hardiness to change?

**Physiology/ mechanisms**

Energy is necessary to drive acclimation and sugars play an essential role in freezing tolerance, the

resiliency of photosynthesis under stress conditions and how photosynthates are utilized (growth vs acclimation) also need to be better understood (Gusta and Wisniewskib 2012). Coudl there be a growth cost to being more cold hardy? Do more cold hardy vines produce smaller yeilds?

Proteins work in concert with sugars to establish cold tollerance. If plants havent got enouph sugars (carbohydrates) from the growing season then they cant be cold hardy ( Gusta and Wisniewskib 2012).

There is a model based on carbohydrate amounts in cells that models cold hardiness in Walnut trees

What are teh physiological differences between a more and a less cold hardy vine variety?

Lots of references in Lenz et al 2016 about how budbreake is closely related to loss of winter hardiness. Expect more cold tolerant leaves to mean earlier budbreak because the risk of frost is lower. Is that why ,ore cold hardy vines budbreak earlier? Or do they budbreak earlier for other reasons? Are the leaves of more generally cold hardy varieties more cold hardy too?

Lenz et al 2016 – suggest freezing resistance is rather fixed trait in trees. Freezing resistance was very similar amoung distinct populations of teh same species. SO its easier to adjust leaf-out date than how cold hardy your leaves are.

Phenological response to temperature seems to be quite plastic based on elevation. For example budburst should change based on climate conditions (see Caffarra and Eceel 2020). So should hardiness be plastic also? - Yes. But should the rate of acc/deacc also be plastic? Maybe this relates to the physiological mechanisms underpinning winter hardiness?