Carbohydrates

Assimilation,
Translocation & Utilization:

The Basis of Shoot, Fruit and Root Growth

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All plant material is built from three main chemical elements.



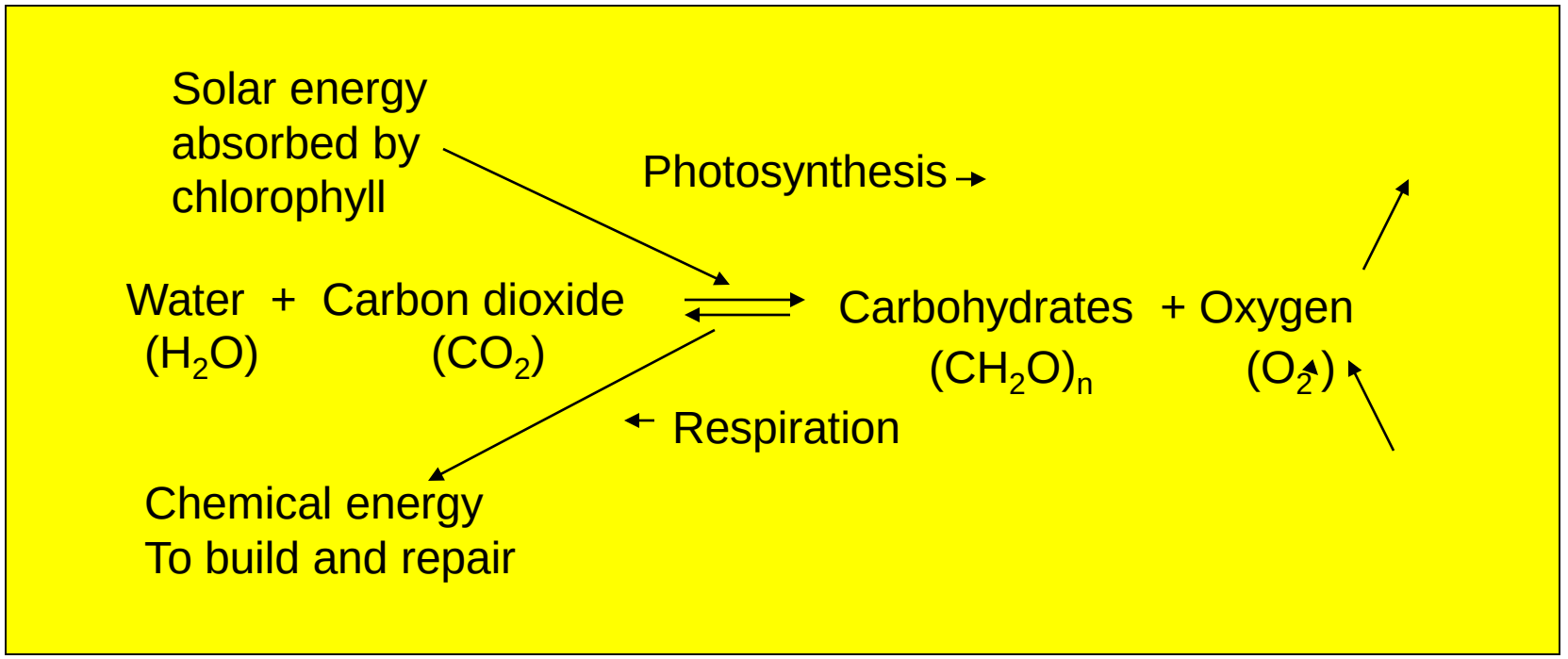

Carbon C Hydrogen H Oxygen O

Where does all that CH_2O come from?

Photosynthesis!

The basic photosynthesis/respiration reactions

(the most important processes for supporting life on the planet)



But What Are carbohydrates Really?

A biomolecule consisting of carbon, hydrogen and oxygen. Also called a saccharide, they are a group that includes sugar starch and cellulose.

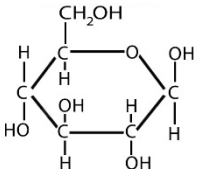
Monosaccharides

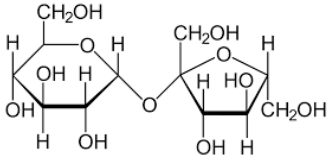
Glucose

Disaccharides

Sucrose

Sugars (Soluble Carbohydrates)



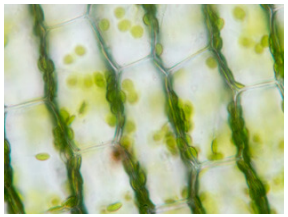


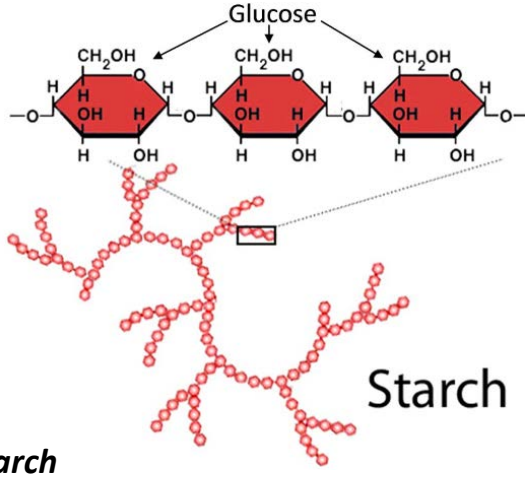
Polysaccharides

Starch

Cellulose

Structural Carbohydrates



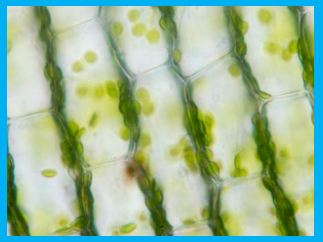


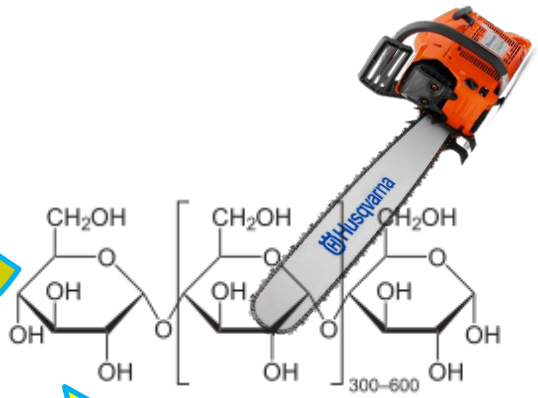
NSC : Non structural carbohydrates = soluble carbohydrates (SC) + starch

Sugars

Starch

Cellulose





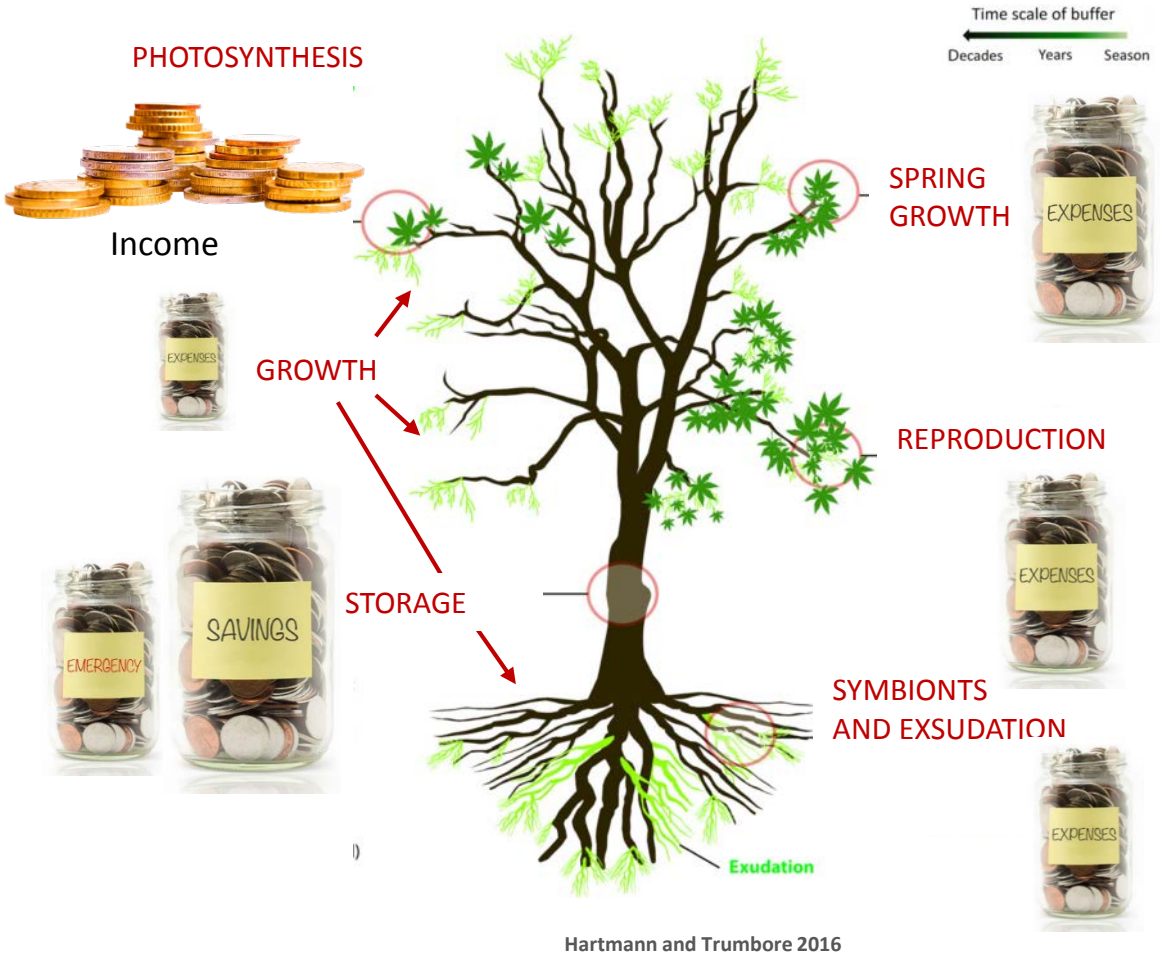
E

Respiration

Non Structural Carbohydrates Are Crucial For Plants

NSC as currency for plant functions …

….But plants can't have a negative balance



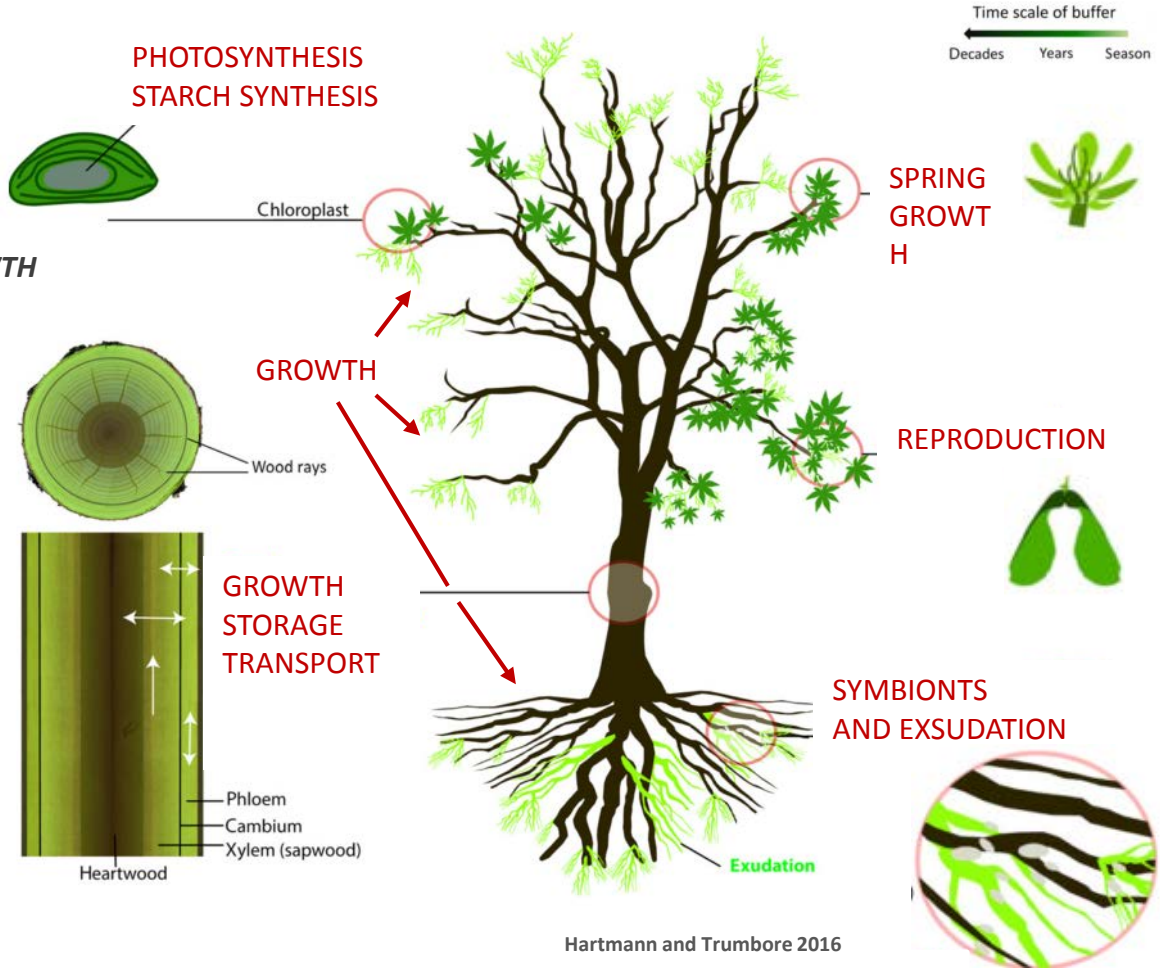
Hartmann and Trumbore 2016

Non Structural Carbohydrates are Crucial For Plants

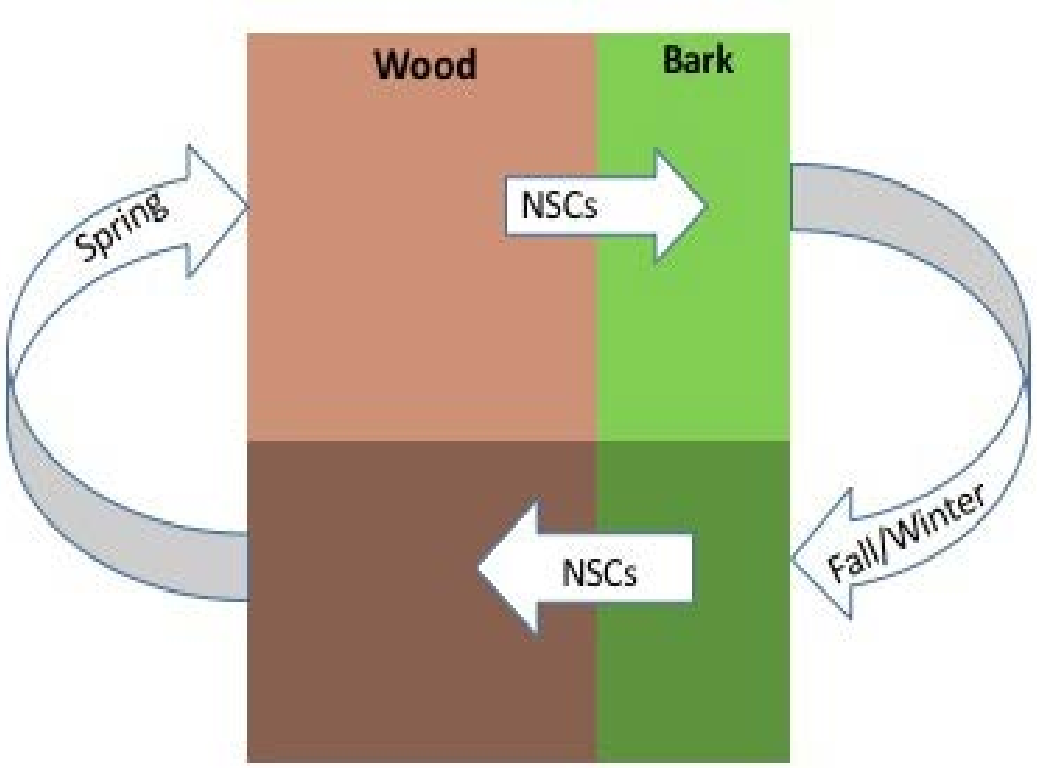
NSC fulfil major functions

- *ENERGY METABOLISM*
- *OSMOREGULATION*
- *TRANSPORT*
- *BUILDING BLOCK FOR BIOMASS AND GROWTH*
- *STRESS RESPONSES*
- *EXCHANGES WITH SYMBIONTS*
- *REPRODUCTION*

Their mobilization has to be balanced with STORAGE to meet demands when supply by photosynthesis isn't enough



Movement of starch and sugar from wood to bark in the spring and back into the wood during the fall for storage.



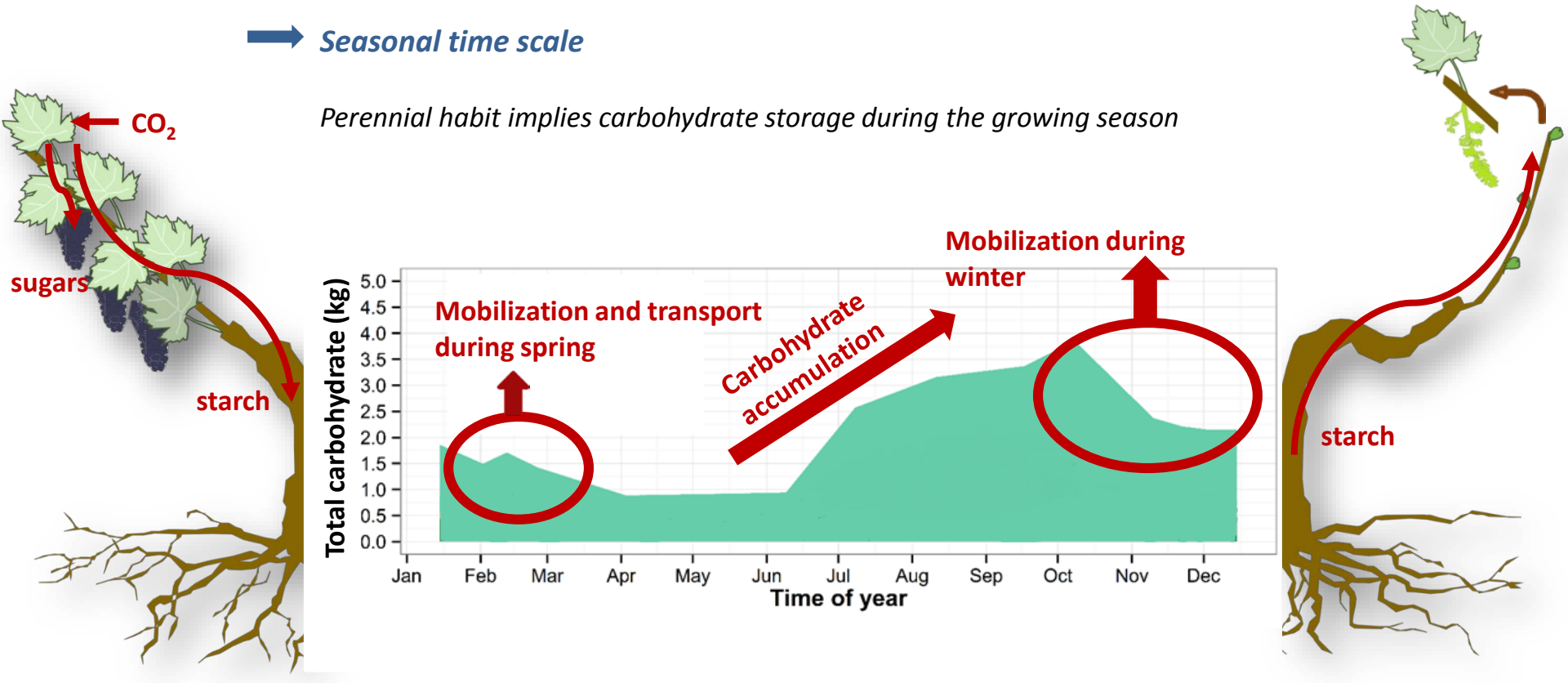
Trees Must Store to Balance Supply and Demand

"At the whole-plant level, NSC storage buffers the asynchrony of supply and demand on diel, seasonal or decadal temporal scales "

Hartmann &Trumbore, 2016

Seasonal time scale

Perennial habit implies carbohydrate storage during the growing season



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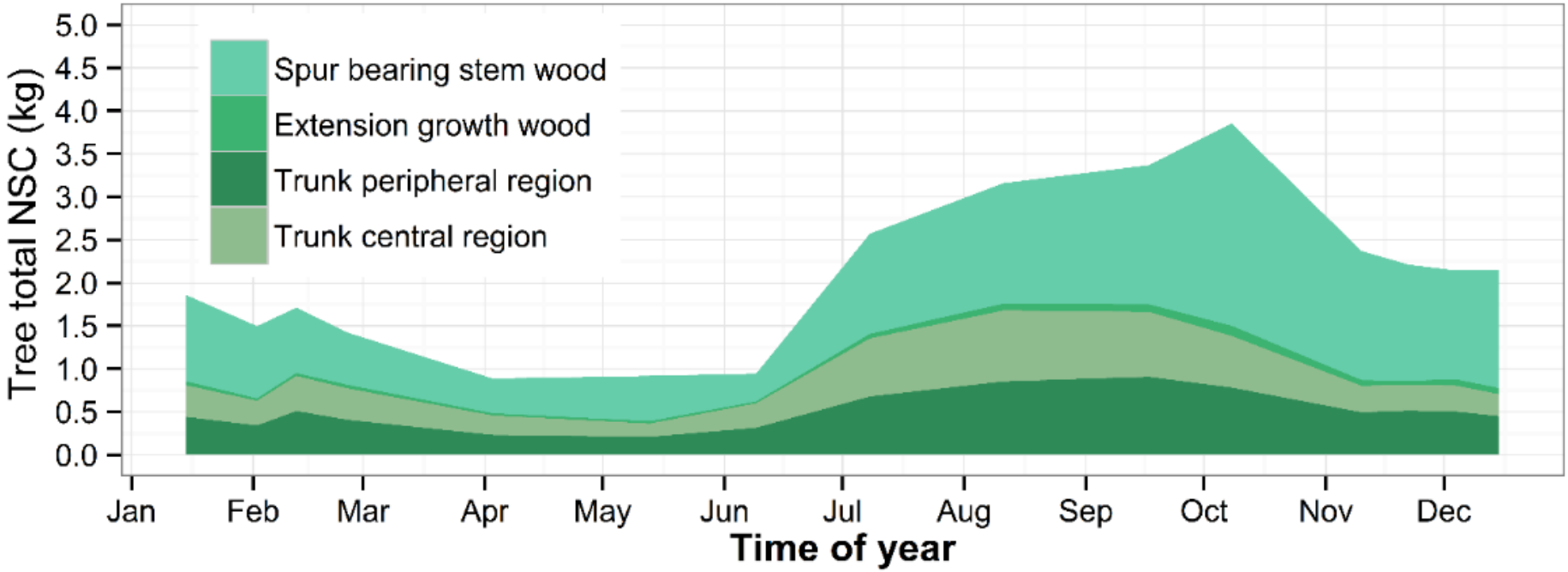
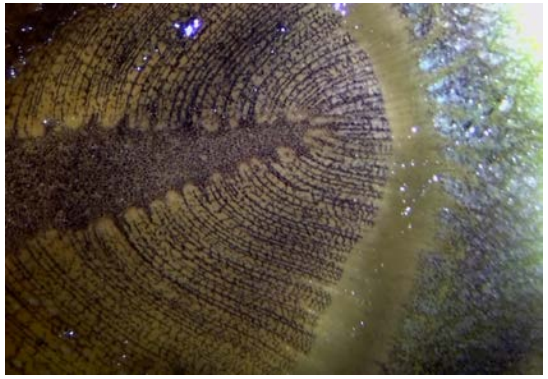


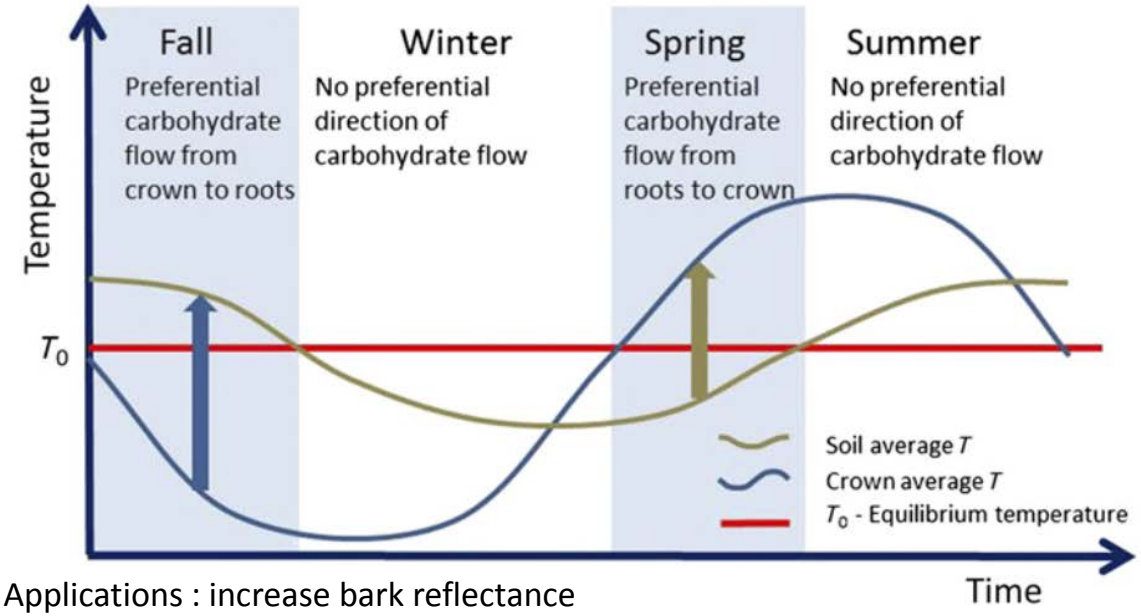
Perennials need to accumulate carbohydrates in storage tissues for winter. They store it as starch in parenchyma cells of xylem.



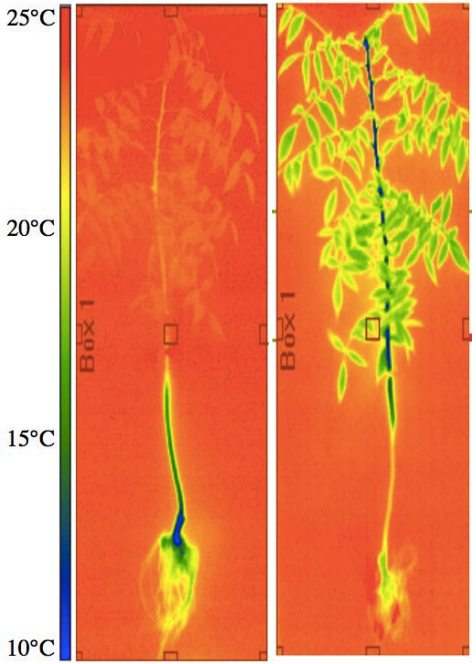
Tixier et al., (2017)

Effect of Temperature on NSC Transport

ANNUAL SCALE



DIURNAL SCALE



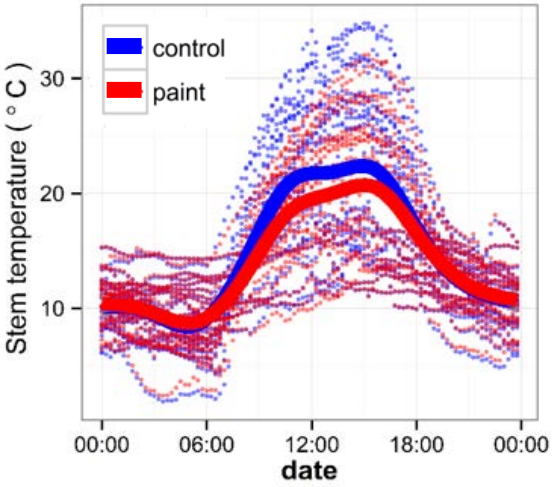
➡ Applications : increase bark reflectance

Zwieniecki et al. (2015)
Sperling et al. (2017)
Tixier et al., (2017)

Effect of Temperature on NSC Transport

During spring bud growth

Increase stem reflectance with white paint

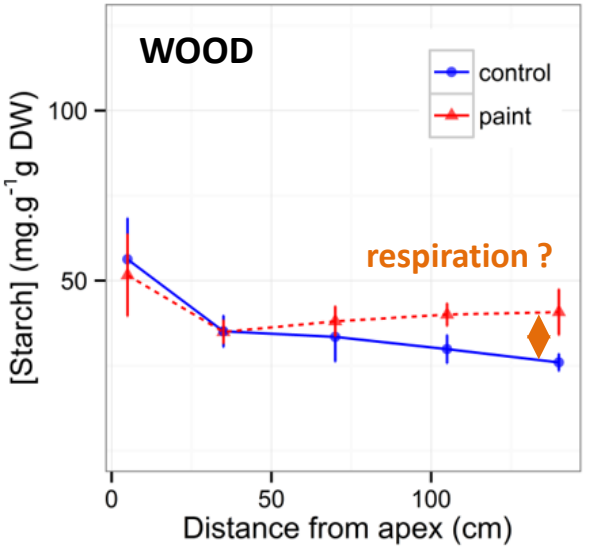


➡ **Decreases mean Temperature**

➡ **Decreases Temperature variance** (diurnal and spatial)

➡ **Delays phenology**

Control Paint

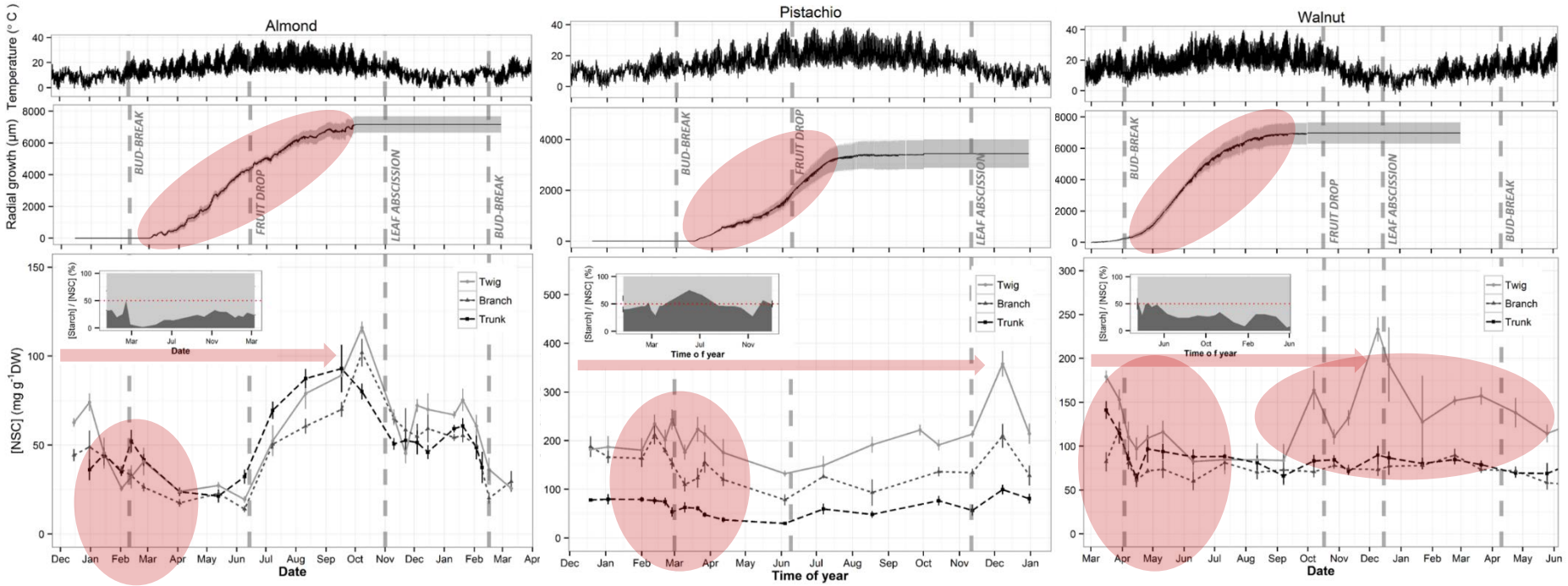


➡ **Lower NSC content in control stems**

(No freezing stress)

Tixier et al., (2017)

- **Different phenology leads to different patterns of NSC mobilization, accumulation and utilization for growth.**
- **Organs don't necessarily have the same patterns.**
- **Carbohydrate content varies among species.**



Carbohydrate Observatory

Carbohydrate Observatory

Summary: The Carbohydrate Observatory uses a "citizen science approach," the citizens being almond, pistachio and walnut growers who send us monthly wood and bark samples from their orchards to be analyzed for sugars and starch. The results are made available through a website that each grower has access to. He or she then track the carbohydrate levels of their nut trees throughout the year while pairing it with climate, management or pheneological events such as dormancy, pollination, bud break, flowering, fruiting, harvest and leaf drop. The goal is to have a better biological understanding of the role carbohydrates and use this massive data set as a tool to predict yield and understand environmental stresses such as lack of chilling hours and drought. **Our goal is to:**
• Understand how annual patterns of starch and total nonstructural carbohydrates (TNC) differ throughout the Central Valley, which will aid in the improvement of spring/fall management practices and our understanding of chilling requirements. • To develop a tool that uses starch and TNC levels as a predictor of yield for the following year and to understand variable crop yields. • Create an easy interactive map for growers to use that displays all of the data across the Central Valley.

Carbohydrate Observatory NEWS

07/07/2017 -- We reached first milestone - 250 sites

We are in the news -Western Farm Press

02/16/2017 -- Maciej and Anna are preparing CDFA Specialty Crop proposal to support scientific effort of the Carbohydrate Observatory, do not hesitate to let CDFA know you support it too.

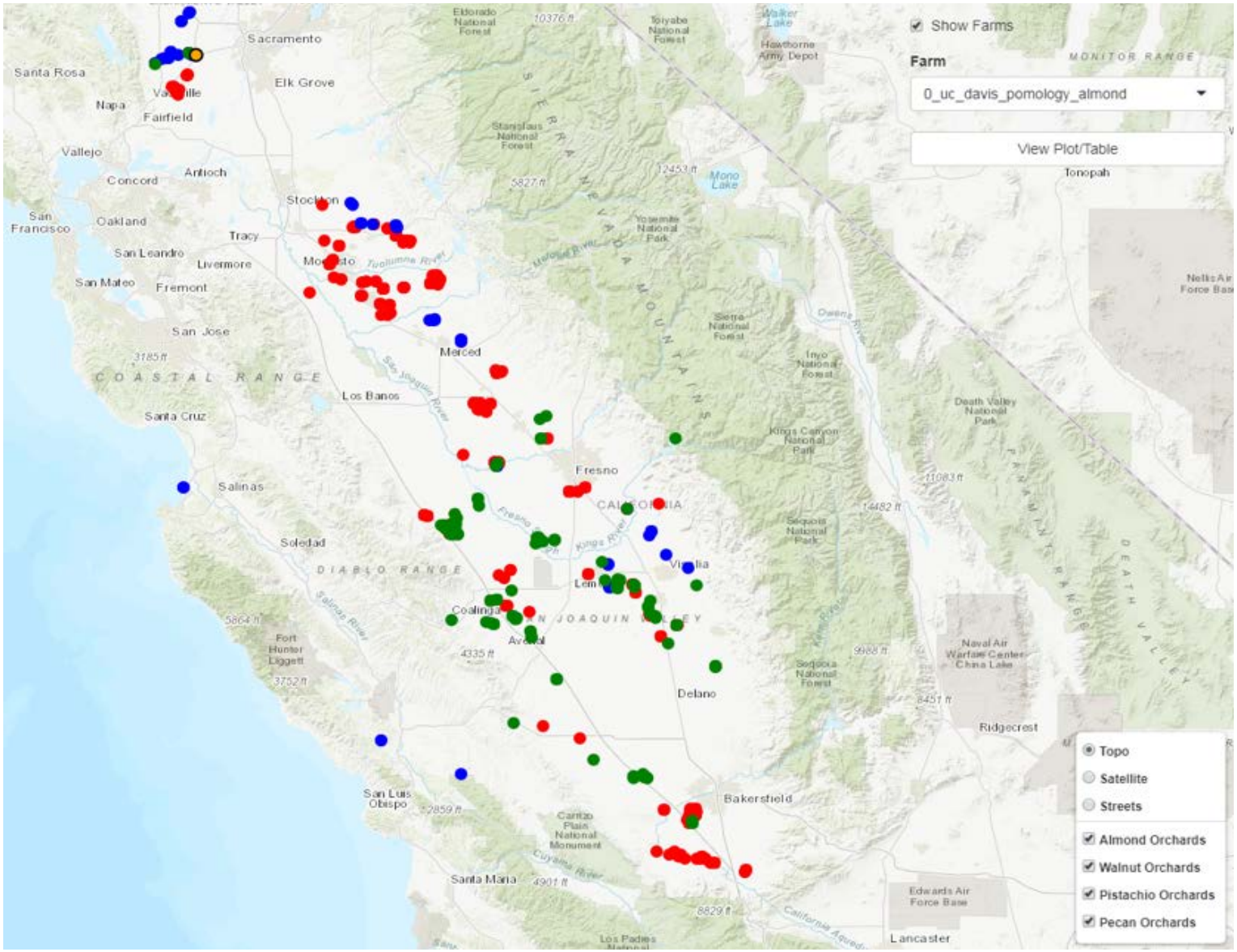
Anna Davidson got stack in mud while collecting samples in rain near Fresno 01/17/2017. Ask her for a picture

Liquid handler arrived !!! Be first to get naming rights. It made its first plate on 01/16/2017.

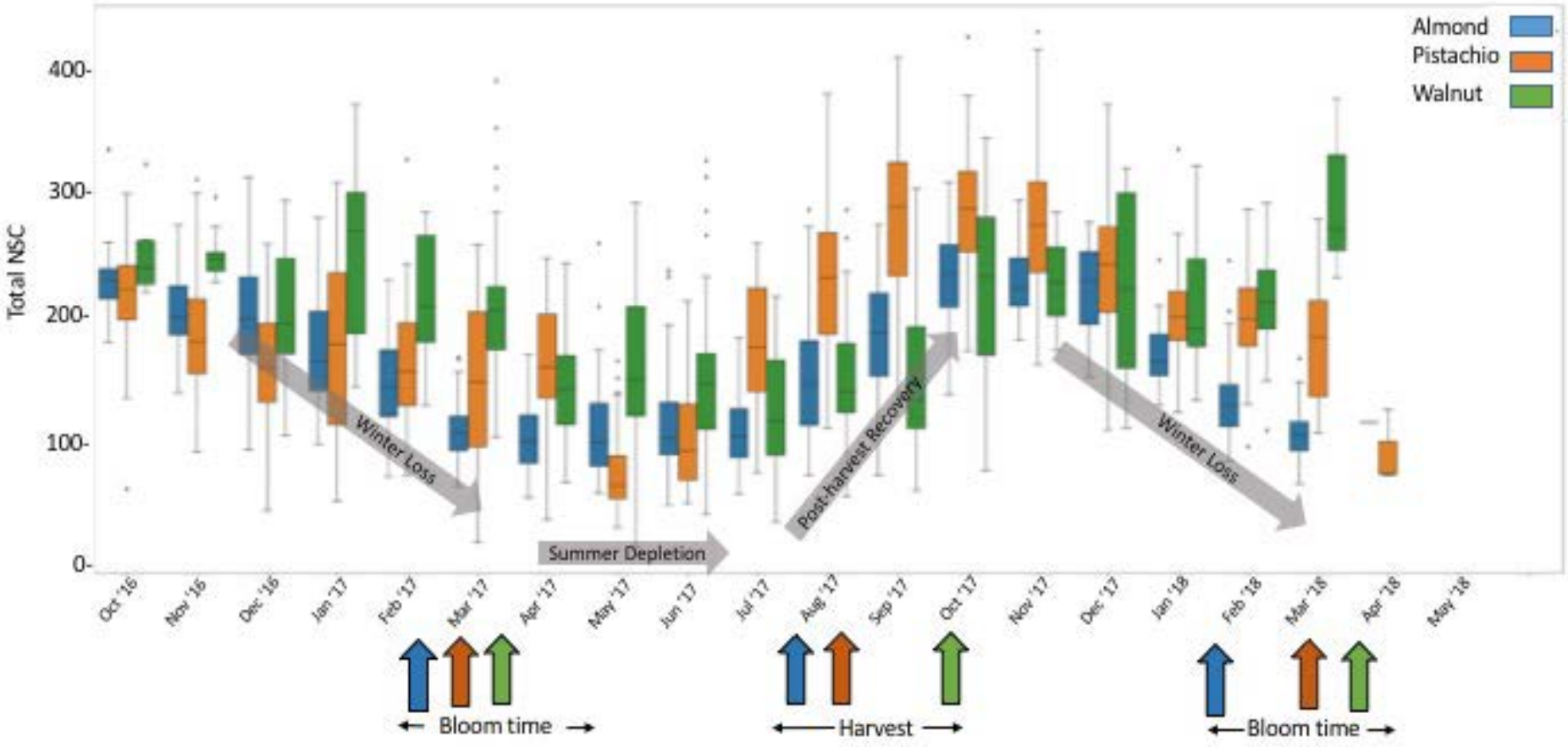
---- Link to new graphical Crbohydrate Observatory data
Realy Cool way to compare farms (beta_version) ----

---- Link to map interface (beta_version) ----

Web-based map of the Central Valley, California.



Seasonal trend of total nonstructural carbohydrates from fall 2016 to spring 2018 in three species. Bloom time and harvest time are indicated by arrows below. Note: almond and pistachio bloom before leaf out while walnut leaves and blooms occur in synchrony.



Thank you For Your Attention

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