Monitoring Seasonal Variation of Foliar Heat Content in Big Sagebrush

Rachael Kropp, W. Matt Jolly, Kathleen Huguet, Yi Qi, Phil Dennison
USFS, Rocky Mountain Research Station, Fire Sciences Laboratory, Missoula, MT

Introduction

Big Sagebrush (*Artemisia tridentata* Nutt.) ranges from Arizona to British Columbia (Figure 1) and plays a large role during fire season in Western North America. Fires in sagebrush fields often burn with high intensity and are stand replacing (Kauffman and Sapsis 1989, 1991). In order to explain and model these fires, the foliar heat content of Sagebrush was monitored alongside other chemical components.

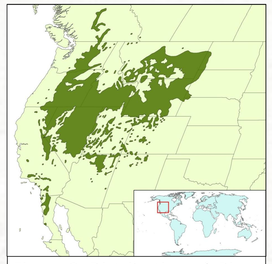

Figure 2. Distribution of Big Sagebrush in North America (US Geological Survey)

Figure 1. Foliar samples were taken from the terminal tips of new Sagebrush shoots

Methods

Big Sagebrush samples were collected between the months of July and September 2012 at two sites North of Missoula, Montana. Foliar samples were randomly chosen from the terminal tips of new shoots once per week during the study period (Figure 2). Samples were oven dried and their heat content was determined using an IKA 200 Oxygen Bomb Calorimeter. Additionally, their foliar moisture content and crude fat were determined in the laboratory.

Results

- Crude fat content increased by about 4% from a low of 3.8% to a high of about 7.8% (Figure 3)
- Moisture content decreased by around 200% from a high around 260% to a low of around 76% (Figure 4)

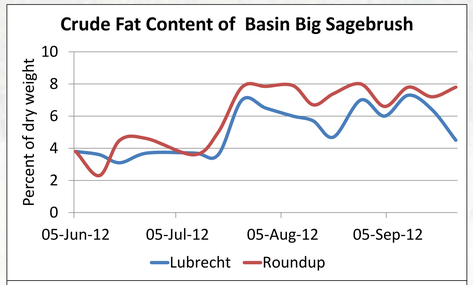

Figure 3. Crude fat content of Big sagebrush collected in Montana between July and October 2012

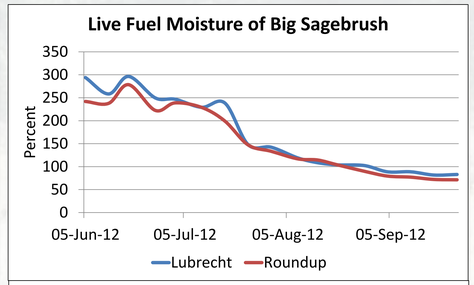

Figure 4. Live Fuel Moisture of Big sagebrush collected in Montana between July and October 2012

- Foliar heat content increased 3MJ/kg (16%) over the study period from a low around 18 MJ/kg to a high of 21 MJ/kg (Figure 5)

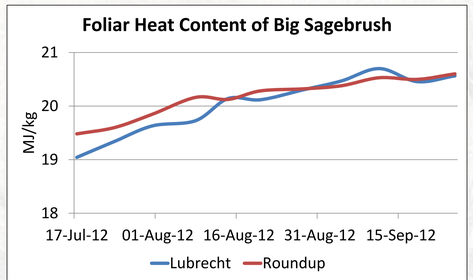

Figure 5. Foliar heat content of Big sagebrush collected in Montana between July and October 2012

- Ash and protein also decreased (Figure 6)
- Non- structural carbohydrates, starch, and sugars also increased (Figure 7)

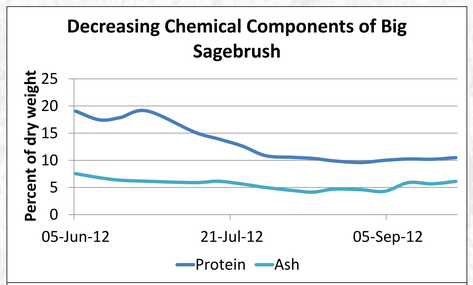

Figure 6. Site averaged decreasing components of Big sagebrush collected in Montana between July and October 2012

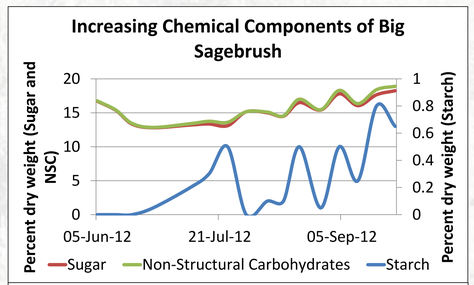

Figure 7. Site averaged increasing components of Big sagebrush collected in Montana between July and October 2012

Conclusions

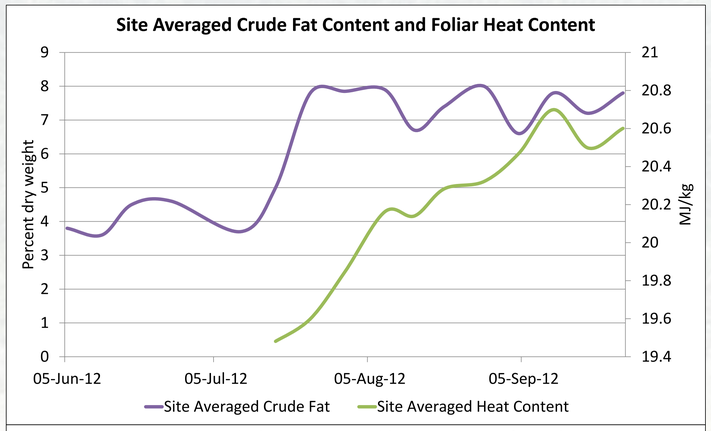

Figure 8. Site averaged crude fat content and heat content of Sagebrush tips collected in Montana between June and September 2012

The increases in foliar heat content and crude fat content are concurrent with the decrease in moisture content. The increases (Figure 8) explain the high flammability and fire intensity in sagebrush fields as the season progresses. Figure 8 also shows changes in crude fat content are mirrored by changes in heat content, implying a functional relationship. Figure 9 shows this relationship is seen in many plant species.

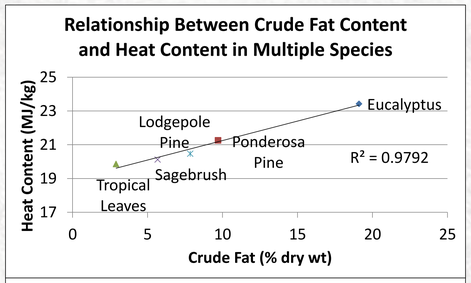

Figure 9. Average crude fat content of several species graphed against their average heat content (based on Mutch 1970)

Literature
United States Geological Survey [US Geological Survey]. 2012 Digital Representations of Tree Species Range Maps from "Atlas of United States Trees" by Elbert L. Little, Jr. (and other publications). <http://esp.cr.usgs.gov/data/atlas/little/> Accessed 19 Nov.
Kauffman , J.B., and D.B. Sapsis. 1991. Fuel Consumption and Fire Behavior Associated with Prescribed fires in Sagebrush Ecosystems. Northwest Science 4(73): 173-179
Kauffman , J.B., and D.B. Sapsis. 1989. The Natural Role of Fire in Oregeon's High Desert. Special Report 841, Oregon State University and USDA, Corvallis, Oregon, USA.
Mutch, R.W. 1970. Wildland Fires and Ecosystems – A hypothesis. Ecological Society of America 51(6): 1046-1051