CNH-L: Assessing the Stability of the Maple Socio-Ecological System to Market and Climate Variability

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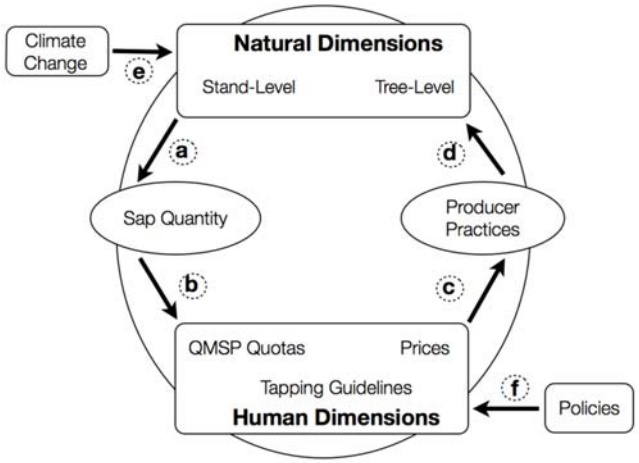
1. CNH Components of the Project: The overall objective of this project is to examine a forest-based and culturally-valued natural resource, maple syrup, and elucidate how management, environmental, and socio-economic components of its production interact in order to inform societal action towards sustainability (Fig. 1). We will examine the sugar maple socio-ecological system and its interactions through *in situ* field sampling, interviews, surveys, and engagement with key stakeholders, as well as coupled ecological-econometric modeling techniques. The maple syrup industry is a compelling study system in that it is based on a perennial resource managed in a dominant-firm oriented landscape in North America whose production is vulnerable to shifts in climate, tapping (harvesting) guidelines, pricing, and market quotas. The ultimate goal of assessing the current and future stability of this system is to design adaptive management strategies and policies to mitigate future uncertainty and risk associated with environmental and market variability. To achieve our goals, we will focus on the following four primary objectives:

Objective #1: Quantify Management and Environmental Effects on Maple Sap Yield and Tree Health (Fig. 1*a*). We will discern the impact that producer harvesting and other management practices have on annual maple sap (raw material for maple syrup) yields. Additionally, we will quantify the interactive effects between weather and management practices at the enterprise level on maple tree health via *in situ* data collections at the Proctor Maple Research Center at the University of Vermont (PMRC). Results will be applied to validate an empirical model of sap production at the enterprise level.

Objective #2: Estimate Annual Sector-Wide Maple Syrup Production (Fig. 1*b*). We will construct a dynamic bioeconomic model of the maple system based on the current configuration of maple industry, historical records from project partners (Table 1, p8), climate data, and Objective #1 findings.

Objective #3: Characterize Stakeholder Decisions Regarding Maple Production (Fig. 1*c, d)*. We will characterize stakeholder decisions to market, climate, and policy factors that influence maple production quota limits, market prices, maple management guidelines, and forest characteristics via production practices through interviews, surveys, and focus groups.

Fig. 1. The Maple Socio-Ecological System. First, we will examine the influence of forest characteristics and producer practices on sap quantity and tree health (*a*). Second, we will construct a dynamic bioeconomic model to characterize and quantify regional sap production across the maple sector (*b*) and use this model to calculate yearly syrup supply and prices. Third, we will conduct producer surveys, interviews, and focus groups to elucidate the effects of changes in price, tapping guidelines, and climate variability on producer practices and feedbacks on forest characteristics (*c*,*d*). Finally, we will simulate Fourth, we will simulate exogenous change scenarios incorporating climate change (*e*) and tapping regulations (*f*).



<u>Objective #4</u>: Estimate the Stability of the Maple System in Response to Exogenous Change (Fig. 1*e*, *f*)**.** We will test the influence of various exogenous changes on the maple system including climate change, quota policies, Canadian-U.S. exchange rates, and global market growth to assess sector production capacity and economic viability in the future using our models constructed in Objectives **#1-3.** We will then apply this evidence in association with stakeholder engagement to develop management plans and recommendations to sustain maple production under these scenarios.