1. Project Goals and Scope

1a. Background

Global average temperatures continue to rise and set a record high in 2016 (NASA Goddard Institute for Space Studies, 2017). Human activities, especially but not limited to the burning of fossil fuels, increase the concentration of heat-trapping carbon dioxide (CO_2) and other greenhouse gases in the atmosphere and are the main cause of climate change. Changes in temperature and precipitation will affect human health, water supplies, agriculture, biodiversity and other aspects of life on Earth (Melilo, Richmond, & Yohe, 2014). Rising temperatures are, even now, having profound effects on many ecosystems. For example, 2016 marked a record-tying year for the least amount of sea ice in the Arctic Ocean (NOAA Arctic Program, 2017). (Melilo et al., 2014).

There are, however, solutions to the climate challenge. Low-carbon energy sources can provide clean electricity and heat. Willow biomass energy crops are one such solution being explored at Grand Valley State University (GVSU). Researchers have shown that willow shrubs (not a weeping willow tree) can be planted in high densities like corn and harvested on three-year cycles. The shrubs can grow to 15 feet or more in height during those three years. The wood from the shrubs can be chipped, dried, and used as a fuel for electricity production, heat production, and/or as a renewable source for bio-based chemicals (E. E. Nordman, Robison, Abrahamson, & Volk, 2005; Volk et al., 2006).

Much of the research on willow biomass energy crops has been conducted in New York but no experiments have been conducted in West Michigan. Therefore, in 2016, the area's first willow biomass energy crop trial was planted at, and with funding from, the GVSU Sustainable

Agriculture Project. The trial includes four varieties of hybrid (non-GMO) willow shrubs. The project's long-term goals are: 1) to compare the survival, growth, insect resistance, soil properties, and other performance measures of the four willow varieties in West Michigan; 2) compare observed West Michigan growth patterns to trials elsewhere in the Northeast; 3) analyze the economic feasibility of commercial-scale willow biomass crops in West Michigan; 4) engage undergraduate students in Natural Resources Management, Environmental Studies, Business, Biology, Chemistry, and other majors in evaluating willow biomass crops.

The goals for this particular student summer scholar are to: 1) measure and compare the one-year survival rate for each of the four willow varieties; 2) measure and compare the first-production-year growth rates for each of the four willow varieties; and 3) compare soil properties inside and outside of willow plots.

1b. Big Picture

Willow is a carbon-neutral fuel. CO_2 is released when the willow wood chips are burned for fuel. The next growth cycle, however, pulls that CO_2 out of the atmosphere and stores it in the wood. Willow biomass crops can be grown on lower-quality old fields that are no longer actively farmed. Unlike corn for ethanol, willows grown on farmland that is not currently in production does not compete with food crops. Willow biomass crops provide farmers with an additional income stream from otherwise unproductive land (Keoleian & Volk, 2005). The willow wood chips can be processed into pellets for wood stoves; used in industrial-scale biomass electricity generating facilities; or used as the key input in a state-of-the-art biorefinery that produces a variety of value-added chemicals. This S^3 project is just one-step toward enhancing rural economic development through a willow-based bioeconomy.

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