

Special Project - Mast Collector

Background

At the base of every forest ecosystem are mast, which play many purposes in ecology: both sustaining animal populations and serving as a critical role in reproduction. What are mast? Mast are the seeds of trees and include acorns, hickory nuts, and beech nuts. Mast are everywhere in the Duke Forest, and are especially prevalent during masting years when trees release a heightened volume of mast. The number of mast can cause fluctuations in animal populations and can also lead to human-wildlife interactions as mast can collect along the sides of trails. In addition, trees expend much of their resources to produce mast.



One of the main goals of the Duke Forest is to study masting cycles in order to better understand forest trends and to educate the public. To conduct this research, the Duke Forest staff collects thousands of mast to study. The original method of mast collection employed by Duke Forest researchers was a simple laundry basket with a net on top to separate out sticks and leaves. However, it takes Duke Forest researchers a significant amount of time to sort the collected mast by genus and remove all other organic debris by hand for testing after collection. Thus, the Duke Forest researchers sought a design which would ultimately remove organic debris from the collected mast as well as sort the mast by genus.

In Fall of 2018, this design project was assigned to a group of first-year Duke engineering students in partnership with Duke University's First Year Design experience to give practical, real-world applicable tasks to incoming freshman engineers. The project was then continued in the Spring of 2019 by a different team.

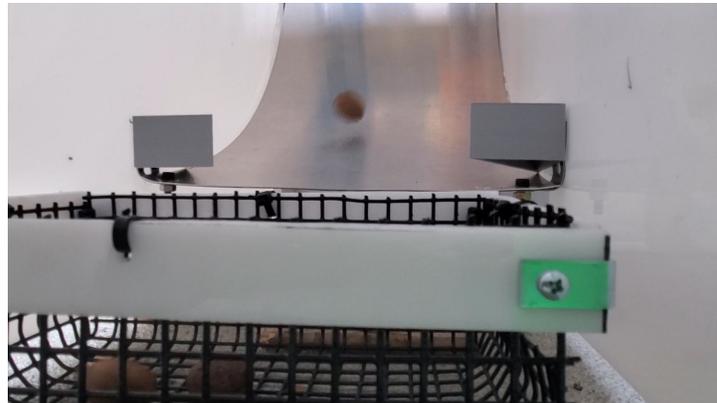
Design

In designing the mast collector, a clear focus was placed on the efficacy of the collector: filtering of sticks, leaves, and other debris was a large priority, along with the collection of various types of mast.



However, certain other factors were also considered, such as the cost, weight, and durability of the collector. The final mast collector design is split into two parts: an upper filter and a lower collector. The lower collector uses the relative shapes and sizes of different tree debris to sort them using a metal ramp inclined at a specific angle.

Lower Collector: The lower collector separates mast from other tree debris. Mast, which tend to be heavier and more spherical, are able to gain more momentum as they slide down the ramp, which allows them to launch further as they exit and allows them to make the gap between the ramp and the collection bin, which is placed some distance away from the end of the metal ramp. On the other hand, sticks and leaves are much worse at rolling (leaves due to their light weight, and sticks due to their abnormal shapes). These unwanted debris fail to gain enough momentum on the ramp to launch into the collection bin; instead, they simply fall out of the bottom of the mast collector onto the forest floor. The lower collector is made out of a strong and lightweight polycarbonate material and held together by lightweight 3D printed plastic joints and metal L-brackets, which allows for ease of transportation and maneuverability, along with making the entire design modular.

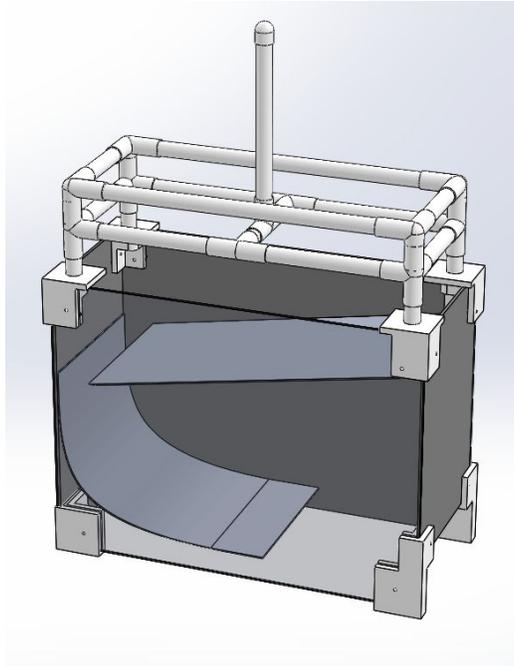


A mast as it rolls down the lower collector into the collection mesh bucket below. More mast can be seen inside of the basket.

Upper Filter: To prevent larger branches from falling into the device and clogging up the lower collector, the upper filter was created using PVC plastic and a mesh net. The goal of the upper filter is to block out larger debris (as most mast will be pretty small) that could possibly impede the collector's function by blocking the metal ramp, allowing for the collector to operate for a longer time before requiring declogging/maintenance.



Most sticks get caught in the net of the upper filter, preventing them from clogging up the lower collector below.



Final Collector Design as of Spring 2019

Future Plans

Combined with a tarp system to funnel debris into the collector, the new collector is now small and lightweight enough to be easily transported and assembled, while still retaining the ability to separate mast from other natural foliage. By placing it near a grove of trees, collection of mast will become much easier. Now that mast can easily be isolated from other natural debris, the next step in the development of this project is to sort the collected mast by genus. This design challenge will be tasked to another group of freshman engineers at Duke in the coming Fall semester, and with any luck, the product will be ready for testing very soon.