SOILTHRIVE™
ENVIRONMENTAL SOLUTIONS MAUI LLC

MAUI NUI
MARINE RESOURCE COUNCIL

REEF FRIENDLY LANDSCAPING
PILOT REPORT

PREPARED FOR: MAUI NUI MARINE RESOURCE COUNCIL

01

Prepared by
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Abbreviations & Definitions

Bacteria - Bacteria are ubiquitous, mostly free-living organisms often consisting of one biological cell. The higher the bacterial levels, the higher total nutrients in the soil. These nutrients only become plant-available once they're eaten and digested by predators (Protozoa and Nematodes). The outputs of predators consuming bacteria are plant-available nutrients. Once there is a high enough population of Bacteria and Predators, the soil will be filled with plant-available nutrients.

Actinobacteria are bacteria which share the characteristics of both bacteria and fungi, they primarily function as decomposers in the soil. Actinobacteria thrive in reduced oxygen conditions, a small amount of Actinobacteria is of benefit to the soil, however large amounts are an indicator of conditions moving towards anaerobic.

Fungi - Fungi are incredibly diverse and perform many crucial functions in the soil. They are one of the largest contributors keeping the soil aerobic, a crucial component to keeping the soil healthy. Fungi hold and distribute water within soil, and to the plant roots. Without Fungi, water quickly drains away leading to higher watering requirements. For example, mycelium (a type of fungi) colonize plant root systems and have a symbiotic relationship with plants, trading sugars for nutrients and water.

Protozoa - Protozoa are predators whose main food source is bacteria. One protozoan on average will eat 10,000 bacteria a day, the majority of which are excreted as nutrients in plant-available form. Protozoa release the nutrients Bacteria contain making them accessible to the plant. Once Protozoa are introduced into the soil, they will balance the Bacterial population, allowing the nutrients to become plant-available.

Nematodes - Most nematodes feed on bacteria, fungi, or other microscopic creatures. As such, they are a major component of soil and sediment ecosystems. The presence of Nematodes signal the soil is progressing through its Successional Stages (see diagram below for successional stages overview).

Fungi:Bacteria (F:B) Ratio - The ratio of Fungi to Bacteria tells us what Successional Stage the soil is in. As you cultivate your soil succession to match the plants you're trying to grow, nature will provide a thriving environment for your plant, denying pests, bugs, invasive species, and weeds. Below is a visual chart illustrating soil/plant succession. A higher fungi to bacteria ratio typically indicates healthy soil.

Soil biological succession causes plant succession

Introduction

Healthy plants require healthy soil. SoilThrive's mission is to facilitate healthy, aerobic soil structure to support the thriving plant systems above the surface. SoilThrive™ has developed protocols that facilitate this goal by cultivating and propagating beneficial, indigenous microbiology that effectively promote healthy landscapes without the use of chemical pesticides and fertilizers. Rather than utilizing untold labor hours and synthetic compounds to amend unproductive soil, SoilThrive™ promotes and leverages nature's pre-existing systems to reduce unwanted biomass, build soil structure to fight compaction and improve water retention, and thus enable plant health and vitality.

Project Goals

This collaborative pilot project had a specific focus on organically supporting the soil health of different high traffic areas. The pilot project's focus is to achieve this utilizing organic liquid biological soil amendments produced locally on Maui from plant-based compost. The ultimate goal was to create an environment that would enhance the natural biological balance of the soil, which in turn will promote the health of the plants. One of the supporting goals is to reduce the amount of irrigation required to maintain the health of the turf. Using a holistic approach, the team worked to create a more efficient system conserving water and reducing costs. Additionally, the protocols deployed provided additional value with a reduction in the amount of labor-hours required for manual dethatching, which is time-consuming and labor-intensive. The outcome of the pilot project initiated the process in creating a sustainable system for long term support of soil health in an environmentally friendly and economically feasible process. With this in mind, the pilot projects included 3 initial test plots:

- **County of Maui, Keopuolani Park - Baseball Field 1**
- **Mākena Golf & Beach Club - South Course Tee Boxes**
- **Wailea Community Association - Event Parking Turf**

The Product

SoilThrive™ Liquid Biological Amendment products are made by taking our Engineered Biological Compost and aerating and monitoring the microbial content of specific foods to feed the desired beneficial microorganisms. Once food is added the microorganisms become active, proliferate in number, and start producing enzymes.

The enzymes act as a glue, allowing us to spray our product as a foliar feed, as well as a preventative pest and disease solution. Our Engineered Liquid Biological Soil Amendment is a climate smart replacement product for Herbicides, Fungicides, and Fertilizers.

SoilThrive™ liquid biological amendment is made from materials sourced locally, or grown on-site, reducing our product's carbon footprint possible, as we can go directly from production to distribution, with no inputs needing to be shipped for our ongoing production. This creates a localized solution for a global problem. While at the same time, diverting green waste streams within our own operation.

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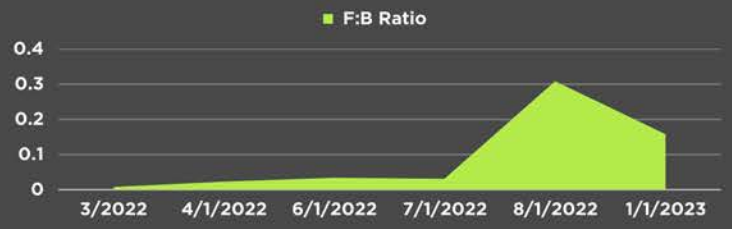
01 County of Maui Keopuolani Park Baseball Field 1

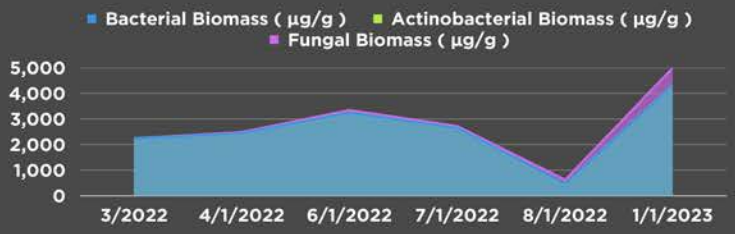
Key Performance Indicators

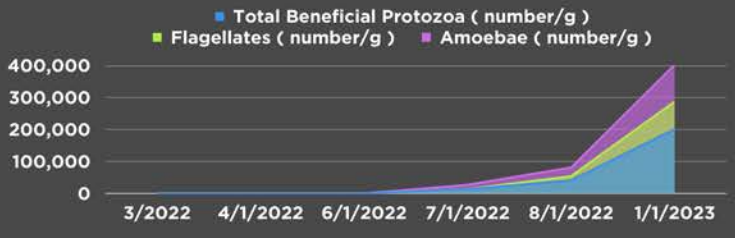
Successional Target: Grasses/Turf
F:B Ratio Target: 0.75
Irrigation / Water consumption
Thatch (dead grass) Layer

Results

F:B Baseline March, 2022: 0.019
F:B Final January 2023: 0.155
F:B Percent increase: 716%
Elapsed time: 10 Months







Soil Scientist Notes:

From April of 2022 through January of 2023, our team began treating Keopuolani Park Field 1 on a quarterly interval as part of the pilot project. The data in the figures below show the numbers of Protozoa (Flagellates and Amoebae) and Fungi rose significantly to meet acceptable levels for healthy soil by the end of the pilot. Protozoa are a primary predator of bacteria, and with this significant increase in numbers it's expected to bring the bacteria population under control in the near future. Final soil samples have shown a 0.155 F:B ratio. The higher the fungi and bacterial biomass, the more nutrients become bioavailable to the plants.

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01 County of Maui Keopuolani Park Baseball Field 1

March 2022

January 2023

02 Mākena Golf and Beach Resort

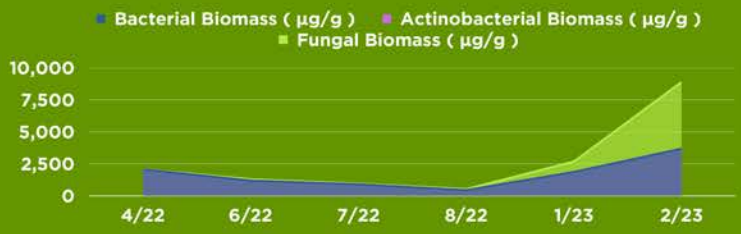
South course tee boxes

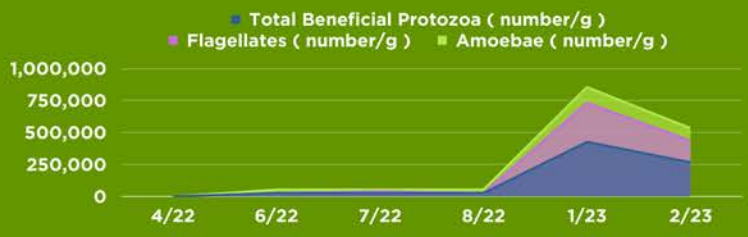
Key Performance Indicators

Successional Target: Grasses/Turf
F:B Ratio Target: 0.75
Irrigation / Water consumption
Thatch (dead grass) Layer

Results

F:B Baseline March, 2022: 0.006
F:B Final February 2023: 1.409
F:B Percent increase: 23,383%
Elapsed time: 10 Months





Soil Scientist Notes:

The first sample taken pre-treatment showed high levels of bacteria and very low biodiversity with the soil consisting mainly of sand with a small layer of soil on top. **Over the course of the pilot almost an inch of sand was converted into loam-like material; this is a huge win.** Accelerating the process that Nature on its own would take several generations to produce similar results.

The 1:1 ideal F:B ratio was achieved, likely due to the low client usage, as the tee boxes in the test plot area are only maintained for aesthetics. This is likely why the F:B ratio was achieved much faster than the other test plots, which indicates the need to apply the biological soil amendments more frequently to combat human use of landscape areas.

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02 Mākena Golf and Beach Resort

South course tee boxes

March 2022 | Before

January 2023 | After

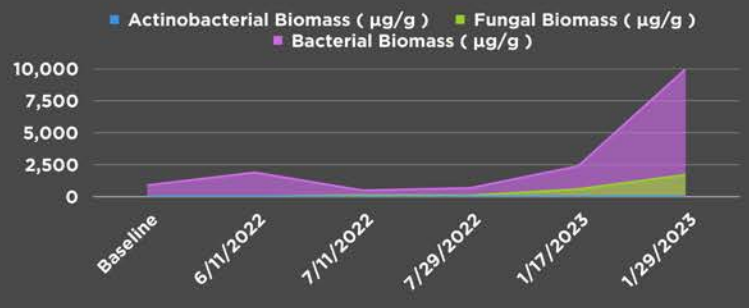
03 Wailea Community Association
EVENT PARKING TURF

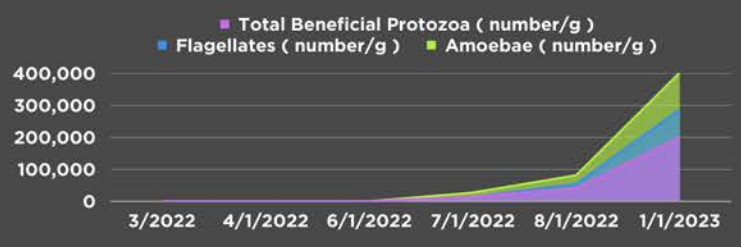
Key Performance Indicators

Successional Target: Grasses/Turf
F:B Ratio Target: 1:1
Irrigation / Water consumption
Thatch (dead grass) Layer

Results

F:B Baseline March, 2022: 0.019
F:B Final January 2023: 0.155
F:B Percent increase: 716%
Elapsed time: 10 Months





Soil Scientist Notes:

Initially, the pilot showed soil with a high concentration of bacteria and low microbial biodiversity, which indicates frequent watering, leading to susceptibility to pests, fungal diseases, and inadequate nutrient availability in plants. However, during the pilot, there was a remarkable shift in the balance between bacteria and fungi, resulting in a significant increase in fungal biomass and an impressive F:B ratio of 0.205, over a 3000% increase. When the F:B ratio reaches 1:1, the soil will be suitable for turf and landscape plants minimizing weed growth. Normally, this process of achieving an F:B ratio of 1:1 from 0.001 would take several generations to occur in nature, but the pilot achieved significant results in just a few months. As a result, there has been a noticeable improvement in plant growth, soil structure, and visual appeal, along with a decrease in pest and disease problems. These benefits will continue to expand and improve over time with the biological management approach.

03 Wailea Community Association
EVENT PARKING TURF

Heavy Thatch layer | March 2022

Same Location | January 2022

Conclusion

Through the pilot studies, it was evident that the team achieved their goal of improving soil health by applying a liquid, biological soil amendment. They increased the numbers of Protozoa and Fungi while reducing Bacteria to acceptable levels. New topsoil was observed in each location, highlighting the restoration of the natural biological balance of the soil. By inoculating fungi, beneficial bacteria, and protozoa, nutrients became bioavailable to the plants, reducing the need for pesticides and fertilizers. The higher levels of fungal biomass facilitated water retention and reduced labor hours in dethatching, resulting in potential savings. Environment Solutions Maui believes this holistic approach to land management can be scaled and adapted in various environments, creating healthier soils for thriving landscapes. The team looks forward to continuing their efforts on Maui and beyond.