Identification of rare and unique conifers at HSU and Risk of Phytophthora by proximity to water

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Abstract

There are rare tree species all over Humboldt State University, HSU campus. Some of these trees are at risk of invasion by phytophthora. Our goal was to map these trees using GPS data points, and to map water discharge areas, also taking GPS points. We mapped all of these rare trees and their proximity to visible water outputs. Based on our results, we were able to identify areas of high risk, and were able to provide recommendations based on our analysis of our findings.

Introduction

Humboldt State University is home to many rare species of trees. Many of these trees come from different countries and continents. For example, *Cathaya argyrophylla* is protected by the Chinese army. These rare, non-native species could be at risk for diseases spreading across the state.

New Zealand and Australian have been dealing with a disease known as "Kauri Dieback," and have lost many trees to this infection. It is a rapidly spreading phytophthora (a plant destroying water mold genus), that can potentially kill many genera of trees. Phytophthora is known to kill pine trees as well, many that are native to Northern California. Not much is known about the specific species of phytophthora that are spreading to the United States, just that they are present are could turn into a large threat to our native populations. *Phytophthora cinnamomi* and *Phytophthora agathadicida* are the two known largest culprits to Australian and New Zealand trees. *P. tentaculata* recently showed up on some imported Toyon into the Bay area. *P. ramorum* (Sudden Oak Death) is the documented phytophthora in the area that poses the largest threat for native trees other such as such as the tanoak. Bishop pine *P. muricata* has been dying off possibly from *Polyporus abietinus.* These spread by water and are highly infectious. Coastal Humboldt county has a temperate rainforest climate with an average annual precipitation of 48 inches.

For this project, we mapped out all the non-native species of trees on Humboldt State University campus (Figure 1 and Image 3) and their proximity to water courses that could be potentially infectious. Since *phytophthora* is a water mold that spreads its spores by water, we created a buffer of 15 ft around all the trees to decide which were at high or low risk for infection. We worked closely with the Greenhouse manager, Brianne Lee, who gave us the original map of the inventory of trees, which is 30 years old (Image 1 and 2). We were also to update the map with current species and omit those that have died or been removed.

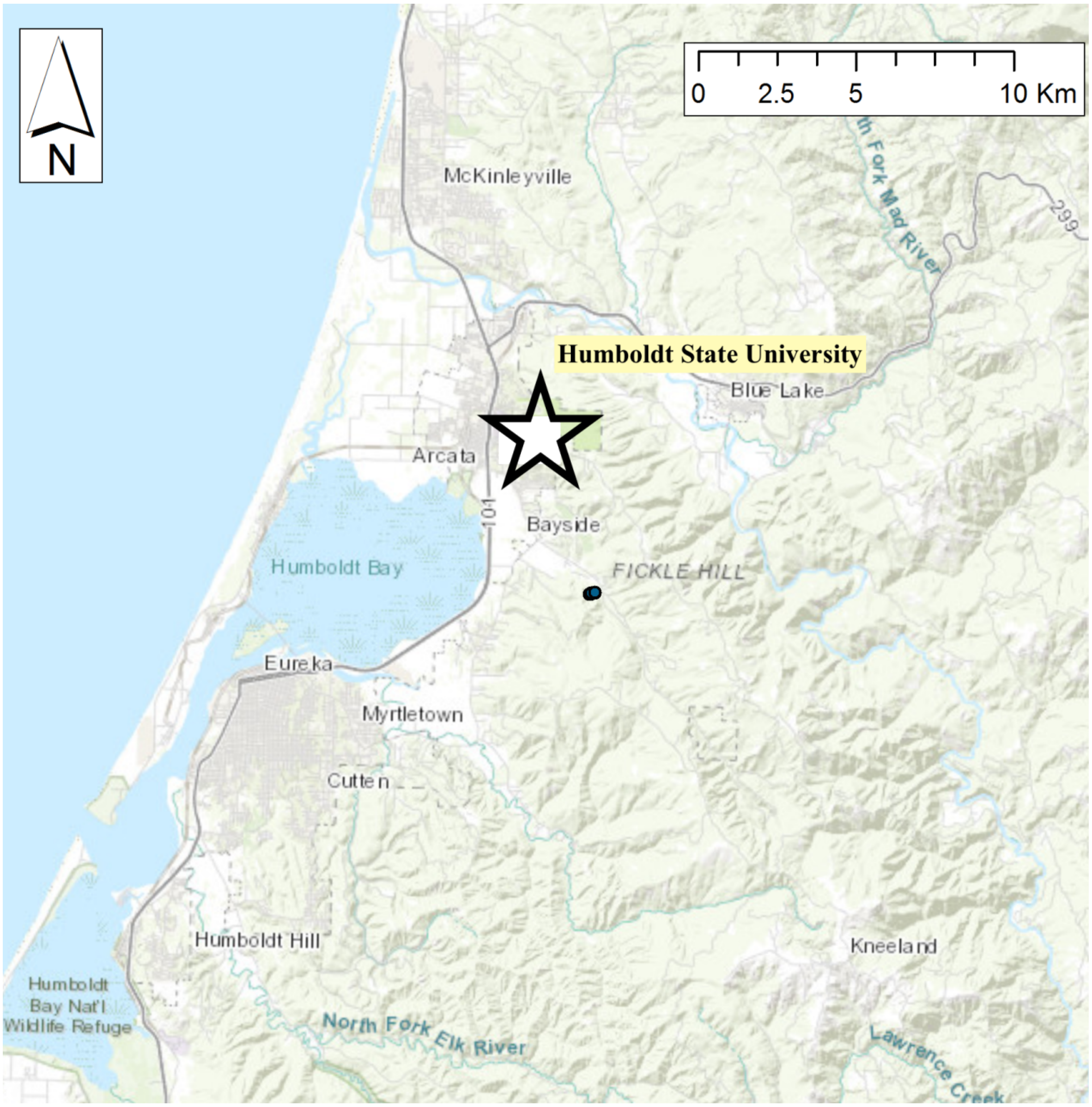

Figure 1: Locator Map of Humboldt State University relative to Humboldt Bay.

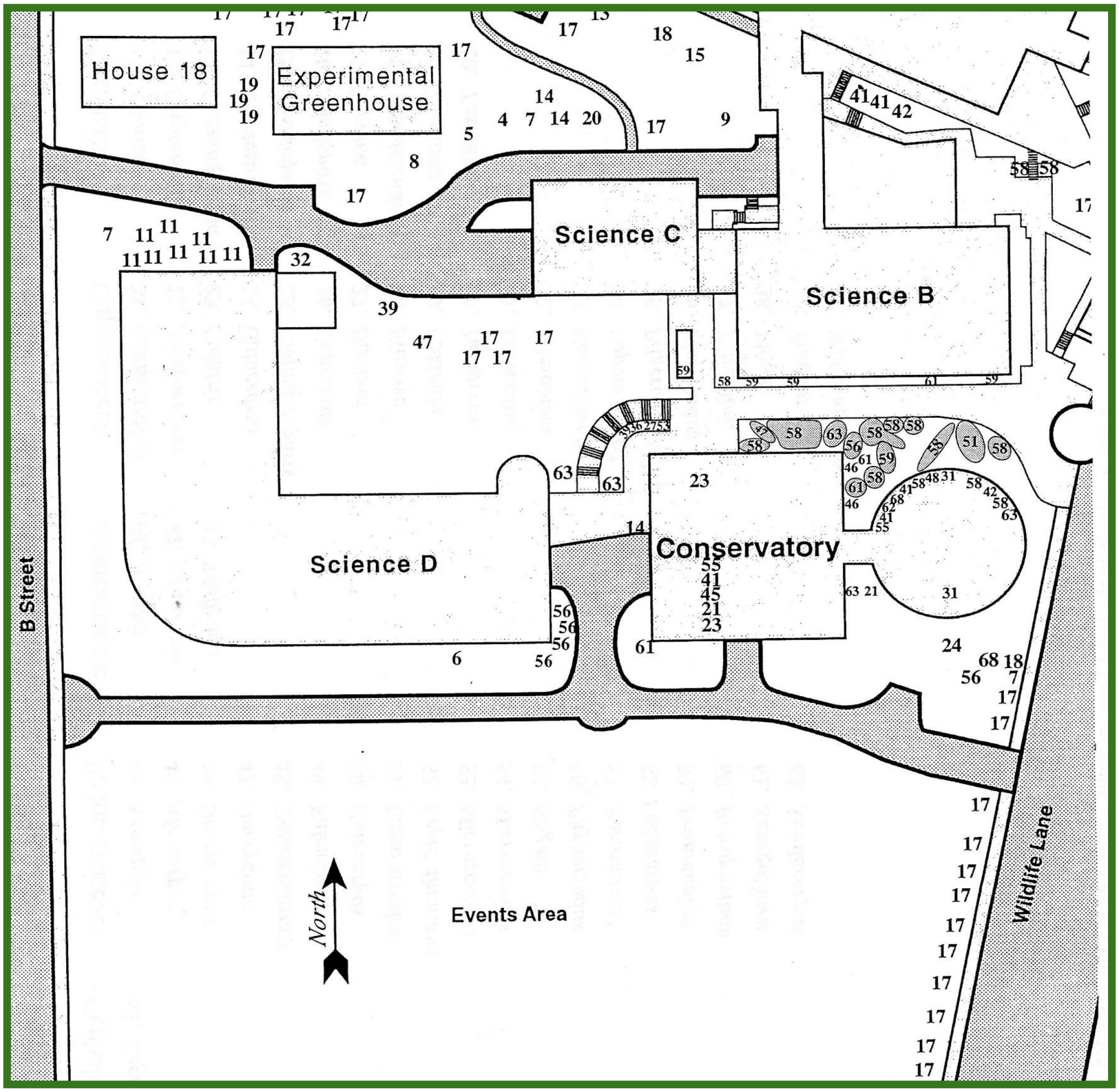

Image 1: Map of Project site and original Greenhouse inventory of trees.

Conifers

Coniferales

Pinaceae:

1. ***Abies***
2. ***Cathaya***
3. ***Cedrus***
4. ***Keteleeria***
5. ***Larix***
6. ***Picea***
7. ***Pinus***
8. ***Pseudolarix***
9. ***Pseudotsuga***
10. ***Tsuga***

Taxodiaceae:

11. ***Athrotaxis***
12. ***Cryptomeria***
13. ***Cunninghamia***
14. ***Glyptostrobus***
15. ***Metasequoia***
16. ***Sciadopitys***
17. ***Sequoia***
18. ***Sequoidendron***
19. ***Taiwania***
20. ***Taxodium***

Cupressaceae:

21. ***Actinostrobus***
22. ***Austrocedrus***
23. ***Callitris***
24. ***Calocedrus***
25. ***Chamaecyparis***
26. ***Cupressus***
27. ***Diselma***
28. ***Fitzroya***
39. ***Fokienia***
30. ***Juniperus***
31. ***Libocedrus***
32. ***Microbiota***
33. *Neocallitropsis**
34. *Papuacedrus**
35. ***Pilgerodendron***
36. ***Platycladus***
37. ***Tetraclinis***
38. ***Thuja***
39. ***Thujopsis***
40. ***Widdringtonia***

Araucariaceae:

41. ***Agathis***
42. ***Araucaria***
43. ***Wollemia***

Podocarpaceae:

44. ***Acmopyle***
45. ***Afrocarpus***
46. ***Dacrycarpus***
47. ***Dacrydium***
48. ***Decussocarpus***
49. ***Falcatifolium***
50. ***Halocarpus***
51. ***Lagarostrobus***
52. ***Lepidothamnus***
53. ***Microcachrys***
54. ***Microstrobos***
55. ***Nageia***
56. ***Phyllocladus***
57. *Parasitaxus**
58 ***Podocarpus***
59. ***Prumnopitys***
60. ***Retrophyllum***
61. ***Saxegothaea***
62. ***Sundacarpus***

Cephalotaxaceae

63. ***Cephalotaxus***

Taxales

Taxaceae:

64. *Amentotaxus**
65. ***Austrotaxus***
66. ***Pseudotaxus***
67. ***Taxus***
68. ***Torreya***

* Not available in the local flora, campus landscape, botanical garden, or conservatc

Image 2: Names of conifers and symbol number.

Image 3: Aerial map of the Area of Focus.

Methods

Using the map provided by the campus greenhouse as a reference, we went to each map point in order to identify the tree to genera. We also took GPS coordinates of each individual. To determine which trees were at risk of phytophthora, a water transferable disease, we took GPS coordinates of visible water drainage areas or inferred within our mapping area. We took a satellite image of Humboldt State University campus and added our GPS points of both the trees and the water drainage areas. Next, for the drainage points, we created a 15 foot buffer from the direction of flow. All the trees that are within this buffer area are at high-risk of being infected by *Phytophthora*. Another 10 ft buffer was created beyond the 15 ft buffer and trees that fall within the additional area are at medium risk of the disease. All trees that are outside of this range are at low risk. A basemap was uploaded from USGS. Data points from two GPS devices were uploaded. All data points were merged into a single layer. Selected water points were created into a new layer. A 15 ft buffer was created around these waterways and then 10 ft buffer beyond the 15 feet. We dissolved the 15 ft buffer and 10 ft buffer to make a doughnut 15 ft buffer zone of medium risk trees. We selected by location high and medium risk respectively to create new layers of high and low risk trees. We made appropriate symbology changes to all layers for clarity. Last we added cartography features.

We reformed the family list of trees, and found that the family "Taxodiaceae" is now no longer recognized as a distinct plant family. It was dissolved into the family "Sciadopityaceae". We also did not add names of trees that we did not map because of absence, death, or inability to identify. All numbers on the new location maps correspond to the old numbers from the list we received from the greenhouse.

Results and Discussion

Out of 160 original trees mapped, 37 have died either due to *phytophthora* or failed establishment, our study found 123 trees total (Figure 2). The original map listed 68 genera, but only 39 of the shown were originally on the map. Of those 39 genera, 35 genera were documented. We found and mapped *Cathaya*, a genus on the original list but not on the original map. We updated the old greenhouse map to show new species names and locations. We excluded the dead trees from the final, newly made inventory map. Nine living trees in the genus *Athrotaxis* were documented 30 years ago. Two of those trees are alive today. Seven have substantial root rot and are dead.

We determined six high-risk saturated concentration areas. These were: 16 high-risk trees (red on map), 22 medium risk trees (yellow) 85 low risk trees (green). It was determined that all trees were likely at risk for *Sp. phytophthora* because of the climate of the area and high traffic of students on campus. It would be best for the Greenhouse to keep up mapping to track future developments to track changes and development. In addition, they should have a tree specialist continue to ID rare trees that have been added from the last time of mapping, and to suggest appropriate trees species.

We would suggest that waterways be mapped during rain to get accurate representation of where the water is flowing, its extent and duration of intubation. We mapped it out before the rains came in a drier than normal month. The Greenhouse should take the waterways we mapped into consideration when planning out future planting of trees, especially when planting those with documented substantial vulnerability. There could also be protected zones created to mitigate any damages from phytophthora via waterways.

Family	**Species**	**Risk**
Podocarpaceae	*Podocarpus*	High-Medium
Podocarpaceae	*Prumnopitys*	High
Cephalotaceae*	*Cephalotaxus*	High-Medium
Sciadopityaceae	*Sciadopitys*	High
Pinaceae	*Keteleeria*	High
Pinaceae	*Larix*	High
Pinaceae*	*Pinus*	High-Medium
Pinaceae	*Pseudotsuga*	High

Table 1: Continued Risk Assessment with Family name asterisked that have documented substantial vulnerability.

Family	Species	Risk Factor
Cupressaceae*	*Glyptostrobus*	High
Cupressaceae*	*Sequoia*	High- Medium
Cupressaceae*	*Actinostrobus*	High
Cupressaceae*	*Austrocedrus*	High
Cupressaceae*	*Callitris*	Medium
Cupressaceae*	*Calocedrus*	High
Cupressaceae*	*Diselma*	Medium
Cupressaceae*	*Fitzroya*	Medium
Cupressaceae*	*Libocedrus*	Medium
Cupressaceae*	*Pilgerodendron*	Medium
Cupressaceae*	*Platycladus*	Medium
Cupressaceae*	*Thujopsis*	Medium

Table 2: Risk Assessment with Family name asterisked that have documented substantial vulnerability.

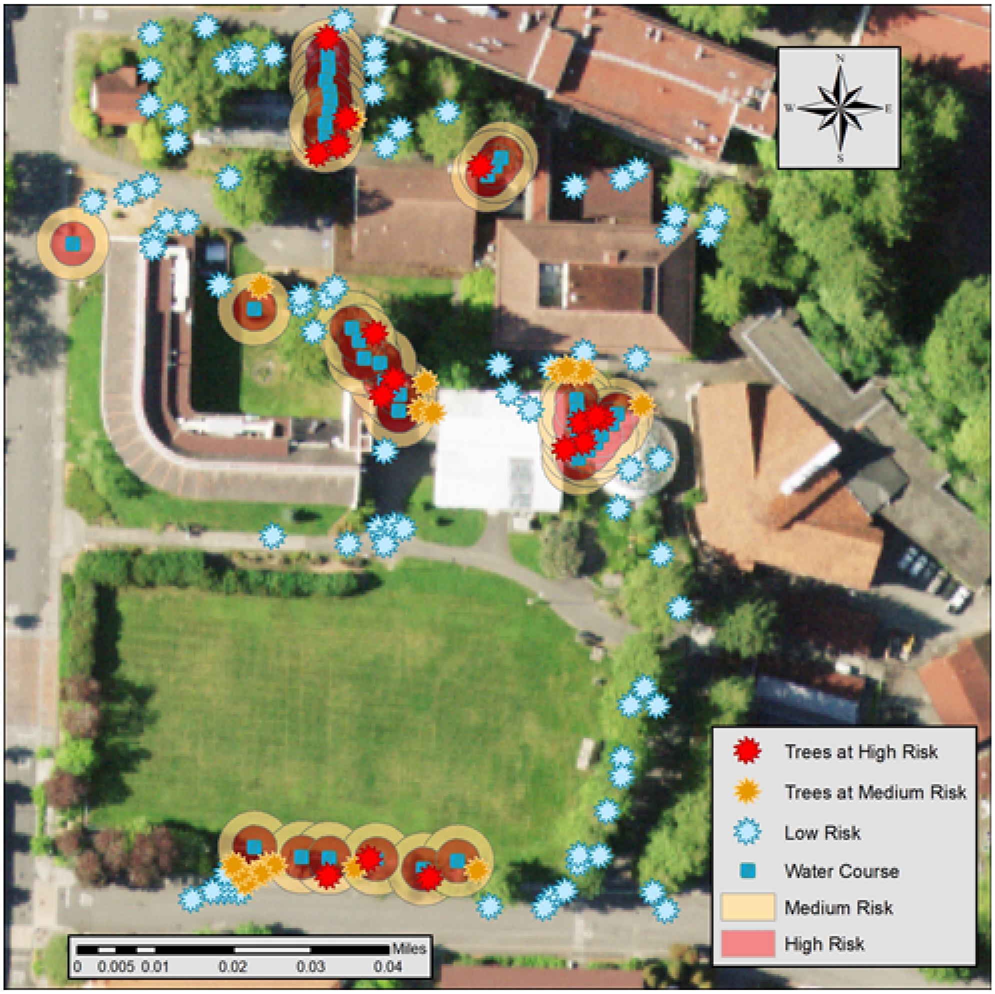

Figure 2: Final Project Map

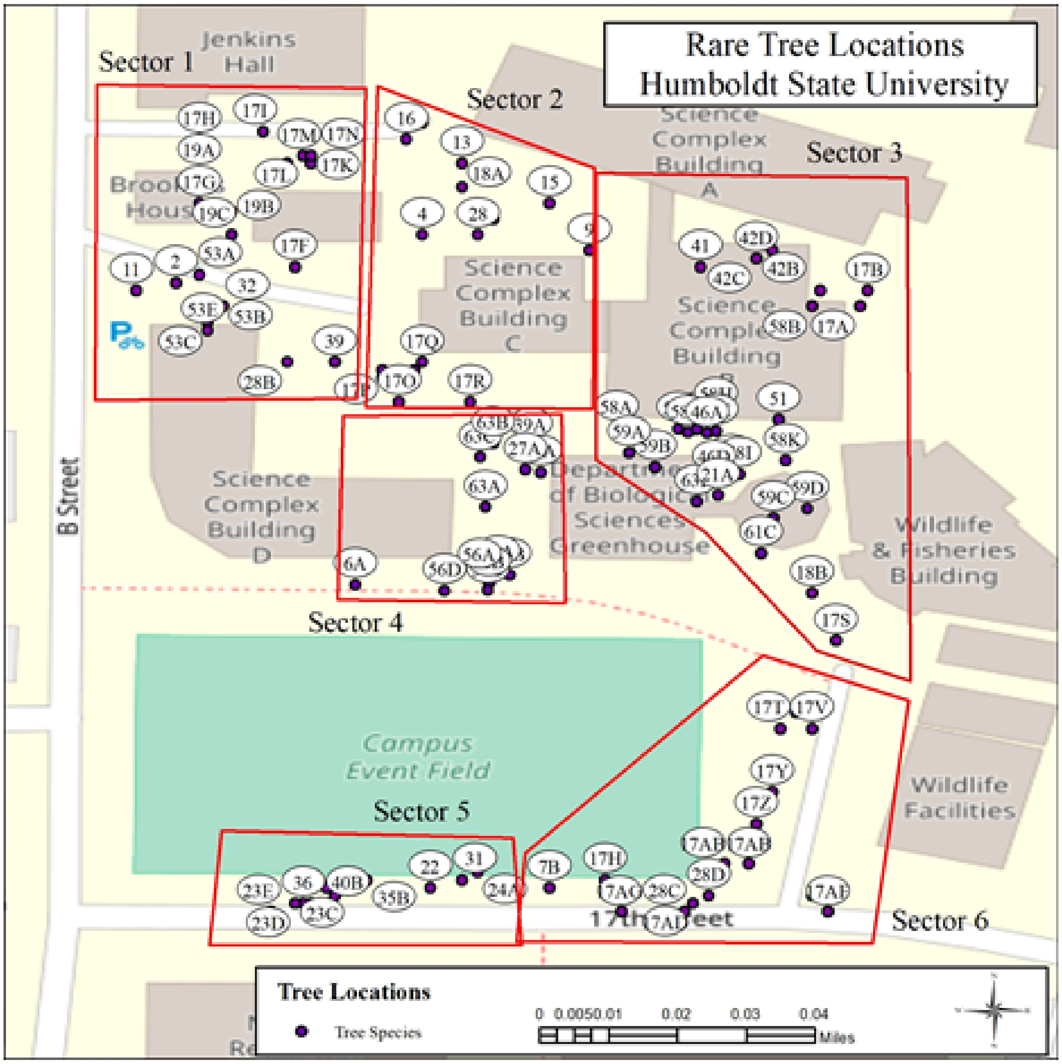

Figure 3: Numbered Tree Identification Map

Conclusion

In conclusion, we found that there were many high-risk zones on campus for phytophthora infection. Many of the trees who were high-risk species to begin with were in close proximity to these zones. Protecting rare and exotic trees would protect scientific knowledge and diversity in our research institution.

We would recommend for a future project to find a more accurate GPS that operates well under tall redwoods. We would also remove the Redwoods from map in whole. We would also suggest monitoring the waterways during the raining season to get a more accurate representation of where water flows, as we mapped the waterways before the rains came. We would also recommend they look at other possibly confounding variables, such as cover of English Ivy, or soil texture. We would recommend the greenhouse get assistance from Chris Lee (phytophthora specialist), from the USDA Forest Service who works on campus. It would be useful to use the resources of the HSU STEM lab on campus to culture phytophthora strains and identify them.

Acknowledgements

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