

Dr. Øystein Svendson is the Chief Biosecurity Engineer in New Atlantis, an underwater international seed vault that houses the world's germplasm (living genetic resources, both natural and genetically manipulated, used to maintain the biodiversity levels of the world's flora). The facility, built underwater on Zealandia's continental shelf, provides a secure pressure and temperature-controlled environment for the germplasm's storage. Global Crop Diversity Trust (GCDT) operates New Atlantis. To ensure international biosecurity protocols, GCDT hires only the most experienced botanists, genetic engineers, and biosecurity experts from around the world to work at New Atlantis. Latest information from the surface shows a rising threat of indigenous plant species' extinction around the world, causing concerns among the scientific community.

Dr. Svendson's thoughts whirl in his mind and materialize on the holo-board in front of him. This thought-visualizer is great, especially during times like these when he needs to clarify his thoughts by projecting them onto the holo-board.

*“New Atlantis seed vault facility is charged with the protection of historic plants and the reintroduction of these endangered species into environments where they can best grow and thrive. Our latest project involves the reanimation of an extinct plant species from DNA found in fossilized spores and its reintroduction into a compatible environment. Unfortunately, this process is hampered by countries whose fear of hybridization has resulted in stringent biosecurity restrictions. I'm afraid that this project may be in great danger if it is viewed as an unnecessary biosecurity threat. But how can we advance science if we don't take some risks?”*

Today GCDT personnel are preparing to receive a shipment of spores from a recently discovered horsetail fossil of the genus Calamite. Calamites lived about 300 million years ago. Paleo-botanists in northern Europe, where the specimen was found, claim that reanimation of this species poses no danger of hybridization. They further note that the knowledge science can glean from its reanimation outweighs any biosecurity risks. However, environmental activists claim that the effects of the reintroduction of an ancient plant species into a new environment cannot be determined.

*“After I transport the spores back to New Atlantis, our botanists will extract the DNA from these spores and begin the reanimation process of the ancient Calamite species. Of course, in order to improve the plants' viability, we will need to modify the genes to increase pollen production. The best opportunity for growth of the species will be within the Santa Elena Cloud Forest Reserve in Costa Rica. The soil type, temperature, and humidity levels of this rainforest are most like the area where these plants originally flourished. However, I'm still worried. When we transfer the Calamites to the rainforest, New Atlantis won't have direct control of the plants or their environment.”*

The scientific community is excited over this latest discovery and its potential for advancing new procedures for extinct plant reanimation. GCDT has scheduled a symposium to coincide with Dr. Svendson's arrival in Europe. Paleo-botanists, pro-experimental environmentalists, and genetic engineers are scheduled to explain the merits of the introduction of non-indigenous flora into Costa Rica's ecosystems. Government leaders and concerned environmentalists from Costa Rica are also expected to be in attendance. Dr. Svendson realizes that he will be embroiled in another ecological debate about the role of New Atlantis in biosecurity issues. He also knows that input from an independent agency will be invaluable. Thus, he opens his communication board, dictates the following message, and converts it to video transfer protocol encryption. He sends it to the Executive Director of FPSPI for immediate relay to teams of problem solvers around the world.

*“2050.07.15. Problem Solvers of the International Community, I need your help. Please use your expertise to address an important biosecurity challenge facing the reanimation of Calamites by New Atlantis. We would like you to present your Action Plan at the symposium in September.”*

# Symposium offered by Global Crop Diversity Trust, Owner & Creator of New Atlantis

Protecting the World's Flora One Seed at a Time...

New Atlantis is introducing a plan for the reanimation of an extinct plant species from spores fossilized in amber. Dr. Svendson, New Atlantis's Chief Biosecurity Engineer, will chair a symposium on the new advancements in biosecurity and the plan for the reanimation of an ancient Calamite species into the *Santa Elena Cloud Forest Reserve* of Costa Rica.



## Issues to Be Discussed

- Biosecurity protocols
- Bioethical considerations
- Agricultural concerns
- Global impact

## Prehistoric Calamites



- Resembled modern horsetails with trunks similar to bamboo
- Grew to heights of 10– 20 meters
- Anchored to ground by underground rhizome from which clones of itself sprouted
- Reproduced by spores

## New Atlantis Biosecurity

- State-of-the-art methods to control and account for all biological materials
- No unauthorized access to the facility
- Protection of all Valuable Biological Materials (VBM) against theft, misuse, and destruction



## Biosecurity Management

- Secure location between Australia and New Zealand on Zealandia, reducing chances for contamination of pristine species
- Competent staff of scientists, including genetic engineers, botanists, and biosecurity experts
- Improved longevity and agricultural production experiments
- Stringent biosecurity protocols in place

## STEP 1. Identify Challenges

Read the Future Scene carefully and generate ideas for challenges, concerns, and possible related problems. Choose the 16 most important challenges and write them in the space provided. Writing on reverse side or in margins will not be scored. One additional page for both challenges and solutions is provided. (page 14)

1. In the FS, it states that "environmental activists claim that the effects of an ancient plant species into a new environment cannot be determined". This statement poses a possible threat to the indigenous species of that environment. An article from the USDA stated that "plants have throughout history, been used for medicine and pharmaceuticals". This may be a problem because a threat to indigenous species could decrease the innovation/use of pharmaceuticals which could heavily impact the finances of

2. Pharmaceutical companies.]

In the FS, it states that the effects of placing an ancient plant species into a new environment is viewed as "an unnecessary biosecurity threat" which can harm the indigenous species of an environment. The Smithsonian Museum of the Arts stated that "Plants and wildlife are inspirations to artists. Have you ever been to an art museum without seeing a piece from nature?". This may be a problem because the possible eradication of the indigenous species could cause artists to no

3. longer inspire from well known species from their native land.

In the FS, it states that "GCDT hires the most experienced... from around the world to work at New Atlantis". Research has shown how persons from each country live with their own culture, language, and communication standards. This may be a problem because the workers differences in culture/language/communication could possibly affect their potential to advance the New Atlantis community.

4. In the FS, it states that "...the reintroduction of these endangered species where they can best grow and thrive"... Countries that have better environments for many of the historic species may receive more of the historic species than other countries. This may be a problem because countries with more historic species may receive more interested tourists which may cause an unfair financial bias in the tourism industry.

## STEP 2. Select an Underlying Problem

Using the challenges listed in Step 1, identify a problem of major importance to the Future Scene situation. Write your Underlying Problem making sure your question clearly explains the action that will be taken and the desired results/goal of that action.

Writing on reverse side or in margins will not be scored.

Challenge #(s) several challenges combined  
1

Because environmental activists claim that the effects of reintroduction of an ancient plant species into a new environment cannot be determined, Calamites could potentially pose a major biosecurity risk to the ecosystem of Costa Rica.

How might we increase protection of native plant species in Costa Rica so that the risk of calamites damaging the ecosystem is decreased in 2050 and beyond?

biosec

reintroduction

## STEP 3. Produce Solution Ideas

Generate solution ideas to the Underlying Problem in Step 2. Choose the 16 most effective solutions and write the elaborated ideas in the space provided. Writing on reverse side or in margins will not be scored. One additional page for both challenges and solutions is provided. (page 14)

1. The International Federation for Biosecurity will close off a microcosm used for experimental testing to notice the interaction between specific native species and the calamites. This will help them understand the interaction between such species, to make sure the calamites would not harm native species. The data recieved from the microcosm would aid in developing materials to help decrease the possible damage of calamites on the ecosystems.

2. The center for Disease Control (CDC) will produce an antiviral that combats any negative effects from the calamites. This antiviral will be given to all native species in the same ecosystem as the calamites. This way the native species will be able to properly defend themselves from the calamites, therefore decreasing the effect of the calamites on the ecosystem.

3. The Federation of American Botanists will introduce new gardening programs in all environments with Calamites. These gardening programs will only be meant to garden native species, and will be for leisure and recreational time for the citizens around the environment. These programs will help increase the protection for native species which will consequently decrease any

4. Possible damage of the calamites to the ecosystem. The United States Department of Agriculture will ration meat products to be sold in the meat industry. Research shows that cattle consume more than 30% of the plants that people do. Rationing meat items will decrease the amount of needed cattle which will decrease the consumption of native species. This government intervention will increase the protection for native species therefore decreasing the possible negative effect on damaging ecosystems.

**STEP 4. Select Criteria**

Generate criteria to determine which solution idea does the best job of solving the Underlying Problem and/or addressing the Future Scene situation. Select the 5 most important criteria for measuring solution ideas and write them in the spaces provided. Writing on reverse side or in margins will not be scored.

1.	Which solution will most increase protection of native plant species in Costa Rica in 2050 and beyond?
2.	Which solution will decrease the risk of calamites damaging the ecosystem in Costa Rica the most?
3.	Which solution will be the most humane in combatting the unknown effects of the Calamites in Costa Rica in 2050 and beyond?
4.	Which solution will most ensure international biosecurity protocols are being followed to its fullest?
5.	Which solution will ensure that the bioethical concerns of citizens in Costa Rica, New Atlantic, etc. are being addressed the most?

**STEP 5. Apply Criteria**

From the solution ideas written in Step 3, select the 8 ideas with the most potential to solve the Underlying Problem and list them on the grid. Use each criterion to rank the solutions on a scale from 1 (poorest) to 8 (best). The numerical ranking for one important criterion may be doubled.

Step 3 Sol'n #	Solution Idea	Criteria					Total
		1	2	3	4	5	
# 13	CRISPR 1	8	6 <sup>14</sup>	7 <sup>21</sup>	7 <sup>20</sup>	6	34
# 16	Trojan Female Technique	4	8 <sup>1</sup>	5 <sup>11</sup>	6 <sup>20</sup>	8	31
# 5	Drones	7	3 <sup>10</sup>	3 <sup>13</sup>	2	1	16
# 6	Traps	5	1	1	4	3	14
# 1	Microplasm	2	2	8	5	7	24
# 2	Anti-rinuv's	6	5	2	3	4	20
# 3	Gardening program	1	7	4	1	5	18
# 14	Education	3	4	6	8	2	23

**Please write your Underlying Problem from Step 2:**

Because environmental activists claim that the effects of reintroduction of an ancient plant species into a new environment cannot be determined, Calamites could potentially pose a major biosecurity risk to the ecosystem of Costa Rica. How increase protection of native plant species in Costa Rica so that the risk of Calamites damaging the ecosystem is decreased in 2050 and beyond?

**STEP 6. Develop an Action Plan**

Develop your top-scoring solution idea into an Action Plan. Thoroughly explain how the Underlying Problem is solved, how the plan will be implemented, and how the Future Scene will be affected.

Writing on reverse side or in margins will not be scored.

Solution # 13

Dr. Øystein Svendsen,

We, the Problem solvers of the International Community, received your message and acted promptly, coming up with this idea in two hours after thorough vetting.

Our basic idea is to use the cutting-edge technologies of CRISPR-Cas9 to add a second genetic modification to the genome of Calamites. Geneticists at the University of California at San Diego have been one of the pioneers of this technology, and they are more than willing to work with New Atlantis to achieve the goal of safely maintaining biodiversity. This second genetic modification would make the Calamites susceptible to low doses of a species-specific <sup>humane</sup> poison. The poison itself would be developed by the World Health Organization. This way, the population of Calamites could be easily controlled if it got out of hand. The two genetic modifications - poison susceptibility and increased pollen production - would work as a brake and accelerator on the Calamites population, allowing New Atlantis to maintain greater control even after the Calamites are introduced in Costa Rica.