

THE ETHICAL ECOSYSTEM OF SCIENCE

GENE-DRIVE SIMULATION

INTRODUCTION

As a group, you constitute the executive board of the young tech startup Gene Drive Solutions, Inc. (GDSI).

You will be faced with three situations which *require decisions*.

Although you are collectively acting in the role of members of an executive board, *be yourselves* for the simulation.

DECISION-MAKING PROCEDURE

5 minutes of **private reflection**.

~15 minutes of group discussion with the **goal of arriving at a consensus**, but consensus that does justice to the **moral complexity** of the cases.

If consensus cannot be reached, **majority rules**.

RESOLVING THE OUTCOMES

The outcome of your decisions will depend on the choices you make and the roll of the dice.

Dice are meant to represent uncertainty, not to make this a “game.”

Rolls must be official to count!





SCENARIO ONE

Picking a test case

SCENARIO ONE

- A. Delay deployment of the technology by two years to collect further safety data in more lab-based trials, then try again to convince New Wyland to be the test case.
- B. Bribe the generalissimo, using Equatorial Mbini as the test case. Hopefully it will lead New Wyland to change its mind and become a second adopter.
- C. Have GDSI lobbyists twist arms to get Parliament to ignore public opinion and move quickly to test the technology in New Wyland anyway. Ignore the generalissimo's offer.
- D. Bribe the generalissimo and aggressively lobby Parliament to ignore public opinion, using both nations as simultaneous test cases.

RESULTS OF DECISION ONE

ROLL OF 2-10

- Option A
- Option B
- Option C
- Option D

ROLL OF 11-12

- Option A
- Option B
- Option C
- Option D



SCENARIO TWO

Determining liability
for unforeseen
consequences

SCENARIO TWO

The activists argue that GDSI is morally liable for this outcome and they want the company to 1) publicly apologize and 2) pay reparations to the victims of the generalissimo's abuses of power.

RESULTS OF DECISION TWO

2 – 4: The statement has the exact opposite affect it was intended to have. GDSI shares lose 20 percent of their value.

5 – 7: The statement rubbed much of the public the wrong way. GDSI share value declines by 10 percent.

8 – 10: The statement adequately addressed activists' criticisms. GDSI stock stays stable.

11+: The statement was a resounding success. GDSI share price increases 20 percent!



SCENARIO THREE

A repugnant request

SCENARIO THREE

- E. Develop an infertility gene drive to eliminate the local tiger population.
- F. Refuse to aid development of a gene drive to eliminate the local tiger population.

RESULTS OF DECISION THREE

OPTION E

- Result of 2 – 6
- Result of 7 – 9
- Result of 10 – 12

OPTION F

- Result of 2 – 6
- Result of 7 – 12

SIMULATION DEBRIEF

INTENDED TAKEAWAYS

1. Ethical reasoning cannot be outsourced.
2. Ethical reasoning is hard.
3. Ethical reasoning is worthwhile.

DOING ETHICS

- Ethics is about **justification**
- Justification requires providing **reasons**
- **Consequences** are one source of ethical reasons, but **not the only source**
- Identifying reasons is a **skill**
- **Reasonable** people can disagree

WHY MIGHT REASONABLE PEOPLE DISAGREE?

- **Complex evidence**
- Disagreement about the relative **weight** of ethical considerations
- Interpretive **judgment** is required for vague concepts
- Different lived **experiences**
- Hard to compare **types of reasons**

Matters of judgment are not
simply matters of taste!

APPENDIX

A. 2-10

Delay for further testing reconfirmed that the gene drive technology appears safe and ready for implementation. In the meantime, New Wyland forewent \$7.7 billion in GDP growth as a result of inaction. Additionally, two of the endangered bird species were driven to extinction by rats that preyed on the eggs of their young. Equatorial Mbini forewent \$4.8 billion in GDP growth as a result of inaction. Additionally, 22,000 people who could have been saved died of malnourishment and diseases carried by the rodents that were not eliminated. GDSI's stock price fell \$10/share because of the delays.

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A. 11-12

Delay for further testing uncovered a defect, which has been corrected. Had the defect not been corrected, the gene drive could have spread from the targeted rat population to several adjacent native species, leading to the extinction of the native species as well as the targeted rats. The long-term impact on the ecosystem had this occurred is unknowable, but economists estimate that the total costs of a faulty release could have run to over \$10 billion. GDSI dodged a bullet!

That said, delaying the implementation of the gene drive resulted in two of the endangered bird species being driven to extinction by rats that preyed on the eggs of their young. Additionally, 22,000 people in Equatorial Mbini who could have been saved had the rats been eliminated died of malnourishment and disease. GDSI stock price falls \$15 as the discovered defect has made investors nervous.

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B. 2-10

For a mere \$2 million bribe, GDSI secured access to Equatorial Mbini as a test case, and the technology passed its trial with flying colors. Implementation in Equatorial Mbini confirmed the safety of the gene drive technology! As a result, Equatorial Mbini experienced \$4.8 billion in GDP growth and 22,000 Mbinians are still alive who would have died had the rodent problem gone unaddressed. Things are less rosy in New Wyland: New Wyland forewent \$7.7 billion in GDP growth as a result of inaction. Additionally, two of the endangered bird species were driven to extinction by rats that preyed on the eggs of their young. The success of the trial in Equatorial Mbini has made New Wyland anxious to acquire GDSI's services. GDSI stock soars \$100/share!

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B. 11-12

For a mere \$2 million bribe, GDSI secured access to Equatorial Mbini as a test case. Unfortunately, implementation in Equatorial Mbini revealed an undiscovered defect in the gene drive technology! The gene drive was able to spread from the targeted rat population to several adjacent native species, leading to the extinction of the native species as well as the targeted rats. The long-term impact on the ecosystem is unknowable, but economists estimate that the total costs of the faulty release will run to over \$10 billion. On the bright side, an estimated 22,000 Mbinians did not die of pest-borne disease. Even so, GDSI stock falls \$50/share!

New Wyland forewent \$7.7 billion in GDP growth as a result of inaction and two of the endangered bird species were driven to extinction by rats that preyed on the eggs of their young. However, given the technology's catastrophic consequences in Equatorial Mbini, New Wylanders are counting themselves lucky.

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C. 2-10

Implementation without public support in New Wyland was risky, but the people came around when the release confirmed the safety of the gene drive technology! As a result, New Wyland experienced \$7.7 billion in GDP growth and no endangered bird species were lost.

Equatorial Mbini, which did not receive the technology, forewent \$4.8 billion in GDP growth and 22,000 people died of preventable malnourishment and disease. In light of the technology's successful implementation in New Wyland, a majority of Mbinians now support using gene drives to eliminate their rodents, too. GDSI stock rises \$50/share!

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C. 11-12

Implementation without public support in New Wyland was risky, and that risk didn't pan out when implementation revealed an undiscovered defect in the gene drive technology! The gene drive was able to spread from the targeted rat population to several adjacent native species, leading to the extinction of the native species as well as the targeted rats. The long-term impact on the ecosystem is unknowable, but economists estimate that the total costs of the faulty release will run to over \$10 billion. That said, no endangered bird species were killed. Even so, GDSI stock collapses, losing \$80/share!

In Equatorial Mbini, 22,000 people died of preventable malnourishment and disease. However, given the technology's catastrophic consequences in New Wyland, Mbinians are counting themselves lucky.

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D. 2-10

Implementation without public support in New Wyland was risky, but the public came around when the release confirmed the safety of the gene drive technology! As a result, New Wyland experienced \$7.7 billion in GDP growth and no endangered bird species were lost. GDSI stock soars \$50/share!

For a mere \$2 million bribe, GDSI secured access to Equatorial Mbini and the technology passed its trial with flying colors. Implementation in Equatorial Mbini confirmed the safety of the gene drive technology! As a result, Equatorial Mbini experienced \$4.8 billion in GDP growth and 22,000 Mbinians are still alive who would have died had the rodent problem gone unaddressed. A second successful demonstration of the gene drive technology is drawing further interest around the globe! GDSI stock rises an additional \$30/share!

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D. 11-12

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The premature implementation in New Wyland as well resulted in an additional \$10 billion in damages, and the fact that Parliament caved to GDSI lobbyist pressure cost the company half a dozen friendly faces in the legislature in the subsequent election. That said, no endangered birds were killed. Even so, GDSI stock tanks an additional \$45/share!

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E. 2-6

GDSI releases a gene drive targeting tigers. Because tigers have a longer reproductive cycle than rats, the effects are not immediate, but over the next few decades the tiger population that escapes hunting should dwindle to nothing. Global reaction to GDSI's actions is uniformly negative. Many people are beginning to question the ethics of using gene drives for animal management entirely. GDSI's stock falls 50 percent.

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E. 7-9

GDSI releases a gene drive targeting tigers. Because tigers have a longer reproductive cycle than rats, the effects are not immediate, but over the next few decades the tiger population that escapes hunting should dwindle to nothing. GDSI's reputation suffers from its decision to eliminate a popular species like tigers, and animal rights protestors make the company a prime target of their ire. GDSI's stock falls 25 percent.

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E. 10-12

GDSI releases a gene drive targeting tigers. Because tigers have a longer reproductive cycle than rats, the effects are not immediate, but over the next few decades the tiger population that escapes hunting should dwindle to nothing. Global reaction to GDSI's actions is surprisingly muted. In light of the steady cash flow generated by the contract with Indigia, GDSI's stock rises 10 percent.

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F. 2-6

GDSI refuses to supply Indigia with a gene drive targeting their wild tigers. This plays well around the globe. However, GDSI's refusal does not deter Indigia's tiger elimination program. Instead, Indigia offers its business to an upstart GDSI competitor, Death Drive Inc. Unfortunately, Death Drive's gene drive technology was less well developed. As a consequence, its gene drive contained a fault that allowed it to cross from the Indigian tiger population to the Caracal cat population as well. Now both Indigian tigers and Caracal cats are expected to go extinct within a few generations. Given the bad name the incident has given to gene drives, GDSI's stock falls 25 percent.

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