MTFC Project Proposal 2024-25

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MTFC Project Proposal Template Use Notes:

- *Refer to the official MTFC Project Proposal Prompts 2024-25 for the 15 prompts and scoring instructions.*
- *The use of this template is OPTIONAL.*
    - *It is provided as an optional resource for teams to keep their Project Proposal response organized. Teams who wish to use this template should make a copy in order to edit.*
- *The final version of the team's MTFC Project Proposal should be downloaded as a PDF or Word document to submit on the ICS Dashboard. A single file will be submitted.*
- *Additional resources (including the Actuarial Process Guide) can be found on the Modeling the Future Challenge website: https://www.mtfchallenge.org/resources/*
- *Please direct any questions to challenge@mtfchallenge.org.*

Part 1: Project Definition *(Team's Topic)*

These prompts can be found on page 3 of the MTFC Project Proposal Prompts 2024-25. Additional information on Project Definition can be found in ***Step 1: Project Definition*** in the Actuarial Process Guide.

Team Responses:

#1: Identify the topic

- Response: We want to investigate the effect of trade on invasive species establishing themselves. Invasive species have the potential to throw off an ecosystem's balance and lead to the extinction of some species as well as take valuable resources away from crops. While it has always been a prevalent issue, with the increase of world trade, it is especially important today.

#2: Identify potential risks

- Response: One risk would be the eradication of beneficial native species caused by an invasive species takeover. Agricultural companies are also at risk of monetary loss because their crops could be damaged or overtaken by an invasive species. This causes exponential decreases in the money being made by agricultural companies.

#3: Identify a behavior change risk mitigation strategy

- Response: One behavior change strategy would be encouraging companies to follow stricter guidelines to avoid the spread of invasive species. Particularly risky activities and species could be identified, and businesses advised to limit their use of these practices.

#4: Identify a modifying outcomes risk mitigation strategy

- Response: One possible modifying outcomes strategy would be to store seed samples in a seed bank. In the event that the ecosystem incurs significant damage, having samples of the plants that were originally located there can help rebuild the ecosystem and promote genetic diversity in damaged areas.

#5: Identify an insurance risk mitigation strategy

- Response: One possible insurance strategy is crop insurance. While not limited to usefulness only for invasive species, this type of insurance could help farmers whose farms are damaged by invasive species.

#6: Identify driving research questions for your topic

- Response:
    - Do the financial gains for companies through certain activities outweigh the environmental impacts of the spread of invasive species associated with those activities?
    - Which activities, methods of transportation, and types of goods are the biggest contributors to the establishment and dispersal of invasive species?

Part 2: Data Identification & Assessment *(Team's Topic)*

These prompts can be found on page 4 of the MTFC Project Proposal Prompts 2024-25. Additional information on Data Identification and Assessment can be found in ***Step 2: Data Identification & Assessment*** in the Actuarial Process Guide.

#7: Identifying the type of data, you hope to find

- Response: We hope to find data regarding the most frequent methods of transmission for invasive species; if we know *how* they travel to native soil and by which means they travel the most frequently, we can target specific causes to construct mitigation strategies. It would also be favorable to have data regarding current strategies used to control/attack invasive species, including metrics such as effectiveness, frequency, and cost. We specifically would like to quantify the impacts of particular species on the environment, perhaps finding the monetary cost of cleanup or the area of native species that was affected, which we can then link to transmission methods for that species.

#8: Identify potential data sources for your topic

- https://figshare.com/articles/dataset/InvaCost_References_and_description_of_economic_cost_estimates_associated_with_biological_invasions_worldwide_/12668570 InvaCost is a public database on worldwide information for the monetary loss associated with invasive species with published articles in Nature explaining the process of developing it. Their data is retrieved from peer reviewed articles and grey literature.

- https://data-usfs.hub.arcgis.com/datasets/usfs::current-invasive-plants-feature-layer/about This is a database that defines the historical range of severity of potential losses because it defines the land area for each species which can be combined with other data sets that can be compared to it. It is trustworthy because it is from the official U.S Forest Service whose job is to sustain the health, diversity, and productivity of the nation's forests and grasslands to meet the needs of present and future generations. This shows how they are a trustworthy data set to use and the information they are providing us with is valid. We could create a histogram of the land areas affected

- https://datadryad.org/stash/dataset/doi:10.5061/dryad.m93f6 This data set combines sources of existing data from trusted organizations like the IUCN and others to provide a comprehensive record of the introduction pathways of a variety of invasive species worldwide. This data is qualitative and would allow us to **categorize risks and potential outcomes** of different pathways in invasive species introduction in order to make policy recommendations. One possible visualization we could create would be a bar chart of the number of species introduced by each pathway.

Part 3: Mathematical Modeling *(Team's Topic)*

These prompts can be found on page 5 of the MTFC Project Proposal Prompts 2024-25. Additional information on Mathematical Modeling can be found in ***Step 3: Mathematical Modeling*** in the Actuarial Process Guide.

Team Responses:

#9: Modeling research on your topic

- There is a research paper that used math modeling and Maxent (machine learning algorithm that models and maps the distribution of species and their environmental niches) which can be helpful in finding the distribution of invasive species. However, we are not familiar with the "kriging" mathematical technique and would need to do further study to apply it. https://www.frontiersin.org/journals/ecology-and-evolution/articles/10.3389/fevo.2022.1036816/full
- Another research paper uses different functions to model the dispersal of a species over short and long ranges, specifically considering human impacts on their dispersal. This is helpful because it shows us how different functions can be incorporated to model both human and natural factors, but our team members were unfamiliar with some of the more advanced calculus aspects as well as Poisson distributions. https://www.nature.com/articles/s41598-020-78633-3
- There is also a research paper on modeling the effects of certain factors on the takeover of an invasive species. This can be used to model severity of a invasive species spreading and we could add in other factors to this model like geographical location. The paper uses notation and techniques our group is not fully familiar with, but can be applied with some minor research. https://www.nature.com/articles/s41598-024-53344-1

#10: Goals of a mathematical model in the project phase

- Response: We hope that our math model can show us the distribution of invasive species through trade. We also want to see which industries have the highest risk of transporting invasive species and geographical areas of this. We also want to investigate which activities have the most risk of spreading invasive species and how big the impact is. We may want to do an agent-based model so that we can simulate each organism of the invasive species interacting with different things such as native species or through trade.

#11: Assumption development

- Response: We want to look up to 2030. Given the rapidly developing climate change situation, we don't know how far into the future our data will remain accurate. However, we expect our changes to take some time to implement due to the time it takes plants to grow, and we would like to model over that interval, so we considered 5-6 years a reasonable time period. We expect the data we have will likely reflect the trends in the period we are analyzing as well, because we are not expanding to such a large interval that the trends become unpredictable.

Part 4: Risk Analysis *(Team's Topic)*

These prompts can be found on page 6 of the MTFC Project Proposal Prompts 2024-25. Additional information on conducting a Risk Analysis can be found in ***Step 4: Risk Analysis*** in the Actuarial Process Guide.

Team Responses:

#12: Goals for mitigation strategy

- Response: If no interventions are made, many problems that are caused by invasive species become far more dangerous to local environments. Worst case scenario is that invasive species cannot be accepted or dealt with by the local environments, and this is a very possible outcome if the current state of inaction against these issues is continued. The goal of possible mitigation strategies is to reduce the number of invasive species brought to other geographical locations, have more defense or screening on incoming transports, and more effective discovery and removal of current species that have already invaded.

Part 5: Recommendations *(Team's Topic)*

These prompts can be found on page 7 of the MTFC Project Proposal Prompts 2024-25. Additional information on making Recommendations can be found in ***Step 5: Recommendations*** in the Actuarial Process Guide.

Team Responses:

#13: Recommendation differences between mitigation strategies

- Response: One metric that we can use to decide on our mitigation strategy is the projected complexity of the strategy we are implementing. This is important because we will be dealing with companies and officials, which will increase the number of hoops that we will have to jump through during implementation, so we want to make things as simple as possible to provide the best chance our strategy will work as intended. We also want to consider cost, as this provides an incentive to get the most responsible parties to work with us and contribute less.

#14: Audience for recommendations

- Response: The project recommendations will be aimed at government officials or regulatory bodies who can implement restrictions on trade practices that most significantly increase the spread of invasive species. The spread of invasive species is a global issue and can only be significantly less severe if a large company or multiple companies implement preventative measures.

#15: Goals for situation improvement

- Response: We hope that our recommendations can help regulatory bodies prevent the transfer of invasive species among companies. By mitigating this, native species can remain in their land and the danger of native species becoming extinct can be deferred. Also, by following our recommendations, the environment can avoid the dangers of becoming destroyed due to invasive species. This can overall benefit our ecosystem and preserve what we have left of our environment.