Conceptual Models for Ecological Risk Assessment and Risk Management: *Investigating a potential Nile tilapia introduction*

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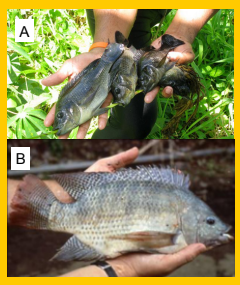
Background and Motivation

- Population growth, depletion of fisheries, and climate change are expected to put **increasing pressure on the food security** and livelihoods of people living in Pacific nations.
- **Aquaculture** may contribute towards a solution. There is, however, concern about biodiversity conservation and the threats posed by **introducing non-native species** that are considered superior for aquaculture.
- **Ecological Risk Assessment** (ERA) can be used to estimate the likelihood and consequences of undesirable ecological events caused by an introduction.
- Within the context of ERA, **we developed a conceptual model** for identifying risks and benefits of importing a strain of non-native Nile tilapia, Genetically Improved Farmed Tilapia (GIFT), to Solomon Islands for freshwater aquaculture.
- The model includes both **ecological and economic factors** and their interactions and is **based on values identified by stakeholders** (assessment endpoints) in a scoping workshop in Solomon Islands, conducted by WorldFish Center.
- We used the conceptual model to **identify potential effects of introduction and management decisions** on these endpoints. Here, we present the model goals, methods, and applications.



A. Mozambique tilapia currently found in Solomon Islands. **B.** GIFT variety proposed for introduction.

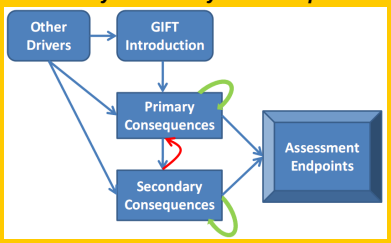
Conceptual Model Objectives

We developed the conceptual model with the following goals.

1. **Identify and hypothesize pathways** by which the introduction of GIFT might affect ecological and economic attributes of the system.
2. **Estimate likelihood of hypothesized interactions** and identify key knowledge gaps that make it difficult to identify causal relationships.
3. **Evaluate potential effects of different management options** by identifying pathways between policy options and assessment endpoints. Assessment endpoints included Biodiversity, Water Quality, Food Supply, Culturally Important Species, and Economic Indicators.

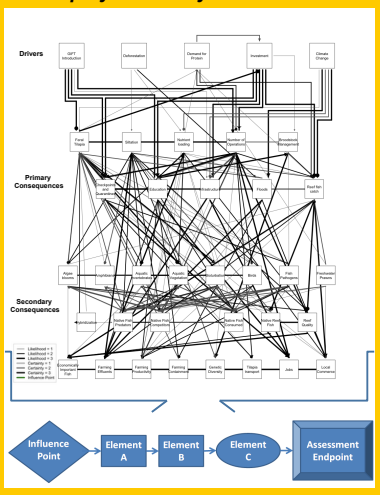
Methods

1. Identify and link system components.



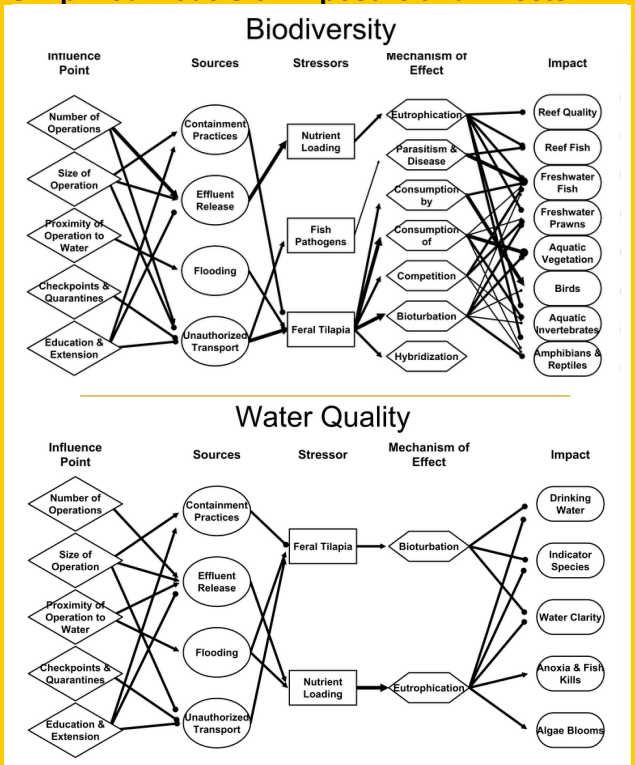
- The **model scope** is at the scale of a country over 5-10 years.
- We **identified ecological and economic elements of the system** that could be impacted by introducing GIFT.
- **Using published literature**, we hypothesized the likelihood and certainty of links between model elements, allowing for feedbacks.

2. Simplify and Analyze the Model



- Links in the full model that decision-makers affect are called **influence points**.
- We **identified pathways** between influence points and assessment endpoints containing three links or less.
- We synthesized simplified pathways, feedbacks and indirect effects to **hypothesize key pathways** from influence points to assessment endpoints.
- We identified stressors and estimated the likelihood of **environmental exposure** to these stressors and the **effects on environmental attributes.**
- Simplified **pathways can be ranked** to identify the most important influence points or the impacts most at risk.

Simplified Models of Exposure and Effects



Simplified models of exposure and effects for the Biodiversity and Water Quality assessment endpoints. Arrows in the model indicate positive effects; points indicate negative effects. Line weighting signifies our estimate of the likelihood of an interaction, based on the literature. Influence points can affect the sources of exposure to stressors. Stressors affect environmental impacts that directly affect an assessment endpoint. Similar models can be constructed for other endpoints. Note that some influence points reduce exposure to stressors, and that most effects of stressors on ecological impacts are negative.

Applications and Limitations of the Model

- Provides logical, stepwise reasoning within ERA, **allowing more transparent and defensible decision-making processes.**
- Can be **iteratively revised** and **readily modified for similar scenarios in other Pacific nations**.
- **Knowledge gaps** prevent estimates of effect magnitudes and cause high uncertainty. Also, **alternatives** to GIFT are not included in the model.

Acknowledgements: We thank Michael Phillips, Chris Paul, and Anne-Maree Schwarz of The WorldFish Center, Alex Meloty of the Solomon Islands Ministry of Fisheries and Marine Resources, and Tim Pickering from the Secretariat for the Pacific Community for their insight, guidance, support, and feedback during this project. Research funding and student support was provided by the National Science Foundation (Integrative Graduate Education and Research Traineeship Program: Risk Analysis for Introduced Species and Genotypes, NSF DGE-0653827). Travel was covered by the College of Food, Agricultural and Natural Resources Science; and the International Programs in Food, Agricultural and Natural Resources Sciences at the University of Minnesota.