Fishery
Causal Loop Diagram

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collective capacity for a scale that matters

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Note: this is work-in-progress, comments and suggestions welcomed.

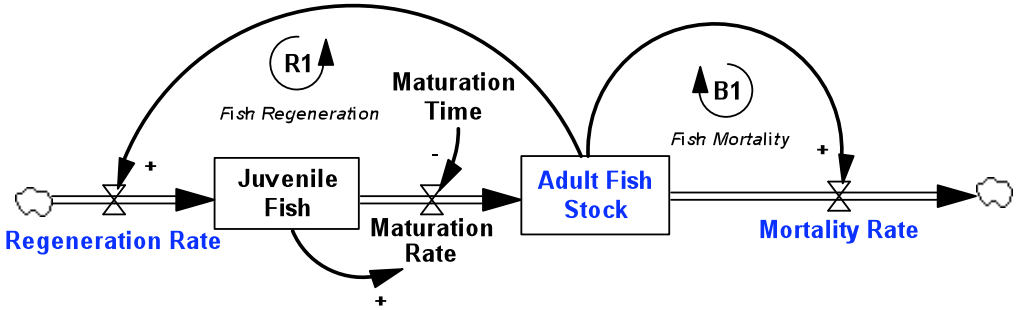
Multi-stakeholder Dialogue and Collaboration Through Collective Model Building

- This fishery causal loop diagram reveals one way of seeing the system of fishery and ocean conservation, the theory of change of various interventions and how they interact with each other.
- By making each stakeholder's mental model explicit, it enables people to understand each other's perspective, examine one's underlying assumptions about the change process logically and objectively, and sense-make the whole system collectively.
- This is work-in-progress, it is intended for fostering multi-stakeholder dialogue and collaboration through collective modeling building. We hope the **process** of revising this model collectively will allow us to deepen mutual understanding, see the current reality, form a shared vision and identify high-leverage points for creating together what we truly desire.

- Special thanks to Peter Senge, Scott Edwards, Tom Grasso, Michael Marlowe, Alejandra Robles, Laura Rodriguez and participants in the systems thinking workshop in La Paz, Mexico and 2011 Executive Champion's Workshop in Stowe, Vermont.

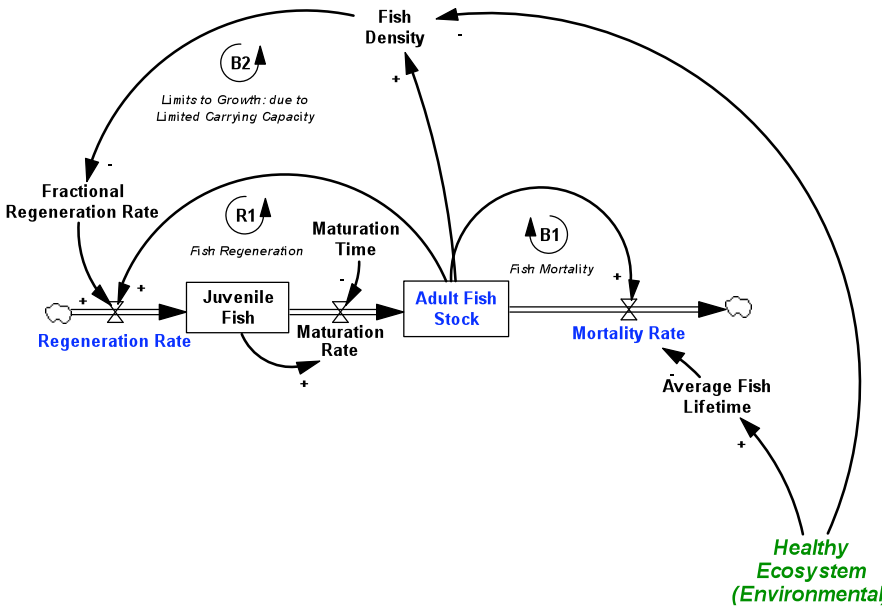
- Questions and comments? Please contact joehsueh@mit.edu - The Academy for Systemic Change.

Fish Stock



Causal Loop Diagram Notations:

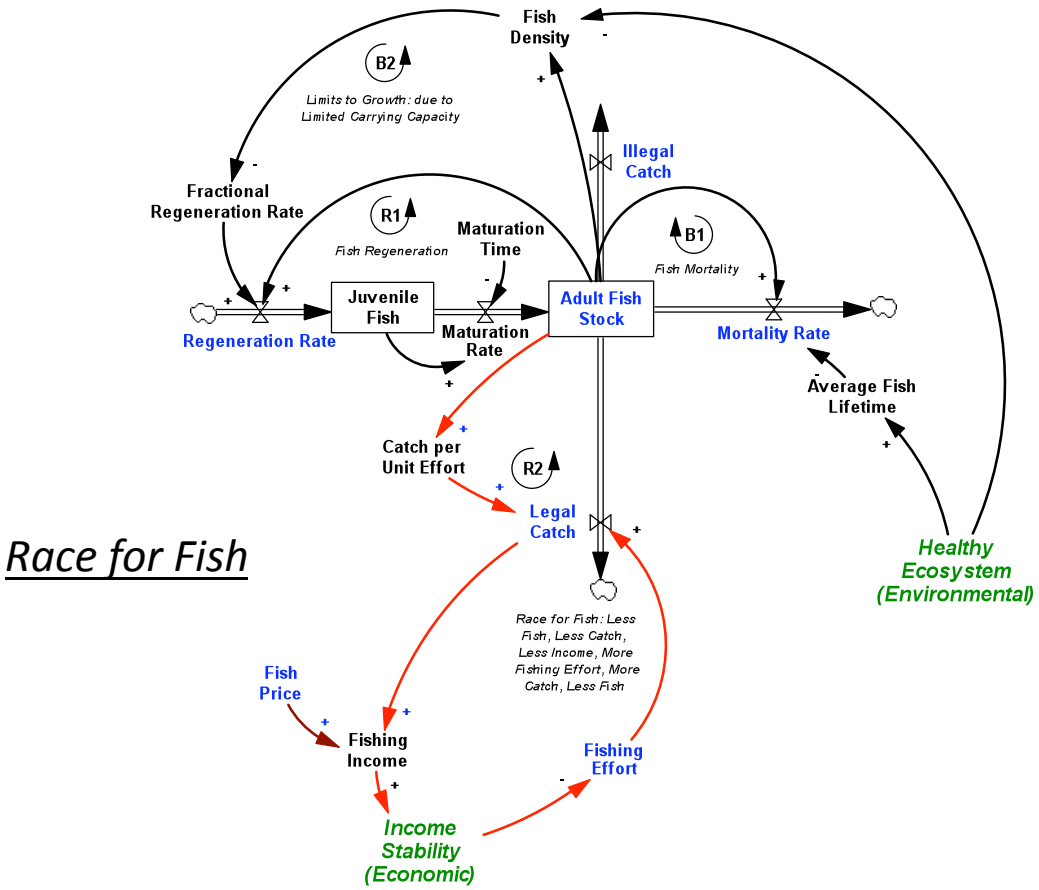
- **Arrows** represent a causal direction moving from a cause to an effect.
- **Polarity Signs**: a **'+'** sign denotes that the cause and effect move in the same direction holding all else constant, e.g. an increase (decrease) in adult fish stock causes an increase (decrease) in regeneration rate. A '-' sign indicates the cause and effect move in the opposite direction, e.g. an increase (decrease) in maturation time causes a decrease (increase) in maturation rate.
- **Loop identifier: R** indicates a positive (Reinforcing) feedback loop and **B** denotes a negative (Balancing) feedback loop.
- **Stock and Flow**: The rectangle "Juvenile Fish" denotes a stock variable that behaves like a bathtub. The inflow of regeneration rate increases the stock of juvenile fish, while the outflow of maturation rate decreases the stock as juvenile fish move into the stock of adult fish stock over time.
- Note: causal loop diagram comes from the field of System Dynamics developed at MIT.



Carrying Capacity

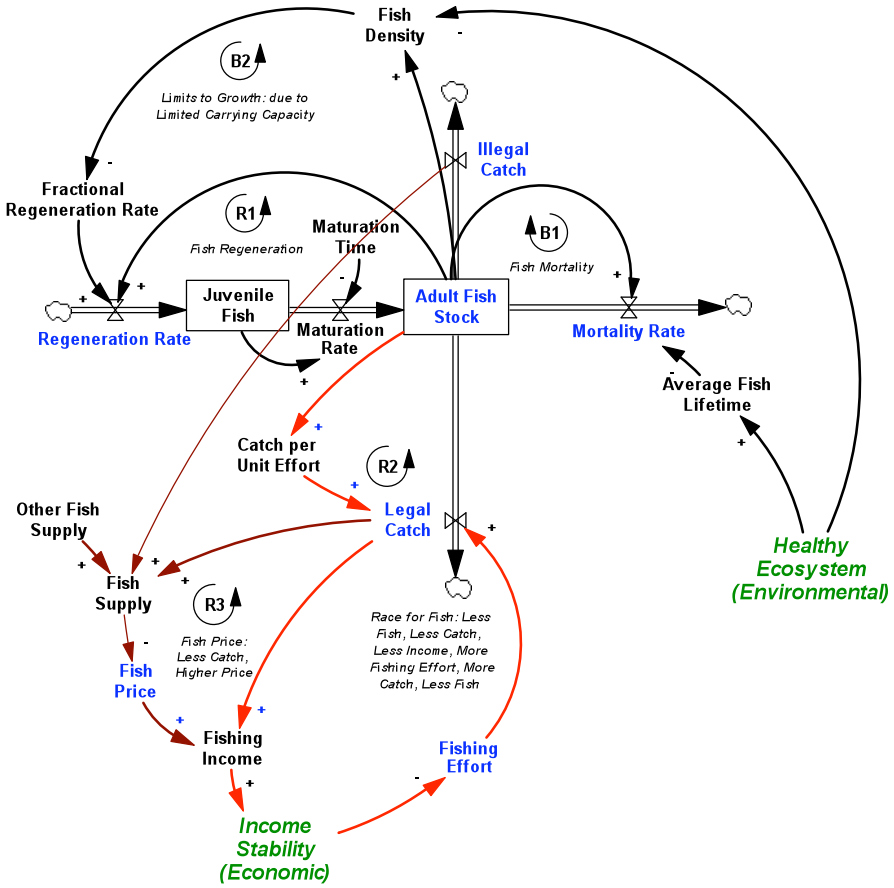
- **R1 (Fish Regeneration Loop)**: More adult fish leads to more regeneration rate for a given fractional regeneration rate, which generates more adult fish after the maturation time delay. This is the key regeneration loop that causes fish population to grow over time .

- **B2 (Limits to Growth Loop):** Healthy ecosystem in the diagram denotes carrying capacity. There is a carrying capacity in the marine ecosystem that supports a given amount of fish population. More fish, higher fish density for a given carrying capacity (thus less nutrients per fish), which leads to lower fractional regeneration rate. When total fish population reaches its carrying capacity, reproduction slows down, as there is no more capacity to support further population growth. Starting from a small population relative to this carrying capacity, the fish population over time will grow and eventually stabilizes near this carrying capacity.



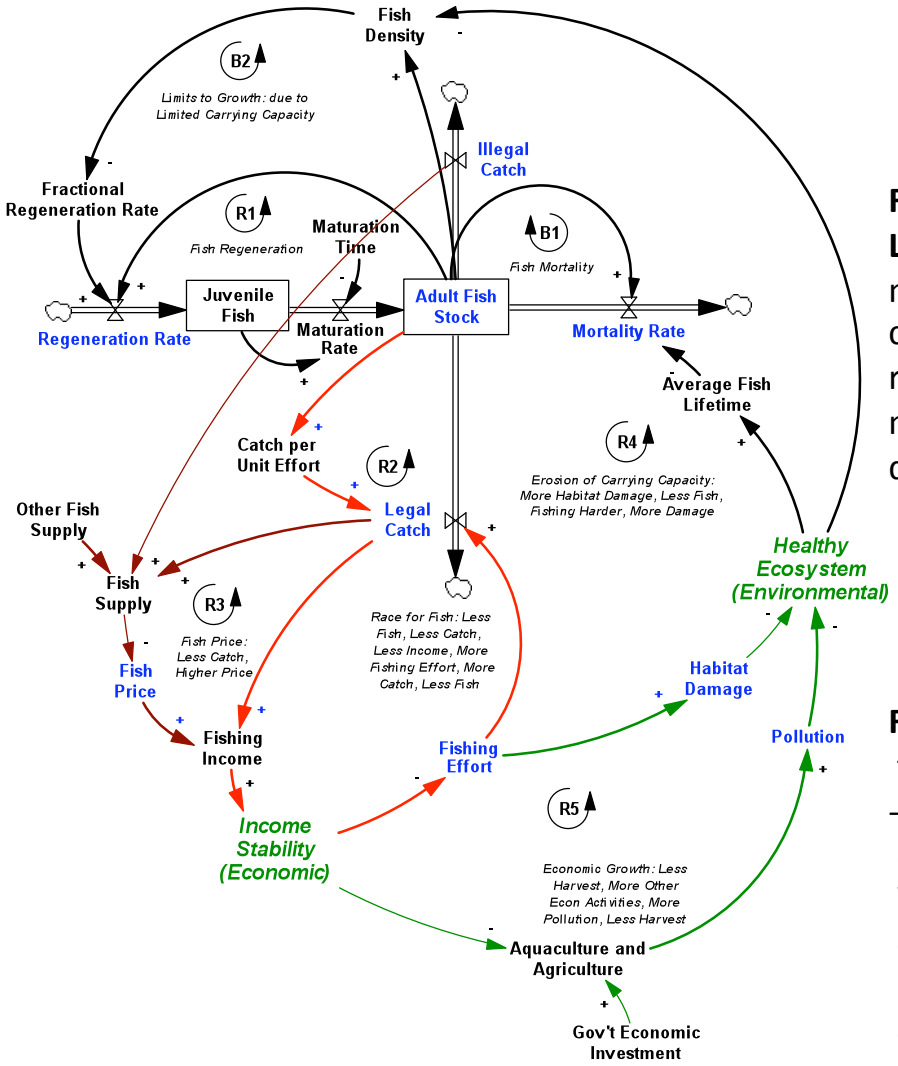
R2 (Race for Fish Loop): less adult fish stock, less catch per unit effort, which lowers fishing income and drives up fishing effort. More fishing effort increases catch and further declines fish stock. This is a key reinforcing loop that causes the fishery to collapse.

Fish Price



R3 (Fish Price Loop): overfishing (both legal and illegal catch) causes market price to collapse and reduces income, which drives up fishing effort and leads to further overfishing.

Green: Program Objectives
RED: Program Interventions
BLUE: Key Indicators



R4 (Erosion of Carrying Capacity Loop): more fishing effort leads to more habitat damage and erodes carrying capacity, which lowers regeneration rate and increases mortality rate that leads to fishery decline.

R5 (Economic Growth Loop): less fishing income leads to more non-fishing activities such as aquaculture and agriculture. Without proper regulation, these economic activities increase pollution and cause faster erosion of healthy ecosystem.

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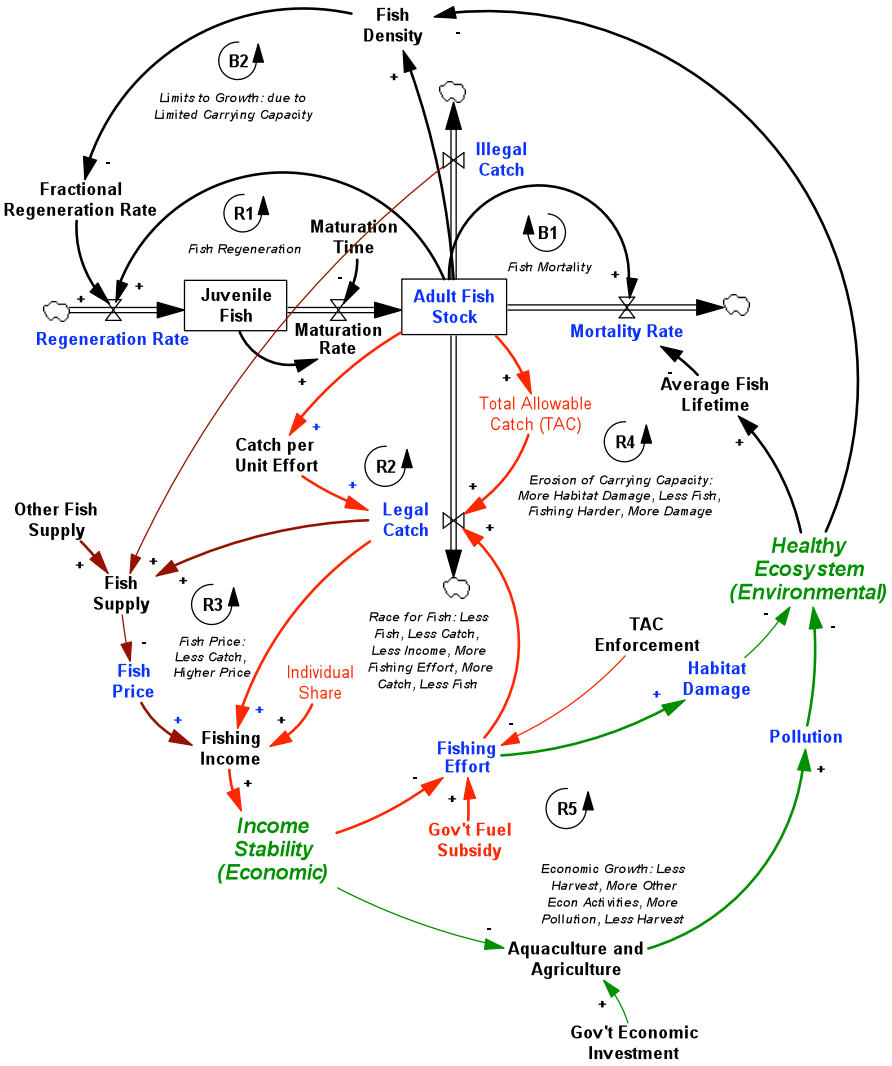
<u>Catch-Shares:</u> Total Allowable Catch caps the outflow of fish stock. Individual share incentivizes the growth and quality of fish stock.

Without intervention, the combinations of R2 Race for Fish, R3 Fish Price Collapse, R4 Erosion of Carrying Capacity and R5 Pollution effects could tip the fish stock into a collapse mode easily. However the same reinforcing loops could turn into *virtuous* cycles.



For example, a **Catch Shares program** sets a total allowable catch (TAC) and assigns individual shares to fishermen. Since each fisherman has a fixed share of the total quota every year, this creates an incentive for fishermen to increase the total quota, fish quality and price, which depends on the health of the fish stock. Thus, a sustainable catch enables fish stock to regenerate and increase, which allows the total quota to be set higher over time. The key is to set a TAC sufficiently lower than the regeneration rate so the fish stock can restore in time.

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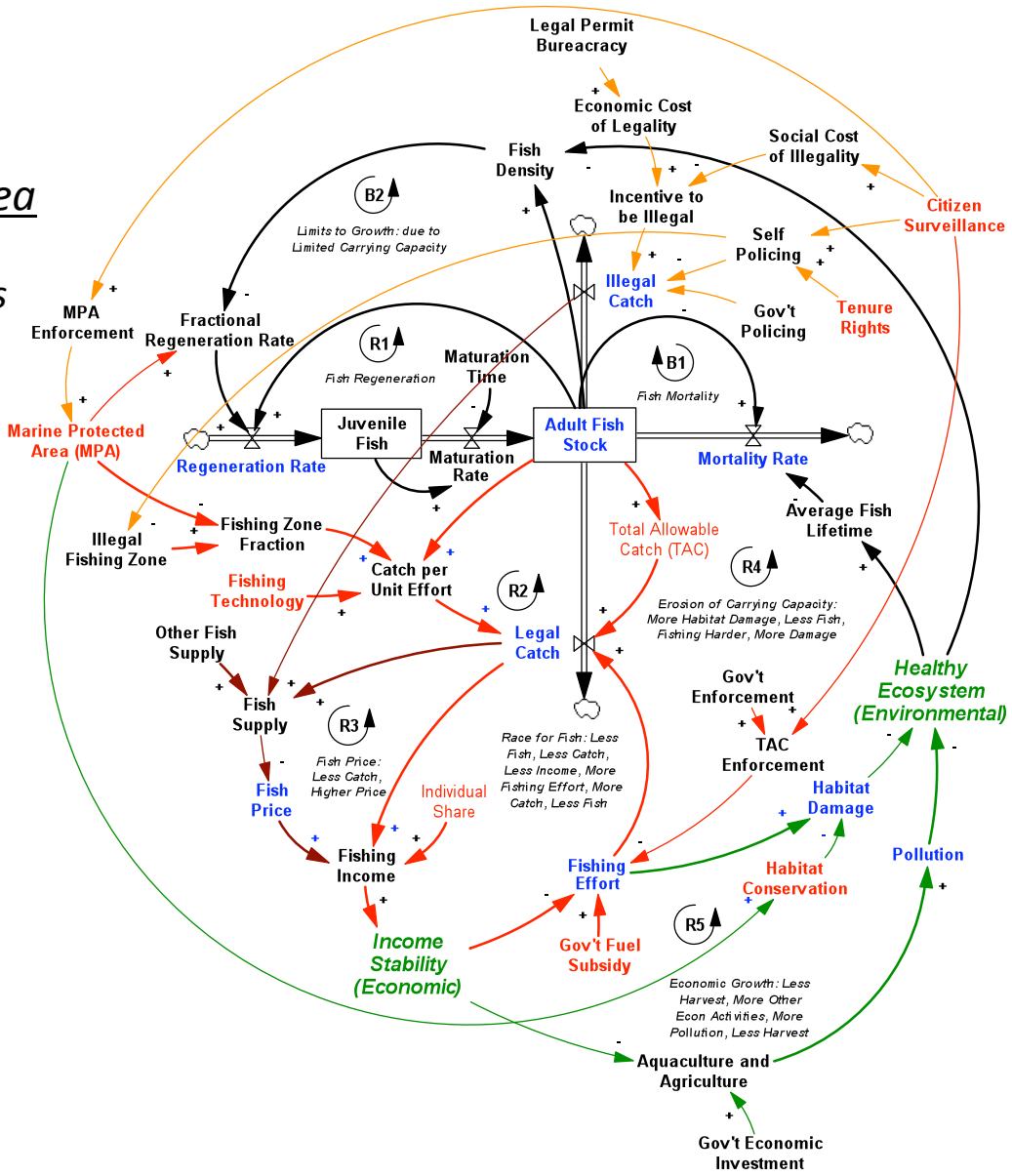
Marine Protected Area *limits fishing zone, increases regeneration rate, and conserves habitat.*



Citizen Surveillance *self-polices illegal fishing, enhances TAC and MPA enforcement.*

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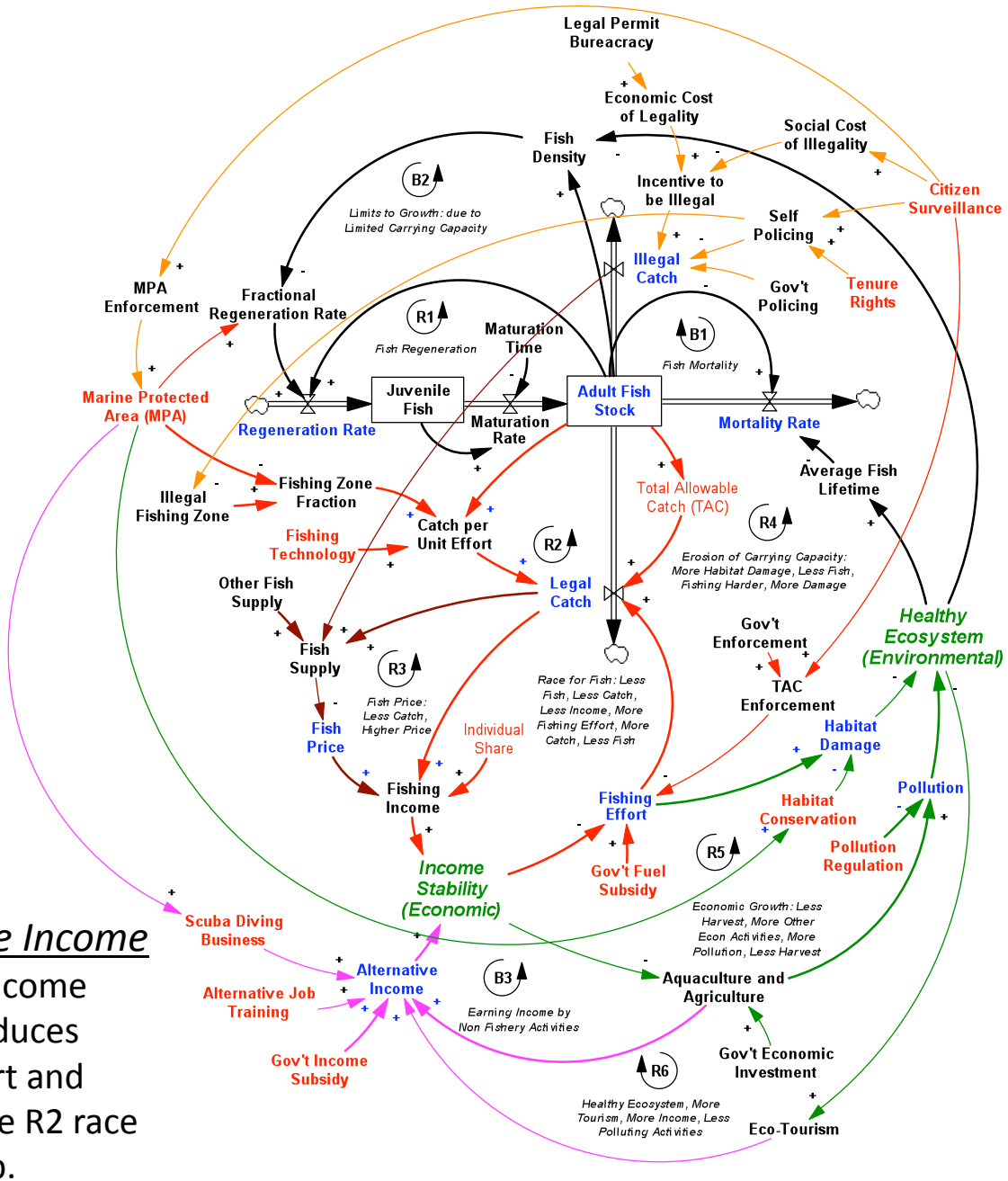

Healthy Ecosystem attract eco-tourism, reduce fishing effort and polluting activities.

R6 (Healthy Ecosystem Loop): habit conservation and pollution regulation improve ecosystem health, which attract eco-tourism as alternative income, reduce fishing effort and polluting activities, and further improve ecosystem health.

Alternative Income increases income stability, reduces fishing effort and weakens the R2 race for fish loop.

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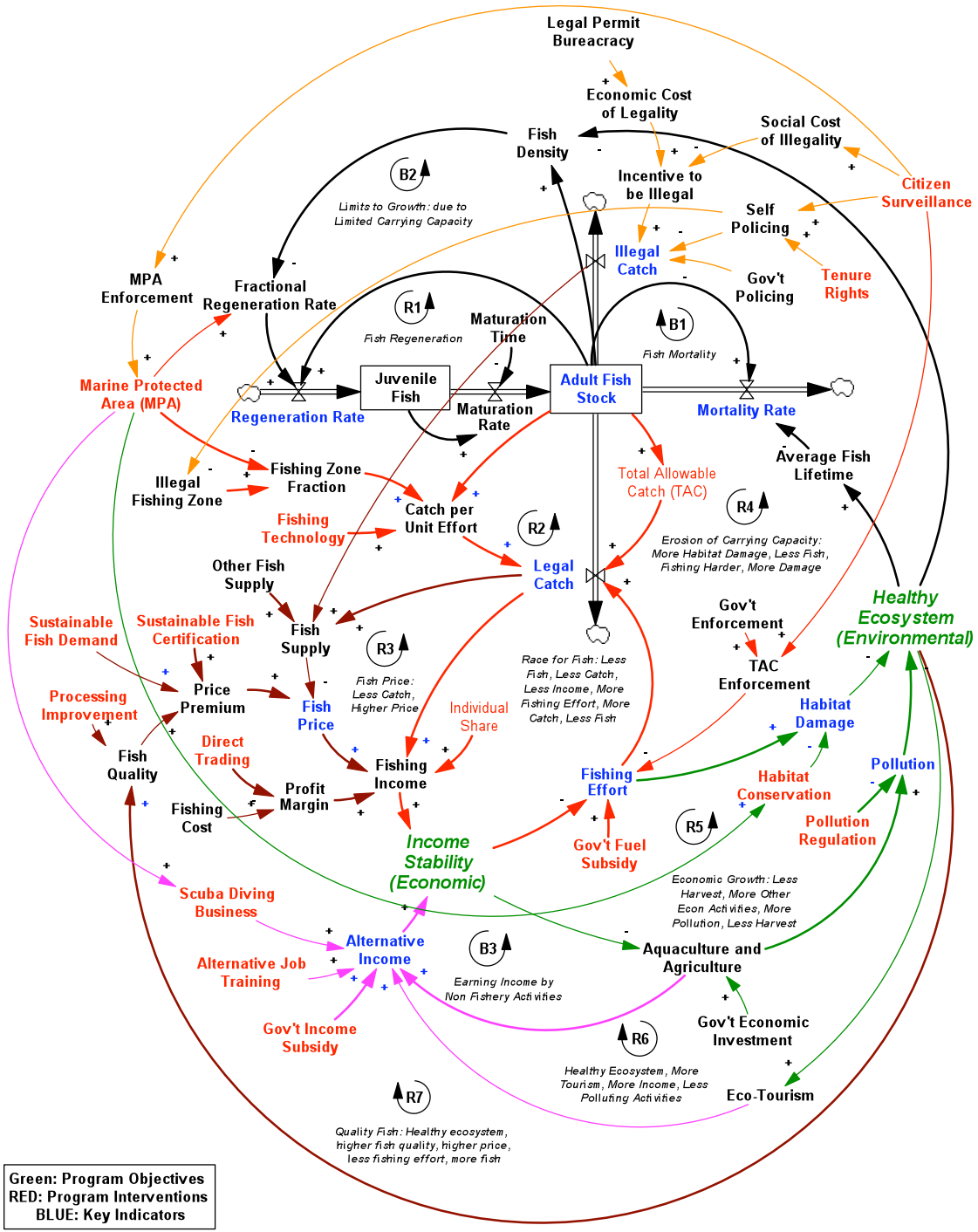

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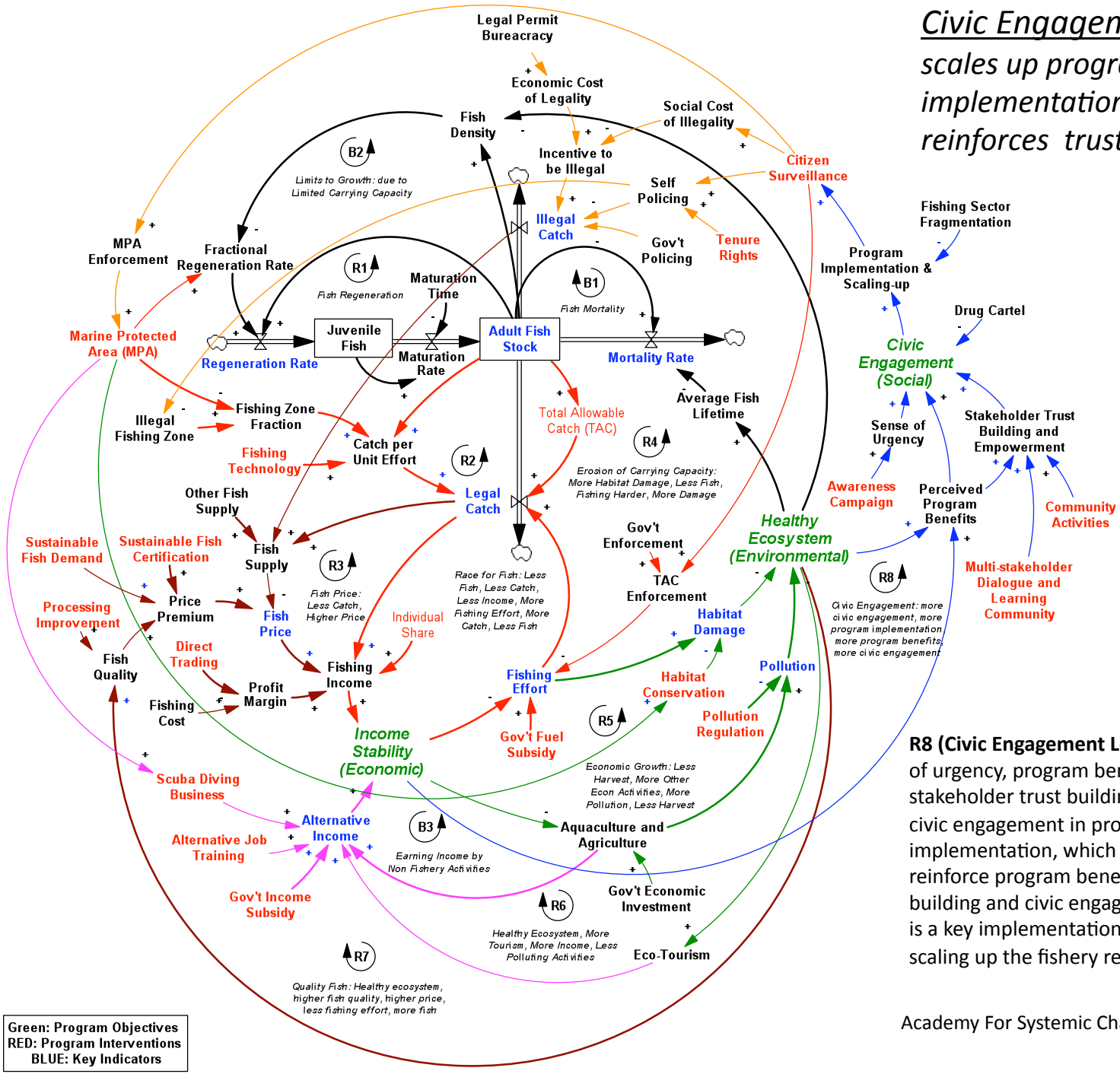
Sustainable Fish

Sustainable fish demand and certification, processing improvement and direct trading increase price premium and profit margin, which reduce the pressure to fish harder.

R7 (Sustainable Fish Loop): Healthy ecosystem improves fish quality. Under Catch Shares program, fishermen have incentives to improve the health of fishery, which could lead to higher price premium for certified fish. Higher price allows fishermen to meet their income target with lower catch, which helps restore the fishery stock.



Civic Engagement

scales up program implementation and reinforces trust building

R8 (Civic Engagement Loop): sense of urgency, program benefits and stakeholder trust building increase civic engagement in program implementation, which further reinforce program benefits, trust building and civic engagement. This is a key implementation loop for scaling up the fishery restoration.

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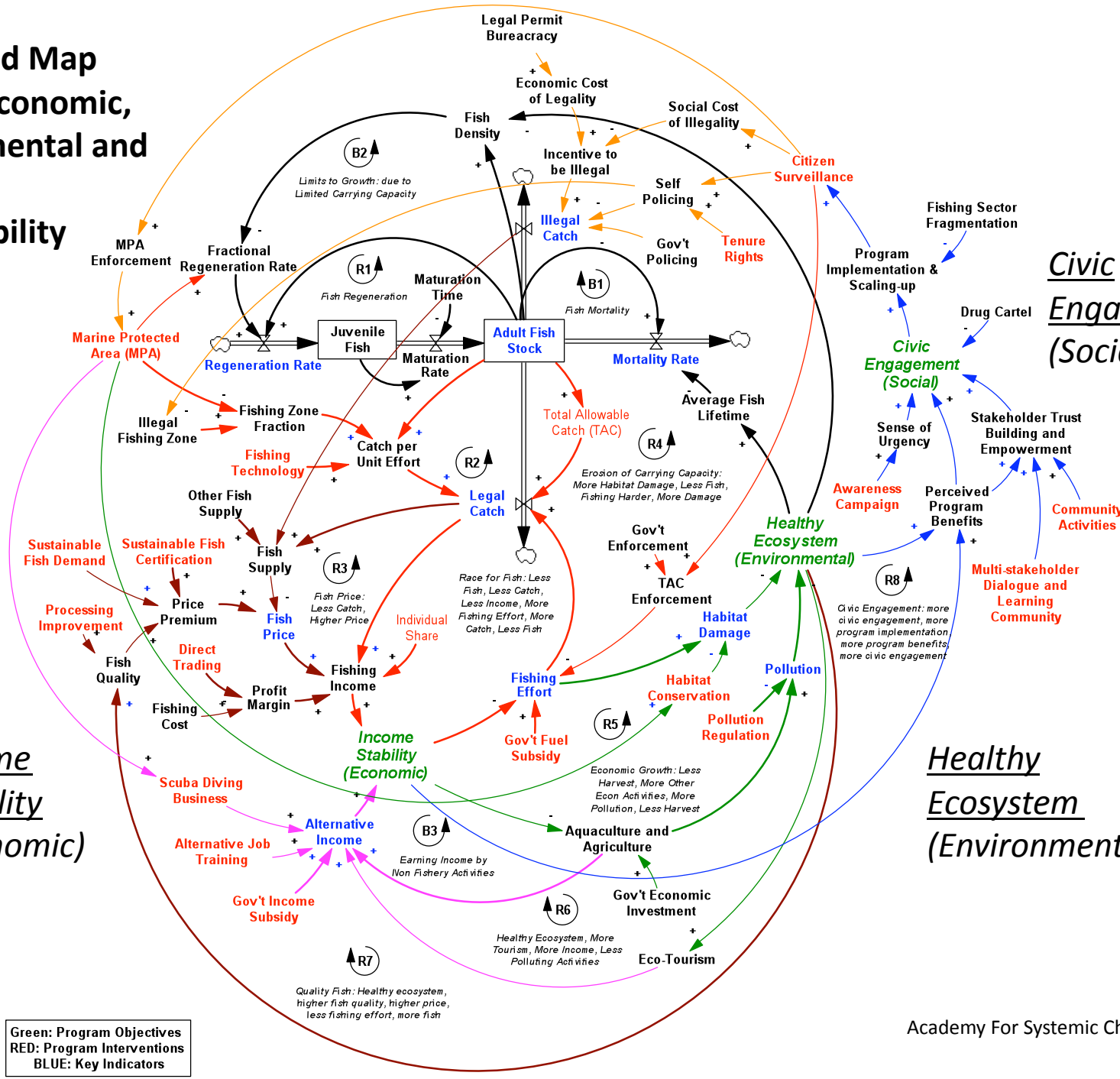
A Detailed Map Linking Economic, Environmental and Social Sustainability



Civic Engagement (Social)

Income Stability (Economic)

Healthy Ecosystem (Environmental)

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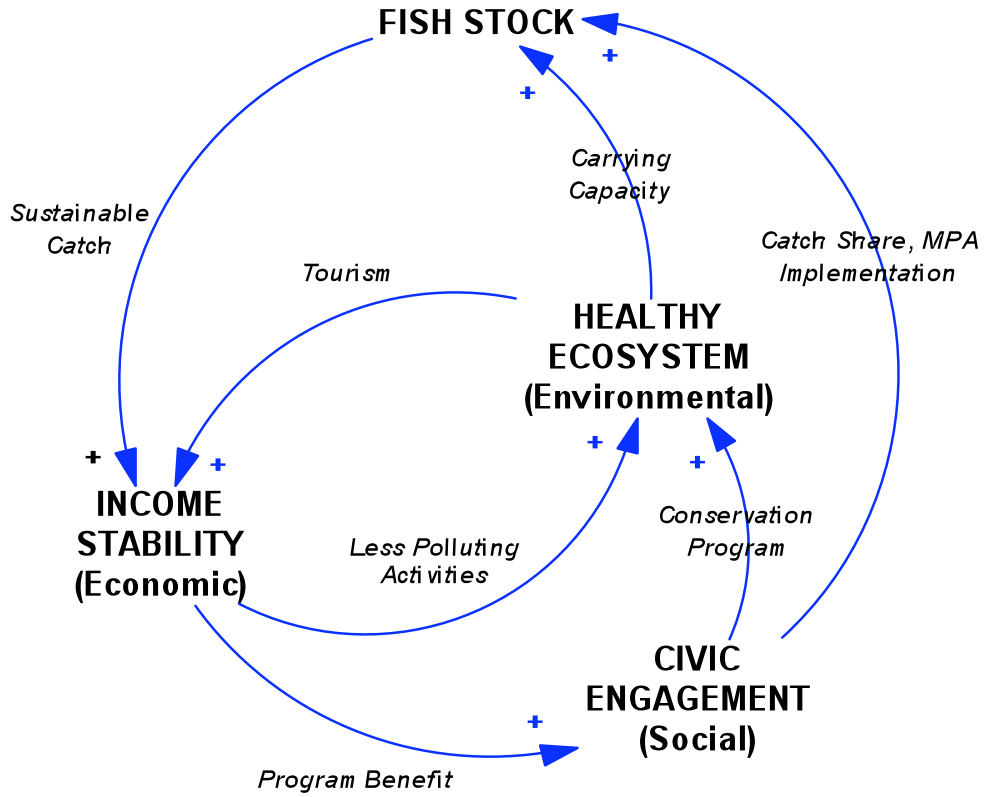
A Conceptual Map linking Economic, Environmental and Social Sustainability



Summary

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Reflection

- What is my work and where does it show up in the map? If not, where would I map it?
- What does my current work intend to create?
- What is my theory of change? Does the map capture it? Why and why not?
- What are the conditions for the success of my work?
- What help do I need to achieve my vision that I cannot do alone?
- Does my work has unintended consequence that I am not aware of?

- How does the systems view help me understand others' perspectives and why they do what they do?
- How does our work relate to each other? Is there an inherent conflict among our work or do we want similar things fundamentally?
- What is the relationship among economic, environmental and social sustainability in fishery conservation?
- What do I really care about ultimately? What do we want to create together that we cannot create alone?
- What are high-leverage interventions to realize our shared vision?
- What is the sequence of intervention?
- How does the systems perspective influence what we do? What insights emerge from the systems view?

- Do I agree with the causal logic in the map? Why and why not?
- Whose perspective is missing in the map? Who should we invite to the dialogue?
- What new questions emerge now?