Universidad Nacional Autónoma de México

Instituto de Investigaciones Económicas

Socio-ecological resilience modeling: Policy implications of drought effects in the wildlife management system in Baja California Sur, Mexico

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Outline

I. Context
II. Motivation and Problem Statement
III. Framework
IV. Method
V. Results
VI. Conclusions

I. Context

Wildlife management system (WMS)

Wildlife use is a rural livelihood strategy for income diversification (Avila-Foucat & Pérez-Campuzano, 2015)

Recreational hunting as a management strategy for conservation and social well-being

bighorn sheep (Ovis canadensis)
http://elvizcaino.conanp.gob.mx/fauna/

Managers
UMA partners. Ejido Alfredo
Vladimir Bonfil, BCS, Mexico

I. Context

Wildlife management system (WMS)

Revenues from sport hunting activities
Reinvestment on habitat conservation and infrastructure development

bighorn sheep (Ovis canadensis)
http://elvizcaino.conanp.gob.mx/fauna/

Environmental Policy
Management Units for Conservation and Sustainable Use of Wildlife (**UMAs**).
Regulates the extraction rate

Managers
UMA partners. Ejido Alfredo Vladimir Bonfil, BCS, Mexico

II. Motivation and problem statement

Wildlife management system (WMS)

Revenues from sport hunting activities
Reinvestment on habitat conservation and infrastructure development

CC STRESOR
2009-2011
The worst drought in 70 years (CONAGUA, 2013)

bighorn sheep (Ovis canadensis)
http://elvizcaino.conanp.gob.mx/fauna/

Environmental Policy
Management Units for Conservation and Sustainable Use of Wildlife (**UMAs**).
Regulates the extraction rate

Managers
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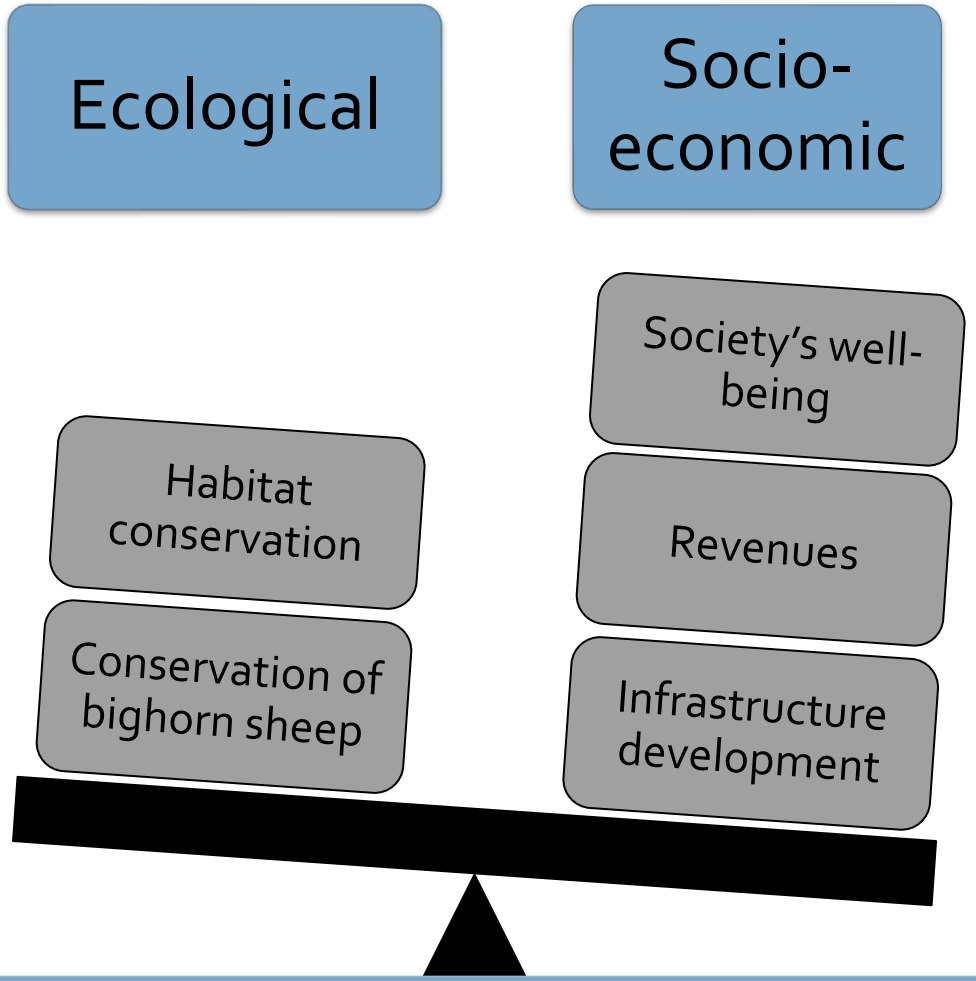
Vladimir Bonfil, BCS, Mexico, 2016

II. Motivation and problem statement

Sustainability Tradeoff's in the WMS



Both sub-systems (socio-economic and ecological) maintain its structure and function. If one of them crosses a threshold and collapses then, the socio-ecological system is not resilient.

II. Motivation and problem statement

Achieving sustainability in this context is challenging because it is affected by deeply uncertain stressors

Climate change

- Difficult to accurately estimate potential changes in precipitation and drought patterns.
- Difficult to predict how the specie would respond to different drought scenarios

Behavior of economic agents

- Hunters response to permits prices
- Investment decisions and diversifications strategies of local stakeholders

III. Framework

Thresholds and Resilience in Socio-ecological Systems (SES)

- Thresholds are transition points between alternate systems' states (Brock et al., 2005).

When ecosystems are degrading, effects on human well-being may not be apparent until ecological changes reach thresholds (Millennium Ecosystem Assessment, 2005).

In this study. The drought threshold is based on two given thresholds, ***the minimum bighorn sheep population*** size and ***the minimum cost-benefit*** needed to develop the recreational hunting.

- Resilience is the ability of SES to retain similar structures and functioning after disturbances or stressors for continuous development (Holling, 1973; Walker & Meyers, 2004; Walker et al., 2006)

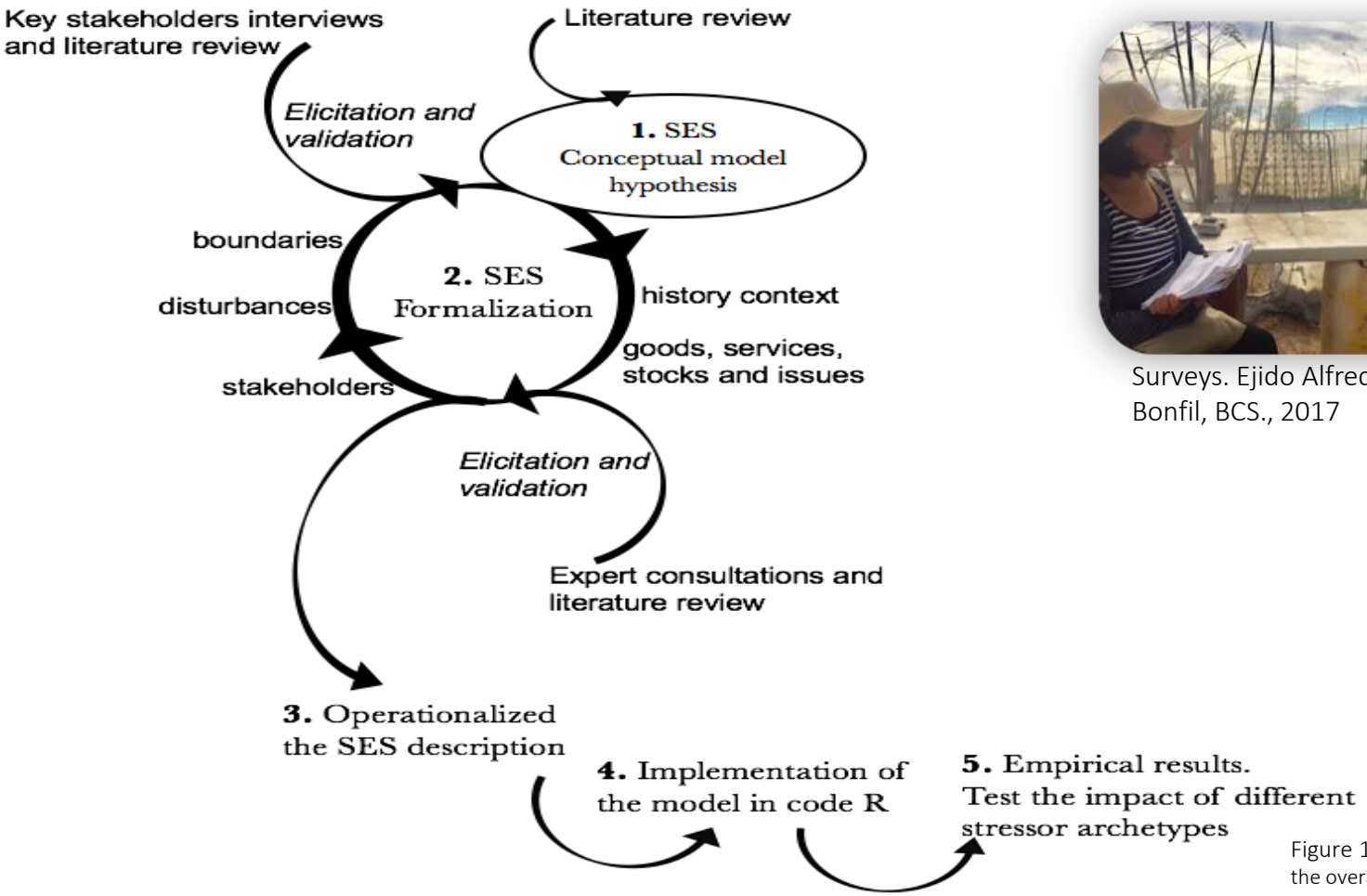
III. Framework

DMDU methods can be used to consider the interplay of uncertainties, stressors and policy options for enhancing resilience

Stressors (X)	Policy options (L)
Drought scenarios Demand and supply elasticities	Number of hunting permits Fixed or variable prices for hunting permits
System model relationships (R)	**Performance metrics (M)**
Dynamic socio-ecological model	Gross income of local stakeholders Specie conservation

IV. Method

Integrated Assessment Model



Surveys. Ejido AlfredoVladimir Bonfil, BCS., 2017

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Figure 1. Stages in the construction of the SES exploratory model. This diagram explains the overall process in the model construction

IV. Method

Integrated Assessment Model

Dynamic model with three state variables:

1. bighorn sheep population in BCS (P_{BCS})
   b = births, d = deaths, p = bighorn population

$$\frac{\partial P_{BCS}}{\partial t} = b - d - p$$

2. bighorn sheep population in the ejido Alfredo Vladimir Bonfil (P_e)
   I = immigration, E = emigration, p = bighorn population

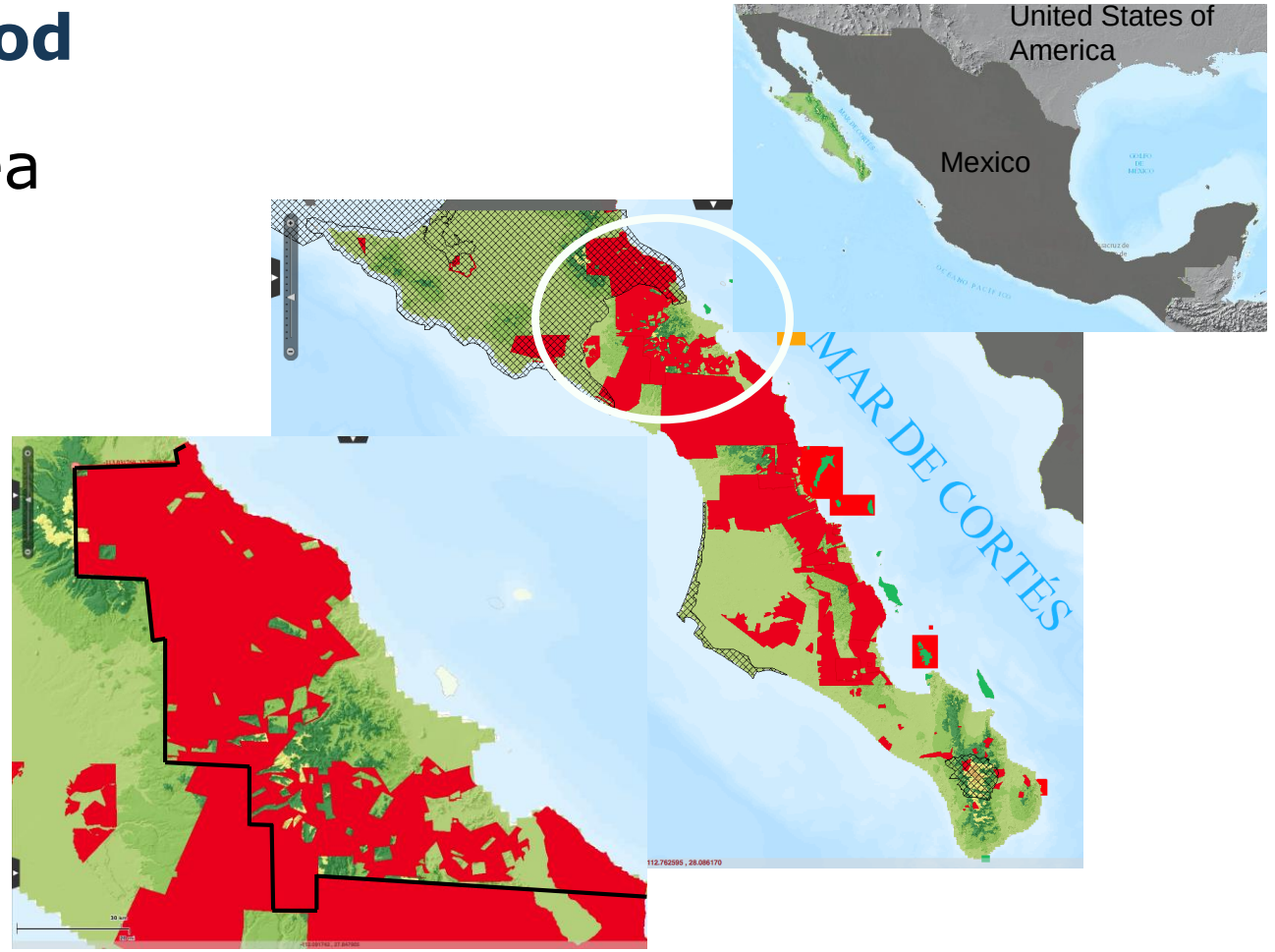
$$\frac{\partial P_e}{\partial t} = I - E - p$$

3. prices of hunting permits (supply and demand) (HPP_e)
   S = supply, D = demand, ε_D = demand elasticity, ε_S = supply elasticity

$$\frac{\partial HPP_e}{\partial t} = \frac{D}{\varepsilon_D} - \frac{S}{\varepsilon_S}$$

IV. Method

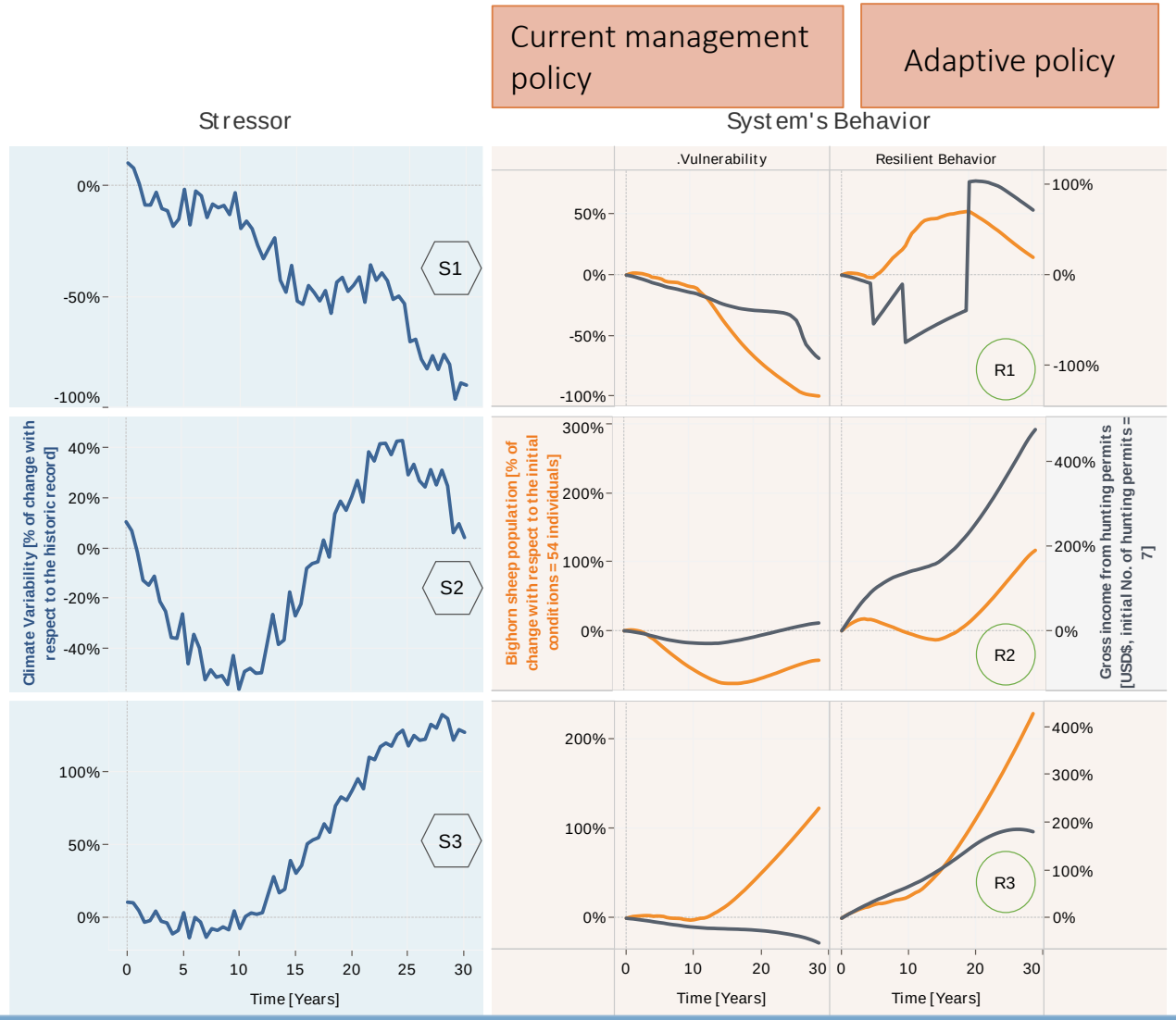
Study Area



SEMARNAT http://gisviewer.semarnat.gob.mx/geointegrador/

Figure 2. Study area (5,500 km^2). Polygon in black line = E.A.V.B. (Ejido Alfredo Vladimir Bonfil, Baja California Sur, Mexico). Polygons in red = Wildlife Management Units (UMAs) in the state. Black grid area = Natural Protected Areas. 80% of the ejido is part of the Natural Protected Area.

V. Results

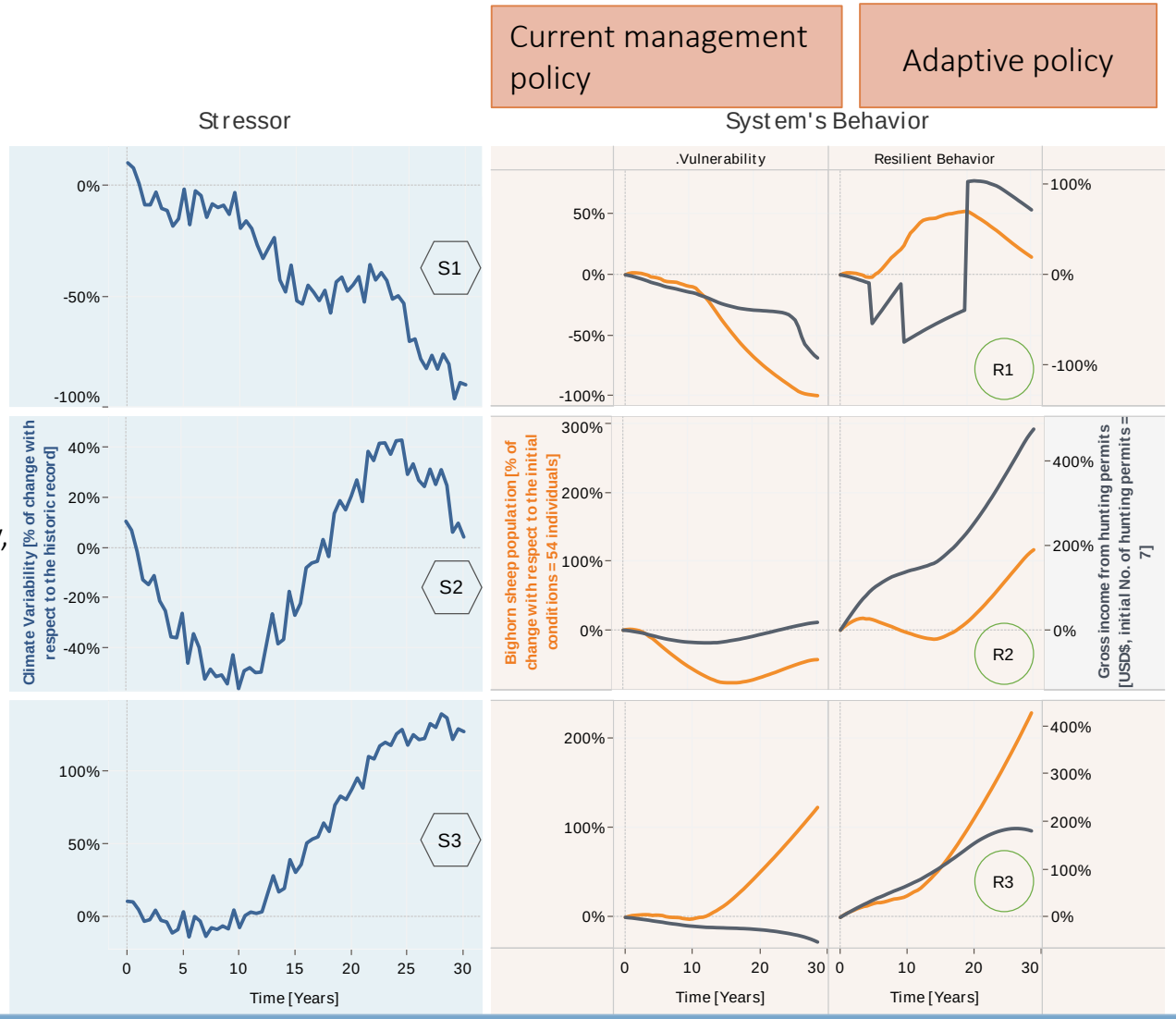

Current management policy
Adaptive policy
Stressor
System's Behavior
.Vulnerability
Resilient Behavior
S1
S2
S3
R1
R2
R3
Climate Variability [% of change with respect to the historic record]
Bighorn sheep population [% of change with respect to the initial conditions = 54 individuals]
Gross income from hunting permits [USD$, initial No. of hunting permits = 7]
Time [Years]

V. Results

S1: Climate variability archetype 1-Negative trend (prolonged drought), both ecological and social vulnerability

S2: Climate variability archetype 2-Oscillatory, ecological vulnerability

S3: Climate variability archetype 3-Slight negative trend with growing positive trend (increase precipitation), social vulnerability.



V. Results

We propose different environmental policy responses in the bighorn sheep harvest rates in order to get socio-economic and ecological stability in the long term

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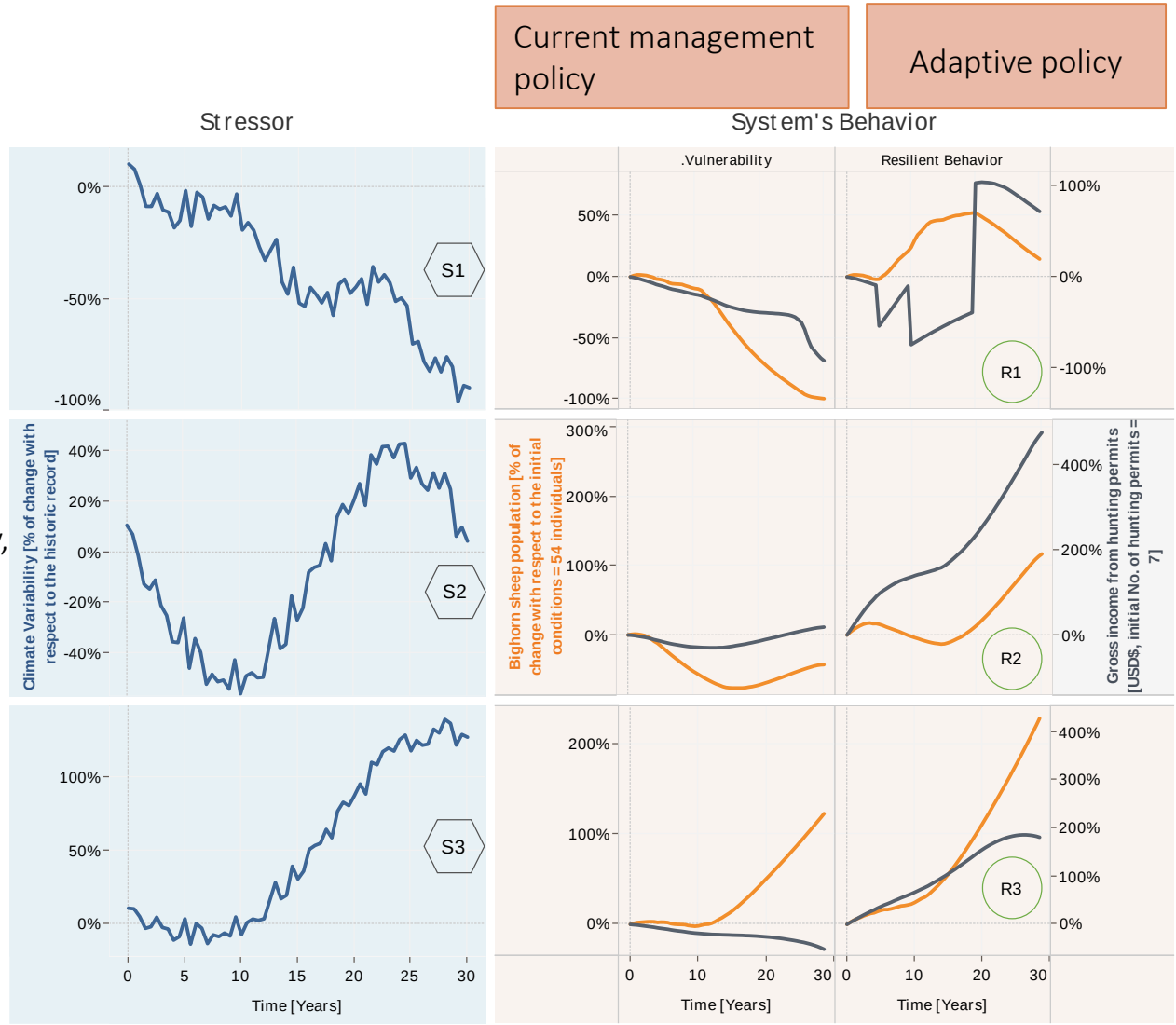

R1: Response 1 from year five to ten the harvest rate is half (3) of the current management strategy. From year ten to twenty, the number of hunting permits in the ejido is one

V. Results

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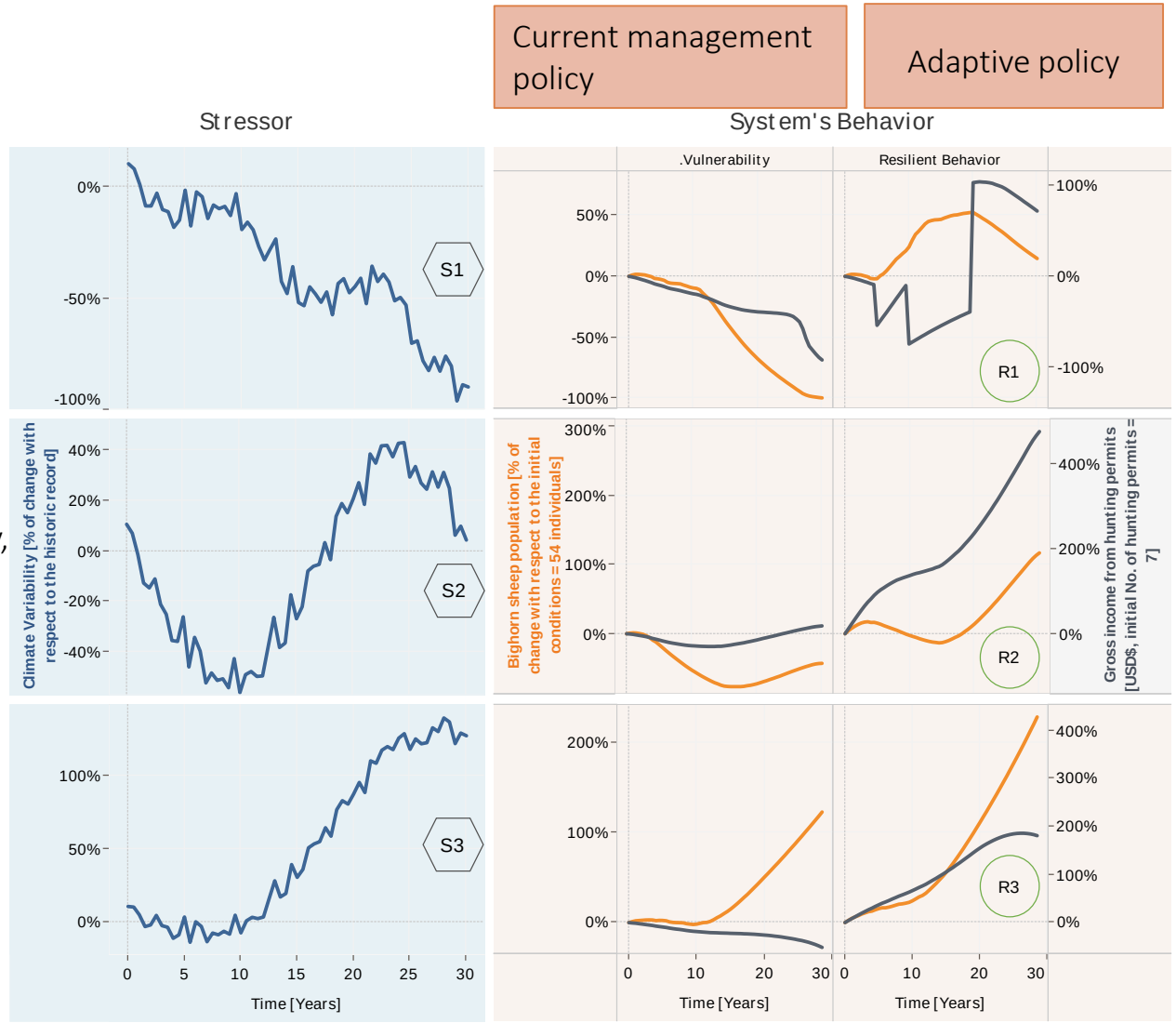

R1: Response 1 from year five to ten the harvest rate is half (3) of the current management strategy. From year ten to twenty, the number of hunting permits in the ejido is one

R2: Response 2 the harvest rate is half (3) of the current management strategy

V. Results

S1: Climate variability archetype 1-Negative trend (prolonged drought), both ecological and social vulnerability

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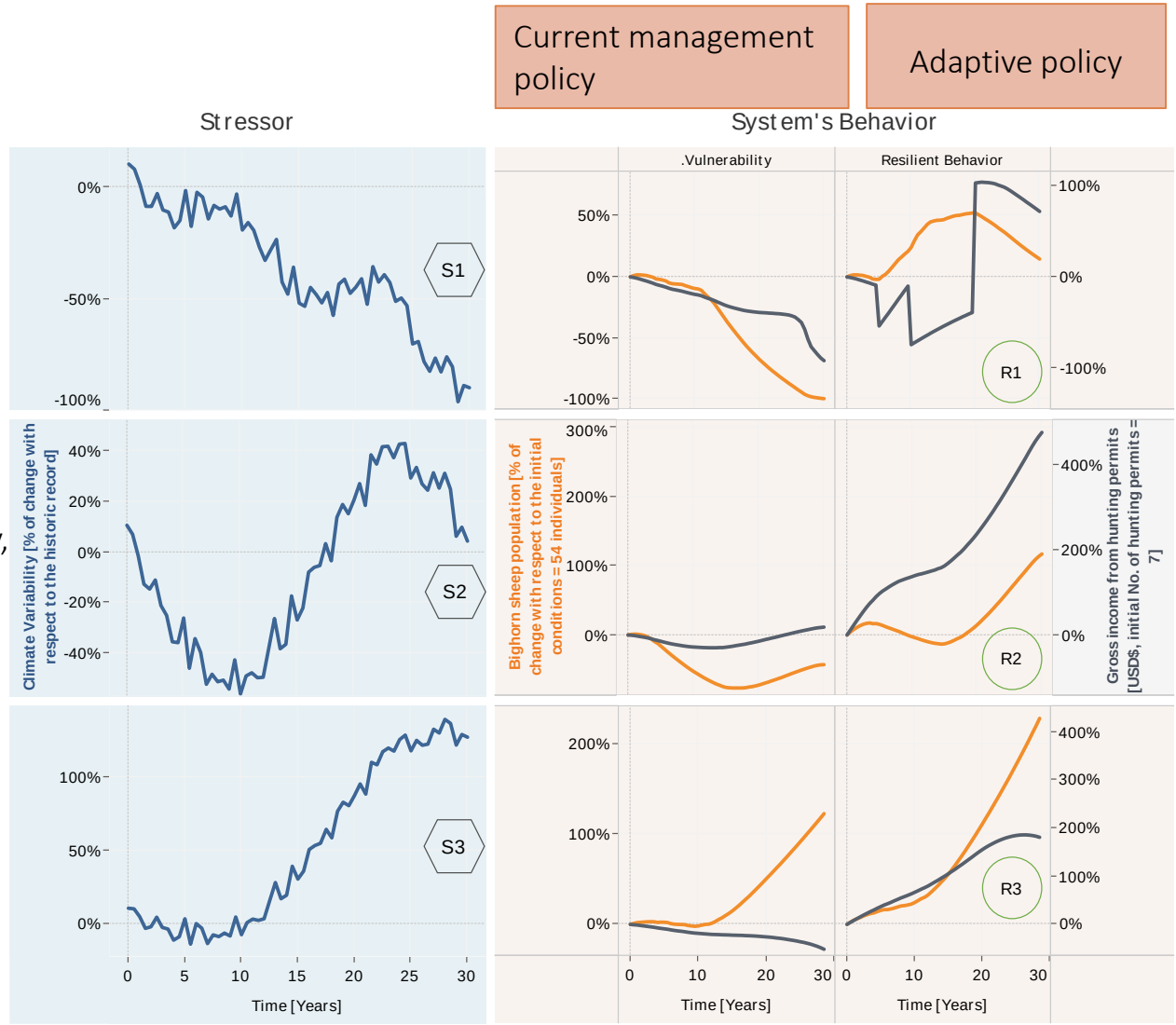

R1: Response 1 from year five to ten the harvest rate is half (3) of the current management strategy. From year ten to twenty, the number of hunting permits in the ejido is one

R2: Response 2 the harvest rate is half (3) of the current management strategy

R3: Response 3 the harvest rate is twenty percent less (5) than the current management strategy.

VI. Conclusions and next steps

- We argue that updating the UMA policy through the extraction rate such that it can adapt to unfolding rainfall conditions can increase the resilience of this management system.

- The modeling approach allow us to explore the effect of possible stressor's trends and its implications in the system. It is a tool that allows the communication between stakeholders and researchers.

- This framework can be used to guide thinking about the probable benefits of resilient adaptive management and how valuable these strategies might be to stakeholders that operate within the SES

- In a next stages of this analysis we will consider a bigger set of stressor scenarios and policy options

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Backup slide

Dynamic model of the WMS

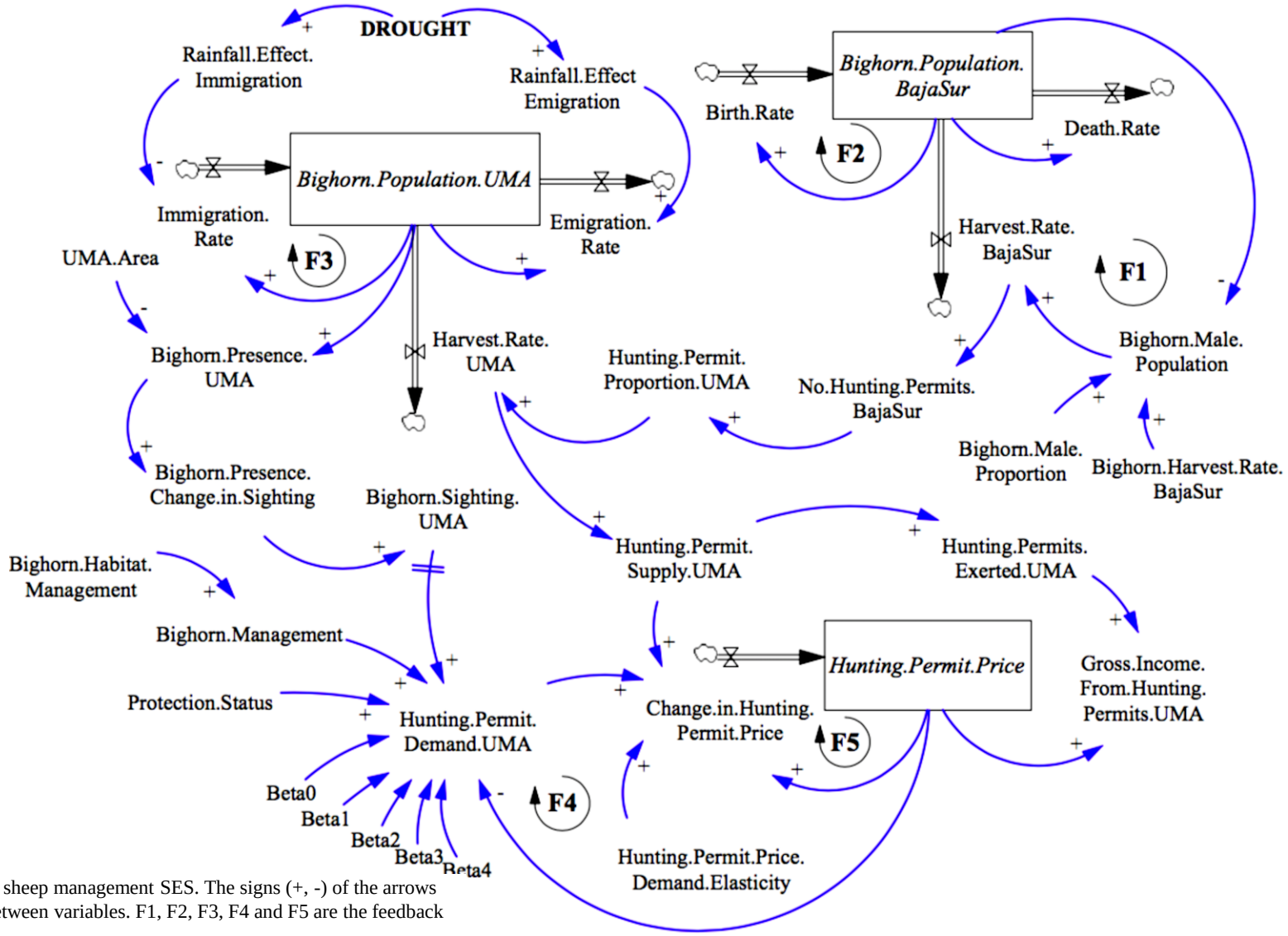

Figure 3. Conceptual model of the bighorn sheep management SES. The signs (+, -) of the arrows point out the polarity of the relationship between variables. F1, F2, F3, F4 and F5 are the feedback loops.