CORNELL INSTITUTE FOR PUBLIC AFFAIRS
College of Human Ecology

Sustainability in the Galápagos Islands: A Systems Thinking approach reveals the need for Environmental and Social Balance

Systems Thinking, Modelling and Leadership (STML) Certificate

Authors: Sarah Brown, Victoria Kasonde, Priscilla Koo Wilkens, William LaRose, Manshuk Mukhamejanova, Stefanie Smith, Dora Tan, Adam Terragnoli, Dr. Derek Cabrera, and Dr. Laura Cabrera

Advisors: Dr. Derek Cabrera, PhD and Dr. Laura Cabrera, PhD

Abstract

This research paper applies a systems thinking approach to provide an analysis of the Galapagos Islands. The purpose of the analysis is to uncover the patterns, underlying structures and mental models to understand and overcome the challenges of the Galapagos. Following, we provide a set of principles which serve as the basis of our recommendations and address the socio-environmental imbalance observed in the Galapagos. Designed by Dr. Cabrera and Cabrera, the core systems thinking tools used are DSRP, a CAS-based Policy Analysis, and a POSIWID Analysis. We paired these tools of systemic evaluation by conducting field work of unstructured and semi-structured interviews, observations, and journalistic investigations. Based on our research and analysis, we categorize agents of the Galapagos system into three groups as Global, State, and Local Interested Parties, and identify structural dynamics between them. Finally, we identify three mental models that cause the structural problems in the Galapagos: (1) Lack of Connectivity, (2) Socio-environmental Imbalance and (3) Global and Local Power Dynamics, and offer principle-based recommendations. As a result, the provided recommendations are focused mostly on bridging the gap between social and environmental systems.

Table of Contents

Table of Figures

List of Tables

“You care more about your turtle than my kids.”

-Anonymous

Introduction

Imagine that you and your family lived on a world-famous island with turtles, and myriad interesting birds, fishes, and other organisms. Imagine that people around the world showed concern for these turtles but rarely, or never, showed concern for you, your family, your livelihood, or your communities. Imagine that more attention and resources and time and energy were lavished on those turtles than to your own children. Would you slowly, overtime, begin to resent those turtles?

Situated 800 miles off the coast of Ecuador, the Galapagos Islands are a complex system that faces wicked problems. The Islands represent a unique dichotomy—a geographically isolated archipelago that is learned about in classrooms around the world. The Islands are venerated as the birthplace of Darwin's Theory of Evolution, for their diversity of flora and fauna, and remarkable endemic species. Less commonly known is that the Islands are also a place of social, economic, political, and cultural diversity. All too often, international headlines depict a host of environmental and sustainability issues on the islands, but seldom do we hear about the problems faced by the people that live there. From the islands of Santa Cruz to Isabela, Galapaguenos (people from the Galapagos) face wicked problems related to food, water, infrastructure, and education — to name a few— that are often overlooked.

Whether you care more for turtles and ecosystems, or for people and social systems, this imbalance of care—which focuses, research, resources and attention—is unsustainable. It may be okay for you, personally, to care more about turtles than the people, but because the turtles and the people of the Galapagos are interdependent on each other to survive, it is *unsustainable* for that personal preference to play out as a policy preference. To address this unsustainable imbalance, one must look at systems in a different way. One must observe, analyze, and assess systems as they exist: systemically. To do this, one

must look deeper, past surface-level issues, and uncover patterns, structures and mental models that allow an issue to persist. Thus, a systems thinking approach— with its myriad sundry methods and perspectives—becomes a critical decision in understanding such systems.

Background

The Cornell Institute for Public Affairs (CIPA) Systems Thinking, Modelling, and Leadership (STML) Certificate 2019 Cohort was composed of eight Fellows who chose a systems thinking emphasis for their two-year MPA degree program. Fellows took a 9-credit block of courses in systems thinking and engaged in extracurricular systems thinking activities throughout the first 1.5 years of their Public Administration degree. Their studies culminate in a student project, presentation, and report. In January 2020, the STML cohort traveled to the Galapagos Islands to conduct a systemic analysis. The geographical isolation of the Islands creates a contained system with clear boundaries which lends itself to a robust systems analysis (i.e., food, water, infrastructure, education). The manifold problems that persist on the Islands make it an ideal place for researching and studying systems.

Prior to the fieldwork conducted, the STML cohort spent four months researching the Islands, and conducted stakeholder interviews in order to formulate a preliminary understanding of Galapagos as a system. After preliminary research, our original mental model hypothesized that an imbalance existed between social and environmental factors, meaning that most of the attention from the Ecuadorian government and international community was directed toward environmental issues, often to the exception of the issues being faced by the local population.

We then entered the fieldwork stage of research where we continued to test and evolve our mental model of the socio-environmental imbalance to ascertain the models alignment with “reality” on the

ground. Fieldwork included observation, journalistic investigation, and stakeholder interviews on the islands of Santa Cruz, Isabela, and San Cristobal with individuals across the political, economic, social, environmental, and scientific spectrum. By receiving "feedback" from these stakeholders, we adapted our original mental model towards a better fit of reality. By doing so, we were exercising the crux of systems thinking (see Figure 1), the "Systems Thinking Loop" (Cabrera, 2020).

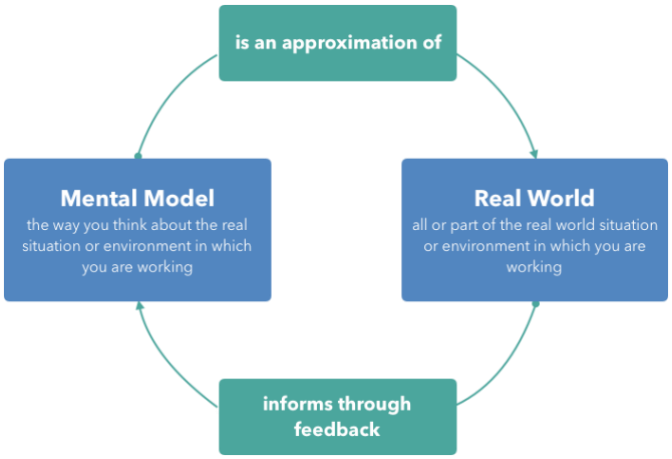

Figure 1. The Systems Thinking Loop

It should be noted that this process is the first step and a continuous step in a systems thinking analysis. First, that one must purposefully differentiate one's mental model from reality, recognizing explicitly that the "map is not the territory." Second, that the process of model building is a cyclical, continuous-refinement process. Each piece of information being added also transforms the model and then the model is tested against reality. The purpose of this research paper is threefold: (1) to highlight the socio-environmental imbalance in the Galapagos Islands; (2) to utilize a systems thinking approach to analyze the systems structure of the Islands; and (3) to provide a set of principles and recommendations that address the socio-environmental imbalance. For this analysis, the paper has been organized into the following sections: Literature Review, Methods, Fieldwork, Structural Analysis, Principles, and Recommendations.

The Literature Review section highlights the research that was done prior to the fieldwork conducted in the Islands (but that also continued throughout the process). It includes an introduction, a summary of the literature, a description of the scope of the research, how the literature was chosen, the methodologies utilized in the literature, and the significance of these researches.

The Methods section includes a description of the methodologies used (DSRP, POSIWID, and CAS analyses), as well as how these methods informed and affected the fieldwork conducted. The Fieldwork section discusses the data collected in the field. The Systems Analysis section combines the literature, data, and methods as the basis for a systems analysis of the structures and dynamics that lead to various problems in the Galapagos System.

Based on the system analysis, we developed a set of principles that serve as a robustness check not only for our recommendations but possibly for future recommendations. All of the recommendations align with the principles and are designed to address the socio-environmental imbalance of the Galapagos Islands.

Literature Review

The first stage of research was reviewing relevant literature and forming an initial mental model prior to traveling to the Galapagos Islands. While synthesizing this literature review, we utilized *Boote and Beile's* (2005) Literature Review Scoring Rubric which attempts to make the literature review process as transparent and scientific as the research itself. The rubric is divided into five sections: coverage, synthesis, methodology, significance, and rhetoric. Each section can be assigned a score based on a scale from one to three— 1 (low), 2 (medium), 3 (high). There is the possibility of scoring a 4 (highest) on the methodology section, which will be discussed in that section. *Boote and Beile's* rubric was chosen because of its clear criteria, methodological depth, and scientific approach to literature reviews (which is not always the norm).

Furthermore, *Boote and Beile* assert that their framework is particularly useful when dealing with "messy, complex problems," (2005, p. 3). Through their stepwise process, this report avoids the "too-narrow conception of the literature review" which often is "merely an exhaustive summary of prior research" (Boote and Beile, 2005, p. 3). This literature review aims to provide the reader the necessary context for an informed discussion about the Galapagos. *Boote and Beile* provide a table that is used herein as a guiding framework for assessing the stopping rules of our literature review. *Table 1* on the next page is an adaptation of *Boote and Beile's* framework for literature review.

Table 1. Boote and Beile's "Literature Review Scoring Rubric" (adapted for tense only)

CATEGORY	CRITERION	SCALE (3 ON 1–3 SCALE)
1. Coverage	A. Justified criteria for inclusion and exclusion from review.	Justified inclusion and exclusion of literature
2. Synthesis	B. Distinguish what has been done in the field from what needs to be done	Critically examine the state of the field
	C. Place the topic or problem in the broader scholarly literature	Clearly situate the topic in broader scholarly literature
	D. Place the research in the historical context of the field	Critically examine the history of the topic
	E. Acquire and enhance the subject vocabulary	Discuss and resolve ambiguities in definitions
	F. Articulate important variables and phenomena relevant to the topic	Note ambiguities in the literature and propose new relationships
	G. Synthesized and gained a new perspective on the literature.	Offer a new perspective
3. Methodology	H. Identified the main methodologies and research techniques that have been used in the field, and their advantages and disadvantages.	Critiqued research methods (3). Introduced new methods to address problems with predominant Methods (4)
	I. Related ideas and theories in the field to research methodologies.	Critiqued appropriateness of research methods to warrant claims
4. Significance	J. Rationalized the practical significance of the research problem.	Critiqued practical significance of research
	K. Rationalized the scholarly significance of the research problem.	Critiqued scholarly significance of research
5. Rhetoric	L. Was written with a coherent, clear structure that supported the review.	Well developed, coherent

Coverage

The first step for literature review involved coverage, which according to *Boote and Beile's* (2005) rubric includes justifying criteria for inclusion and exclusion from review. Our initial research began by searching for publications in Cornell University's Library Catalog and Databases. These expansive and multidisciplinary resources provided access to more than 8,500 academic journals and more than 4,600 peer-reviewed titles. An initial search for "Galapagos Islands" yielded 34,158 full-text articles and books. Realizing that this general search was too general, specific search terms were used to hone the scope of the search. The specific search terms were based on the types of systems that one might conclude exist in the Galapagos. *Table 2* shows the terms that were used and the number of articles and texts that were retrieved. During the initial search, which yielded 91,078 articles, we noticed that much of the literature focused on the fields of ecology and environmental science, and not social systems and people. This discovery was instrumental in informing what would eventually become our "unsustainable social-environmental imbalance" hypothesis. In a region where there were just as many social agents and issues as there were environmental agents and issues, it could not be random that there was such an imbalance in the literature, a preponderance that leaned *heavily* toward the environment. This discovery was instrumental in informing what would eventually become our "unsustainable social-environmental imbalance" hypothesis. In a region where there were just as many social agents and issues as there were environmental agents and issues, it could not be random that there was such an imbalance in the literature, a preponderance that leaned heavily toward the environment. The search term "Galapagos Environment" yielded 4,365 full-text articles and books, while the "Galapagos Conservation" yielded 5,587 sources. These search results differ in quantity when compared to "Galapagos Social" and "Galapagos Social System" which resulted in 1,440 and 360 sources, respectively.

Table 2. Specific Search Terms for Literature Review

SEARCH TERM	NUMBER OF ARTICLES AND TEXTS
Galapagos Systems	4,179
Galapagos Wicked Problems	0
Galapagos Problems	3
Galapagos Economy	272
Galapagos Economics	1,186
Galapagos Politics	252
Galapagos Political Systems	73
Galapagos Conservation	5,587
Galapagos Evolution	5,642
Galapagos Water	4,607
Galapagos Water System	666
Galapagos Fishing	1,300
Galapagos Marine	7,439
Galapagos Tourism	2,464
Galapagos Policy	840
Galapagos Environment	4,365
Galapagos Social Systems	360
Galapagos Social	1,440
Galapagos Complex Adaptive Systems	82
Galapagos CAS	40
Scalesia	281
TOTAL	**91,078 articles retrieved**

After those searches were conducted, and due in part to the constraints of time and resources, we extracted sources that had relevant titles (by searching, on average, 5-6 search pages deep (30 per page or 180 results)). This resulted in 250 articles (N = 250). Of those 250, some were relevant as their title indicated consideration of a systemic, multidisciplinary, multi-system approach. For the ambiguous items, we used the keywords and the sources' abstracts to narrow the scope. For example, if the keywords and abstract included social and biological, ecological, or environmental topics, those items were kept; if the keywords were biological, ecological, or environmental and did not include social ones, that item was rejected. A further examination was conducted for items that were still ambiguous. For these items, the introduction and conclusions were used to determine if the source was primarily on a single disciplinary biological/ecological/environmental phenomenon or considered multidisciplinary, multi-system, multi-phenomena. This process resulted in N=92 articles. To put this reduction of publications into context, there are many research reports on specific biological or ecological phenomena (what we generally call "environmental") such as species like the blue-footed boobie or aquatic microorganisms. While we wanted to account for these articles in terms of their sheer number and note the imbalance, we did not consider it necessary to read about how:

> *"It has repeatedly been shown that external egg morphology is an important tool for anostracan species identification (ootaxonomy) (Mura et al., 1978; Munuswamy et al., 1985; Alonso and Alcaraz, 1984; Mura, 1986; Mura and Thiery, 1986; Thiery and Champeau, 1988). The morphology of eggs of Dendrocephalus, previously unknown, is here described for the first time" in Taxonomy and Biogeography of the Galapagos Branchiopod Fauna (Anostraca, Notostraca, Spinicaudata)."*

Instead, we focused on the portion of the literature that highlighted the obvious imbalance that we were seeing in the larger literature (N≈ 90,078) itself, in order to discover more about what might be leading to this imbalance.

The credibility of publication sources was also checked. The item was considered to be from a credible source if the journal was peer-reviewed. This, once again, resulted in 92 articles (N=92). The fact there was no change is likely because the Cornell System includes generally credible sources. Publications that included scholarly peer-reviewed research were derived from sources such as *The International Journal of Justice and Sustainability*, *MDPI Journals, Social Studies of Science,* and the *Journal of Sustainable Tourism*. Lastly, research that was not available in English or Spanish was excluded, as it was inaccessible due to language barriers.

The 92 articles that remained were then categorized into the following groups based on the type of source: Politics/Economics, Fishing/Marine Life, Conservation, Sustainability, Scalesia, Evolutionary Biology, Earth Science, Wicked Problems/Complex Systems, Tourism, Water, and Other. After the fieldwork, it was determined that the sources that were generated by the search terms "Scalesia" and "Galapagos Evolution" were also too far afield from the focus of our literature review. This resulted in a total of 62 sources (N=62). To ensure that the sources were relevant, we checked the dates of publication and found a vast majority (84%) were published between 2009-2020.

We also read primary sources. These items helped provide context for how the contemporary political, economic, and bureaucratic systems were shaped. These items include Galapagos laws, statutes, and formal memos. For example, one source often mentioned was the Special Law of the Galapagos of 1998 and its amendments in 2015, as well as Darwin's, *On the Origin of Species*. Additionally, other relevant sources for contextual framing included the ninety-six State of Conservation Reports, Decision Memos, and State of Mission Reports from the United Nations Educational, Scientific and Cultural Organization (UNESCO). It is important to note that these sources were focused on the years 1978-2020, starting when the islands first gained their World Heritage Status and continuing until today.

Ultimately, we concluded that there was a deep and unsustainable asymmetry between the social and environmental works given the high volume of ecological and biological sources. This imbalance rose to the surface no matter where we looked and who we consulted. This imbalance pushed us further to explore how the different parts of the 'Galapagos system' interacted, and how those interactions affected the system itself and its populations. The imbalance of literature is further described and illustrated in the section below.

Synthesis

Boote and Beile's (2005) rubric allows for the resolution of "inconsistencies and tensions" across academic literature reviews. This synthesis section will provide clarity by (1) distinguishing what has been done in the field; (2) placing the topic and problem in the broader scholarly literature; (3) placing the research in the historical context of the field; (4) acquiring and enhancing the subject vocabulary; (5) articulating important variables and phenomena relevant to the topic; and (6) synthesizing several viewpoints to gain a new perspective on the literature.

First, the breadth of the literature in the field extends from Charles Darwin's 1895, *On the Origin of Species*, that introduced the world to the Galapagos and the theory of evolution, to the most recent, *Social and Ecological Interactions in the Galapagos Islands* by Springer (2019) on the ecological and social interactions that create the complex adaptive system of the modern Galapagos. Given the importance of Darwin's contributions to the scientific field, most of the literature, over time, has focused on issues pertaining to the environment, and a paucity focused on social systems. An examination of our original set of 90,078 sources reflected this theme. Even after the reduction of the literature to 92 articles that specifically looked at the socio-environmental imbalance, we found that 70% of these 92 sources still

focused predominantly on environmentally-related topics. *Table 3* below identifies these percentages by topic. This means that within the 92 items included in this review—which was already reduced from nearly 90,078 total articles, and subsequently 24,000 biological-ecological-geological references, and subsequently to 250 more focused resources— only 31.4% legitimately focused on social, political, education, economic type issues.

Table 3. Percentage of Repository by Topic

SOURCES BY TOPIC	**PERCENTAGE**
Political & Economics	4.3%
Wicked Problems & Complex Systems	14.1%
Tourism	5.4%
Other	7.6%
SOCIAL TOTAL	**31.4%**
Conservation	28.3%
Fishing & Marine Life	10.9%
Water	5.4%
Sustainability	3.3%
Evolutionary Biology	15.2%
Scalesia Plant	4.3%
Earth Science	1.1%
ENVIRONMENTAL TOTAL	**68.8%**

The disproportionate amount of research on the human and social systems unfortunately becomes a self-reinforcing and self-replicating cycle. Scholars like to contribute and build upon existing literature. Since there is much more on scientific and environmental factors, scholars keep building on it as opposed to social literature. Both scholars and practitioners cannot approach issues they are unaware of or unwilling to research or report on.

The 31% of the literature that does focus on social issues tends to describe social systems as if they exist only in occupational roles— treating people merely as the jobs they hold. Discussions involving the local population mostly refer to them as "fisherman," "park guides," or "farmers," etc. If the environment is central and people are actors in preserving or conserving the environment, this can be seen as reducing people to their occupational roles. Rather, people are much more than merely occupational roles, they are fathers, mothers, brothers, sisters, community members, leaders, agents in the economy, etc. The social systems of the Galapagos are all largely composed of locals as well as others who do not hold *Galapagueno* status. It is these *people* that inhabit and interact with the island ecology.

As indicated in the above discussion, quantitatively speaking, the literature on the Galapagos is a good indication of a serious asymmetry and imbalance that skews heavily toward concern for environmental concerns and away from social concerns. Our conclusion is that this is unsustainable—that a continuation of this imbalance in focus and concern will only manifest in and exacerbate the problems that exist in the Galapagos. It is likely that this imbalance originated in the earliest accounts in studies about the Galapagos Islands that began in the mid-1800s (Agassiz, 1873). Perhaps due to Darwin's influence, in the intervening years, the focus on the Galapagos Islands was primarily concerned with research relating to environmental, biological, or geological studies.

Beginning in 1978, the Galapagos Islands were granted status as a UNESCO World Heritage Site, which once again drew increased focus. It is clear that the UNESCO status did not result from the unique social phenomena on the island but instead solely because of its unique ecological and historical value which was influenced heavily by Darwin's own focus on the Galapagos. The UNESCO status exacerbated the trend of environmental focus in the literature well into the 2000s.

Predating the UNESCO status and also after it, the literature on the Galapagos can be characterized quite accurately as being overwhelmingly skewed toward ecological, biological, and geological species, concerns, issues, and phenomena (what we have collectively called "environmental"). There is a paucity of articles dealing with the social concerns, issues, and phenomena while there is an abundance of articles that focus on the environmental, such as:

- Bisconti, et al. "Biogeographic Relationships of the Galapagos Terrestrial Biota: Parsimony Analyses of Endemicity Based on Reptiles, Land Birds and Scalesia Land Plants." Journal of Biogeography, vol. 28, no. 4, 2001, pp. 495-510.
- Lindhardt, M. S., et al. "Molecular, Morphological, and Experimental Evidence for Hybridization between Threatened Species of the Galapagos Endemic Genus Scalesia (Asteraceae)." International Journal of Plant Sciences, vol. 170, no. 8, 2009
- Alexandre Pryet, Christian Dominguez, Pilar Fuente Tomai, Cédric Chaumont, Marcos Villacis, et al. Quantification of cloud water interception along the windward slope of Santa Cruz Island, Galapagos (Ecuador). Agricultural and Forest Meteorology, Elsevier Masson, 2012, 161, pp.94-106
- Lyell, C. (2009). Principles of Geology: An Attempt to Explain the Former Changes of the Earth's Surface, by Reference to Causes now in Operation (Cambridge Library Collection - Earth Science). Cambridge: Cambridge University Press. doi:10.1017/CBO9780
- Torres María de Lourdes, and Carlos F. Mena. Understanding Invasive Species in the Galapagos Islands: from the Molecular to the Landscape. Springer, 2018.

NPR's *Analysis: Fishermen, Conservationists at Odds in Galapagos* is one of the few sources that introduces social topics on the Galapagos. The analysis begins, "Conservationists say that the Galapagos are threatened by overfishing. Fishermen say their livelihoods are at stake. Both sides agree that tourism may provide a way out of the *deadlock*" (2005).

Likewise, Hennessy's (2010) *Crisis in Nature's Eden: Conserving Nature and Culture in the Galapagos Islands* addresses the effects of tourism, migration, and invasive species, as they relate to their negative effects on nature. Hennessy says, "The central research question we explored was: how are livelihoods and the environment interconnected in the Galapagos and how are relationships between the two changing in response to pressures from tourism, fishing, and conservation?" Again, the author acknowledges the immense international attention that the Islands receive for environmental issues in relation to the local population.

Even as the social makes its way into the limelight, as was previously mentioned, people are framed predominantly as occupational roles in relation to conservation. Nevertheless, in a vast historical ocean of environmental concerns, the emergence of islands of social concern of any kind warrant attention.

In 2019, Kvan and Karakiewicz identified individuals on the Galapagos Islands outside of their occupations, as autonomous agents that comprise a complex adaptive system (CAS). In *Urban Galapagos: Transition to sustainability in Complex Adaptive Systems*, Kvan and Karakiewicz note, "The Galapagos Islands are an appropriate living laboratory in which to consider both the consequences of a growing urban population and the interlinked systems" (p. 1). The authors explore the topic of CAS, and discuss agents as defined by demographics, social-ecological systems, and urban contexts. Kvan and Karakiewicz offer a CAS-based approach to studying tourism sustainability, urban self-sufficiency, and overall sustainability in an island environment. The authors offer potential solutions to the consequences of an imbalanced social and ecological environment. Krav and Karakiewicz state, "evolution, however, proceeds not only by natural selection but, indeed, as the result of selection and shocks of any kind" (p. 155). Therefore, the agents (humans in the Galapagos) must take advantage of these natural structures.

They conclude, “this adaptation shifts the emphasis (Chap. 4) for creating sustainable development away from simple conservation and places it on the forces created by humans on ecosystems. Critically, this shift of perspective leads to a more dynamic view of coupled urban-natural systems (Chap. 3) away from static conservation” (p. 155).

These sparse islands of social concern do stand out as unique in a sea of environmental literature on the Galapagos. But this stark contrast— a paucity of social focus against an abundance of environmental focus— belies the structural problem that makes current-day approaches to the Galapagos’ problems so unsustainable. If we are to solve the problems of the Galapagos, we must ironically look to one of the great wisdoms of biology in recent decades— symbiosis isn’t the exception, it is the norm (Helmann, 1997). The social systems and environmental systems of the Galapagos are symbionts. They are mutually dependent on each other. Shifting this mental model writ large, will transform the system as a whole.

Methodologies Used in the Literature

We identified the methodologies and research techniques that were used in order to understand the current state of the literature, and their advantages and disadvantages. In order to code these sources, we relied on The Knowledge-Method Matching Matrix (Cabrera & Cabrera, 2007). This matrix provided clarity for synthesizing the state of the literature. The KMMM is a heuristic framework that provides a continuum of methods to classify the literature reviewed based on the condition of knowledge and research method used for any given study.

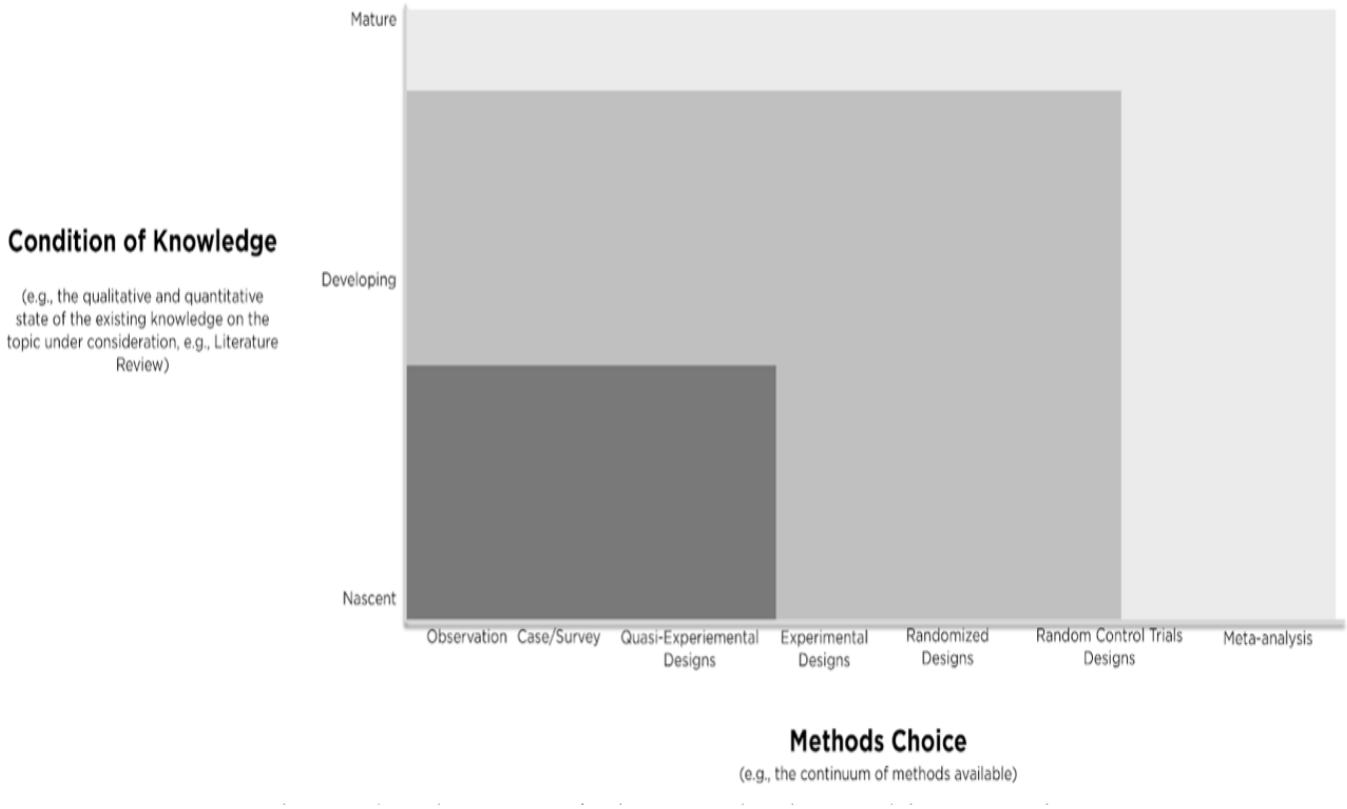

Figure 2. Knowledge-Method Matching Matrix

We coded these sources into four general categories: Descriptive, Quantitative, Qualitative, and Mixed-method. *Table 4* below shows this breakdown.

Table 4. Sources Tallied According to Methodology

PERCENTAGE	TOTAL	SOURCES BY METHODOLOGY
19%	12	Descriptive
47%	29	Qualitative
15%	9	Quantitative
19%	12	Mixed-Methods
100%	**62**	**TOTAL**

These four categories were then broken down further into eight methodologies (as illustrated in *Table 5* below): Descriptive, Observational, Case Study/Survey techniques, Quasi-Experimental Design, Experimental Design, Randomized Design, Random Control Trial Design, and Meta-Analysis.

Table 5. Sources Used by Methodology

PERCENTAGE	TOTAL	SOURCES BY METHODOLOGY
44%	27	Descriptive
18%	11	Observational
21%	13	Case/Survey
11%	7	Quasi Experimental Design
5%	3	Experimental Design
0%	0	Randomized Design
0%	0	Randomized Controlled Trial
2%	1	Meta-Analysis
100%	**62**	**TOTAL**

A majority of the literature, 38 sources (62%), used either descriptive or observational research methods. Thirteen sources (21%), used a case study or survey techniques. Another seven sources (11%) utilized quasi-experimental design. Three sources (5%) used experimental design. None of the sources utilized Randomized Design or Random Control Trial Design. Only one source utilized Meta-Analysis (Kvan, T., & Karakiewicz, J., 2019).

A significant challenge for sources based primarily on descriptive or observational research is the ability to be replicated in a systematic way, which also leads to issues with validity. As mentioned, the methodology section of *Boote and Beile's* Rubric (2005) is the only section where there is the possibility of obtaining a score of four (4). A literature review that earns a four (4), "Introduced new methods to

address problems with predominant method[s].” The STML team does this with systems thinking (DSRP) and CAS and POSIWID analyses, which are discussed in the methodology section.

According to Cabrera and Cabrera (2016), when the knowledge of a phenomena is low, the methods available to the research are orthogonal. In the Galapagos, where socio-environmental balanced studies are concerned, the condition of knowledge is extremely low. We simply know very little about these extremely complex, and interconnected systems. Therefore, it makes sense that the preponderance of the highly relevant sample of the literature (N=62) has been methodologically focused on Descriptive, Observational, and Case/Survey methods. As our knowledge of this area grows— and with it an increase in the construct validity of testable variables— we should aspire to utilize orthogonal methods commensurate with the growing condition of knowledge, such as: Quasi Experimental Design, Experimental Design, Randomized Design, Randomized Controlled Trial, and Meta-Analysis. In our methodological analysis of this literature, it is our estimation that the methods used are appropriate to the current condition of knowledge.

Significance

The social and environmental systems in the Galapagos are strongly interconnected; however, much of the literature has prioritized the latter over the former. Research needs to focus on both environmental and social problems. The imbalance in the literature has led to an incomplete understanding of the Galapagos systems, and begets the need to address the relationship between the two systems. The aim of this research is to identify the socio-environmental imbalance (Figure 3) and highlight the need for a more holistic representation of the Galapagos systems through a systems thinking approach.

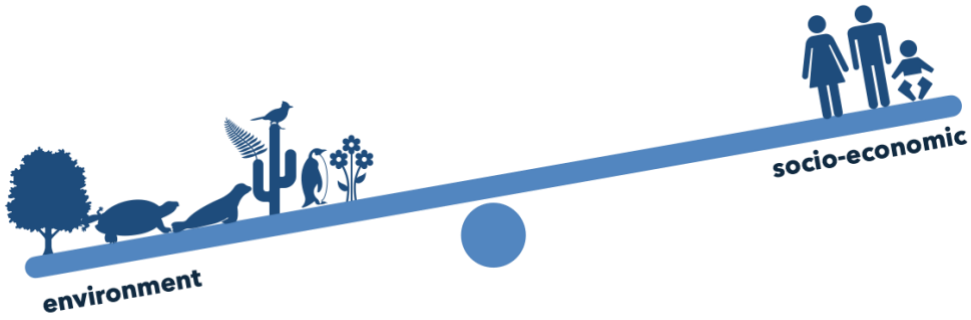

Figure 3. Environment and Social-economic Imbalance

This study will add value to the literature from a systems thinking perspective — by using the DSRP Theory, CAS and POSIWID (mentioned in the methods section) developed by Cabrera and Cabrera — and thus balancing the literature's focus that will lead to greater knowledge of why systemic problems persist. As a result, more funding may shift to protecting the social aspects of life on the Galapagos as opposed to mainly the environmental. NGOs can modify their mission to account for both aspects, businesses can have a greater understanding of their role in the process, and government officials can adjust their structures to accommodate a more symbiotic relationship when allocating funding. These changes would lead to greater balance between the socio-economic and environmental aspects of the Galapagos Islands system, approaching Figure 2.

Figure 4. Environment and Socio-economic Balance

The impact of this research extends beyond contributing to the literature; this systems analysis seeks to provide information and context that will inform recommendations that can improve the Galapagos. Behind this rationale is the acceptance that a socio-environmental balance is critical for

environmental conservation and sustainable development — both priorities within the islands (Villacis & Carrillo, 2013). It has even been found that illicit environmental behavior among locals resulted from a policy that gave privilege to the ecosystem over the interests and needs of the people when public services were limited (Brewington, 2013). Meanwhile, there is growing recognition that citizen involvement in conservation programs is important towards achieving environmental protection in the Galapagos (Echavarria, 2015). Given this, it is crucial that a socio-environmental balance is achieved in the islands. By providing a systems analysis of the Galapagos that describes underlying structural dynamics, we identify areas that perpetuate the imbalance we seek to alleviate. Highlighting interactions that require attention further provides specific, strategic approaches for decision-makers to consider in crafting future policies.

Methodology

As indicated in the literature review, there is an unsustainable imbalance between the social and environmental systems on the Islands. With this imbalance in mind, we embarked on fieldwork that would allow us to test this hypothesis. In the following section we detail the impetus for methodologies chosen. The Galapagos is a system with well-defined geographic boundaries, which creates optimal conditions for a systems thinking analysis. Using the following methods, we collected data which informed our Systems Analysis (Cabrera, 2006) (Cabrera and Cabrera, 2016). Predominantly, we used the DSRP as a Method. We also used CAS-based Policy Analysis and POSIWID Analysis and, in our field work, unstructured and semi-structured interview techniques, observational methods, survey methods, and journalistic investigation techniques.

Systems Thinking: DSRP

We used the DSRP /Systems Thinking method devised by Cabrera (2006). DSRP stands for Distinction, Systems, Relationships, and Perspectives, which, when dynamically combined, help one think systemically. Systems thinking is an emergent property of DSRP and can help structure thinking when conducting a systems analysis. There is no linear progression of the rules; that is, there is no starting or ending point of the system. The patterns can be mixed and matched, viewed independently or combined to form a holistic picture.

Table 6. DSRP rule described

Distinctions	Any idea or thing can be distinguished from other ideas or things
Systems	Any idea or thing can be split into parts or lumped into a whole
Relationships	Any idea or thing can relate to other things or ideas
Perspective	Any idea or thing can be the point or the view of a perspective

DSRP is a systematic framework that is content agnostic, meaning it allows a systemic analysis to remain contextualized by adding systemic variables and webs of causality. For example, a social system can be distinguished from other systems (e.g. environmental); can be broken up into parts (e.g., health, education) or viewed as a whole; relationships or the lack thereof can be identified between parts; and multiple perspectives can be taken for a more complete understanding.

DSRP Theory (Cabrera, 2006) provides the basis for a systems research method that structures systemic analysis of any phenomena and can be used by researchers to approach difficult problems. The DSRP Theory is not the same as the DSRP Method. The Method is a derivation of the theory that reduces it to stepwise, although nonlinear, process for analyzing and performing structural analysis. Methodologically, one adheres to the simple rule set, starting with an initial condition (the pink section in Figure 5), and running through the primary, secondary, tertiary, and quaternary possibilities until a stopping rule is reached. Stopping rules are determined by perspectives (which are part of the analysis).

The DSRP Method is dynamic, nonlinear, cyclical, and stepwise rather than linear and stepwise. The following schematic shows the DSRP Theory in terms of its methodological approach. The key

below details the meaning of the colors in terms of stepwise processes. Note that DSRP is not a stepwise process per se but occurs simultaneously and in different orders.

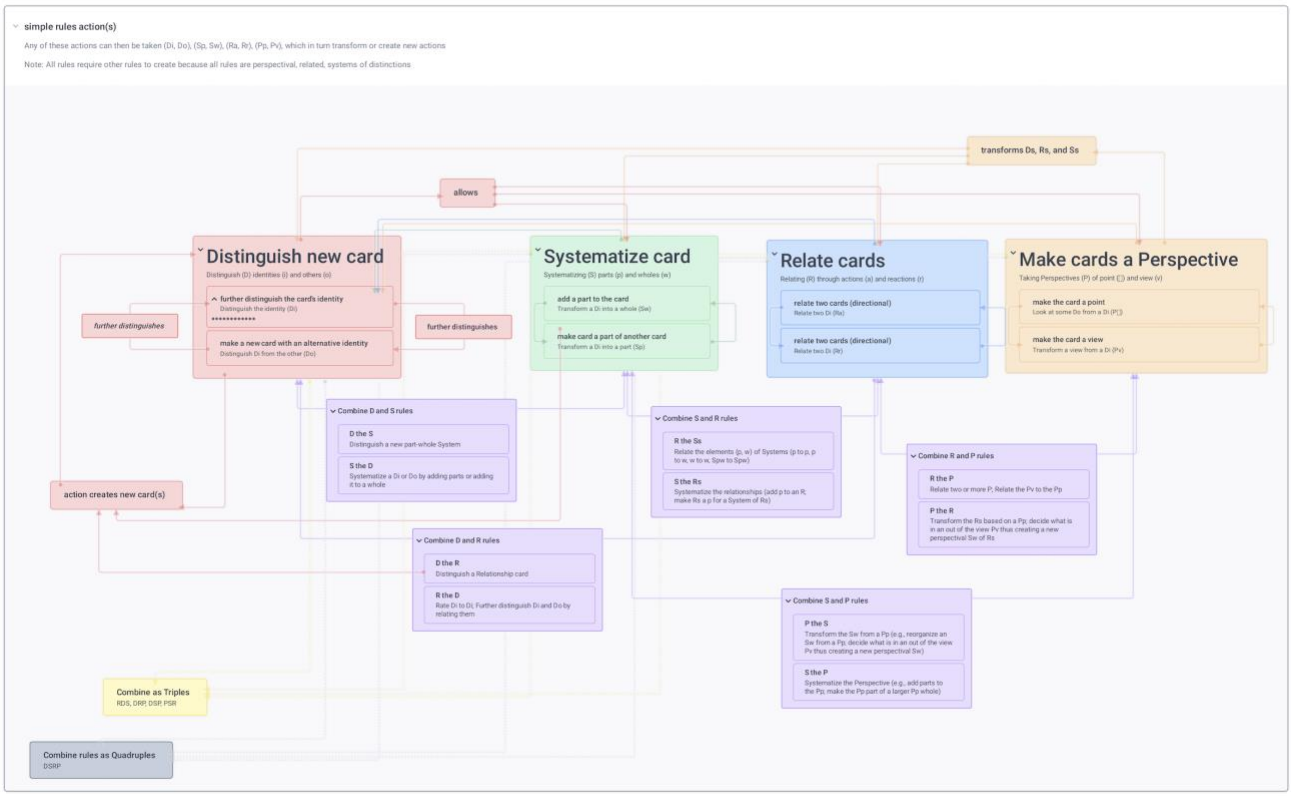

Figure 5. DSRP Theory as Method - Description

The ST Loop

Inherent to the DSRP Method is the idea of the ST Loop and the ST Iceberg. As discussed above, the crux of systems thinking (see Figure 1), the "Systems Thinking Loop" (Cabrera, 2020) means that the DSRP Method that yields a mental model (output) is recursively tested, informational feedback received, and the output and new inputs become a collective new input to a recursive process (i.e. it is put back into the DSRP Method and the process starts again). First, one must purposefully differentiate one's mental model from reality, recognizing explicitly that the "map is not the territory." Second, the process of model

building is a cyclical, continuous-refinement process. Each piece of information being added also transforms the model and then the model is tested against reality.

The Iceberg Model

The Iceberg Model acknowledges that observable events are merely the tip of a metaphorical iceberg. When one hears about a problem, it's important to ask if that problem is actually the problem or merely the output of a system that is broken. More often than not, a problem is the result of a broken system. Underneath any observable event are underlying patterns, structures, and mental models (Figure 6). For example, if there is a pothole in a road, one could say that the pothole is the problem, but if you look deeper, one may realize that there are potholes all over the city (patterns), and no one to fill them (structures) and the real problem is that there is no funding for critical infrastructure because people don't make the connection between taxes, potholes, and voting due to delays in the system (mental model).

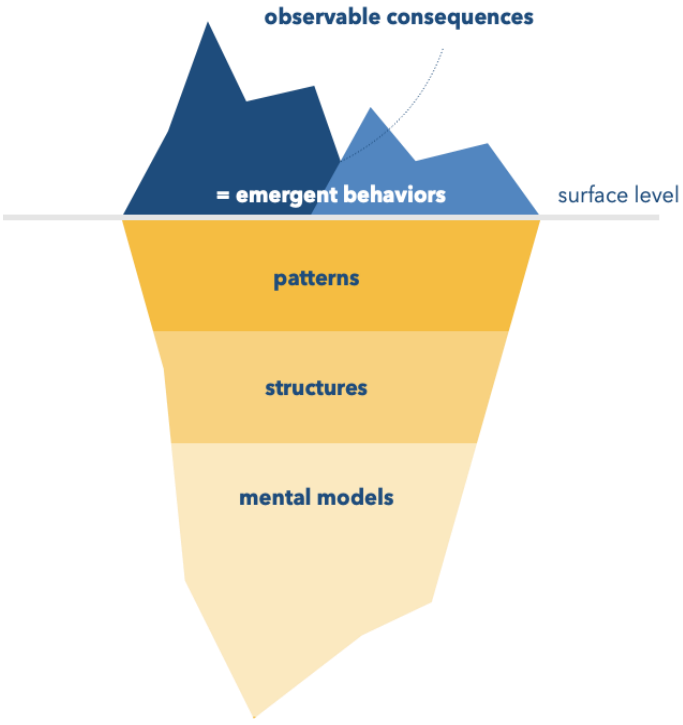

Figure 6. The Iceberg Model

Mental models are the complex product of information and DSRP structure that underlies thinking. DSRP also provides a systematic way to implement the CAS and POSIWID Methods.

Complex Adaptive Systems (CAS)-Based Policy Analysis

The Galapagos Islands is a complex adaptive system. A CAS exists when autonomous agents follow simple rules, leading to emergent behavior (Cabrera & Cabrera, 2018).

The formula for CAS is:

autonomous agents + simple rules = emergent behavior

For example, individuals at a sporting event follow simple rules to emulate a wave. In this case the simple rules are (1) when the person to your left stands, you also stand; (2) when you stand, put your hands in the air; (3) when the person to your left sits down, put your hands down and sit down. If you were to change the rules, for instance, create the situation when you stand when the person to your right stands, then the wave would completely change direction. The point is, by understanding the simple rules one can alter them to create different outcomes and change the system.

There are innumerable examples of CAS in the world, and it's crucial to understand this concept when looking at problems systemically. Social systems are a CAS. Viewing a social system through a CAS lens could allow a policymaker the ability to alter those rules in order to produce better outcomes for the general population. When we conducted our fieldwork, we did so in part by viewing systems through a CAS lens.

Cabrera developed the idea of a "CAS-based Policy Analysis" by combining CAS with traditional policy analysis techniques. Cabrera explains that in doing a CAS-based Policy Analysis, one must first,

> *"Conceptualize the system in terms of emergent properties (behaviors), collective dynamics (black, white, or gray box analysis), the agents (various stakeholders, actors or players), and the simple rules (the simple local things the agents do repeatedly)."*

Cabrera explains that this is often an entirely different approach than a traditional top-down view of policy making. Doing a CAS-based Policy Analysis, Cabrera explains,

> *"...is bottom up and top-down. Top-down in the first step because you work backwards from the high-level emergent properties one sees in the system, perhaps using POSIWID analysis, etc. But it is also bottom-up in the first step because you are linking the agents and simple rules to this high-level emergence."*

But, in the second step of the CAS-based Analysis, it moves from being bottom-up and top-down to what Cabrera calls, "fractal:"

> *"The second step is really fractal rather than either bottom-up or top-down. We are also shifting the lens of analysis in the second step from 'what is going on here?' to 'what can be done about it' In other words, the second step is, 'what can be done about it, fractally?' So, in the second step we are looking at principles and eventually policy recommendations that can be applied fractally, across scale. For a policy maker to say, I analyzed this system and all the President has to do is X' isn't helpful unless you're that one guy who can do X. So a CAS-based Analysis makes the effort to build off of the thorough review of agents and simple rules that govern the systems' current behavior and leverage those toward general principles and specific recommendations that can be implemented to fix the problem no matter who you are and no matter at what level in the system you exist."*[1]

[1] D. Cabrera (personal communication, January 2020)

POSIWID Analysis

POSIWID stands for “the purpose of a system is what it does.” A POSIWID model can be described as "Instead of looking at the results of a system as problematic, you look at the results of the system as designed or by design" (Cabrera & Cabrera, 2018). POSIWID acknowledges that the structure of a system serves a purpose, and perhaps not always the stated purpose. Identifying the purpose is key to understanding how, and why, the system is operating. For example, if a system is designed to help an underserved population, but there are loopholes that allow for corruption, then the system is actually serving those who are exploiting it. When we conducted our fieldwork, we did so with POSIWID in mind, and sought to identify the actual purpose of the system.

Fieldwork

The fieldwork was designed to test our original mental model— there exists an unsustainable imbalance between socio-economic and environmental systems— against reality. We collected data to apply our methods, as described above. Our fieldwork employed systemic, unstructured and semi-structured interviews, and observational/survey methodologies. We interviewed 29 people (N=29), which are detailed in *Table 7*. Each individual was asked a universal question, “What are the biggest challenge(s) facing the Galapagos Islands?” Data collected informed our analysis.

The paucity of social system information (as referenced in our literature review) hindered our ability to create social connections prior to our fieldwork. Therefore, we used purposive, convenience, and expert sampling methods to better understand policy issues. Examples of interviewees include individuals we came in contact with in day-to-day activities, but we also interviewed subject-matter experts such as the Minister President of the Council of the Galapagos Islands, the Mayor of Pueblo Baquerizo, and

representatives of non-profit organizations. For example, we often approached community members to ask them our universal question .*Table 7* below describes the individuals and groups who were interviewed.

Table 7. Fieldwork Interviewees

GOVERNMENT	LOCAL COMMUNITY	NGOs
Norman Wray - President of the Council of the Galapagos (Consejo de Gobierno de Galapagos) Assistant Mayor - Puerto Baquerizo National Park	Hunters Taxi Drivers Hotel staff Restaurant owners/staff Artists Park Guides Tourism guides	Intercultural Outreach Initiative (IOI) Galapagos Conservancy Haciendas Tranquilas Charles Darwin Station
Individuals in Category: 7	**Individuals in category: 15**	**Individuals in Category: 7**

As Cabrera (2018) elucidates in the KMMM, the condition of knowledge is correlated to the methodological choice. The condition of knowledge on the Galapagos specifically with respect to the sustainability of balanced socio-environmental systems is extremely low. In addition, gaining knowledge about such a complex system (the Galapagos Archipelago) requires a systemic approach. Therefore, our methodological choice to use systems thinking was, in many regards, made for us, both by the condition of knowledge and the conditions on the ground.

The strengths of our methods are that they make it possible to get started in unknown territory where even establishing the most basic construct or variable is prone to bias and threats to construct validity. There is simply not enough knowledge to even isolate a variable in any meaningful way.

The weaknesses of our methods are that the N is very small, the data leans toward qualitative, and the sample may not be representative. This is because the individuals tended to be located in predominantly tourist locations, hence the sample was not random. Also, due to interviews being conducted in English — not the interviewees' native Spanish — individuals might have not been able to fully express their ideas. But, when the knowledge condition is low, and the complexity on the ground is high, a systemic, un/semi-structured interviews, and observational/survey methodology— our approach — is entirely appropriate and indeed the responsible methodological choice scientifically.

Systems Analysis

The following systems analysis aggregates the data collected through fieldwork, structured using the DSRP framework, to offer an understanding of the Galapagos system and its wicked problems. Specifically, the issues observed on the Islands were analyzed under the Iceberg Model as Surface Level emergent behaviors, uncovering the patterns, structures, and mental models behind them.

Surface Level

We asked all of our interviewees, "What are the greatest challenges on the islands?" Their answers, we came to realize, were symptoms of a greater systemic web of interrelated issues. When analyzing their responses, we asked ourselves if these problems are in fact *the problem*, or if they are *the output* of fractured system(s). We concluded the following problems reported (*Table 8)* were representations of the emergent behaviors of the system (Figure 7). According to the Iceberg model, these are the surface-level events.

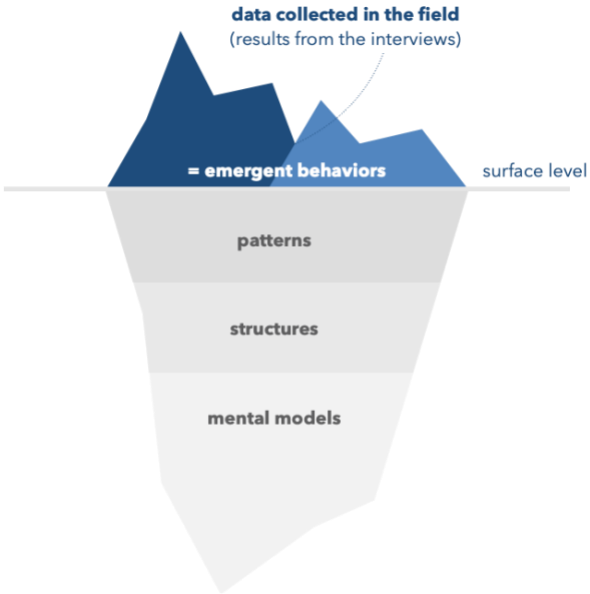

Figure 7. Surface Level Emergent Behavior - The Core Issues Identified in the Field

Table 8 below describes the problems (left column) and the aggregated responses from one or more stakeholders (right column).

Table 8. Persistent issues as described in stakeholder interviews

Issue	What Locals Reported
Lack of potable water	Water-related infrastructure is insufficient. Money is spent on conservation programs rather than social ones.
Water contamination from Chinese ships	The ship's waste pollutes the water and further contaminates accessible drinking water leading to health issues.
Workforce shortage for construction	Projects are often delayed or not completed at all based on workforce and human capital issues.
Cargo Ships	Cargo ships bring invasive species that disrupt the natural ecosystem. However, these are needed to sustain tourism and local populations with food and supplies. Cargo imports (70% of imports) are unsustainable because food is not locally sourced. Food is also more expensive due to shipping costs.
Growing tourism puts pressure on infrastructure and ecosystems	Similar to cargo ships, tourism disrupts both social and environmental systems. More visitors strain the water, sewage, and infrastructure systems. More visitors also introduce invasive species and generate waste
English Skills	Galapaguenos who wish to benefit most from the influx of tourists and researchers must learn English for the greatest benefits. Guides, service workers, and transportation providers, rely on foreign capital for wages, but access to English courses is extremely limited, even in the local schools
Lack of collaboration among institutions	Collaboration cannot take place between organizations with similar missions because they lack relationships.
Political system structure	Locals assert most of the money made from the National Park entrance fees in the Galapagos is returned to mainland Ecuador
Lack of structure for park guides	Guides exist in silos, and rarely engage in island-to-island collaboration. Many guides have not been to other islands.
A focus on environmental policies at the expense of social	Policies do not balance social and environmental systems. They heavily focus on protecting the environment and do not provide aid to locals.

Lack of quality healthcare	Locals do not have access to quality healthcare systems.
Education	The quality of education in the Galapagos is seen as subpar. Environmental education is often provided by NGOs and is disproportionately represented in the curriculum. Also, locals reported concerns for attracting professors to the institutions of higher education.
Socioeconomic inequality	Many examples of wealth inequality were discussed, such as land ownership, permits, and access to other social systems (e.g. education, healthcare, water, jobs).
Lack of youth activities	Programs do not exist to engage local youth. Suggested programming ranged from soccer programs to sex education.
Tourism work preferred over agriculture	Tourism is seen as a more desirable job than agriculture. This means there are fewer locally sourced food products and therefore a greater demand on cargo shipments.
Immigration	The process of obtaining Galapagos citizenship is arduous. Locals mentioned that you must reside in the Galapagos for at least 10 years before you are allowed to apply for citizenship. To this day the exact number of immigrants and emigrants is uncertain. Despite this, these individuals help form the core workforce of the Galapagos economy. There are limits to the numbers of people who can come and stay, but these limits are sporadically enforced, if at all.
Locals are not connected to heritage	Since locals often do not have the means to travel to other islands, the history of "the Galapagos" is often not realized. As a result, environmental importance is not understood, further exacerbating the socio-environmental imbalance. Locals do not realize that assisting conservation initiatives can be in their own self-interest.
Locals feel sense of favoritism from NGO towards specific families—sense of unfairness	When new capital is being injected, some individuals claim there was corruption that led to certain families always being chosen for these investments.
Foreign capital focuses on environmental initiatives rather than social ones	International groups fund projects that help the environment, but rarely is money spent to improve the lives of Galapeguenos.
Boards and investor are often foreign and don't understand local context	Decisions are made based on incomplete perspectives, often from people who have never been to the islands and end up focusing solely on improving the environment.

Patterns

The problems described above are surface-level issues, meaning there are patterns, structures, and mental models that are all contributing factors that allow these problems to persist. After identifying surface-level problems, our analysis probed another level deeper, and we recognized patterns and recurring themes. We then understood that these patterns are connected and often are a result of problems that overlap. Additionally, the patterns helped us to identify structures, and mental models in the system.

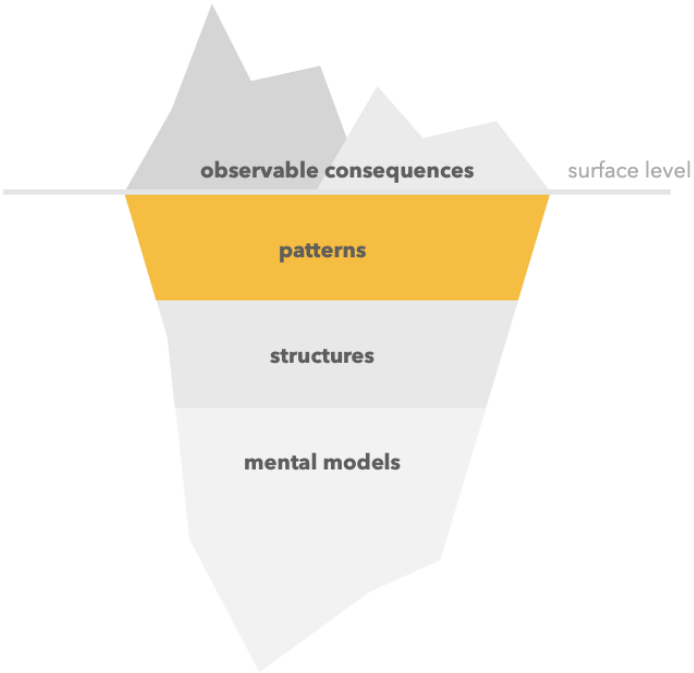

Figure 8. Underlying Patterns - The Identification of Recurring Issues

Imbalanced Foreign Influence

Respondents reported that many of the problems involved locals' perspectives on foreign capital and influence on the Islands. Foreign capital often prioritizes environmental initiatives at the expense of local and social programs. Respondents also expressed that funding should, at least in part, be directed at

both environmental *and* social programs. Often this problem is twofold; board members do not have relationships or are unconnected with the local population, and locals are not represented on boards. This is likely influenced by the imbalance between social and environmental concerns that plays out globally. When foreign interests engage in the Galapagos, they often self-select due to their interest in environmental issues or alternatively are influenced by the trend that leans toward caring more about environmental issues.

Untapped Social Resources

The Galapagos, as remote islands, are host to an incredible resource: human ingenuity. The Islands are full of small and service-oriented businesses, farms, and entrepreneurs; there is creativity and resourcefulness in abundance. However, as is evident in the structural analysis, these individuals and individual organizations are not networked in interest groups, nor are they largely connected and interconnected with other island organizations and businesses. The result is that although there is a common set of complaints, there exists no common voice which represents various interest groups.

Weak Institutions

Access to social institutions is limited. Healthcare and education are two examples where there are limitations for the local population. In the case of healthcare, there are not many hospitals and not enough medical workers in place to meet medical needs. Such limited capacity results in a need to transport patients with severe health conditions to the hospitals in mainland Ecuador. Interviewees mentioned the requirement of powerful contacts and money to guarantee a positive decision from the authorities to gain access to a medical helicopter.

Underfunded and under-supported education systems coupled with a lack of jobs outside of direct tourist support service jobs leads to many students leaving the islands to pursue higher education, and often to establish their adult lives on the mainland. This means the young are leaving in droves. Having the option for local students to remain on the Islands for their studies would be beneficial for students, school, and the Islands.

Inadequate Infrastructure

The lack of updated infrastructure, or sometimes any infrastructure, on the islands is another area where issues exist. Infrastructure includes hard infrastructure such as sewage systems or supporting soft infrastructures like the internet, the policies and institutions that support the hard infrastructure. A functioning infrastructure system is necessary to support residents as well as tourists and researchers, and provide basic services like education, transportation, power, and water to the islands.

Corruption

One of the frequently referenced problems across sectors was corruption. Interviewees stated corrupt forces allow for the status quo, and sometimes nefarious forces, to persist. Corruption stymies progress and dampens the effect of development products. It also erodes the legitimacy of institutions.

Structures

There are many ways we could present the structures of the Galapagos system. For example, one could choose to look at the Islands from the perspective of the Law, Budgeting or even from the perspective of Evolution, but given our original hypothesis, our CAS-based analysis led to the distinction of the relevant agents and relationships in the system described below.

The Galapagos “system” is a system of systems composed of agents that we categorized structurally into: Global Interested Parties (GIPs), State Interested Parties (SIPs), and Local Interested Parties (LIPs). Each of these structural groupings is comprised of a number of “agents” and each of the groupings interacts dynamically with the other groupings.

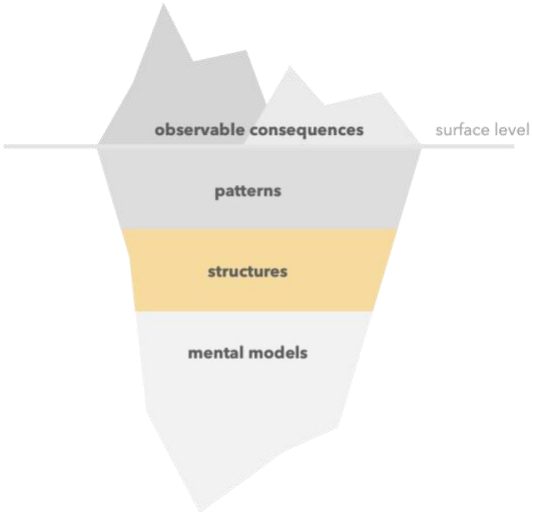

Figure 9. Underlying Structures

GIPs: Global Interested Parties

Global Interested Parties or GIPs are the large, multinational entities that have both significant interest, and influence in the Galapagos. Ranging from the media to the United Nations, these large government and non-profit organizations have selectively intervened and spurred action on the islands since the 1970s. Their power and ability to shift the status quo makes them critical stakeholders within this system.

United Nations Educational Scientific Cultural Organization

Since the Galapagos Islands first became a World Heritage site in 1978, UNESCO has had significant interest and systemic influence on how the islands operate. Within the greater system, UNESCO has been one of the rare institutions able to cut through local corruption and influence change in the Galapagos. There is perhaps no better example of this than when UNESCO placed the Galapagos Islands on its danger list of world heritage sites in 2007. This devastating blow prompted local and state actors to implement a three-year overhaul of the damaging environmental and immigration policies throughout the Galapagos Islands. Readmitted in 2010, this case highlights the undeniable power of influence that GIPs like UNESCO have within this system. While primarily focused on environmental issues, it is clear their structural power has the potential to reshape the myriad social issues currently facing the islands.

World Wildlife Fund

With five million supporters worldwide, efforts in over 100 countries, and over $1 billion invested across more than 12,000 conservation initiatives since 1995, the WWF is a global powerhouse similar to UNESCO (WWF, 2020). Its influence in the Galapagos is undeniable, having supported the management and oversight of the historic Galapagos Special Law of 1998 since its inception. Currently involved in overseeing efforts with the Innovative Fisheries Management and Monitoring of the Galapagos Marine Reserve, like UNESCO, WWF also has had a hype-focus on environmental issues. It is clear within the current system that the WWF's significant political and financial powers are also able to produce concrete results and circumnavigate bureaucratic roadblocks. By establishing key relationships and reframing their perspective to also include social issues, wide-ranging impacts would be felt across the islands.

News Outlets & Social Media

The final and arguably most powerful GIPs encountered in this structural analysis are international news and social media. Given its aforementioned status as a World Heritage Site, any story involving environmental damage in the Galapagos quickly makes front page news or goes viral. These range from CNN's 2019 piece on the oil spill off the coast of San Cristobal to actor Leonardo Dicaprio's social media posts on the Galapagos tortoises. These key GIPs are able to apply pressure and spread awareness when needed but have traditionally only done so with respect to environmental and conservation issues. It is clear that reorienting the GIPs' focus and capacity and creating newfound relationships with LIPs will allow a more balanced focus on socioeconomic issues.

Tourists

Tourism is the largest industry on the islands. Each year the Galapagos sees just over 270,000 visitors. Roughly one-third of the visitors are native Ecuadorians from the mainland, and visitors from the United States take a close second. Tourists are unaware of the asymmetry in social and environmental relationships and are unconcerned with human well-being. Their primary objectives are to engage in the cultural, culinary, educational, and leisure aspects of the islands. When any attention is given to issues facing the islands, all materials focus on environmental issues such as the status of the tortoises or Blue Footed Boobies. Tourists are also unaware of their impact on the islands beyond surface-level policing of sunscreen, non-reusable water bottles, and water usage. However, tourists should or will soon have an interest pertaining to the social elements of society since the current model is unsustainable. Soon, tourists will lose access to the environmental images, activities, and experiences glamorized by international media, if they do not start caring about the people.

SIPs: State Interested Parties

State Interested Parties or SIPs are the large, state run entities of mainland Ecuador and the Galapagos. These large government and non-profit organizations have immense influence on day-to-day life on the islands and are often working at the behest of the mainland. Their focus is often on maintaining the lucrative status quo and protecting the endemic species and environment across the islands.

Parque Nacional Galapagos

Created under Executive Decree N-17 on July 4, 1959, the National Park of Galapagos is an immensely powerful SIP that actively shapes the policy and regulations surrounding the environment on the islands. In charge of caring for the 7,970 square kilometers of land, nearly 97% of the islands, there are several key issues within the jurisdiction of the park that influence life on the islands, ranging from the ways in which they balance the needs of local Galapaguenos with issues of tourism, threats to the marine reserve, and mitigating invasive species. In the current system, the SIPs have great power and ability to stifle local dissenting voices and appear susceptible to corruption. SIPs like the National Park also currently seem to lack transparency, where no official budget is available to see how funds are allocated within the park. Any proposed recommendations should look at ways in which LIPs, who will be discussed in the following section, can circumnavigate the power and spoiling efforts of SIPs, who historically have attempted to maintain the status quo.

Galapagos and Ecuadorian Government

The Galapagos Islands are one of the 22 provinces of the nation of Ecuador, with the Instituto Nacional Galapagos (INGALA) as the primary governing authority of the islands. This unique structure allows significant administrative and financial autonomy from the mainland of Ecuador; however, large

portions of funds from the tourism revenue generated on the islands return to the mainland government. There are various SIPs with differing degrees of influence in the islands as well. As a recent report notes, since 1980, "the number of government institutions in Galapagos responsible for public policy, regulations, and/or health and welfare has grown, resulting in an increasingly complicated governance framework. There are over 50 central government organizations and nine local government organizations with responsibilities in Galapagos" (Martinez, 2008). The SIPs govern based on the legal authority granted from Special Law of 1998 and its 2015 amendments.

LIPs: Local Interested Parties

Local Interested Parties or LIPs are the local community members and groups that inhabit the Galapagos Islands. Ranging from park guides to restaurant owners, these small businesses, branches of municipal government and non-profit organizations have limited power and influence in the system. The exception to this lies with the local "mafia," whose loyalty to powerful SIPs allows them to profit and flourish in the realm of LIPs. While often vocal of the many pervasive problems on the islands, LIPs have historically only achieved success with the support and advocacy of GIPs.

This section highlights the main agents of the system we observed in fieldwork. These agents are described as separate entities because our central observation of the LIPs was the lack of integrated networks, and cross-sector networks. The LIPs on the whole stand to gain the most, especially initially, if greater balance between the social and environmental systems is attained. The challenge for this group centers on acknowledging the current beneficiaries and determining ways to improve the system for the greater percentage of people without harmful consequences imposed from those currently benefiting.

Operators

Tour operators represent a party interested in an increasing number of tourists and income growth. According to the Special Law for the Conservation and Sustainable Development of Galapagos (LOREG), foreign investors are required to have a permanent resident as a business partner and are not allowed to own more than 49% of any joint business in the islands. Notwithstanding such measures taken to redistribute the benefits from the tourism sector towards local citizens, the latter ones still serve bigger "outside" operators rather than managing their own businesses due to their inability to compete.

The system of these large operators is characterized by island-based owners and a high concentration of revenue and tourism infrastructure that gives them power over local authorities and conservation policy. Large Galapagos tourism operators are associated with corruption and described as the tourism "mafia" (Brewington, L., 2013) (Walsh and Mena, 2013).

Park Guides

Park guides form a unique group of actors due to the employment conditions, scope and scale of work, and the requirement to be a Galapagos resident. Being born and raised on the islands, they cannot gravitate only towards conservation or development agendas. Park guides have a sense of belonging to the place and understand the environmental uniqueness of the archipelago; however, they also cannot stay indifferent to the needs of an average local citizen. Consequently, they share both pro-environment and pro-social perspectives, seeking a balance between these aspects of the Galapagos reality.

In addition, the nature of Parque guides' work which involves interacting with almost all GIPs, SIPs and LIPs makes them the "eyes and ears" of the Galapagos. They are a group of people who are

amongst the first observers and therefore notice any positive and/or negative outcomes of a policy in place or a project implemented, as well as gaps and issues needed to be addressed.

Although employment conditions provide some independence and flexibility to Park guides, they create underlying organizational issues such as the absence of a formal institutional network/association as well as an ability to deliver suggestions and concerns of the group to relevant stakeholders.

Restaurants/Hotels

Restaurants and hotels are the infrastructure of the tourism sector and a part of the tour operators' system, meaning that the main areas of their concern are tourists and income. At the same time, it is a group that generates demand for both ecological and economic resources of the islands. Restaurants and hotels are among the biggest consumers of water, sewage system, electricity and food, and thus, decisions taken at their level can affect a balance in the islands. For example, restaurants and hotels play a crucial role in food security and invasive species problems as they import food from the mainland in order to serve and accommodate an increasing number of visitors. Having the power of choice as a consumer, this part of the tourism industry can significantly reduce their negative footprint by purchasing locally-produced food and supporting local agriculture. However, such changes require coordination with local farmers due to a gap between local demand needs and supply capacity.

In comparison to a highly monopolized hotel business, there are some small family-style restaurants owned by local residents. Such places are remarkable not only because of the traditional dishes served there, but also because of locally-produced ingredients. Family-owned and farm-based restaurant business can develop further with a certain promotion and coordination with other LIPs, especially

tourists. This will benefit both local residents by empowering them financially and tourists by offering authentic experiences, thereby contributing to the development of the local community.

Farmers

Farmers serve as the primary food source outside of mainland imports. They help source local families and restaurants and therefore serve as an integral vein of affordable food suppliers. The majority of the farmers operate independently and are therefore in charge of the production process, quality, and price points of the food. However, unlike the animals, few environmental protections exist to encourage efficient and sustainable practices that protect them. Farmers are seeing the immediate and daily influence of global warming and struggle to accommodate changing climates and growing conditions.

"Mafia"

The "mafia" (as it is sometimes referred to by locals) is a metaphor for an extremely influential and well-known network of individuals who span a variety of professions. They are not a literal "mafia" but an influential group. The people involved are primarily concerned with raising and consolidating revenue. They raise capital by either infiltrating jobs that serve as critical infrastructure and passing those positions on through their connections or through frivolous activities or unneeded services. Unlike other LIPs, their incentives and value structure run contrary to every other LIP. The status quo is the most optimal situation and they would be resistant to change since they benefit the most from the current status.

Non-governmental organizations (NGOs)

Many non-governmental organizations (NGOs) have established a presence in the Galapagos, with the majority's focus on environmental conservation. The Charles Darwin Foundation, for instance, supports scientific research in the Islands with the purpose of aiding conservation efforts. Other NGOs are

centered around cultural immersion and education or volunteerism, providing people with the opportunity to stay in the Galapagos and work on small-scale conservation projects. The Intercultural Outreach Initiative is an example of such. NGOs do meaningful work in the Galapagos, but there is a noticeable gap in what their efforts accomplish. Many organizations centered around conservation exist, but rarely any do in the realm of social issues.

Fishermen

Fishermen are critical actors in the Galapagos food system. Living in coastal communities, Galapaguenos depend heavily on fisheries for food, with fishing being one of the oldest economic activities on the Islands. Many fishermen rely on fishing for their livelihoods but have found themselves at odds with conservation efforts. The Galapagos Marine Reserve has seen overexploitation in the past, as in the case of the sea cucumber, so increasing pressure is now being placed on fishery management.

Municipalities

Municipalities are responsible for governance of the Galapagos, carrying out the Special Law of the Galapagos created in 1998. A Special Regime was established through this ordinance to manage the Islands, and local governments exist on each human-inhabited island to enforce regulations and provide public services for the residents. Beyond community welfare, the municipalities are primarily involved with matters surrounding environmental conservation, sustainable development, and tourism, working to maintain a balance between human use and natural land preservation on the Islands.

Structural Dynamics

In several places in the current system, there exists a unique dynamic among structural components such as GIPs, SIPs, and LIPs. Often where a formal, transparent relationship should exist, the

local forces of corruption have a powerful and deep-rooted hold. Pervasive both internally among entities on the islands as well as externally between the GIPs and SIPs, these relationships have immense influence on the current system. These key relationships are highlighted in red in Figure 10, which highlight the current system dynamics given the existent agents and relationships.

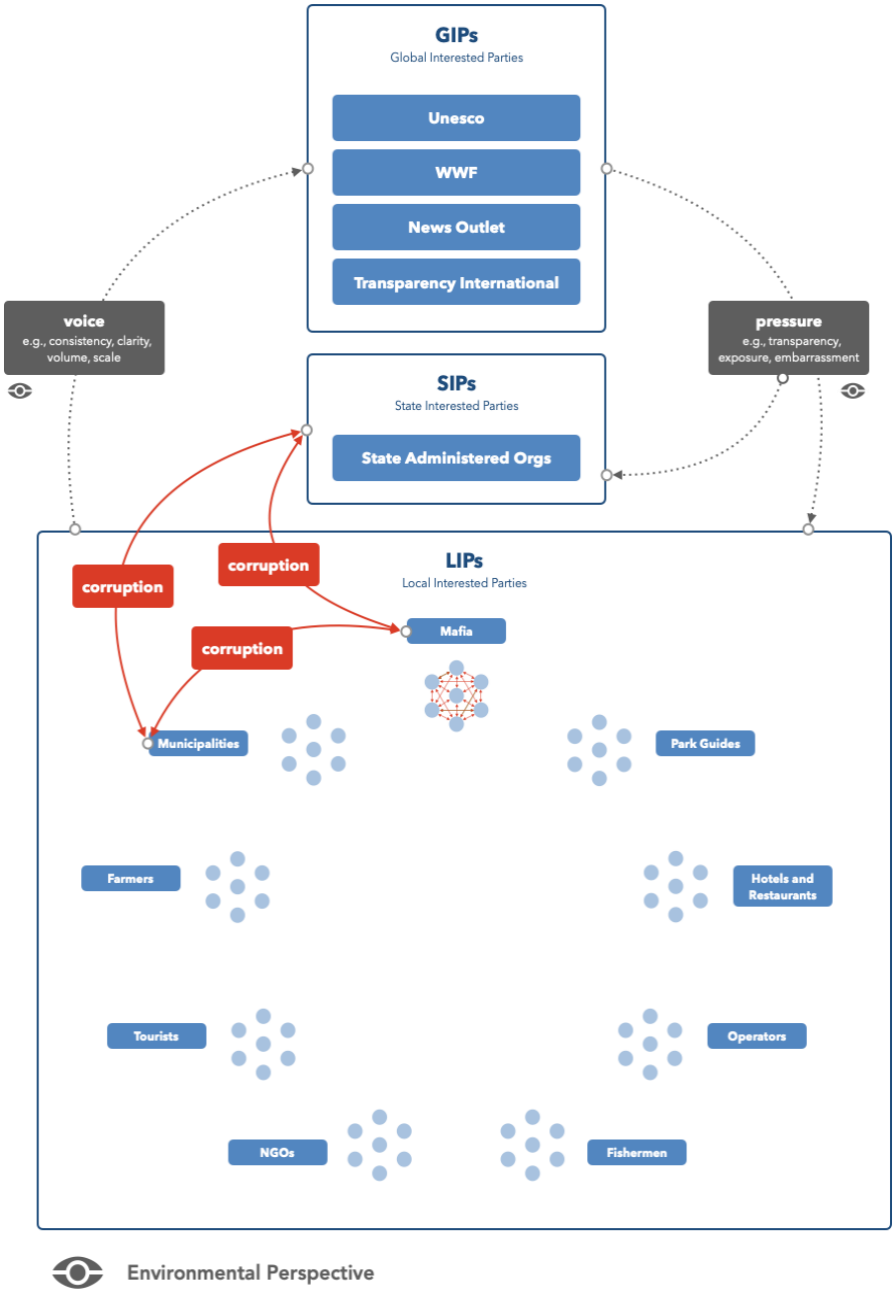

Figure 10. The Galapagos CAS-Based System
(Developed by Cabrera and Cabrera, authors of the DSRP Method)

The sole counterweight to the forces of corruption highlighted above come from another critical set of relationships existing between the influential global organizations like UNESCO and WWF and the LIPs. There are several clear-cut examples of the strength of this relationship. These relationships are highlighted in gray in Figure 10. Unfortunately, this relationship and its ability to pressure and spur change on the ground in the Galapagos has historically been reserved only for environmental issues. This was perhaps most apparent in the 2007 expulsion of the Galapagos from UNESCO over its increasingly poor environmental standards. In three short years, the UN was able to make the Galapagos fundamentally strengthen its state and local environmental policies before its ultimate readmittance in 2010. The same elements of international pressure are immediately present in any environmental disaster that occurs on the islands, seen with the rapid front-page coverage of a 2019 oil spill off San Cristobal.

Our analysis of structural dynamics highlights that the existing power is skewed towards international forces (GIPs) and an environmental agenda in the Galapagos, as exemplified by how timely actions are taken by municipalities (due to pressure on the local interested parties) when environmental concerns are raised (the voice of global interested parties), as in the case of the aforementioned oil spill. The analysis of current existing relationships also highlights a strong and coordinated network that connects LIPs (through the municipalities and the local mafia) and the SIPs. These relationships were recurrently mentioned by interviewees as corrupt interactions amongst agents; according to community members, for instance, illegal permits are issued benefiting cruise industry members, and infrastructure projects that would benefit the general society are hampered by individual interests. This is not to say that community members are not connected at all— Figure 10 highlights the relationships that are coordinated and strong.

After understanding the system as-is, it is possible to structurally predict (Cabrera, 2016) that if LIP subgroups developed the ability to band together under a coordinated network, a common voice would emerge, creating yet another channel of communication with influential GIPs. This would introduce a social perspective to balance the current sole environmental perspective. In this new arrangement, local social issues would be influenced not merely by special and deterrent interests (e.g., mafia) and corruption, but also by global pressure (e.g., threat of embarrassment) on local social interests. A further understanding of the findings of structural dynamics leads the analysis towards underlying mental models described in the following section.

Mental Models

There are many mental models (Figure 11) that compose the structures we identified. We identified three mental models that contribute to the structural issues described above: (1) Lack of Connectivity, (2) Socio-environmental Imbalance, and (3) Global and Local Power Dynamics.

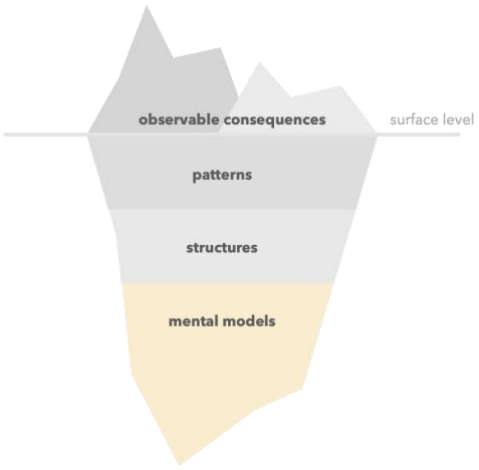

Figure 11. Underlying Mental Models

Lack of Connectivity

One of the themes that respondents reported was that organizations and stakeholder groups lack *relationships* with other organizations or groups (Figure 12). “Lack of Connection” refers to an absence of coordinated efforts among agents in the system. For example, National Park Guides mentioned there is no formal communication channel among Guides on various Islands. This leads to silos, which leads to uncoordinated entities. If Guides were able to coordinate, they could have a shared mental model, leading to synergistic efforts across islands, including the sharing of best practices and lessons learned. On the other hand, environmental groups, such as the Charles Darwin Foundation and Galapagos Conservancy, have an awareness of each other, and to this effect are more connected. This pattern repeats itself among that farmers of the highlands, where disjointed, ill coordinated efforts lead neighboring farms to produce the same types of crops. A systematic agricultural effort could reduce redundant crop production and allow the islands to reduce expensive cargo imports for crops produced domestically.

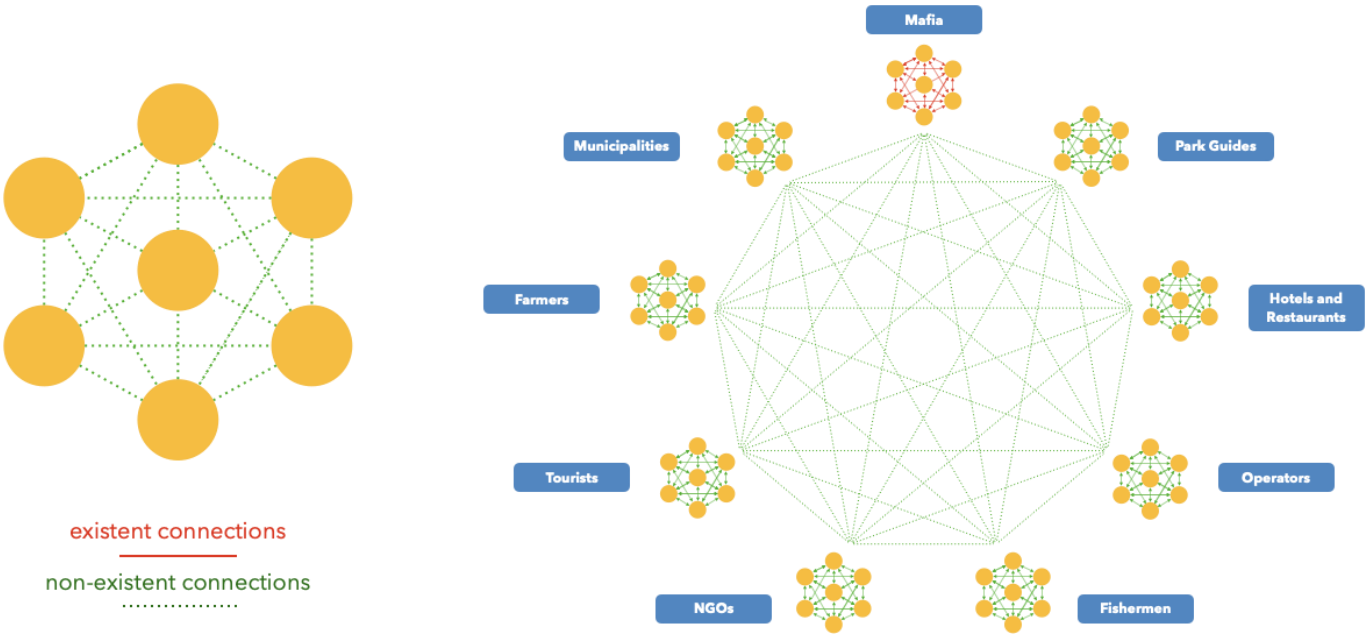

Figure 12. Lack of Connectivity

Social-environmental Imbalance

Various stakeholders reported the imbalance that exists between social and environmental efforts which Figure 12 addresses. The connection between the sustainability of one system does not reinforce the other, meaning that in order to have a healthy environmental conservation effort, you also need a healthy social system. For example, when visiting a local farm, respondents reported that they are constantly scrambling to find capital and funding for their social programs. Far too often, foreign investment and capital are overwhelmingly invested in environmental programs, leaving social programs neglected and strapped for cash. A local farmer told us that while this money has good intentions, a portion of this should also go towards the people who live on the land. “The money doesn’t have to be an equal 50/50 split, but to at least have some, 10 or 20 percent, would help people a lot.” Strengthening the social sector will lead to a strengthening of the environment. Retooling organizations with a more equitable distribution of capital and resources would allow wicked problems like fixing brackish water or the poor sewer infrastructure across the Galapagos Islands.

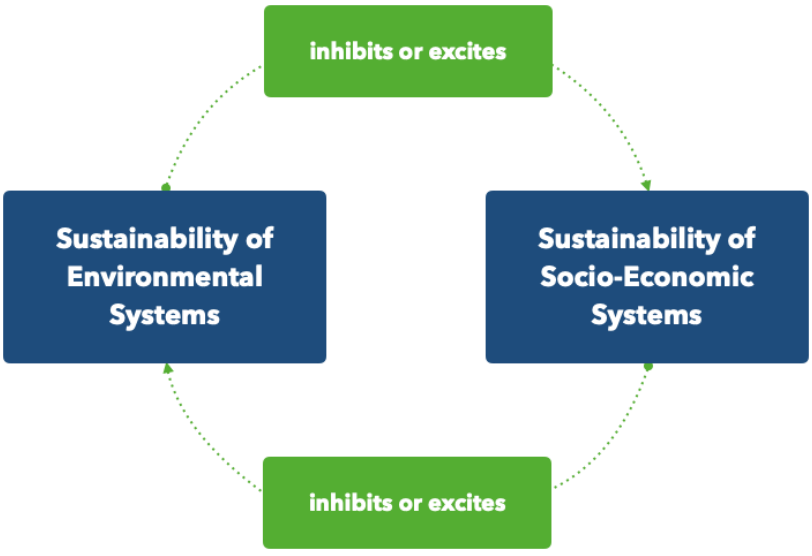

Figure 13. Socio-environmental Imbalance

Global and Local Power Dynamics

In addition, numerous stakeholders discussed a power imbalance between local and global entities (Figure 13).

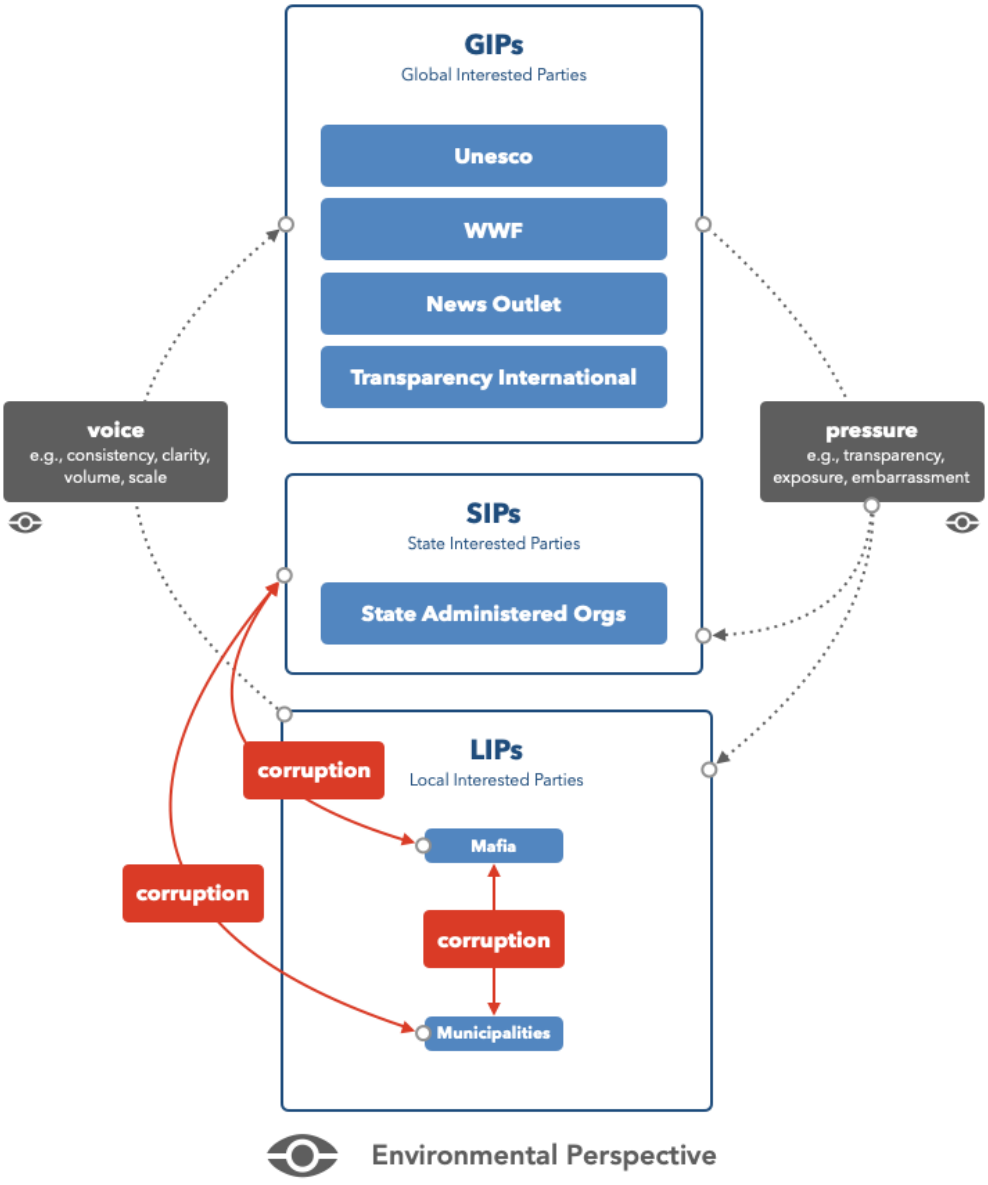

Figure 14. Global and Local Power Dynamics

While there are several critical social problems at the local level, pervasive corruption and inefficient local structure often obstruct any sort of progress. By maintaining the immensely profitable status quo, this dynamic not only enriches the local "mafia" and "cronies" in government at the expense of social welfare, but mainland Ecuador as well. However, one notable pattern concerning this local/global dynamic emerged across various groups. Whenever large, international organizations like UNESCO, the WWF, or global media were engaged, progress at the local level was almost immediate. As mentioned previously, a clear example of this was the swift and overwhelming reaction to the 2019 oil spill off the coast of San Cristobal, where in a matter of hours CNN and other major news organizations had this story plaster across their headlines. Another example previously mentioned includes UNESCO labeling the Galapagos Islands "at risk" in 2007 and being stripped of their World Heritage Status. In a few short years, this international pressure forced the Galapagos to renew and rededicate its conservation efforts, allowing them to be readmitted in 2010. These patterns clearly indicate the immense power of global institutions of local environmental efforts, and one that should be re-focused on the myriad social problems across the Galapagos Islands. Our analysis clarified which relationships already existed. It became apparent that the purpose of the system served only a few. The imbalance served as an emergent property and the true structure was revealed.

In addition to the imbalance of forces present in the system, we recognized that these forces exist in a feedback loop. Specifically, the interests and behaviors of GIPs affect those of LIPs, which further impact GIPs and continue the cycle (see Figure 15). However, this relationship is rarely acknowledged. Observing this, we identified a third mental model: GIPs and LIPs act in isolation, despite their interests being intertwined.

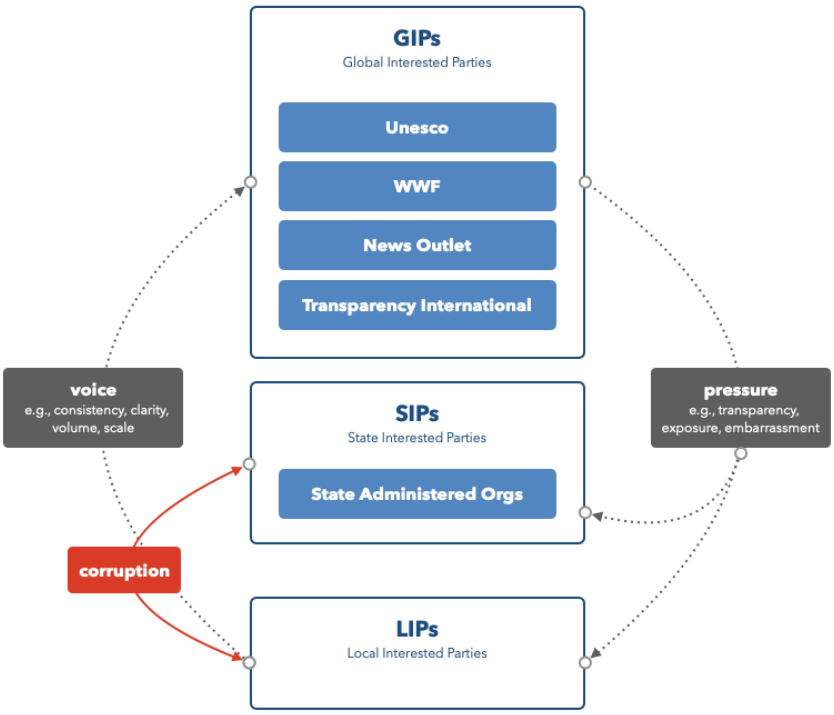

Figure 15. SIPs, LIPs, and GIPs

Another feedback loop exists between environmental and socio-economic systems. That is, the sustainability of one impacts the other. However, we noticed that the sustainability of environmental systems tended to be given more weight. Our Systems Analysis identified the emergent behaviors that stem from the patterns, structures, and mental models. Our analysis described the current state while identifying gaps in a potential future state. From this perspective, we created general principles to effectuate our recommendations.

Principles

From the structural analysis, we were able to identify the existent structures and mental models that were leading to the observed emergent behavior. Through the analysis of these structures, it was possible to identify important systems, relationships, perspectives (DSRP), and mental models that were lacking, which guided the creation of recommendation principles (i.e. generic, yet relevant guidelines and design specifications for the current recommendations and for future recommendations). We strongly encourage any stakeholder that is interested in driving change in the Galapagos Islands to reflect on these principles in their design of new recommendations. These principles could and should be used as a check, since there is a likelihood these principles may be forgotten after multiple sessions of discussions and implementation versions.

The POSIWID Principle

If the powers that be (e.g. corrupt agents in the State, the "Mafia,") wanted to change things they would. In the Galapagos, the current status serves certain interests (POSIWID). Therefore, recommendations which increase future sustainability but require authority or power to implement, may be ignored if the new ideas do not support the interests currently benefiting from the system. Any specific policy recommendation that does not account for the POSIWID character of the Galapagos as a System and therefore does not account for policy resistance and maintenance of the status quo is likely to be ineffective. This is not a reason to create weak recommendations or actions but acts as a check to ensure the recommendations are feasible and consider all pertinent perspectives.

The CAS Principle

A CAS-based approach (CBA)[2] allows for incrementalism and scale. It can be bottom-up or top-down (if Principle the POSIWID Principle proves inaccurate) or both. The Galapagos is a complex and adaptive system and thus, most of the solutions we propose should attempt to be CAS-based. Any specific recommendation that does not account for the CAS-like character of the Galapagos as a System and therefore does not promote multi-agent action regardless of formal or informal authority is likely to be ineffective. No policy or plan can survive the adaptivity of interests if it is not itself massively adaptive.

The Symbiont Principle

The Galapagos is a symbiont. The social and environmental sustainability of the Galapagos System are elements in a symbiotic balance. One cannot be improved without the other. Any effort to improve environmental sustainability should also attempt to improve social systems in order to maintain the balance. If the balance is not maintained the elements are competitors and become antagonistic. The current system in the Galapagos displays the results of imbalanced policies and recommendations.

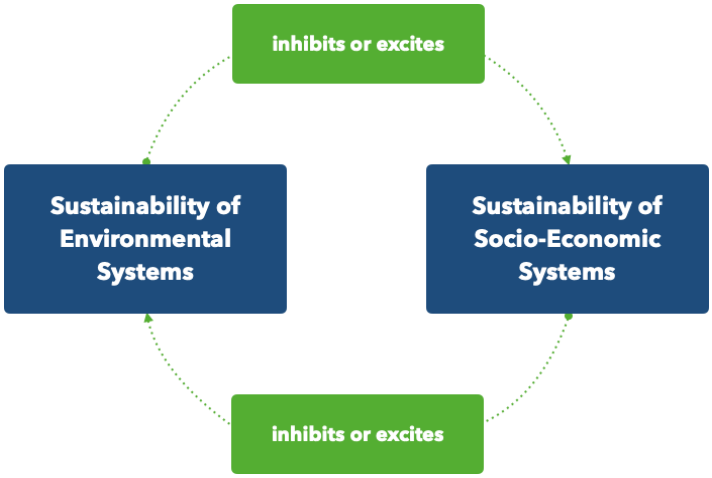

Figure 16. Sustainability of Systems

[2] A CAS-based approach is defined as emergent change predicated on individual choices/actions of agents.

The Sustainable Conservation Principle

Sustainability as the ultimate goal should aim for conservation and not preservation. This principle cannot be decoupled from the Symbiont Principle. Conservation in this context means that social systems are acknowledged and balanced when ameliorating environmental conditions, where preservation's focus is solely on the environment.

The Scalar Interests Principle

There are multiple levels of interest including Locally interested parties (LIPs), State Interested Parties (SIPs), and Globally Interested Parties (GIPs). The significance of this latter group (GIPs) makes the Galapagos System unique in the world. There are many other natural ecosystems like the Galapagos, but there are few to none that have the social implications and global awareness of the Galapagos. This unique circumstance can be leveraged toward the goals and provides an example for addressing systemic imbalances in other parts of the world where the GIPs are not as significant.

As stated, these Principles are used as a back check on the Recommendations in the following section. This also means that anyone with agency could utilize the Principles to come up with and implement their own changes on the Islands.

Recommendations

We used the guiding principles for recommendations outlined above as a check when developing our specific recommendations. We ensured that each recommendation aligned with one or more of our principles. Perhaps more importantly, we ensured that no specific recommendation violated any of the guiding principles for recommendations.

It is important to note that, while we have made nine specific recommendations for a sustainable Galapagos based on balancing social and environmental needs, these recommendations are not exclusive. There are likely many more. We provide these here as examples of the types of recommendations that could be effective.

Recommendation 1: Start "Cuerpo de Conservación de Galápagos (CCG)"

Work with local community leaders and local/global partnerships to fund and implement the CCG (Cuerpo de Conservación de Galápagos) or the Galapagos Conservation Corps as a primary win-win agent for balancing social and environmental sustainability.

The creation of a Conservation Corps of the Galapagos (CCG) would empower the local population to improve the environment, while simultaneously benefiting themselves and their communities. A conservation corps is a locally-based organization that engage young adults to get involved in their community with projects related to environmental conservation (Corps Network, n.d.). Through projects, participants learn the background and impetus for engaging in projects, accomplishing goals, and most importantly the understanding the purpose and why it matters (USA Conservation, n.d.).

Environmental Benefits of a Conservation Corps (Corps Network, n.d.)

● Build, maintain, and improve trails ● Maintain fish and wildlife habitats ● Control the spread of invasive species	● Support community recycling efforts ● Natural disaster recovery

Social Benefits of a Conservation Corps (Corps Network, n.d.)

● Sense of being involved in something bigger than yourself ● Workforce skill improvement ● Gain English language skills	● Health benefits ● Improved ties to community ● Leadership development ● Natural environmental education

Creating the CCG will foster international and domestic partnerships, while training local youth and community members to provide a sense of cohesion and relationship building among different agencies and stakeholders on the islands.

Within the CCG, we recommend creating a "youth corps" that engages individuals, called "crew members" between 16 and 18 years old. The prescribed model could be adjusted, as necessary, to engage younger individuals, aged 10 to 15 years old. Groups would be composed of older and younger crew members. This would allow for older crew members to serve as mentors and role models for younger members. One critical component is that all crew members must be Galapaguenos, although individuals from international organizations could be a part of the group for exposure to the English language. The crews would work on fee-for-service projects sponsored by local/global partnerships such as the National Park, the Ministry of Agriculture, and municipal governments, among others. It is critical that projects balance social and environmental sustainability, meaning projects should not only benefit the partner organization, but also the community.

Basic structure and Corps Concept

A Conservation Corps = Fee-for-service project (from agency, municipality, avoiding taking projects away from labor, etc.) + Crew leader (Lead and Assistant) + 8-10 Youth Crewmembers:

- The size of the Corps is simply a function of the number of projects and the number of crews
- Crews camp together with tools and vehicles with a trailer
- Crew members do not receive a "wage"
    - Compensation options could include a "living stipend" and/or an "educational stipend" for crew leaders and their assistants
    - Since most of the crewmember's experience is camping roadside or onsite, their living wage can be minimal
    - Depending on projects, community-based crews could also reside at their own homes and camp onsite for some but not all of their work projects
- Conservation Corps are relatively easy to start
    - All that is needed is a project, a crew, and transportation
- Focus on experiential trainings for both Crew Leaders and Crew Members
- Focus on English language, entrepreneurialism, ecology, and journalism
- Curriculum planning for skills development (badges earned for English, Environmental and Social development, First Aid).

Esprit de Corps (the "Spirit of the Corps") is essentially important.

- Uniforms, badges, patches, training, culture, and marketing builds a sense of pride, fellowship, self-esteem and connection to community and environment
- Organizationally, it is important to maintain low overhead, where fee-for-service projects and some local-global fundraising supports overhead

The Conservation Corps is non-partisan and non-political. For various reasons, people from across the political spectrum will be supportive of the "Corps Concept," often for similar or different reasons.

Some of the many reasons include community development, work skills development, youth development, environmentalism, social good, youth development, personal responsibility, among others.

Recommendation 2: Connect Galapagos Guides and use them as a valid source of the voice of balance

Connect Galapagos Guides across Galapagos (in San Cristobal, Santa Cruz, and Isabela, etc.) through social media platform(s) to leverage their voice to communicate the concerns of the local activities. The Galapagos Guides, among all of the interest groups, are structurally, the role that would be most likely to maintain a balance between social and environment.

- Create subgroups (e.g. Facebook group for Isabela Guides) for localized issues (in San Cristobal, Santa Cruz, and Isabela, etc.)
- Create one large group for all guides
- Create another group or make it part of the *Conversation Crew* that other interested parties are members (WWF, UNESCO, News outlets, etc.) so that they can see emerging issues
- Set up formal relationships and channels of communication between Guide Leadership and Global Interested Parties (GIPs) such as UNESCO, WWF, Transparency International, Cornell, etc.
- Utilize news cycle and exposure to create embarrassment to prompt change and amplify Guide voice
- Encourage Galapagos Guides to continue to pursue newly emerging leadership and solidarity efforts among guides

Recommendation 3: Build a "three-legged stool" partnership

Create a three-legged stool between GIPs, CCG and the Galapagos Guides providing these local collectives as local voices representing the Galapagos in order to combat pervasive corruption. This could also build a pipeline for youth to become Galapagos Guides by increasing connections through

community service requirements, and mentoring. This tripartite partnership could influence the National Park and the Ministry of Agriculture to select projects for funding which would be beneficial to social and environmental sustainability. In turn, these funded projects could act as fee-for-service projects for the CCG.

Recommendation 4: Start Farmer Federation

Work with local community leaders and local and/or global partnerships to fund and implement a marketing campaign, insignia, and certification to encourage production and consumption of locally produced food in order to reduce cargo imports. Such measures are targeted to address the lack of communication in the production chain among farmers as well as in the supply chain between farmers and consumers, including hotels and restaurants. Specifically, this recommendation being implemented through a Galapagos mobile app will connect farmers and consumers in a social media network in order to coordinate and systematize growing, transport, and sale of produce.

The first step should be taken at the farmers level through the coordination of the scalable growth of certain agricultural commodities. The created farmers network would allow producers to ensure production of agricultural output both in terms of the amount produced and delivery time in order to meet local demand on certain crops, vegetables and fruits. Based on the information on local market structure, including production, demand and supply, farmers would be able to coordinate their actions, for example, through such forms of agricultural production as specialization and cooperation.

The following step is to connect local farmers with restaurants and hotels that seek local sourcing as the main import-based sourcing to fill a gap in local demand and supply. Consequently, there should be a trustworthy system in place that will connect the demand of food by the hospitality business with the

supply by local farmers. It is worth mentioning that local farmers need some transitional period to build their production pipeline and improve capacity; that is why readiness of restaurants and hotels to redistribute some part of consumption towards locally grown agricultural products is crucial in achieving food security objectives.

Finally, to address the food security and invasive species problems, particular actions could be taken at the level of individual consumers (local citizens and tourists) to educate people on the relationship between food consumption, cargo, invasive species issues, and how an individual's choice contributes to that problem. Additionally, to develop community gardens and co-ops, they must allow individuals to grow the crops they need for household consumption.

Recommendation 5: Start "Other" Federation Networks

Based on the success of the Guides, CCG, Tourist, and Farmer Networks, start other networks modeled after this success. Such network systems can be built among NGOs and/or municipalities for more efficient development and implementation of projects and programs that ensure a socio-environmental balance. Additionally, certain coordination actions could be taken at the level of operators and fishermen.

Recommendation 6: Start Import = Invasive species Campaign

Work with local community leaders and local/global partnerships to fund and implement a "Import-free = Invasive-free" marketing campaign. This consists of insignias and certifications accessed through a Galapagos mobile app with two user groups in mind, tourists and vendors. Through the app, tourists would know where to patronize (e.g. dine, shop, stay, find services) based on the degree to which

that organization is “cargo-free” or utilizes locally-sourced products and services. Meanwhile, vendors would be able to apply and receive certification that allows them to use insignia and certification labelling on their brochures, menus, and marketing materials to attract tourists. From this campaign, there would be an increase in local social sustainability (economies) and a decrease in net cargo/imports that would mitigate the issue of invasive species.

Recommendation 7: Start a "Balance" Campaign

Work with local community leaders and local/global partnerships to fund and implement a marketing campaign, insignia, and certification accessed through a mobile app that commits Galapagos NGOs to balance activities toward social AND environmental sustainability. Similar to the Import = Invasives campaign, this one would establish a certification that could be utilized to garner support for high-performing actors, specifically NGOs that maintain a good rating serving local communities in this case. Among the requirements for this program is a commitment and audit of participating NGOs’ goals and metrics. At least 25% initially—working towards a 5-year plan of 50%—of their goals and metrics must be socially impactful.

Recommendation 8: Widely Publish and Disseminate Accessible Report and Collateral

Write a report and executive summary that provides clear mental models of difference with attached marketing campaigns. Ecuador sees Galapagos as a place to generate a lot of revenue, and utilizes siphoning, corruption, and bureaucracy to manage money/power flows. The fable of “*La gallina de los huevos de oro*” is locally understood and could be used to move people. Additionally, sustainable

development must be seen as a Social-Environmental Symbiont and used to commit networks, elevate local-global voices, and add pressure to embarrass authorities into compliance, diminishing corruption.

The Galapagos is a system made up of a Network of Networks (Guides, Farmers, Fisherman, Drivers, Tourists, GIPs, NGOs, Operators/restaurants/hotels, CCG, “Mafia”) operating at different Scales (Global, Country-Ecuador, Local-Galapagos) so even marginal changes have the ability to have a profound impact.

Recommendation 9: Partner with an Independent Organization to Monitor Transparency

An independent organization (a university, or other independent advisory organization) should be used to monitor Recommendations 1 to 4 above. This organization would be able to monitor initiatives for corruption and certify validity/results. For example, if a university were to be this organization, a sponsored website should be created that "houses" all of these materials, apps, reports, collateral, applications, and related materials. This site would serve as a trusted source of information that could be leveraged by international news organizations that is up-to-date and accurate.

Principles as a Checklist for Recommendations

As stated before, these Principles are used as a back-check on the Recommendations section. This also means that anyone with agency could utilize the Principles to come up with and implement their own changes on the Islands. We strongly encourage any stakeholder that is interested in driving change in the Galapagos Islands to reflect on these principles in their design of new recommendations. These principles could and should be used as a check, since there is a likelihood these principles may be forgotten after multiple sessions of discussions and implementation versions.

Table 9. Principles versus Recommendations

	PRINCIPLES				
	The POSIWID Principle	The CAS Principle	The Symbiont Principle	The Sustainable Conservation Principle	The Scalar Interests Principle
Proposed Recommendations	✓	✓	✓	✓	✓
Start Cuerpo de Conservación de Galápagos (CCG)	✓	✓	✓	✓	✓
Connect Galapagos Guides	✓	✓	✓	✓	✓
Build a "three-legged stool" partnership	✓	✓	✓	✓	✓
Start Farmer Federation	✓	✓	✓	✓	✓
Start "Other" Federation Networks	✓	✓	✓	✓	✓
Start Import = Invasives Campaign	✓	✓	✓	✓	✓
Start "Balance" Campaign	✓	✓	✓	✓	✓
Widely Publish and Disseminate Accessible Report and Collateral	✓	✓	✓	✓	✓
Partner with an Independent Organization to Monitor Transparency	✓	✓	✓	✓	✓
Example Recommendations That Fail Principle Checks					
Reform the Special Law of 1998		✗			✗
Found an English Language School				✗	

Conclusion

The geographical isolation of the Galapagos uniquely positions the Islands as an isolated system with clear boundaries. Being a CAS, this system presented itself as an ideal object of study for the Systems Thinking, Modelling, and Leadership (STML) cohort. Upon an initial search that revealed an often single-lens approach in the literature about the Galapagos, we noticed an imbalance in the representation of social and environmental systems—despite the two being interconnected. Fieldwork confirmed this suspicion. Employing a systems thinking approach guided by DSRP, we sought to gain a holistic understanding of the Islands, specifically in an attempt to investigate whether persistent issues can be attributed to the existing tensions between these two systems.

Our systems analysis reinforced this disparity; environmental systems are indeed given higher priority than social ones. The disproportionate focus between two equally significant (and synergetic) systems is indeed responsible for certain wicked problems in the Galapagos. However, our findings go further to suggest that the observed issues on the Islands, and the patterns by which they reoccur, stem from additional underlying systemic structures and mental models. Not only is a balance between social and environmental systems absent, but there also exists a lack of connectivity as well as uneven power dynamics between local and global agents that give way to the emergent issues we noticed in the field. Ultimately, unaddressed relationships, or the lack thereof, yield the current state we see.

With this deeper understanding of the system, we established a set of principles based on our analysis to guide changes, taking into account the importance of treating the Galapagos as a system, and developed appropriate recommendations. While these recommendations can accomplish much in bridging the gap between social and environmental systems, they alone are not enough. To drive the Galapagos

towards a more sustainable future, there needs to be a shift in how we approach what we do on the Islands. Whether in researching phenomena or crafting policies, future endeavors must be systemic, taking care to consider the existence and interconnectedness of multiple component systems within the larger Galapagos system. In order to reach a sustainable approach to the problems, issues, and systems of the Galapagos, all stakeholders must work towards symmetry between environmental factors and social factors because these factors are inherently symbiotic—only when neither is given short-shrift will both be protected and solutions be sustainable into the future.

Our systemic approach addressed both the surface-level issues that were identified and the underlying reasons that explained the observable behaviors in the Galapagos Islands. However, given the current state of knowledge highlighted in the Literature Review section, our work has merely scratched the surface of all the dynamic interactions amongst the agents in this system. Our contribution lies in the empirical finding of the socio-economic and environmental imbalance and the Systems Thinking approach to our principles and recommendations. This alone will allow future research to converge towards more balanced outcomes, both in the Galapagos and in other regions with similar contexts, where the interdependence of man and nature are key to a sustainable future.

Works Cited

Berón, Echavarría, D., & Amherst College. Department of Environmental Studies. (2015). Looking-glass paradise: Identity, economic growth, and natural resource governance in the Galápagos islands, 1535-2015(Unpublished doctoral dissertation). Amherst College.

Boote, David N., and Penny Beile. “Scholars Before Researchers: On the Centrality of the Dissertation Literature Review in Research Preparation.” Educational Researcher, vol. 34, no. 6, Aug. 2005, pp. 3–15. DOI.org (Crossref), doi:10.3102/0013189X034006003.

Brewington, L. (2013). The Double Bind of Tourism in Galápagos Society. Science and conservation in the Galápagos Islands: frameworks & perspectives. New York: Springer.

Brewington, Laura. (2011) The Politics of Invasion: Defining and Defending the Natural, Native and Legal in the Galápagos Islands of Ecuador, ProQuest Dissertations Publishing.

Cabrera & Cabrera (2018) *Flock Not Clock: Design, Align, and Lead to Achieve your Vision*

Cabrera & Cabrera (2016) *Systems Thinking Made Simple: New Hope for Solving Wicked Problems*

Cabrera & Cabrera (2018) *The Knowledge-Method Matching Matrix*

Cabrera, D. (2006). *Systems thinking* (p. 303) [Dissertation]. Cornell University.

Celata, Filippo, and Venere S. Sanna. (2012) "The Post-Political Ecology of Protected Areas: Nature, Social Justice and Political Conflicts in the Galápagos Islands." Local Environment, vol. 17, no. 9, pp. 977-990.

Corps Network, (n.d.) Retrieved from: https://corpsnetwork.org/our-impact/conservation/

Darwin, C. (2003). On the origin of species by means of natural selection. (J. Carroll, Ed.). Peterborough, Ont.: Broadview Press.

DSRP Theory as Method - Plectica. https://www.plectica.com/maps/HKVJ003OA. Accessed 13 May 2020.

Helmann, J. D. (1997). what is life? . Lynn margulis , dorion sagan. The Quarterly Review of Biology, 72(1), 62–63. https://doi.org/10.1086/419666

Hennessy, Elizabeth. (2018) "The Politics of a Natural Laboratory: Claiming Territory and Governing Life in the Galápagos Islands." Social Studies of Science

Mackey, Richard H. Sr. Translating Vision into Reality: the Role of the Strategic Leader. (Carlisle Barracks, PA: US Army War College, 1992), 10. Footnote: 15

SpringerLink. (2019). Urban Galápagos: Transition to Sustainability in Complex Adaptive Systems. (T. Kvan & J. Karakiewicz, Eds.) (1st ed. 2019.). Cham: Springer International Publishing. https://doi.org/10.1007/978-3-319-99534-2

Taylor, J., et al. (2003) "The Economics of Ecotourism: A Galápagos Islands Economy-Wide Perspective." Economic Development and Cultural Change, vol. 51, no. 4, 2003, pp. 977-997.

Villacis, B., & Carrillo, D. (2013). The socioeconomic paradox of Galápagos. In Science and conservation in the Galápagos Islands (pp. 69-85). Springer, New York, NY.

USA Conservation, (n.d.) Retrieved from: http://www.usaconservation.org/programs/conservation-corps/

What is DSRP as a research method? (n.d.). Retrieved May 13, 2020, from https://help.cabreraresearch.org/what-is-dsrp-as-a-research-method

Appendix A: Literature Review Methods Analysis

TOPIC	METHOD	AUTHOR	YEAR	TITLE	SAMPLE
Politics/Economics	Observational	Brewington, Laura	2011	The Politics of Invasion: Defining and Defending the Natural, Native and Legal in the Galápagos Islands of Ecuador,	160 - semi structured interviews
Politics/Economics	Combining previous frameworks	Celata, Filippo, and Venere S. Sanna.	2012	"The Post-Political Ecology of Protected Areas: Nature, Social Justice and Political Conflicts in the Galápagos Islands." Local Environment,	0
Politics/Economics	Observational	Hennessy, Elizabeth.	2018	"The Politics of a Natural Laboratory: Claiming Territory and Governing Life in the Galápagos Islands."	2
Politics/Economics	Surveys - quant done on govt survey data	Taylor J et. al	2003	"The Economics of Ecotourism: A Galápagos Islands Economy-Wide Perspective."	1142
Fishing/Marine Life	Combining previous frameworks	Barragán P., Maria José	2019	Exploring the Governability of Small-Scale Fisheries in Ecuador and Galapagos Islands Under the Buen Vivir Principle	0
Fishing/Marine Life	Quasi-quant aka Questionnaire	Schuhbauer, Anna, and Volker Koch.	2013	"Assessment of Recreational Fishery in the Galapagos Marine Reserve: Failures and Opportunities	133 logbooks from boat

Fishing/Marine Life	Survey	Johnston, Richard S., and Ann L. Shriver.	2001	Impacts of Marine Reserves in the Galapagos Islands: Some Considerations. International Institute of Fisheries Economics and Trade,	884
Fishing/Marine Life	Quasi quant - survey data and estimation	SHEPHERD, S. A., et al.	2004	The Galápagos Sea Cucumber Fishery: Management Improves as Stocks Decline	Estimation
Fishing/Marine Life	Description	Merlen, Godfrey	1995	"Use and Misuse of the Seas Around the Galápagos Archipelago."	0
Fishing/Marine Life	Semi structured and informal interviews	Barragán Paladines, María J., and Ratana Chuenpagdee	2015	Governability Assessment of the Galapagos Marine Reserve.	NA
Fishing/Marine Life	Surveys	Stewart, Micki	2008	Of Fish and Men: An Economic Analysis of the Galápagos Marine Reserve Resources Management Plan	1st Round: 260 households + 517 tourists 2nd Round: 276 tourists + followup 3rd Round: post follow up on secondary sources
Fishing/Marine Life	Descriptive	Castrejón, Mauricio, and Anthony Charles.	2013	"Improving Fisheries Co-Management through Ecosystem-Based Spatial Management: The Galapagos Marine Reserve."	0
Fishing/Marine Life	Description	Carrión-Cortez, Javier A., Patricia Zárate, and Jeffrey A. Seminoff.	2010	"Feeding Ecology of the Green Sea Turtle (Chelonia Mydas) in the Galapagos Islands."	65

Fishing/Marine Life	Observation	Usseglio, Paolo, et al	2016	So Long and Thanks for all the Fish: Overexploitation of the Regionally Endemic Galapagos Grouper Mycteroperca Olfax	7 photos 4 different datasets
Conservation	Descriptive	Drumm, Andy & Moore, A	2005	Ecotourism Development - A Manual for Conservation Planners and Managers. Volume I - An Introduction to Ecotourism Planning.	0
Conservation	Meta Analysis	Carlos A Valle	2013	Ch 1 "Science and Conservation in the Galapagos Islands"	150 references
Conservation	Description	Diego Quiroga	2013	Ch 2 Chainging views of the galapagos	48 references
Conservation	Quasi Expiermental	Stephen Walsh and Carlos Mena	2013	Ch 3 Perspectives for the study of the Galapagos Islands: Complex Systems and HUman Environment Interactions	53 references
Conservation	Descriptive	Byron Villacis and Daniella Carrillo	2013	Ch 4 The SOcioeconomic Paradox of Galapagos	NA
Conservation	Observational	Wendy Wolford, Flora Lu, & Gabriella Valdivia	2013	Ch 5 ENvironmental Crisis and Production of Alternatives: Conservation Practices in the Galapagos Islands	Interviewed 105 local residents/ observations during field work
Conservation	Observational / Survey	Laura Brewington	2013	Ch 6 The double bind of tourism in Galapagos society	1242 respondents
Conservation	Descriptive/Interview	Michelle Hoyman and Jamie McCall	2013	Ch 7 The evolution of ecotourism: the story of Galapagos Islands and the Secial Law of 1998	Interviewed local government and nonprofit leaders (N

					not provided)
Conservation	Observational / Interviews	Rachel Page, Margaret Bentley, and Juliee Waldrop	2013	Ch 8 People Live Here: Eternal and Child help on Isla Isabela, Galapagos	18 respondents
Conservation	Quasi Expiermental	Amy McClearey	2013	Ch 9 Characterizing Contemporary Land Use/Cover Change on Isabela Islands	Sampling areas (n = 263).Quick Bird satellite images used for analysis
Conservation	Observational	Curtis Stumpf, Raul Gonzalez, and Rachel Nobel	2013	Ch 10 INvestigating the Costal Water Quality of the Galapagos Islands, Ecuador	Two islands (molecular techniques to determine the quantities of Enterococcus spp. and Bacteroides spp. specific mark- ers)
Conservation	Observational	George Malanson and Stephen Walsh	2013	Ch 12 geographical approach to optimization of response ot evasive species	28 plots (2 study sites, 14 plots in each study site)
Conservation	Descriptive	Hennessy, Elizabeth	2013	Producing ‘prehistoric’ Life: Conservation Breeding and the Remaking of Wildlife Genealogies.	1
Conservation	Descriptive	Hearn, Alex.	2008	"The Rocky Path to Sustainable Fisheries Management and Conservation in the Galápagos Marine Reserve.	2 (lobster fishery and sea cucumber fishery

Conservation	Descriptive	Hennessy, Elizabeth, and Amy L. Mccleary	2011	"Nature's Eden? the Production and Effects of 'Pristine' Nature in the Galápagos Islands.	125
Conservation	Observation - interviews, photography, mapping, etc	Mathis, Adrienne, and Jeff Rose.	2016	"Balancing Tourism, Conservation, and Development: A Political Ecology of Ecotourism on the Galapagos Islands."	30
Conservation	Quasi-experimental	Benitez-Capistros, Francisco, et al.	2016	"Exploring Conservation Discourses in the Galapagos Islands: A Case Study of the Galapagos Giant Tortoises."	54
Conservation	Descriptive data analysis	González, José A., et al	2008	"Rethinking the Galapagos Islands as a Complex Social-Ecological System: Implications for Conservation and Management."	0
Conservation	Descriptive	Grenier, Christophe, and Mark Gardener	2011	"Linking Livelihoods and Conservation-Challenges Facing Galápagos Islands."	0
Conservation	Descriptive	National Public Radio	2005	Analysis: Fishermen, Conservationists at Odds in Galapagos	3
Conservation	Observational - interviews	Hennessy, Elizabeth.	2010	Crisis in Nature's Eden: Conserving Nature and Culture in the Galápagos Islands	28 interviews, 43 people
Sustainability	Using a framework - case study	Pazmiño, Andrés, Silvia Serrao-Neumann, and Darryl L. Choy	2018	Towards Comprehensive Policy Integration for the Sustainability of Small Islands: A Landscape-Scale Planning Approach for the Galápagos	0

				Islands.	
Sustainability	Descriptive	Kvan, Thomas, and Justyna Karakiewicz	2018	Urban Galapagos : Transition to Sustainability in Complex Adaptive Systems	NA
Wicked Problems/Complex Systems	Descriptive	Bassett, Carol Ann	2009	Galapagos at the Crossroads: Pirates, Biologists, Tourists and Creationists Battle for Darwin's Cradle of Evolution	NA
Wicked Problems/Complex Systems	Summary of gathered national data sources and description. surveys	Denkinger, Judith, and Luis Vinueza	2014	The Galapagos Marine Reserve : A Dynamic Social-Ecological System	NA
Wicked Problems/Complex Systems	History - description and summary	David Berón Echaverria	2015	“Looking-Glass Paradise: Identity, Economic Growth, and Natural Resource Governance in the Galápagos Islands,	0
Wicked Problems/Complex Systems	Summary and recommendation	Calvopiña M, S Chamorro, E Cruz, W Tapia and A Izurieta	2015	The Management Plan for the Protected Areas of Galapagos for Good Living: An innovative tool that contributes to the integrated management of the Archipelago.	0
Wicked Problems/Complex Systems	Summary	Bocci, Paolo	2017	Tangles of Care: Killing Goats to Save Tortoises on the Galápagos Islands."	0

Wicked Problems/Complex Systems	Observational/quasi-experimental	Taylor, J. E., Jared Hardner, and Micki Stewart	2009	"Ecotourism and Economic Growth in the Galapagos: An Island Economy-Wide Analysis."	$ not people
Wicked Problems/Complex Systems	Observational - interviews	Westerman, Alyssa.	2012	An Analysis of Energy Consumption on the Galápagos Islands: Drivers of and Solutions to Reducing Residents' Energy Consumption."	32
Wicked Problems/Complex Systems	Descriptive	Llerena-Pizarro, Omar R., et al.	2019	"Electricity Sector in the Galapagos Islands: Current Status, Renewable Sources, and Hybrid Power Generation System Proposal."	0
Wicked Problems/Complex Systems	Survey	O'Connor Robinson, Megan, Theresa Selfa, and Paul Hirsch	2018	"Navigating the Complex Trade-Offs of Pesticide use on Santa Cruz Island, Galapagos."	27
Wicked Problems/Complex Systems	Quasi-experimental, ABM	Walsh, Stephen J., and Carlos F. Mena.	2016	"Interactions of Social, Terrestrial, and Marine Sub-Systems in the Galapagos Islands, Ecuador."	Simulation
Wicked Problems/Complex Systems	Observational - interviews	Khatun, Kaysara	2018	Land use Management in the Galapagos: A Preliminary Study on Reducing the Impacts of Invasive Plant Species through Sustainable Agriculture and Payment for Ecosystem Services."	23
Wicked Problems/Complex Systems	Experimental	Cruz, Felipe, et al	2009	"Bio-Economics of Large-Scale Eradication of Feral Goats from Santiago Island, Galápagos."	NA

Wicked Problems/Complex Systems	Observational - surveys	Benitez-Capistros, Francisco, Jean Hugé, and Nico Koedam.	2014	Environmental Impacts on the Galapagos Islands: Identification of Interactions, Perceptions and Steps Ahead."	45
Tourism	Frameworks used to analyze observational data	Ruiz-Ballesteros, Esteban, and Eduardo S. Brondizio.	2013	"Building Negotiated Agreement: The Emergence of Community-Based Tourism in Floreana (Galápagos Islands)."	0
Tourism	Use of models (SD) to analyze observational and obtained data	Pizzitutti, Francesco, et al.	2017	"Scenario Planning for Tourism Management: A Participatory and System Dynamics Model Applied to the Galapagos Islands of Ecuador."	NA
Tourism	Case Study	Viteri Mejía, César, and Sylvia Brandt	2015	"Managing Tourism in the Galapagos Islands through Price Incentives: A Choice Experiment Approach."	NA
Tourism	Observational (interviews) and lit review	Hoyman, Michele M., and Jamie R. McCall	2013	"Is there Trouble in Paradise? the Perspectives of Galapagos Community Leaders on Managing Economic Development and Environmental Conservation through Ecotourism Policies and the Special Law of 1998."	100
Water	Experimental	Reyes, Maria F.	2017	Assessment of Domestic Consumption in Intermittent Water Supply Networks: Case Study of Puerto Ayora (Galápagos Islands).	15 households

Water	Quasi Experimental / Literature Review	Reyes, Maria F.	2017	"Mitigation Options for Future Water Scarcity: A Case Study in Santa Cruz Island (Galapagos Archipelago)."	NA
Water	Descriptive		1995	"Management of Urban Wastewater on One of the Galapagos Islands.	NA
Water	Experimental	William A. Gerhard, Wan Suk Choi, Kelly M Houck, Jill R Stewart,		Water quality at points-of-use in the Galapagos Islands	NA
Other	Observational	Stepath, Carl M.	2009	Environmental Education in the Galápagos: Where do we go from here? In Wolff, M and Gardener, M. (Eds.)(2009) Proceedings of the Galápagos Science Symposium 2009, Galápagos Islands, 20-24 July 2009	NA
Other	Quant Analysis	Viteri, César, and Carlos Chávez	2007	"Legitimacy, Local Participation, and Compliance in the Galápagos Marine Reserve.	NA
Other	Observational	Charles Darwin Research Foundation	2015-2019	Charles Darwin Research Foundation Annual Report	NA
Other	Observational	Charles Darwin Research Foundation	2015-2019	Charles Darwin Research Foundation Annual Report	NA