NEW APPROACHES

GALAPAGOS REPORT 2015-2016

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PLAN GALAPAGOS: AN INSTRUMENT FOR THE HOLISTIC SUSTAINABLE DEVELOPMENT OF THE PROVINCE

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PLAN GALAPAGOS: An instrument for the holistic sustainable development of the province

Ana Rousseaud[1], Eliecer Cruz[1], Edwin Naula[1], Ángel Ramos[1], Marianita Granda[1], Mónica Calvopiña[1], Patricia León[1], Danny Sanchez[1], Fabián Zapata[2], José Guerrero[2], Lucio Gabriel[3], and Esteban Falconí[3]

[1]Governing Council of Galapagos, [2] UNPD–Ecuador, [3] WWF–Ecuador Program

With the establishment of the new Ecuadorian Constitution of 2008 and the subsequent legal framework to regulate Land Use Planning, Development and Land Use Plans (DLUP)[1] are the current planning instruments for the sustainable development of our societies and their territories. A primary objective of DLUPs is to articulate national policies at the local level and to establish development targets for each territory according to its attributes. This article describes the development of the Plan for Sustainable Development and Land Use Planning for the Galapagos Province 2015-2010 (Plan Galapagos) and its objectives for the sustainable development of the province. We also provide recommendations for next steps in the implementation of the Plan.

Plan Galapagos was approved by the plenary of the Governing Council of Galapagos on 9 December 2015, as stipulated in Article 5 of the Special Law for Galapagos (LOREG – Spanish acronym). It replaces the previous regional plan (Regional Plan for the Conservation and Sustainable Development of Galapagos, 2002) as the guiding instrument for provincial public policy to achieve sustainable development of the inhabited areas of the islands and the conservation of Galapagos ecosystems.

As the primary coordinating instrument of the Governing Council of Galapagos, Plan Galapagos articulates and empowers the existing planning tools at the national[2], provincial[3], and cantonal[4] levels, within the framework of the Special Law.

Given the unique conditions of Galapagos, Plan Galapagos also integrates international commitments, such as the World Heritage Convention, the Protocol for the Conservation and Management of Marine and Coastal Protected Areas of the Southeast Pacific, the Convention on Wetlands of International Importance (RAMSAR Convention), and others[5].

[1] Organic Code for Territorial Organization, Autonomy and Decentralization, and the Organic Code for Planning and Public Finance.
[2] Constitution of the Republic of Ecuador, National Plan of Good Living, national strategic agendas, National Strategy for Changing the Production Matrix, National Strategy for Equality and the Eradication of Poverty, among others.
[3] Management Plan for the Protected Areas (GNPD), Bioagricultural Plan for the Archipelago (MAGAP), Institutional Strategic Plan 2015-2018 of the Agency for the Regulation and Control of Biodiversity and Quarantine for Galapagos; Provincial Plan for Galapagos Culture 2015, among others.
[4] Cantonal and parish development plans.
[5] Convention on Biological Diversity, Man and Biosphere Program, Whale Sanctuary.

With regards to compliance with national and constitutional commitments, Plan Galapagos defines island conditions for *buen vivir* or good living, and essential conditions for the long-term conservation of the unique ecosystems of the province. Plan Galapagos strengthens the conceptual approaches forged during multiple planning processes in Galapagos over the last several years. In this context, Plan Galapagos describes the province as:

1. **A socioecosystem** (DPNG, 2014) that recognizes the high social value of the protected areas, which provide the foundation and support for *buen vivir* for the local population, through the provision of ecosystem services and biodiversity (food, water, energy, coastal protection, and spiritual enjoyment, among others).

2. **An ecotourism destination of excellence that promotes a model for sustainable development based on responsible tourism,** which promotes conservation of the Archipelago, visitor satisfaction, and the *buen vivir* of Galapagos residents.

3. **A pioneer territory for bioagriculture** (MAGAP, 2015), where a process of productive reconversion results in agriculture conducive to island conditions, to guarantee local provision of healthy food and contribute to the conservation of the protected areas.

4. **A model knowledge society, through a change in the production matrix,** so that wealth is generated not only through the exploitation of natural resources, but also through the knowledge and capacities of the local population.

5. **A sustainable society where urban and rural development** is combined in a way to enhance natural resources and where renewable energy is generated to reduce the use of fossil fuels.

These five concepts form the foundation of Plan Galapagos, which was developed following the methodology recommended by the Ecuadorian Ministry of Planning and Development (SENPLADES, 2014a) for the elaboration of provincial development plans.

Plan Galapagos is based on the first stage of a territorial diagnostic study, which defined the weaknesses and opportunities of the territory and the insular socioecosystem. The study was based on information collected during a public participation phase, and on available technical information and information generated specifically for this purpose. It is important to highlight the participation during this phase of the technical team and researchers of the Center of Strategic Prospective, the National Institute of Higher Learning, and SENPLADES, who developed a flow analysis of the province, which was essential for the formulation of development scenarios for the Archipelago (SENPLADES, 2014b). This analysis was consolidated with feedback from technicians and authorities of the autonomous decentralized governments, other governmental institutions present in the Islands, and the coordinating ministries.

Methodology

The SENPLADES methodology for Development and Land Use Plans is structured according to five stages. The first stage involves developing a high-level diagnostic study of territorial dynamics by thematic area and defining problems and opportunities of the territory by sector. In the second stage, information collected in the first stage is compiled across sectors and a strategic territory diagnosis completed. These first two stages provide the foundation for stage three, the development of the Proposal for Sustainable Development for the region. This is the most important stage, as this is where the vision, policies, and goals of sustainable development are defined. Once the strategic proposal is completed, the land use plan is developed, a process that overlays the established policies across the province. Finally, the management model provides tools for the management and execution of the Development and Land Use Plan. This methodology was used to develop the structural components of Plan Galapagos (Figure 1).

A broad participatory process was employed to develop Plan Galapagos. Several participation mechanisms were developed to involve local citizens as well as public and private institutions.

During workshops held in the four populated islands, representatives were elected to form the first Provincial Citizen Assembly. The Provincial Assembly then met in Santa Cruz to prioritize problems and opportunities identified by the communities on the four islands.

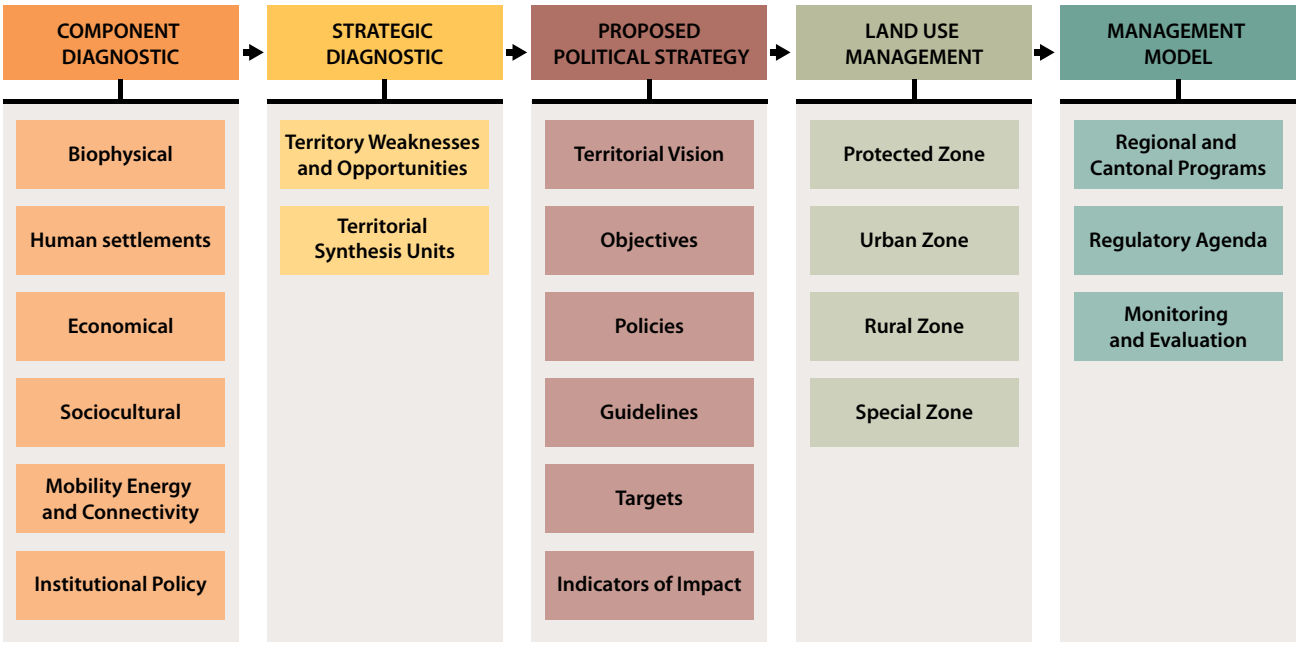

Figure 1. Methodological components of Plan Galapagos. Methodology SENPLADES

During the workshops, communities noted the importance of biodiversity and ecosystem conservation as the basis for good living in the Islands. Recommendations for immediate action included strengthening local human talent and the diversification and adaptation of productive sectors to local conditions. This information was used as a foundation for the programmatic proposal for regional planning.

Finally, both regional and national institutions actively participated in the construction of this management tool over the course of multiple multilevel, technical workshops (national, regional, municipalities, and parishes). Institutional capacity grew over time, and technicians and authorities demonstrated the skills and expertise that exist in the province. This local capacity is an important resource for consolidating a sustainable territorial model.

Results

The central problem raised by the present Territorial Diagnosis is that **the current development model for Galapagos is unsustainable over time**, due to multiple causes that generate negative impacts in human settlements as well as in protected areas. The main structural causes identified are low diversification of economic activities, high dependence on the continent for energy needs, poor Internet connectivity, growing unplanned urban expansion, a shortage of quality public spaces for recreational activities for the local population, limited coverage and quality of basic services, and a weak governance model that still does not respond to the dynamics and conditions of the territory.

These causes are producing a high dependency on tourism, introduction of invasive alien species to the province, biodiversity loss, inappropriate changes in land use, habitat fragmentation, impacts on water quality, and degradation of the living conditions of island communities.

However, multiple opportunities were also noted in the diagnosis, most notably the regular availability of natural resources in good conservation status, and the presence of human, economic, and institutional resources, which, if correctly articulated, could allow for the consolidation of a sustainable model of territorial management.

Plan Galapagos

The widely debated and agreed upon vision for the future of Galapagos is:

> A peaceful territory whose inhabitants are committed to the conservation of their natural heritage, where the exercise of the constitutional rights of *buen vivir* of the citizens and of nature are guaranteed; interculturality is encouraged, and makes possible fair and equitable access to the use and exploitation of natural resources according to the biophysical limits of the Archipelago, with a management and governance approach that establishes Galapagos as a national and international model of sustainable territorial development.
>
> Vision Plan Galapagos 2015-2020

Five strategic objectives for sustainable development were drawn from this vision. A set of integrated public policies and a battery of mileposts and indicators that will enable the monitoring and evaluation of Plan Galapagos will be implemented to achieve these objectives.

The five objectives, which focus on solving identified problems and strengthening opportunities associated with the Galapagos socioecosystem, are:

1. Consolidate an integrated model of sustainable development of the socioecosystem of Galapagos;
2. Promote *buen vivir* or good living of the residents of Galapagos, within the context of island life;
3. Promote a knowledge society and diversification of the production matrix;
4. Reduce energy dependence on the continent, optimizing the generation of renewable electricity, transport, and connectivity;
5. Strengthen the governance model of the Special Regime of Galapagos.

These five objectives involve specific and ambitious commitments, with interrelated lines of action. They serve as points of reference for obligatory policy and programmatic elements for the public and private sectors and other social actors present in the province (Table 1).

Table 1. The objectives and regional public policies of Plan Galapagos 2015-2020.

Consolidate an integrated model of sustainable development of the socioecosytem of Galapagos	1.1	Implement a model of comprehensive land management that considers biophysical limits and focuses on stopping the expansion of human settlements.
	1.2	Promote the sustainable use of ecosystems and their natural resources.
	1.3	Promote forms of sustainable consumption and production that reduce the flow of energy and materials from the continent.
	1.4	Regulate population growth according to applicable law and based on scientific information related to biophysical constraints of the ecosystems.
Promote *buen vivir* or good living of Galapagos residents, within the context of island life	2.1	Promote the cultural identity of the Galapagos population based on its unique surroundings and with a gender perspective.
	2.2	Improve social cohesion through the exercise of the rights of *buen vivir* or good living.
	2.3	Ensure adequate drinking water supply and environmental sanitation systems in ways that are appropriate for the insular ecosystem.
	2.4	Ensure access to quality public health services according to the geographical conditions of the Islands.
	2.5	Increase awareness of Ecuadorians in other provinces of the country regarding the natural and scientific values of Galapagos, its commitment to preserving this heritage for the future, and the *buen vivir* of its population.
Promote a knowledge society and diversification of the production matrix	3.1	Foster basic and applied research applicable to sustainable development of the territory and promote technology transfer.
	3.2	Promote the development of human talent according to labor demand in the territory.
	3.3	Consolidate a sustainable and solidarity-based socioeconomic system that favors artisan, agricultural, and fishing sectors.
Reduce energy dependence on the continent, optimizing the generation of renewable electricity, transport, and connectivity	4.1	Optimize air, land, and maritime transport systems, and the connectivity of the province.
	4.2	Promote the transformation of the energy matrix to a reliance on renewable resources.
Strengthen the governance model of the Special Regime of Galapagos	5.1	Consolidate the model of participatory management for planning for sustainable development to improve the governance of the province.
	5.2	Strengthen transparency and tax collection systems to enhance the equitable redistribution of income, and the economic and financial sustainability of the Special Regime.
	5.3	Consolidate a risk management system according to the characteristics of the territory.
	5.4	Strengthen and expand inter-institutional coordination capabilities among all government and private entities.

The strategic proposal of Plan Galapagos also includes the first territorial planning exercises in the province and the first time that land use planning unified the protected zones and the populated areas of the province. The purpose of this process is to respond to the needs of the island communities and preserve the natural heritage of the Islands based on the following objectives:

1. Establish sustainable human settlements that exist in harmony with the Galapagos National Park (GNP) and the Galapagos Marine Reserve (GMR);
2. Establish the optimal conditions for the *buen vivir* or good living of the inhabitants of the Islands, without compromising ecological well-being and equilibrium;
3. Preserve the natural heritage.

Zones are classified according to function and use, as follows: protected zone (GNP and GMR), urban zone, rural zone, and special zone (Figure 2). Each zone has strategic guidelines aligned to regional objectives and public policy.

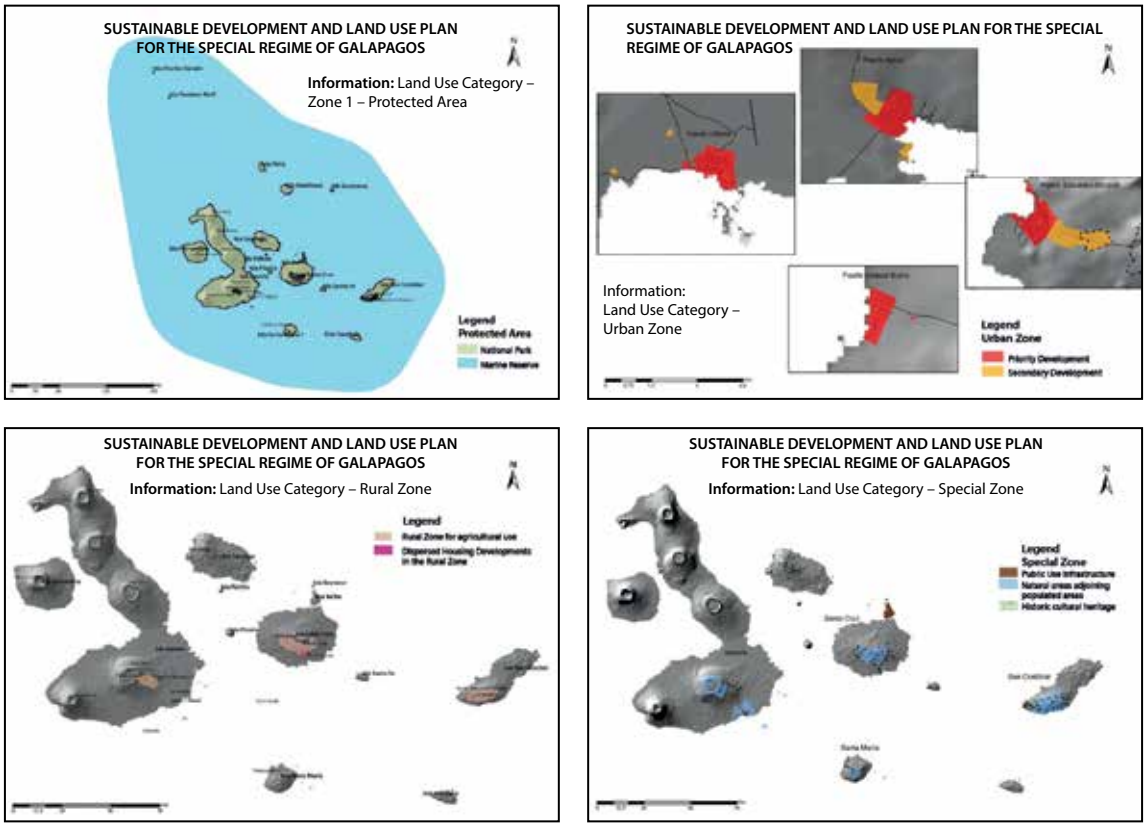

Figure 2. Maps of land use planning zones.
Source: Topographical maps of Galapagos, 1:100000, IGM. Processing and preparation: CGREG

The last section of Plan Galapagos proposes two key tools for implementation: 1) Targets and Indicators, and 2) Management Model of the Plan. The first is composed of 46 targets and 59 indicators that will allow a concrete assessment of the impact of proposed public policies and guidelines. The second presents an array of regional programs to be implemented within the next five years. These two technical and administrative tools will facilitate the execution of Plan Galapagos and the realization of the long-term vision.

Conclusions and recommendations

Plan Galapagos 2015-2020 proposes guidelines for the sustainable development and conservation of terrestrial and marine ecosystems of the Galapagos province. Based on current conceptual approaches developed from and for the Archipelago, the Plan synthesizes and aligns national and local planning instruments, projects sustainable development objectives for the province, and lays the foundation for provincial land use planning. In essence it becomes the reference planning instrument for the province.

Proposed sustainable development objectives and targets are ambitious and reflect the needs and aspirations of the Galapagos community and their representatives.

The integrated and sustainable management of this territory will require multiple responses from the social, environmental, economic, technological, political, and institutional sectors. To achieve the desired results, coordination among the public and private sectors as well as various social actors is fundamental.

Photo: © Richard Polatty

Finally, the empowerment of the population as key stakeholders and actors in developing a sustainable Galapagos will require that the objectives of Plan Galapagos are developed efficiently, fairly, and democratically, and contribute to *buen vivir* or good living of present and future generations.

The next steps for the implementation of Plan Galapagos are presented as recommendations:

1. Refine the proposal for land use planning on a smaller geographic scale to allow the continuation of work linking regional policies in land use planning to both protected and populated areas. This process will enable medium- and long-term solutions to current problems linked to land use conflicts and exploitation of natural resources (marine and terrestrial), an important step in achieving a better quality of life for citizens and the conservation of the ecosystems of the Archipelago.

2. Collaborate with the Executive and the Autonomous Decentralized Governments of the province to develop an annual regional agenda based on the management model of Plan Galapagos. This tool will facilitate institutional coordination and monitoring of actions of national and regional institutions in the province.

3. Strengthen the Provincial Citizen Assembly, responsible for citizen oversight of compliance with the provincial objectives and policies, leading the participatory process to update the regional plan, and informing the community about progress and content, to ensure that Plan Galapagos constitutes a tool for all Galapagos citizens.

4. Implement the process of generation and analysis of regional information for monitoring and evaluation of Plan Galapagos. The availability of data bases and up-to-date information will be vital to document the fulfilment of Plan objectives. This process will provide early alerts that allow feedback regarding the implemented public policies and will help ensure updates required by the Plan.

Acknowledgments

The richness and value of Plan Galapagos lies in the participatory process in which it was developed. This process involved citizens, technicians, experts, and various public and private institutions. The authors would like to thank each of these groups. We extend a special thanks to our donor organizations: Helmsley Trust, UNDP Ecuador, WWF Ecuador, Conservation International, and institutional members of the Governing Council, CEPROEC, and IAEN for technical advice and support throughout the process.

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BIOSECURITY IN GALAPAGOS IS VITAL FOR PROTECTING HUMAN HEALTH, THE LOCAL ECONOMY AND BIODIVERSITY

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Biosecurity in Galapagos is vital for protecting human health, the local economy and biodiversity

Marilyn Cruz, Mónica Ramos, Viviana Duque, Mariela Cedeño, Martín Espinosa, Alberto Vélez, Ronal Azuero, Manuel Mejia, David Arana and Rommel Iturbide

Agency for the Regulation and Control of Biosecurity and Quarantine for Galapagos

Introduction

The first quarantine program in the Galapagos Islands, the Inspection and Quarantine System for Galapagos (SICGAL – Spanish acronym), began May 31, 1999. Its aim was to prevent the entry of exogenous species to the Galapagos Islands. The program was run within Ecuador's national health authority. In 2012, the Ecuadorian Government decided that Galapagos required a stronger prevention system, given its special regime status. The government allocated additional funding and established the Agency for the Regulation and Control of Biosecurity and Quarantine for Galapagos (ABG – Spanish acronym) on 17 October 2012, through Executive Decree No. 1319. The ABG is a technical entity of public law ascribed to the Ministry of Environment.

The mission of the ABG is to control, regulate, prevent, and reduce the risk of introduction, movement, and dispersal of exotic organisms, which put human health, the economic system, and the native and endemic biodiversity of the Galapagos Islands at risk. The prevention and control system was strengthened through three quarantine barriers: (a) inspection and control at ports and airports of origin and destination; (b) surveillance and monitoring of pests and diseases in Galapagos; and (c) rapid response to phytozoosanitary emergencies.

At the start of 2013, the ABG had 49 employees; today there are 180. Over the last few years, various measures have been implemented including: installation of x-ray equipment at airport inspection points, procedural manuals, renewal of vehicle fleet, inspection equipment for examining the hulls of ships, detection dogs for the giant African land snail, and purchase of laboratory equipment. These actions have strengthened the three barriers of the prevention system for Galapagos, minimizing the risk of entry of introduced species or pathogens to the Islands.

Inspection and control at ports and airports of origin and destination

Through the implementation of the first quarantine barrier, phyto- and zoosanitary inspections are carried out on all air and maritime transport, including cargo, luggage, and passengers traveling to or transiting through the Galapagos Islands. The inspections are carried out at departure points on the Ecuadorian mainland as well as at destination points in Galapagos. The marine unit, added in 2014, carries out inspections of hulls of domestic and foreign ships traveling to the Islands, to prevent the potential arrival of invasive marine species.

At the end of 2015, the Agency increased the inspection staff by 88, thus substantially improving its capacity to inspect cargo at the different checkpoints. This resulted in a significant increase in confiscation of banned products, pest species, and permitted products that lacked the necessary requirements for admittance. The increase in confiscations occurred in spite of the decrease in the volume of cargo and transport modes, due to the sinking of three cargo ships that resulted in serious temporary food shortages in Galapagos (Table 1).

Table 1. The number of inspectors, inspections, and confiscations in the first quarantine barrier from 2013 to 2015.

Year	Number of inspectors	No. of quarantine and control points on the continent and in Galapagos	No. of means of transport inspected*	Organic cargo inspected (MT)	No. of hull inspections	No. of baggage inspected	No. of confiscations
2013	41	7	20,394	15,590.1	-	658,242	5844
2014	71	7	27,257	18,452.3	30	1,106,565	7034
2015	88	7	22,599	18,589.3	228	1,160,784	8057
		Total	**70,250**	**52,631.7**	**258**	**2,925,591**	**20,935**

*Includes cargo ships, private yachts, tourism vessels, international sailboats, interisland transport boats, and national and inter-island commercial boats.
Source: Annual reports ABG 2013-2015

Food safety

In order to identify which chemical pesticides enter the province, and to prevent contamination of the Islands' fragile ecosystems, ABG inspects the eight retail warehouses of agricultural products and five fumigation companies existing in the Islands. Control and regulation of the entry, storage, and dispensing of potentially dangerous products has become a primary task for AGB.

ABG also carries out periodic inspections of raw materials being transported or stored in silos for use in the dairy production chain.

Surveillance and monitoring of pests and diseases in Galapagos

The Mediterranean fruit fly (*Ceratitis capitata*) is considered one of the most serious pests worldwide because of its impact on several species of commercial crops, as well as endemic, and native plants. This pest is currently present on Santa Cruz and San Cristóbal Islands, where various ecofriendly control methods are being employed. The fruit fly population is measured by the technical index FTD (flies per trap per day), which estimates the average number of flies caught in a trap in a day of exposure in the field. This population index provides a relative measure of the size of the adult pest population in a given time and space (IAEA, 2005).

Regular monitoring is carried out on Santa Cruz (600 ha) and San Cristóbal (800 ha) (Table 2). The pest has not been reported on Isabela, Floreana, and Baltra, according to the information provided by the permanent monitoring system on those islands. The monitoring system includes 14 access routes and 479 traps (Figure 1).

In Santa Cruz and San Cristóbal Islands, the FTDs are currently low, indicating that the fruit fly populations have been controlled. However, in both 2014 and 2015, there was an increase in the fruit fly population during the period from January to May due to climatic conditions more favorable to the insect (Figure 2).

Table 2. Number of routes and traps for monitoring fruit flies.

Island	Hectares monitored	No. of routes	No. of traps
Santa Cruz	600	6	247
San Cristóbal	800	4	149
Floreana	90	1	25
Isabela	60	2	35
Baltra	10	1	23
Total	**1560**	**14**	**479**

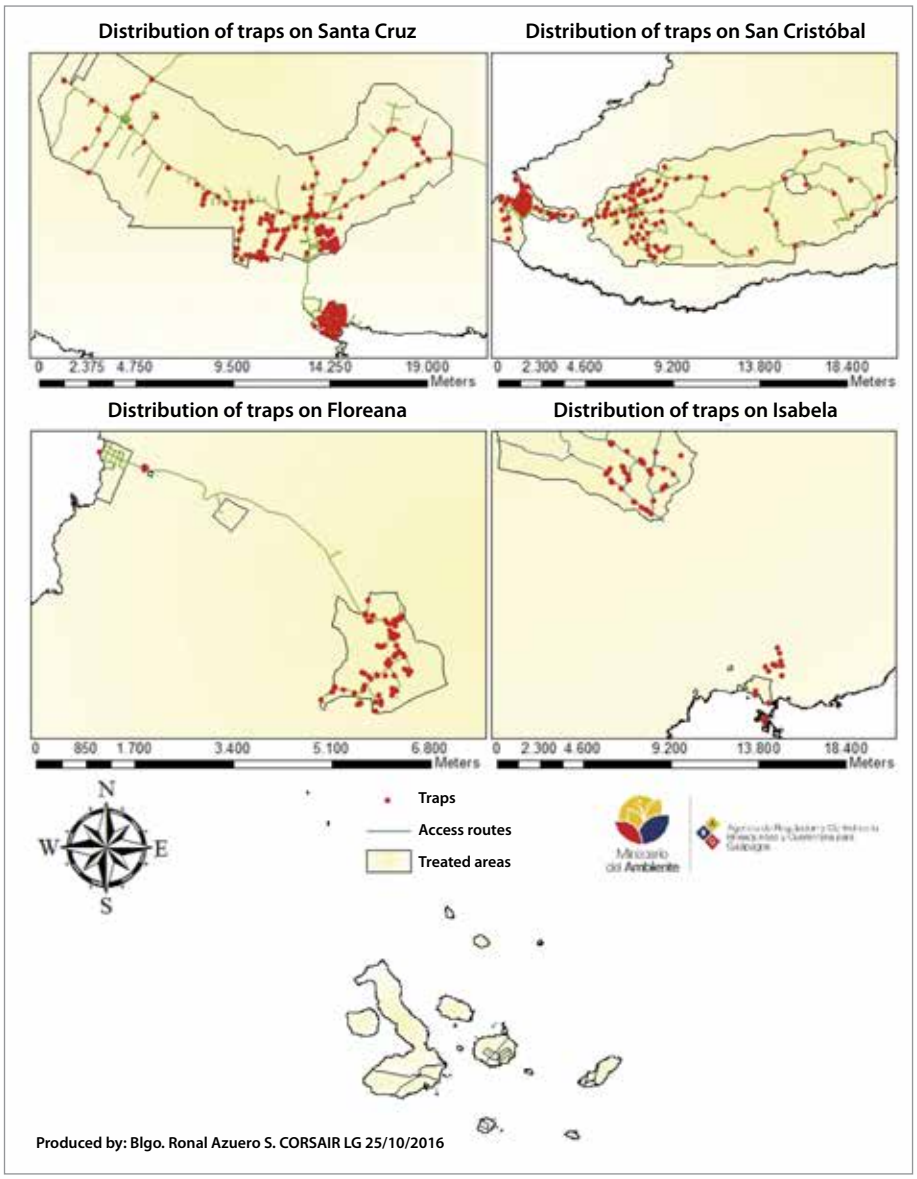

Figure 1. Distribution of fruit fly traps in the human populated islands.

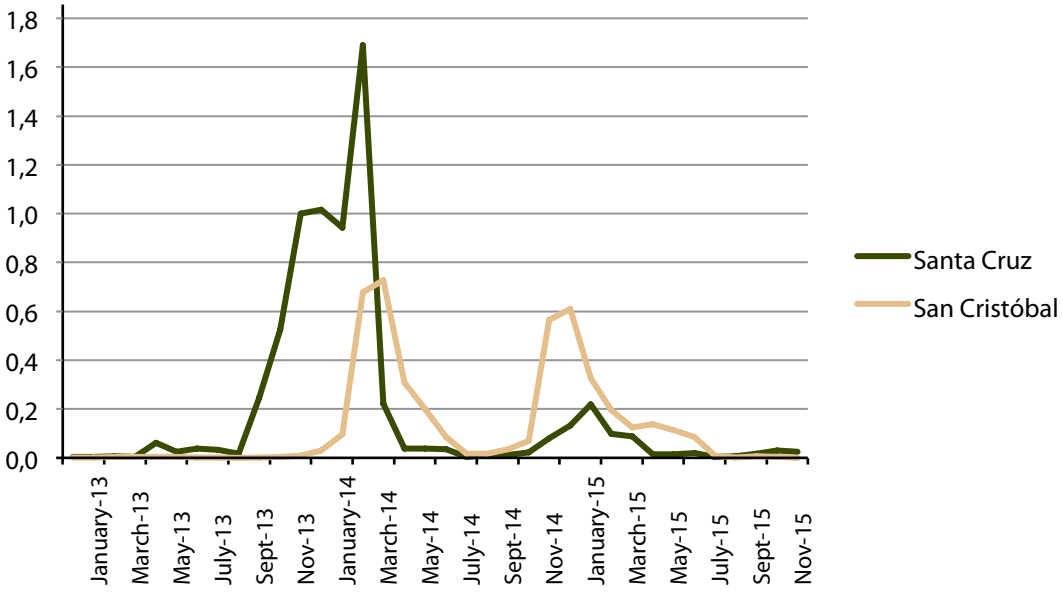

Figure 2. FTD (flies/trap/day) reported on the islands of Santa Cruz and San Cristóbal, 2013-2015.

Control and surveillance of the giant African snail

The giant African snail (*Lissachatina fulica*) is one of the pests of highest importance worldwide, due to the economic damage resulting from its impact on several plant species and endemic animal species, as well as its impact on humans, given that it is a transmitter of parasites. This species was first reported in Puerto Ayora and Bellavista on Santa Cruz Island in March 2010. To date, it has not been recorded on San Cristóbal, Isabela, or Floreana. However permanent monitoring is ongoing.

The ABG has been implementing a series of control measures, including manual collection and incineration, and removal of rocks and stones from infested areas, reducing population numbers and preventing its dispersal. This is a priority species for the quarantine system, as its characteristics facilitate its establishment and dispersal.

In 2013, 3391 individuals were incinerated. The implementation of the canine unit for snail detection and an increase in personnel in January 2014 contributed to a substantial increase the number incinerated in 2014 and 2015 (Figure 3). The number of farms infested has declined from 50 in 2010 to only 14 today.

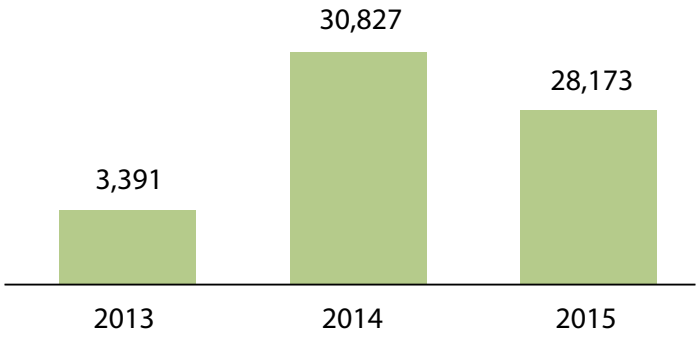

Figure 3. Number of snails detected and incinerated on Santa Cruz Island, 2013-2015.

Animal health surveillance and control

The cattle herds of Galapagos include approximately 10,000 animals distributed on the four populated islands (Santa Cruz, San Cristóbal, Isabela, and Floreana), with the greatest concentration on Santa Cruz. The first epidemiological study of cattle in Galapagos was carried out in 1997 following an outbreak of foot-and-mouth disease (Cruz, 2013). Fifteen years later, ABG initiated the collection of baseline data on diseases using a serological sampling design. These data provided information on the presence or absence of diseases such as: foot-and-mouth disease, bovine brucellosis, bovine leucosis, bovine neosporosis, and the prevalence of infectious bovine rhinotracheitis (IBR) and bovine viral diarrhea (BVD) (Table 3).

These studies provide baseline information on the health status of Galapagos livestock. In 2015, on the basis of these surveys, the province of Galapagos was declared free of foot-and-mouth disease without the use of vaccines (OIE, 2015).

Table 3. Baseline for disease in cattle in Galapagos established in 2015.

Disease	Island	No. of samples	Presence/ absence	Prevalence (%)
Foot-and-mouth	Santa Cruz, Isabela and San Cristóbal	647	Absent	0
Brucellosis	Santa Cruz, Isabela, San Cristóbal and Floreana	1195	Absent	0
Bovine leucosis	Santa Cruz, Isabela, San Cristóbal and Floreana	649	Absent	0
IBR	Santa Cruz	419	Present	45.8
BVD	Santa Cruz	419	Present	6
Neosporosis	Santa Cruz	419	Present	40.1
Anaplasmosis	Santa Cruz, Isabela y San Cristóbal	184	Present	64

Source: Technical report, ABG 2015

Control of pets

The ABG implemented the "I am a Responsible Pet Owner" communication campaign to control the population of pets (dogs and cats). During the ABG's first three years, 2149 pets (dogs and cats) were sterilized across the four populated islands (Table 4). During the same period, a total of 2520 dogs (60% of the dog population) were registered (Table 5). In 2015, nine deworming campaigns were carried out on Santa Cruz (462 pets), three in Isabela (68 pets), two in San Cristóbal (86 pets), and one in Floreana (24 pets), with a total of 640 pets dewormed.

Table 4. Number of pets sterilized on the four populated islands 2013-2015.*

Year	Santa Cruz	San Cristóbal	Isabela	Floreana
2013	145	42	0	38
2014	237	164		
2015	186	604	102	
2016	246	245	140	

*Some of the sterilization campaigns were carried out thanks to the support of Animal Balance, Intercultural Outreach Initiative, and Darwin Animal Doctor.

Table 5. Number of registered dogs on the four populated islands.

Year	Santa Cruz	Isabela	Floreana	San Cristóbal
2013	14	96	38	557
2014	195			150
2015	133	114		349
2016	306	84		484
Percent*	55%	80%	100%	98%

* Percentages are calculated based on the dog census carried out by ABG during 2014.

In San Cristóbal, a serological sampling of 245 dogs was carried out. The results were negative for *Brucella canis*.

Rapid response to phytozoosanitary emergencies

For the third barrier, "Rapid Response to Emergencies", ABG has responded in a timely manner to suspected new threats. In 2014, the rapid response system focused on verifying presence or absence of the Argentine ant and the fruit fly *Bactrocera* sp., after these were intercepted in modes of transport. In addition, the detection and capture of a false coral (*Lampropeltis* sp.) and a boa (*Boa constrictor*) activated the system and subsequent monitoring by ABG technicians who determined the absence of additional individuals of these species in the province.

Diagnosis and identification: The crosscutting method for the three barriers

The acquisition of additional laboratory equipment has contributed to better technical support for all quarantine barriers through the identification of invertebrates and diagnosis of pathogens.

Identification of invertebrates

Transport inspection activities from 2013 to 2015 resulted in detection of 5061 invertebrate organisms. Samples are analyzed to monitor the possible entry of new invasive species and to take control measures when warranted. The system has identified 152 different invertebrate species in the various modes of transport, including marine invertebrates detected on hulls of ships by the Marine Inspection Unit. Most of these correspond to species already introduced and established in Galapagos. However, several detected pests were not previously reported for Galapagos and some are considered quarantine pests. Samples of invertebrates found in the Islands through various phytosanitary monitoring systems have also been analyzed with the aim of early detection of new introductions.

Diagnosis of pathogens

A study using coproparasitological analysis was carried out to determine the incidence of eggs of *Ancylostoma caninum* and *Toxocara canis* (parasitic worms found in domestic dogs) in stool samples from dogs in Galapagos.

A total of 671 samples were analyzed from the four islands. *A. caninum* was found to have 44.2% prevalence on Santa Cruz, 55.9% on San Cristóbal, 38.9% on Isabela, and 87.5% on Floreana. *T. canis* was found to have 17.1% prevalence on Santa Cruz, 22% on San Cristobal, 9.2% on Isabela, and 12.5% on Floreana.

In addition, molecular techniques were used to detect pathogens, specifically herpesvirus (Herpeviridae family) and *Mycoplasma* sp., from blood samples taken from tortoises at the Galapagos National Park's Giant Tortoise Breeding Centers prior to their repatriation to their home islands. These pathogens affect the upper respiratory tract of tortoises in other regions of the world. The ABG also completed a diagnosis using PCR (polymerase chain reaction) of *Parvovirus canino* and canine distemper in domestic dogs. This pathogen is of importance for the conservation of endemic species, as it could be transmitted to Galapagos sea lions.

Conclusions

ABG's first barrier, inspection and control at ports and airports of origin and destination, has been strengthened through the implementation of various techniques and investments in equipment and inspection capacity. These measures have contributed to the reduction of pests and diseases entering Galapagos. In economic terms, the investments are less costly than implementing control programs for introduced species in the field, such as ongoing control and monitoring of fruit flies and the giant African snail.

Surveillance and monitoring in Galapagos, the second barrier, has contributed to the timely detection of pests and diseases, as well as reduced populations of introduced species. The different control and surveillance programs that have been implemented have improved the capacity for early identification and diagnosis of pathogens and have provided a baseline for decision-making.

The ABG activates its rapid response mechanisms (the third barrier) to respond to emergencies in a timely manner. The ability to respond quickly is essential in order to decrease the likelihood of a pest or disease dispersing.

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GALAPAGOS REPORT 2015-2016

NEW APPROACHES

RESEARCH PRIORITIES FOR THE GALAPAGOS ISLANDS: A PARTICIPATORY AND COLLABORATIVE PROCESS AMONG RESEARCH INSTITUTIONS, GOVERNMENT AGENCIES AND CIVIL SOCIETY

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*The **Galapagos National Park Directorate** has its headquarters in Puerto Ayora, Santa Cruz Island, Galapagos and is the Ecuadorian governmental institution responsible for the administration and management of the protected areas of Galapagos.*

*The **Governing Council of Galapagos** has its headquarters in Puerto Baquerizo Moreno, San Cristóbal Island, and is the Ecuadorian governmental institution responsible for planning and the administration of the province.*

*The **Charles Darwin Foundation**, an international non-profit organization registered in Belgium, operates the Charles Darwin Research Station in Puerto Ayora, Santa Cruz Island, Galapagos.*

***Galapagos Conservancy**, based in Fairfax, Virginia USA, is the only US non-profit organization focused exclusively on the long-term protection of the Galapagos Archipelago.*

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Research priorities for the Galapagos Islands: A participatory and collaborative process among research institutions, government agencies and civil society

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Introduction

It is widely recognized that there are gaps between the information generated by the scientific sector and that required by public policy makers (Sutherland *et al.*, 2011). In Galapagos, authorities make their best effort to make sound decisions for the management of the Islands, often without access to data and analysis related to key ecosystem indicators. An effective monitoring program for Galapagos should provide the best scientific evidence for decision-making (Gibbs, 2015): *Decision-making based on science is not just good logic but also efficient because science, if done well, can point to useful solutions rapidly.*

Sutherland *et al.* (2011) indicates that there are three main audiences for priority-setting exercises that link conservation, environmental science, and policy. These are: 1) policy makers and specialists in public, private, and non-profit sectors, who can benefit from the development of a scientific research agenda that meets their information needs; 2) funders of research, who may find this agenda useful in determining support of broad themes identified by both suppliers and users of knowledge as relevant; and 3) researchers, who can apply the knowledge generated and prioritize questions or research areas considered important for policymakers. The results obtained from this type of prioritization exercise are the product of the people involved in the process. However, a moderately large and diverse group, clear criteria, and a participatory process can help reduce the impacts of individual bias or interests. It is of great importance that the participants reach a consensus; most programs that have failed in the Islands have the common denominator of not having an initial consensus on what aspects must be evaluated (Gibbs, 2015).

Article 5, Section 17 of the Special Law for Galapagos (LOREG) of 2015 names the Governing Council of Galapagos (CGREG – Spanish acronym) as the entity responsible for *"determining provincial policies for research and innovation of knowledge and development and transfer of appropriate and necessary technologies for provincial development, within the framework of national planning."* The CGREG, in coordination with the Ministry of Knowledge and Human Talents (MCCTH – Spanish acronym) and the National Secretary of Higher Education, Science and Technology (SENESCYT – Spanish acronym), led a participatory/collaborative process among research centers, government agencies, and civil society, to advance and encourage the establishment of priorities for collaboration between the scientific sector and public policymakers in the Galapagos Islands.

Methodology

The methodology of "Horizon Scanning" was used. This method aims to identify priority research questions in a participatory and collaborative way involving research institutions, government agencies, and civil society. The method, developed by Sutherland (2011), has been widely tested in the United Kingdom and North America for more than ten years by Cambridge University.

A wide range of institutions, researchers, and social groups with diverse expertise was identified as participants who provided an initial list of "Priority Research Questions", which they believed would contribute to efforts aimed at conservation and sustainable development of Galapagos. The formulation of questions was based on the following criteria:

a) can be answered through a realistic research design;

b) has a factual answer that does not depend on value judgments;

c) addresses important gaps in knowledge;

d) has a spatial and temporal scope that can reasonably addressed by a research team;

e) is specific and explicit;

f) is not formulated within a subject area that is too general;

g) cannot be answered with it "depends," or simply a "yes" or "no," and

h) suggests the design of research and related hypothesis required to answer it.

Participants were given a time limit for submitting questions. Once received, the questions were subjected to a filtering process to eliminate duplicates and group questions in initial categories according to previously established criteria.

After the filtering process, a panel of experts was selected based on geographic representation, field of expertise, organization type, and other fields of interest. The panel should be conformed to ensure balanced working groups in a face-to-face workshop. Three different criteria were used to determine the number of experts required for each of the thematic areas identified during the initial filtering process (Tables 1-3).

Table 1. The number of experts required by thematic area according to the Organization for Economic Co-operation and Development (OECD, 2007) classification.

Theme	#	%	Experts
Biological sciences	127	33.2	17
Agriculture, silviculture and fisheries	56	14.7	7
Social and economic geography	35	9.2	5
Environmental engineering	30	7.9	4
Earth sciences	28	7.3	4
Economy and business	19	5.0	2
Multidisciplinary	18	4.7	2
Educational sciences	15	3.9	2
Other	54	14.1	7
	382	**100.0**	**50**

Table 2. The number of experts required by thematic area according to the Web of Science classification.

Theme	#	%	Experts
Biodiversity conservation	71	18.6	9
Multidisciplinary	43	11.3	6
Ecology	37	9.7	5
Fisheries	36	9.4	5
Environmental studies	26	6.8	3
Economy	15	3.9	2
Education and education research	15	3.9	2
Energy and fuels	15	3.9	2
Other	123	32.3	16
	381	**100.0**	**50**

Table 3. Number of experts required by thematic areas based on key words.

Theme	#	%	Experts
Invasive species	28	8.0	4
Climate change	26	7.4	4
Economy	22	6.3	3
Fisheries	21	6.0	3
Agronomy	15	4.3	2
Tourism	14	4.0	2
Biosecurity	12	3.4	2
Biogeography	11	3.2	2
Other	200	57.3	28
	349	**100.0**	**50**

The list of "Priority Research Questions" identified and formulated during the first phase of the exercise by national and international research organizations, government agencies, and civil society, was sent to the panel of experts. Each expert was asked to classify each questions with "0" or "1", where "0" indicated "non-priority" and "1" indicated "priority."

Then, in November 2015, a workshop was conducted on Santa Cruz Island to identify the 50 highest-priority research questions for the Galapagos Islands. Four groups of experts were formed, each with its respective facilitator. Questions were then filtered, prioritized, and eliminated through successive rounds of voting by working groups and areas of expertise. The questions were then classified into four thematic areas: biological sciences, education/ tourism, agriculture and fisheries, and multidisciplinary. Dr. William Sutherland of Cambridge University, an expert in the methodology, acted as workshop facilitator.

Results

Fifty different entities participated in the initial stage of formulating priority questions for the Galapagos Islands, representing the public (36%), private (24%), and academic (26%) sectors, as well as several research centers (14%; Figure 1).

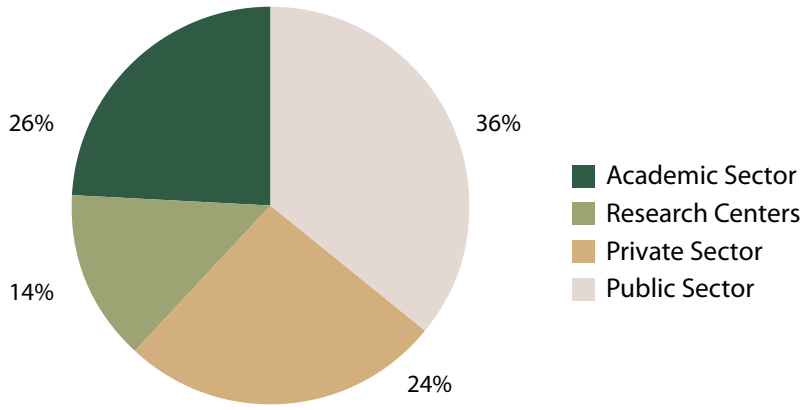

Figure 1. Percentage composition of the sectors represented by the participating institutions.

The participants generated a total of 781 priority questions during the initial phase of the exercise. The analysis and filtering process reduced this number by 44%. Some questions were repeated and others did not meet the required criteria. The panel of experts then analyzed the remaining 415 questions during the collaborative workshop held on 12-13 November 2015 on Santa Cruz Island. This panel was comprised of experts in various fields of knowledge, and included biologists, agronomists, ecologists, oceanographers, economists, veterinarians, and planners, among others. They represented the public sector (50%), research centers (23%), the private sector (13%), the academic sector (9%), and civil society (5%; Figure 2).

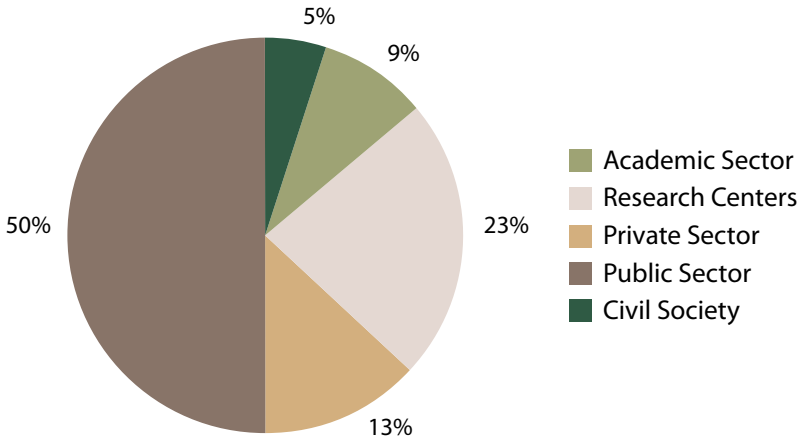

Figure 2. Percentage composition of the sectors represented in the Panel of Experts.

Through additional rounds of voting, working groups reduced the list to 165 questions, and then, in the final stage, to 50 priority questions.

The 50 priority questions for the Galapagos Islands (Table 4) are not listed in a hierarchical order since all meet the same level of priority for the Islands. Currently, the 50 priority questions are undergoing a validation process by the relevant authorities and will be presented in the plenary of the CGREG for approval. Once this is done, the 50 priority questions will form the research agenda for planning research in the province for all governmental entities, and private research and academic organizations.

Table 4. The 50 priority research questions for the Galapagos Islands.

No.	RESEARCH QUESTION
1	What is the population status, and what factors influence the distribution and abundance of the key and most emblematic species of Galapagos?
2	What is the effect of the introduction of marine invasive species in Galapagos and what would be the most efficient management measure to reduce such impacts?
3	What is the effect of acidification of the ocean on ecosystem processes in Galapagos?
4	What are agents and mechanisms of biological control that could be applied to reduce the impact of major invasive species in Galapagos?
5	How do El Niño Southern Oscillation (ENSO) dynamics influence food chains in marine and terrestrial communities of Galapagos?
6	What are the priority areas for restoration of degraded ecosystems, and how can the restoration process be accelerated with and without the use of innovative methodologies?
7	What are the strategies to reduce anthropogenic impacts on endemic and native biodiversity in urban areas in Galapagos?
8	What are systems (mechanisms and other tools) for more effective prevention and biosecurity to mitigate the introduction of species into and among the Islands due to human mobility?
9	What instruments of adaptation and mitigation of effects of climate change can be applied in Galapagos ecosystems?
10	How can the implementation, monitoring, and evaluation of the terrestrial mobility plan and the design of a sustainable marine transportation and mobility system in the Islands be achieved?
11	What is the multiplier effect of tourism in Galapagos, i.e., for every dollar that flows in in services, what is the multiplication of that amount in indirect transactions (e.g., real estate, construction, energy consumption, management and public policy, taxation) and how does this affect the economy of Galapagos?
12	What are the characteristics of the labor market in Galapagos according to the proposed sustainable development model?
13	How can the sustainability of the land use and management model in Galapagos be achieved to prevent urban sprawl, and efficiently provide basic and social services?
14	What are the scenarios in terms of population growth in the following decades in Galapagos and what actions should be taken to ensure that such growth does not affect sustainability in the Archipelago?
15	What strategies, systems, and sustainable technologies contribute to local production activities (including agroforestry) for food and nutritional security, and thus decrease the dependence on products from the continent?

16	What is the capacity of the ecosystems (environmental limit) to support socioeconomic development in Galapagos? For example: what is the capacity of the aquifers?
17	How can understanding and subsequent behavior representing what it is to live in a fragile insular system, limited and unique in the world, be achieved through formal education and higher learning?
18	What management systems and policies implemented in other protected areas could be adapted to Galapagos to increase local participation in conservation?
19	What are the value chains in production activities and how can they be optimized in a sustainable and inclusive manner?
20	What are strategies to manage the introduced species that represent the greatest threat in the agricultural zone?
21	Which techniques and food species are the most suitable for sustainable crops in Galapagos considering biosecurity processes?
22	What is the proportion (space and time) of no extraction zones within the Galapagos Marine Reserve that will ensure the sustainability of marine ecosystems?
23	What are the effects of climate change on the performance and profitability of production processes?
24	What are the characteristics of the productive soils in the agricultural zones of the Islands and what is their potential use in bioagriculture?
25	What beneficial organisms (predators, parasites, pollinators, antagonists, and mutualists) have been identified in the agricultural areas of Galapagos and what is their role in these systems?
26	What is the importance of the Galapagos Marine Reserve for transzonal and migratory fish populations?
27	What is the effectiveness of existing and innovative tools for control and monitoring of different uses of protected areas?
28	Based on existing and lacking climate-sea-land indicators, how can the land-sea-atmosphere observations network be expanded to support adaptive management in response to El Niño Southern Oscillation (ENSO) events and climate change, which will serve as a basis for research in Galapagos?
29	What are the priority comprehensive health needs (nutrition, family planning, addiction treatment) of the inhabitants of the Islands and how can they be incorporated as improvements of the health service?
30	What is the degree of contamination of agricultural products (local and continental), water, soils, humans (producers and consumers), and animals by agrochemicals?
31	What are the risk scenarios for natural or anthropogenic disasters in Galapagos considering a multi-threat focus?
32	What is the hydrogeological potential and qualitative state of the highlands, verified by drilling and pumping tests, of the populated islands?
33	What is the current and future water demand for household consumption and the business sector?
34	Based on the demand and distribution of construction materials needed in the Islands, what alternatives could be employed, in accordance with the environment, that will cause the least impact from extraction or processing?
35	What are the emerging levels of heavy metals, PCBs, and contaminants in the terrestrial and coastal marine ecosystems of Galapagos?
36	How can prevention and mitigation strategies for contamination of bodies of water by wastewater be implemented, according to the reality of the Galapagos Islands?
37	What is the ideal range of technical, vocational, and university training to bridge the current gap in demand for professional galapagueños?
38	What are the renewable energy resources and the most optimal locations by island with the best potential and stability to provide for sustainable expansion of electricity generation?
39	What are the spatial and temporal patterns of dispersal of priority invasive species?
40	How effective are current strategies to integrate scientific knowledge into policies and how can they be improved?
41	What are the effects of fishing on the structure and dynamics of the socioecosystem, and how can its sustainability be ensured?
42	How will climate change affect the distribution and prevalence of introduced species and diseases?
43	What is the baseline of pests present in the agricultural sector in both urban and rural areas?
44	What are the best strategies for the sustainable use of water in agricultural activities?
45	What are the major drivers of threat and extinction of endemic species in Galapagos, and what do we need to do to minimize, avoid, or mitigate these impacts?
46	What is the model of effective governance for protected areas in Galapagos that will ensure the conservation of the Archipelago in the long term?
47	What low impact and small scale tourism alternatives can be implemented following a model of community-based tourism?

48	How can the implementation of the mechanisms to reduce the impact of tourism operations (hotels, cruises, and food and beverage services) on the environment be improved in the Archipelago?
49	What socioenvironmental strategies will help to involve the main actors of the agricultural zone to support the control of introduced species that threaten biodiversity?
50	What coastal zoning system in the Galapagos Marine Reserve will allow access to ecosystem services and ensure its conservation?

Conclusions and recommendations

The 50 priority research questions identified reflect a wide range of challenging situations in the Galapagos Islands that must be addressed. Fortunately, research and academic institutions are currently carrying out projects that could help answer some of these questions. The identification of the priority questions will help define a research agenda for the Islands that will promote interinstitutional and interdisciplinary research projects that will provide the best possible scientific evidence for decision-making.

It is important to note that the Galapagos Special Law of 2015 (Article 5, Literal 17) confers authority to the CGREG to "Determine provincial policies for research and knowledge innovation, and the development and transfer of appropriate and necessary technologies for provincial development, within the framework of national planning and in accordance with the regulations and policies defined by the competent national authority." Similarly, SENESCYT is responsible for arranging, coordinating, and evaluating the formulation, execution, control, and monitoring of public policies on knowledge and human talent. Based on the unique geological and biological characteristics of Galapagos, SENESCYT is consolidating a scientific working group that will contribute to the formulation of concrete proposals and sustainable strategies consistent with the paradigm of good living and that respond to the needs of the local population.

The CGREG considered it essential to integrate these 50 priority research questions via the creation of the Scientific Cluster for Galapagos (SCG) in order to involve additional institutions in the execution of priority research over the next three to five years. During the process of establishing the SCG, CGREG, MCCTH, and SENESCYT have been in communication with the academic sector, including universities such as the Escuela Politécnica del Litoral (ESPOL) and the Polytechnic School of the Army (ESPE – Spanish acronym), as well as with research institutions in Galapagos such as the Charles Darwin Foundation.

In this initial stage of creation of the SCG, the 50 priority research questions have been categorized within five lines of research (Table 5). Most questions relate to human-environment interactions (30%), biodiversity and natural resources (24%), and engineering and innovation of sustainable systems (20%). The SCG will continue to be strengthened through the involvement of additional research centers and academic institutions.

It should be noted that the questions prioritized for Galapagos do not necessarily conform to any single line of research. In many cases, they correspond to two or more lines of investigation, some of which might be considered secondary in nature. Therefore, research projects should be formulated and executed via the SCG, with the corresponding identification of profiles of specialists/researchers required to form the interdisciplinary and interinstitutional research teams.

The list of research priorities will be incorporated into other planning strategies. CGREG will approve and disseminate the list of priorities for its inclusion in the planning of public and private entities. Similarly, research priorities will be disseminated among the different collaborators and research institutions. This prioritization exercise is extensive and frames a wide diversity of topics requiring research. However, like all strategic planning and management, the list will be reviewed and regularly updated according to the needs identified through ongoing assessments.

Table 5. Number and percentage of priority research questions for Galapagos within the major research lines of the Scientific Cluster of Galapagos.

Research Lines	#	%
Oceanic-atmospheric processes, climate change and modeling	9	18
Biodiversity and natural resources	12	24
Human-environmental interactions	15	30
Engineering and innovation of sustainable systems	10	20
Knowledge transfer and development of research capacity	4	8
Total	**50**	**100**

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