General trends in scientific research in Galapagos

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Since the creation of the Galapagos National Park (GNP), the solid link between applied research and management has been one of its greatest strengths, providing a foundation for the development of a system of adaptive management that has achieved notable conservation successes for the protected areas of the archipelago. However, various recent analyses have recognized the urgency of identifying new research needs and priorities to provide decision-makers with the scientific information necessary to better confront future challenges.

The Management Plan of the GNP clearly outlines the necessity of establishing an interdisciplinary research agenda, one that is open and flexible, will provide the knowledge needed for the management of the complex socio-economic of Galapagos, and will promote a scientific culture that facilitates the fluid participation and collaboration of all stakeholders.

This analysis of general trends in Galapagos research was completed in an attempt to establish a baseline for the current status of knowledge and to identify biases and possible information gaps. An initial database was constructed consisting of 10 081 references recorded between 1535 and 2007. This was then filtered to eliminate grey literature, studies of a regional character, and duplicated references published in various languages. The resulting database was reduced to 4884 references, which were then analyzed, beginning with a categorization of each reference on the basis of 82 key words. Some analyses were repeated for a sub sample consisting of only 1392 references, which included only cited publications in journals of "high impact" (defined as those included in Journal Citation Reports® - JCR).

Evolution of the scientific effort

This analysis of scientific research reveals a growing cumulative effort and reflects the importance of key historical events that caused a directional change in research carried out in the archipelago, such as the California Academy of Sciences expedition, the creation of the Charles Darwin Foundation (CDF), and the enactment of the Special Law for Galapagos, among others (Figure 1).

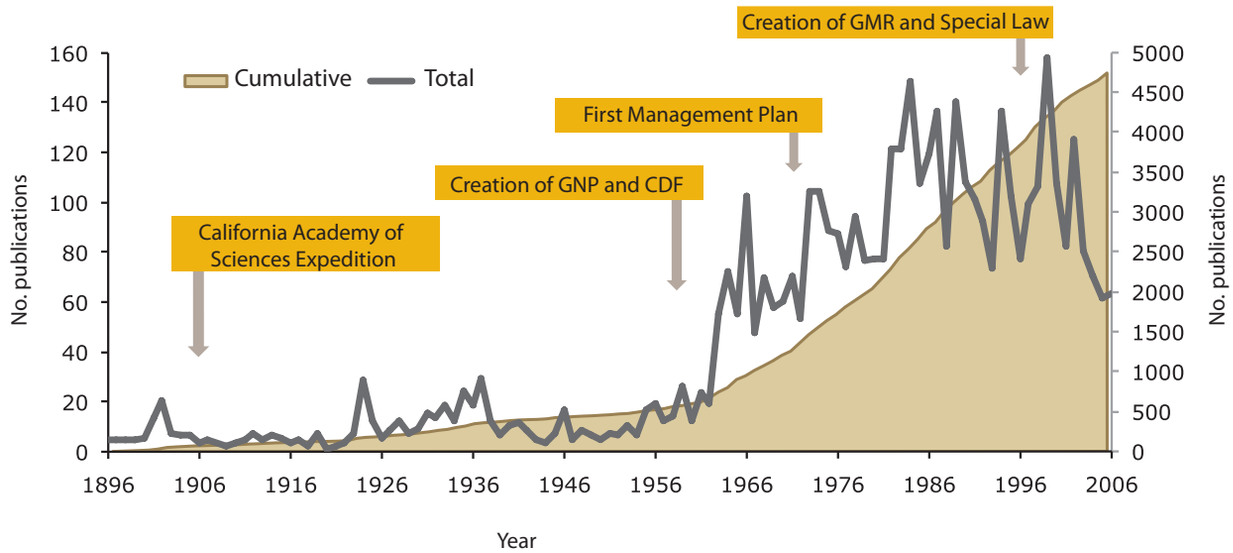
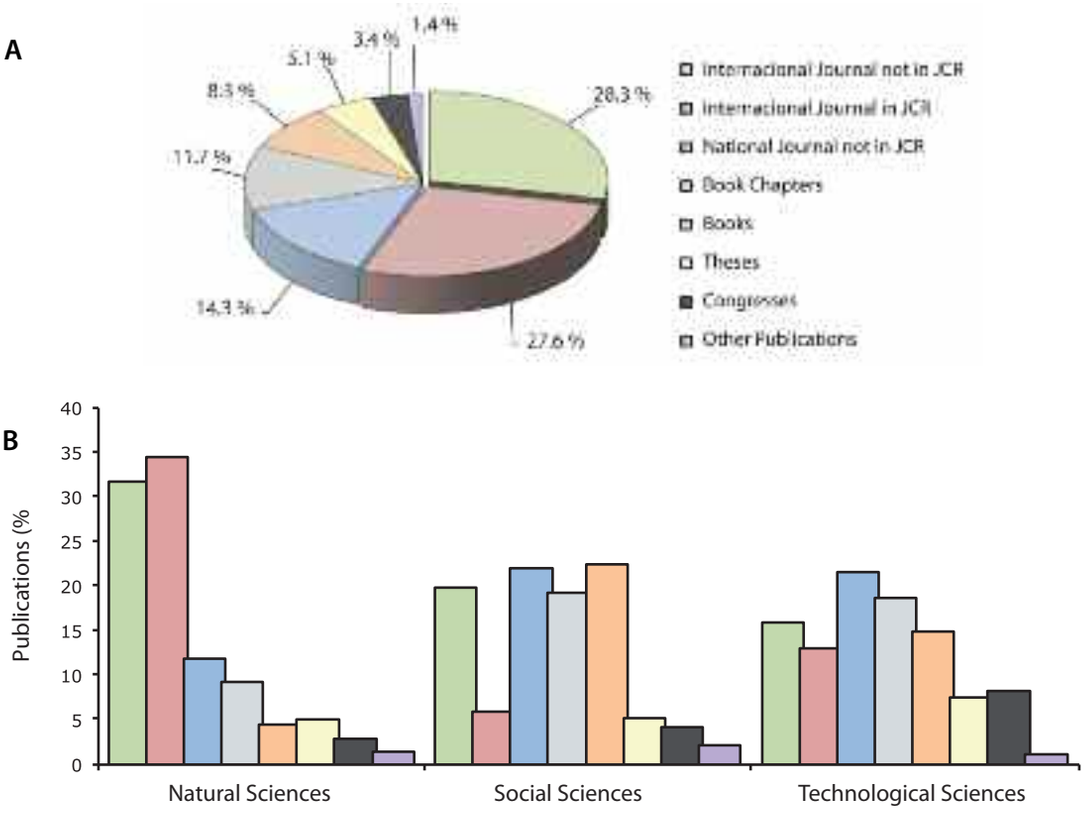


Figure 1. The evolution of scientific effort measured as the annual and cumulative number of publications, with key events that impacted the research carried out in Galapagos indicated by date. GMR = Galapagos Marine Reserve.

General characteristics of the publications

A majority of articles (55% of those registered) was published in international journals. However, the percentage varies greatly when major scientific disciplines are analyzed separately (Figure 2). In natural sciences, articles published in international journals of high impact continue to predominate. In the case of the social sciences and technological science, books, book chapters, and national journals constitute the primary mediums of publication. In terms of language, English clearly is the dominant language of publication (71.9%), while Spanish is second (20.3%).

Figure 2. Distribution by type of publication (A: the full database; B: by major areas of knowledge).



Another notable aspect is the low level of interdisciplinary research in Galapagos. Only 8% of the references include some type of collaboration between different academic disciplines. This percentage declines to 3.3% when only the research published in scientific journals of impact are included. At the same time, there is a clear predominance of basic over applied research and evaluative or follow-up studies (Figure 3). It must be noted however that a large body of applied research used for management can be found in the grey literature but these publications remained outside of the focus of this analysis.

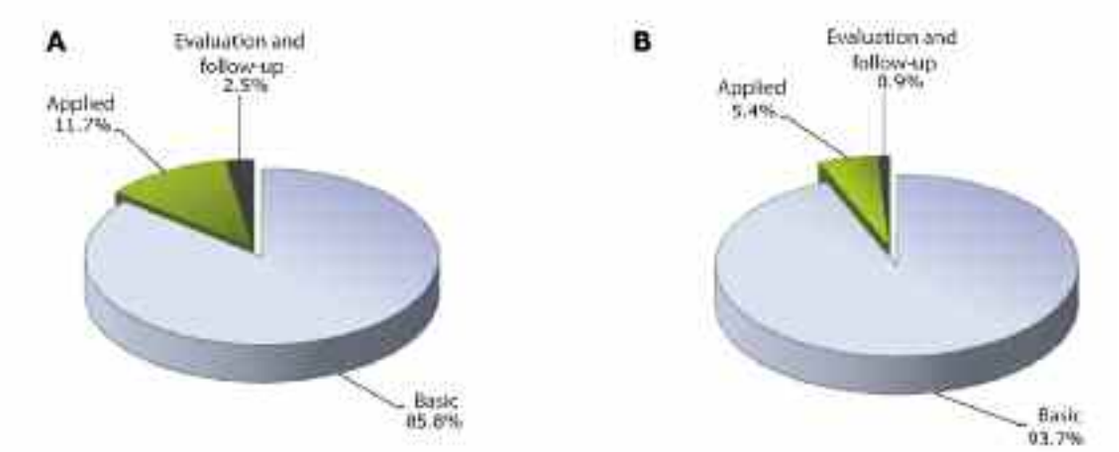


Figure 3. Type of research carried out in Galapagos (A: the full database; B = including only those articles published in journals of the JCR).

Trends by scientific discipline

The analysis by scientific discipline reveals a clear predominance of natural sciences (74.4%), which is even more evident when analyzing only those articles published in journals of impact, in which case the social sciences and technological sciences decline to a marginal level (Figure 4).

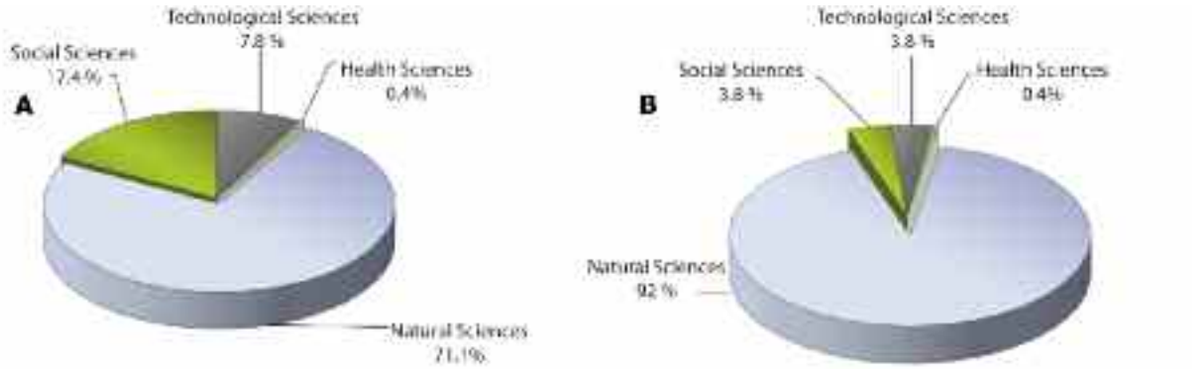


Figure 4. Percent of publications in the four main scientific disciplines (A: full database; B: only those articles published in journals of the JCR).

The evolution over time in the number of references published by scientific discipline highlights interesting trends (Figure 5). For example, there was an exponential growth in scientific research in Galapagos starting with the creation of the GNP and the CDF, in comparison with the preceding half century. However, this growing trend ended during the last two decades. The contrary effect can be seen in the social sciences and technology, both of which experienced a significant increase during recent years.

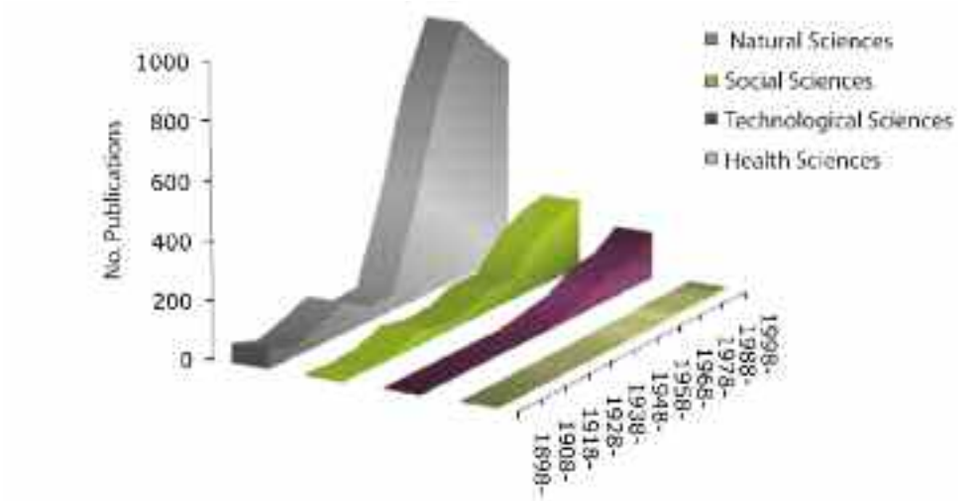


Figure 5. Historical evolution in the number of publications in the four scientific disciplines analyzed.

Research objectives

Analyzing the publications according to the focus of the research demonstrates some of the biases characteristic of research in Galapagos. In natural sciences, there is a clear dominance of research focused on taxonomy and biogeography, evolutionary ecology, and conservation biology (Figure 6). In social sciences, studies related to geography and history predominate. However, there is a notable peak that reflects studies of fisheries in journals of impact.

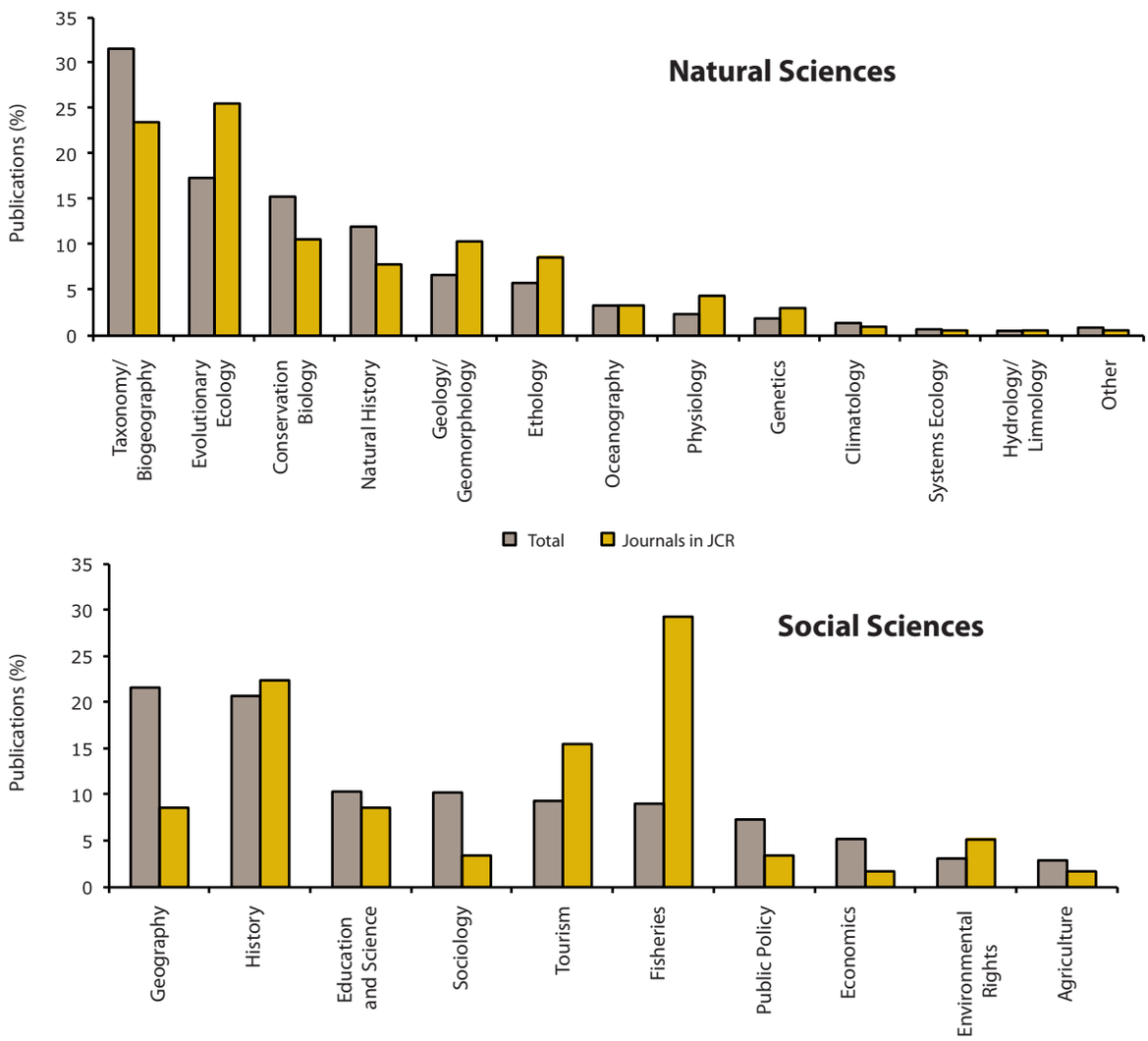


Figure 6. Percent of publications by focus of research in the two disciplines that contain the majority of publications.

Research effort by taxonomic groups

In natural sciences, the distribution of publications according to taxonomic group shows a clear bias toward higher organisms (Figure 7). Vertebrate studies account for 54.8% of all publications, while other taxonomic groups, such as fungi or microorganisms, received much less attention.

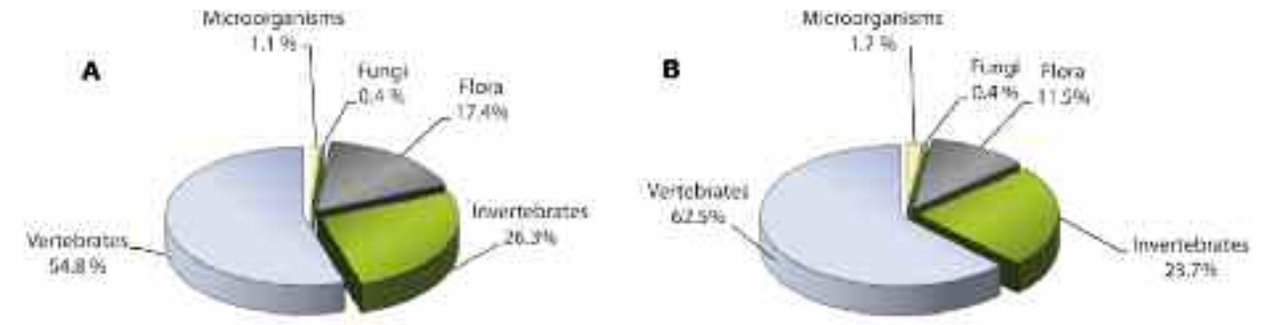


Figure 7. Percent of publications by taxonomic group (A: complete database; B: articles published in journals of the JCR).

The number of references by taxon also reveals a notable bias toward birds and reptiles, which becomes especially evident when the analysis includes only those articles published in journals of impact. In the case of publications on introduced species, there is a clear predominance of studies focused on mammals (Figure 8).

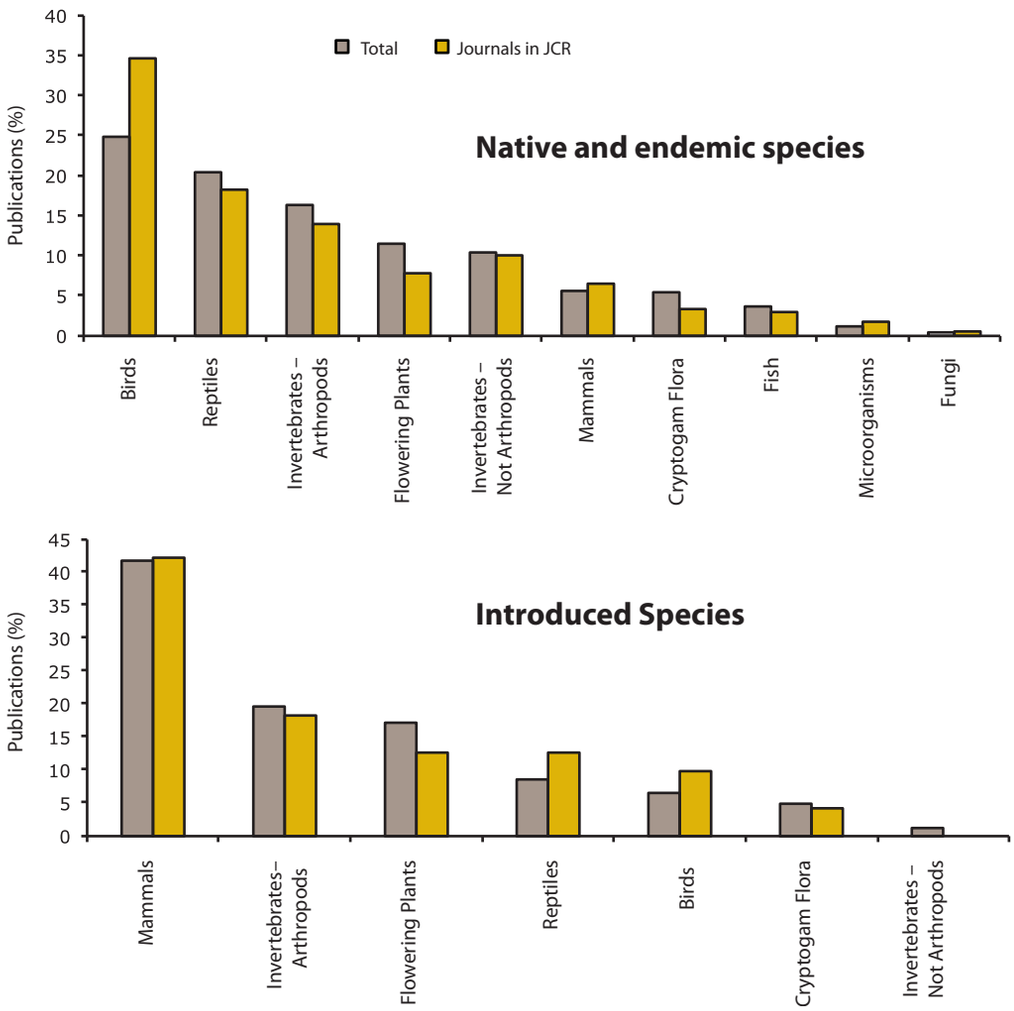


Figure 8. Percent of publications by major taxonomic groups.

Photograph: Frank Bungartz

Conclusions

In spite of the solid historical relationship between research and management and the fact that Galapagos is probably one of the most studied places on the planet, it is evident that the research to date has been biased toward specific aspects of the biophysical sciences and toward specific taxonomic groups, with a scarcity of applied or interdisciplinary research that span the connections between nature, society, and the economy. This biocentric focus, characteristic of the science in Galapagos, has provided an exhaustive and very valuable body of knowledge on certain subjects (e.g., biology and ecology of emblematic species and management of introduced species), while other social or ecological processes essential to sustainability remain practically unexplored (e.g., water cycles, nutrient cycles, functional diversity, etc.).

As has occurred in many other world renowned protected areas around the world, these results are probably a consequence of historical patterns where research begins with the larger species that are obviously threatened and is not focused on the overall ecosystem. Many times a research policy founded on a shared vision of all stakeholders is lacking. The new Management Plan of the GNP tries to resolve this deficiency with its Program of Interdisciplinary Research and Technological Innovation. This cross-cutting program creates a foundation for a new model of research directed at achieving sustainability in the archipelago. With this, the GNP is endeavoring to stimulate and coordinate a science policy that will help to efficiently respond to the challenges created by the changes in Galapagos during the last decade, changes that make greater diversity of knowledge both urgent and critical for more effective decision-making.

The development of this new model for research is considered a priority, in line with the Management Plan of the GNP and especially needed in the moment of crisis in which Galapagos finds itself. Research priorities should be established based on objective criteria about the real needs for knowledge. This change signifies moving from a model of "research in Galapagos" to a new paradigm of "research for Galapagos."