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Adaptive Management of Sustainable Tourism in Antarctica: A Rhetoric or Working Progress?

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Abstract: Growth and diversification of tourism activities in Antarctica have not been matched by proactive strategies for planning or management. Recognizing that the adaptive management approach has been effectively implemented in managing tourism in protected areas, we examine to what extent this approach has been incorporated into the Antarctic tourism research and management, and what constraints exist for its implementation. To better understand the extent of literature contributions, we conducted an appraisal of 72 peer-reviewed journal articles published from 1992 to 2020 and Antarctic management documents. From a scientific perspective, researchers have been advocating for adaptive management approaches to Antarctic tourism and have applied different elements, particularly ecological assessments, design of management measures, monitoring, and regulatory mechanisms. However, these contributions have not been necessarily translated into management policy and regulations. We acknowledge that full implementation of an adaptive management approach is not easily achievable due to the unique Antarctic regime. However, we argue that comprehensive site-specific and regional adaptive management models could be applied as the first step for a more systematic implementation. This incremental approach could contribute to enhanced stakeholder participation and improved decision-making processes, ultimately leading to a more proactive and effective management of Antarctic tourism, essential for the conservation of the continent.

Keywords: Antarctic treaty system; comprehensive process; environmental impact; protected areas; monitoring; polar regions; strategic planning

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1. Introduction

Antarctica is the last and vast wilderness on Earth [1]. For a long time, Antarctica's remote location and extreme climatic conditions represented the major constraint for any type of human activity, including tourism [2]. First attempts of tourist trips to Antarctica can be dated back to 1930 [3]. However, it was not until the late 1950s when commercial tourism in the Antarctic began [4]. Since then, tourist numbers in Antarctica have been climbing progressively, with a total number of 74,401 tourists visiting the Last Frontier in the 2019–2020 season [5].

Through time, Antarctic tourism has also diversified in terms of itineraries and activities [6]. Major concerns revolve around the spatial and temporal concentration of tourism activities, the introduction of non-native species, the interaction of humans and wildlife, and the potential of cumulative impacts [7–9]. Biological, social science, and policy studies have improved our understanding of Antarctic tourism. The need for a comprehensive approach to setting policies and managing tourism has also been voiced repeatedly by the

scientific community [10–13]. Still, these contributions have been scarcely translated into policy, regulations, or comprehensive management processes.

Tourism in natural destinations around the world, particularly iconic protected areas, faces similar challenges [14]. Increasing and diversifying tourism uses, seasonal and spatial concentration of tourists, negative environmental impacts, conflicting uses among stakeholders, and the lack of accurate evidence to inform decisions are major issues. These have triggered the development and implementation of comprehensive tourism management practices. Specifically, the Adaptive Management (hereafter AM) approach has been applied through an array of tourism frameworks developed since the late 1970s. Positive implementation examples could be found in different protected areas (hereafter PAs) which have been illuminating management proposals for Antarctic tourism [14,15].

As Antarctic tourism management is still considered by many as a reactive and piecemeal without a strategic and comprehensive vision [16–19], this begs the question of what factors have hindered the adoption and implementation of an AM approach for Antarctic tourism? This study aims to contribute to the discourse about effective management solutions for Antarctic tourism. Specific objectives of this paper are to: 1. analyze the context of tourism management in Antarctica; 2. review the elements of AM concerning tourism management; 3. examine the extent to which the elements of AM have been incorporated into the Antarctic tourism research; 4. propose an incremental AM approach for contributing to Antarctic tourism management. Our discussion and evaluation are informed by an appraisal of the most relevant Antarctic management documents and peer-reviewed scientific publications in the Antarctic tourism context sourced from the Antarctic Treaty System library, the authors' collections, and a supplementary literature search.

2. Antarctic Tourism and Its Management Context

2.1. Antarctic Tourism in Brief

Commercial tourism in the Antarctic Treaty Area (south of 60° S latitude) began in the late 1950s and early 1960s, with a few overflights and cruises organized from Argentina and Chile. In 1966, Lars-Erik Lindblad began offering regular trips to the Antarctic. Hereafter, expedition cruises to the Antarctic Peninsula became annual activities being also offered by other tour operators, growing significantly in the 1990s and early 2000s [4,11]. Commercial tourist flights to Antarctica involving landings were slow to develop but increased gradually during the 1980s and 1990s. Since 2003, commercial flights have expanded more rapidly into different modalities and activities [20,21].

In the 2019–2020 season, the International Association of Antarctica Tour Operators (IAATO) reported a total of 74,401 tourists visiting the continent, representing a 134% increase if compared with the season 2010–2011 [1,5]. Diversification of tourism in Antarctica has resulted in six tourism modalities, introducing variations in the length of trips. Moreover, tourism activities have increased from 7 to 49 [6]. Even though the traditional cruise modality (with landings) and the cruise-only peninsula (no landings) continue to be the most popular modalities, the recent expansion of the air-cruise modality is making it possible to perform one-day visits to Antarctica.

A major concern of the tourism increase is related to temporal and spatial concentration. The Antarctic season takes place from late October to early April [5]. During these months, most of the tourism activities involving landings take place in the Western Antarctic Peninsula Region, causing a significant concentration of visitors in specific routes and sites [8,22]. According to IAATO [5], during the 2019–2020 season, tour operators used a total of 313 sites, among which 282 (90%) were in the Peninsula Region. However, 65% of the visits were concentrated in just 31 sites, most of which were located in the Peninsula.

Human impact in Antarctica has different sources and only a few cases could be attributed exclusively to tourism activities. At sea, passengers and cargo transportation are considered forms through which the introduction of non-native species is a possibility. Moreover, the increase in vessel traffic in Antarctica also increases the potential of collision with marine animals (i.e., whales) as well as accidents that may cause fuel spills [23]. On

land, the potential introduction of non-native species is also an important concern. For example, in a study conducted during the 2007–2008 season, Chown et al. found 31,732 seeds present in tourists and their belongings (i.e., gear, shoes, clothes), and 38,897 seeds carried by scientists [24]. Moreover, several experimental studies have analyzed the effects of human trampling on physical and biological indicators. These studies recommended improving biosecurity measures and implementing local management actions [25,26].

Disturbances in wildlife caused by human interactions have also been a topic of important concern among researchers, generating a significant body of literature [27–30]. Different conclusions have been drawn as responses could be site- and species-specific. However, the authors concurred on the need for revisiting management measures adopted by the ATS, and they recommended more site- and species-specific studies to inform management decisions [9,27–30].

Other than the ecological impacts, there are also social dimensions of Antarctic tourism. The most notable studies in this topic are related to cognitive and affective outcomes from the Antarctic experience [31–33], impacts of tourism diversification [10], tourists' perceptions [34–36], and the Antarctic ambassadorship concept [37,38]. These studies have emphasized the experiential, learning and pro-environmental outcomes produced by the Antarctic experiences and their potential importance in contributing to the conservation of the continent.

2.2. Management Context

Antarctica is a global commons managed under the regime established by the Antarctic Treaty (AT), which was signed by twelve countries in Washington DC on 1 December 1959 [19,39]. Since then, it has been expanded into the Antarctic Treaty System (ATS). Complementary management instruments have been developed and adopted through the years to accomplish the primary objectives of the treaty [39]. To date, 54 nations have signed the AT and 29 maintain a consultative status, which means only they take part in all decision-making processes regarding Antarctica. Every decision and measure to be adopted shall comply with unanimous voting of the Consultative Parties [39].

The legal text devoted to environmental issues is the Protocol on Environmental Protection to the AT, also known as the Madrid Protocol, which was signed in 1991 and entered into force in 1998. Comprising five Annexes currently in force [40], the Madrid Protocol also established the Committee for Environmental Protection (CEP) to formulate recommendations to the Antarctic Treaty Consultative Parties (ATCPs) in connection with the implementation of this protocol, including the operation of its Annexes [39].

The Madrid Protocol applies to all human activities in Antarctica, including tourism and non-governmental activities developed within the limits of the Antarctic Treaty. In this sense, tourism activities must comply with the provisions of the Annexes to the protocol, specifically:

- Annex II: The taking or harmful interference with flora and fauna must be avoided and precautionary measures must be taken to prevent the introduction of non-native species and diseases.
- Annex III (on land) and Annex IV (at sea): Tourist expeditions should follow all waste management provisions.
- Annex V: Tourists' activities must comply with the regulations concerning Antarctic Specially Protected Areas (ASPAs) and Antarctic Specially Managed Areas (ASMAs), according to their specific management plans.

The Treaty Parties also must notify of any tourists' activities that are to be developed in the Antarctic Treaty Area. Based on Article eight and Annex I of the protocol, a priori Environmental Impact Assessment (EIA) must be prepared for tourist activities. This means that tour operators must present an EIA of their proposed activities to their competent authority (i.e., country to which they belong), which will be responsible for the activities conducted by that operator. However, EIA has been the subject of important criticisms as this has not been seen as the most appropriate tool for assessing tourism activities because

of the changing nature of those activities, and because the EIA is designed for site-based projects [41–43].

Antarctic Treaty Consultative Meetings (ATCM), held annually, constitute the most important decision-making forum for Antarctica. Measures (legally binding), Decisions, and Resolutions (not legally binding) are adopted at the ATCM by consensus among the ATCPs, giving effect to the principles of the Antarctic Treaty, the Madrid Protocol, and other provisions constituting the ATS. Before the adoption of any of these instruments, topics are treated by ATCM stakeholders (i.e., Antarctic and Southern Ocean Coalition-ASOC, IAATO) through official channels such as Working Groups, Intersessional Contact Groups (ICGs), and Meetings of Experts. An appraisal of the ATS database (up to 5 May 2021) showed that the first ICG for the treatment of tourism and non-governmental activities (earlier identified as Working Groups) was established in 1979. Since then, a total of 24 ICGs have been established debating a total of 18 topics (Table 1). Among them, four lasted more than one year and four were informal ICGs. A total of four meetings of tourism experts have been conducted during this same period. In these fora, New Zealand, the Netherlands, Norway, the United Kingdom, Australia, and the United States are the countries with more active participation, either as convenors or taking part in the preparation of recommendations and reports.

Table 1. Summary of outputs from Working Groups (WG), Intersessional Contact Groups (ICGs), and Meeting of Experts (ME) for the treatment of tourism and non-governmental activities in the Antarctic Treaty Area developed. Records extracted from AT Secretariat database from 1962 to 2020. Topics are organized from a general to a specific level.

Year	Convenor	Type	Output Documents
			Tourism and non-governmental activities in the Antarctic Treaty Area
1979	USA	WG	Working group on the effects of tourism and non-governmental expeditions
1992	Italy	WG	Working group 1: Tourism and non-governmental activities in the AT area
1996	Netherlands	WG	Working group 2: Tourism and non-governmental activities in the AT area
1997	New Zealand	WG	Working group 2: Tourism and non-governmental activities in the AT area
2002	USA	ME	Informal meeting of Experts in Tourism: Aspen Meeting Nature and scale of tourist activities in Antarctica, possible future trends of tourism
2004	Norway	ME	Meeting of Experts on tourism and non-governmental activities in Antarctica. Results: 26 papers submitted to ATCM (WP, IP, SP)
			A strategic approach to tourism
2011–2012	Netherlands	ICG	Outstanding questions on Antarctic tourism
2015–2016	New Zealand India	ICG	Developing a strategic approach to environmentally managed tourism and non-governmental activities
2019	Netherlands	ME	International workshop on Antarctic tourism Proactive management of Antarctic tourism: Time for a fresh approach
			Environmental aspects and impacts of tourism and non-governmental activities
2008–2009	Secretariat CEP Chair	ICG	Environmental aspects and impacts of tourism and non-governmental activities in Antarctica. CEP tourism study **
2009–2010	Secretariat CEP Chair	ICG	Environmental aspects and impacts of tourism and non-governmental activities in Antarctica. CEP tourism study **
2010–2011	Secretariat CEP Chair	ICG	Environmental aspects and impacts of tourism and non-governmental activities in Antarctica. CEP tourism study **
2013–2014	Germany	*ICG*	*Discussion on tourism and the risk of introducing non-native organisms*
			Regulations and guidance for Antarctic visitors
1994	Japan	WG	Working group 1: Adoption of guidance for visitors in the Antarctic
2002–2003	France	*ICG*	*Usefulness of an Intersessional Working Group on the adoption of a regulation on tourism activities in Antarctica.*
2007–2008	Norway	ICG	Issues concerning passenger ships operating in Antarctic waters **
2008–2009	Norway	ICG	Issues concerning passenger ships operating in Antarctic waters **
2009	New Zealand	ME	Management of ship-borne tourism in the Antarctic Treaty Area Results: 31 papers submitted to ATCM (WP, IP, SP)
2010–2011	Argentina	ICG	Supervision on Antarctic tourism
2019–2021	Germany	ICG	Strengthening the existing guidance for visitors to Antarctica—Proposal to adopt updated General Guidelines for Visitors to the Antarctic **

Table 1. *Cont.*

Year	Convenor	Type	Output Documents
			Diversification on tourism activities
2009–2010	Chile	ICG	Marathons and other large-scale sporting activities in Antarctica **
2013–2014	Chile	ICG	Marathons and other large-scale sporting activities in Antarctica **
2012–2013	Netherlands	*ICG*	*Increasing diversity of tourism and non-governmental activities in Antarctica*
			Site guidelines for visitors
2005–2006	UK	ICG	Site guidelines for visitors to Antarctica. Revision and recommendations on site guidelines
2008–2009	France	*ICG*	*Discussion on non-specific information contained in site guidelines*
			Monitoring and information exchange
2003–2004	Australia	ICG	Development of ATS database on non-governmental activities
2012–2013	New Zealand	ICG	Information exchange and the environmental aspects and impacts of tourism
			Accreditation schemes
2004–2005	UK	ICG	Accreditation scheme for tour operators in Antarctica

One period ICG, *informal ICG*, ** continued ICG. WP—working paper; IP—information paper; SP—secretariat paper.

Two specific measures have been adopted until now regarding tourism management. Measure 4 (2004) on *"Insurance and Contingency Planning for Tourism and Non-governmental Activities in the Antarctic Treaty Area"* and Measure 15 (2009) on *"Landing of Persons from Passenger Vessels in the Antarctic Treaty Area"*. Even though they were adopted 10 and 15 years ago, neither of them have entered into force yet as unanimous consensus for adopting these measures was not reached among the ATCPs due to different perspectives on the priority and need to regulate and manage Antarctic tourism. For the period 1966–1995, a total of ten tourism recommendations (later reclassified as Resolutions) were adopted. From 1995 to 2019, five Decisions and 32 Resolutions were adopted by the Treaty Parties [40,44]. Critical Resolutions are Recommendation I (1994) *Guidelines for visitors to the Antarctic*, Resolution three (2004) *Tourism and non-Governmental activities*, Resolution seven (2009) *General Principles of Antarctic Tourism,* and Resolution three (2011) *General Guidelines for Visitors to the Antarctic.* However, the recommendations from the ICG or Meeting of Experts are not always consequential, as some recommendations have never been brought to ATCM decisions for incorporation into hard or soft legal instruments.

Antarctic tourism is also recognized by a self-regulation scheme led by the IAATO since its foundation in 1991. Visitor site guidelines, part of a large body of self-regulatory guidelines, constitute the most important non-binding documents whose implementation is encouraged to tour operators. Visitor site guidelines are instruments developed or proposed by Treaty Parties in conjunction with IAATO and adopted through Resolutions. They contain instructions for visitors, taking into account site-specific sensitivities, safety considerations, and environmental values at a site level [8,45]. To date, there are a total of 42 visitor site guidelines in place [45]. In general, the tourism self-regulatory scheme has been criticized that tourism management has been handed over the industry, while others are concerned that the increase in non-IAATO tour operators will challenge the performance of this scheme, an important threat for the conservation of Antarctic values and ecosystems services [1,42,46,47].

3. Adaptive Management Approach

3.1. Concepts and Applications

AM has been recognized as an influential approach for the management of natural resources around the world, including the Antarctic. One of its earliest articulations of AM in the literature of natural resources was developed by Beverton and Holt (1957), who described adaptive decision making in fisheries without calling it AM [48]. Later, Holling (1978) [49] and Walters and Hilborn (1976) [50] first connected AM with natural resource management. According to Holling (1978), AM manifests itself *"when uncertainties about system characteristics are large, there may be considerable value in designing management so that*

information and other benefits are obtained. This information would reduce the uncertainty about the underlying biological relations, and more precise management actions could be taken" [49].

Based on different interests and needs, practitioners and researchers may focus on distinct aspects of AM. Consequently, there is a large body of literature concerning large-scale field experiments [51], business [52], systems theory [53,54], and policy and planning [55]. In natural resources, AM is referred to a structured process of learning by doing and adapting based on what is learned [51]. AM also recognizes that natural systems are partially understood and highly dynamic. Therefore, the results of monitoring could contribute to not only scientific advancements but also policy or operational adjustments. As such, monitoring provides learning, understanding, and adaptation that will benefit decision-making processes [48,56].

Operationally speaking, AM is conceived as a cyclical process for assessing and designing alternative ways to meet management objectives, implementing management alternatives, monitoring the achievement of objectives, evaluating results, and adjusting management actions [57,58]. Even within the conservation field, the steps of the AM cyclical process may vary. Salafsky and Margoluis (2003) [59] included five different steps with one starting and one iterative step to advance with the implementation of the AM approach. The Open Standards for the Practice of Conservation methodology [60] also present a five-step AM process for planning and managing protected areas. Williams et al. (2009) proposed nine different steps for the operationalization of AM [59]. Regardless, all AM processes present several shared characteristics: 1. constitute a systematic and iterative process; 2. apply science-based evidence (or the best information available) to reduce uncertainties; 3. provide a rationale for improving management practices and decision-making processes; 4. generate learning and use this learning for assessing decisions; 5. use monitoring for evaluating changes and measure the achievement of outcomes; 6. include the participation of different stakeholders in different contexts and levels [49,61,62].

Walters and Holling, 1990 distinguished three ways in which AM could be developed [51]. Stankey et al. (2005) [55] and Allan (2003) [62] summarized them as 1. *evolutionary AM* or trial-and-error learning, defined as a reactive approach in which some learning comes from whatever management experience is undertaken; 2. *passive AM* or sequential learning, focused on the strong implementation of a historically informed best practice or policy, followed by the evaluation of that implementation; 3. *active AM*, focused on integration of experimentation into policy, management design, and implementation. Active AM deliberately uses learning to reduce uncertainties and to lead the design and implementation of policy and management actions [63].

3.2. Adaptive Management Approaches for Tourism Management in Protected Areas

In protected areas (PAs), the AM approach has been encouraged and effectively applied by managers around the world to link conservation values with management categories and objectives, design of monitoring and management strategies, evaluation of results, and strategy adjustments [55,60,64]. Considering that tourism uses are inherent to the objectives of multiple PA categories [65], several tourism AM frameworks have been designed and adapted for these natural spaces at different scales and contexts.

Using the foundations of Marshall, 1933 [66], the Recreation Opportunity Spectrum (ROS) was developed as a planning and zoning tool that provided the foundation to most AM frameworks for tourism in PA [54]. Limits of Acceptable Change (LAC) [67] was proposed as a framework that establishes measurable limits to human-induced changes in the natural and social settings of a PA [14]. After LAC was released, similar ideas and concepts were incorporated into related frameworks that used different terms and procedural details such as the Visitor Experience and Resource Protection (VERP) [68]. However, these methodologies were not without criticism [69]. Among the most relevant is the perception that these frameworks were not fully integrated into current planning processes or were developed under very specific conditions complicating its replication. There were also concerns about the complexity and cost involved in their implementation. To address these

challenges, and to integrate the functional elements across the existing frameworks, the Visitor Use Management framework (VUM) was released by the Interagency Visitor Use Management Council (IVUMC) in 2016 to institutionalize a unified AM approach to visitor use on public lands and waters among all federal PA agencies in the U.S. [70].

Examples of tourism AM frameworks, under different names and with specific adaptations, could be found around the world [14,15,71]. In the US, Yosemite National Park is recognized for the implementation of a monitoring system to inform its scientifically based standards for long-term planning and management [72]. The Delaware Water Gap National Recreation Area in Pennsylvania is one of the most recent applications of VUM which included important participation of local stakeholders [73]. As for marine activities, the management system implemented by the Great Barrier Reef (GBR) in Australia has been well recognized and replicated in marine PAs. This management includes not only zoning but site-specific management plans, best practices for users, and permit schemes to accommodate a diversity of activities [74]. Integrating marine and terrestrial tourism uses, the System of Visitor Management (SIMAVIS) is an example of a tailored management framework designed for the Galapagos PAs [75]. This AM framework allowed managers to better design the uses of terrestrial and marine tourist sites while diversifying their recreational and educational opportunities. SIMAVIS applied a spatial and temporal organization of tourism activities through zoning. Participatory monitoring has enhanced the involvement of tour guides allowing managers to respond more efficiently to management needs [76].

4. How Adaptive Management of Tourism Is Conceived by the Scientific Community in Antarctica?

The global trend of AM approaches to PA tourism has not gone unnoticed for Antarctica. In fact, the adoption and adaptation of AM frameworks to the context of Antarctic tourism have been discussed and proposed by researchers. In many cases, proposals presented to the Antarctic fora were stimulated by successful AM approaches implemented in PAs around the world. While the Treaty Parties have considered and adopted an array of regulatory options and management actions to deal with tourism affairs over time, the scientific community often consider that this approach falls short of a strategic long-term vision, suggesting the need for a more systematic, adaptive, and comprehensive process for the treatment of tourism matters [19,43,77]. To assess the extent to which the AM approach and its constituent elements have been conceived or advocated by the scientific community, we conducted an appraisal of scientific literature on Antarctic tourism that is relevant to the AM approach.

This appraisal started with the authors' literature collections, which were accrued from over 15 years of focused research on Antarctica tourism and management. These collections served as the initial source from which we drew policy, regulatory, empirical, review, and discussion papers related to tourism management and tourism impacts in Antarctica. To be exhaustive, we conducted a supplementary literature search using two leading databases: Web of Science (WoS) and Scopus. We used the keywords "Antarctic tourism", "Antarctic tourism management", "Antarctic tourism policy", and "Antarctic tourism history". The first 100 references appeared during the search were compared and complemented to our collection. For both sources, we included only full-length peer-reviewed journal articles in this appraisal as they are considered to meet the scientific publishing standards. Book chapters, editorials, short notes, press articles, and commentaries were excluded. After applying this criterion, we identified a total of 127 articles.

Fifty-five papers were excluded from the final dataset in the second screening as they were just mentioning tourism as an indirect contributing factor to the analysis performed (e.g., presence of microplastics, oil spill risks, measures for conservation of geological features, uses of Antarctic terrestrial protected areas), or they had no specific analysis on the tourism matter presented. Our final reference compilation consisted of 72 papers published from 1992 through 2020. Within this period, six years (2007, 2011, 2012, 2013, 2017, 2019) contributed to 52% of the total number of papers analyzed. Year 2012 appeared as the

most productive with 10 published papers followed by 2011 (7) and 2019 (6). According to the paper typology (Figure 1), 37 corresponded to *empirical studies*, 20 to *discussion* papers (including conceptual, perspective, and policy/governance papers), and 15 were *reviews*.

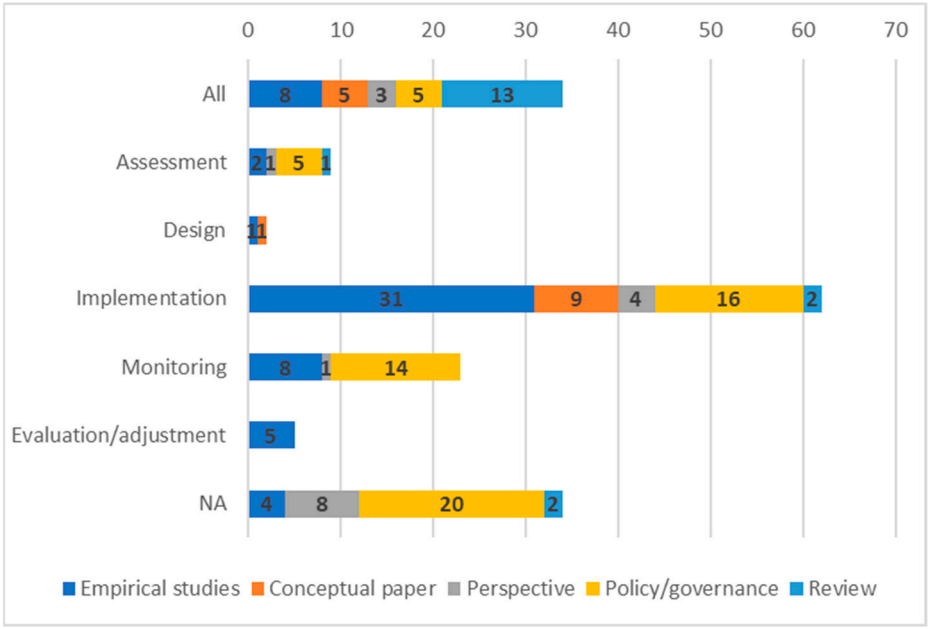

Figure 1. Number of recommendations by AM element and paper typology.

We analyzed, systematized, and extracted every recommendation provided by each research article. Each recommendation was categorized according to the topic treated. Then, we classified each recommendation to the corresponding element of the AM framework (i.e., assessment, design, implementation, monitoring, evaluation/adjustment, as defined below), and to one of the four general categories of recommendation (i.e., policy/legal/institutional, planning/management, capacity building, partnership/collaboration). A second researcher revisited the categories and classification process conducted to assess its accuracy.

Elements of the AM framework were classified following the next set of definitions, which were prepared using the five elements inherent to the concept of AM and the conceptualizations used by the different applications of tourism AM frameworks, particularly IVUMC 2016 [70] and CMP 2007 [60].

- **Assessment:** Generation and assessment of baselines and inventories with ecological, social, and/or management information (e.g., regulatory frameworks, governance conditions) to better understand the current conditions and contextualize the management problem.
- **Design**: Definition of the goals and objectives concerning the desired future conditions to be achieved. Design of management strategies to be implemented (i.e., zoning and monitoring plans, regulatory and collaborative frameworks).
- **Implementation**: Implementation of management actions to achieve management objectives (e.g., implementation of zoning, use limitations, site-specific measures such as distances, biosecurity protocols, education strategies).
- **Monitoring**: Development of structured and programmatic monitoring activities to reduce uncertainties, evaluate management strategies and actions, and inform decision-making processes.
- **Evaluation/adjustment:** Effectiveness evaluation of the actions implemented. Adjustments to plans, strategies, and actions that are based on monitoring results and what was learned through the process.

From the 72 papers analyzed, we extracted a total of 169 specific recommendations. Seventy-nine percent of these recommendations directly addressed topics related to tourism

management, while twenty-one percent (35) of recommendations addressed topics indirectly related but consequential to tourism management (i.e., changing voting rules within the ATS).

Figure 1 presents the total number of recommendations by each one of the AM elements in correspondence to the type of paper analyzed. *Empirical studies* and *discussion* papers under the category *policy/governance* account for 70% of the recommendations. Within all the paper types, we found a total of 34 (20%) recommendations incorporating *All* the AM elements, which means the adoption of strategic planning and comprehensive processes. A total of 62 (36%) recommendations were associated with *Implementation* and 23 (13%) with *Monitoring*. By paper typology, within *empirical studies*, a total of 31 (52%) recommendations were related to *Implementation* actions. In the case of *policy/governance* papers, a total of 30 (50%) recommendations were associated with *Implementation* and *Monitoring*.

When we contrasted the category of recommendation by AM elements (Figure 2), we found that 107 recommendations fell into the recommendation type *planning/management*. Within this body of recommendations, every one of the elements of AM were proposed, being the most frequently mentioned those related to *All* the AM elements with 34 (31%), *Implementation* 34 (31%), and *Monitoring* 23 (21%). Across all the categories of recommendations, *Implementation* accounted for 62 recommendations (58%).

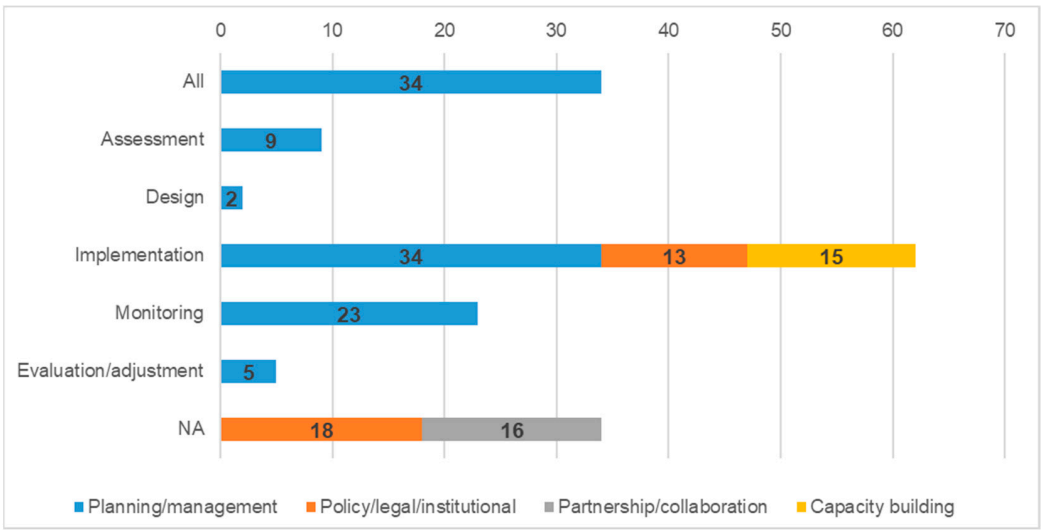

Figure 2. Number of recommendations by category of recommendations and AM element.

Table 2 presents the results of our systematization by category of recommendation and AM element. Twelve recommendation topics fell under the category policy/legal/institutional. From them, six corresponded to the AM element *Implementation* and six to the *NA* category (as they go beyond tourism management). The need to *"Develop a comprehensive and effective tourism regulation"* was the most mentioned recommendation. As part of this, the authors suggested reconsidering the revision of a specific annex on tourism or the development of a separate tourism legislation body (i.e., tourism convention). Another recurring recommendation was to provide IAATO with a more formal role within the ATS to strengthen tourism management.

Table 2. Systematization of peer-reviewed journal articles grouped by category of recommendations and AM element. The last column shows the number of journal articles that proposed each recommendation.

Category of Recommendation	Recommendations	AM Elements *	Citations **
Policy/legal/institutional	Create financial incentives programs	I	[78]
	Eco-taxes and fees on tourists and tour operators for management	I	[19,78]
	Payment for ecosystem services and emission compensation schemes	I	**[79]**, [80]
	Development and application of biosecurity protocols and procedures	I	**[7,81]**
	Apply the precautionary principle when previous scientific information is limited or scarce	I	**[25,82,83]**
	Adapt existing guidelines in other natural settings to inform Antarctic tourism	I	[21]
	Give CEP more power and ultimate decision on EIA	NA	[19,84]
	Revisited voting rules within the ATS, not unanimity, non-Consultative Parties to vote	NA	[19,84]
	Review of the existing regulatory framework for tourist activity and consistent application	NA	[85]
	IAATO co-management of tourism affairs, give IAATO a formal role within the ATS, membership mandatory	NA	[21,86,87]
	Develop a "comprehensive and effective" tourism regulation: revision of annex on tourism (1992), develop tourism convention	NA	[10,19,84,88]
	A new organization for tourism management (such as the United Nations)	NA	[86]
Planning/management	Conduct regional assessments, incorporating zoning at a coastal zone level	AL	[89]
	Strategic planning approach to tourism with a long-term vision shared with stakeholders	AL	[10,16,41], **[77]**, [85,90], **[91,92]**, *[93–96]*, **[97,98]**
	Develop and implement action plans towards achieving a shared long-term tourism vision	AL	[10,23,78]
	Develop comprehensive management guidance according to specific field conditions (e.g., additional biosecurity and safety measures) in line with general regulations	AL	*[98–104]*
	Establish a management decision-making system with an integral component of a research and monitoring program	AL	**[105]**
	Adapt tourism management frameworks for Antarctic tourism	AL	[2,16,78]
	Using ASPA and ASMA as current legal frameworks to manage tourism and ensure the conservation of biodiversity	AL	[10], **[18,106–108]**
	Develop comprehensive guidelines on EIA	A	[89,109]
	Establish a baseline through emission inventories for assessing the performance of individual tour ships	A	**[79,110]**
	Implement Strategic Environmental Assessment as a more comprehensive evaluation for tourism activities	A	[41,42,89,111]
	Calculate Antarctic Tourism Ecological Footprint (ATEF) and Antarctic tourism environmental carrying capacity (ATECC)	D	[78]
	Discrimination of certain types of tourism activities using EIA as a filter	D	**[18]**
	Implement active remediation actions, especially when detecting non-indigenous species	I	**[112–114]**
	Implement site management decisions according to specific conditions (i.e., dispersion or use concentration, temporary closures, activities, time of visit, number of people, guides)	I	[9,10], **[18,26,27,77]**, [84], **[112,115–119]**
	Establishment of caps and limitations in numbers of tourists by season	I	[10,18,19], *[87]*
	Implement a tourist traffic management system with an annual limit on tourist numbers for tour operators	I	[120]
	Reinforce the application of the biosecurity procedures to avoid alien species	I	*[121]*
	Increase awareness: reinforce educational opportunities	I	[78], **[85]**, [122], **[123]**
	Implement zoning as a strategy for organizing uses	I	[10,19,78], **[87,123]**
	Structured and programmatic approach to scientific and long-term monitoring of Antarctic tourism to inform management decisions and analyze its cumulative effects	M	[10,21,85–87], **[106]**, [124], **[125–128]**
	Designate NGO's or international observers for supervision of tourism activities: more participation of civil society	M	[19], **[77]**, [86,124]
	Develop a centralized and searchable database for monitoring Antarctic EIAs' compliance	M	[89]
	Environmental auditing processes	M	[89]
	Port state controls	M	[10,19,21]
	Special inspection report on the impact of tourism activities in the Antarctic	M	[124]
	Use monitoring results to inform guidelines and management	EA	**[129–133]**

Table 2. *Cont.*

Category of Recommendation	Recommendations	AM Elements *	Citations **
Partnership/collaboration	Enhance and encourage cooperative funding and resourcing	NA	[89]
	Create a nested governance structure by increasing cooperation between ATS and international private and public institutions	NA	[10]
	Define the role of different institutions to make better use of organizations knowledge and experience and networks	NA	**[87]**
	Definition of a tourism commission with representatives of IAATO and ATCP	NA	[10], **[87]**
	Development partnerships among Parties and other stakeholders	NA	[86], **[87]**, [98]
	Encourage greater cooperation and share information among stakeholders (IAATO, CEP, COMNAP, and SCAR)	NA	[10,21,85,88–90], *[100]*
Capacity building	Develop an accreditation scheme for staff members	I	[10,21], **[77]**, [86], **[87]**, [120]
	Certification schemes (i.e., eco-labels, ISO 14000)	I	[10,19], **[77]**, [78,85,89]
	Staff training programs for tour operators	I	**[77]**, [85]

* A—assessment; AL—all elements; D—design; I—implementation; M—monitoring; EA—evaluation and adjustment; NA—none. ** Citations paper type: Discussion/perception, **Empirical study**, *Review.*

Under the category planning/management we found a total of 26 recommendation topics. Seven corresponded to the AM element *Implementation*, 7 corresponded to the category *All* recommending the adoption of strategic and comprehensive processes, and 6 for *Monitoring*. The development of strategic planning to tourism (*All*), the implementation of site management decisions according to specific conditions (*Implementation*), the need for a structured and programmatic tourism monitoring to inform management decisions (*Monitoring*), the use of Strategic Environmental Assessments (SEA) for tourism purposes (*Assessment*) and the need to use the existing regulatory framework of the ASMA and ASPA frameworks to manage tourism and ensure the conservation of biodiversity were the most recurrent recommendations found in our compilation.

Under the category partnership/collaboration, we found a total of six recommendation topics not belonging to any AM element. The most frequently mentioned by authors was the need to develop partnerships, encourage greater cooperation, and share information among stakeholders (IAATO, CEP, the Council of Managers of National Antarctic Programs COMNAP, and the Scientific Committee on Antarctic Research SCAR). Finally, three recommendation topics were categorized as capacity-building and belonging to the AM element *Implementation*. The development and implementation of accreditation and certification schemes were the most recurrent recommendations under this category which were frequently mentioned in studies involving the perception of stakeholders.

5. Adaptive Management for Antarctic Tourism: Lessons Learned from the Analyses

AM has been a common and widely advocated approach to PA tourism management [14,71], assisting managers in developing recreation opportunities while reconciling conservation and management objectives. Therefore, if AM has been advocated as the best-practice approach to PA tourism around the world, what factors have hindered its adoption and implementation in the context of the Antarctic tourism? First and foremost, Antarctica is a global commons, and this sole condition imposes limitations on the range of options for regulating tourism development [10]. Another structural reason is related to Antarctica's consensus-based governance regime. The Antarctic Treaty (AT) requires unanimous agreement of ATCPs for the adoption of policy and management instruments. As stated by Verbitsky 2013 [19], some ATCPs could be hesitant to adopt decisions and implement actions that could be inconsistent with their domestic legislation. On the other hand, they could hold different perspectives for the treatment of specific issues (e.g., establishment of permanent tourism facilities) or may consider tourism a high priority issue. Finally, as the AT puts in abeyance all territorial claims, Antarctica lacks a sovereign government able individually to determine and implement management decisions [13]. This condition is not present in PAs where sovereignty is established, and decisions could be made unilaterally by one country or specific countries as in the case of transboundary PAs. All the above become more complex with the adhesion of new ATCPs who may hold different views on policy and management [13,43].

These conditions, however, have not prevented ATCPs from suggesting strategic planning and comprehensive processes for tourism management. A review of the different ICGs recommendations, reports of Meeting of Experts, and ATCM archives since 1972 to date reflects that a total of 21 ICGs reports, 1 tourism study and 57 documents produced by Meeting of Experts were submitted to the ATCM demonstrating the continued interest among ATCPs and related stakeholders for the adoption of a comprehensive regulatory mechanism for Antarctic tourism. One example is the proposal for creating Areas of Special Tourist Interest (ASTIs), first suggested in 1972, and which were considered in subsequent ATCMs. Although ASTIs did not receive explicit regulation and, therefore, were never implemented, they could be considered the first approach of the ATCM to comprehensively address tourism affairs [40]. Moreover, the adoption of the statement of accepted principles [134] the proposal for introducing a specific Annex on Tourism [135] and the adoption of the first Guidelines for visitors to the Antarctic [136] also reflect the continued interest in addressing tourism management in the Antarctic.

Recently, ATCPs and observers such as ASOC (2009, 2012, 2017) have stressed the importance of introducing strategic planning and comprehensive processes to tourism management (Table 1). In fact, in 2016 the ICG named *"Developing a strategic approach to environmentally managed tourism and non-governmental activities"* presented a comprehensive report which, among others, recommended ATCPs to agree on a common vision for Antarctic tourism and develop a multi-year work plan focused on tourism [137]. Finally, the intersessional workshop on Antarctic tourism held in Rotterdam (2019) also emphasized the importance of a proactive management to cope with the increasing demands of tourism in Antarctica [40]. Therefore, it would be unfair to argue that ATCPs have not considered the importance of adopting strategic planning and comprehensive processes when it comes to tourism management. However, decisions taken to date correspond to a more passive AM approach, which means that they were informed by historically best practices and not as part of a deliberate learning process that characterizes the active AM approach.

The voice from the scientific community on proactive management of Antarctic tourism has also been clear. Results of our appraisal of peer-reviewed literature (Table 2) show that 34 mentions in 72 papers provided recommendations for strategically, comprehensively, and adaptively managed Antarctic tourism. During the 1990s and 2000s, the scientific community contributed elaborated proposals, adaptations of management frameworks, and conceptual models for managing Antarctic tourism. Hall (1992) [88] elaborated the first recommendation for adopting similar tourism management models from those applied in Macquarie Island because of the similarities with Antarctica. While Enzenbacher (1992) [85], Beck (1994) [111], and Hall (1992) [88] continued to back the idea of adopting a more comprehensive regulatory model for Antarctic tourism (i.e., tourism annex or convention), it was not until 1999 when Davis [16] proposed the first adaptation of ROS and LAC for Antarctic tourism. Later, Bauer et al. (2003) [4] proposed the adaptation of the Environmental-Based Tourism Framework [138] to the Antarctic context. Finally, Lamers et al. (2008) [2] propose the Antarctic tourism opportunity spectrum (ATOS) which was based on the ROS and Ecotourism Opportunity Spectrum (ECOS) frameworks. These different proposals are not indicative of differences of opinion regarding the most suitable models for the management of Antarctica, but rather reflect the historical evolution of visitor management models, all of which incorporate AM approaches to a greater or lesser extent, depending on the time in which they were proposed.

The 2010 decade also reflects an important number of recommendations. The scientific community continued emphasizing the need for developing adaptive, strategic, and comprehensive planning processes [10,42,77] encouraging collaboration [89], using monitoring as a tool for informing management decisions [20,107], and advancing with proposals for the adoption of Payment for Ecosystems Services schemes related to tourism [80]. Intriguingly, neither previous conceptualizations for adopting tourism management frameworks (e.g., ROS, LAC, ATOS) nor these last ones were further developed or encouraged. Similar to the proposals presented by ATCPs, research proposals have also been stalled at the recommendation level with no further development. Antarctica's governance regime, sovereignty issues and the low probabilities of changing structural conditions of the ATS (e.g., changing the unanimity requirement) constitute the principal factors for preventing the adoption of a fully AM approach for Antarctic tourism [19].

Despite this, the scientific community has persistently advocated for the adoption of certain elements of the AM approach, particularly *implementation* with 31 mentions in 72 papers, and *monitoring* with 22 mentions in 72 papers (Table 2, planning/management). For example, research on human disturbances resulted in specific management measures for wildlife and human interactions, especially approach distances and human behavior [9,27,29,30,116]. Trampling studies contributed to site-specific management measures regarding the use of paths [25,26]. An invasive species analysis helped to develop general guidelines and protocols [93]. Biological assessments and monitoring were also used to inform management decisions at a site level [91,107]. Most recently, the COVID-19 out-

break also motivated researchers for developing field guidance for scientific personnel and tourists to avoid potential transmission of the virus, especially to wildlife [139].

Considering the uniqueness of Galapagos' natural environments, as well as the operational similarities with Antarctica (e.g., cruise activities, access to visitor sites by zodiac, guided activities, viewing distances to wildlife, non-invasive species protocols), it could be reasonable to think that an AM approach similar to the Galapagos could be useful to the Antarctic setting, especially when similar constraints are being faced by both destinations. Tourism management in the Galapagos has been facing challenges of responding to the increasing and diversifying tourism, the imperative of developing a comprehensive strategic vision, and using monitoring and science to inform management decisions [76]. These lessons can still contribute important insights to the Antarctic if the aim is to use tourism as a tool to support Antarctica's conservation.

In the Galapagos under a single regime, the implementation of a full AM approach has been challenged by political, regulatory, financial, personnel, and logistical constraints. An alternative to overcome these challenges, has been the prioritization of sites and the implementation of specific AM elements for coping with the increasing tourism management needs. Similarly to the Galapagos and many other PAs, *implementation* and *monitoring* seem to be the most common AM elements suggested or applied by researchers. Indeed, the applications of specific AM elements are already contributing to some planning, management, and decision making of Antarctic tourism and should be considered a progress towards the full AM implementation. However, it is important to note that AM should not be considered just as a toolbox from which one element could be used independently of the other. These initial efforts should be guided by a plan for the full AM implementation through which all AM elements would be incrementally introduced, connecting, and informing each other in the management process.

6. Recommendations and Conclusions

Considering the structural complexities for adopting a full AM tourism approach applicable to the entire continent, we propose an incremental AM approach that will help strengthen the management of Antarctic tourism. This proposal starts with the establishment of a permanent Tourism Advisory Group (TAG) with a dedicated and continuing focus on tourism issues. Structurally, the TAG will report directly to the CEP, the main advisory body to the ATCM on environmental matters. It will be led by representatives of National Antarctic Programs (NAP) and researchers with management and research interests in the geographical areas where the TAG will operate. The TAG would be built on the existing "management groups" that operate during the intersessional ATCM periods (e.g., Deception Island, Palmer management group). However, the TAG would have a more optimized membership, clearer functions, and stronger communication and collaboration linkages with other institutions and the scientific community, essential for improving the management of this complex destination [140].

A defining characteristic of this incremental approach is collaboration and partnership among stakeholders. Figure 3 shows how this collaboration scheme would operate under an AM approach. Other than the TAG, we identified four additional key tourism stakeholders with specific proposed actions by each stakeholder to support different AM elements. SCAR, for instance, will be related to initial phases of assessment by identifying research gaps for an AM approach. Jointly SCAR and TAG will design and translate research outputs into management recommendations. At an operational level, the TAG and NAP will be jointly responsible for implementing, monitoring and evaluating/adjusting management actions.

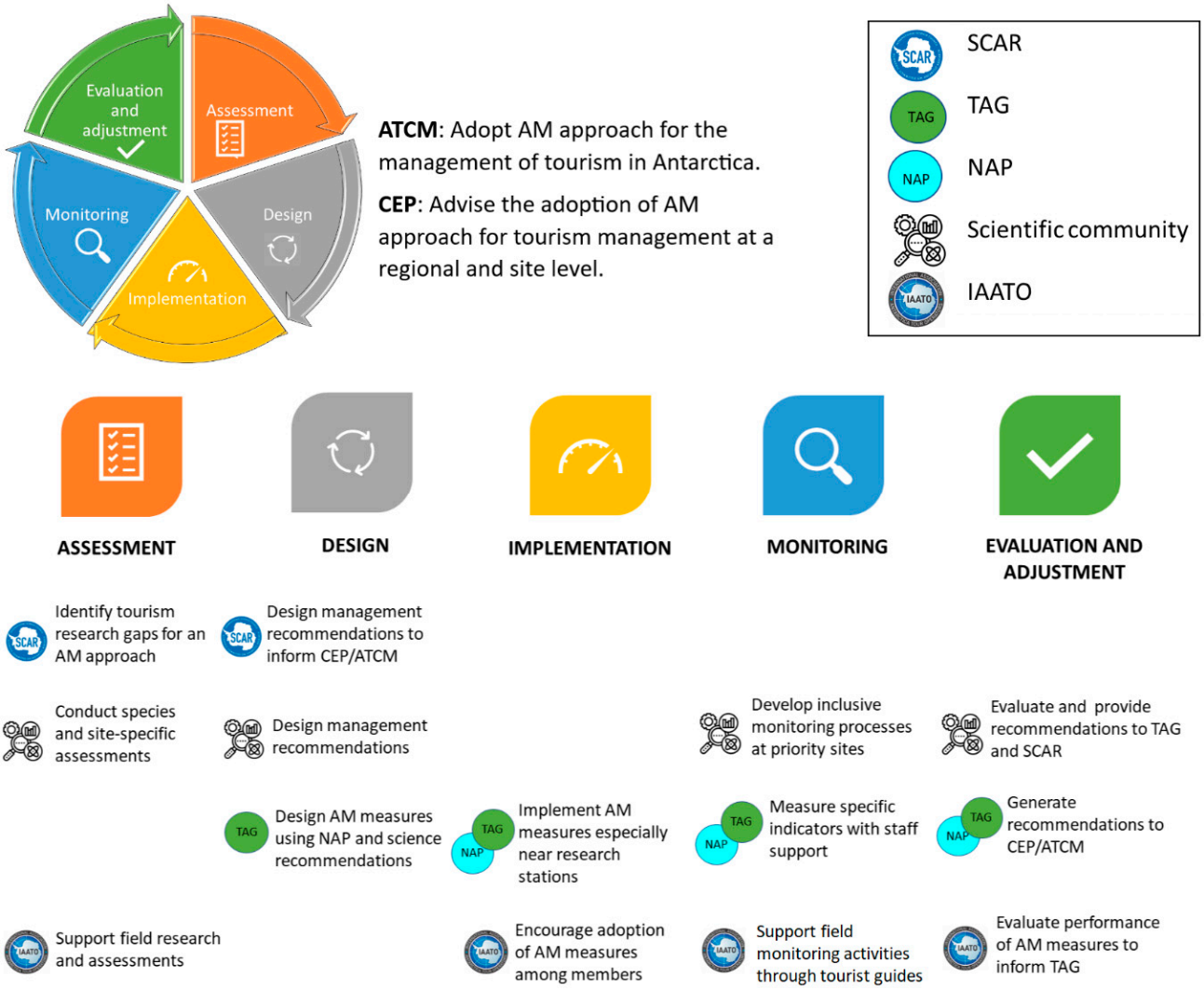

Figure 3. A proposed AM approach to tourism management in Antarctica with specific actions for Antarctic stakeholders.

The scientific community will be part of the assessment, design, monitoring and evaluation/adjustment of management measures by collaborating with the TAG/NAP and SCAR at different steps. IAATO's fundamental role will be related to the implementation and evaluation/adjustment of the AM measures applied at different sites, as well as the support to field monitoring and research activities. Independent observers, technical staff from research stations, and tourism guides may have an important role on data collection.

The incremental implementation strategy is another key characteristic of our proposed AM approach, which will call for pilot demonstration sites to be identified based on specific criteria (e.g., conservation values, vulnerability, levels of tourist use, possibilities for access and monitoring, proximity to research stations). Once identified, specific site management plans could be developed for a mid-term period. Management plans could follow the same structure as the ASMA management plans. The benefits of this strategy will be the assessment of whether a current tourist site is being appropriately managed, including the design and implementation of site management measures for specific needs, the generation of comparable monitoring, and the evaluation and adjustment of management practices based on best available monitoring data. This site-level AM implementation will contribute to the goal of the ATCM in developing a strategic and comprehensive process for tourism management while narrowing the gap between science and policymaking.

If successful results are obtained from the pilot demonstration sites, implementation of the proposed AM approach could be scaled up incrementally to more sites or networks

of sites. Management comparisons would be afforded by using core monitoring indicators, while lessons learned would make future management processes more efficient. This strategy would effectively create a community of practice through which collaboration could be improved among different countries without the necessity of introducing significant, structural and regulatory changes to the ATS. Lastly, this also entails an essential shift to the ATCM: changing from a traditional passive AM approach to an active AM tourism approach in which deliberate learning will reduce uncertainties and lead to the design and implementation of comprehensive policy and management actions.

PAs and Antarctica face similar challenges as both are coping with increasing tourism uses, attending to new management needs, and being confronted with the urgency for improving collaboration [140]. For this, our proposed incremental AM approach to Antarctic tourism in which selected pilot sites will allow the progressive implementation of active and comprehensive management. In natural destinations where uncertainties and complexity are common elements, an approach such as the one we propose would help in forming a community of best practice with enhanced collaboration and learning among different stakeholders, thereby contributing to policy and decision making with a more structured and systematic rationale [14]. There is not a unique formula though, and AM approaches should be contextualized and designed according to the specific management needs of destinations. Nevertheless, a comprehensive and strategic vision will allow managers, practitioners, researchers, and policymakers to make substantial contributions to the conservation and sustainable future of natural destinations, including those so unique as Antarctica.

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