Toward an Integrated Visitor Management Framework for Protected Areas: A Comparative Review of Capacity, Experience, and Impact-Based Approaches

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Toward an Integrated Visitor Management Framework for Protected Areas: A Comparative Review of Capacity, Experience, and Impact-Based Approaches

Em direção a um modelo integrado de gestão de visitantes para áreas protegidas: uma análise comparativa de abordagens baseadas em capacidade, experiência e impacto

Hacia un marco integrado de gestión de visitantes para áreas protegidas: revisión comparativa de los enfoques basados en la capacidad, la experiencia y los impactos

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Abstract

Visitor pressure is rising in protected areas, intensifying ecological impacts and perceived crowding while increasing demand for high-quality recreation. This article presents a systematic scoping–integrative review of eleven visitor-management methodologies (Carrying Capacity, LAC, VERP, ROS/VOP, PSR, VIM, AAA, VAMP, TOMM, and SIMAVIS). Searches of peer-reviewed databases and authoritative agency literature (1979–2025) were screened with PRISMA-ScR and coded for theoretical assumptions, operational steps, indicator systems, and scales of application. Results show that all methodologies share a common adaptive architecture—objectives, opportunity or use allocation, indicators, standards, monitoring, and response—but diverge in their entry points and managerial emphasis. Synthesizing these convergences, the study proposes a PSR-aligned integrated pathway that sequences zoning, desired-condition standards, impact diagnosis, and optimization, positioning carrying capacity limits as a contingent response tool. The framework strengthens defensible, scalable visitor governance under growing tourism pressure.

Keywords: Tourism, Environmental management, Nature conservation, Nature reserves, Sustainable development

Resumo

A pressão de visitantes está aumentando nas áreas protegidas, intensificando os impactos ecológicos e a percepção de superlotação, ao mesmo tempo em que eleva a demanda por experiências recreativas de alta qualidade. Este artigo apresenta uma revisão sistemática de escopo com abordagem integrativa de onze metodologias de gestão de visitantes (Capacidade de Carga, LAC, VERP, ROS/VOP, PSR, VIM, AAA, VAMP, TOMM e SIMAVIS). As buscas em bases de dados revisadas por pares e em literatura institucional autorizada (1979–2025) foram selecionadas conforme o protocolo PRISMA-ScR e codificadas quanto a pressupostos teóricos, etapas operacionais, sistemas de indicadores e escalas de aplicação. Os resultados mostram que todas as metodologias compartilham uma arquitetura adaptativa comum — objetivos, alocação de oportunidades ou uso, indicadores, padrões, monitoramento e resposta — mas divergem quanto aos seus pontos de partida e ênfases gerenciais. Ao sintetizar essas convergências, o estudo propõe um percurso integrado alinhado ao modelo PSR, que organiza de forma sequencial o zoneamento, os padrões de condições desejadas, o diagnóstico de impactos e a otimização, posicionando os limites de capacidade de carga como instrumento contingente de resposta. O marco proposto fortalece uma governança de visitantes defensável e escalável diante da crescente pressão turística.

Palavras-chave: Turismo, Gestão ambiental, Conservação da natureza, Reservas naturais, Desenvolvimento sustentável.

Resumen

La presión de visitantes está aumentando en las áreas protegidas, intensificando los impactos ecológicos y la percepción de hacinamiento, a la vez que aumenta la demanda de recreación de alta calidad. Este artículo presenta una revisión sistemática, de alcance e integración, de once metodologías de gestión de visitantes (Capacidad de Carga, LAC, VERP, ROS/VOP, PSR, VIM, AAA, VAMP, TOMM y SIMAVIS). Las búsquedas en bases de datos revisadas por pares y literatura de agencias autorizadas (1979-2025) se filtraron con PRISMA-ScR y se codificaron para supuestos teóricos, pasos operativos, sistemas de indicadores y escalas de aplicación. Los resultados muestran que todas las metodologías comparten una arquitectura adaptativa común (objetivos, asignación de oportunidades o usos, indicadores, estándares, monitoreo y respuesta), pero divergen en sus puntos de entrada y énfasis gerencial. Sintetizando estas convergencias, el estudio propone una ruta integrada alineada con PSR que secuencia la zonificación, los estándares de condición deseada, el diagnóstico de impactos y la optimización, posicionando los límites de la capacidad de carga como una herramienta de respuesta contingente. El marco fortalece una gobernanza defendible y escalable de los visitantes bajo la creciente presión del turismo.

Palabras clave: Turismo, Gestión ambiental, Conservación de la naturaleza, Reservas naturales, Desarrollo sostenible.

INTRODUCTION

The current operational framework for Protected Areas (PAs) has become highly multidimensional, requiring a balance between the protection of natural and cultural heritage and emerging opportunities related to nature-based recreation, education, and tourism. While increased visitation to PAs has enhanced their social importance and economic sustainability, it has also amplified the environmental impact of these visits and altered the visitor experience. As tourism grows in volume and spatial concentration, visitor use management is shifting from a marginal to a key component of protected area governance (Bang & SooCheong, 2025).

Soil compaction, loss of vegetation, disturbance of animals, loss of infrastructure, and any other impacts of unmanaged visitation are certain. These impacts are even more severe when visitation is concentrated in certain areas or during specific seasons (Sardar & Islam, 2024). The closure of areas is part of the social impacts and is characterized by the perception of overcrowding, conflicts between social groups, and a decrease in the quality of the experience. These impacts are more recently, and appropriately, considered key indicators of management success (Bang & SooCheong, 2025). The social and ecological elements of the system are interdependent. Environmental degradation decreases visitor satisfaction, and a degraded experience reduces support for environmental protections. Visitor management means more than simply controlling visitor numbers; it also means providing the adaptive management required to ensure that environmental and social objectives are met.

The concept of carrying capacity (CC) originally provided the principal organizing logic for managing visitor use. Defined as the maximum level of use that can occur without unacceptable deterioration of resources or experiences, CC offered an intuitively appealing framework. Yet decades of practice have revealed its limitations. What constitutes “unacceptable” change is inherently normative and context-dependent, varying with ecosystem sensitivity, infrastructure, managerial goals, and visitor expectations (DuPuy et al., 2025). Over time, carrying capacity has evolved from a presumed fixed threshold into a managerial judgment informed by indicators and negotiated standards rather than a singular calculable number.

In response to these problems, subsequent frameworks redefined visitor management as an adaptive and context-sensitive approach. Approaches such as Limits of Acceptable Change (LAC) and Visitor Experience and Resource Protection (VERP) shifted the focus from trying to answer the question of how many visitors are “too many” and instead guided management to focus on defining and measuring desired conditions, whether ecological or experiential. This included establishing benchmarks and changing management in response to conditions during monitoring periods (Stankey et al., 1985). Complementary frameworks, such as the Recreation Opportunity Spectrum (ROS), focused on different zones and the intentional creation of varied experiential environments. More targeted frameworks like VIM and VAMP formalized systematic assessment, while broader, adaptive frameworks like TOMM and SIMAVIS used a multidimensional approach to monitoring across the ecological, economic, and sociocultural layers of a system. Taken together, these changes illustrate the evolution of visitor management from a static boundary-setting system to a structured, adaptive management system.

Despite this methodological evolution, an important structural issue persists. Although these frameworks share common building blocks—goal setting, spatial allocation, indicators, standards, monitoring, and management response—they rest on different conceptual entry points and managerial priorities. Capacity-based approaches foreground thresholds; experience-based models emphasize desired conditions; impact-oriented systems prioritize causal diagnosis; and optimization models seek broader socio-economic balance. In practice, agencies often apply these approaches selectively or

sequentially, without explicitly addressing their theoretical compatibility or integration. This fragmented application can lead to inconsistent decision logics and reduced transparency in management justification (Wenjing et al., 2021).

Recent guidance suggests that the central gap in visitor-use management is not the absence of tools, but the absence of coherent integration architectures capable of aligning them within a unified adaptive cycle (Medina, 2024). This challenge is particularly acute in contexts experiencing rapid tourism growth alongside limited financial and technical resources, where clarity, scalability, and defensibility are essential.

Against this background, this article develops a theoretically grounded and operationally scalable integration architecture for visitor management in protected areas. Rather than merely comparing existing methodologies, it examines their normative assumptions, decision logics, and structural compatibilities. By identifying both convergences and tensions among capacity-, experience-, and impact-based paradigms, the study proposes a sequenced framework aligned with the Pressure–State–Response (PSR) logic. Within this architecture, carrying capacity is repositioned as a contingent regulatory instrument embedded in a broader adaptive governance system. In doing so, the paper seeks to provide a conceptually robust yet practically applicable foundation for integrated, defensible, and context-sensitive visitor governance.

LITERATURE REVIEW

From Numerical Limits to Adaptive Governance: Conceptual Evolution of Visitor Management

The last five decades have shown significant changes in visitor management systems in protected areas. The time-consuming work of determining how many visitors are "too many" has been replaced by more sophisticated and continuous processes where visitor management systems are designed considering desired outcomes, adaptive feedback, and the legitimacy of governance (Pollock et al., 2021). The sophistication of these systems and methods shows that visitor use is much more than a numbers game. It is a complex and integrated phenomenon with ecological, social, and political dimensions.

Carrying capacity emerged as the earliest and most influential organizing principle in visitor management. Traditionally understood as the maximum level of use that can be sustained without unacceptable ecological or social degradation, it offered managers a clear and communicable regulatory reference point. Over time, however, its conceptual boundaries proved more complex than initially assumed. The notion of “limits” extends beyond biophysical thresholds to encompass experiential quality and managerial objectives, reflecting the inherently normative character of what counts as acceptable change (Comrie, 2016). This conceptual breadth helps explain both its durability and its operational fragility. Although administratively straightforward and politically appealing, the approach is frequently reduced to a single numeric ceiling, even in contexts where impacts are shaped more by visitor behavior, spatial distribution, or infrastructure conditions than by aggregate visitation levels alone.

Recognizing these shortcomings has led to second-generation conditional frameworks that reconceptualize visitor management as an iterative process. The Limits of Acceptable Change (LCA) model makes a significant difference. LCA encourages managers to process a set of variables involving general trends in a given situation rather than seeking a finite range of acceptable change. LCA practitioners establish desired ecological and experiential conditions; develop measurable variables; set standards; monitor changes; and take management actions if standards are exceeded. Acceptability is a norm, and managing change is a policy-related decision rather than an ecological condition that can be

discovered (Stankey et al., 1985). The U.S. National Park Service's Visitor Experience and Resource Protection (VERP) model was developed from this reasoning and further strengthened the quality of the experience embedded in the traceability and defensibility of zoning and overall management plan decisions (ICRT Global, 2025). While these frameworks emphasize transparency and adaptability, they also require ongoing organizational resilience for sustained monitoring and collaboration with stakeholders.

Like condition-based models, zoning and opportunity frameworks focus on spatial variation and differentiated expectations. The Recreational Opportunity Spectrum (ROS) divides recreational spaces based on social, physical, and management elements, as well as the outcomes that govern their use, and suggests the deliberate manipulation of opportunity types across a managed unit (USDA Forest Service, 2024). Across varied landscapes and management objectives, the Visitor Opportunity Spectrum (VOS) and Visitor Opportunity Profile (VOP) frameworks have positioned management objectives relative to experience profiles as a responsible, ecologically sensitive, and policy-compliant management goal (Wenjing et al., 2021). While zoning frameworks are highly effective at differentiating experiences and spatial planning, they are insufficient to ensure the maintenance of desired circumstances in the absence of tangible metrics and the means to enforce them.

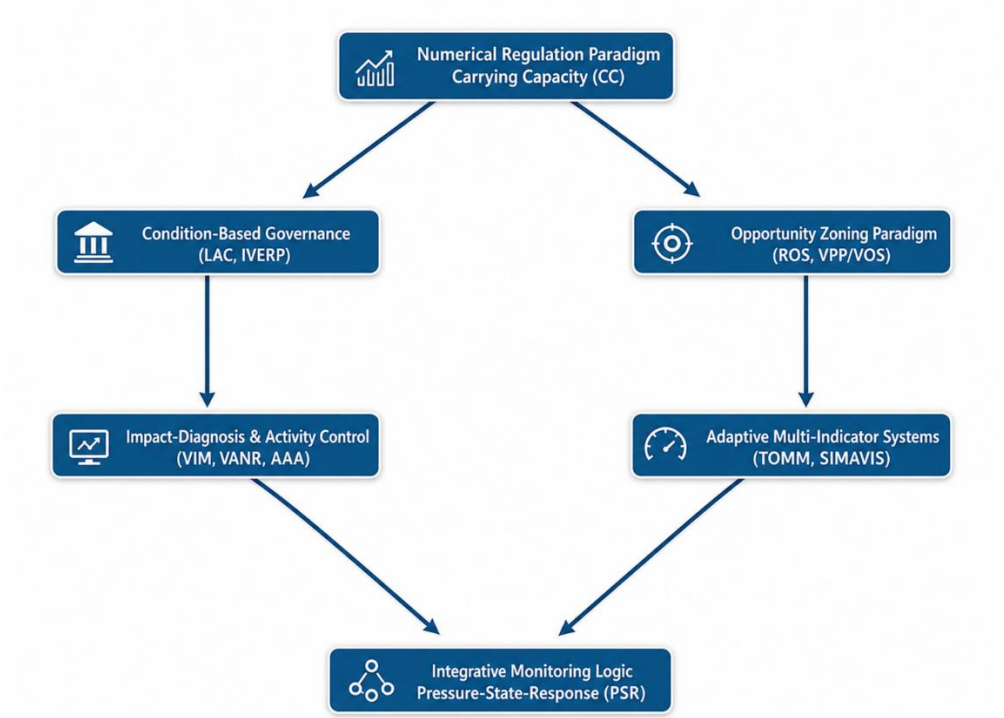
The third group of methods focuses on impact assessment and the evaluation of activities at the individual level. Visitor Impact Management (VIM) encompasses steps to identify the impact caused by visitors, assess the acceptability of that impact, analyze the causal factors of the impact, and choose specific management responses. In this regard, Parks Canada has formalized procedures with the Visitor Activity Management Process (VAMP) and the Appropriate Activity Assessment (AAA), which are developed in relation to park plans and ecological integrity (Minister of the Department of Canadian Heritage, 2016). Impact-based methodologies for describing causality and defining mitigation measures on a case-by-case basis have their applications. However, when impact-based approaches are used in isolation, they tend to be more reactive than proactive, and ultimately, they are only one fragment of the strategic cycle.

Finally, adaptive multi-indicator systems have shifted visitor management from individual sites to destinations or networks. The Tourism Optimization Management Model (TOMM) was first operationalized on Kangaroo Island and provides a way to continuously adjust to specific environmental, sociocultural, economic, and experiential indicators (Miller, 2007). The same is true of the Galapagos SIMAVIS, which, as of 2024, integrates adaptive monitoring, zoning, itinerary management, site-specific standards, and control of a dispersed, high-value network (Charles Darwin Fundation, 2024). Such systems embody the culmination of visitor management and, rather than imposing limitations, focus on the continuous optimization and correction of a system. However, these systems are data-intensive and require coordination and incur transaction costs.

Across these diverse approaches, broader indicator logics such as the OECD's Pressure–State–Response (PSR) framework offer a unifying causal structure. By conceptualizing visitation as a pressure, environmental and social conditions as state, and management actions as response, PSR provides a shared analytical grammar for linking use patterns to governance interventions. Yet PSR functions as an organizing logic rather than a standalone planning method.

Figure 1.

Conceptual lineage and clustering of visitor management methods



Comparative Performance and Structural Divergences

Comparative scholarship on visitor-use governance makes one point consistently clear: effectiveness is not inherent to any single framework but emerges from the interaction between institutional capacity, ecological context, political constraints, and the specific configuration of visitor pressure. Rather than competing models in a linear progression, existing methodologies represent distinct managerial rationalities that prioritize different leverage points within the socio-ecological system (Jaroslav, 2013).

Numerical regulation approaches remain particularly important in policy practice because of their ability to simplify and decompose multidimensional environmental problems into simple and easily understandable administrative responses. Entry limits, quotas, and permit systems are politically visible and relatively simple to implement. Yet regulatory clarity does not necessarily translate into ecological precision (Micah et al., 2021). Where degradation is driven by spatial concentration, behavioral patterns, or infrastructure design, aggregate limits may only partially address underlying dynamics. In such cases, numeric thresholds function more as governance signals than as comprehensive control mechanisms.

Condition-oriented systems redefine the problem not by starting with visitor counts, but with explicitly articulated ecological and experiential states. They excel at transforming qualitative aspirations into quantifiable criteria, thus guiding decision-making processes around commonly agreed-upon criteria (Pollock et al., 2021). This process clarity increases accountability and can strengthen an institution's legitimacy. However, such systems depend heavily on the sustained availability of monitoring and long-term management continuity. Where monitoring is diminished or criteria are politically contested, unregulated adaptation cycles can become stagnant.

Spatial opportunity frameworks introduce another layer of differentiation by recognizing that protected areas rarely operate as homogeneous landscapes. By deliberately distributing use intensities and experience types across zones, these models seek to reconcile conservation sensitivity with recreational diversity (Kang et al., 2025). They are particularly important in pluralistic situations involving multiple visiting communities and ecological gradients. However, simply allocating space will not guarantee the integrity of resources unless it is linked to specific and measurable condition objectives and supported by enforcement mechanisms.

Impact-focused methodologies provide added diagnostic value by analyzing specific pathways of degradation and detailing relevant, context-specific interventions. These methodologies clarify and construct relevant causal relationships and provide rationales for response management (Jaroslav, 2013). However, when these diagnostic methodologies are applied in isolation, there is a risk of reinforcing reactive management cycles, in which intervention occurs after visible degradation rather than addressing the underlying systemic pressure.

Some more comprehensive and integrated monitoring systems attempt to address these limitations by incorporating visitor governance into multilateral monitoring systems that include environmental, social, and economic aspects and dimensions (Micah et al., 2021). The ongoing effort to modify these systems indicates that visitor use is part of a more dynamic and complex destination system. These systems improve transparency and flexibility, but their complexity, along with the need for advanced design, multi-sectoral collaboration, and stable funding, makes them difficult to implement, particularly within protected area systems.

Viewed collectively, these frameworks do not merely differ in operational technique; they diverge in their conceptual starting points. Some regulate pressure, others define desired states, allocate opportunities, diagnose impacts, or optimize multi-dimensional performance. This structural plurality explains both their individual strengths and the persistent difficulty of integrating them coherently. The challenge, therefore, is less about identifying the "best" tool and more about understanding how distinct managerial logics can be sequenced or nested within a unified governance architecture.

Table 1.

Comparative matrix of visitor management methodologies

Method	Primary management focus	Key operational steps	Typical scale	Main strengths	Main limitations
CC	Maximum use level	Estimate limits; regulate numbers	Site / park	Simple, communicable	Weak without standards; ignores behavior & distribution
LAC	Desired conditions & acceptable change	Define conditions → indicators → standards → monitor → respond	Site / park	Explicit trade-offs; adaptive	Monitoring-heavy; politically sensitive
VERP	Experience + resource	Zone experiences/conditions →	Park / sub-areas	Integrates experience &	High planning

	protection by zone	indicators/standards → monitor → adapt		ecology; defensible	and data demands
ROS	Recreation settings & opportunity zoning	Classify settings → allocate zones → set objectives	Park / region	Enables diverse opportunities	Zoning alone doesn't control impacts
VOP/VOS	Spectrum of visitor opportunities	Define opportunity classes tied to values	Park / region	User-oriented zoning; legitimacy of varied uses	Less standardized globally; needs coupling with standards
PSR	Causal indicator organization	Pressure → State → Response indicators	Any	Unifies monitoring logic	Not a stand-alone planning tool
VIM	Impact diagnosis & mitigation	Identify impacts → evaluate acceptability → select actions	Site / park	Targets causes of impact	Can fragment if not nested in broader planning
AAA	Activity appropriateness	Criteria-based assessment of proposed uses	Park / site	Clarifies what uses fit mandates	Requires clear policy criteria
VAMP	Activity & opportunity planning	Opportunity allocation → activity planning → monitor → adapt	Park	Park-mandate alignment; adaptive	Limited diffusion outside Canada
TOMM	Continuous tourism optimization	Multi-indicator monitoring → threshold triggers → adjust	Destination / region	Balances conservation & benefits	Data- and governance-intensive
SIMAVIS	Network/site management with standards	Zoning + itineraries + site limits + indicators → adaptive response	Multi-site networks	Strong for dispersed systems	Requires coordination & sustained monitoring

Figure 2.

Generic adaptive visitor management cycle (synthesized)

A cross-cutting conclusion in the literature is that these methodologies share a common architecture—objectives, allocation (spatial or numeric), indicators, standards, monitoring, and adaptive response—yet are often implemented separately. Comparative policy work and recent inter-agency guidance argue that the key contemporary challenge is integration: managers need coherent sequences that combine (1) opportunity zoning (ROS/VOP), (2) condition standards (LAC/VERP), and (3) impact-focused mitigation (VIM/VAMP/AAA) within a PSR-style monitoring logic (Hassel & Cedergren, 2025).

This gap is particularly evident in resource-constrained protected-area systems, where partial adoption can produce inconsistent thresholds, weak monitoring, and reactive rather than preventive management.

METHODOLOGY

Review Design and Protocol

This study adopted an integrative-scope systematic review approach to map, compare, and synthesize the main visitor management methodologies used in protected areas (PAs), and to derive an integrated conceptual framework. In order to extend the analytical depth beyond a superficial mapping, the review incorporated integrative synthesis principles, allowing the inclusion of empirical, conceptual, and policy-oriented sources, which supported the development of the framework (Eirini et al., 2025).

The methodological protocol followed the SALSA logic—Search, Evaluation, Synthesis, and Analysis—to ensure transparency and replicability. Reports were aligned with the PRISMA-ScR checklist for scoping reviews, documenting search decisions, eligibility pathways, and synthesis procedures in a standardized and audited manner (Micah et al., 2021).

Search strategy

The research was conducted in the interdisciplinary fields of conservation, recreational ecology, and tourism, and in the following multidisciplinary databases: Scopus, Web of Science Core Collection, ScienceDirect, Taylor & Francis Online, and Wiley Online Library. Since US conservation agencies developed the first visitor management frameworks, the grey literature from the US National Park Service, the USDA Forest Service, Parks Canada, and the IUCN-WCPA was also reviewed. The inclusion of verified official manuals is consistent with the premise that practical knowledge about visitor management is often codified in technical guidance rather than solely in peer-reviewed journals (Comrie, 2016).

The search strings combined free-text terms and controlled vocabulary using Boolean operators. The main strings included:

- (“visitor management” OR “visitor use management” OR “tourism management”) AND (“protected areas” OR national park* OR wilderness area OR nature reserve*)
- (“carrying capacity” OR “limits of acceptable change” OR LAC OR VERP OR ROS OR “spectrum of visitor opportunities” OR VOP OR VIM OR VAMP OR TOMM OR SIMAVIS OR “pressure state response”)

Searches were conducted in English and Spanish to capture documentation on the Latin American system, especially related to SIMAVIS. The review period spanned from 1979 to 2025, beginning with the foundational publications of the ROS and extending to recent models of adaptive visitor management. Backward snowballing was applied to the reference lists to identify key technical documents and highly cited empirical applications (Sardar & Islam, 2024).

Eligibility Criteria

The eligibility criteria were defined prior to the selection process to ensure that they aligned with the study's objectives.

Tabla 2.

Eligibility Criteria

Criterion	Inclusion	Exclusion
Topic relevance	Works that develop, apply, compare, or evaluate visitor management methods in PAs (CC, LAC, VERP, ROS/VOP, PSR, VIM, AAA, VAMP, TOMM, SIMAVIS).	Tourism studies in PAs without explicit methodological discussion of visitor management.
Context	Protected areas, wilderness areas, national parks, biosphere reserves, nature reserves, and equivalent conservation designations.	Urban parks or recreational settings without conservation mandates.
Document type	Peer-reviewed articles, books/chapters, official handbooks, and technical reports from recognized PA authorities.	Blogs, informal reports, news articles, or non-verifiable documents.
Language	English or Spanish.	Other languages without sufficient methodological detail in an English abstract.
Time frame	1979–2025.	Documents outside the specified period.

Study selection process

Selection was executed in three sequential stages:

- Title deduplication and review: The retrieved records were exported to a shared database, and duplicates were removed. Titles were assessed for their relevance to visitor management in protected areas.
- Abstract review: Abstracts were reviewed according to eligibility criteria. Abstracts with uncertainties were retained for full-text review, following scoping review standards.
- Full-text assessment: The full texts were assessed to ensure that a visitor management framework was essential to the work and that the operational steps/indicators were articulated in a way that allowed for data extraction. All full-text exclusions were documented along with the reasons for them to maintain traceability and comply with PRISMA-ScR reporting guidelines.

Data extraction and charting

A standardized extraction template was developed iteratively. For each eligible source, the following information was extracted and represented:

- Methodological framework and family (based on capacity, adaptive planning for conditions, zoning/opportunity, impact assessment, optimization/network systems).
- Theoretical assumptions (e.g., fixed boundaries vs. negotiated standards; experiential vs. ecological primacy).
- Operational sequence (decision steps, monitoring triggers, response points).
- Indicators used (biological, social/experiential, managerial, and, where applicable, economic).
- Scale of application (site, park, network, regional destination).
- Reported strengths and limitations and implementation requirements.
- Evidence of results where evaluative studies were available.

This approach allowed for a direct comparison between frameworks, prioritizing methodological compatibility over a narrative description (Miller, 2007).

Quality appraisal

Although formal risk-of-bias tools are not mandatory in scoping reviews, this study conducted a robustness assessment to strengthen methodological rigor. Using review guidelines that emphasize critical assessment of credibility, peer-reviewed studies were classified as having high, medium, or low evidential strength, based on the application of the review framework, the evaluator's definition of indicators/criteria, the design of the evaluation, and the degree to which the results were connected to management actions. Grey literature was retained only when it was produced by authoritative agencies and when procedures were explicitly defined operationally (Pollock et al., 2021).

Synthesis and framework development

Synthesis proceeded in two complementary stages:

- Comparative Thematic Synthesis: The extracted data were coded to identify common components across the methods, including goal definition, opportunity allocation, indicator selection, standard definition, monitoring design, and adaptive responses. The codes were grouped into the following main methodological frameworks:
    - Capacity/Boundary Control (CC)

- Condition-Based Adaptive Management (LAC, VERP)
- Opportunity and Impact Optimization (ROS/VOP, VIM, VAMP, AAA, TOMM, SIMAVIS)

- Configurational Synthesis for Integration: The framework elements were reorganized into a unified adaptive cycle using Pressure-State-Response (PSR) logic as the causal backbone. PSR facilitates integration by linking visitor pressures, measured conditions, and management actions through indicator-based feedback loops.

Results and Discussion

Overview of Collected Sources and Evidence

The document selection process identified 145 relevant studies covering the period from 1979 to 2025. Of these, 35% are empirical studies applied in protected areas of Latin America and North America, particularly national parks, biosphere reserves, and natural protected areas. This systematic review encompassed academic literature, technical documents from government agencies (such as the US National Park Service, USDA Forest Service, Parks Canada, and the IUCN-WCPA), and grey literature, which provides practical evidence on visitor management frameworks in protected areas (Hassel & Cedergren, 2025).

Through methodological frameworks (CC, LAC, VERP, ROS, VIM, TOMM, SIMAVIS), three key approaches to visitor management were identified that have evolved over time:

- Capacity and Limit Control – Initial approaches based on measuring visitor limits.
- Condition-Based Adaptive Management – Models focused on desired conditions and adaptability (LAC, VERP).
- Optimization of Opportunities and Impacts – Usage zones and experience optimization (ROS, VOP, VIM, VAMP, TOMM, SIMAVIS).

This analysis has been fundamental in synthesizing an integrated conceptual framework that allows combining the most effective elements of each approach into an adaptive management cycle, as detailed below.

Comparative Performance and Structural Divergences

The comparative results show that, despite operational differences between the methodological frameworks, they all share a common adaptive structure: the definition of clear objectives, the selection of indicators, the definition of standards, monitoring, and adaptive actions. However, there are fundamental differences in how each addresses the problem of visitor management in protected areas. A comparison of the main strengths and limitations of each approach is detailed below (Bureau of Land Management, 2016).

Tabla 3.

Strengths and Limitations of Visitor Management Frameworks

Framework	Strengths	Limitations
Carrying Capacity (CC)	- Fundamental for protected area management	- Limited in addressing visitor behavior and spatial concentration.
	- Easy to communicate and aligns with regulatory instruments such as permits	- Focuses primarily on visitor numbers, overlooking

	and quotas, facilitating administrative application.	ecological and social impacts of visitor use patterns.
Condition-Based Adaptive Management (LAC, VERP)	- Provides an adaptive and flexible approach that adapts to changing environmental conditions.	- Requires long-term monitoring capacity.
	- Defines desired conditions for resources and experiences, with a framework to monitor and continuously adjust visitor use conditions.	- May face political resistance when proposed restrictions affect traditional visitor use patterns.
Opportunity and Impact Optimization (ROS, VOP, VIM, SIMAVIS, TOMM)	- Zoning frameworks like ROS and VOP enable the creation of diversified experiences based on ecological sensitivities of different park or reserve areas.	- Can be ineffective if not accompanied by robust monitoring and impact management strategies.
	- These frameworks integrate continuous impact management, promoting long-term sustainability.	- Zoning without adequate enforcement may not be sufficient to ensure the conservation of natural resources.

Synthesis and Conceptual Framework Integration

The synthesis of the reviewed frameworks indicates that, although each approach has its strengths and limitations, there is a common element: they all address visitor management through an adaptive cycle that defines objectives, selects indicators, and establishes response actions.

In this regard, we propose an integrated model that articulates the different methodologies in a coherent and adaptive cycle using PSR (Pressure-State-Response) logic as its causal backbone. This adaptive cycle allows for the integration of capacity, conditions, and optimization approaches into a continuous decision-making process.

Integrated Adaptive Cycle:

- Goal Setting: Establishing specific conservation goals and expected outcomes.
- Indicator Selection: Defining biological, social, and experiential indicators.
- Standard Setting: Defining acceptable levels of change.
- Monitoring: Establishing a system for continuous monitoring.
- Data Analysis: Evaluating the degree of compliance with established goals.
- Action Implementation: Basing adaptive decisions on monitoring results.
- Impact Evaluation: Reviewing and, if implemented actions are ineffective, adjusting strategies.

Figure 3.

Adaptive visitor management cycle

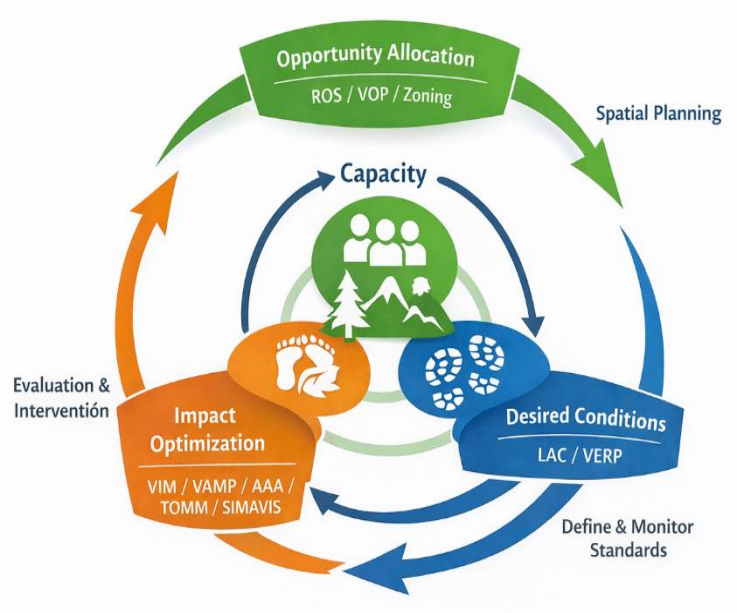


Table 4.

Shared components and primary emphasis by framework

Framework	Primary entry point	Dominant emphasis	Typical indicator mix
CC	Use limits	Numbers and density	Mostly biophysical + crowding
LAC	Desired conditions	Standards + adaptive triggers	Biophysical + social
VERP	Experience/resource zoning	Experience quality + resource protection	Social/experiential + biophysical
ROS/VOP	Opportunity zoning	Spatial differentiation of experiences	Setting attributes + use type
VIM	Impact diagnosis	Causal pathways + targeted mitigation	Biophysical + behavior drivers
AAA	Activity appropriateness	Consistency with mandates	Policy criteria + risk indicators
VAMP	Activity management	Activity planning within mandates	Activity-specific + site condition
TOMM	Optimization cycle	Multi-outcome balancing	Biophysical + social + economic
SIMAVIS	Site network control	Itineraries + site standards	Biophysical + social + managerial
PSR	Indicator organization lens	Pressure–state–response linkage	Any (organizing logic)

This pattern confirms a key finding in comparative scholarship: the frameworks are not competing substitutes but complementary tools that address different decision moments within adaptive visitor management (Medina, 2024).

Evidence on Operational Strengths by Problem Type

The reviewed studies consistently highlight that the effectiveness of visitor management frameworks is closely linked to the dominant management problem at hand, rather than any universal superiority of a single framework. This contextual adaptability is critical for selecting the most suitable approach.

Carrying Capacity (CC) demonstrates its greatest utility in contexts where visitor use is highly concentrated and the primary management question is: "How many users can a site reasonably accommodate without causing harm?" CC-based quotas are widely recognized for providing effective short-term stabilization in high-demand sites. However, evidence suggests that CC alone is insufficient to ensure the protection of ecological and social conditions unless combined with explicit standards and behavioral enforcement. In practice, CC is most effective when treated as a decision derived from desired conditions, rather than as a standalone metric.

LAC and VERP frameworks exhibit clear strengths in settings where the primary objective is to maintain specific ecological and experiential conditions over time. Their main comparative advantage lies in their traceability: both frameworks explicitly define standards, creating a defensible chain of reasoning from values → indicators → thresholds → actions. Empirical applications of LAC/VERP underscore their utility in addressing politically sensitive trade-offs, as managers can justify constraints as necessary to meet publicly stated goals (Dredge & Jenkins, 2016).

ROS/VOP frameworks perform optimally in heterogeneous landscapes, where there is a mix of visitor demands for diverse recreational experiences, and ecosystem resilience varies. These frameworks offer an effective solution for spatially allocating high-intensity uses to robust areas while protecting sensitive zones. The zonation process supports both conservation objectives and experiential diversity. However, the effectiveness of zoning is contingent upon the implementation of downstream processes such as indicators, standards, and monitoring. Without these components, ROS/VOP remains largely descriptive rather than regulatory.

VIM, VAMP, and AAA frameworks are particularly effective for diagnosing the causes of impacts and selecting targeted interventions. The literature consistently shows that when impacts are driven by specific visitor behaviors (e.g., off-trail walking, improper wildlife interactions, informal camping), impact diagnosis models yield more precise interventions than broad quota policies. However, these frameworks can become reactive if not integrated within a broader context of LAC/VERP-style standards.

Finally, TOMM and SIMAVIS represent advanced, mature solutions for managing complex, high-pressure systems. TOMM excels in its ability to balance multiple objectives—social, economic, environmental, and experiential—through continuous optimization. SIMAVIS has developed practical innovations for multi-site networks based on itineraries, microzonation, and site-specific standards (Bencardino et al., 2025). However, the institutional demands of these models are substantial, as they depend on sustained monitoring and inter-agency collaboration, which is often not possible in resource-constrained areas.

Table 5.

Strengths, Limitations, and Application Scales of Visitor Management Frameworks

Framework	Fortalezas	Limitaciones	Escala de Aplicación
Carrying Capacity (CC)	Simple, fácil de comunicar, alineado con regulaciones	No considera comportamiento ni concentración espacial de los visitantes	Sitio, Parque
LAC	Gestión adaptativa, trade-offs claros, indicadores medibles	Requiere monitoreo continuo, resistencia política	Sitio, Parque
VERP	Integración de experiencia y ecología, adaptabilidad	Requiere capacidad institucional, puede ser políticamente sensible	Parque, Sub-áreas
ROS	Diversificación de experiencias, legitimidad de usos	Sin monitoreo adecuado, no garantiza conservación	Parque, Región
VOP	Legitimidad de usos, centrado en el usuario	Fragmentación sin monitoreo y estándares	Parque, Región
VIM	Diagnóstico de impactos preciso, intervenciones específicas	Fragmentación si no se integra en un marco más amplio	Sitio, Parque
VAMP	Alineación con mandatos de parques, planificación de actividades	Limitado a regiones específicas, requiere recursos elevados	Parque
SIMAVIS	Optimización continua, adecuada para destinos de alta presión	Requiere alta coordinación y costos operativos	Redes de sitios

The Integrated Framework Derived from the Review

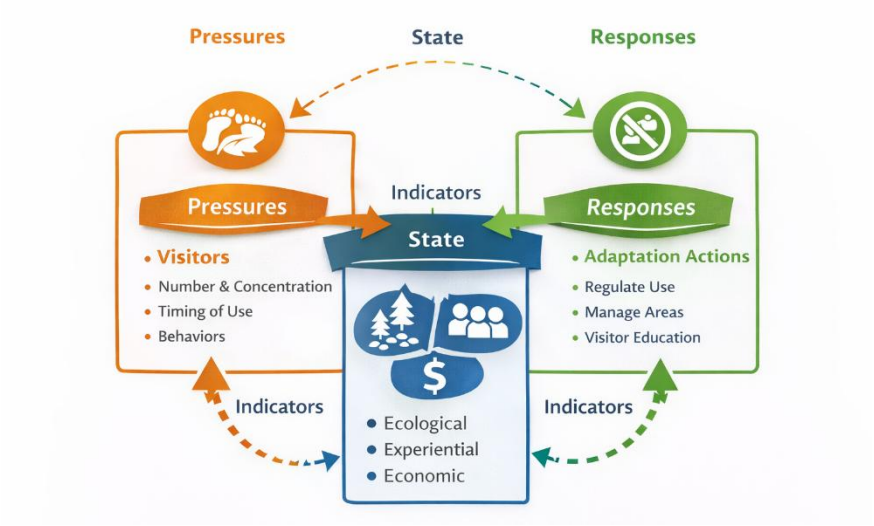
A key outcome of this review is the integration of methodologies based on their dominant decision-making roles. The synthesis suggests that effective visitor management requires the combination of three logics:

- Opportunity Allocation (ROS/VOP, sometimes CC-derived zoning) – Used for managing diverse experiences in heterogeneous landscapes.
- Standards-based Desired Conditions (LAC/VERP) – Applied where the goal is to maintain ecological and experiential states.
- Impact Diagnosis and Optimization (VIM/VAMP/AAA with TOMM/SIMAVIS tools) – Best for diagnosing impact causes and applying targeted responses.

The PSR (Pressure-State-Response) model functions as the backbone and logic connects visitor pressures with measured states and management responses through a set of systematic indicators. The integrated pathway below consolidates the shared architecture found across frameworks, sequencing tools according to the management problem they address most effectively.

Figure 4.

Causal architecture of the integrated model



Persistent Gaps and Research Needs

Although progress has been made in visitor management, many challenges remain. The following is outlined:

Restricted Integrative Methodology in Practice:

Many protected area agencies continue to adopt a single framework (often CC or ROS) without comprehensive monitoring or standards, leading to fragmented management. The lack of integration between frameworks hampers long-term effectiveness.

Underdeveloped Social-Experiential Indicators in Non-North American Contexts:

While frameworks like VERP and LAC emphasize experience quality, empirical applications in the Global South often focus on biophysical indicators due to resource constraints, leaving important social indicators like crowding and visitor satisfaction weakly monitored.

Inadequate focus on behavioral drivers:

Research shows that visitor behavior and spatial concentration are more often than total visitor numbers the primary drivers of impact (Fefer et al., 2016). However, many crowd control applications continue to focus on total counts, ignoring visitor behavior, timing, and dispersion—all of which are critical to impact management.

High Transaction Costs of Advanced Models:

While TOMM and SIMAVIS show promise for complex, high-pressure systems, they require substantial resources. Low-resource settings rarely receive guidance on scaling down advanced models for simplified applications.

Need for Comparative Effectiveness Studies:

Few studies compare frameworks directly under similar conditions, leaving a gap in understanding which combinations of tools and frameworks produce the best outcomes for conservation and visitor experience.

Table 6.

Fit-for-purpose guide to framework selection (review-derived)

Dominant Management Problem	Most Suitable Core Framework	Complementary Tools
Overcrowding at a single hotspot	LAC/VERP with CC as response	VIM for causal diagnosis
Diverse landscapes + multiple experience demands	ROS/VOP zoning	LAC/VERP standards by zone
Impacts driven by specific behaviors	VIM/VAMP/AAA	ROS/VOP to disperse use
Multi-site network with itineraries	SIMAVIS	LAC/VERP indicators per site
Destination-scale tourism–conservation trade-offs	TOMM	PSR indicator system

Discussion

The findings of this research offer a detailed synthesis of the main visitor management frameworks in protected areas, including Carrying Capacity (CC), LAC, VERP, ROS/VOP, VIM, VAMP, TOMM, and SIMAVIS. One of the main findings is that no single framework provides a universal answer, as each framework captures particular components of visitor management and addresses specific challenges in distinctly different ways. This aligns with previous findings, such as those of Touloun & Eddali (2023) , who argued that "visitor behavior and spatial concentration are often causes of far more significant environmental impacts than the mere number of visitors" (p. 245). Manning argues that there is no single global framework suitable for regulating visitor use in protected areas, but rather a need to address specific management challenges.

The concept of Carrying Capacity (CC) remains a fundamental tool in visitor management, particularly in areas with high visitor concentration. As identified in this review, CC is most effective when used in combination with behavioral controls and spatial distribution measures to ensure the protection of ecological and social conditions. This aligns with the work of Dredge & Jenkins (2016), who point out that "CC's simplicity and ability to align with regulatory instruments like permits and quotas make it attractive to policy makers" (p. 45). However, as highlighted in this study, CC alone is insufficient unless supplemented with explicit standards and enforcement measures. The framework's utility is maximized when it is treated as a tool within a broader adaptive management strategy, as proposed by Stankey et al. (1985), who argue for the integration of behavioral insights and spatial factors into the decision-making process.

In comparison, LAC and VERP are particularly effective in contexts where the goal is to maintain defined ecological and experiential states over time. The frameworks outline definable steps that show a clear order in the process: the establishment of values, the selection of indicators, the designation of thresholds, and the implementation of adaptive measures. This reinforces the findings of Fefer et al. (2016), who illustrate "the benefits of VERP by merging visitor experience and resource protection objectives" (p. 17). As this study confirms, the clear definition of desired conditions in LAC and VERP provides an adaptive pathway that makes these frameworks particularly useful in contexts where managing trade-offs among competing interests is essential. Furthermore, LAC and VERP offer the advantage of being politically defensible, as they allow managers to justify visitor restrictions as

necessary for meeting publicly stated objectives (Sardar & Islam, 2024). However, the limitations of these frameworks are significant, especially in resource-constrained settings where long-term monitoring and institutional capacity are needed to make these systems effective.

The ROS/VOP frameworks perform optimally in heterogeneous landscapes, where multiple visitors demand coexists alongside varying ecological sensitivities. These frameworks allow for spatial differentiation of visitor experiences, thus maximizing the diversity of both visitor experiences and conservation goals. Wenjing et al. (2021) noted that "ROS/VOP frameworks are excellent for allocating high-intensity uses to durable areas while protecting sensitive areas" (p. 12). These observations are consistent with this review, which highlights the importance of zoning for diversifying visitor experiences within large protected areas. On the other hand, Miller (2007) observed that "the application and monitoring of zoning restrictions were insufficient to provide numerous conservation benefits" (p. 23). This study reiterates the concern that ROS/VOP frameworks may remain more prescriptive than descriptive without essential supporting mechanisms such as indicators, standards, and monitoring.

For impact assessment, evaluating frameworks such as VIM, VAMP, and AAA is most useful in situations where the impact is linked to specific visitor actions, such as walking off-trail or disturbing wildlife. From an impact management perspective, these frameworks' ability to facilitate more focused and direct interventions is beneficial. For example, Bencardino et al. (2025) demonstrated that "visitor education and trail strengthening as targeted impact management approaches can be more effective and result in less impact than an indiscriminate management strategy, such as imposing visitor fees" (p. 35). On their own, these frameworks remain reactive and therefore constitute a lower level of management. However, their long-term effectiveness can be achieved when integrated with a more comprehensive management framework, such as LAC or VERP, which provides managerial guidance and operational standards.

The frameworks TOMM and SIMAVIS, designed for complex, high-pressure systems, represent advanced models of adaptive governance. As Erini et al. (2025) points out, "TOMM excels in balancing multiple outcomes—social, economic, environmental, and experiential—through continuous optimization, and SIMAVIS contributes practical innovations for managing multi-site networks, such as itineraries and micro-zoning" (p. 945). While these models have substantial potential, this study agrees with Pollock et al. (2021), who stress that "the institutional demands required for their implementation are high, making them less adaptable for resource-constrained areas" (p. 1110). The lack of institutional capacity and cross-agency cooperation often limits their successful application, as noted in both this study and the findings of Medina (2024)

Overall, the integrated model proposed by this review emphasizes the value of designing an adaptive management cycle by integrating multiple frameworks. The Pressure-State-Response (PSR) model offers a causal hierarchy that structures the relationships between visitor pressure, measured states, and management response, which is supported by the frameworks mentioned above. This integration provides assurance that frameworks such as ROS/VOP and LAC/VERP, when used in conjunction with impact assessment frameworks like VIM and VAMP, will offer a more comprehensive approach to visitor use management in protected areas.

CONCLUSIONS

In conclusion, the results of this research emphasize that visitor management frameworks cannot provide a definitive answer. Each framework—Carrying Capacity (CC), LAC, VERP, ROS/VOP, VIM, and TOMM—offers different possibilities, advantages, and challenges depending on

the situation. However, broader integration of these frameworks into an adaptive management cycle improves visitor use management in protected areas (PAs).

Carrying Capacity (CC) remains a foundational tool, especially in areas with high visitor concentration, but it requires behavioral controls and spatial distribution measures to be fully effective. On its own, CC is insufficient to protect ecological and social conditions.

LAC and VERP provide strong adaptive management approaches by focusing on desired conditions and continuous monitoring, making them effective in contexts where long-term ecological and experiential stability is a goal. However, they depend on sustained monitoring and may face challenges in resource-constrained settings.

ROS/VOP frameworks perform well in diverse landscapes by allowing for the spatial differentiation of experiences, but they need robust monitoring and enforcement to ensure the effectiveness of zoning.

VIM, VAMP, and AAA are most effective for diagnosing specific impacts and applying targeted interventions. While they provide precise solutions for certain behaviors, they risk being reactive if not integrated into broader management frameworks.

TOMM and SIMAVIS are sophisticated frameworks that offer continuous optimization of the social, economic, and environmental triangles. However, their implementation is limited by high resource requirements and challenges in inter-institutional collaboration.

When positioned within an adaptive cycle linked to the Pressure-State-Response (PSR) model, these frameworks promise to improve visitor management by making it more holistic and responsive. This combination offers a novel approach to addressing the most critical gaps in Protected Area (PA) management and promotes a more integrated approach to balancing the preservation of ecological integrity with the enhancement of the visitor experience.

Authors' contribution statement

Jefferson Damián Almeida Peñaherrera: Conceptualization, Supervision, Writing –Original Draft Preparation

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Jairo Andrés Terán Andrade: Formal Analysis, Methodology, Project Administration

Jorge Enrique Morocho Almache: Software, Visualization, Resources,

Willian Edmundo Guallpa Caguana: Validation, Writing –Review & Editing

Declaration of conflict of interest

The authors declare that there is no conflict of interest.

Data availability statement

The research data are included in the manuscript itself.

AI Usage Statement

The ChatGPT artificial intelligence tool has been used to assist in the grammar review of the text and the standardization of references.

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