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New Approaches to Biodiversity Assessment and Conservation

Sheikh Hilal Ahmad

LL.M Environmental law, University of Kashmir (India)

ABSTRACT

Solving the problem of environmental threats and a dwindling biodiversity has been on the international agenda for some decades now. The formulation of environmental questions, however, is changing slowly People have made unprecedented changes to ecosystems in recent decades to meet growing demand for food, fresh water, fibre and energy. The quality of life for billions of people has improved, but these changes have weakened nature's ability to deliver key services.

Assessing the status and trends of biodiversity is essential for sustainable development strategies at all levels, *from village to nation to region. Biodiversity is crucial for the wellbeing of people and the Earth. Ecological communities maintain the ecological and evolutionary processes that sustain life. These are necessary to help maintain the planet's chemical balance, moderate climate, renew soil, and conserve species diversity. Plant animal and other species have intrinsic worth. They are also the source of all biological wealth—supplying food, raw materials, medicines, recreational resources, and a store of other goods and services worth many billions of dollars per year. The genetic stocks within crop varieties, livestock breeds and their wild relatives provide essential traits for increasing and improving agricultural production and the development of biotechnologies.*

In its pretext this paper recognizes that current practices in social and environmental affairs operate in isolation and this is already having a severe impact on human wellbeing and biodiversity. High export rates coupled with increasing overexploitation of nature are driving down the provisioning of ecosystem services, and this in turn is most affecting local and poor communities in developing countries. The environmental costs for the high standards of living of more developed countries are in many cases externalized and shifted towards poorer countries with high bio capacity. The more developed countries are saving their own resources due to international trade. Especially areas in the northern boreal hemisphere like Russia, Japan and northern Europe are importing agricultural products while they maintain high quantities of forest coverage. Since biodiversity and human development are constantly interacting and are mutually dependent, conservation has to be incorporated in human development policy much more consciously and actively. Equally, biodiversity conservation has to operate within the realistic expectations of social needs including growing demands on resources. The extreme affects of globalization on both ecology and social wellbeing demands a radical approach to future strategies of managing human and environmental sustainability.

Keywords: Advanced Technology, Biodiversity, Climate Change, Environment Globalization, Sustainable Development

I.INTRODUCTION

Global biodiversity is endangered by several human-induced processes. The harshest current threats are land use change and invasive species. Climate change is already affecting species distributions and its future impacts are predicted to be extensive. An additional threat that has emerged recently is the escape of genetically modified organisms (GMOs) or parts of their genotypes. Dispersal, defined as the movement of organisms, their prop gules, or their genes (e.g. pollen in plants) away from the source, plays a central role in all four threats. Land use changes lead to a reduction in habitat area and to fragmentation, which as a rule reduces connectivity between patches. Climate change alters the geographical location of suitable climatic niches, resulting in shifts in species distributions. In extreme cases, the entire future climatically suitable niche lies outside the present species range, necessitating migration for the species to survive. For invasive species and GMOs, the threat to biodiversity conversely results from excessive movement of elements not native to the ecosystem.

Loss of biodiversity in general, and in tropical forests in particular, has been a source of major concern for modern society. The mainstream response, promoted by conservation groups and adopted by governments, has been the establishment of 'protected areas' (PAs) where human use and presence is minimized or at least curtailed significantly. Today, there are over 100,000 protected areas that cover _12% of the Earth's land area[1] of which 28% (by area) are in the tropics. Several studies suggest that protected areas have reduced rates of deforestation, prevented species extinction, and conserved land and water resources[2]. The PA approach, however, remains plagued by several problems. First, its effectiveness in conservation has been somewhat more mixed than the above studies suggest. Although deforestation rates have decreased in many areas, significant forest decline has continued in others. There is also probably a selection bias in protected area sites, that is, sites that are less accessible and so less subject to degrading pressures in the first place are likely to be selected as PAs. Second, in several regions pressures from resource use have 'leaked' into surrounding areas, causing higher deforestation rates elsewhere. Third, it is not clear whether complete exclusion of human activities is necessary for conservation effectiveness, and whether pristine-ness is a meaningful goal, given historical modifications of these landscapes [3]. In some places, mega fauna inside PAs have disappeared even after strict exclusion (e.g., the Sariska tiger[4]. In a few places, excluding resource use has actually been deleterious to the key biodiversity value of the protected area. Fourth, the alienation of local communities has turned potential conservation allies into adversaries. Fifth, at a more fundamental level, an exclusionary approach inevitably produces ethical challenges, calling into question the legitimacy of such conservation interventions. The last three aspects have generated significant conflicts around PAs and limited their conservation gains . Consequently, analysts and activists have proposed, and conservation agencies and field organizations have experimented with, alternative approaches. The Integrated Conservation-Development Projects (ICDPs) of the

late 1980s were followed by more explicitly community-oriented and participatory experiments starting the mid-1990s. The last decade has seen the emergence of another model, namely, payments-based schemes that seek to marry the efficiency of the market with conservation goals.

State conservation initiatives here have historically been PA-focused. Nevertheless, one difficulty in comparing different approaches is that the normative lenses through which different assessments are carried out often differ greatly. In some cases, success is defined solely in biodiversity terms, while others use multi-criteria approaches incorporating social dimensions of outcomes in various ways. The absence of a consistent framework causes researchers to talk past each other. We therefore begin with a brief overview of the literature that highlights the social impacts of Pas (section 'Conservation by exclusion'). We use this analysis to argue that biodiversity conservation is as much a social issue as an ecological one. Consequently, we contend that conservation approaches and assessments should not use biodiversity outcomes as the sole measure of success. We therefore review community based (section 'Community-based conservation: rights and enterprises and payments-based conservation (section 'Payment-based conservation: conservationists turn market-savvy using multiple norms.

II.BIODIVERSITY CONSERVATION

The most successful scientific endeavours to conserve biodiversity have been in conservation biology. Research on the habitat requirements and management needs of emblematic and Red List species continues to contribute considerably to the establishment and conservation of species and the management of habitats, including protected areas. In addition, much scientific focus is now on methods by which to prioritize conservation action, such as on biodiversity hotspots that is areas with many species or high levels of endemism and on means by which to measure and monitor conservation progress through biodiversity indicators. Yet, although more than 130 000 protected areas now cover almost 14% of the earth's surface — but much less of its waters — the rapid decline in biodiversity has not stopped. One reason is that not all the habitat requirements for the persistence of biodiversity generally can be fulfilled within the boundaries of protected areas. Among causes of biodiversity loss are the fragmentation and degradation of habitat, overexploitation of natural resources, pollution, climate change and invasive species. These can be the result of poor management and/or the expansion of commercial interests, be they conversion of forests for plantations or commercial wildlife trade. Finally, many countries are reluctant to set aside (more) land solely dedicated for biodiversity conservation, particularly in areas with high population pressure on the land.

There are broadly two approaches to improve the appalling situation of persistent hunger and equally persistent biodiversity loss. One approach holds that increased use efficiencies of light, water and nutrients, and mechanization will double the world food production, while drastically reducing negative effects on the environment per unit of product (ecological intensification senses Under this approach, if production falls short of its potential or if land is being (further) degraded, then the constraints, be they social, technological and/or political, need to be identified and incentives put in place to overcome the impediments. If production would be concentrated on those soils, it would be possible to increase the area allocated to biodiversity conservation, at

the same time protecting the resource base for agricultural germplasm that may be needed in future. Biodiversity often happens to be highest on agriculturally marginal soils, which renders a win-win situation, if agriculture is concentrated on the most fertile soils. This has been referred to as the intensive agriculture approach. This approach is built upon the notion that there are tradeoffs between agricultural productivity and biodiversity, but the approach largely fails to recognize the potential synergies between productivity and biodiversity.

Ecoagriculture approach, In the second approach to overcome persistent hunger and biodiversity loss, agriculture's role is expanded well beyond efficient food production. This approach assumes that biodiversity at the landscape level is pivotal to sustain both agricultural production and the provision of ecosystem services. This has been referred to as the ecoagriculture approach[5]. In this approach, the land provides a wide array of ecosystem services, all having a bearing on social welfare, from the well-being of local people (e.g. regulation of availability and purification of water) to that of the world community (e.g. carbon sequestration). Improvement, adaptation or re-design of existing agricultural landscapes would be in order with a focus on crop, livestock and landscape diversification instead of the specialization implied by the first approach on extensive instead of intensive production on the multi functionality of agriculture and on regionalization instead of globalization.

2.3 CONSERVATION BY EXCLUSION

Historically, the creation of protected areas with strong prohibitions on land and resource use has been a defining feature of the conservation paradigm in most countries. This exclusionary approach was integral to the first national parks celebrated in the United States[6], was subsequently exported across the world in diverse colonial settings, and was embraced by most governments in the developing tropics after independence .

The exclusionary approach typically involves the forced removal of people from their homes and/or significantly curtailment of their activities. Thus, socio-economic impacts can be of three different kinds: complete physical displacement, economic displacement through restrictions on resource use (e.g., on collection of firewood and other non-timber forest products, grazing, and water use), and cultural displacement through restricted access to locations of cultural and symbolic value. Reliable data on the form, extent, and socio-economic impacts of resettlement from protected areas are hard to come by. For instance, estimates of physical displacement range from 900,000 to 14 million people for the African continent [7] and have generated significant controversy. For India, they range from 100,000 to 600,000 [8]. Some research suggests that economic displacement is the most significant impact . Uncertainties notwithstanding, the social costs of exclusionary approaches are clearly considerable , but equally clear is the need for more research on the magnitude and nature of these impacts While some conservationists continue to support a completely exclusionary approach (and the use of force to implement it) , most now accept the need for some level of inclusion, although reasons differ. Many have Stressed a pragmatic argument, namely, that conservation without local support is doomed to fail. Others have, however, pointed out that conservation projects can succeed even if they lack local participation and support, because communities in these areas are often poor, politically weak, and isolated[9]. The most

convincing argument is an ethical one: that displacing some groups without their consent is unfair and displacing already disadvantaged groups is doubly so. Balancing legitimate claims of local communities with a larger social claim on biodiversity is thus a necessary complication that conservationists have to address.

One policy response to these critiques of exclusionary conservation has been to experiment with alternatives that might integrate local priorities with conservation, to which we now turn. But the methodological implication of the ethical argument also is that assessments of conservation programs must include the socio-economic impacts, quality of participation, and social justice as independent additional criteria along with biodiversity conservation for evaluating success.

2.4 COMMUNITY BASED RIGHTS: RIGHTS AND ENTERPRISES

The integrated conservation development projects of the 1980s and early 1990s used a combination of buffer zones and general local development support to 'reduce the pressure on a protected area. Local communities were 'involved' more as recipients of concessions and development assistance than as part of conservation activities. Thus, the early ICDPs were just an extension of conservation by exclusion .Subsequently, advocacy for increased local participation led to the emergence of the idea of 'community- based conservation' (CBC), which has biodiversity conservation as one of its goals and some form of community involvement as its approach. Occasionally, this may simply involve sharing of revenues from Pas with the local community. But most CBC experiments usually aim to provide both poverty alleviation and participation in governance of the PAs, using a combination of changing the rules of engagement between state agencies and local communities, providing financial subsidies, livelihood training, and building community institutions to regulate resource access and use. In most cases, the experiments seek to build on historical traditions of conservation in the community.

'Enterprise-based conservation' (EBC) is a subset of CBC that has specifically focused on increasing the economic incentive for conservation by investing in strengthening or setting up a new conservation-compatible activities that are based on the biological resource in PAs and other biodiversity-rich areas. These include ecotourism, safari hunting, and the sale of non-timber forest products (NTFPs). Such programs assume that an increase in communities' economic returns from use of a natural resource will create an incentive to protect the resource.

Assessing the success of CBC and EBC programs is constrained by (a) the scarcity of good and comparable data, especially covering social and ecological dimensions with equal rigor, (b) varying goals of the programs, (c) the wide variety of potential criteria for evaluation, and (d) the inherent challenges in abstracting from complex local conditions. Nevertheless, the available studies suggest that outcomes have been mixed. One relatively systematic attempt to run an 'adaptive experiment' in EBC—the Biodiversity Conservation Network (BCN)— concluded that 'yes, an enterprise strategy can lead to conservation, but only under limited conditions. . . and never on its own'. A recent review of three experiments in the Caribbean suggests that EBC may generate financial benefits to local communities but these may 'result in the adoption of more unsustainable resource use practices[10]. But some projects have lasted and even thrived as a visit after 10 years to a sea-turtle CBC project,

showed. And a meta-analysis of 28 CBC-type projects showed positive outcomes on multiple dimensions of success (ecological, economic, attitudinal, and behavioural) correlated with decentralization.

Reasons for the mixed success of CBC programs need careful sorting. First, many may not really constitute serious CBC attempts, as they focus only on livelihood enhancement or poverty alleviation and not on conservation goals. Second, many others suffer from significant implementation flaws, with too much outsider influence and funding and not enough insider buy-in. Third, building community institutions is easier said than done.

Communities are fragmented and rife with political tensions at various levels[11]. Even local non-governmental organizations (NGOs) involved in implementation can become obstacles to community empowerment. Fourth, enterprise-based approaches run the risk of co- modifying biodiversity, with both ecological and equity implications. For instance, payments for ibex hunting in Pakistan distorted conservation priorities and created intra-community tensions and when a 'successful' eco-tourism enterprise adversely affected traditional social relations and intensified resource harvest[12].

Perhaps the biggest constraint faced by CBC efforts is the tenuous and incomplete nature of rights and operational space that are granted to participating communities by the state. Substantive changes in rights of access and role for communities in PA governance often do not take place, and control remains with state agencies on key issues. A classic example of this is that, after 10 years of permitting an NTFP-based CBC experiment in which rigorous biological monitoring was being carried out, the forest department of Karnataka state in India cancelled the permission for NTFP harvest citing a Supreme Court order, depriving the enterprise of raw material and the NTFP-dependent tribals of their traditional livelihood[13].

2.5 PAYMENT BASED CONSERVATION: CONSERVATIONISTS TURN MARKET-SAVVY

Community based conservation projects often involve substantial external support (financial, technical, human). Nevertheless, some economists consider CBC-type efforts as 'indirect' in the sense that they do not link local communities directly through the market to those who wish to see conservation happen and payments are not 'performance-based' that is, in proportion to biodiversity conserved [14]. Pointing to the mixed performance of ICDPs and EBCs, they argue for 'direct' payments for conservation as being more economically efficient. This is part of a larger trend in support of 'payments for ecosystem services' (PES) including watershed services and carbon sequestration. Experiments with payments to local people for conservation began post-2000, mostly in Costa Rica and other parts of Latin America. China has also implemented a major program of fiscal subsidies for upland conservation. However, in these cases, biodiversity is almost always bundled along with other 'services' such as watershed benefits or carbon sequestration[15]. Furthermore, payments usually do not come from individual 'buyers' of conservation 'service', but from the state or international donors, making these transactions not quite market-based .Proper tests of PES-based conservation are therefore difficult to carry out.

The limited information that is available on these partial experiments provides an ambiguous picture. Outcomes may not be equitable or locally empowering. They may not even be efficient unless careful targeting is done PES in practice requires a similar amount of state intervention and NGO facilitation as that required in CBC-type approaches.

Normatively, Payment for ecosystem services is concerned with efficiency, not with equity; it takes the existing distribution of property rights as a given (and implicitly equitable). Analytically, payment- based approaches make broad assumptions about well-defined and secure property rights and adequate control (including the right not to conserve) in the hands of the payee, full information about the biodiversity implications of land-use decisions, and low transaction and monitoring costs . These assumptions rarely hold good. For instance, while farmers in Latin America in some cases do control large portions of the forested landscape, in most of Africa, south Asia and China, the state asserts rights over most forested areas and the rights of communities are highly attenuated and contested [16]. Even in Brazil, 'land grabbing, insecure tenure, overlapping claims, and lacking information on private tenure constitute real medium-term impediments to PES'. Thus, while PES sounds pro-poor as it assumes communities have the right not to conserve and proposes paying them to conserve, it makes too many simplifying assumptions to be able to achieve these social and environmental objectives in practice.

Social structure meets social process: the challenges of pursuing conservation in practice

The constraints faced by CBC efforts and the critiques of payments-based approaches point to a larger set of issues—the complexity of structural and process-based factors in shaping all efforts. One way of thinking about this is to see biodiversity conservation as falling within the broader domain of environmental governance . Core issues such as decentralization, connectivity across multilevel social–ecological systems, and democratization have been covered in previous reviews. In examining how governance concerns play out with respect to conservation arrangements, social process, and political economic forces.

Institutional arrangements refer to both organizations and rule systems that govern social interaction. One area of the research in this area explores how different complex organizations—including network forms of organization— interface with one another in the context of conservation programs. Much of the work focused on conservation dovetails with the literature on development, analyzing how complex social–ecological problems require multi-scalar, nested regimes (rules systems) that depend on the production and maintenance of human made capital: physical, human, and social. For example, Brondizio et al. [17]examine the case of the Xingu Indigenous Park in Brazil, uncovering how successful management by an indigenous group was undermined by agro-pastoral development in the wider watershed. The study points to the need for broader connectivity across resource governance systems. In comparison to the institutional design literature, less attention has been focused on conservation as a social and political process. Brechin et al[18]. point to several considerations in constructing and maintaining collaborative processes that are perceived by those involved as being legitimate. The diversity of actors typically involved with conservation interventions makes deliberative approaches difficult and potentially time and resource intensive. Examples from Bolivia, Brazil, and Colombia suggest that partnerships

among indigenous communities, NGOs, multi-lateral aid organizations, and state agencies have achieved some success but also point to complex power dynamics.

Similarly, West's work in Papua New Guinea [19] shows how an EBC effort failed to account for how Gamy speaking people produce knowledge. Thus translation, broadly construed, becomes a key process issue in cases where ontological and epistemological differences regarding human/nature relations emerge among cultural groups. Finally, studies that unravel complex social processes within community-based conservation initiatives suggest how local histories of both conflict and cohesion impact discrete projects. Beyond institutional arrangements and social process, a major challenge to pursuing conservation in practice stems from the political-economic contexts within which interventions are embedded. A considerable number of recent studies have focused on the ways in which neoliberal economic approaches have shaped conservation

III. THE NEED FOR BIODIVERSITY ASSESMENT

Assessing the status and trends of biodiversity is essential for sustainable development strategies at all levels, from village to nation to region. Biodiversity is crucial for the wellbeing of people and the Earth. Ecological communities maintain the ecological and evolutionary processes that sustain life. These are necessary to help maintain the planet's chemical balance, moderate climate, renew soil, and conserve species diversity. Plant, animal and other species have intrinsic worth. They are also the source of all biological wealth—supplying food, raw materials, medicines, recreational resources, and a store of other goods and services worth many billions of dollars per year. The genetic stocks within crop varieties, livestock breeds and their wild relatives provide essential traits for increasing and improving agricultural production and the development of biotechnologies.

3.1 AN INTRODUCTION TO SUSTAINABILITY ASSESMENT:

The Six Stages Each sustainability assessment can be undertaken in a cycle of six stages. A cycle implies a continuous process, recognizing that assessments will be done repeatedly to show changes over time, and to support a broad range of decision-making needs. The first four stages of the cycle are designed to help users articulate a shared vision of sustainability, which is defined in increasingly more specific ways, using elements, objectives, indicators and performance criteria. The aim of the first four stages is to unpack the components of a broadly defined vision into measurable indicators. The first four stages of the cycle move participants from the general to the specific. The last two stages help users to assess overall human and ecological wellbeing from the individual indicators, by combining and reviewing. This approach uses performance scales for indicators to help provide a common unit by which indicators can be combined. If indicators are combined, they can be used to show aggregate performance and overall human and ecological wellbeing. All of this information, from individual indicators to aggregated indexes, can be used to aid an assessment of performance and identification of priorities.

The stages are:

1. Define the system and goals: The system consists of the people and ecosystem of the area to be assessed. The goals encapsulate a vision of sustainable development and provide the basis for deciding what the assessment will measure.

2. Identify elements and objectives: Elements are key concerns or features of human society and the ecosystem that must be considered to get an adequate sense of their condition. They are grouped under dimensions. Objectives break the identified system goal(s) into specific parts that relate to each element.

3. Choose indicators and performance criteria: Indicators are measurable and representative aspects of an issue. Performance criteria are standards of achievement for each indicator.

4. Measure and map the indicators: Indicator results are recorded in their original measurements, given scores on the basis of the performance criteria, and mapped.

5. Combine the indicators and map the indices: Indicator scores are combined up the hierarchy: indicators into sub-issue indices; sub-issue indices into issue indices; issue indices into dimension indices; and dimension indices I subsystem indices (separate indices for people and the ecosystem). Indices are mapped to reveal visually overall findings and specific patterns of performance.

6. Review results and propose policies. The review links the assessment to action by analysing the patterns and the data behind them to suggest what actions are needed and where. The review also provides the diagnosis for the design of programs and projects.

3.2 SUSTAINABILITY ASSESSMENT METHOD

Sustainability is a specific method of system assessment – a way of assessing both human and environmental conditions and progress toward sustainable development. The system is a spatial area that serves as the basis for the assessment, and can be applied at any level, from global to local. Sustainability Assessment is intended to support national and local decision-making and can be used for reporting on Agenda 21 and international conventions such as the Convention on Biological Diversity[20]. Sustainability assessment helps users be more inclusive about the topics that are considered when assessing sustainability. The method not only asks participants to consider human and ecological wellbeing together, but also suggests a wide range of topic areas that should be applicable in any circumstance. Procedures have been developed to identify indicators that can be combined into indexes that help clarify what is otherwise a confusion of non-comparable numbers. A full Sustainability Assessment implies the consultation of a wide range of stakeholders and collection of a considerable amount of data. In this context, the broad purpose of the assessment is to construct a systematic and shared vision of sustainability, which is in turn, supported by a strong information base. However, it is recognized that many users have neither the desire nor the resources to undertake such an activity. Accordingly, Sustainability Assessment can be scaled back to support a wide range of needs – reporting on international conventions, thematic assessments, as an input to strategic analysis and planning or for baseline analysis and impact studies.

IV.CONCLUSION

This overview of the critique of exclusionary conservation and alternative approaches in the developing tropics has highlighted several issues relevant to conservation policy and research. First, the exclusionary approach has provided biodiversity gains in certain locations. But it has imposed severe hardships on local communities through physical, economic, and cultural displacement, leading to political conflict in several locations. Ultimately, this approach has lost legitimacy owing to its inherent unfair and undemocratic approach, and conflicts are emerging not only around proposed new PAs, but even in existing PAs. Local communities may or may not be critical to conservation, but a broader approach to thinking about conservation as an ethical social process is clearly required. Researchers need to generate more detailed, comparative studies on the social, economic, and cultural impacts of PAs.

Second, local communities are neither inevitably the destroyers (when not involved) nor (when involved) the saviors of biodiversity. The evidence regarding CBC and EBC projects is mixed: most did not have adequate data to reach a conclusion, some achieved gains in community development, but few made a positive impact on conservation. Basic design flaws, poor implementation, assumptions about homogeneous communities and inattention to or inadequate support for tenurial security plague most efforts.

Third, while CBC/EBC approaches have received a limited trial, donor and international conservationist attention has rapidly swung towards payments-based programs. These programs inherently limit the normative focus to economic efficiency, and make several additional assumptions about nature of rights and monitoring costs that are not valid in practice and eventually require state and other interventions.

Fourth, a common theme is the lack of attention to how rights to resources and biodiversity need to be [21]distributed and regulated between individuals, communities, and the state, and the more detailed restructuring of different agencies that may be required. Equally important is the need to recognize that institutional re-design cannot ensure success—location-specific histories and processes will inevitably complicate matters. And trends in the larger political economy and how these forces may constrain or enable conservation also need to be understood.

Research on conservation strategies must define success along multiple dimensions, monitor these dimensions more rigorously, and develop more nuanced propositions about the links between social process, tenure, economics, and outcomes. Much will, however, depend upon the space provided by states for alternative approaches. Mainstream development pressures and neoliberal thinking forces states to reduce the concern and space for all—conservation, sustainable use, poverty alleviation, and social equity. Conservation researchers would do well to see this convergence and engage with civil society groups to expand the space for such alternatives. Also community level modelling can provide a basis for the assessment of conservation priority to be attached to any particular vegetation remnant using the predicted original distribution of that vegetation type and the percentage remaining. The approach can also provide a basis for the setting of priorities for revegetation to connect and expand existing forest remnants in an area that has been extensively cleared since various settlements.

Systematic conservation planning is another effective way to seek and identify efficient and effective types of reserve design to capture or sustain the highest priority biodiversity values and to work with communities in support of local ecosystems. Identify six interlinked stages in the systematic planning approach:

1. Compile data on the biodiversity of the planning region
2. Identify conservation goals for the planning region
3. Review existing conservation areas
4. Select additional conservation areas
5. Implement conservation actions
6. Maintain the required values of conservation areas

An integrative scientific discipline applying physiological concepts, tools, and knowledge to characterizing biological diversity and its ecological implications; understanding and predicting how organisms, populations, and ecosystems respond to environmental change and stressors; and solving conservation problems across the broad range of taxa (i.e. including microbes, plants, and animals). Physiology is considered in the broadest possible terms to include functional and mechanistic responses at all scales, and conservation includes the development and refinement of strategies to rebuild populations, restore ecosystems, inform conservation policy, generate decision-support tools, and manage natural resources.'[10] Conservation physiology is particularly relevant to practitioners in that it has the potential to generate cause-and effect relationships and reveal the factors that contribute to population declines.

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