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LEAD ARTICLE

Conservation Revisited

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ABSTRACT

This paper proposes that Sri Lanka's nature conservation efforts are hampered by the lack of a clear understanding of the meaning of the word conservation. This lack of understanding then impedes effective implementation of conservation actions. It revisits terminology to obtain clarity of the definition of conservation. Inherent in many current definitions are the following. 1) Humans are integral to conservation biology. Anthropogenic activities drive the loss of biodiversity, necessitating conservation, but humans must be a part of the solution; 2) Preservation, maintenance, enhancement, restoration and sustainable use are all elements of conservation. The difference between preservation and conservation is clarified. The paper assesses gaps in current conservation measures, as: 1) lack of practice of true conservation in Sri Lanka that includes all its elements; 2) lack of focus on landscape-scale conservation; 3) lack of focus outside protected areas; 4) lack of negotiation with decision-makers using a tender that is understood by them; 5) lack of congruence between conservation knowledge and conservation practice; 6) complacency with regard to Red Listing™; 7) inadequate prioritisation of conservation research; 8) inadequate predictive research; 9) lack of research on the impact of climate change on species and ecosystems; and 10) focus on a sectoral, rather than a holistic approach. The paper concludes by providing recommendations for future actions.

Keywords: conservation, preservation, management, ecosystems.

INTRODUCTION

Sri Lanka has a long history of protecting its natural resources (BDS, MoERE, 2014). The Mahawansa chronicles that both rulers of the kingdom and its subjects valued and protected animals and forests (MoFE, 1999). As early as 1907, the Forest Ordinance (No. 16 of 1907) was enacted for the protection of some forests and their products, and, by 1937, the Fauna and Flora Protection Ordinance (FFPO) was, in turn, enacted to afford protection to some species (UNEP, 2009). Currently, there are some 15 laws and some 30 organisations directly focused on nature conservation (BDS, MoERE, 2014); and Sri Lanka is party to 32 multilateral environmental agreements (MoENR, 2008).

About 28% of the land area is protected under the aegis of the Forest Department, Department of Wildlife Conservation and the Central Environmental Authority (BDS, MoERE, 2014). Most forests of the wet zone and many mangroves are protected under the aegis of the Forest Department (BDS, MoERE, 2014).

Sri Lanka is one of the few Asian countries that has engaged, since 1987, in the preparation of threatened species lists (Abeywickrama, 1987): two in 1989 (Wijesinghe *et al.*, 1989) and 1993 (Wijesinghe *et al.*, 1993) that were based on subjective assessments of risks of extinction; and later, since 1999, three iterations that used global Red Listing™ criteria for assessment (IUCN, 2000; IUCN and MoNRE, 2007; MoE, 2012). A fourth iteration, using globally accepted criteria is being prepared for 2016 (MoMDE, 2015). The latest amendment of the FFPO (No. 22 of 2009) affords protection to a quarter of the indigenous flowering plants of the island, including all native orchids; all species of Odonata and Lepidoptera, and over 90% of species of amphibians, reptiles, birds and mammals (FFPO, 2009). On paper, Sri Lanka appears to have a range of mechanisms and tools to conserve its natural wealth.

Why then is there, across ecosystems, continued habitat destruction, the prime driver of species loss? Natural forest cover was 29.6% of the total land area in 2010, a reduction from 44% in 1950 (BDS, MoERE, 2014). Reclamation and degradation of wetlands (*inter alia* through pollution, changes in tidal inflows/ outflows/ hydrological alterations) continue (BDS, MoERE, 2014; Samarakoon and Samarawickrama, 2012). Why then are invasive alien species (IAS) spreading in protected areas — such as Bundala and Udawalawe National Parks — posing threats to native species, which are meant to be protected within these areas? Why then are more than 50% of

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species of dragonflies, freshwater crabs, land snails, freshwater fish, amphibians and reptiles considered Threatened with extinction (MoE, 2012)? What is even more distressing is that 124 species of inland vertebrates are listed as Critically Endangered (Weerakoon, 2012). In other words, one in every six species of native vertebrates of Sri Lanka is under severe threat of extinction (Weerakoon, 2012).

This paper proposes that Sri Lanka's conservation efforts are hampered by the lack of a clear understanding of the meaning of the word conservation. This lack of understanding then impedes effective implementation of conservation actions. This paper will revisit terminology, to obtain clarity of the definition of conservation. As Salafsky *et al*. (2008) note *'an essential foundation of any science is a standard lexicon.'* The paper will then examine inherent assumptions in given definitions, address misconceptions, assess gaps in current conservation measures and provide recommendations for future actions.

What is conservation?

A clear understanding of what conservation is, obviously, a prerequisite for developing and expressing conservation goals and actions (Redford and Richter, 1999).

Rampant among many scientists, decision-makers, practioners and laypersons is the misconception that preservation is conservation. Preservation is often interchanged with the word conservation, resulting not only in 'a terminological muddle' (Robinson 1993 and Norton 1994 in litt. Redford, 1999) but also confusion in management.

The first person to couple the words conservation and science was Michael Soulé in 1985. He defined conservation biology as '*a new stage in the application of science to conservation problems, [that] addresses the biology of species, communities, and ecosystems [which] are perturbed, either directly or indirectly, by human activities or other agents. Its goal is to provide principles and tools for preserving biological diversity*.'

This definition has since been refined and re-fashioned. Appendix 1 presents a list of definitions of conservation, extracted from various sources, including popular sources such as dictionaries. Inherent in many of these definitions are the following.

1. *Humans are integral to conservation biology*
   a. As the veteran biologist George Schaller (2007) notes, 'conservation problems are social and economic, not scientific . . .' ;
   b. The Sri Lanka National Strategy and Action for Mangroves for the Future (2009) describes ecosystems as 'socio-ecological systems';
   c. Conservation issues 'cannot be separated from issues of values, equity, and social justice' (Ludwig, 2001);
   d. 'People dominate landscapes' (Seidensticker, 2008);
   e. 'Humans are and will continue to be a part of both natural and degraded ecological systems, and their presence must be included in conservation planning' (Meffe *et al*., 1997); and
   f. The Convention on Biological Diversity (CBD) (2008) and IUCN/UNEP (1980) explicitly define conservation as management of *human use* of natural resources.

The conundrum that many biologists face it that although anthropogenic activities drive the loss of biodiversity, necessitating conservation, *humans must be a part of the solution*.

2. *Preservation, maintenance, enhancement, restoration and sustainable use are all elements of conservation* (Figure 1).

I maintain that sustainable use is part of conservation, and not, as commonly used, separate from it, as often stated, for example, in the Convention on Biological Diversity (1992). I use the definition of the first World Conservation Strategy (IUCN/UNEP, 1980) that clearly itemises each of the above '*Thus conservation is positive, embracing preservation, maintenance, sustainable utilization, restoration, and enhancement of the natural environment.'* (Figure 1), and highlighted the change that management can effect on exploitation, i.e., make it sustainable. The Global Biodiversity Strategy promoted the concept that the elements of biodiversity conservation were 'save, study and use' (WRI, IUCN, UNEP, 1992), again stressing that sustainable use was part of conservation. This inclusive definition allows for a clarity of understanding and much easier paths to action.

The above definition clarifies the difference between preservation and conservation. Conservation includes sustainable use, but preservation does not. Preservation is the maintenance, in present condition, areas of 'wilderness' (or near wilderness), with little or no human intervention (Meffe *et al*., 1997).

3. Because conservation encompasses such a range of actions, it is, therefore, effectively *management* (Figure 1). Preservation, maintenance, sustainable use, restoration and enhancement all require management.

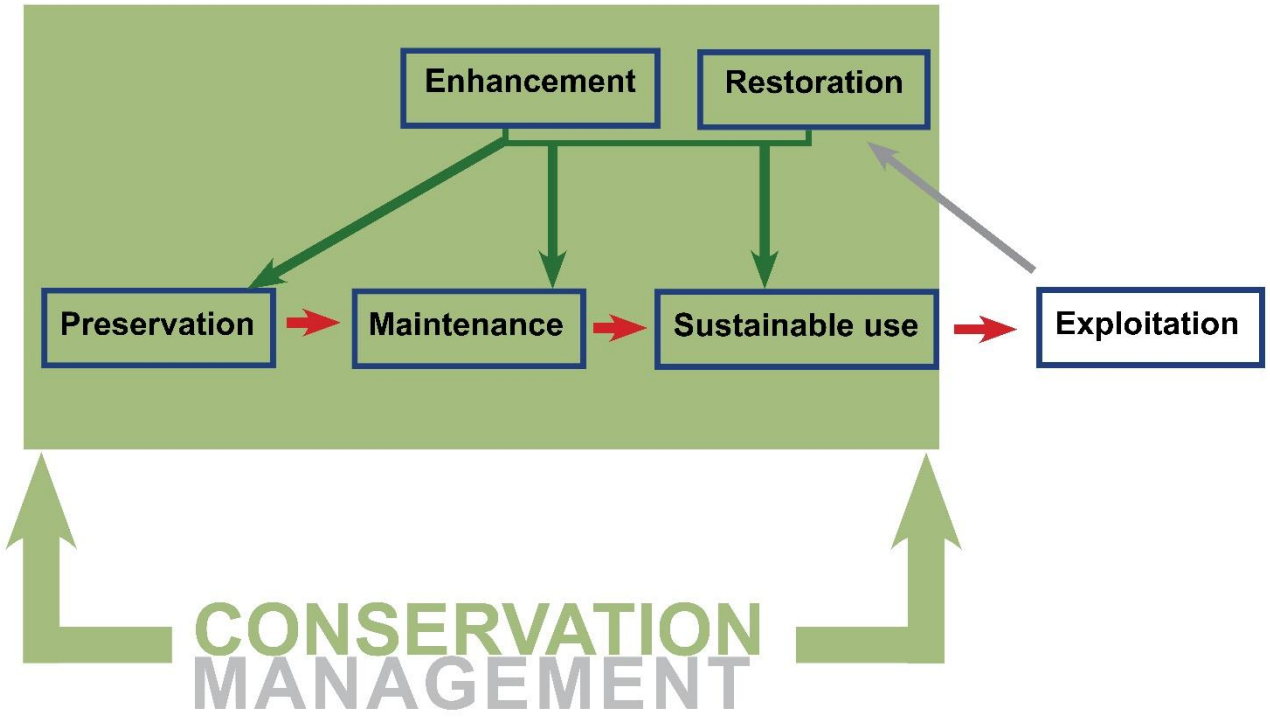

Figure 1. Elements of conservation

There is no ecosystem or area in Sri Lanka, or, in fact, anywhere else in the world, that is free of any anthropogenic presence. Aldo Leopold, considered the father of wildlife and wilderness management in the USA, appreciated, as early as 1949, that landscapes were 'cultural landscape[s] . . . transformed (Seidensticker, 2002). Meffe *et al*., (1997) note 'Conservation efforts that attempt to wall off nature and safeguard it from humans will ultimately fail'.

4. Also inherent in this context of conservation that includes humans, is *compromise*. Often conservation actions are pitted against development needs and then, there is a need for negotiation and compromise. The best case scenario is rarely possible. Ludwig (2001) states that '[t]ension between science (which is devoted to the pursuit of truth) and politics (which is devoted to the pursuit of power) is an important obstacle'.

Not inherent in the above definitions, but nonetheless essential in the practice of conservation is the knowledge and acceptance of the following concepts:

1. *Ecosystems are not only complex and often unique, but also dynamic* (CBD, 1992). Ecosystems processes are rarely linear, and therefore ecosystems interactions and processes are always complex. As Ludwig (2001) succinctly states '[t]he conservation of forests, the conservation of endangered species, and climate change are examples of "wicked problems," as defined by Rittel and Webber (1973). Such problems have no definitive formulation, no stopping rule, and no test for a solution. There will likely never be a final resolution of any of them. Each such problem is unique: They defy classification.' *This means that solutions related to their well-being will also, necessarily, be complex and each solution, unique*.

   Because ecosystems are dynamic, predictability relating to a process or change is extremely limited, if not impossible. *Therefore, each solution for their conservation must also be bound within a temporal scale, i.e., must be adaptive.*

2. *Ecosystems exist within a 'heterogeneous landscape'* (Meffe *et al*., 1997) forming a mosaic of interconnected units (Kallesöe *et al*., 2008). The importance of this fact in conservation is twofold. Firstly, an individual species can exist as sub-populations in isolated habitats as a metapopulation (Levins, 1969; Hanski, 1999), and if habitat conditions permit, these subpopulations can be linked to support immigration and emigration (Meffe et al., 1997). Secondly, ecosystems are affected by actions taken both within and without their boundaries (Meffe *et al*., 1997). This is clearly

seen on coastlines, where human impacts in catchment areas of upland forests can have detrimental impacts on coastal systems such as lagoons, estuaries, mangroves, seagrasses and coral reefs (Samarakoon and Samarawickrama, 2012).

3. Also critical to a concept of conservation is the acceptance that *conservation is a crisis discipline*. As Soulé (1985) and Ludwig (2001) state respectively 'A conservation biologist may have to make decisions or recommendations about . . . management before he or she is completely comfortable with the theoretical and empirical bases of the analysis' and 'typically facts are uncertain, values in dispute, stakes high, and decisions urgent'. *The provision of recommendations based on incomplete knowledge is a risk that faces all conservation biologists* (Meffe *et al*., 1997).

We need to change our current model of conservation, because business (management) as usual, has not and is not stemming the tide of loss biodiversity. As Ludwig (2001) notes, 'If the old ideas of management don't work, [we need to figure out] what will . . .'

Identified gaps

The holistic definition of conservation, and the implicit and explicit caveats that enfold a different concept of conservation, discussed in the previous section, led me to assess the major gaps in conservation in Sri Lanka and make recommendations to fill them.

True conservation that is inclusive of all its elements is not practised in Sri Lanka

It is laudable that Sri Lanka has some 28% allocated as protected areas under the jurisdictions of the Department of Wildlife Conservation, the Forest Department and the Central Environmental Authority (BDS, MoERE, 2014). With many additions of national parks by the DWC, the current percentage is much higher now. The Department of Wildlife Conservation oversees 24 national parks (with two more to be gazetted in the next few months) (DWC, 2015; DWC, personal communication).

Formulation of management plans is mandated under the revised FFPO (2009) and under the GEF-funded Protected Area Management (PAM) Project, some eight management plans were developed and others are currently being developed as well (DWC, personal communication). Yet, much of the effort of management has been focused on infrastructure development — such as boundary marking, erection of sign boards, construction/repair of offices, repair/purchase of vehicles; road building/repair and electric fencing (ADB, 2010; DWC, 2012). Habitat enrichment is confined to removal of invasive alien species, tree planting, construction of new water ponds and maintenance of fire belts (DWC, 2012).

Less attention appears to ecological and conservation principles related to the dynamic nature of ecosystems as exemplified by the current plight of elephants in Udawalawe National Park. Ecological succession is a natural process by which abandoned land reverts to mature forest (Meffe *et al*., 1997). In the 1960s, a combination of logging and *chena* cultivation artificially created a savannah ecosystem in Udawalawe: scattered trees among grasslands (Fernando, 2015a). Elephants were driven into the area, and a national park was established in the 1970s (Fernando, 2015a). Guinea grass (*Panicum maxicum*), an exotic grass, became established and spread, providing fodder for elephants year round (Fernando, 2015a). Fires, usually set alight by farmers, that encouraged the growth of guinea grass, were banned. Udawalawe became famous for its elephants. However, with no management measures to keep succession in check, natural processes took over and the grassland transformed into forest (Fernando 2015a), leaving the elephants deprived of food. The elephants of Udawalawe are now emaciated. 'Conservation', in this example, was merely the isolation of both elephants and habitats, with no reference to natural processes, rather than habitat management to preserve a seral stage to support for the famous elephants of Udawalawe.

In addition, the management of humans within the national parks of Sri Lanka is virtually non-existent. Yala National Park, popular with both local and foreign visitors, is over-visited, with one third of all visitors to national parks flocking there (SLTDA, 2014), causing traffic jams at the entrance to and within the park. This over-visitation is layered with irresponsible behaviour, resulting in the deaths of several animals (who have been run over by speeding vehicles), including, in the last three months, nine spotted deer and since 2011, two leopards (which are listed as Endangered) and a jungle cat (Near Threatened) (Malaka Rodrigo, personal communication; MoE, 2012).

The bottom line is that we are not engaging in proactive *conservation*. There are several urgent questions that need answering in relation to our protected area network. What are our goals in relation to each protected area? What is the overall goal for each protected area — i.e., what is it managed *for*? What are our specific targets and plans in relation to the overall goal and in keeping with ecological principles? For example, if a general goal is to conserve the endemic birds of Sri Lanka, which are the protected areas that need to

manage for this goal? What specific objectives should then be formulated and actions developed to meet these objectives?

Also a major issue is that, barring a spike of mostly ill-planned mangrove re-planting after the Indian Ocean tsunami of 2004 (Samarakoon and Samarawickrama, 2012) and efforts by the Forest Department to reforest degraded forests (BDS, MoERE, 2014), ecological restoration is not mainstreamed into conservation, although several national plans have called for restoration (CCS, MoENR, 2011, CCS, MoENR, 2010). A study by IUCN (2011a) revealed that there were 1,1167.67 hectares of abandoned prawn farms in divisional secretaries divisions of Vanatavillu, Puttalam and Kalpitiya in the Puttalam district. Such land is ideal for ecological restoration.

Pethiyagoda (2012) argues that marginal habitats should be 'viewed as a conservation opportunity rather than a threat' as his analysis shows that many threatened species use these habitats. Enhancement of such marginal lands will assist in increasing the survival of such species.

Lack of focus on landscape-scale conservation

The lack of focus on a landscape approach to conservation is important for several reasons. Firstly, ecosystems are not isolated and exist as mosaics of interconnected units across a heterogeneous landscape. Much of Sri Lanka's forests in the wet zone are small fragmented patches. A recent study by Kittle *et al.* (2014) shows that the island's apex terrestrial predator, the leopard (*Panthera pardus kotiya*) is found in fragmented forests in the central hills as small as 5 km^2. This means that even small forest fragments remain important for species conservation and maintaining or enriching these fragments, will contribute to the conservation of leopards. A distribution map of leopards generated by the Biodiversity Secretariat of the Ministry of Environment (2012) for the Red List, shows leopards living outside protected areas.

Researchers have found that other wide-ranging species such as elephants (*Elephas maximus*) have home ranges that lie not only within protected areas, but also partially and completely outside (Fernando *et al.,* 2008). The conflict that ensues when natural movement of such species is thwarted by human habitation or cultivation is a serious problem for the Department of Wildlife and makes national news. Later studies revealed that elephants in human-dominated areas tend to have larger home ranges than others, the size determined by the availability of food and that they use fixed cross over points between habitat patches (Weerakoon *et al.*, 2004). Fernando categorically states that the conservation of elephants requires a landscape approach (Fernando, 2015b).

The above examples illustrate clearly the need for establishing connectivity between forest/habitat patches in a heterogeneous landscape, albeit based on scientific knowledge of the movement of wide-ranging animals. The long term resilience of such species may be dependent on establishing connectivity (also known as corridors, linkages, ecological networks) between fragmented habitats using science-based knowledge (Seidensticker, 2015).

Since 2007, several national documents have highlighted the need for establishing linkages between fragmented forests (MoENR, 2007, 2009, 2010; MoERE, 2014).Yet the practice continues of largely establishing isolated protected areas with little effort to connect them. For example, seven national parks have been declared since 2011 (DWC, 2015), but the attempt to link protected areas is far from adequate.

Secondly, without a lens that views landscapes from 'ridge to reef' (R2R) (IUCN, 2015), impacts on coastal ecosystems from anthropogenic actions inland cannot be managed. The impacts of upstream activities on the coast is exemplified in a study by Dahdouh-Guebas *et al.* (2005), who used remote sensing and ground-truthing and compared these data to ancient maps, to reveal drastic changes in mangrove distribution as a consequence of altered river hydrology of the Walawe Ganga.

The third reason for concern of the lack of focus on a landscape approach is that it largely ignores humans, who are an integral part of the landscape. If one looks at a map of Sri Lanka, it is obvious that despite Sri Lanka's admirable efforts at establishing protected areas, many of these areas lie in a sea of human habitation and other forms of land use, such as cultivation (Figure 2). That villagers living around protected areas feel the full force of impacts of wildlife straying out of national parks is dealt with largely *a posteriori*, or by fencing in animals within national parks.

Contrast this approach to that of the management of Chitawan National Park in Nepal — home to tigers and rhinoceros — where, since 1993, a thriving community forestry/guardianship programme ensures that the profits of the national park are channelled towards the improvement of local communities, and making it possible for 'potentially dangerous mammals . . . to successfully coexist with the nearly 300,000 people living in thirty-six villages adjacent to the park' (Seidensticker, 2008).

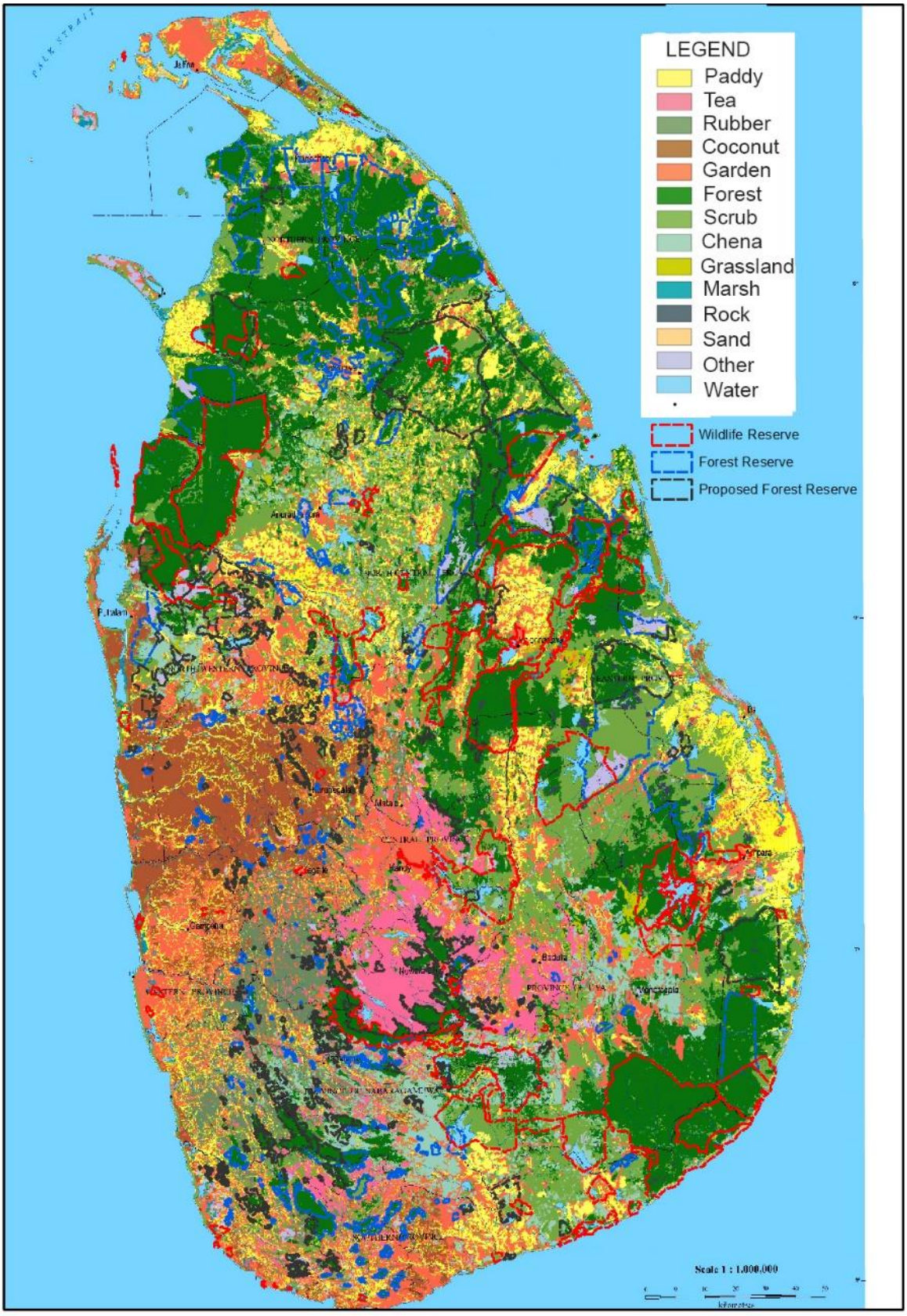

Figure 2. Sri Lanka's protected areas superimposed with land use
(Source: Land use: Survey Dept. 2007; Protected areas: MoE, 2012)

Lack of focus outside protected areas

It is obvious that with a finite extent of land, there are increasing anthropogenic demands upon this land.

Instead of setting aside more and more protected areas — which are then left unmanaged or not managed properly, as noted in the previous section — the focus could be on areas outside protected areas, enriching them to increase biodiversity.

Even where there is heavy human footprint — such as in cultivated areas — it is possible to increase biodiversity, for example, with the practice of ecoagriculture. The ecoagriculture framework, introduced by Jeffrey McNeely and Sara Scherr in 2003, has the following characteristics:

1. *It is large-scale*: Ecoagriculture is practised at a landscape level (understanding that species are not only integral parts of ecosystems, but that many inter-connected and inter-dependent ecosystems form a mosaic in a larger landscape).
2. *It emphasises synergies:* Ecoagriculture seeks to find synergies between agriculture and ecology and promote them.
3. *It recognises the importance of conservation:* The Millennium Ecosystem Assessment identified the importance of ecosystem services to agriculture but ecoagriculture recognises that native biodiversity has an intrinsic value and also seeks to find environmentally-friendly livelihood strategies (Buck *et al*., 2006).

Ecoagriculture uses six strategies for the practice of ecoagriculture: 1) creates biodiversity reserves that benefit local farming communities; 2) develops habitat networks in non-farmed areas of agricultural landscapes; 3) reduces land conversion to agriculture by increasing farm productivity; 4) minimises agricultural pollution; 5) modifies the management of soil, water and vegetation to increase natural capital; and 6) designs farm systems to mimic natural ecosystems.

Simple actions — such as leaving shelterbelts, windbreaks, tree rows between cultivated areas; retaining roadside vegetation; intercropping, increasing crop diversity; reducing water and soil pollution — will increase diversity.

Lack of negotiation with decision-makers using a tender that is understood by them

Our conservation rhetoric has not served us well in the last few decades, given the continuing loss of biodiversity. We need to seek a new way of conveying the message of the urgency needed in conservation to persons who are not biologists and therefore, do not understand the complexities and uncertainties inherent in conservation biology. We need to be able to obtain the best possible compromise in negotiating with decision-makers in the context of a drive for development.

Since 1983, when Ehrlich and Mooney presented a concept that intact ecosystems provided services that bettered our lives, environmental valuation has become available as a tool for conservation biologists. Then, in 2005, the Millennium Ecosystem Assessment clearly linked ecosystem well-being and human well-being. Suddenly, conservation biologists had a tool that allowed for the presentation of the value of the services ecosystems provide in hard currency, and it became possible for conservation biologists to present a species or an ecosystem as an 'economic asset, not a liability' (Seidensticker, 2010).

The Strategic Action Plan 2011-2020 presented by the Secretariat of the Convention on Biodiversity is a 'shared vision, a mission, strategic goals and 20 ambitious yet achievable targets, collectively known as the Aichi Targets' (CBD, 2015). Target 2 deals specifically with valuation of biodiversity and the incorporation of such values into national accounting (CBD, 2015).

This approach of valuing nature has its critics (*inter alia*, Erickson, 2000; Go´mez-Baggethun and Pe´rez, 2011; McCauley, 2006; Rodríguez-Labajos and Martínez-Alier, 2013; Sagoff, 2008; Schröter *et al*., 2014; Soulé, 2013). However, the morality of an environmental ethic 'that there is some 'higher' value residing in Nature which humans have at least an obligation, and perhaps a duty to [pre]serve', while appealing to many, does not provide a practical solution for the conservation of biodiversity and 'may have little substantive influence in policy arenas' (Pearce *et al*., 2007).

'The economic approach send[s] signals to those who make the decisions to destroy diversity that they may want to think and act differently' (Pearce *et al*., 2007).

For example, in the Maldives, marine and coastal tourism — the largest industry in the Maldives — directly accounts for 20% of GDP and its wider effects help produce 74% of national income. Tourism contributes more than 60% of foreign exchange receipts, over 90% of government tax revenue comes from import duties and tourism-related taxes, and almost 40% of the workforce is employed in the industry. Because such figures are integrated into the national accounting, the coral reefs of the Maldives are afforded more protection than if they were not (Emerton, 2006).

In Sri Lanka, there has been a steady rise of environmental economic studies and valuation of ecosystems over the years (*inter alia*, Bandara *et*

al., 2001; Bandara and Tinsdell 2005; Batagoda, 2003 in Kallesøe *et al*., 2008; Dharmasena and Bhat, 2011; Emerton and Kekulandala, 2002; Herath, 2001; Piyadasa and Thiruchelvam, 2005; Ranasinghe and Kallesoe, 2006; Rathnayake and Gunawardena, 2011; Rathnayake, 2015; Wattage, 2011). An excellent value of the provisioning services of Batticaloa, Negombo and Puttalam lagoons is presented in Samarakoon and Samarawickrama (2012), who state that the annual income from fisheries in these lagoons exceeds two billion rupees.

A few years ago, the then Ministry of Environment and Renewable Energy convened a workshop called 'Ecosystem Services for Linking Biodiversity with Livelihoods' under the aegis of their project on 'Pricing the Biodiversity of the Island' in order that environmental economists could share their studies and discuss a way forward for the project (MoENR and IUCN, unpublished). Green reporting guidelines have now been introduced to Sri Lanka (MoE, 2011). Despite these efforts, ecosystem valuation has yet to be mainstreamed. Such mainstreaming will ensure that ecosystems are considered part of infrastructure: just as a building will have a monetary value, so must an ecosystem (Emerton, 2006; Emerton, 2007).

There is now available landscape scenario spatial modelling software — such as Integrated Valuation of Ecosystem Services and Tradeoffs (InVEST) — that model changes in ecosystem services based on predicted land use changes. This provides a series of scenarios from which the best trade-off can be obtained (Nelson *et al.*, 2009).

Lack of congruence between conservation knowledge and conservation practice

When the Red List™ status (the threat status) is compared with the level of legal protection afforded to species, there is a great difference between the threat level and the protection provided for certain groups.

In the 2012 Red List™ 44 species of freshwater fish were as Threatened (Critically Endangered, Endangered, or Vulnerable) (MoE, 2012). Of these only 16 are afforded protection (36.4%) under the FPPO (2009) and 21 (47.7%) under the Fisheries and Aquatic Resources Act 1996 (specifically, the Export and Import of Live Fish Regulations, 1998). Of the latter, only 13 species are provided full protection and for the rest of the species (8) export is permitted for captive-bred individuals (Table 1). Alarmingly, of the 15 threatened species exported in the ornamental fish trade (CR=4, EN=8, VU=3), nine species (CR=2, EN=4, VU=3) are not protected by either law (Table 1).

For six species that have been listed as threatened since 2000, in three iterations of Red Lists, the status of protection has not changed. (See grey highlighted rows in Table 1.) This lack of congruence between the conservation status and the legal status of freshwater fish was raised by Amarasinghe *et al*. in 2006. A decade later, nothing has changed.

Another example of this lack of correspondence relates to the calculation of natural forest cover in Sri Lanka. An essential requirement in the assessment of biodiversity loss is the analyses of trends. One of the most serious threats to biodiversity in Sri Lanka is habitat destruction, including and perhaps primarily, of forests (BDS, MoERE, 2014; IUCN, 2011; Mattsson *et al*., 2012; Perera, 2001).

Although a clear classification of vegetation types has been published in the National Atlas (Jayasingham *et al*. 2007) and previous authors (Ashton *et al*., 1997; Gunatilleke and Gunatilleke, 1981; Jayasuriya *et al*., 2006) have also provided detailed descriptions, there is doubt that these definitions are used in analyses of forest cover, leading to misleading computations. For example, Sri Lanka's Fifth National Report to the Convention on Biological Diversity 2014, submitted by the then Ministry of Environment and Renewable Energy presented figures that indicate an increase from 3,099.5 to 44,758 hectares in montane forests between 1999 and 2010, which is simply not possible, given the high human population density of the area. It is noted in the report that 'the discrepancies between areas given for montane and sub-montane forests in the 1999 and 2010 forest assessments are reportedly due to differences in criteria for separation of these forest types'. This again simply reinforces the concern that science is not translated into practice.

Complacency in Red Listing™

Even though Sri Lanka has been at the forefront of Red Listing™ in the Asian region, we have not progressed beyond this process. Although we have identified species that need urgent intervention, actual conservation actions related to these species have not kept pace with the generation of Red Lists. For example, we have not focussed sufficiently on research related to threatened species (see section below). Even when such research is identified, have we established an adequate source of funding for such research? For example, the Mohamed bin Zayed Species Conservation Fund provides grants for research specifically targeted for species survival. A similar national source of funding is urgently need. Once Threatened species are identified, we have not formulated recovery plans for their continued survival.

Table 1. Examination of the legal status of threatened freshwater fish
(Sources: * MoE, 2012; **MoNRE,2007,+ IUCN, 1999; ++Gunasekera, 2011; ǂFFPO, 2009; # FARA, 1996)

	Scientific name	Common name	Species status*	Conservation status 2012*	Conservation status 2007**	Conservation status 2000+	Traded as an ornamental species ++	Protected by FFPO (No. 2 of 2009) SCHEDULE VI	Schedule I and II Export prohibited/ restricted of live form
1	*Acanthocobitis urophthalmus*	Sri Lanka Tiger Loach	Endemic	EN	VU	T	Yes	No	No
2	*Amblypharyngodon grandisquamis*	Sri Lanka Large Silver Carplet	Endemic	EN			No	No	No
3	*Aplocheilus dayi*	Sri Lanka Day's Killifish	Endemic	EN	NT	T	Yes	No	No
4	*Aplocheilus werneri*	Sri Lanka Werneri's Killifish	Endemic	EN	VU	T	Yes	No	No
5	*Belontia signata*	Sri Lanka Combtail	Endemic	NT	NT	T	Yes	No	Export restricted (Schedule II)
6	*Channa ara*	Sri Lanka Giant Snakehead	Endemic	EN	VU	T	No	No	No
7	*Channa orientalis*	Smooth-Breasted Snakehead	Endemic	VU	NT	T	No	Yes	Export prohibited Schedule I
8	*Dawkinsia srilankensis*	Sri Lanka Blotched Filamented Barb	Endemic	CR	EN	T (*Puntius srilankensis*)	No	Yes (*Puntius srilankensis*)	Export prohibited Schedule I (*Puntius srilankensis*)
9	*Devario aequipinnatus*	Sri Lanka Knuckles Danio	Endemic	CR		HT (*Danio aequipinnatus*)	Yes	No	No
10	*Devario pathirana*	Sri Lanka Barred Danio	Endemic	CR	CR	HT (*Danio pathirana*)	Yes	Yes	Export restricted (Schedule II)
11	*Garra ceylonensis*	Sri Lanka Stone Sucker	Endemic	VU		T	Yes	No	No
12	*Labeo fisheri*	Sri Lanka Mountain Labeo	Endemic	CR	CR	T	No	Yes	Export prohibited Schedule I
13	*Labeo lankae*	Sri Lanka Knuckles Laubuca	Endemic	CR	CR	HT	No	Yes (*Labeo porcellus*)	Export prohibited Schedule I (*Labeo porcellus*)

	Scientific name	Common name	Species status*	Conservation status 2012*	Conservation status 2007**	Conservation status 2000+	Traded as an ornamental species ++	Protected by FFPO (No. 2 of 2009) SCHEDULE VI	Schedule I and II Export prohibited/ restricted of live form
14	*Laubuca lankensis*	Sri Lanka Blue Laubuca	Endemic	VU			No	No	No
15	*Laubuca ruhuna*	Sri Lanka Ruhunu Laubuca	Endemic	EN			No	No	No
16	*Laubuca varuna*	Sri Lanka Varuna Laubuca	Endemic	CR			No	No	No
17	*Lepidocephalichthys jonklaasi*	Sri Lanka Jonklaas's Loach	Endemic	CR	EN	T	No	Yes	Export prohibited Schedule I
18	*Macrognathus pentophthalmos*	Sri Lanka spiny eel	Endemic	CR (PE)	CR	HT (*Macrognathus aral*)	Yes	Yes (*M. aral*)	Export restricted (Schedule II) (*M. aral*)
19	*Malpulutta kretseri*	Sri Lanka Ornate Paradise Fish	Endemic	CR	VU	T	No	No	Export prohibited Schedule I
20	*Monopterus desilvai*	Sri Lanka Lesser Swamp Eel	Endemic	CR	CR	T	No	No	No
21	*Mystus ankutta*	Sri Lanka Dwarf Catfish	Endemic	EN			No	No	No
22	*Ophisternon bengalense*	Asian Swamp Eel	Native	CR	CR	T	No	Yes	No
23	*Pethia bandula*	Sri Lanka Bandula Barb	Endemic	CR	CR	HT (*Puntius bandula*)	No	Yes (*Puntius 'handula'*)	Export prohibited Schedule I (*Puntius bandula*)
24	*Pethia cumingii*	Sri Lanka Cuming's Barb	Endemic	EN	VU	T (*Puntius cumingii*)	Yes	No	Export restricted (Schedule II), red fin variety (*Puntius cummingii*)
25	*Pethia melanomaculata*	Sri Lanka tic tac barb	Endemic	VU			Yes	No	
26	*Pethia nigrofasciata*	Sri Lanka Black Ruby barb	Endemic	EN	VU	T (*Puntius nigrofasciatus*)	Yes	No	Export restricted Schedule II (*Puntius nigrofasciatus*)
27	*Pethia reval*	Sri Lanka Redfined barb	Endemic	EN			Yes	No	No

	Scientific name	Common name	Species status*	Conservation status 2012*	Conservation status 2007**	Conservation status 2000+	Traded as an ornamental species ++	Protected by FFPO (No. 2 of 2009) SCHEDULE VI	Schedule I and II Export prohibited/ restricted of live form
28	*Puntius kamalika*	Sri Lanka Kamalica's barb	Endemic	EN			No	No	No
29	*Puntius kelumi*	Sri Lanka Redeye	Endemic	EN			No	No	No
30	*Puntius titteya*	Sri Lanka Cherry barb	Endemic	EN	VU	HT	Yes	No	Export restricted Schedule II
31	*Rasbora armitagei*	Sri Lanka Armitagi Rasbora	Endemic	CR			No	No	No
32	*Rasbora naggsi*	Sri Lanka Naggasi Rasbora	Endemic	CR			No	No	No
33	*Rasbora wilpita*	Sri Lanka Wilpita Rasbora	Endemic	EN	EN	T	No	Yes	Export prohibited Schedule I
34	*Rasboroides atukorali*	Horadandia	Native	VU	NT	T (*Horadandia athukorale*)	Yes	No	No
35	*Rasboroides nigromaginata*	Sri Lanka blackline Rasbora	Endemic	CR			No	No	No
36	*Rasboroides vaterifloris*	Sri Lanka Golden Rasbora	Endemic	EN	EN	T (*Rasbora vaterifloris*)	Yes	No	Export restricted schedule II
37	*Schismatogobius deraniyagalai*	Redneck Goby	Native	EN	EN	T	No	Yes	Export prohibited Schedule I
38	*Sicyopterus griseus*	Stone Goby	Native	CR	EN	T	Yes	No	No
39	*Sicyopterus halei*	Red-Tailed Goby	Native	CR	EN	T	No	Yes	Export prohibited Schedule I
40	*Sicyopus jonklaasi*	Sri Lanka Lipstick Goby	Endemic	EN	VU	T	No	Yes	Export prohibited Schedule I
41	*Stiphodon martenstyni*	Sri Lanka Martenstyn's Goby	Endemic	CR (PE)	CR	HT	No	Yes	NARA says prohibited but not in regulation
42	*Systomus asoka*	Sri Lanka Asoka Barb	Endemic	CR	CR	HT (*Puntius asoka*)	No	Yes (*Puntius asoka*)	Prohibited Export prohibited Schedule I (*Puntius asoka*)

	Scientific name	Common name	Species status*	Conservation status 2012*	Conservation status 2007**	Conservation status 2000+	Traded as an ornamental species ++	Protected by FFPO (No. 2 of 2009) SCHEDULE VI	Schedule I and II Export prohibited/ restricted of live form
43	*Systomus martenstyni*	Sri Lanka Martenstyn's Barb	Endemic	CR	CR	HT (*Puntius martenstyni*)	No	Yes (*Puntius martenstyni*)	Export prohibited Schedule I (*Puntius martenstyni*)
44	*Systomus pleurotaenia*	Sri Lanka Black-Lined Barb	Endemic	EN	VU	T (*Puntius pleurotaenia*)	No	No	No
45	*Wallago attu*	Shark Catfish	Native	EN	VU		No	No	No
46	*Clarias brachysoma*	Sri Lanka Walking Catfish	Endemic	NT		T	Yes	No	Export of 'live form' prohibited (Schedule II)

Inadequate prioritisation of conservation research

Many global assessments have identified Sri Lanka's southwestern quarter as an area where priority conservation actions must be taken: for example, Wikramanayake *et al*. (2001) 'globally outstanding for biological distinctiveness'; Conservation International (2015) 'biodiversity hotspot'; Carwardine et al. (2008) 'irreplaceability'. The southwest is a large area with 3,772[1] threatened plants (50.9% of which are endemics); and 926 vertebrates (72.5% of which are endemics) (MoE, 2012). There is a need then, for a fine-scale approach that will permit the selection of priority areas or threatened species.

Wijesundara and Perera (2015) used weighted endemism (Crisp *et al*., 2001) to identify nine endemic areas for angiosperms (southwest wet zone, northern highlands, central highlands, eastern highlands, Yala, Doluwa, Ritigala, Wilpattu and Jaffna) and five core endemic areas (Sinharaja, Adam's Peak, Knuckles, Horton Plains and Kandy) within the endemic zones. Significantly. Wijesundara's research identifies areas outside the southwest quarter. Such research that can guide conservation actions in Sri Lanka is woefully inadequate. Other tools such as IUCN Ecosystem Red Listing (Keith *et al*., 2015); and Key Biodiversity Areas (Eken *et al*., 2004) are now available for fine-grained analyses.

Because of the complexity of ecosystems, understanding interconnections and measuring changes in processes to examine ecosystem health takes up considerable time and expense. A simpler conceptual approach is to monitor a species/some species as proxies or surrogates (for example, indicator, umbrella, and flagship, phylogenetically unique species) for ecosystems or groups of species (*inter alia*, Caro and O'Doherty, 1999; Cushman *et al*., 2010).

There are 1,754 Threatened plants (1,531 angiosperms) and 805 Threatened animals listed in the Red List (Threatened = Critically Endangered, Endangred and Vulnerable categories) (MoE, 2012). Of these, 446 plants and 327 animals are considered as Critically Endangered (MoE, 2012). This again begs the question, how can these species be prioritised for conservation action?

Only a few studies have attempted to prioritise such species for conservation action. Balmford *et al*. (1996) used the richness of families and genera as a surrogate for species richness in 35 forest reserves in the wet zone. IUCN (2014) shortlisted Threatened species for translocation from the Mahaweli inundation areas of Moragahakanda and Kaluganga by using a set of criteria (whether endemic or native; threat status, geographical distribution, and use value — for plants) and using a scoring system. Ratnayeke and Manon (2012) used sloth bear (*Melursus ursinus*) presence as a surrogate for the conservation of other carnivores in Sri Lanka. Nekaris *et al*., (2015) used the Cinderella species concept[2] and ecological niche modelling to show that the red slender loris (*Loris tardigradus tardigradus*) and the fishing cat (*Prionailurus viverrinus*) were good surrogate species[3]. Similar studies are urgently needed.

Inadequate predictive research

Much of the current research carried out in Sri Lanka is descriptive (See http://cjsbs.sljol.info/issue/archive/). In the last few decades, the taxonomic and phylogenetic studies of species that inventorised the island's biodiversity have been exceptional, documenting new species, as well as endemic species (*inter alia*, Bahir and Ng, 2005; Batuwita and Bahir, 2005; Bedjanič *et al*., 2014; Benjamin *et al*., 2012; Dias, 2006; Karunaratne *et al*., 2005; Manamendra-Arachchi and Pethiyagoda, 2005; Meegaskumbura, and Manamendra-Arachchi, 2011; Meegaskumbura *et al*., 2002; Meegaskumbura *et al*., 2007; Meegaskumbura *et al*., 2014; Naggs *et al*., 2005; Pethiyagoda *et al*., 2012; Ranil and Pushpakumar, 2012; van der Poorten and van der Poorten, 2012; van der Poorten and van der Poorten, 2012a; Warakagoda and Rasmussen, 2004; Weerakoon and Aptroot, 2014; Wickramasinghe and Munindradasa, 2007).

However, fewer studies have striven to study in detail the ecology of these newly identified species, examine their niche needs and provide conservation guidance. Tools such as niche modelling and habitat suitability modelling use habitat environmental variables of the area where a species is known to occur, in order to predict where it could be found (Giriraj *et al*., 2008; Hirzel and Le Lay, 2008; Kumara and Suganthasakthivel, 2011; Lyet *et al*., 2013; Nekaris and Stengal, 2013; Thriveni et al., 2015; Wikramanayake *et al*., 1999). Nekaris and Stengal (2013) conclude from their study, that the status of *Loris tardigradus tardigradus* should be changed from Endangered to Critically Endangered.

Since 2008, only two articles of the Ceylon Journal of Science (Bio.Sci.) have used predictive modelling[4].

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[1]The numbers presented are aggregates for lower and higher plants for each wet zone district and not calculated by climate zone.

[2]A Cinderella species is an aesthetically pleasing but overlooked species that fulfils the criteria of flagship or umbrella species.

[3]The elephant, of course, is often referred to as an umbrella, flagship and keystone species IChoudhury *et al*., 2008) but the conservation practices used to manage this large herbivore have been largely unsuccessful with Fernando calling for a paradigm change in elephant conservation (Fernando, 2015b).

[4]One, by Fakruddin *et al.* (2011) modelled microbial responses in food; the other by Nagabhatla *et al* (2008) used geospatial tools to monitor change in Muthurajawela Marsh and Negombo Lagoon.

Lack of research on the impact of climate change on species and ecosystems

Climate change is an over-arching driver of biodiversity loss that is predicted to be the dominant driver of loss by the end of this century (MEA, 2005). Much of climate change research in Sri Lanka has focussed on a) predicting the climatic changes in Sri Lanka (Basanyake, 2007; de Costa, 2008; Jayawardene *et al*., 2015; Zubair and Ropelewski, 2006; Zubair *et al*., 2007); b) examining the impacts of climate change on natural hazards (Zubair *et al*., 2006b); and c) predicting impacts of climate change on agriculture and the adaptive strategies needed for the sector and for food security (*inter alia*, Athulathmudali *et al*., 2011; De Costa, 2000; Eriagama *et al*., 2010; Esham and Garforth, 2013; Fernando, 2000; Panabokke and Punyawardena, 2010; Peiris *et al*., 2008; Wijeratne,2007; Zubair, 2002).

Very little attention has been paid to the impacts of climate change on species and ecosystems.

A sector vulnerability profile for biodiversity and ecosystem services carried out by the Climate Change Secretariat of the Ministry of Environment and Natural Resources (2011) predicts that there will be a possible shift in climatic zones, with the dry zone expanding into the intermediate zone, and the latter, into the wet zone. Through the preparation of a series of maps, a composite map of the distribution of threatened species of amphibians, dipterocarps and orchids and district-wise vulnerability reveals that the biodiversity in the districts of Colombo, Galle, Kalutara, Matale, Nuwara Eliya and Ratnapura will be significantly affected (MoNRE, 2011).

It is in the montane zone that climate change impacts are already being felt: night time annual mean minimum air temperatures have increased maximally in Nuwara Eliya (Basanyake, 2007). In addition, the highest rate of decline in rainfall has been shown to be in Nuwara Eliya (Costa, 2008).

In 1992, mass deaths of the pygmy lizard (*Cophotis ceylanica*) were observed in Nuwara Eliya and Hakkgala and these deaths were attributed to drought and high temperatures in the region (de Silva, 2006). In Sri Lanka, there are 59 extant species of the Genus *Pseudophilautus* — oriental tree shrub frogs, found in the wet zone that lay their eggs not in water but in moist places (Meegaskumbura and Manamendra-Arachchi, 2011; Wickramasinghe *et al*., 2015). These are species that could be similarly adversely affected. Half the plant species of the montane zone are found nowhere else in the world (Wijesundara, 2012). Among native orchids — a group of plants known to be vulnerable to the impacts of climate change (Barman and Devadas, 2013; Swarts and Dixon, 2009) — 41.5% are found only in the sub-montane and montane zone (Fernando and Ormerod, 2008). Of these, 38.5% are endemics (Fernando and Ormerod, 2008).

A Google and Google Scholar search of impact+climate change+species+Sri Lanka or climate change+ecosystems+Sri Lanka returns only Somaratne and Dhanapala's (2008) study on impacts of forest distribution and a taxonomic and ecological study of a threatened genus of Bufonid *Adenomus*, that concludes that the overlap of two species is the consequence of a low-latitude species moving into the range of a high-altitude species, with warming temperatures (Meegaskumbura *et al.*, 2015). Since issue 2 of 2007, only one research article in the Ceylon Journal of Science (Bio Science) dealt with climate change — the lead article in issue 2 of 2014, relating to climate change and invasive alien species (Iqbal *et al*., 2014).

The impact of climate change on invasive alien species has also not been investigated, despite the enormous ecological and economical threat from invasive alien species (Jayarathne and Ranwala, 2010; Iqbal *et al*., 2014).

Another lacuna in relation to climate change is the absence of long-term monitoring plots in different climatic zones and ecosystems. Long-term monitoring (since 1993) has been carried out in 25 ha plot in the Sinharaja World Heritage Site to understand forest dynamics (Gunatilleke *et al*., 2004). Similar plots must be established, as noted above, and monitored specifically in relation to climate change.

Focus is on a sectoral rather than a holistic approach

The definition of conservation used in this paper inherently warrants a holistic approach that involves players from different disciplines. However, much of practised conservation in Sri Lanka is sectoral, administered by organisations mandated to conserve Sri Lanka's biodiversity. The problems of a sectoral approach, which drives most conservation in Sri Lanka, is exemplified in the coastal sector. The Coast Conservation and Coastal Resource Management Department is the principal authority for the coastal areas of Sri Lanka (CCA, 1981; 1988). However, within the coastal zone are several coastal and marine protected areas — such as Wilpattu National Park and Bar Reef Sanctuary on the northwestern coast — which come under the purview of the Department of Wildlife Conservation. Also within the coastal zone are 15,669 ha of mangroves (BDS, MoERE, 2014), which are under the jurisdiction of the Forest Department (IUCN, 2012; Joseph, 2003). In addition, there are some 13 fisheries management areas (areas protected for fisheries), which in turn,

are administered by the Department of Fisheries and Aquatic Resources (FARA, 1996). Any structural changes — such as hard engineering solutions needed for the prevention of erosion — are the responsibilities of engineers (BOBLME, 2013). Adding to this mix are provincial and local governments and two existing parallel structures — one political, *i.e.*, elected (chief ministers, urban/municipal/local councils) and the other bureaucratic, *i.e.*, appointed (district secretaries, divisional secretaries and *grama niladharis*) (IUCN, 2011b).

Tourism, as a sector, is a heavy user of biodiversity: in 2014, 1,252,699 tourists (both local and foreign) visited 18 national parks and one sanctuary and generated a revenue of nearly 8.75 million rupees (SLTDA, 2014). Yet, this sector, barring piecemeal efforts by some large hotels, is rarely called upon to engage in conservation.

RECOMMENDATIONS

1. Shift to a new paradigm of conservation that includes preservation, enhancement, restoration and active management of ecosystems and species that is based on sound science. This will require concerted capacity building and a complete attitudinal shift of the mandated custodians of the island's biodiversity.
2. There is an urgent need to shift to a landscape approach to conservation that includes connectivity between fragments or pockets of habitats, examines the impacts of upstream/upcountry activities on downstream/coastal systems and includes people as a part of this landscape. There are now many types of landscape modelling software (see section on valuation for an example) that can be applied to support such an approach.
3. Ensure that ecosystem valuation (which accounts for ecosystem services) is mainstreamed into conservation activities, national biodiversity action plans and other plans such as national adaptation plans and, that these feed into development plans and activities.
4. Ensure that current legislation accurately reflects the results the current Red Listing™ process, and ensure that conservation science is translated into conservation practice.
5. Methods for prioritising ecosystems and species must be developed and applied, so that conservation actions may be better focussed.
6. Parallel to the description and taxonomic research that is ongoing in the country, it is critically important that predictive research is increased and strengthened to complement these descriptive studies, to better inform conservation plans.
7. Increase targeted research on the impacts of climate change. Such research combined with recommendation 6 will provide information for proactive, *a priori* conservation, rather than reactive, *a posteriori* conservation.
8. Strengthen *ex-situ* conservation (as also recommended in BDS, MoERE, 2014) to complement efforts in recommendations 6 and 7.
9. Although it will be a considerable challenge, a shift to a multi-sectoral, multi-stakeholder approach — such as an ecosystem approach (Figure 3) — is urgently needed. Several piecemeal efforts have been made towards multi-stakeholder involvement — such as efforts at integrated coastal zone management and multi-stakeholder platforms (CCD, 2004; IUCN, 2011b). However, such approaches must be mainstreamed. As Kawanishi and Seidensticker (2010) note, what is needed is 'collaboration not competition'.
10. Because ecosystems are dynamic, conservation must be adaptive. Every management plan, or action plan must be continually updated. This occurs at a national level (for example, biodiversity action plans, Red Lists™), but whether there is adequate adaptive management as a matter of course is questionable.
11. Because conservation is often a crisis discipline (see Introduction), when data are not available, conservation biologists must rely on the precautionary principle, using the more conservative recommendation in order to take preventive action (Kriebel, 2001).

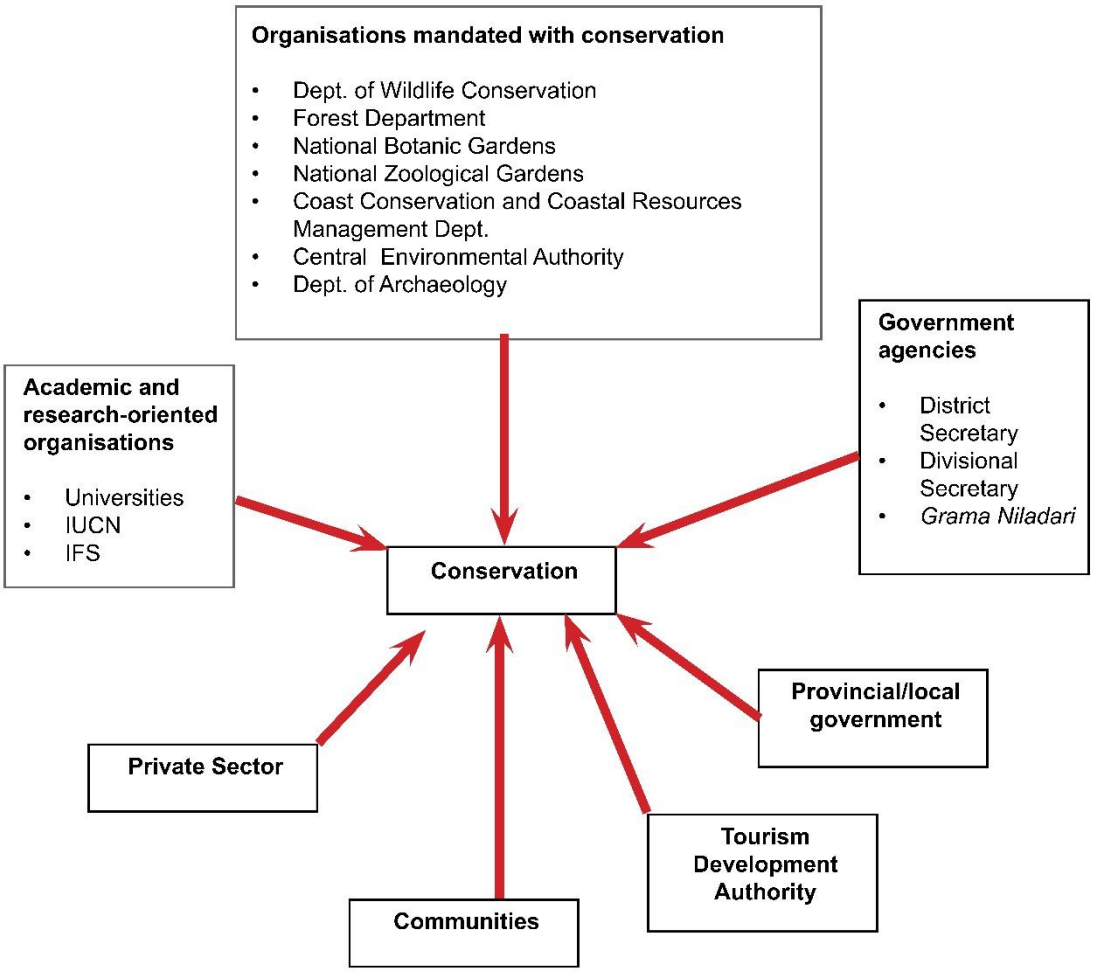

Figure 3. Shifting to a mutil-sectoral approach
(Source: Miththapala, 2001; adapted from Nature Conservancy 2005)

Concluding Remarks

Many of the gaps that I have noted above have been repeatedly identified in various national plans (MoENR, 2007, CCS, MoENR, 2010, 2011; BDS, MoERE, 2014). What I have discussed is not new. My attempt in this paper was to revert to the very basics of conservation biology and to remind us afresh of what conservation really is. Unless we transform our thinking and move conservation in Sri Lanka into the 21st century, making informed predictions about change and being proactive with our actions; guiding and being guided by conservation needs, we will indubitably fail in our efforts, because, currently we are not engaging in conservation.

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Appendix 1. Various definitions of conservation
(Sources are listed within the table.)

	Source	Definition
1	**Audubon Society** http://www.audubon.org/	To conserve and restore natural ecosystems, focusing on birds, other wildlife, and their habitats for the benefit of humanity and the earth's biological diversity.
2	**Conservation International** http://www.conservation.org/about/Pages/default.aspx#mission	Protecting natural wealth; fostering effective governance, promoting sustainable production.
3	**Convention on Biological Diversity** https://www.cbd.int/cepa/toolkit/2008/doc/CBD-Toolkit-Glossaries.pdf	The management of human interactions with genes, species, and ecosystems so as to provide the maximum benefit to the present generation while maintaining their potential to meet the needs and aspirations of future generations; encompasses elements of saving, studying, and using biodiversity.
4	**Earthwatch** http://earthwatch.org/about	Vision is a world in which we live within our means and in balance with nature.
5	**Food and Agriculture Organization** http://www.fao.org/nr/cgrfa/cgrfa-vision/en/	Conserving biodiversity for food and agriculture and promoting its use in support of global food security and sustainable development, for present and future generations.
6	**Dictionary.com** http://dictionary.reference.com/browse/conservation	Official supervision of rivers, forests, and other naturalresources inorder to preserve and protect them through prudent management.
7	**Dictionary.com** http://dictionary.reference.com/browse/conservation	The careful utilization of a natural resource in order to prevent depletion.
8	**Merriam Webster Dictionary** http://www.merriam-webster.com/dictionary/conservation	A careful preservation and protection of something; especially: planned management of a natural resource to prevent exploitation, destruction, or neglect.
9	**Free Dictionary** http://www.thefreedictionary.com/conservation	The protection, preservation, management, or restoration of wildlife and of natural resources such asforests, soil, and water
10	**Oxford English Dictionary** http://www.oxforddictionaries.com/definition/english/conservation	Preservation, protection, or restoration of the natural environment and of wildlife.
11	**Oxford English Dictionary** http://www.oxforddictionaries.com/definition/english/conservation	Prevention of wasteful use of a resource.
12	**IUCN** http://www.iucn.org/about/	Vision is a just world that values and conserves nature.
13	**IUCN** https://cmsdata.iucn.org/downloads/en_iucn__glossary_definitions.pdf	The protection, care, management and maintenance of ecosystems, habitats, wildlife species and populations, within or outside of their natural environments, in order to safeguard the natural conditions for their long-term permanence.
15	**IUCN/UNEP** World Conservation Strategy (1980) https://portals.iucn.org/library/efiles/documents/WCS-004.pdf	Conservation, like development, is for people; while development aims to achieve human goals largely through use of the biosphere, conservation aims to achieve them by ensuring that such use can continue. Conservation's concern for maintenance and sustainability is a rational response to the nature of living resources (renewability+ destructibility) and also an ethical imperative, expressed in the belief that "we have not inherited the earth from our parents, we have borrowed it from our children".

	Source	Definition
16	**Sierra Club** http://www.sierraclub.org/policy	To explore, enjoy, and protect the wild places of the earth; to practice and promote the responsible use of the earth's ecosystems and resources; to educate and enlist humanity to protect and restore the quality of the natural and human environment; and to use all lawful means to carry out these objectives.
17	**The Nature Conservancy** http://www.nature.org/about-us/vision-mission/about-vision-mission-main.xml	Vision is a world where the diversity of life thrives, and people act to conserve nature for its own sake and its ability to fulfill our needs and enrich our lives.
18	**UNEP** Our planet http://web.unep.org/ourplanet/	Healthy planet, healthy people.
19	**United Nations Environmental Program** http://www.unep.org/about/	To provide leadership and encourage partnership in caring for the environment by inspiring, informing, and enabling nations and peoples to improve their quality of life without compromising that of future generations.
20	**Wildlife Conservation Society** http://www.wcs.org/about-us.aspx	Envisions a world where wildlife thrives in healthy lands and seas, valued by societies that embrace and benefit from the diversity and integrity of life on earth.
21	**World Bank** http://www.worldbank.org/en/topic/environment/overview#2	To manage land, sea and freshwater natural resources in a sustainable way that helps create jobs, improve livelihoods, enhance ecosystem services (such as carbon sequestration, pollination or water regulation), decrease pollution and increase resilience to climate change.
22	**World Resources Institute** http://www.wri.org/about/mission-goals	To move human society to live in ways that protect Earth’s environment and its capacity to provide for the needs and aspirations of current and future generations.
23	**World Wide Fund for Nature** http://www.worldwildlife.org/about	To conserve nature and reduce the most pressing threats to the diversity of life on Earth. Our vision is to build a future in which people live in harmony with nature.