An assessment of protected areas management effectiveness in the conservation of Red Listed Western Tragopan *Tragopan melanocephalus* in Pakistan.

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Summary

Protected areas are a critical tool to conserve biodiversity in the face of the global crisis of species extinction. Here we report the first ever management effectives assessment of Pakistan's Protected Areas (PAs). We link these assessments to the delivery of conservation outcomes focusing on the threatened Western Tragopan (*Tragopan melanocephalus*) endemic to Pakistan and India.

We used two approaches, first mapping the spatial distribution of potential habitat coverage using machine learning ensemble models and second, an assessment of management effectiveness of protected areas. Our results show that only Machiara National Park scored just above 40% (indicating relatively weak management), 22 of the PAs fell within the 25-50% quantile (indicating weak management), and three scored below 25% (indicating poor management). PAs within the species distributional range covered 92,387 ha which is only 2% of the total potential habitat of the Tragopan. Scoring of planning element was insufficient both in term of the site and species. Likewise, inputs (e.g. research & monitoring programme, staff numbers, staff training, current budget, security of budget, and management process were also inadequate.

Finally, we recommend establishment of more protected areas within the species potential habitat and inclusion of species-specific plans in Pakistan's PAs management are highly recommended.

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1. Background

Protected areas are a critical tool to conserve biodiversity in the face of the global crisis of species extinction brought on by increasing impacts of humans over the last century (United Nations, 2016; Bradshaw and Brook, 2014). This has resulted in land-cover and land-use change, unsustainable utilization of species, spreading invasive species, climate disruption, and pollution, causing reductions in biodiversity and key ecosystem services (IPBES, 2019; United Nations, 2016).

South Asia is one of the regions at the forefront of global population and economic growth. According to the United Nations; the human population has more than tripled between 1950 and 2009 in South Asia, from 473 million to 1.6 billion, and is projected to grow a further 41% by 2050 (United Nations, 2009). Similarly, Pakistan, the sixth most populated country on Earth, has one of highest population growth rates in the world United Nations, 2016. Population of Pakistan grew from 31 million people in 1951 to about 185 million people in 2014 and the increased demand for natural resources is accelerating loss of biodiversity and environmental degradation (Government of Pakistan, 2015).

Perhaps the most far reaching response to the biodiversity crisis has been the development of Protected Areas (PAs), of which more than 238,563 have now been designated with most areas on land, and collectively protect just over 20 million km2, equivalent to 14.9% of the earth's land surface (UNEP-WCMC, IUCN and NGS, 2018). PAs have long been regarded as an important tool for maintaining habitat integrity and species diversity (Brooks et al., 2004; Butchart et al., 2015; Coad et al., 2015; Rodrigues et al., 2004). PAs are increasingly becoming final refuges for threatened species and natural ecosystem processes as deforestation probably imperils global biodiversity more than any other existing threat, whereas PAs are generally considered effective at abating habitat conversion and biodiversity loss (Clark et al., 2013; Laurance et al., 2012; Geldmann et al; 2013). The success of PAs has generally been evaluated using measures such as the representativeness of PA networks in terms of their species diversity, or coverage of endemic and threatened species (e.g. Rodrigues et al., 2004), assuming that PAs provide effective protection once established (Geldmann et al., 2013).

1.1. History of Protected Areas in Pakistan

Prior to 1966, Pakistan had taken no significant steps towards establishing a PAs network but the continuing noticeable decline of wildlife during the 1950s and 1960s prompted the Government of Pakistan in 1967 to commission the World Wildlife Fund (WWF) to undertake extensive surveys of the status of the wildlife in the country and requirement of its conservation. This led the WWF to carry out a survey of the country's wildlife resources and recommended measures to arrest their deterioration (IUCN, 1990). These included the establishment of a PAs system in the country which initially included six sites within IUCN management category II (i.e. National Park), 45 in category IV (i.e. managed nature reserve/wildlife sanctuaries) and four in category V (i.e. protected landscapes/seascapes) covering ≥1,000 ha. This initiative was followed by the constitution of the Wildlife Enquiry Committee in 1968, which made further recommendations for the establishment of five National Parks, 18 Wildlife Sanctuaries and 52 Game reserves (Government of Pakistan, 2000). These recommendations have been substantially exceeded with 4 National Parks, 44 Wildlife Sanctuaries and 65 Game reserves established by the year 1978 (Davey, 1996). Currently, Pakistan has 157 PAs of which five are classified National Parks of IUCN category II, 62 Wildlife sanctuaries (category IV), five protected landscapes/seascapes (category V), two managed resource protected areas (Category VI) and 83 unclassified areas (Government of Pakistan, 2015).

The importance of PAs in safeguarding biodiversity is now enshrined in the Aichi Target 11 that forms part of the Strategic Plan for Biodiversity 2011–2020 of the Convention on Biological Diversity which Pakistan is a Party to (CBD, 2008). Science has already demonstrated the contribution of PAs to species coverage (e.g. Rodrigues et al., 2004) and has developed methods for evaluating management and interventions (Leverington et al., 2010). So, in this study we look at role of PAs in the conservation of Western Tragopan a red-listed Galliformes which is endemic to the Western Himalayan biodiversity hotspot. With a relatively small geographical range found only in northern Pakistan and north-western India, it is an extremely elusive pheasant occurring between 2,400-3,500 m.a.s.l. (Ali and Ripley, 1987). In Pakistan, it

occurs in comparatively smaller pockets in the northern parts of the country i.e. Pallas Valley, Kaghan valley and Azad Jammu and Kashmir (BirdLife International, 2020).

Herein we present an assessment of the management effectiveness of 26 PAs in Pakistan, including all PAs within the range of the Western Tragopan following the process of adapting the Management Effectiveness Tracking Tool (METT) for PAs (Stolton et al., 2007). In relation to conservation outcomes we focus on the Western Tragopan as a case species given its conservation significance in this region. However, this method could be further applied on many other species of global conservation concern.

1.2. Project objectives

- To assess the effectiveness of the protected areas system for the protection of Western Tragopan in Pakistan.
- To evaluate Threats to Species and its habitat in PAs
- To find out the species preferred habitat coverage by the protected areas system in Pakistan.

2. Project Methodology

In total we examined 26 PAs in the two region of Pakistan. We used two approaches to understand the management effectives of the PAs and their role in the conservation of the target species, the Western Tragopan. First, by mapping the spatial distribution of the potential habitat coverage, modeled in software R for Windows Ver. 3.5.2; R (Core Team, 2018) using the package 'Dismo' (Fick and Hijmans, 2017). The machine learning models used for building an ensemble (average) of three analysis included Random Forest (Breiman, 2001), Support Vector Machine (Kecman, 2005) and Maximum Entropy Modeling (Maxent; Phillips et al., 2006). Second, assessment of Management Effectiveness of PAs adapting the Management Effectiveness Tracking Tool (METT) for PAs (Stolton et al., 2007).

2.1. Habitat Suitability data

In order to predict the potential habitat of Western Tragopan in Pakistan, we used data on breeding call count locations (n=234) as a response variable against a suit of bioclimatic predictor variables (Supplementary File 1). The breeding call locations (n=150) were GPS-marked during field surveys carried out for the period of 2008-2020. In order to make the study more comprehensive, records from previous studies emphasizing three main distribution pockets in Pakistan were also added (n=84, Fig 1).

2.2. Management effectiveness Assessment

Analysis were undertaken for this assessment using Management Effectiveness Tracking Tool (METT) (Stolton et al., 2007) which involve a WCPA Framework and is based on the idea that good protected area management follows a process that has six distinct stages, or elements: 1) it begins with understanding the context of existing values and threats, 2) progresses through planning, and 3) allocation of resources (inputs), and 4) as a result of management actions (processes), eventually produces 5) products and services (outputs), that result in 6) impacts or outcomes (Stolton et al., 2007). In this study we used Management Effectiveness Tracking Tool

(METT) along with WCPA Framework to evaluate the effectiveness of the PAs in the conservation of the Westren Tragopan in Pakistan. Furthermore, we used a threat assessment sheet to evaluate and quantify different threats to Pakistan's PAs generally and in regard to Western Tragopan specifically.

2.3. Data collection

Data was collected through five consultative workshops, with 15 participants each taking place between March and June 2020. Participants were selected primarily working in PAs or directly/indirectly involved with PAs including PA mangers and staff (n=10), Students or researchers (n=2) and local representatives (n=3). In this way, 26 PAs with known Western Tragopan occurrence were evaluated, including one National Park (Machiara), six Game reserves, one Wildlife sanctuary and 18 with other designation types .

PICTURE 1: PARTICIPANTS DURING THE ASSESSMENT WORKSHOP

A questionnaire was used to collect data on some basic information about the site, such as

name, size and location. We used a unique site code given to the protected area included from the World Database on Protected Area (WDPA) accessed via the UNEP-World Conservation Monitoring Centre website at: www.unep-wcmc.org/wdpa. Other contextual information such as local designation, i.e. National Park, National reserve etc., along with the IUCN protected area management category (IUCN, 1990), ownership, staff number and budget was also recorded.

The assessment was made by assigning a simple score ranging between 0 (poor or absent) to 3 (excellent or fully implemented). Four answers were provided against each question to help assessors to make judgments as to the level of score given. In addition, supplementary questions were used to elaborate on key themes in the previous questions and provide additional information and points (see SF).

PICTURE 2. TEAM MEMBERS DURING THE FIELD SURVEYS

For threat analysis a separate sheet was used to evaluate the different types of threats to the species and its habitat within each protected area. Each sheet was holding questions about a set of 12 categories of threats as described in the Management Effectiveness Tracking Tool (METT) by Stolton et al., (2007) following the taxonomy laid out in Salafsky et al., (2008). Each

category holds relevant threats which were scored according to the intensity from low to high.

2.4. Data Analysis

Using a Geographical Information System (GIS)-based habitat suitability analysis of key habitat variables, we calculated the potential habitat suitable for Western Tragopan in Pakistan (Fig 1). We then mapped the boundary of the PAs to estimate the potential habitat of the species falling within the PAs and outside the PAs.

Overall management effectiveness scores were used to understand the management effectiveness at each protected area and across the network. Similarly, scores were also used to evaluate the threat level in all PAs whereas species specific threats were also scored to underhand scenario of threats to PAs and species. We calculated mean value of each variable with Standard Error (SE), percentage value of each question and further calculated mean ± SE for each element of the WCPA framework. Finally, to understand the correlation among different variables, we examined the coefficients of determination (Pearson correlation) between different variables of the contributing elements of Protected Areas management Effectiveness and threats.

3. Results

3.1. Spatial Distribution of Protected Areas

We report here all 26 PAs falling within the potential habitat of the Western Tragopan in Pakistan (Table 1).

TABLE 1. PROTECTED AREAS FALLING WITHIN THE POTENTIAL HABITAT OF THE SPECIES IN PAKISTAN

Site Code	Name of the PAs (Area)	National Category	IUCN category	Size (ha) Govt. Notified	Long	Lat
P1	Hillan (AJK)	Game Reserve	VI	384	74°15'18.47"E	33°57'5.30"N
P2	Phala (AJK)	Game Reserve	VI	472	74°10'7.80"E	33°58'52.71"N
P3	Mori Said Ali (AJK)	Game Reserve	VI	273	74° 4'28.82"E	33°56'14.50"N
P4	Qazi Nag (AJK)	Game Reserve	VI	4,830	73°57'47.36"E	34°13'22.82"N
P5	Moji (AJK)	Game Reserve	VI	3,859	73°47'15.69"E	34°17'50.67"N
P6	Machiara (AJK)	National Park	II	13,532	73°38'19.47"E	34°31'53.90"N
P7	Salkhala (AJK)	Game Reserve	IV	890	73°53'39.85"E	34°33'2.87"N
P8	Makhiar (KPK)	Reserve Forest	IV	1,035	73°25'58.74"E	34°35'15.51"N
P9	Malakandi (KPK)	Reserve Forest	IV	1,923	73°30'32.27"E	34°36'36.21"N
P10	Chitta Par(KPK)	Reserve Forest	IV	918	73°34'35.49"E	34°36'59.33"N
P11	Nuri Bithcla(KPK)	Reserve Forest	IV	1,787	73°34'12.19"E	34°38'29.64"N
P12	Manur(KPK)	Reserve Forest	IV	425	73°38'59.00"E	34°46'10.91"N
P13	Karkana(KPK)	Reserve Forest	IV	1,452	73°34'32.92"E	34°50'11.92"N
P14	Chitta Khatta(KPK)	Reserve Forest	IV	361	73°36'33.97"E	34°51'38.08"N
P15	Battal (KPK)	Reserve Forest	IV	2,500	73°38'55.08"E	34°52'41.20"N
P16	Naran (KPK)	Reserve Forest	IV	290	73°39'41.74"E	34°55'11.42"N
P17	Bhimbal (KPK)	Reserve Forest	IV	220	73°35'23.85"E	34°51'52.54"N
P18	Andhera Bela (KPK)	Reserve Forest	IV	410	73°33'29.65"E	34°51'20.13"N
P19	Kinari (KPK)	(KPK)Reserve Forest	IV	241	73°29'18.43"E	34°48'3.44"N
P20	Shortham (KPK)	Reserve Forest	IV	272	73°30'36.66"E	34°46'9.02"N
P21	Diwan Bela (KPK)	Reserve Forest	IV	1,510	73°31'5.70"E	34°44'8.88"N
P22	Kamal Ban (KPK)	Reserve Forest	IV	2,212	73°31'35.14"E	34°42'38.71"N
P23	Manshi (KPK)	Wildlife Sanctuary	IV	2,560	73°25'50.96"E	34°42'17.99"N
P24	Nagan (KPK)	Reserve Forest	IV	1,637	73°22'40.98"E	34°40'17.08"N
P25	Panjul (KPK)	Reserve Forest	IV	2,482	73°18'36.90"E	34°40'11.70"N
P26	Unna (KPK)	Reserve Forest	IV	2,249	73°16'24.25"E	34°43'23.30"N
	Total Area			92,387		

Within the Pakistani Himalayas, the PAs network falling within the species distributional range covered 92,387 ha which is only 2% of the total potential habitat of the Tragopan (Fig 1).

Seventeen Protected landscapes (65%) are falling within the boundary of province of Khyber Pakhtunkhawa and only seven (35%) in the state of Azad Jammu and Kashmir (Fig 1).

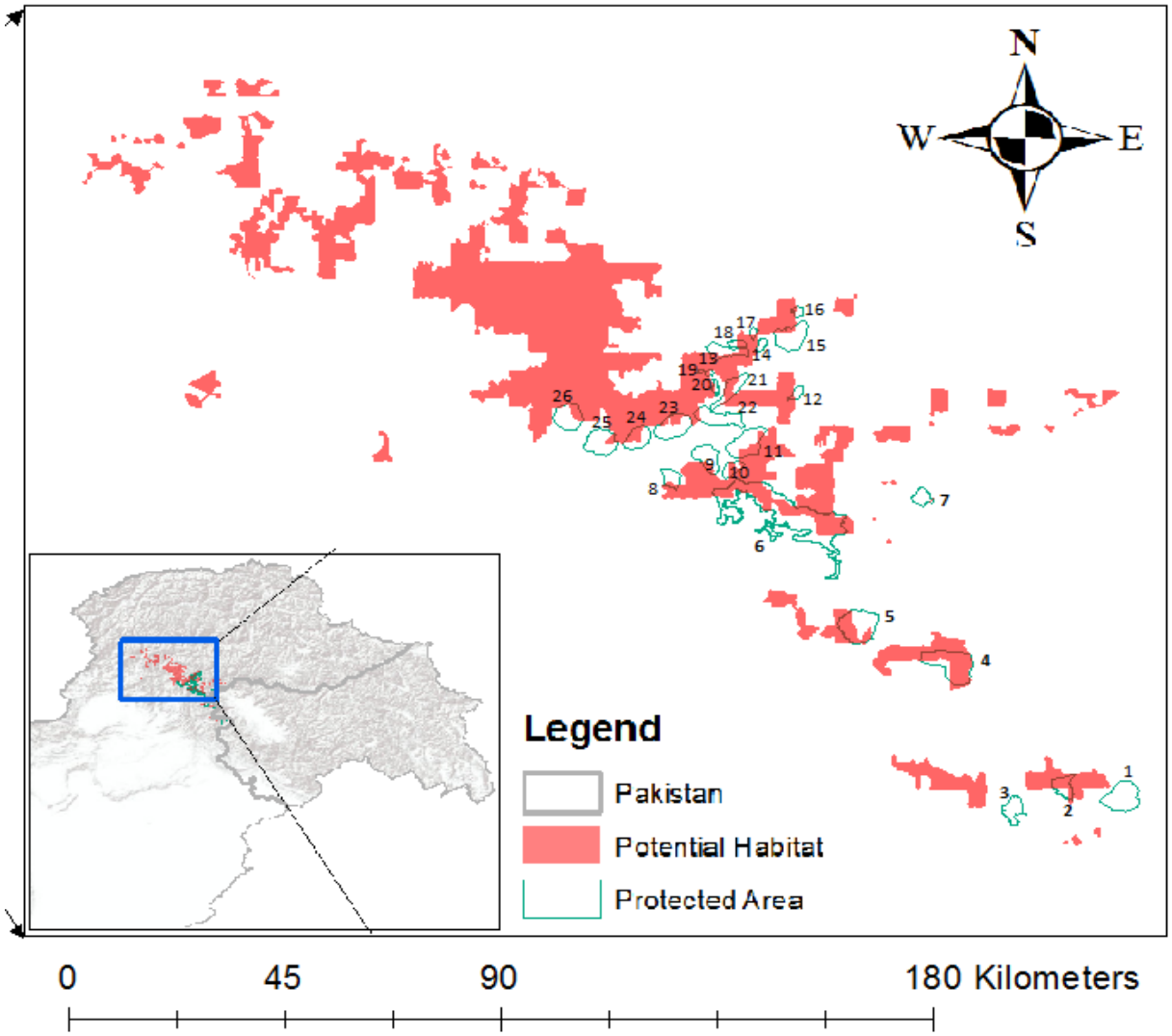

FIGURE. 1. SPATIAL DISTRIBUTION OF PROTECTED AREAS FALLING WITHIN THE POTENTIAL HABITAT OF THE SPECIES. FOR NAMES OF NUMBERED PROTECTED AREAS

Inside the PAs about 50% (47,468 ha) of the landscape is potential habitat of the Western Tragopan, whereas about the same landscape portion (50%) within PAs is not suitable for the species.

3.2. Protected Areas Management Effective analysis

3.2.1. Overall Ranking of the Contributing Protected Areas

We herein present results of our survey of management effectiveness from 26 PAs within the distributional range of the Western Tragopan in Western Himalayan landscape of Pakistan (Fig. 1). All 26 PAs reported severe deficits in their management. Only one (Machiara National Park) scored close to 50%, when all questions were combined, while 22 PAs fell within the 25-50% quantile, indicating that they are weakly managed, and three scored less than 25% when looking at the scores across all questions (Fig. 2).

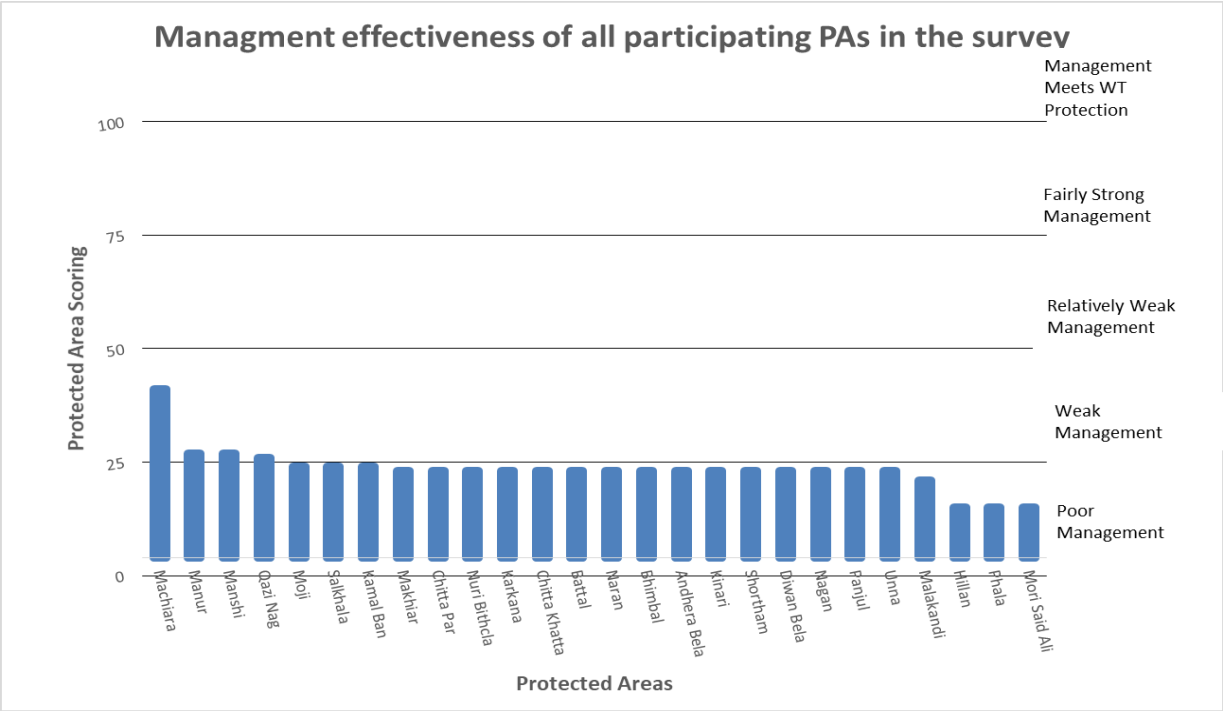

FIGURE 2. MANAGEMENT EFFECTIVENESS OF DIFFERENT PROTECTED AREAS SURVEYED DURING THE STUDY.

All 26 protected areas showed severe deficiencies in resources and management capacities (Fig. 2). Of the 26 PAs, Machiara National park was the highest ranked (although still within the weak management category), scoring 41% (mean = 1.7, S.E. = 2.1) followed by Manur (27%), Manshi (27%), and Qazi Nag (26%) which scored mean 1.1, SE.=0.17, mean 1.1 S.E. = 0.18, and mean

1.1, S.E. = 2.1 respectively. The least scoring PAs are Hillan, Phala and Mori Said Ali with 15% each, (mean= 0.6 S.E.= 0.16).

3.2.2. Scoring based on the elements of the WCPA Framework

Looking at scores divided by the six elements of the WCPA management effectiveness framework (Stolton et al., 2007) reviled some interesting differences. PAs, on average, were recorded as reasonably effective for questions related to their context (mean = 47.6, S.E. = 8.846). Thus, the PAs were legally recognized, had clear boundary demarcation, as well as clear biodiversity resource inventories and management objectives (Fig. 3). However, for other elements, the results were less encouraging. Planning was insufficient both in term of the site and species (mean = 16.6, S.E. = 9.795). Likewise, inputs (e.g. research & monitoring programme, staff numbers, staff training, current budget, security of budget, (mean = 24.6, S.E. = 3.01), and management process (mean 18.33, S.E. = 3.76) were also inadequate (Fig. 4).

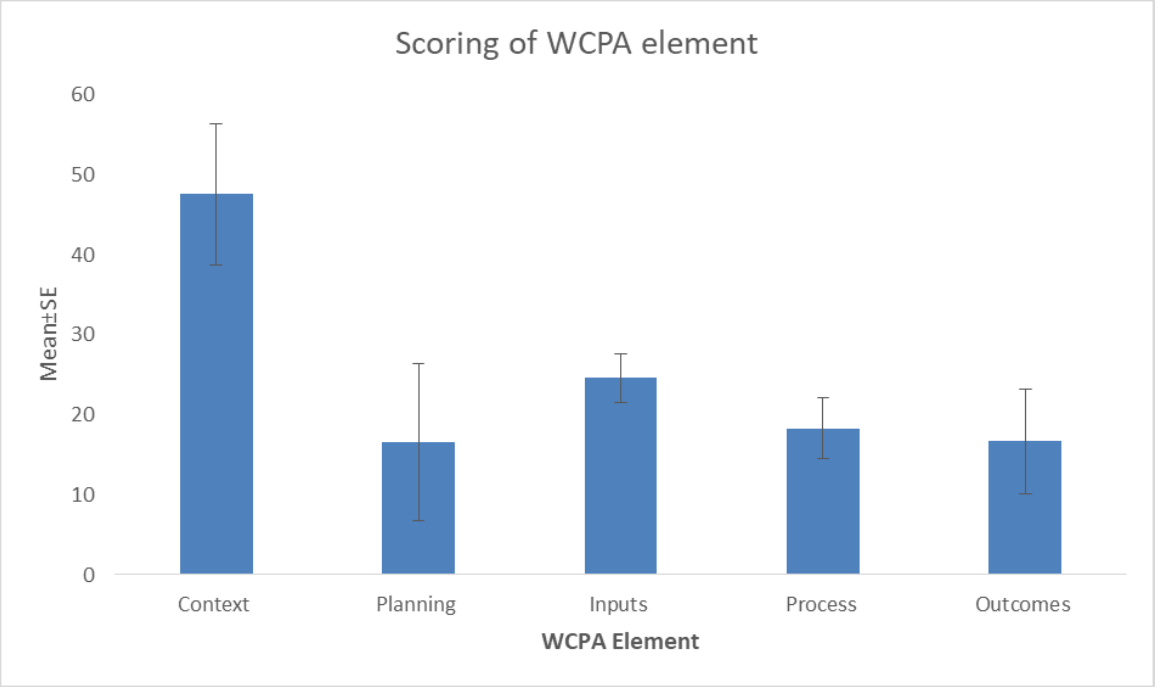

FIGURE 3. SCORING RESULTS OF DIFFERENT ELEMENTS OF WCPA FROM PARTICIPATING PROTECTED AREAS IN PAKISTAN.

3.2.3. Target Species management in and outside protected areas

While having adequate resources and well-established management systems is key, these are ultimately means towards an end – delivering positive conservation outcomes. To address this we also had four questions that addressed the PAs contribution to maintaining and/or improving the conservation status of the target species the Western Tragopan. Overall these questions revealed that the conservation status of the Western Tragopan is poorly managed (mean = 1.30, S.E. = 0.15). In the planning element there were two species specific questions: 1) Species specific action plan and 2) planning outside of the PA for the target species. Both questions scored zero indicating that all protected areas are lacking species specific action plans and no planning outside the PA to help to protect the species.

3.2.4. Ecological outcomes

Results of the ecological outcomes were equally ineffective compared to the species outcomes (mean = 16.66, S.E. = 6.56). The survey included three questions about the state of the ecological outcome all showing that the PAs on average had a poor ecological status: 1) ecological condition assessment (mean=0.77, S.E. = 0.08, 25.6%), 2) species conservation status assessment (mean=0.15, S.E. = 0.07, 5.1%), and 3) species protection systems (mean = 1.00, S.E. = 0.00, 33.3%).

The current PAs budgets (inputs) showed a positive correlation with the species' protection system and ecological condition assessment (outcomes, $p < 0.0001$) but a negative, though not significant, correlation with the species' conservation status assessment ($p = 0.1250$) suggesting that PAs with more adequate budgets also had higher scores for conservation outcomes. Similarly, a Strategic Management Plan included in the planning element resulted in a positive correlation with the ecological condition assessment ($p < 0.05$) and species protection system ($p < 0.0001$) but negative, though not significant, correlation with species conservation status assessment ($p = 0.1250$).

PICTURE 3. A VIEW OF MANCHI WILLDIFE SANCTUARY IN KAGHAN VALLEY

Ecological outcomes of the survey were found negatively correlated with most of the variables of contributing elements, e.g. ecological condition assessment is negatively correlated with PAs design (p = 0.66), whereas species conservation status assessment has also been recorded negatively correlated with Protected area design (p = 0.778), Species Resource inventory (p = 0.93), Conservation Development Framework (p = 0.68), Research & Monitoring Programme (p = 0.86) and Staff training (p = 1.00).

3.3. Threats

3.3.1. Site-wise threat ranking

Based on the results of our surveys, Machiara National park had the highest level of threats across all categories (mean=3.08, S.E. = 0.16,). Three sites i.e. Moji, Salkhala and Qazi Nag received mean = 2.98, S.E. = 0.15, mean = 2.94, S.E. = 0.15 and mean = 3.08, S.E. = 0.16 respectively. Batal is the site which received the lowest scoring mean = 2.9, S.E. = 0.15. There was a positive correlation between PAs management effectiveness and threats ($p < 0.0001$).

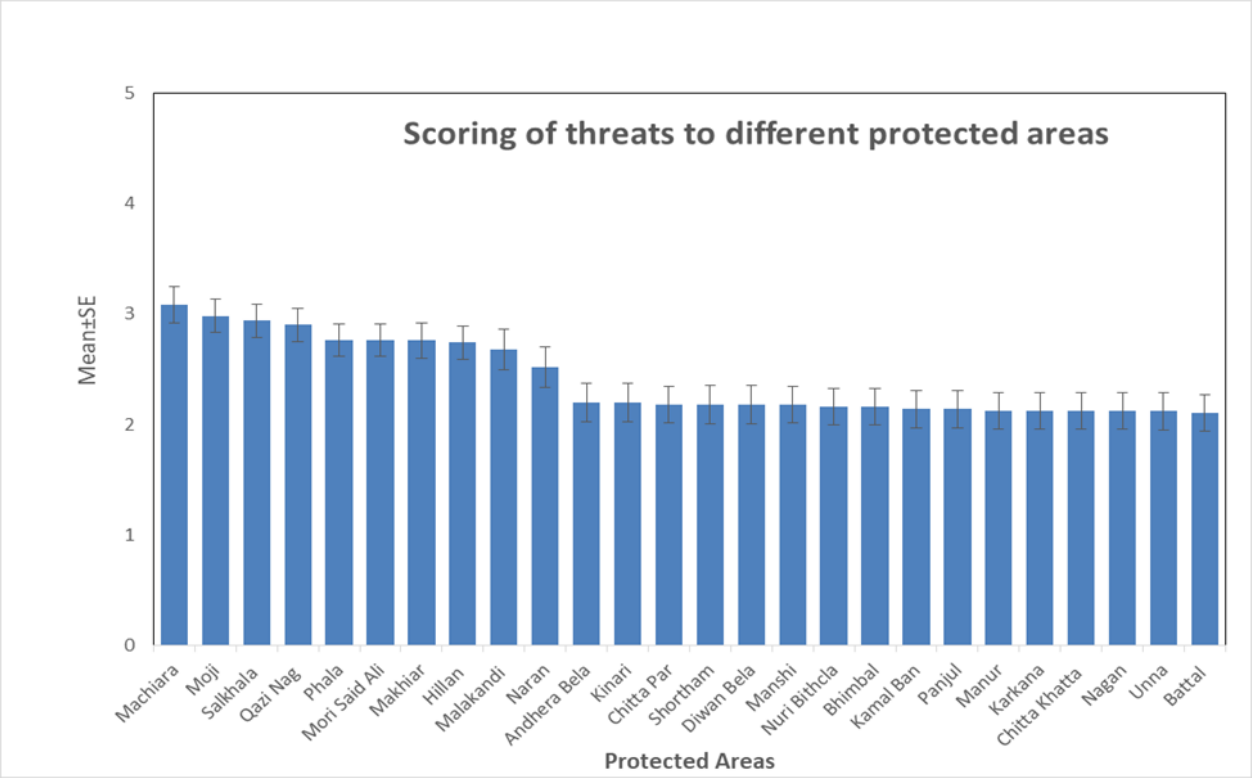

FIGURE 5. THREATS SCORING FOR PARTICIPATING PROTECTED AREAS

3.3.2. Specific threat's ranking (species related)

The results of surveys show that the conservation concerns related to fire and fire suppression, garbage and solid waste, avalanches/landslides and temperature extremes are the main threats facing all protected areas, with all 26 PAs achieving the top score (mean = 4.00, S.E. =0.00). Furthermore, species specific threats recorded were habitat fragmentation (mean =3.96, S.E. = 0.20), livestock farming and grazing (mean=3.81, S.E. = 0.141), roads and paths (mean =3.42, S.E. = 0.10) hunting, killing and collecting of terrestrial animals (mean = 3.31, S.E. = 0.09),

housing and settlement (mean =3.11, S.E. = 0.09) and natural deterioration (mean =3.00, S.E. = 0.00), gathering of terrestrial plants (mean =3.96, S.E. = 0.20), logging and wood harvesting (mean=3.96 , S.E. = 0.20, Fig. 7).

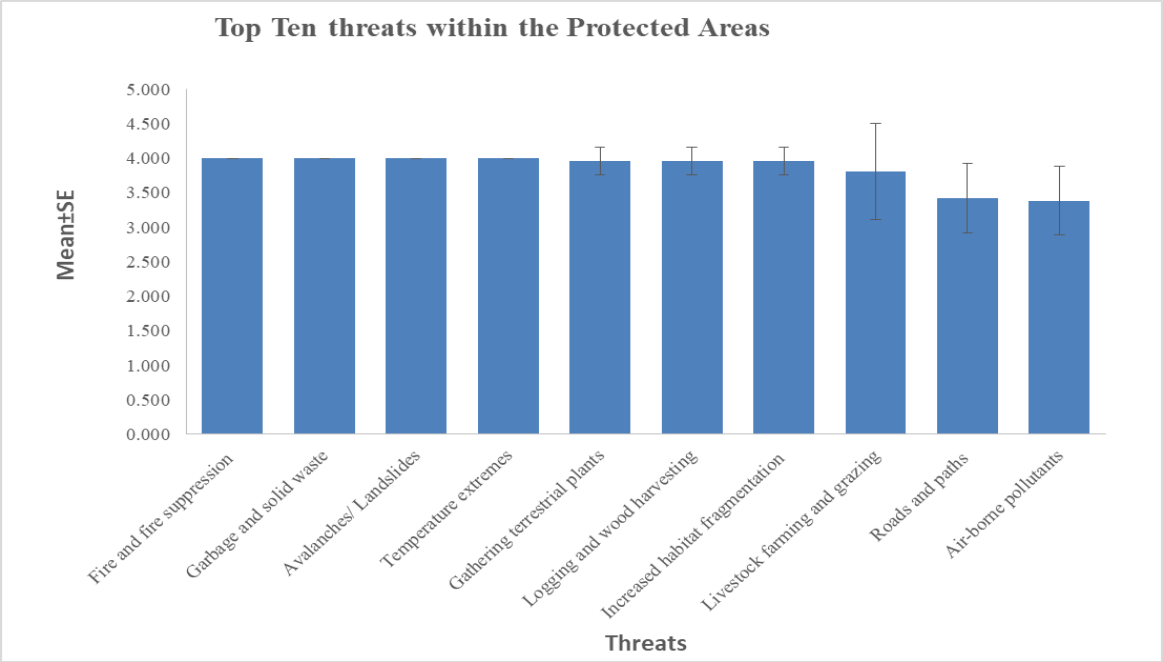

FIGURE 7. DYNAMICS OF MAJOR THREATS AMONG 26 PAS IN PAKISTAN WHERE WESTERN TRAGOPAN OCCURS.

Birdlife International (2020), already identified some threats for the Western Tragopan, such as habitat degradation and fragmentation, browsing of understory shrubs by livestock, tree-lopping for animal fodder and fuel wood-collection, disturbance by grazers. This study additionally highlights further threats inside PAs such as fire and fire suppression, garbage and solid waste management, avalanches/ landslides and temperature extremes, additional to the current main threats faced by all protected areas (Fig. 5).

4. Conclusion and Recommendation

Finally, we conclude that current PAs management is not sufficiently effective in protecting the Western Tragopan and its habitat in Pakistan. We therefore recommend a major revision of all of Pakistan's PAs management plans including specific targets for threatened species such as the Western Tragopan.

Furthermore, management plans for the internationally recognized Important Bird and Biodiversity Areas (IBAs; BirdLife International, 2020) must be developed to help protect the species and its habitat also outside of the PAs, with priorities given to threatened species facing global extinction risk. The habitat model presented in the study provides a guideline for future research and monitoring and the establishment for further PAs which is expected to help to contribute to the protection of this species of global conservation concern together with the fragile ecosystem it inhabits.

To help protect the species outside the PAs, Conservation education and awareness of the communities is strongly recommended. Education awareness in schools and colleges is also important beside capacity building of university students in conducting quality research on Tragopan and its ecology using standardize methodologies. Furthermore, capacity building of the field staff is much important to conduct species monitoring surveys in and outside the PAs to help compare the species population.

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