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Technical Report: PR220

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GLOSSARY

ABR	Agasthyamalai Biosphere Reserve
AIC	Akaike's Information Criterion
APW	Anti-Poaching Watcher
CAMPA	Compensatory Afforestation Fund Management and Planning Authority
CNWLS	Cauvery North Wildlife Sanctuary
EPT	Elephant-Proof Trench
FA	Fringe Area
FD	Forest Division
FRO	Forest Range Officer
GLM	Generalized Linear Model
HCC	Human-Carnivore Conflict
HEC	Human-Elephant Conflict
HGC	Human-Gaur Conflict
HLMC	Human-Large Mammal Conflict
HMC	Human-Megaherbivore Conflict
HWC	Human-Wildlife Conflict
HWI	Human-Wildlife Interaction
IDWH	Integrated Development of Wildlife Habitat
KMTR	Kalakad Mundanthurai Tiger Reserve
MTR	Mudumalai Tiger Reserve
NABARD	National Bank for Agriculture and Rural Development
NBR	Nilgiri Biosphere Reserve
NTFP	Non-Timber Forest Produce
PA	Protected Area
RF	Reserved Forest
SADP	Special Area Demonstration Program
STR	Sathyamangalam Tiger Reserve
TBGP	Tamil Nadu Biodiversity Conservation and Greening Project
TN	Tamil Nadu
WEGPTN	Western and Eastern Ghats part of Tamil Nadu
WLS	Wildlife Sanctuary

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Acknowledgements

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Executive Summary

Escalating anthropogenic pressure and ensuing human-large mammal conflict (HLMC) incidents jeopardize the wildlife conservation goals as well as security of human life and livelihoods. It results in loss of human life and livestock, damage to crop and property, leading to negative perceptions among the local communities, and further retaliatory killing of conflicting animals. Evidentially, large mammal populations are declining at a faster pace majorly due to anthropogenic pressures such as habitat loss and fragmentation, poaching, and retaliatory killing. It is crucial to ascertain the intensity of conflict and its ecological and anthropogenic determinants at the regional scale to develop appropriate mitigation measures to conserve the populations of large mammals, secure human life and promote co-existence. The major objectives of the study are to (a) identify spatial and temporal characteristics of livestock depredations by large carnivores (tiger, leopard, dhole, and hyaena), (b) quantify the effect of ecological anthropogenic pressure and habitat loss on the spatial distribution of large carnivores, and (c) assess the effectiveness of Protected Area (PA) management in minimizing human-large carnivore conflicts. Asian elephant (*Elephas maximus*) and Indian gaur (*Bos gaurus*) are also included as the study species because the human-wildlife conflict (HWC) incidents with these megaherbivore species are also a rising concern in the State. In addition, we extended study area from the Western Ghats region to adjoining Eastern Ghats part of Tamil Nadu because many parts of the Eastern Ghats reported high rates of HWC incidents. A study in such large and contiguous landscape can bring out the actual pattern of HLMC in the State and help policy-makers to develop effective mitigation measures.

Towards the first objective, we used a systematic grid-based (5x5km) sampling framework (n=485), across an area of 14,200 km^2 encompassing sixteen Forest Divisions, covering sixteen PAs and Outside PAs of Western and Eastern Ghats part of Tamil Nadu (WEGPTN), India namely, Kanyakumari Wildlife Sanctuary (WLS), Kalakad-Mundanthurai Tiger Reserve (KMTR), Nellai WLS, Srivilliputhur Grizzled Squirrel Sanctuary, Megamalai WLS, Coimbatore Forest Division (FD), Kodaikanal WLS, Theni FD, Nilgiri FD, Gudalur FD, Mudumalai Tiger Reserve (MTR), Sathyamangalam Tiger Reserve (STR), Erode FD, Dharmapuri FD, Cauvery North WLS (CNWLS) and Hosur FD. The data was collected between November 2017 and March 2019 based on conflict incidents from tiger (*Panthera tigris*), leopard (*Panthera pardus*), dhole (*Cuon alpinus*), hyaena (*Hyaena hyaena*), elephant, and gaur for the past five years, through semi-structured interviews (n=1460) of local communities. Forty eight percent (n=694) of households reported having experienced human-

carnivore conflict in the form of livestock depredations. Most of the livestock were killed by large carnivores in the mornings up until mid-day, between 6 am and 12 pm, coinciding with livestock grazing time inside the forest. Only a fewer tiger and leopard attacks occurred during the nights, followed by evening; the attacks were minimum during afternoon hours. Dhole attacks peaked in the early mid-evening hours and afternoon; no incidences of livestock predation by dholes occurred during night. Using the Generalized Linear Model (GLM) approach, the importance of potential predictor variables of HLMC was examined. Livestock predation risk by the tiger, leopard and dhole was found to be driven by the size of livestock species, dependency of local people on the forest, topography, proximity to the water body and forest boundary, precipitation, and forest cover. The probability of livestock depredation by tiger increased with a higher relative abundance of cow/buffalo, higher dependence of people on forests, greater proximity to water sources, shorter distance to forest boundaries, relatively higher elevations and villages located within the forest areas, particularly in core areas of PAs; Livestock depredation risk probability from leopard increased with relatively higher abundance of goat/sheep, domestic dog, higher dependence on the forest by households and an increase in topographical slope. The probability of livestock depredation by dhole increased with higher forest cover loss, increase in the relative abundance of goat/sheep, greater dependence on the forest by households, and relatively lower precipitation. The risk of predation from leopard and dhole exhibited high spatial overlap, and predation by leopards was higher than dhole and tiger. Livestock predation by leopard and dhole was frequent in open areas of Reserved Forest and buffer zones, while that from tiger occurred in densely forested core regions of PAs. Forty five percent (n=660) and ten percent (n=140) of households surveyed reported experiencing elephant and gaur conflict respectively. Of these, both elephant and gaur are largely involved in crop damage, followed by property damage, human injury/death. Unlike large carnivores, most of the conflict incidents by elephant and gaur peaked in the night, followed by morning, evening and afternoon. Using GLM, we found that the major variables that influenced elephant and gaur conflict with man were: percentage of crop cover, distance to the water source, the number of major crops grown, the number of minor crops grown, mean annual precipitation and mean slope. The probability of human-elephant conflict increased with increased crop cover, increase in distance to the water source, number of major and minor crops grown, while the conflict decreased with an increase in mean annual precipitation and mean slope. The risk of human-gaur conflict increased with lower percentage of crop cover, increase in distance to the water source, number of major crops grown, increase in mean annual precipitation and mean slope. We found that households inside Reserve Forests to report elephant conflict the

most, followed by PAs and Fringe Areas. The reported gaur conflict was more in Fringe Areas, followed by Reserved Forest and PAs. We identified ca. 175 km^2, 420km^2, 430km^2, 8900 km^2, 625 km^2 of the total sampled area, prone to tiger, leopard, dhole, elephant and gaur conflict with man, respectively.

Semi-structured questionnaire survey was conducted to address the third objective with the Forest Range Officers (FROs) of all sixteen FDs between November 2018 and March 2020 across the WEGPTN to investigate the human-wildlife interactions, employed mitigation measures and their effectiveness, poaching incidents, and availability of manpower and resources. Our study highlighted the disparity in resource allocation among PAs and outside PAs though the intensity of conservation issues was similar. Over 50% of the FROs reported an increase in human-wildlife conflict incidents during the past five years. Major species involved in the conflict in PAs and outside PAs were elephant, wild pig (***Sus scrofa***), leopard, bonnet macaque (***Macaca radiata***), followed by sloth bear (***Melursus ursinus***), sambar (***Rusa unicolor***) (more in PAs), gaur (more in outside PAs), dhole, chital (***Axis axis***), and tiger. There were no variations in the mitigation measures employed in PAs and outside PAs. The endangered species, namely tiger (only in PAs), leopard, elephant, and pangolin (***Manis crassicaudata***) were amongst the fourteen wildlife species poached in the PAs and outside PAs, although wild pig, sambar, black-naped hare (***Lepus nigricollis***), and chital dominated the list. Prevalent methods for poaching were snares, trained dogs, guns (dominant in PAs), followed by hand-made bombs, poisoning, cage traps, electric traps (only outside PAs), and food baits. Fund availability, anti-poaching camps and anti-poaching watchers were insufficient in outside PAs. Over 50% of the FROs reported a decrease in poaching incidences in the past five years with improved wildlife management strategies.

Based on the information gathered, we chose nine high-conflict zones, covering PAs and outside PAs across the WEGPTN (MTR, STR, CNWLS, Gudalur FD, Nilgiris FD, Coimbatore FD, Erode FD, Dharmapuri FD and Hosur FD) and conducted ecological sign survey and vegetation survey between May 2019 and March 2021 to ascertain the occupancy of large mammals and quantify degree of human disturbances inside the forests. Considering the average home range size of the dominant large mammal species, 10x10 km sampling grids were laid across the entire study area. We used a systematic grid-based Markovian model occupancy framework to identify the impact of ecological and anthropogenic variables (prey abundance, habitat features, direct human disturbance and habitat patchiness) on large mammal occupancy at a 100km^2 scale. We found that tiger and dhole occupancy was driven by the

abundance of large and medium-sized prey. However, leopards also relied on the available small prey species and utilised perforated forest patches. Broadly, large mammal occupancy was more in the contiguous forests with ample water sources and decreased in habitats with increased human disturbances and habitat patchiness. We found that tiger occupancy was highly confined to the contiguous forests of PAs while the rest of the large mammal species had scattered but concentrated occupancy in PAs. The substantial proportion of large mammals inhabiting outside PAs demands strong efforts for habitat restoration and minimizing further habitat degradation, which can also reduce the risk of HLMC.

HLMC are inevitable when natural landscapes undergo modifications. Bringing down the HLMC incidents to a tolerable limit through effective mitigation measures appears to be a viable solution to ensure harmonious existence of people and wildlife in a forest ecosystem. Findings underscore the importance of identifying priority conflict hotspots, ecological and anthropogenic determinants of HLMC and large mammal occupancy, and the effectiveness of employed conflict mitigation measures. Our hotspot maps provide a powerful visual tool to understand patterns of HLMC at the landscape level by the stakeholders. The identified HLMC zones regardless of PAs/outside PAs should be provided with sufficient resources to mitigate conflict. Improved livestock husbandry practices, constructing predator-proof enclosures, and using shock-collars in high livestock depredation areas can be effective in decreasing the frequency of human-large carnivore conflict. Changing the cropping patterns, using a combination of elephant proof trench and electric fence, using early warning systems through mobile technology and drones in the high conflict areas can reduce elephant and gaur conflict with humans. Providing timely compensation to the affected household is also an important mitigation measure to reduce the negative attitude of local communities. The study emphasizes the need for forest habitat restoration by abating biotic pressure within the forest boundary, thereby enhancing prey abundance, availability of water resources, improved habitat connectivity to increase large mammal occupancy within the forests, reduce HLMC and promote coexistence.