frontiers in Ecology and Evolution

ORIGINAL RESEARCH
published: 03 July 2020
doi: 10.3389/fevo.2020.00198

Wild Seve: A Novel Conservation Intervention to Monitor and Address Human-Wildlife Conflict

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Human-wildlife interactions resulting in conflict remains a global conservation challenge, requiring innovative solutions to ensure the persistence of wildlife amidst people. Wild Seve was established in July 2015 as a conservation intervention program to assist people affected by conflict to file and monitor claims and receive ex-gratia payments from the Indian government. In 48 months of operation, Wild Seve filed and tracked 13,808 claims on behalf of those affected from 19 forest ranges around the Bandipur and Nagarahole National Parks in Karnataka, India. This included 10,082 incidents of crop loss, 1,176 property damage incidents, and 1,720 incidents where crop and property loss occurred together. Wild Seve also filed claims for 782 livestock predation incidents, and assisted in 45 human injury incidents and three human fatalities. Elephant related losses comprised 93.9%, and big cat losses comprised 5.5% of reported cases. Wild Seve provides an immediate response to human-wildlife conflict incidents and improves access to ex-gratia payment schemes. Wild Seve is a low cost intervention that uses open-source technology and leverages existing policies to facilitate ex-gratia payments. The Wild Seve model of monitoring and addressing human-wildlife conflict is adaptable and scalable to high conflict regions globally, to the benefit of people and wildlife.

Keywords: compensation, conservation, human-wildlife conflict, human-wildlife interactions, India, intervention, wildlife, Wild Seve

OPEN ACCESS

Edited by:
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Reviewed by:
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Specialty section:
This article was submitted to Conservation, a section of the journal Frontiers in Ecology and Evolution

Received: *28 January 2020*
Accepted: *02 June 2020*
Published: *03 July 2020*

Citation:
Karanth KK and Vanamamalai A (2020) Wild Seve: A Novel Conservation Intervention to Monitor and Address Human-Wildlife Conflict. Front. Ecol. Evol. 8:198. doi: 10.3389/fevo.2020.00198

INTRODUCTION

Effective conservation efforts have resulted in rebounding wildlife populations in India's fragmented network of protected areas (Nayak et al., 2020). Such localized increases, along with changes in land and habitat use, rapid development, and growing human populations have been associated with increased reporting and severity of human-wildlife interactions (DeFries et al., 2010; Sodhi et al., 2010; Chartier et al., 2011; Karanth and Kudalkar, 2017). Human-wildlife conflict (HWC) incidents resulting in losses to people or wildlife pose a major conservation challenge (Treves et al., 2006; Madden and McQuinn, 2014). While numerous species are responsible for such incidents, reported cases are largely associated with charismatic megafauna such as elephants (*Elephas maximus*), tigers (*Panthera tigris*), and leopards (*Panthera pardus*) (Anand and Radhakrishna, 2017). Affected families may become antagonistic and retaliate by injuring or killing "problem" animals, adversely affecting conservation efforts (Choudhury, 2004; Lingaraju and Venkataramana, 2014; Manral et al., 2016; Kalam et al., 2018).

Providing ex-gratia payments or financial assistance to those affected, and its effectiveness in the mitigation of conflict has been widely debated (Nyhus et al., 2003; Bulte and Rondeau, 2005;

Wunder, 2013). However, in India, ex-gratia payments or financial compensation for incidents of HWC is a major policy backed by central and state government mandates, with a majority of states implementing such policies (Karanth et al., 2018). In a single year (2012–2013), Indian states reported 78,656 cases of conflict and paid US $5,332,762 as ex-gratia payments (US $1 = IN ₹66.91). The majority of these incidents were crop loss and property damage cases (73.4%), and livestock predation (20%). Cases of human injury (6.2%) and fatality (0.4%) were also reported during this period (Karanth et al., 2018). This study noted that these numbers significantly underestimate the situation as many states did not provide or keep adequate records of HWC incidents. States also had varied ex-gratia payment policies and procedures which affected the number of cases filed (Karanth et al., 2018). Studies also note that the effectiveness of ex-gratia payment schemes in the country is often hindered by inconsistent policies, delays in the application process, lack of transparency, high transaction costs, ineffective implementation and variable payment amounts (Barua et al., 2013; Karanth, 2016; Manral et al., 2016; Johnson et al., 2018).

Developing innovative, adaptable and scalable solutions which help mitigate the effects of HWC, and improve management, especially for endangered conflict-prone species such as elephants, tigers, leopards, etc., is essential. Direct, technology-based conservation interventions are appealing as they can transcend the prevailing culture, socio-economic and political systems and context within which HWC occurs (Maffey et al., 2015).

The Wild Seve program ("Seve" means to serve in the regional language Kannada) was launched as a conservation intervention in July 2015. Designed to improve conflict reporting, response, and ex-gratia payment processing in India within the established policy framework, the program's objectives included (1) establishing a mobile-based reporting and response system in high-conflict villages and settlements around national parks, (2) increasing accessibility to ex-gratia payment programs, (3) evaluating incidents of human-wildlife conflict reported to the program, and (4) improving outcomes for long-term conservation monitoring of high conflict species and locations. This manuscript highlights program implementation, methodology, and insights and results from 48 months of operation.

MATERIALS AND METHODS

Program Implementation Area

The Wild Seve program was initiated in villages and settlements surrounding Bandipur and Nagarahole National Parks in Karnataka, India. Located in the Western Ghats biodiversity hotspot (Myers et al., 2000), these reserves support globally important populations of tigers, leopards, elephants, and other conflict-prone species both within protected areas and outside them (Karanth et al., 2004; Karanth, 2016). The core area of Nagarahole and Bandipur cover 643.35 km^2 (562.41 km^2 buffer), and 872.24 km^2 (584.06 km^2 buffer), respectively (ENVIS, 2020). They are predominantly composed of tropical moist and dry deciduous forests, and receive 625–1500 mm of rainfall annually (Karanth and Kudalkar, 2017). Elephant densities within the protected areas have been estimated at around two individuals/km^2 (Baskaran et al., 2011; Thuppil and Coss, 2012; Jathanna et al., 2015). Densely populated human settlements and agricultural fields surround these reserves, and farmlands are often irrigated and cultivate up to three crops in a year (Karanth et al., 2018). Six sub-districts (taluks) adjacent to the reserves have 1,229 villages, with population densities between 140 and 346 people/km^2 (Census of India, 2011). Over 80% of households in the program implementation area are categorized as rural, with at least 80.9% of this population earning less than US $1,600 annually (see **Table 1**). Scheduled Castes and Scheduled Tribes comprise, on average, 37% of the rural population (range 26–52%; Census of India, 2011). Livestock density (excluding dogs and elephants) in the sub-districts ranged between 89 and 173 livestock/km^2, and poultry density (including poultry farms and hatcheries) ranged between 27 and 520 poultry/km^2 (Livestock Census, 2012).

Between 2010 and 2014, the state of Karnataka provided ex-gratia compensation for 141,234 (annual $\bar{x}$ = 28,246.8, σ = 7,339.11) incidents of HWC across all categories (Karanth et al., 2018). Annual reports of the Karnataka Forest Department between 2014 and 2019 identified over 19,840 (annual $\bar{x}$ = 4,961) reported and compensated HWC incidents in administrative divisions covering the Wild Seve implementation area (see **Supplementary Table 1**). Karanth et al. (2013) had identified locations in this area with higher conflict risk. Among households surveyed in the program implementation area, 58–73% experienced crop loss, and 15–19% experienced livestock predation (Karanth et al., 2013). However, only 66–71% of affected households had reported such losses to the government (Karanth et al., 2013). Surveyed households kept, on average, 3–4 livestock (range 0–40), and faced an average livestock loss of US $43–$211 (range $15–$15,151, US $1 = IN ₹66; Karanth and Kudalkar, 2017). Households in this landscape endured, on average, crop loss between US $328 and $334 (range $15–$10,606; Karanth and Kudalkar, 2017).

Establishing Wild Seve

Wild Seve was launched with the primary objective of improving reporting, response, and access to ex-gratia payments in cases of HWC in 19 forest ranges adjacent to Bandipur and Nagarahole (**Figure 1**). The program was designed to respond to calls made to a toll-free telephone line, collect details on the HWC incident, and file an ex-gratia compensation claim on behalf of those affected. Documentation and information required was sourced by program staff, and each claim was filed with the respective Range Office of the State Forest Department (see **Supplementary Figure 1**).

Wild Seve initially targeted 315 high conflict villages within 10 km of the national park boundaries (Karanth et al., 2013). The program established and publicized a toll-free number linked to an online portal with a play-back recording (in the local language Kannada) prompting callers to provide the location and details about each conflict incident they encountered. Wild Seve staff conducted an outreach campaign distributing > 30,000

TABLE 1 | Socio-economic information, as a percentage of rural households (unless specified) in the program implementation area surrounding the Nagarahole and Bandipur National Parks.

Sl. No.	Attribute	Sub-districts (taluks) in Mysore district				Sub-districts (taluks) in Chamarajanagar district		Source
		HD Kote (%)	Hunsur (%)	Nanjangud (%)	Piriyapatna (%)	Chamarajanagar (%)	Gundlupet (%)	
1	Literacy rate (percentage of total rural population)	55.63	56.92	53.22	62.8	50.86	52.16	Census of India, 2011
2	Rural households (percentage of total households)	91.00	82.91	88.12	93.19	80.86	89.19	SECC, 2011
3	Source of household income:							
	(a) Cultivation	45.41	58.06	39.28	60.35	28.56	52.51	
	(b) Manual Casual Labour	45.91	36.49	48.53	32.75	61.50	35.40	
	(c) Other	8.68	5.45	12.19	6.90	9.94	12.09	
4	Annual income of highest earning member:							
	(a) Under US $800	57.87	52.00	71.79	48.54	76.71	75.11	
	(b) Between US $800–$1600	30.98	32.26	23.19	32.31	19.73	20.52	
	(c) Over US $1600	11.15	15.74	5.02	19.15	3.56	4.37	
5	Land-owning households	47.68	57.59	53.31	60.81	46.57	59.27	
6	Land details (% of total land)							
	(a) Un-irrigated land	70.76	62.40	67.87	65.17	72.48	58.26	
	(b) Assured irrigation for two crops	13.48	20.87	11.45	20.08	16.87	26.32	
	(c) Other irrigated land	15.76	16.73	20.68	14.75	10.65	15.42	

pamphlets and held direct meetings with village representatives, community leaders, and local governmental authorities. Publicity efforts were repeated periodically, and coverage of the program expanded to over 600 villages and settlements by June 2019.

Staff Recruitment and Training

Initially, a staff of six field assistants and one field coordinator were recruited from villages adjacent to the parks and trained in incident documentation and data collection. The team grew to a total of 10 members in the field as the coverage of the program expanded. Field assistants were assigned an area of operation covering multiple villages and forest ranges surrounding their domicile. They were trained to collect information about each conflict incident using a basic camera and GPS unit, and prepare ex-gratia claims in a format required by the forest range in which the incident occurred. The field coordinator was responsible for handling field-based finances and expenditures, daily data aggregation from the field assistants, and for maintaining daily logs on the cases covered, claims filed, and acknowledgments of submitted claims. Training sessions for the staff were conducted periodically for updates on data collection and management practices, stakeholder interactions, and short-term program targets.

Data Collection and Management

For the first 2 years, the program kept written (and later digitized) records of all cases, spatial data, and images collected from the field. All personal and sensitive applicant data required for filing of compensation claims were not stored by the program, but were sourced independently for each filed claim. In July 2017, the data collection system was upgraded to the Open Data Kit (ODK) platform, which allowed field assistants to collect data through inexpensive smartphones without cellular network requirements (Hartung et al., 2010). This model was tested for a period of 3 months (April–June 2017) to make necessary adjustments to the format of the data collection forms before implementation. Forms were bilingual (Kannada and English) and included pre-selected sets of questions based on the type and extent of HWC incident. Background information about the villagers required for the submission of a claim, as well as evolving lists of villages, settlements, crops etc., was updated on a monthly basis for quick access. Completed forms were uploaded to a cloud-based server when a cellular network was available, and was used by the field coordinator to prepare the ex-gratia claims submissions. Automated data management, analysis, and visualization tools were linked to the server for better program oversight.

Claims Processing and Submission

Recorded details of HWC incidents included information and location of the caller, the animal responsible, and the type and quantity of losses incurred. Each incident was photographed, and spatio-temporal data logged. The periphery of damaged crops were geo-traced to calculate the area of damage. When required, officers or staff from the local Forest Department were contacted to be present at the site. Ex-gratia compensation claims were then filed with the Karnataka State Forest Department in 19 wildlife ranges on behalf of the affected individuals, using the information and photographs collected from the field. Services incurring transactional costs (previously borne by the applicants), such as those of logistics, transport, supplies, and printing of documents were handled by the program.

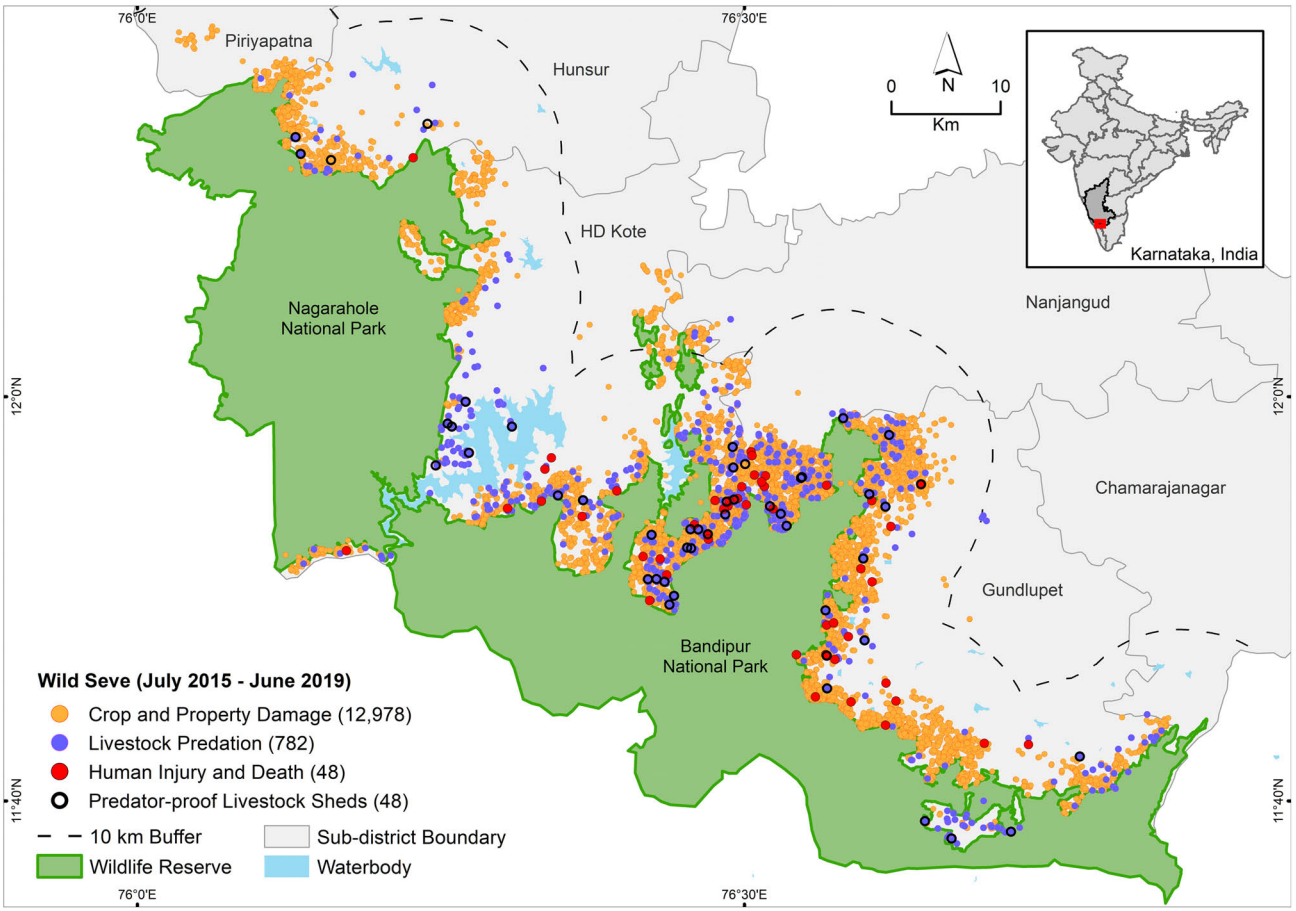

FIGURE 1 | Map of the Bandipur-Nagarahole region showing incidents of human-wildlife conflict registered by Wild Seve. Predator-proof livestock sheds (n = 48) were built around the landscape to serve as models of mitigation structures.

Estimates of the damaged area (in cases of crop loss) and ex-gratia payment amounts in the official claim were recorded by Forest Department staff assessing the incident. While Wild Seve did share its collected information with officials in the field, it could not verify what the recorded amounts were, as these field records and notes were kept private by the officials.

Respondents were issued a unique identifying number by the program to help track reports over time, as well as identify vulnerable households and villages with repeat conflict incidents. Reports of all ex-gratia payment claims from all forest ranges were obtained under the Right to Information Act (2005). The provided information from the State Forest Department was in the form of "OM Sheets" or records of ex-gratia disbursement by the authority. These records were periodically requested from every forest range the program was operational in. The program worked closely with governmental authorities (Department of Revenue, veterinarians from the Department of Animal Husbandry, Dairying and Fisheries, and local panchayats) to procure crop certificates, landholding documents and post-mortem records (for livestock predation cases). Forest Department officials and staff were consulted regularly to ensure that each ex-gratia payment claim was filed and processed successfully.

RESULTS

Human-Wildlife Conflict Incidents and Claims

Wild Seve logged over 18,000 calls on the toll-free helpline over 48 months (July 2015–June 2019). Calls to the program were first checked by field staff, and the filtering of spurious or unsubstantiated calls resulted in a total of 13,808 registered cases of HWC (**Figure 1**). Filtered calls often included those made by farmers to test the help-line after a publicity drive, or by accident. Incoherent or unintelligible recordings and calls were followed-up by field staff. Wild Seve could not address claims with negligible crop or property damage for lack of visible damage or documentation. Wild Seve did not register claims for incidents occurring within encroached land or forest boundaries, or lacking proper land-holding

documentation, as they were not covered by ex-gratia payment policies (Karanth et al., 2018).

Claims were submitted to the relevant forest range offices by Wild Seve field staff, with a single claim made per incident. However, if deemed necessary by the Forest Department officer or staff present, multiple claims were created for a single incident (n = 8). In 386 cases a completed application form was directly handed over to farmers for submission. Submitted claims were rejected outright by the Forest Department for lacking requisite documentation (five claims) or if no invoices from hospital treatments were provided (seven claims).

The proximity of these incidents ranged from beside the park boundary to 16.9 km from the reserves ($\bar{x}$ = 1,550 m, σ = 1,840; using ArcGIS 10.7) (ESRI, 2011). Wild Seve recorded 12,227 cases originating around Bandipur National Park (88.6%) and 1,581 (11.4%) cases around Nagarahole National Park (**Figure 2**). Registered claims belonged to 6,640 unique individuals or families residing in 357 village settlements. Most users of the service (63.4%) only registered a single incident of HWC. However, a large fraction (39.6%) of the program's cases were from individuals who registered between two and five incidents of HWC each (see **Supplementary Table 2**). A substantial portion (58.5%) of all incidents reported to the Wild Seve program were from 30 settlements, and 94.5% of all reported incidents were from three sub-districts (taluks) (**Figure 2** and **Supplementary Table 2**).

Incidents by Conflict Categories and Wildlife Species

Wild Seve registered 10,082 incidents of crop loss, 1,176 incidents of property damage, and 1,720 incidents where both crop and property loss occurred (**Figure 2**). Farmers reporting crop loss incidents had cultivated land parcels ranging from 0.13 to 9.6 acres ($\bar{x}$ = 2.78, σ = 1.29, n = 8,232). Of the 51 crops recorded, those most often damaged were finger millet (*Eleusine coracana*), tomato (*Solanum lycopersicum*), banana (*Musa* sp.), and horsegram (*Macrotyloma uniflorum*) (**Figure 3**). Multiple crops were often damaged in a single conflict incident.

Trees such as areca nut (*Areca catechu*), jackfruit (*Artocarpus heterophyllus*), coconut (*Cocos nucifera*), teak (*Tectona grandis*), and mango (*Mangifera indica*) were classified as "property" by officials in the field. However, policy documents for the state classify them under the crop lists. The most damaged property types were non-electrified fencing (barbed-wire, chain-link, etc.), coconut trees, and irrigation pipes (**Figure 3**).

The program registered 782 claims of livestock predation (5.7%). Most incidents related to the predation of bovids resulted in a single animal killed, however, multiple goats and sheep were often killed in a single event. This included 227 adult cows, 56 bullocks, 175 calves, and 9 buffaloes (**Figure 3**). Wild Seve recorded 570 cases involving leopards, and 149 cases where tigers were responsible for predation events (**Figure 2**).

Wild Seve responded to incidents where humans were injured or killed by wildlife. The program assisted in 45 incidents

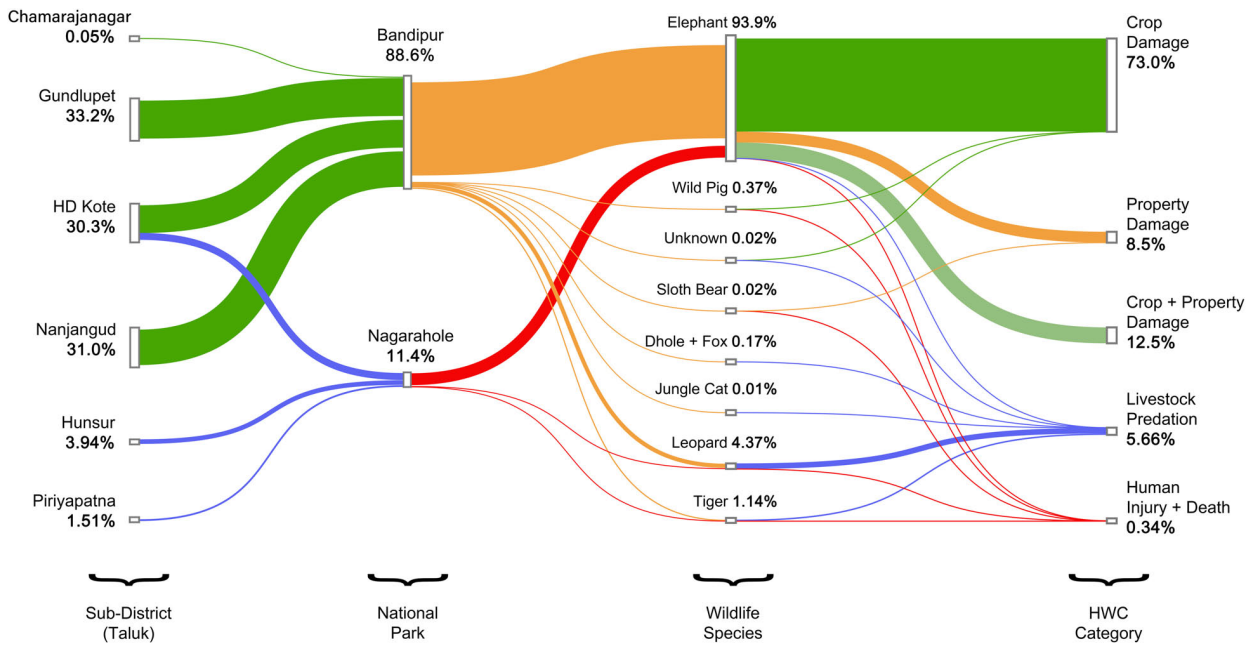

FIGURE 2 | Flow diagram depicting human-wildlife conflict (HWC) incidents as a percentage of the total cases (n = 13,808) registered by Wild Seve across administrative domains and HWC categories. The figure shows the percentage fraction across a domain at each node, with the width of links indicating the flow between administrative divisions (sub-districts), forest divisions (national parks and forest ranges), wildlife species, and HWC categories.

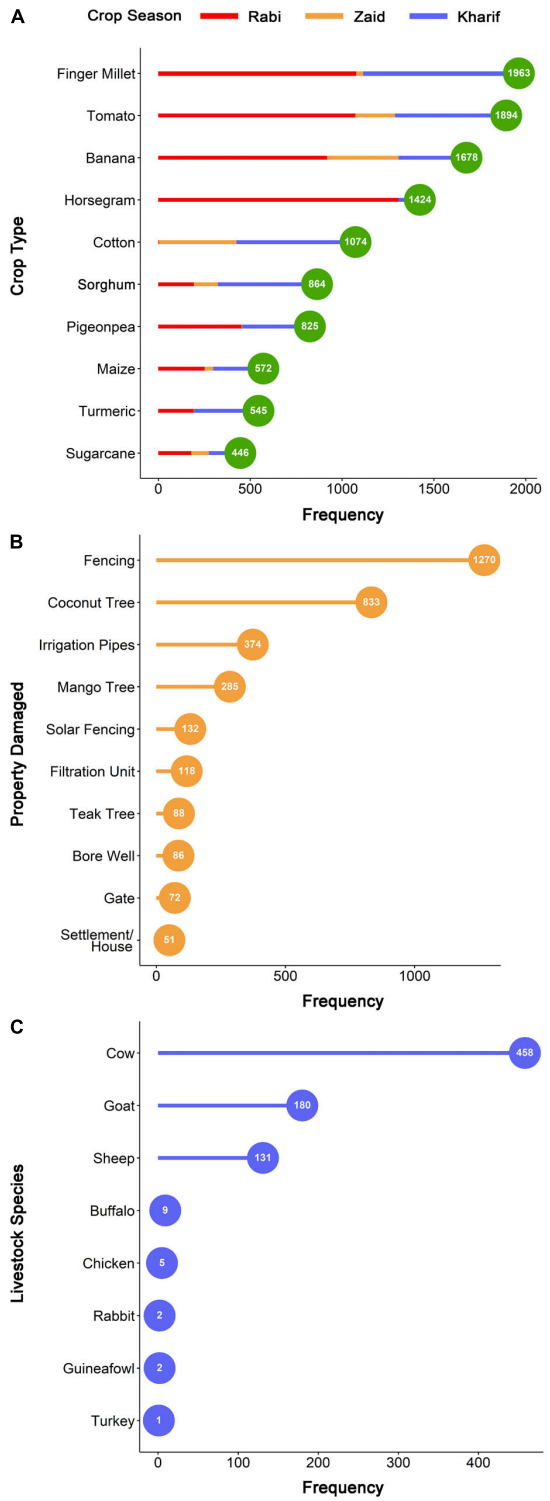

FIGURE 3 | (A) Top 10 crops (by frequency of reporting) damaged in human-wildlife conflict incidents. The cropping seasons of Rabi (Nov–Mar), Zaid (Apr–Jun), and Kharif (Jul–Oct) in which the incidents were reported have been indicated as percentages of the total number of incidents. **(B)** Top 10 property types damaged in reported human-wildlife conflict incidents. **(C)** The number of livestock killed by predators recorded by the Wild Seve program. Cows include adult cows, bullocks, and calves.

of human injury caused by wildlife, the majority of which were caused by encounters with wild pigs (n = 32) and elephants (n = 8) (**Figure 2**). The program also recorded two injuries each caused by leopards and sloth bears, and a single incident of a tiger causing injury (**Figure 2**). Injuries were largely limited to a single limb, such as an arm or leg, or in a few cases, on the chest, stomach or upper thigh. First aid and immediate treatments were generally provided free of cost by the local governmental hospitals. In five incidents, the program recorded that bills of the treatment were not provided, likely invalidating any filed ex-gratia payment claims as ex-gratia policies require invoices to be filed. However, these claims were still submitted by the program to the authorities. Local authorities and officers from the State Forest Department were present at the three incidents of human death reported to the program. The officials administered the claims filing process in accordance with State ex-gratia payment policies.

Elephants were responsible for the majority of all crop and property-related damage, with only 19 incidents of crop loss attributed to wild pigs (*Sus scrofa*), and 1 case of property damage by a sloth bear (*Melursus ursinus*). Incidents caused by elephants showed a seasonal trend, with the number of incidents increasing sharply in September-October, peaking between November-December, and subsiding by January of each year (**Figure 4**).

Ex-gratia Payment

Wild Seve matched ex-gratia payment records, known as "OM Sheets," provided by the Karnataka State Forest Department to the database of claims filed. These records lacked information on the date of the incident, and only provided the name of the recipient, land survey number, amount received, and the type of crop, livestock, or property damaged. The program was often unable to match cases individually and found that ex-gratia payments listed in the records were often clubbed with other claims by the same individual. It was also found that the ex-gratia payments listed were often only in partial fulfillment of a claim.

The program was able to match 3,819 cases to Wild Seve reported incidents, amounting to $157,474 in ex-gratia payments (**Figure 5**). On average, crop loss cases received $37.9 ($n$ = 2,839, σ = 27.04), property damage cases received $35.9 ($n$ = 323, σ = 30.5), and crop and property damage cases received $44.3 ($n$ = 413, σ = 27.5) in ex-gratia payment. Livestock predation cases were compensated at an average of $81.9 ($n$ = 241, σ = 37.4), and human injury cases at $129.5 ($n$ = 3, σ = 46.8). Conversion from INR to USD based on the average yearly exchange rate of ex-gratia payment release (Internal Revenue Service, 2020).

Strategic Interventions

Wild Seve tracked families facing repeat incidents of livestock predation, with the majority of such households utilizing improper or ineffective livestock shelters. The program helped facilitate the construction of predator-proof livestock sheds for 48 such households, with a third of the financial support provided by the program, and funds from the

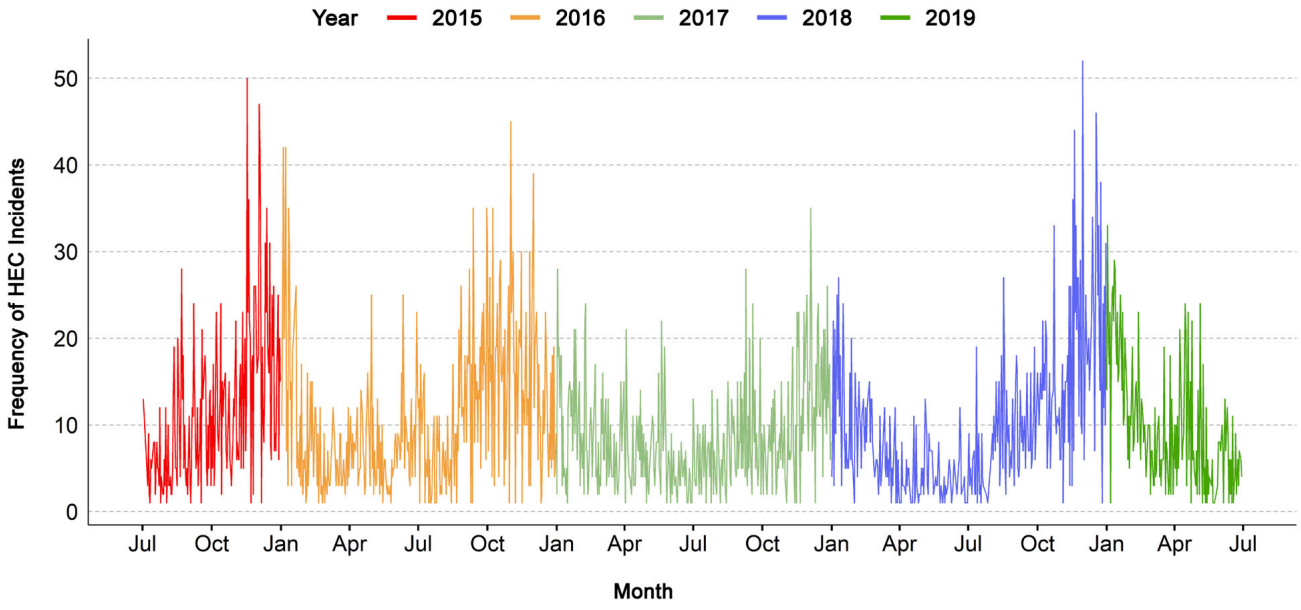

FIGURE 4 | Frequency of human-elephant conflict incidents registered by the Wild Seve program between July 2015 and June 2019.

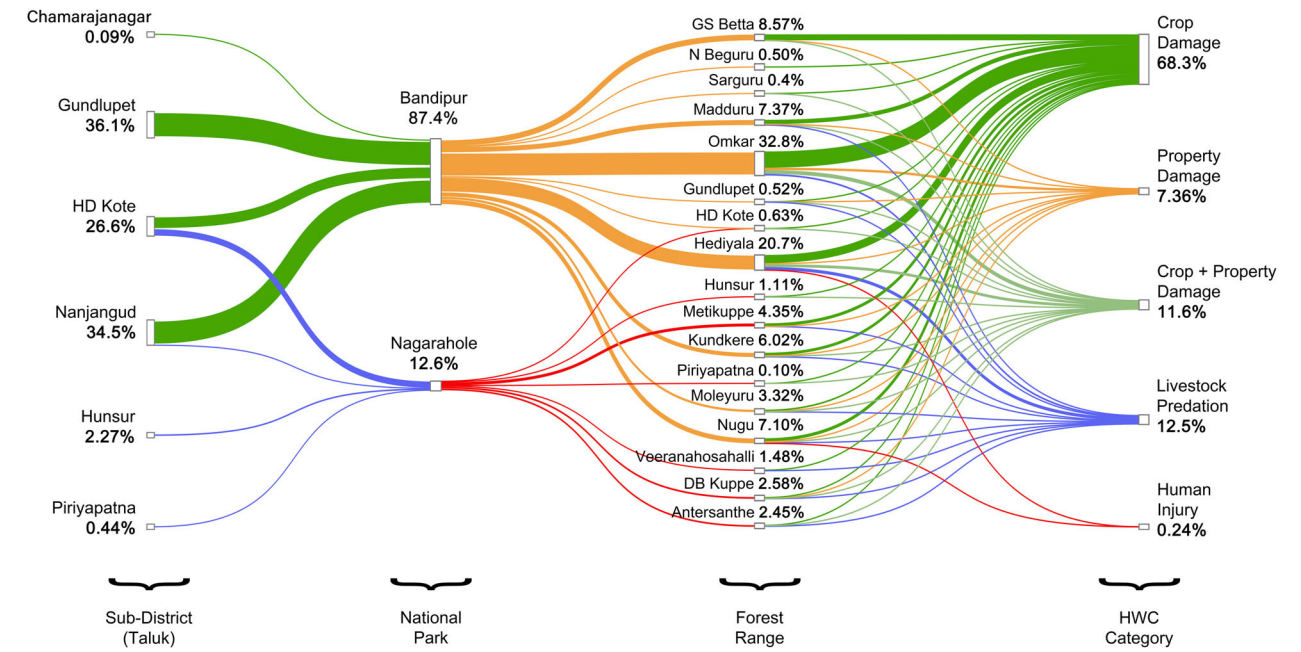

FIGURE 5 | Flow diagram depicting the percentage of total ex-gratia payment (US $157,474) matched from state government provided "OM Sheet" copies to Wild Seve cases across administrative domains and HWC categories.

landowners and government-sponsored schemes for the rest. Sheds generally measured 10 by 12 feet and were constructed of bricks or cinder blocks at an average cost of US $416 ($\sigma$ = $92, ranging between $246 and $645) to the program. These sheds were periodically monitored, and no new incidents of livestock predation were found to have occurred after construction.

DISCUSSION

Wild Seve was designed to augment, not supplant, existing measures, and policy by providing a simple, adaptable, and accessible method of registering incidents of HWC. Wild Seve eliminated transaction costs associated with filing a claim, ensured transparency in the process and enabled

direct participation by those people generally excluded to obtain ex-gratia payments for damage caused by wildlife. By standardizing the quality and process of HWC incident documentation, paperwork, and photographs, Wild Seve reduces the likelihood of claim rejection, and provides a simplified process for registering HWC ex-gratia claims.

Over 48 months, Wild Seve recorded and filed ex-gratia payment claims for over 13,800 cases of HWC. Previous studies identified low intensity and high-frequency conflict species such as wild pigs as responsible as elephants for conflict incidents in the region (Karanth et al., 2013). Reporting of wild pig and other ungulate incidents to such ex-gratia or compensation programs may be lower due to difficulty in species identification or documenting losses. The bias in compensating only for megafauna related damage needs to be addressed adequately through changes in policy and law, with clearer definitions of the term "wildlife" under which ex-gratia claims can be processed (Anand and Radhakrishna, 2017; Karanth et al., 2018). The absence of an explicit association between policies and law often leads to the arbitrary and *ad-hoc* implementation of ex-gratia compensation policies on-ground, and could have detrimental effects on conservation objectives. There is a requirement for clearly defined policies that establish standardized procedures (Reddy et al., 2020). This includes requirements of incident documentation with easily accessible and simplified forms, concise procedural processes for acceptance or rejection of claims, and limited time-frames for filing, processing, and releasing ex-gratia payments (Reddy et al., 2020).

Understanding HWC and its drivers are important for the proper management of wildlife populations. This is particularly important in India, where large and wide-ranging megafauna co-occur amidst high densities of people. Studies have shown that the utilization of landscapes by megafauna often transcends the boundaries of reserves, spanning across dense human and agricultural dominated landscapes (Athreya et al., 2013; Pozo et al., 2018). Human-elephant conflict incidents registered by Wild Seve indicate frequent but seasonal use of landscapes surrounding Bandipur and Nagarahole National Parks (**Figure 4**). Elephants are known to utilize large swaths of land outside designated protected areas (Madhusudan et al., 2015). Factors which have may influence the observed seasonal distribution and movement of elephants in this landscape include social structures within herds (Nandini et al., 2017), vegetation and habitat characteristics of the protected areas (Lakshminarayanan et al., 2016), anthropogenic factors outside protected areas (Jathanna et al., 2015), deforestation (Puyravaud et al., 2019), as well as harvesting seasons of crops in the surrounding landscapes (Bal et al., 2011; Thuppil and Coss, 2012; Lingaraju and Venkataramana, 2014). Large-scale mitigation strategies employed around Bandipur and Nagarahole National Parks, such as railway-line and electrified fencing (Saklani et al., 2018) may be unsuccessful or further exacerbate the issue in other locations. Therefore, a thorough understanding of both the drivers and predictive seasonal occupancy of elephants in and around these protected areas is required before investments into financially intensive mitigation projects can be deemed scientific (Goswami and Vasudev, 2017). Similarly, the co-occurrence of large predators in human-dominated landscapes also provides opportunities for prediction of conflict incidents and the targeted implementation of mitigation strategies such as livestock sheds (Athreya et al., 2015).

Although financial reparations to manage or mitigate HWC may seem inadequate in serious cases, they provide immediate relief and offer a reasonable compromise for people coping from direct and chronic losses from wildlife. Compensation or ex-gratia payment for losses incurred through HWC is a globally accepted strategy (Ravenelle and Nyhus, 2017). However, the success of such schemes often hinged on the ease of accessibility, source and quick reimbursement of funds (Nyhus et al., 2005). Lack of awareness of compensation or ex-gratia schemes, as well as their inability to consistently deliver, could add to people's mistrust of governmental authority (Dickman et al., 2011; Barua et al., 2013; Karanth and Ranganathan, 2018). This continues to be a hurdle in the current Indian scenario, given the lack of awareness, illiteracy, and the often inconsistent and opaque bureaucratic processes in rural communities (**Table 1**; Ogra and Badola, 2008; Johnson et al., 2018; Karanth et al., 2018).

To provide effective services to an audience unversed in filing claims, the program utilized smartphone applications to optimize data collection, an increasingly popular strategy in conservation interventions (Graham et al., 2012; Maffey et al., 2015; Lewis et al., 2016). The switch from paper-based to mobile data collection was highly beneficial in handling the volume of cases and ensuring accuracy. The ODK platform allowed Wild Seve to customize the default form questions and input for each incident type and location, in multiple languages, thereby reducing staff effort and time in the field. Over 78% (range 74–81%) of the rural population in Wild Seve's area of operation had access to or owned a mobile phone (SECC, 2011). While the program's mobile application is currently only filled by field staff, the increasing prevalence and utilization of smartphones in the region invites the possibility of providing such services on mobile platforms available directly to the public.

The development and maintenance of a toll-free web portal, smartphone application, and data storage can be achieved in an inexpensive manner by utilizing open-source software and other resources. Conservation intervention models where field teams are composed of trained community volunteers have been shown to be successful in dealing with local conservation issues (Danielsen et al., 2010). The Wild Seve model is flexible, and can be adapted to fit within existing policy frameworks in different geographic regions. Such programs can also help conservationists and managers better understand policy implementation on-ground, identify gaps in existing legislation, and provide meaningful inputs for its improvement (Reddy et al., 2020). Utilizing low-cost and easily accessible technology and training local teams also helps communities to build capacity in monitoring and managing human-wildlife conflict incidents (Maffey et al., 2015).

Wild Seve found that the requirements for filing a claim and the procedures followed by the government in estimating damage were not standard across forest ranges, and were often subject to changes (Karanth et al., 2018). Procedures to follow in situations involving sub-leased land, properties without documentation,

or livestock predation inside protected areas were also unclear (Margulies and Karanth, 2018). For example, only certain forest ranges required documentation of the burial or cremation of livestock carcasses. While generally accepted as a precaution against poison baiting, this practice deprives both the family of the use of the meat and the predator of food. Wild Seve staff also noted that the area of crop loss in most instances was usually visually estimated and unverified. While the program recorded damage with better accuracy, the separation between the filing of cases by Wild Seve and the processing of claims by the Forest Department meant that these estimates were generally not considered in ex-gratia payment calculations.

Wild Seve was unable to track each claims' progress through the system as the processing and transfer of funds remained solely controlled by the local government. Claims were often combined with others made by the same applicant or provided for a single element in an incident involving more than one damaged crop or property. Ex-gratia payments were often delayed in processing, and applicants were not provided with a method to track the claims. Applicants found that they were provided with no justification on the ex-gratia payment amount or a logical process for appeal. The program field staff also noted that individuals were often unwilling to elicit more information for fear of being rejected by the bureaucracy in future claims. The delay in benefits was observed to reduce trust and confidence in such schemes and led to questions about the efficacy of its administration (Karanth and Vanamamalai, personal observations). Although State policies such as the Karnataka Guarantee of Services Act (KGSCA, 2011) provide for claim tracking and grievance redressal, the program found that ground staff were either unaware of the policy or unwilling to file a claim through the portal (Reddy et al., 2020). Wild Seve was able to improve access to ex-gratia payment but could not assess if people's tolerance toward wildlife improved. Retaliation (through electrocution and poisoning) continued to occur, triggered by human death or livestock predation, especially in regions of high HWC frequency and intensity.

Management strategies have to ensure that the recovery of wildlife populations is unimpeded by people and infrastructure (Nayak et al., 2020). The success of these strategies often relies on the attitudes and perceptions of communities that face HWC (Karanth et al., 2013). Societal factors, including the interplay between various stakeholders, government agencies, and the local communities, often play an important role in HWC response (Dickman, 2010; Margulies and Karanth, 2018). Attitudes toward wildlife and reporting of HWC incidents have also been shown to rely on the gender, ethnic, religious, and cultural background of the communities (Ogra, 2009). Conservation interventions, such as Wild Seve whose staff live and work in these communities, could benefit from a deeper socio-economic and demographic analysis of the landscape they are deployed in to ensure that they remain accessible to all members of the community.

Wild Seve identified that existing policies, which include specific payments amounts for losses incurred, were not exhaustive (Karanth et al., 2018; Reddy et al., 2020). Without mandating periodic updates to policies, this could lead to the exclusion of ex-gratia payments for damages outside the prescribed crop, property and livestock lists and influence livelihood strategies in the landscape. Ex-gratia payment amounts should be constantly regulated to keep up with fluctuations in the market prices (Karanth et al., 2018). Policies need to address shifting practices in agriculture and livestock rearing and evaluate ex-gratia payment amounts and mitigation strategies accordingly. For example, Margulies and Karanth (2018) note that the shift toward stall-fed, high-milk yielding "hybrid" cattle breeds from traditional forest-grazed "scrub" cattle in the Bandipur landscape might reduce opportunities for human-wildlife interactions, but the loss of the more expensive "hybrid" cattle in cases of predation was not offset by a corresponding increase in ex-gratia compensation amount. Therefore, poorer communities were unable to make such a transition, and continue to rear "scrub" cattle and often illegally graze inside protected areas. Wild Seve tried to address this issue by facilitating the construction of predator-proof livestock sheds. While these sheds ensure no repeated predation and were designed to act as models for the community, the program noted that the limiting factor for their widespread adoption was often monetary. To be effective as a mitigation strategy, this would require greater subsidies from government agencies or other actors in the landscape.

Collection of fuel-wood, forest products, cattle-grazing, etc., continues to expedite forest degradation in the region (Davidar et al., 2010), and may increase the frequency of human-wildlife interactions. The infeasibility and impracticality of creating permanent barriers in the landscape, and restricting the movement of wildlife or people and livestock necessitate the innovation and implementation of large scale conflict response and management systems. The high number of reported HWC incidents from a small number of villages could be due to a variety of overlapping factors (see **Supplementary Table 2**). These villages might be experiencing greater frequency of incidents, or have a greater willingness to report and engage with governmental agencies. While the program's publicity efforts were consistent across the landscape, local perceptions of the program and program staff could also have an influence on HWC reporting. Targeted efforts in park management and the development of conservation interventions, mitigation strategies, and community outreach around human-wildlife interactions and conflict could lead to meaningful conservation outcomes. Additional research into effective mitigation strategies, in conjunction with training, awareness, and education programs is also required to reduce retaliation. Interactions between people and wildlife are likely to continue, and the management of expectations from such interactions by programs such as Wild Seve are important to ensure coexistence and the persistence of wildlife in the region.

DATA AVAILABILITY STATEMENT

The datasets generated by the Wild Seve program and those used in this article will not be publicly available as it includes high-resolution spatial information on endangered taxa such

as tigers, leopards, and elephants and sensitive location information of villages and households affected. Requests to access the dataset can be directed to the corresponding author.

AUTHOR CONTRIBUTIONS

KK: conceptualization, methodology, resources, writing – original draft, supervision, project administration, funding acquisition, and validation. AV: methodology, software, formal analysis, data curation, writing – original draft, supervision, project administration, validation, and visualization. Both authors contributed to manuscript revision, read and approved the submitted version.

FUNDING

The Centre for Wildlife Studies and Wild Seve was grateful for the support and funding provided by Oracle, National Geographic Society, Rufford Foundation, Prince Bernhard Nature Fund, Van Tienhoven Foundation, U.S. Fish and Wildlife Service (US FWS-F19AP00354), individual donors, and Rolex (Rolex Awards for Enterprise, 2019).

ACKNOWLEDGMENTS

The program is thankful for the guidance of Dr. K. Ullas Karanth, Muthanna P. M., Nikhil Velpanur, Vinay Kumar, Raghuram R., and the hard work and dedication of the Wild Seve team, namely Biddappa P. A., Chikkaningaiah K., Dhee, Ganesh, Ghanashyam Iyer, Gopalraju, Hemanth, Krithika Sampath, Madegowda, Mahadevswamy, Mahesh, Manjunatha, Mohana H. B., Nagachandan H., Pradeep, Raju, Ravi, Santhosh Kumar, Shankar, Somesh G. M., and Vishwanath C. D.

SUPPLEMENTARY MATERIAL

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fevo.2020.00198/full#supplementary-material

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Conflict of Interest: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.