INTL J BONOROWO WETLANDS
Volume 15, Number 2, December 2025
Pages: 61-70

P-ISSN: 2775-8052
E-ISSN: 2775-8044
DOI: 10.13057/bonorowo/w150201

Wildlife encroachment and local coping strategies in Kampung Laut mangrove villages, Indonesia

ATIKAH KHOIRIYAH AZZAM[1], AULIA TSALATSA AGUSTINA[1], FIKRI ARKAN MAULANA[1], SYAHITA MARTHA DE WELA[1], MEI LAILASARI[2], SUGIYARTO[2], INOCENCIO E. BUOT JR.[3], AHMAD DWI SETYAWAN[1,3,♥]

[1]Department of Environmental Science, Faculty of Mathematics and Natural Sciences, Universitas Sebelas Maret. Jl. Ir. Sutami 36A Surakarta 57126, Central Java, Indonesia. Tel./fax.: +62-271-663375, ♥email: volatileoils@gmail.com
[2]Department of Biology, Faculty of Mathematics and Natural Sciences, Universitas Sebelas Maret. Jl. Ir. Sutami 36A Surakarta 57126, Central Java, Indonesia
[3]Institute of Biological Sciences, College of Arts and Sciences, University of the Philippines Los Banos. College, Laguna 4031, Philippines
[4]Biodiversity Research Group, Universitas Sebelas Maret. Jl. Ir. Sutami 36A Surakarta 57 126, Central Java, Indonesia

Manuscript received: 3 November 2024. Revision accepted: 4 July 2025.

Abstract. *Azzam AK, Agustina AT, Maulana FA, De Wela SM, Lailasari M, Sugiyarto, Buot Jr. IE, Setyawan AD. 2025. Wildlife encroachment and local coping strategies in Kampung Laut mangrove villages, Indonesia. Intl J Bonorowo Wetlands 15: 61-70.* Human-wildlife conflict (HWC) is an escalating concern in tropical coastal regions, where expanding settlements and agricultural activities increasingly overlap with wildlife habitats. This study examines the types, frequency, impacts, and community responses to wildlife disturbances in three mangrove-edge villages—Ujunggagak, Klaces, and Ujungalang—within Kampung Laut Sub-district, Cilacap, Indonesia. Using semi-structured interviews with 93 respondents, the research employed descriptive statistics and spatial comparisons to analyze patterns of conflict. Wild boars (*Sus scrofa*), rats (*Rattus* spp.), and monitor lizards (*Varanus salvator*) were identified as the most problematic species, frequently damaging crops and livestock and occasionally threatening human safety. Conflict intensity was highest in Klaces Village and peaked during the dry season. Local responses varied from passive tolerance and non-lethal deterrents to more aggressive measures, including poisoning and hunting. Response choices were influenced by gender, occupation, and prior experience. Although external support was limited, communities demonstrated adaptive strategies grounded in traditional knowledge. Nonetheless, the use of harmful methods such as indiscriminate poisoning remains a critical concern. These findings highlight the urgent need for community-based mitigation approaches that are ecologically sustainable and culturally appropriate. Strengthening local awareness, early warning systems, and participatory wildlife monitoring is essential to promote coexistence and biodiversity conservation in mangrove-dependent communities.

Keywords: Community response, human-wildlife conflict, mangrove village, *Sus scrofa*

INTRODUCTION

Human-wildlife conflict (HWC) is an increasing concern in regions where expanding human settlements intersect with wildlife habitats. Such interactions often lead to competition for space and resources, resulting in adverse impacts on both human livelihoods and wildlife populations (Dickman 2010; König et al. 2020). In coastal and mangrove ecosystems, these conflicts are further complicated by the ecological fragility of the environment and the socio-economic dependence of local communities on natural resources (Baral et al. 2021). Effective mitigation requires understanding not only species behavior and ecological stressors, but also the cultural and adaptive responses of affected communities (Hill 2021; Ferdin et al. 2024).

Mangrove ecosystems are globally recognized for their biodiversity and ecosystem services, including shoreline stabilization, carbon sequestration, and habitat provision for aquatic and terrestrial fauna (Hilmi et al. 2021; Osland et al. 2022). Indonesia holds one of the world's largest mangrove expanses—approximately 2.95 million hectares, or over 60% of Southeast Asia's total—making it a critical area for coastal biodiversity (Blanton et al. 2024). Among these, the Segara Anakan Lagoon in Cilacap District, Central Java, is ecologically significant for its dense stands of *Rhizophora apiculata*, *Avicennia marina*, *Sonneratia caseolaris*, and *Nypa fruticans*, which support a variety of wildlife including birds, reptiles, primates, and small mammals (Akbar et al. 2020; Kissinger et al. 2020).

However, mangrove degradation and increasing human encroachment have escalated HWC in recent years. In Kampung Laut Sub-district—comprising Ujungalang, Ujunggagak, and Klaces Villages—communities are experiencing growing disturbances from wildlife such as wild boars (*Sus scrofa*), monitor lizards (*Varanus salvator*), long-tailed macaques (*Macaca fascicularis*), and estuarine crocodiles (*Crocodylus porosus*) (Anrozi et al. 2019; Elisa et al. 2024). Rapid population growth, conversion of wetlands into farmland or housing, and sedimentation from upstream rivers have significantly altered wildlife corridors (Ardli and Wolff 2009).

Recent local media reports have documented several alarming cases, including the capture of large crocodiles near settlements and fishermen's nets, raising safety concerns among residents (Fahmi and Arief 2020). In addition to direct threats, villagers report frequent damage

to crops, poultry, and property. These encounters are often seasonal, intensifying during dry periods when natural food sources in the mangrove forest become scarce (Braczkowski et al. 2023; Ullah et al. 2024). While some species have important ecological roles, their encroachment into human zones has provoked retaliatory actions—trapping, poisoning, and even habitat clearance—further exacerbating biodiversity loss (Chakuya et al. 2024).

Community responses to HWC in Kampung Laut vary in intensity and sustainability. Many households adopt traditional methods such as fencing, guard animals, or noise-based deterrents (Musa et al. 2020; Efriansyah et al. 2024), but in cases of economic loss, residents may turn to more harmful practices like poisoning or hunting (Makmur et al. 2024). These reactions raise ethical and ecological concerns, particularly when target species are of conservation interest or protected status (Zimmermann et al. 2020; Kidane et al. 2024). Addressing HWC thus requires not only practical tools, but also culturally informed and ecologically sensitive strategies.

Despite the ecological significance of the region, institutional support for conflict mitigation remains minimal. Kampung Laut lacks coordinated wildlife management plans, habitat restoration efforts, or early-warning systems (Breck et al. 2023). Most conflicts are handled informally by individuals or village leaders, without alignment with broader conservation agendas. This gap between local action and national policy limits long-term effectiveness and perpetuates a reactive cycle of degradation and conflict.

To respond effectively, detailed documentation of HWC patterns is essential—including species involved, types of damage, seasonality, and community coping mechanisms. Such information is critical to inform integrated conflict mitigation strategies, support policy design, and guide future education or ecotourism efforts (Kupika et al. 2024). Moreover, recognizing and integrating local ecological knowledge can strengthen participatory conservation and enhance social legitimacy.

This study aims to identify the primary wildlife species involved in human-wildlife conflicts, assess the types and frequency of disturbances, and examine local mitigation strategies employed by mangrove-edge communities in Kampung Laut Sub-district. The findings are expected to support inclusive, place-based solutions that promote coexistence, strengthen livelihoods, and safeguard biodiversity in tropical coastal ecosystems.

MATERIALS AND METHODS

Study area

This study was conducted in the Kampung Laut sub-district, a geographically isolated coastal area situated within the Segara Anakan Lagoon system in Cilacap District, Central Jawa Province, Indonesia (Figure 1). This region is distinguished by its expansive and ecologically vital mangrove ecosystem, which plays a crucial role in maintaining biodiversity, mitigating coastal erosion, and supporting the livelihoods of the surrounding communities (Hilmi et al. 2021; Osland et al. 2022). The study area extends approximately from 7°32′38.4″S to 7°47′24.0″S latitude and 108°48′36.0″E to 108°56′24.0″E longitude, encompassing low-lying coastal terrain with tidal influence. Administratively, Kampung Laut consists of several villages, three of which—Ujunggagak, Klaces, and Ujungalang (locally known as Motehan)—were selected as focal sites for this research due to their direct adjacency to dense mangrove stands and their recurrent experiences with human-wildlife conflict. Data collection was conducted in September and October 2024.

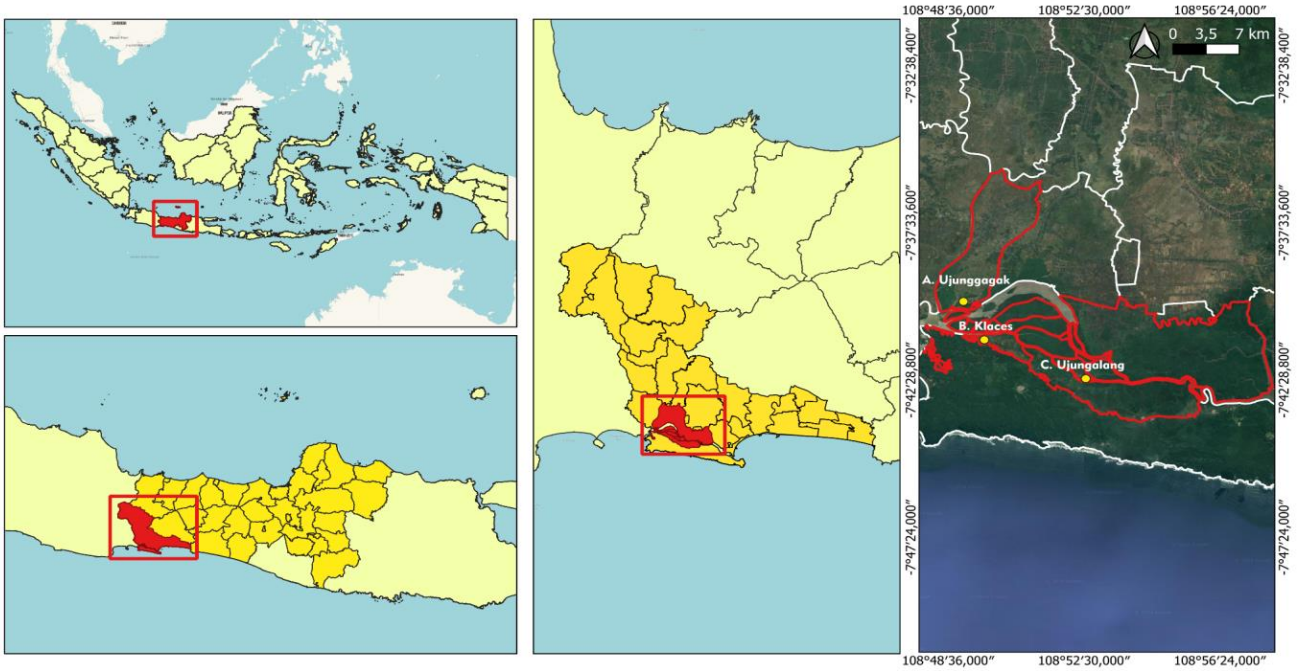

Figure 1. The areas covered by the questionnaire in Kampung Laut sub-district include Ujunggagak, Klaces, and Ujungalang Villages, Cilacap District, Central Java, Indonesia

Kampung Laut is located on the southern coastline of Java, facing the Indian Ocean and bordered by Nusa Kambangan Island. The sub-district is situated at a low elevation, approximately 1 meter above sea level, and experiences a tropical climate with average temperatures ranging from 27 to 31°C throughout the year. The area spans approximately 134.07 km² (BPS 2024) and is accessible only by water transportation, with travel times from Cilacap City averaging 1.5 to 2 hours (Ulya and Sanjatmiko 2018). This isolation has contributed to both the preservation of native vegetation and the infrastructural limitations affecting daily life.

The surveyed villages vary in demographic and spatial characteristics. Ujunggagak covers 26.59 km² and hosts approximately 4,544 residents; Klaces, the smallest, spans 2.21 km² with a population of 1,286; and Ujungalang is the largest, with 64.79 km² and around 4,265 inhabitants (Rahmayana and Handayani 2019; BPS 2024). The economy is primarily based on fishing, smallholder agriculture, and mangrove product harvesting (Setiawan and Sari 2018). Dominant mangrove species include *R. apiculata*, *A. marina*, *S. caseolaris*, and *N. fruticans*, providing essential habitat for wildlife (Kissinger et al. 2020; Hilmi et al. 2021). Yet, pressures from sedimentation, habitat conversion, and ecological degradation have increased, intensifying human-wildlife interactions in recent decades (Ardli and Wolff 2009). These dynamics render Kampung Laut an important case study for understanding wildlife conflict in mangrove landscapes.

Sampling and data collection

This research employed a purposive sampling approach followed by snowball referrals to identify local informants who had direct experience with wildlife in their immediate environment. The study targeted residents of Kampung Laut sub-district who were over 18 years of age and engaged in daily activities that involved frequent outdoor exposure, such as fishing, farming, and livestock raising. These criteria ensured the inclusion of participants with a high likelihood of encountering wildlife and being affected by human-wildlife conflict (Hill 2021; Ferdin et al. 2024).

Fieldwork was conducted throughout September to October 2024. Prior to field deployment, research permits were obtained from local authorities. Interviews were conducted face-to-face using a structured questionnaire, which allowed for consistent data collection while also accommodating brief elaborations from participants as needed. The interviews took place in three villages—Ujunggagak, Klaces, and Ujungalang—and were facilitated by local guides to ensure effective communication and cultural sensitivity.

A total of 93 residents were interviewed during the data collection process. Participants were selected based on their familiarity with local wildlife, willingness to share their experiences, and referrals provided by other villagers. This sampling strategy enabled the research team to capture a broad cross-section of occupations, age groups, and household roles. The final sample encompassed a diverse range of individuals, including fishermen, farmers, housewives, laborers, and small-scale entrepreneurs. The sample size was deemed sufficient based on the principle of thematic saturation, as no substantial new information emerged in the later stages of data collection. Moreover, this number represents a meaningful proportion of the adult population across the three villages, ensuring an adequate representation of local perspectives on human-wildlife conflict.

All interviews were conducted using printed forms in the Indonesian language, with assistance from trained enumerators familiar with the regional dialects and terminology. The interview protocol was designed to take approximately 15-25 minutes per respondent. Data were recorded manually and cross-checked at the end of each day to ensure completeness and accuracy. The questionnaire focused on respondents' experiences with specific wildlife species, the type and frequency of disturbances, and any mitigation measures they had implemented in response.

To enhance the validity of the interview data, especially regarding sensitive topics such as the use of poisons and wildlife hunting, the research team employed basic triangulation methods during fieldwork. Enumerators were instructed to cross-check respondents' answers with observable indicators in the field, such as the presence of traps, deterrent devices, or livestock enclosures. Where possible, informal discussions were conducted with non-participant villagers and community leaders to verify the consistency of reported conflict incidents and mitigation practices. Observations of environmental conditions—such as signs of wildlife intrusion, damage to crops, or remnants of deterrent measures—were recorded to support respondent statements. These triangulation steps, while limited in scope, provided supplementary evidence that increased the credibility of self-reported data in the context of human-wildlife conflict.

Questionnaire content

The questionnaire was designed to gather detailed information on the experiences of local residents with wildlife conflicts and their adaptive responses to these conflicts. It was structured into four main sections to ensure comprehensive data collection while maintaining clarity and ease of response for participants. The questions were formulated based on the literature on human-wildlife conflict in rural and mangrove landscapes (Dickman 2010; König et al. 2020; Elisa et al. 2024). Prior to field deployment, the questionnaire was pilot-tested with five respondents from non-sample households to assess clarity, relevance, and cultural appropriateness. Based on the feedback, minor revisions were made to improve wording, sequence, and the inclusion of locally understood terms.

The first section focused on identifying problematic wildlife species. Respondents were asked to list the animals they perceived as most disruptive or dangerous, whether from direct observation or local knowledge. Common taxonomic groups, such as mammals, reptiles, and birds, were included to guide responses, but the questionnaire also allowed for open-ended input to capture less expected species.

The second section explored the types of disturbance caused by wildlife. These disturbances were categorized into: (i) attacks on humans, (ii) damage to crops and plantations, (iii) predation of livestock, (iv) destruction of property or infrastructure, and (v) other forms of interference. Respondents were asked to indicate all types they had experienced and to describe the specific context of these events (e.g., time of day, season, location).

The third section examined the temporal aspects of wildlife conflict, asking respondents when they last experienced a disturbance. Response options were standardized into categories, including: within the last month, within 1-6 months, 6-12 months ago, more than a year ago, or never. This structure enabled the researchers to identify temporal trends and detect any seasonal patterns in conflict occurrence (Baral et al. 2021; Braczkowski et al. 2023).

The fourth section addressed the strategies used by residents to mitigate or prevent wildlife conflict. Participants were asked whether they had implemented specific measures, such as fencing, keeping guard animals (e.g., dogs), using repellents (e.g., scented cloths, noise makers), setting traps, or applying chemical deterrents (e.g., poisons). They were also asked whether they took no action at all, and if so, why. This section allowed for the analysis of both active and passive response patterns within the community.

In addition to conflict-specific questions, a fifth section collected basic socio-demographic data, including age, gender, occupation, and village of residence. This information was later used to examine potential correlations between livelihood type and exposure to wildlife conflict. The questionnaire design emphasized brevity and clarity, and was pilot-tested with five respondents prior to full deployment to ensure local comprehensibility and cultural appropriateness.

Data analysis

The data obtained from structured interviews were analyzed using a combination of descriptive and inferential statistical methods. All responses were manually tabulated and organized into thematic categories that followed the questionnaire's structure. These included the types of wildlife species involved in conflict, forms of disturbance experienced, timing of incidents, and mitigation strategies adopted. Frequencies and proportions were calculated for each variable, enabling comparisons across villages and respondent profiles such as occupation, age, and gender (Ferdin et al. 2024).

Descriptive statistics formed the core of the analysis, with results presented through bar charts, pie charts, and frequency tables to visualize spatial variations and the relative prominence of each conflict-related factor. Particular attention was given to identifying the most commonly reported nuisance species, sectors most affected (e.g., agriculture, livestock), and the seasonality of wildlife disturbances. This approach emphasized community-reported experiences and was deemed suitable for the study's goal of documenting real-world interactions in a rural mangrove context (Damastuti et al. 2022).

To address potential sources of bias, such as underreporting or exaggeration due to perceived expectations, the data were cross-checked through triangulation techniques. Field enumerators were instructed to verify responses where possible through direct observation, informal side interviews, and environmental cues such as the presence of traps, fences, or signs of crop damage. These verification steps aimed to increase the reliability and credibility of self-reported data.

In addition to descriptive summaries, an inferential statistical test was applied to assess whether the distribution of conflict mitigation strategies varied significantly across the three study villages. A Chi-square (χ^2) test of independence was conducted using the observed frequency distribution of six major mitigation categories: (i) doing nothing, (ii) use of guard animals or repellents, (iii) poisoning or extermination, (iv) direct hunting, (v) use of traps, and (vi) fencing. The analysis was performed using SPSS version 26, with a significance threshold set at $\alpha = 0.05$. The inclusion of this test allowed for a more robust interpretation of response patterns among villages and provided statistical support for the discussion of community-level behavioral consistency.

RESULTS AND DISCUSSION

Socio-demographic characteristics of respondents

A total of 93 respondents participated in the survey conducted across the three villages of Kampung Laut sub-district: Ujunggagak, Klaces, and Ujungalang. The demographic composition varied across age, gender, education, and occupation, reflecting the region's patterns of livelihood and household structures.

In terms of gender distribution, 53.76% of respondents were male (n=50), while 46.24% were female (n=43). Age groups were categorized into four intervals: 18-32 years (14 respondents), 33-47 years (28), 48-62 years (37), and 63 years and above (14) (Table 1). The most represented age group was 48-62 years, comprising 39.8% of the sample, indicating that middle-aged adults are more actively engaged in resource-based activities in Kampung Laut.

Educational attainment varied considerably among respondents. The majority had completed only elementary school (n=45), followed by junior high school (n=24), and senior high school (n=19). A small number had attained higher education (n=5), while a few respondents reported having no formal education at all (n=3). Ujunggagak and Ujungalang showed relatively higher rates of primary-level education, while Klaces had a notable portion of respondents with junior high schooling. This educational profile is typical of remote mangrove-based communities with limited access to formal education services (Setiawan and Sari 2018; Sukardi and Widiastuti 2020).

Regarding occupation, the respondents included 30 fishermen, 32 housewives, 10 farmers, 7 freelancers, 5 civil servants, and 9 individuals categorized under "others" (teachers, drivers, laborers, and the unemployed). Ujunggagak and Ujungalang Villages showed a higher

number of fishermen (14 and 12, respectively), while Klaces had the highest proportion of farmers (n=7). The majority of female respondents identified as housewives, particularly in Klaces (n=12) and Ujungalang (n=10). This distribution reflects the strong dependence of Kampung Laut residents on aquatic and mangrove-based livelihoods, with farming playing a more limited role due to environmental constraints such as tidal exposure and wildlife disturbance.

Types and prevalence of wildlife damage

Residents of Kampung Laut sub-district reported frequent disturbances caused by various wildlife species, particularly those residing in or near the mangrove forest areas surrounding the villages. Of the 93 respondents interviewed, 68 reported having experienced wildlife disturbance, and 57 of them were able to identify the species responsible (Figure 2). Based on interview responses, wildlife-induced damage occurred across multiple sectors, including agriculture, livestock, and residential properties. Although most respondents were engaged in fishing, over 70% of them also kept livestock such as chickens, goats, or pigeons, or maintained small crop plots near their homes, making them vulnerable to wildlife interference.

Figure 2 shows the proportion of wildlife species reported as causing damage by residents of Kampung Laut Sub-district. Wild boars (*S. scrofa*) were identified as the most problematic species, accounting for 19.8% of all reported disturbances. They were followed by rats (*Rattus* spp.) at 16.7%, and monitor lizards (*V. salvator*) at 12.3%. Other notable species included monkeys (*M. fascicularis*, 10.5%) and snakes—such as *Naja sputatrix*, *Python reticulatus*, and *Boiga dendrophila*—which accounted for 8.7%. The remaining 32% were categorized as "Others," comprising less frequently cited or unidentified animals, including civets (*Paradoxurus hermaphroditus*), birds, and small carnivores. These animals were reported to destroy crops, prey on livestock, or cause structural damage to food storage areas and housing.

The frequency of wildlife disturbances also varied among the three study villages. As shown in Figure 3, Klaces Village experienced the highest average disturbance score (3.0), followed by Ujunggagak (2.23) and Ujungalang (1.73). A score of 3 indicated moderate impact (recurring or seasonal damage), 2 represented low-level but noticeable damage, and 1 indicated minimal or no perceived disturbance. The higher frequency in Klaces may be related to a greater prevalence of smallholder agriculture, which tends to attract wild boars and rodents, especially during the dry season when food sources are scarce.

These findings confirm that wildlife conflict is a widespread issue across Kampung Laut, with its severity varying by both species and location. Residents in more agricultural zones appeared to experience greater frequency and intensity of conflict, particularly from herbivorous and omnivorous mammals. These patterns are consistent with previous research that links habitat degradation and resource scarcity to increased human-wildlife interactions (Braczkowski et al. 2023; Ullah et al. 2024).

Temporal trends in wildlife conflict

The timing of recent wildlife disturbances reported by respondents offers valuable insight into both seasonal patterns and the persistence of human-wildlife conflict in Kampung Laut Sub-district. Interview data revealed that such conflicts occurred across varying timeframes, indicating both recurring and declining trends depending on location and exposure.

As shown in Figure 4, 27% of respondents (n=25) stated that they had never experienced any wildlife-related disturbance. In contrast, 8% (n=7) reported incidents within the past month, suggesting continued vulnerability in certain areas. Additionally, 19% (n=18) experienced disturbances within the past one to six months, while 11% (n=10) reported incidents within the past year. The largest proportion—35% (n=33)—indicated that their most recent wildlife encounter occurred more than one year ago.

Table 1. Demographic characteristics of respondents from Kampung Laut mangrove villages, Cilacap, Indonesia (n=93)

Category	Villages		
	Ujunggagak	**Klaces**	**Ujungalang**
Age			
18-32	7	5	2
33-47	12	9	7
48-62	7	16	14
>63	4	3	7
Gender			
Male	16	14	20
Female	14	19	10
Education			
No formal education	1	1	1
Elementary school	15	13	14
Junior high school	6	10	8
Senior high school	6	5	8
College and above	1	3	1
Occupation			
Fisherman	14	4	12
Housewife	10	12	10
Farmer	2	7	1
Freelance	1	2	4
Civil servant	1	3	1
Others	2	5	2

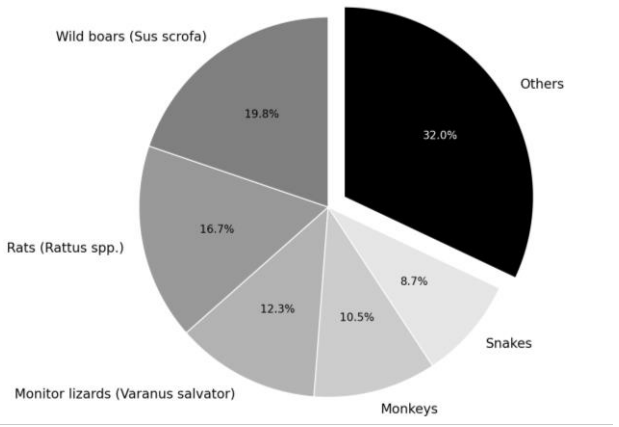

Figure 2. Proportion of wildlife species causing damage as reported by residents of Kampung Laut sub-district, Cilacap, Indonesia (n = 57)

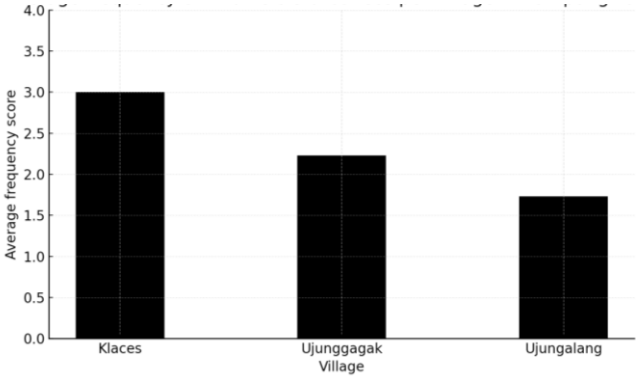

Figure 3. Average frequency of wildlife disturbances per village in Kampung Laut sub-district, Cilacap, Indonesia

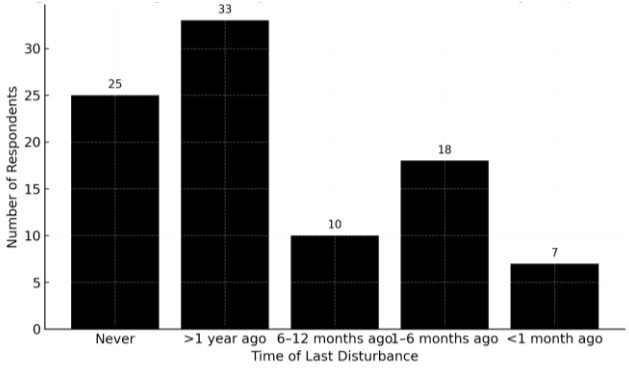

Figure 4. Timing of last reported wildlife disturbance by respondents in Kampung Laut sub-district, Cilacap, Indonesia

These findings suggest that while a portion of the community continues to face active or recent conflicts, a significant number perceive wildlife disturbances as declining. This may reflect seasonal shifts in wildlife foraging behavior, natural food availability in the mangrove ecosystem, or changes in human activity and land use. In some cases, the adoption of deterrent strategies or fencing may have contributed to reduced encounters.

However, the recurrence of conflict—particularly in agricultural zones during the dry season—indicates that human-wildlife interaction remains an ongoing concern (Ferdin et al. 2024). Several informants observed increased wild boar and rodent activity during periods of food scarcity, a pattern consistent with broader ecological studies on wildlife range expansion in degraded or fragmented habitats (Elisa et al. 2024). The fact that nearly 40% of respondents reported disturbances within the last year underscores the importance of seasonal and anticipatory mitigation strategies to protect livelihoods and reduce damage.

Wildlife-induced damage types

Wildlife-related disturbances reported by respondents in Kampung Laut sub-district were categorized into two major types: direct interference, which includes physical attacks on humans, and indirect interference, which involves damage to agriculture and livestock. The extent and distribution of these disturbances varied across the three villages studied.

As shown in Table 2, direct attacks on humans were relatively rare but carried serious implications, with a total of six incidents reported—one in Ujunggagak, four in Klaces, and one in Ujungalang. These incidents involved encounters with animals such as crocodiles, bees, snakes, wild boars, and rats. In most cases, the attacks occurred during routine outdoor activities, such as farming or fishing, and resulted in minor to moderate injuries. Although no fatalities were recorded, the incidents heightened fear among residents and prompted increased vigilance in the affected areas.

Indirect interference, on the other hand, was far more frequent and economically impactful. In the agricultural sector, a total of 56 incidents were reported across the three villages: 16 in Ujunggagak, 17 in Klaces, and 23 in Ujungalang. These incidents included rice fields being damaged by wild boars, as well as crops such as eggplants, chilies, and bananas being consumed by monkeys. Additionally, pest infestations were caused by bamboo insects and rats. Residents emphasized that such losses often coincided with dry periods or the early rainy season, when crops were most vulnerable.

The livestock sector also experienced notable disturbance, with a total of 22 reported incidents: 5 in Ujunggagak, 12 in Klaces, and 5 in Ujungalang. Chickens and ducks were reportedly preyed upon by civets (*P. hermaphroditus*) and weasels, especially at night or during planting seasons when human activity in the fields was lower. These attacks resulted in a reduction of household protein sources and, for some families, economic loss.

These findings underscore the diverse and location-specific nature of wildlife conflicts in Kampung Laut. Klaces Village, for instance, experienced the highest total number of livestock disturbances, likely due to its relatively more concentrated backyard farming. Ujungalang, despite being more remote, reported the highest level of agricultural interference, possibly due to the extensive presence of community gardens along forest edges.

Table 2. Wildlife-related disturbances affecting agriculture, livestock, and human safety across three villages

Variable	Category	Villages		
		Ujunggagak	Klaces	Ujungalang
Direct Interference	Attacks on humans	1	4	1
Indirect Interference	Agricultural sector	16	17	23
	Livestock sector	5	12	5

The persistent nature of indirect interference highlights the need for sustained, community-based responses to wildlife disturbance. Without appropriate mitigation, such interactions not only affect household economies but also influence negative attitudes toward wildlife, increasing the likelihood of retaliatory actions (Chakuya et al. 2024; Makmur et al. 2024).

Community responses and coping strategies

Residents of Kampung Laut sub-district employed various strategies to cope with and mitigate the effects of wildlife conflicts. These responses varied in terms of intensity, cost, and ecological impact, reflecting differences in resource availability, perceived risk, and cultural norms. Broadly, the community's strategies can be categorized into three main approaches: passive tolerance, deterrence, and active elimination.

As summarized in Table 3, one-third of respondents (33%) reported doing nothing when facing wildlife disturbances. This passive approach was typically linked to limited financial capacity, low perceived threat, or cultural beliefs that framed such events as seasonal, tolerable, or even "natural." In several cases, crop losses caused by rats or monkeys were accepted rather than actively countered, with respondents opting instead to replant or relocate their plots.

An equal proportion (33%) adopted deterrent-based strategies, including the use of guard animals (especially dogs), scented cloths to repel wild boars, physical renovation of livestock enclosures, or the creation of loud noises to frighten animals away. These techniques, while low-cost and locally derived, were reported to lose effectiveness over time, particularly against more persistent wildlife such as wild boars or civets.

Smaller subsets of respondents employed direct elimination measures. Approximately 13% reported using poison or chemical exterminators, primarily for controlling rodents and insects. Although such methods were effective in the short term, they pose ecological risks, including harm to non-target species and contamination of the surrounding environment (Efriansyah et al. 2024). Meanwhile, 6% of respondents engaged in direct hunting—often targeting wild boars or civets during peak disturbance seasons—while 5% reported using traps around gardens or animal enclosures.

Finally, 10% of respondents built fences around their agricultural plots or livestock areas to restrict access by wildlife. This method was considered effective against larger mammals but required a significant investment in materials and labor, making it difficult for lower-income households to implement independently. These findings indicate a strong reliance on traditional, household-level strategies with minimal use of external or institutional support. While deterrents and fencing can reduce conflict frequency, strategies such as poisoning and hunting risk undermining the long-term ecological balance; this underscores the importance of promoting ecologically sound alternatives.

To assess whether the use of mitigation strategies differed significantly across the three study villages, a Chi-square test of independence was conducted based on the observed frequency distribution in Table 3. The test revealed no statistically significant differences among villages ($\chi^2 < 0.1$, $df = 10$, $p > 0.95$), suggesting a relatively uniform pattern of response. This implies that residents across Kampung Laut, regardless of their village, tend to adopt similar coping behaviors when dealing with wildlife conflict.

Discussion

Ecological patterns of wildlife conflict

Human-wildlife conflict in Kampung Laut is primarily driven by a small set of adaptable species, including wild boars (*S. scrofa*), rats (*Rattus* spp.), and monitor lizards (*V. salvator*), as well as monkeys, snakes, and civets. These generalist animals thrive in fragmented or disturbed habitats and frequently enter human settlements in search of food, especially during the dry season when resources in the mangrove ecosystem are limited (König et al. 2020; Braczkowski et al. 2023).

Wild boars were the most frequently reported nuisance species (Figure 2), reflecting their strong foraging ability, destructive rooting behavior, and tendency to raid crops and gardens. Rats were associated with grain loss and damage to domestic storage, while monitor lizards, although ecologically beneficial, were often blamed for predation on poultry. These patterns align with other studies in tropical coastal regions, where human-wildlife conflict is closely linked to ecological edge effects and resource overlap (Massei et al. 2015).

Seasonal variation was evident in conflict timing (Figure 4), with over one-third of respondents reporting incidents in the previous year. Wildlife disturbances peaked during the dry season or early planting periods, consistent with seasonal food scarcity and habitat stress (Elisa et al. 2024; Ullah et al. 2024). Some households (35%) reported a gap of over a year since the last incident, possibly due to deterrent effectiveness, changes in land use, or conflict desensitization. These findings underscore the importance of understanding wildlife behavior and seasonal movements to inform anticipatory mitigation strategies.

Table 3. Distribution of mitigation strategies for wildlife conflict across three villages in Kampung Laut Sub-district, Cilacap, Indonesia (N=93)

Mitigation strategy	Villages			Total
	Ujunggagak	Klaces	Ujungalang	
Do nothing	10	11	10	31
Guard animals/ repellents	10	11	10	31
Poison/ extermination	4	4	4	12
Hunting	2	2	2	6
Traps	2	2	1	5
Fencing	2	3	3	8
Total	30	33	30	93

In addition to generalist species, several taxa with ecological and conservation significance were also reported, including snakes (e.g., *N. sputatrix*, *P. reticulatus*) and civets (*P. hermaphroditus*). While these animals are sometimes feared or perceived as pests, they play important ecological roles as predators of rodents and insects. Their presence indicates functioning food webs within the mangrove-village interface. However, due to fear or economic losses, these species are often subject to indiscriminate killing, which may reduce local biodiversity and disrupt ecological balance. Efforts to promote coexistence should therefore include public education on the ecological value of less understood or culturally stigmatized species, especially those with conservation relevance.

Demographic and spatial vulnerability

The intensity of wildlife conflict varied across villages, influenced by differences in land use patterns, mangrove cover, and proximity to wildlife corridors. Klaces Village reported the highest frequency of disturbances (Figure 3), likely due to its dense concentration of home gardens and smallholder farms located near forest margins. Ujungalang, while recording fewer total incidents, reported significant agricultural losses, suggesting the presence of spatial clusters with elevated exposure. In contrast, Ujunggagak exhibited a more balanced disturbance profile, situated between active fishing areas and degraded woodland edges, with lower concentrations of crop fields.

Vulnerability to conflict was also shaped by socio-demographic factors such as occupation, gender, and age. Fishermen and housewives were among the most affected, as their daily routines often coincided with dawn and dusk—periods of increased wildlife activity. Women, in particular, faced heightened exposure due to their roles in managing food storage, backyard livestock, and domestic waste, all of which may attract animals such as rodents and civets. The majority of reports came from middle-aged respondents (48-62 years), who typically serve as decision-makers in land use and household management (Baral et al. 2021). Across all groups, vulnerabilities were exacerbated by structural limitations, including inadequate fencing, unsecured livestock enclosures, and the absence of basic surveillance infrastructure.

These findings reinforce the notion that wildlife conflict is not random but spatially and socially structured—emerging from the intersection of ecological interfaces and human settlement behavior. Risk tends to concentrate in specific zones within the village landscape, often reflecting both environmental exposure and socio-economic capacity. Therefore, mitigation efforts must be place-based and context-sensitive, addressing not only ecological risk factors but also the roles and responsibilities embedded in household and gender dynamics. Interventions such as participatory conflict mapping, improvements in animal husbandry practices, and gender-inclusive training programs can enhance local resilience and reduce future conflict (Dickman 2010).

Damage to livelihoods and perceived risks

Wildlife conflict in Kampung Laut directly affects household livelihoods, particularly in the sectors of agriculture and small-scale animal husbandry. As shown in Table 2, crop damage was the most frequently reported form of disturbance, with wild boars, rats, and monkeys destroying rice, vegetables, and fruit crops. These events commonly occurred during the dry season or early planting periods, when crop defenses were minimal and agricultural inputs had already been invested. The losses were often sudden and severe, resulting in reduced food availability, economic setbacks, and growing disinterest in continued cultivation.

Although less frequent, livestock predation posed a significant threat to households relying on poultry or small ruminants for protein and supplemental income. Chickens and ducks were frequently preyed upon by civets (*P. hermaphroditus*), monitor lizards (*V. salvator*), and weasels, particularly at night or in periods of reduced human activity. In many cases, respondents reported that the absence of secure animal enclosures made their livestock highly vulnerable to attack.

Direct attacks on humans were rare but not negligible. Six incidents were documented across the three villages, involving injuries caused by wild boars, snakes, bees, and rodents. These encounters, although infrequent, contributed to heightened fear and behavioral disruption—especially among elderly residents, children, and individuals working alone in isolated areas. Interestingly, certain species such as crocodiles (*Crocodylus porosus*) continued to elicit strong fear responses, despite the absence of recent attacks, highlighting a gap between perceived and actual risk (Hill 2004; Barua et al. 2013).

The cumulative impact of wildlife conflict extended beyond economic losses. Respondents frequently described feelings of stress, frustration, and helplessness following repeated crop failures or livestock predation. In some instances, this emotional toll gave rise to retaliatory behaviors, including the use of poison or the destruction of nearby vegetation believed to shelter wildlife (Treves and Karanth 2003; Makmur et al. 2024). Such responses, while understandable, carry long-term ecological consequences and reflect the erosion of social resilience in the face of repeated disturbances.

These findings underscore that human-wildlife conflict is not solely a matter of material loss but also a source of psychological and social strain. Effective mitigation strategies must therefore consider both dimensions of risk—economic and emotional—by promoting early warning systems, protective infrastructure, and culturally sensitive outreach that helps rebuild trust in coexistence efforts and prevents cycles of ecological retribution.

Community-based mitigation practices

In the absence of institutional support, residents of Kampung Laut rely on self-initiated strategies to manage wildlife disturbances, ranging from passive tolerance to active elimination. As shown in Table 3, a third of respondents reported doing nothing in response to conflict, often due to limited financial capacity, fatalistic beliefs, or

the perception that disturbances were tolerable and seasonal in nature. This passive stance reflects both cultural norms and structural constraints (Setyawan et al. 2022).

An equal proportion adopted non-lethal deterrents such as guard dogs, loud noises, or scented materials to repel animals like wild boars and monkeys. These methods are low-cost and locally embedded but often lose effectiveness over time. More aggressive tactics, including poisoning (13%), hunting (6%), and trapping (5%), were used selectively, particularly when economic losses were high. However, such methods pose ecological risks, including harm to non-target species and contamination of the mangrove environment (Chakuya et al. 2024; Efriansyah et al. 2024).

Physical fencing—employed by 10% of respondents—was generally viewed as effective but unaffordable for most households. The labor and material costs limited its use, especially among lower-income families. Communal or subsidized fencing initiatives were absent, although such schemes could provide more sustainable protection if implemented collaboratively. Statistical analysis revealed no significant differences in mitigation strategy use across villages (χ^2=0.044, p≈1.00), indicating behavioral convergence likely shaped by shared environmental pressures and cultural practices. This uniformity suggests that sub-district level interventions—rather than village-specific programs—may be more efficient, provided they are tailored to local realities.

Overall, the reliance on household-level responses, combined with limited access to technical assistance, underscores the need for integrated, community-based solutions. Participatory training, the promotion of ecologically safe deterrents, and co-management frameworks are essential for shifting from reactive to proactive conflict mitigation in mangrove-dependent communities.

Implications for human-wildlife coexistence in mangrove systems

The case of Kampung Laut illustrates the complex trade-offs between biodiversity conservation and livelihood security in tropical mangrove landscapes. Wildlife conflict in this region is not merely an ecological issue, but a socio-environmental challenge shaped by land-use patterns, poverty, and governance gaps. Species such as *S. scrofa*, *P. hermaphroditus*, and *V. salvator* exploit the edges between mangrove forests and human settlements, where food sources and habitat structures overlap (Braczkowski et al. 2023).

Current responses—from tolerance to direct elimination—reflect both adaptive resilience and systemic vulnerability. Without coordinated support, households rely on informal strategies that are often ecologically harmful or unsustainable. Limited infrastructure, low educational levels (Table 1), and the absence of formal conflict mitigation programs leave communities trapped in a reactive cycle of loss and retaliation (Ferdin et al. 2024).

Yet, the situation also presents opportunities. The presence of local ecological knowledge, social cohesion, and shared coping strategies across villages provides a strong foundation for participatory wildlife management. Tools such as community-based monitoring, conflict mapping, and seasonal early warning systems can be integrated into village governance to support coexistence initiatives. These approaches align with global calls for decentralized, culturally grounded conservation frameworks (König et al. 2020). Lessons from Kampung Laut are also relevant beyond Indonesia, as similar challenges persist in mangrove-dependent communities across Asia and Africa. Thus, this study contributes to broader efforts to develop equitable and ecologically sound models for human-wildlife coexistence in socio-ecological systems undergoing rapid transformation.

In conclusion, human-wildlife conflict in Kampung Laut Sub-district, Central Java, is shaped by the interactions between generalist species—particularly *S. scrofa*, *Rattus* spp., and *V. salvator*—and mangrove-edge communities experiencing livelihood vulnerabilities. Conflict intensity varies across both space and season, with Klaces Village experiencing the highest frequency of disturbances, especially during the dry season when natural food resources are limited. The most affected sectors include smallholder agriculture and backyard livestock, with indirect consequences for household food security and psychological well-being. Community responses remain largely traditional, encompassing a spectrum from passive tolerance to non-lethal deterrents, and in some cases, harmful practices such as poisoning and hunting. Notably, the similarity in coping strategies across villages reflects shared ecological stressors and cultural perceptions of wildlife. While institutional support for conflict mitigation remains minimal, strong local knowledge and community cohesion provide a valuable foundation for participatory, ecosystem-based management. Strengthening coexistence in mangrove-dependent landscapes will require strategic investments in affordable protective infrastructure, culturally grounded training programs, and decentralized wildlife monitoring systems. Such approaches can empower communities to manage conflict proactively while maintaining ecological integrity and enhancing social resilience.

ACKNOWLEDGEMENTS

The authors gratefully acknowledge the participation and hospitality of the residents of Ujunggagak, Klaces, and Ujungalang Villages in Kampung Laut sub-district, Cilacap, during fieldwork. We thank the village heads and local facilitators for their support in organizing interviews and community discussions. Appreciation is also extended to the field assistants and enumerators who helped in data collection and logistics. The authors also wish to thank their colleagues and reviewers whose feedback contributed to the improvement of the clarity and depth of this manuscript.

REFERENCES

Akbar MR, Arisanto PAA, Sukirno BA, Merdeka PH, Priadhi MM, Zallesa S. 2020. Mangrove vegetation health index analysis by implementing NDVI (normalized difference vegetation index) classification method on sentinel-2 image data case study: Segara Anakan, Kabupaten Cilacap. IOP Conf Ser: Earth Environ Sci 584 (1): 012069. DOI: 10.1088/1755-1315/584/1/012069.

Anrozi R, Siagian A, Restisha VA, Maretta A. 2019. Biodiversity study on Segara Anakan Lagoon. IOP Conf Ser: Earth Environ Sci 298 (1): 012001. DOI: 10.1088/1755-1315/298/1/012001.

Ardli ER, Wolff M. 2009. Land use and land cover change affecting habitat distribution in the Segara Anakan lagoon, Java, Indonesia. Reg Environ Change 9 (4): 235-243. DOI: 10.1007/s10113-008-0072-6.

Badan Pusat Statistik (BPS). 2024. Kecamatan Kampung Laut Dalam Angka. BPS Kabupaten Cilacap, Cilacap. [Indonesian]

Baral K, Sharma HP, Rimal B, Thapa-Magar K, Bhattarai R, Kunwar RM, Aryal A, Ji W. 2021 Characterization and management of human-wildlife conflicts in mid-hills outside protected areas of Gandaki province, Nepal. PLoS One 16 (11): e0260307. DOI: 10.1371/journal.pone.0260307.

Barua M, Bhagwat SA, Jadhav S. 2013. The hidden dimensions of human-wildlife conflict: Health impacts, opportunity and transaction costs. Biol Conserv 157: 309-316. DOI: 10.1016/j.biocon.2012.07.014

Blanton A, Ewane EB, McTavish F, Watt MS, Rogers K, Daneil R, Vizcaino I, Gomez AN, Arachchige PS, King SA, Galgamuwa GP. 2024. Ecotourism and mangrove conservation in Southeast Asia: Current trends and perspectives. J Environ Manag 365: 121529. DOI: 10.1016/j.jenvman.2024.121529.

Braczkowski AR, O'Bryan CJ, Lessmann C, Rondinini C, Crysell AP, Gilbert S, Stringer M, Gibson L, Biggs D. 2023. The unequal burden of human-wildlife conflict. Commun Biol 6 (1): 182. DOI: 10.1038/s42003-023-04493-y.

Breck SW, Davis AJ, Oakleaf JK, Bergman DL, deVos J, Greer JP, Pepin K. 2023. Factors affecting the recovery of Mexican wolves in the Southwest United States. J Appl Ecol 60 (10): 2199-2209. DOI: 10.1111/1365-2664.14483.

Chakuya J, Chikara M, Gandiwa E. 2024. Living with wildlife and associated conflicts in areas adjacent to protected areas, Northern Zimbabwe. Integr Conserv 3 (1): 12-21. DOI: 10.1002/inc3.39.

Damastuti E, de Groot R, Debrot AO, Silvius MJ. 2022. Effectiveness of community-based mangrove management for biodiversity conservation: A case study from Central Java, Indonesia. Trees For People 7: 100202. DOI: 10.1016/j.tfp.2022.100202.

Dickman AJ. 2010. Complexities of conflict: The importance of considering social factors for effectively resolving human-wildlife conflict. Anim Conserv 13 (5): 458-466. DOI: 10.1111/j.1469-1795.2010.00368.x.

Efriansyah, Priyambodo S, Hindayana D. 2024. Effectiveness of using the trap barrier system to control rats in palm oil plantations. Biodiversitas 25: 2993-2998. DOI: 10.13057/biodiv/d250720.

Elisa M, Caro T, Yon L, Hardy IC, Roberts S, Symeonakis E. 2024. Wildlife corridor degradation and human-wildlife conflict: A case study from Tanzania. Afr J Ecol 62 (2): e13264. DOI: 10.1111/aje.13264.

Fahmi I, Arief TMV. 2020. Teror Warga Selama 2 Tahun, Buaya di Segara Anakan Nusakambangan Akhirnya Tertangkap Artikel ini telah tayang di Kompas.com dengan judul "Teror Warga Selama 2 Tahun, Buaya di Segara Anakan Nusakambangan Akhirnya Tertangkap. Kompas.com https://regional.kompas.com/read/2020/12/25/12345581/teror-warga-selama-2-tahun-buaya-di-segara-anakan-nusakambangan-akhirnya. [Indonesian]

Ferdin AE, Aryal UC, Dhungana N, Lamichhane BR, Chook JW, Lee CH. 2024. Prioritizing human-wildlife conflict management strategies through importance-performance analysis: Insights from Chitwan National Park, Nepal. J Nat Conserv 81: 126675. DOI: 10.1016/j.jnc.2024.126675.

Hill CM. 2004. Farmers' perspectives of conflict at the wildlife-agriculture boundary: Some lessons learned from African subsistence farmers. Hum Dimensions Wildl 9 (4): 279-286. DOI: 10.1080/10871200490505709.

Hilmi E, Sari LK, Cahyo TN, Muslih, Mahdiana A, Samudra SR. 2021. The affinity of mangrove species using Association and Cluster Index in North Coast of Jakarta and Segara Anakan of Cilacap, Indonesia. Biodiversitas 22 (7): 2907-2920. DOI: 10.13057/biodiv/d220743.

Kidane EE, Gebremichael Weldetnsae B, Siyum ZG, Yirga G, Kidane Yigzaw T. 2024. Human-carnivore conflict in and around Kafta Sheraro National Park, Northern Ethiopia: Determinants, costs, and conservation implications. Intl J Zool 2024 (1): 8309142. DOI: 10.1155/2024/8309142.

Kissinger, Syahrin NA, Muhayah NP R, Violet. 2020. The potential of mangrove forest as natural tourism area based on the flora-fauna characteristics and social aspect case study: Mangrove forest in Angsana Village. BIO Web Conf 20: 02004. DOI: 10.1051/bioconf/20202002004.

König HJ, Kiffner C, Kramer-Schadt S, Fürst C, Keuling O, Ford AT. 2020. Human-wildlife coexistence in a changing world. Conserv Biol 34 (4): 786-794. DOI: 10.1111/cobi.13558.

Kupika OL, Mutanga CN, Mapingure C, Muboko N, Chiutsi S. 2024. Climate change, human-wildlife interactions and sustainable tourism nexus in protected areas. Front Sustain Tour 3: 1483742. DOI: 10.3389/frsut.2024.1483742.

Makmur A, Riandi LV, Siregar AW, Armanda F. 2024. Evaluasi konflik masyarakat dengan satwa liar di Desa Tongra Kecamatan Teragun Kabupaten Gayo Lues. Jurnal Hutan Pulau-Pulau Kecil 8 (1): 51-60. DOI: 10.30598/jhppk.v8i1.12867. [Indonesian]

Massei G, Kindberg J, Licoppe A, Gačić D, Šprem N, Kamler J, Baubet E, Hohmann U, Monaco A, Ozoliņš J, Cellina S. 2015. Wild boar populations up, numbers of hunters down? A review of trends and implications for Europe. Pest Manag Sci 71 (4): 492-500. DOI: 10.1002/ps.3965.

Osland MJ, Hughes AR, Armitage AR, Scyphers SB, Cebrian J, Swinea SH, Shepard CC, Allen MS, Feher LC, Nelson JA, O'Brien CL. 2022. The impacts of mangrove range expansion on wetland ecosystem services in the southeastern United States: Current understanding, knowledge gaps, and emerging research needs. Glob Chang Biol 28 (10): 3163-3187. DOI: 10.1111/gcb.16111.

Rahmayana L, Handayani W. 2019. Ketahanan masyarakat pesisir Kecamatan Kampung Laut dalam menghadapi penyusutan laguna Segara Anakan. Jurnal Pembangunan Wilayah dan Kota 15 (2): 96-107. DOI: 10.14710/pwk.v15i2.22157. [Indonesian]

Setyawan AD, Nurkhasanah A, Trapsilasiwi D. 2022. Ritual food practices and conservation values in the karst area of Pracimantoro, Indonesia. J Ethnobiol Conserv 11: 35. DOI: 10.15451/ec2022-05-11.35-1-15.

Treves A, Karanth KU. 2003. Human-carnivore conflict and perspectives on carnivore management worldwide. Conserv Biol 17 (6): 1491-1499. DOI: 10.1111/j.1523-1739.2003.00059.x.

Ullah N, Basheer I, Rehman FU, Zhang M, Khan MT, Khan S, Du H. 2024. Livestock depredation by large carnivores and human-wildlife conflict in two districts of Balochistan Province, Pakistan. Animals 14 (7): 1104. DOI: 10.3390/ani14071104.

Ulya LM, Sanjatmiko P. 2018. The household dynamism of a community to survive the landscape changes: the Case Study of Kampung Laut Community in Segara Anakan, Cilacap, Indonesia. Intl Conf Issues Soc Educ Res (ICISER) 2017: 40-45.

Zimmermann A, McQuinn B, Macdonald DW. 2020. Levels of conflict over wildlife: Understanding and addressing the right problem. Conserv Sci Pract 2 (10): e259. DOI: 10.1111/csp2.259.