



Sea turtle protection in Indonesia: A review of constitutional and customary regulations

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ABSTRACT

Sea turtles have been a conservation priority in Indonesia since 1978. Despite numerous regulations at national, regional, and local levels, sea turtle populations and habitats continue to decline. This study assessed current national and provincial (Aceh) regulations for sea turtles using text mining and an extensive review to identify strengths, weaknesses, gaps, and overlap. Local customary law (Hukum Adat Laot) from Aceh was included as a case study to compare constitutional and customary approaches to sea turtle conservation. The analysis of 47 terms across four categories—species, habitat, management, and protection—revealed six institutions involved in conservation, with the Ministry of Marine Affairs and Fisheries (MMAF) having the highest regulatory presence. However, substantial regulatory and institutional overlap was found, with no single institution clearly mandated to lead sea turtle protection. National and provincial regulations primarily emphasised management-related terms (50.19% in Aceh; 43.03% nationally), while species-specific and life-stage-related terms were rarely recognised. In contrast, the customary law Hukum Adat Laot demonstrated stronger provisions in the ‘species’ and ‘habitat’ categories, including explicit bans on adult turtle capture, regulated egg harvesting, and protections for nesting and foraging habitats. Effective management is often hindered by gaps and overlap in regulatory frameworks, which can lead to unclear jurisdiction, conflicting policies, and inefficiencies in enforcement. These challenges can create barriers to coordinated conservation efforts, making it difficult to implement consistent and effective protection measures for sea turtles. Although institutional and regulatory overlap pose challenges, integrating customary law into national conservation frameworks presents an opportunity to enhance species-specific protections, strengthen local engagement, and improve coordination. Recognising *Hukum Adat Laot* as an Other Effective Area-Based Conservation Measure (OECM) could improve enforcement and ecological outcomes for sea turtle conservation in Indonesia.

1. Introduction

Indonesia houses several hotspots for sea turtle populations, which are vital for the global conservation effort of six of the seven sea turtle species existing worldwide: green turtles (*Chelonia mydas*), loggerhead turtles (*Caretta caretta*), hawksbill turtles (*Eretmochelys imbricata*), leatherback turtles (*Dermochelys coriacea*), olive ridley turtles (*Lepidochelys olivacea*), and flatback turtles (*Natator depressus*) (Pike, 2013; Tapilatu et al., 2013; Bailey et al., 2012; Hays, 2008; Wallace and Saba, 2009; Mazaris et al., 2014). Nesting beaches are widely distributed across the archipelago, from Sumatra in the west to Papua in the east, while Indonesian waters provide foraging and migration habitats for

populations from the Indian and Pacific Oceans (Pike, 2013; Bailey et al., 2012; Rumaida et al., 2021; Maslim, 2016; Bowen and Karl, 2007; Wallace et al., 2011; Hitipeuw et al., 2007). As with other global populations, sea turtle populations in Indonesia are threatened by anthropogenic impacts (Mazaris et al., 2014; Wallace et al., 2011; Hamann et al., 2010). Overexploitation, pollution, incidental bycatch, illegal trade, and habitat degradation all contribute to population declines while burgeoning tourism and coastal development increasingly disrupt critical nesting and foraging sites (Morissette et al., 2012; Palacios-Abarrantes et al., 2020; Roe et al., 2013; Pauwelussen and Swanson, 2022; Gomez and Krishnasamy, 2019). For example, the population of leatherback turtles at Jamursba Medi (Papua Barat) has declined by 78.3%

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over 27 years (Tapilatu et al., 2013; Dutton et al., 2007; Benson et al., 2015), and green turtle populations have decreased by over 50% in Berau (East Kalimantan) and Pangumbahan (West Java) within just the past decade (Wiadnyana and Nastiti, 2013; Fathulloh et al., 2021; Adnyana et al., 2008).

In response to these threats, sea turtles have been designated a conservation priority species since 1978 in Indonesia. On a regional level, currently, 14 Regional Management Units (RMUs) are recognised in Indonesia, out of 50 RMUs for all sea turtle species that have been identified globally (Wallace et al., 2010; Komoroske et al., 2017; Wallace et al., 2023). This concept of Regional Management Units (RMUs), which groups the populations based on genetic, nesting, and migration data, was introduced in 2010 and updated in 2023 to optimise global conservation efforts for sea turtle populations (Wallace et al., 2010; Komoroske et al., 2017; Wallace et al., 2023). Within Indonesia, there subsequently numerous regulations by the Indonesian government across various organisational levels, including national and regional (provincial and regency) scales. Despite numerous regulations, sea turtle populations and habitats continue to decline (Tapilatu et al., 2013; Wiadnyana and Nastiti, 2013; Fathulloh et al., 2021; Wiadnyana, 2004; Sloan et al., 1994), raising concerns about current conservation governance.

The complex legislation and institutional structure may complicate management efforts, making coherent conservation strategies challenging to implement (Månsson et al., 2023; Booth et al., 2020; Sahri et al., 2020). This complexity often leads to regulatory overlap (RO), where multiple legal instruments govern similar aspects of conservation, and institutional overlap (IO), where multiple agencies share authority over the same resources. While some degree of overlap can enhance resilience and provide multiple avenues for enforcement, excessive overlap can create unclear responsibilities, duplicative efforts, and conflicting mandates, weakening conservation outcomes (Sahri et al., 2020; Thorburn, 2000). For example, in the United States, overlapping regulatory frameworks have necessitated inter-agency collaboration to address governance inefficiencies (Imperial, 2005). Similar challenges have been observed in marine policy, where uncoordinated mandates between fisheries and environmental bodies have hindered implementation (Ehler et al., 1997). In the context of sea turtle conservation, such overlaps could delay decision-making, dilute regulatory authority, and create enforcement gaps.

These challenges are compounded by the life history of sea turtles. As long-lived migratory reptiles, sea turtles occupy multiple habitat types over the course of their life cycle: coastal and pelagic nurseries for early juveniles, demersal developmental areas for older juveniles, coastal foraging grounds for adults, and beaches for nesting (Hamann et al., 2010). These spatial and jurisdictional demands heighten the potential for administrative overlap, making a thorough review of the legal and institutional landscape critical to improving the coherence and effectiveness of sea turtle conservation efforts in Indonesia.

In addition to constitutional laws and regulations, at the site level, in certain areas, sea turtles are also managed by local communities through customary laws (Priambodo, 2018; Judge and Nurizka, 2008; McLeod et al., 2009; Albartin, 2019; Boli et al., 2014). Across Indonesia, several customary systems regulate access to marine resources, including sea turtles. These include Sasi in Maluku and Raja Ampat, Awig-Awig in West Nusa Tenggara, Papadak in Rote, and Hukum Adat Laot in Aceh. These systems often involve seasonal closures, taboos on species or gear use, and community-enforced sanctions, supporting both ecological conservation and cultural continuity. For instance, coastal communities in Aceh enforce a customary law called “Hukum Adat Laot” (Abdullah et al., 2018). Within this system, sea turtles are recognised as important marine species, and their utilisation is regulated. While hunting adult sea turtles is generally prohibited, local communities are permitted to collect sea turtle eggs only under specific conditions, with restrictions on designated areas and collection periods, requiring that some eggs remain in the nest to ensure population sustainability, and limiting

harvested eggs strictly to personal consumption (Abdullah et al., 2018; Mansur and Marzuki, 2018). This customary law is administered by the *Panglima Laot*, or “sea commander”, who is responsible for enforcing community-based regulations (Abdullah et al., 2018; Keliat et al., 2021). Both *Hukum Adat Laot* and *Panglima Laot* are legacies of the Aceh Kingdom era that still exist and continue to operate today (Judge and Nurizka, 2008; Abdullah et al., 2018). While certain aspects of this customary law align with constitutional laws, *Hukum Adat Laot* exhibits distinct approaches, warranting further exploration to enhance future sea turtle conservation efforts in Indonesia.

Through a structured text analysis of regulations on sea turtles in Indonesia, we aim to answer three questions: (1) How do current regulations acknowledge and protect sea turtles and their habitats, and which institutions are responsible for these regulations? (2) What is the current focus in sea turtle management, and do these regulations address different life-history stages and habitats? and (3) Using Aceh as a case study, how do national constitutional laws (formal legal instruments issued by central government agencies), provincial constitutional laws (regional regulations enacted by the Provincial Government of Aceh), and customary laws (community-based traditional rules such as *Hukum Adat Laot*) differ in their approaches to protecting sea turtles and their habitats? With this comprehensive review, we aim to identify strengths, weaknesses, gaps, and overlap within Indonesia’s regulatory framework and discuss areas to optimise sea turtle conservation.

2. Methods

2.1. Data collection

This study focuses specifically on national-level legislation and provincial-level regulations from Aceh (Fig. 1). Policy documents issued by the national governments (including relevant ministries) and provincial governments related to sea turtles were collected from peraturan.go.id, peraturan.bpk.go.id, jdih.kkp.go.id, and jdih.menlhk.go.id (Sahri et al., 2020). The documents were acquired since sea turtles were protected by the Indonesian government from 1978 to 2022 and were divided into periods of 10 years (Fig. 2). A total of 48 ‘terms’ in *Bahasa Indonesia* (S1) representing the categories of the species, habitat, management, and protection of sea turtles, were used for text mining (Sadili et al., 2015; Cookey et al., 2017). These terms were developed based on conservation needs identified in the Global Conservation Priorities for Marine Turtles (Wallace et al., 2011, 2025), and were selected to reflect key aspects of sea turtle conservation relevant to regulatory frameworks in Indonesia. While no formal stakeholder validation was conducted, the terms were aligned with commonly used terminology in Indonesian environmental and fisheries legislation. After getting results from text mining, all 48 ‘terms’ in *Bahasa Indonesia* were then translated into English, resulting in 47 ‘terms’ in English (‘jenis’ and ‘spesies’ in *Bahasa Indonesia* merged into one term ‘species’ after being translated to English, S1) for further analysis. In addition to frequency-based text mining, we conducted a qualitative content analysis to interpret the legal context in which key terms appeared. This approach allowed us to assess whether institutional mentions represented formal mandates, supporting roles, or general references, ensuring a more accurate understanding of institutional responsibilities.

Customary laws from Aceh (*Hukum Adat Laot*), with a focus on Aceh Jaya, were selected as a case study due to the availability of information and the explicit inclusion of sea turtles in these laws (Fig. 3). Although *Hukum Adat Laot* is primarily an oral tradition with no formalised legal codification, aspects of these customary laws have been documented in various reports, academic publications, and legal studies. In the case of Aceh Jaya, a formal record titled ‘*Hukum Adat dan Adat Laot Lhok Kabupaten Aceh Jaya*’, published by Lembaga Hukum Adat Laot Kabupaten Aceh Jaya (Anas et al., 2022), provides documented insights into these laws. Additional information on *Hukum Adat Laot* was compiled from other available sources, including governmental reports,

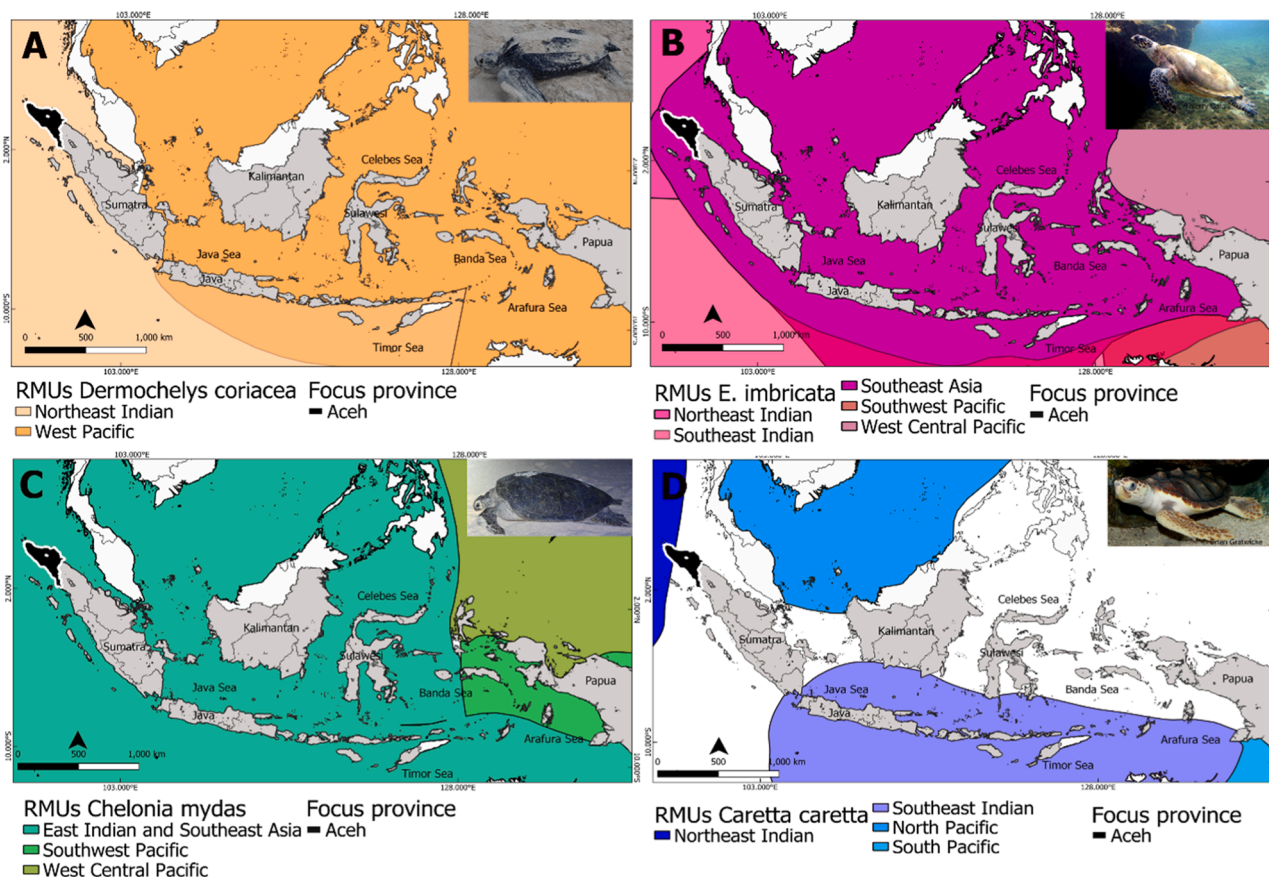


Fig. 1. Regional Management Units (RMUs) distribution of four of six sea turtle species in Indonesia (Wallace et al., 2023) and the focus province that was used for this study. Sea turtle species from left to right (top): A. *Dermochelys coriacea*, B. *Eretmochelys imbricata*, and (bottom) C. *Chelonia mydas*, D. *Caretta caretta*. Note: Regional Management Units (RMUs) of *Lepidochelys olivacea* and *Natator depressus* are not included on the Map as they only have one RMU in the Pacific.

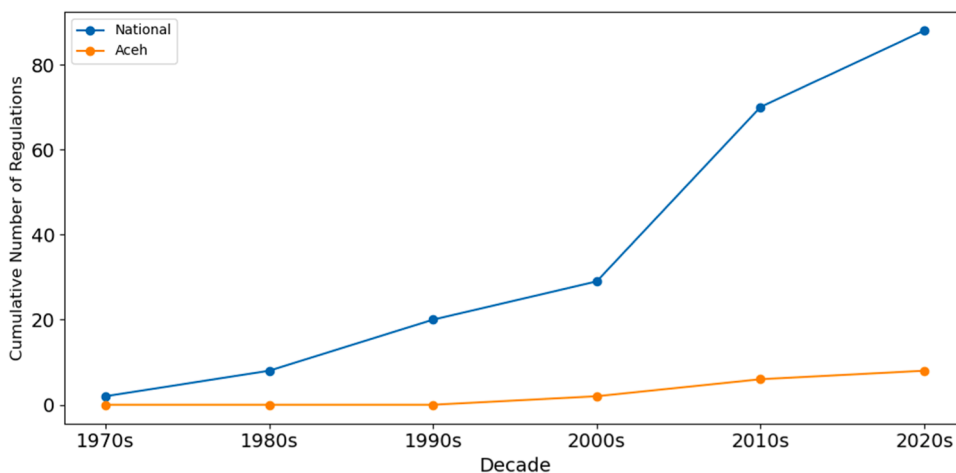


Fig. 2. Cumulative number of active constitutional regulations related to sea turtle protection and management in Indonesia per decade (S2).

articles, and NGO publications (Abdullah et al., 2018; Mansur and Marzuki, 2018; Reni, 2018). Given the nature of the data, Hukum Adat Laot was excluded from the text-mining analysis, and instead, a comprehensive qualitative review was conducted to analyse all collected documents and interview findings related to these laws (Fig. 4) (Sahri et al., 2020).

2.2. Data analysis

A total of 96 documents of constitutional laws (1978–2022), comprising 88 national constitutional laws and eight provincial constitutional laws from Aceh, were assessed and categorised into their specific function: species, habitat, management, and protection. We used the tool of text mining that is for term-count-frequencies using Term Document Matrix (TDM) and Agency Document Matrix (ADM) in both national and regional documents (Cookey et al., 2017; Pita et al., 2020).



Fig. 3. Management areas of Hukum Adat Laot in Aceh Jaya Regency (Aceh Marine and Fisheries Agency, 2024). Each shaded coastal zone represents a distinct Lhok (estuary or bay), with its own Hukum Adat Laot and local customary governance system. These areas are individually managed by appointed Panglima Laot, demonstrating site-specific community-based conservation across the region.

The text mining analysis was applied exclusively to the main body of each legal document and did not include the elucidation sections (*penjelasan undang-undang*), as these sections were not uniformly available across all document types. All analysis was done in Python 3 using nltk, sklearn, sastrawi, and pandas libraries (Fig. 5) (Pedregosa et al., 2011; Bird et al., 2009; McKinney, 2010; Bird et al., 2009; Van Rossum and Drake, 2009).

The Term Document Matrix (TDM) was used to organise the terms in tables according to their frequency of occurrence in each document analysed. Furthermore, the Agency Document Matrix (ADM) was compiled to identify particular institutions mentioned in the regulation as the responsible organisations for implementing the provisions of the regulations. Each institution was given a score of one (1) if it was mandated under that regulation, a half point (0.5) if no specific institution was mandated, and zero (0) if no assignment (Cookey et al., 2017; Ekstrom and Lau, 2008). The distribution of the present constitutional laws and the involvement of each institution based on ADM results were shown in a Sankey diagram created with a plotly library in Python 3 (P. T. Inc., 2015).

Moreover, to assess overlapping in the current regulations and agencies, we used a formula from Cookey et al. 2017 to calculate Regulatory Overlap (RO) and Institutional Overlap (IO) (Cookey et al., 2017). RO was determined by dividing the number of regulations containing the Terms by the total number of regulations reviewed and multiplying by one hundred. IO was determined by dividing the number of agencies associated with the Terms by the total number of agencies reviewed and multiplying by one hundred. Furthermore, we used a degree of recognition for all terms to assess the current focus of constitutional laws related to sea turtles in Indonesia. This involved determining the degree of recognition for each term by dividing its frequency by the total term frequencies, multiplied by one hundred (Cookey et al., 2017). Overlapping and frequency analysis was done in Python 3 and visualised with the matplotlib package (Hunter, 2007).

We assessed six primary national and one provincial constitutional laws for sea turtle conservation; (1) Law No. 5/1990 on Conservation of Living Natural Resources and Their Ecosystems, (2) Government Regulation No. 7/1999 on Preservation of Flora and Fauna, (3) Government Regulation No. 8/1999 on Utilisation of Wild Flora and Fauna, (4) Law No. 31/2004 on Fisheries (as amended by Law No. 45/2009), (5) Government Regulation No. 60/2007 on Fish Resources Conservation, (6) Government Regulation No. 28/2011 on the Management of Nature Reserves and Nature Conservation Areas (as amended by Government Regulation No. 108/2015) and Qanun 11/2019 on the Management of Wildlife; and Hukum Adat Laot Aceh Jaya using structured scoring schemes to reflect the contents of the laws related to sea turtle conservation. These primary constitutional laws were selected because they represent the highest legal framework used as the basis for managing and conserving sea turtle species and incorporate penalty systems within their provisions. The assessment criteria were informed by existing frameworks for legal gap analysis and biodiversity policy evaluation, as well as by previous studies that have applied structured content analysis to conservation legislation (Cookey et al., 2017; Guerrero et al., 2021; Reinsberg, 2024; Meilana et al., 2023; Ghazinoory and Aghaei, 2021). A total of 20 questions from four categories (species, habitat, management, and protection) were used to identify gaps, overlaps, and differences between constitutional law and customary law (S3). Questions and scoring were formulated based on the Evaluation of the Effectiveness of Conservation Area Management (EVIKA) approach developed by the Ministry of Marine Affairs and Fisheries (MMAF), and the policy assessment framework proposed by Ghazinoory and Aghaei (2021) were adapted here to evaluate regulatory content specifically related to sea turtle conservation (Meilana et al., 2023; Ghazinoory and Aghaei, 2021). Percentages were calculated by dividing the total score per category by the maximum possible score for that category and then multiplying by one hundred. A radar chart was used to visualise the total score of each category gained by the regulations. In addition, we also

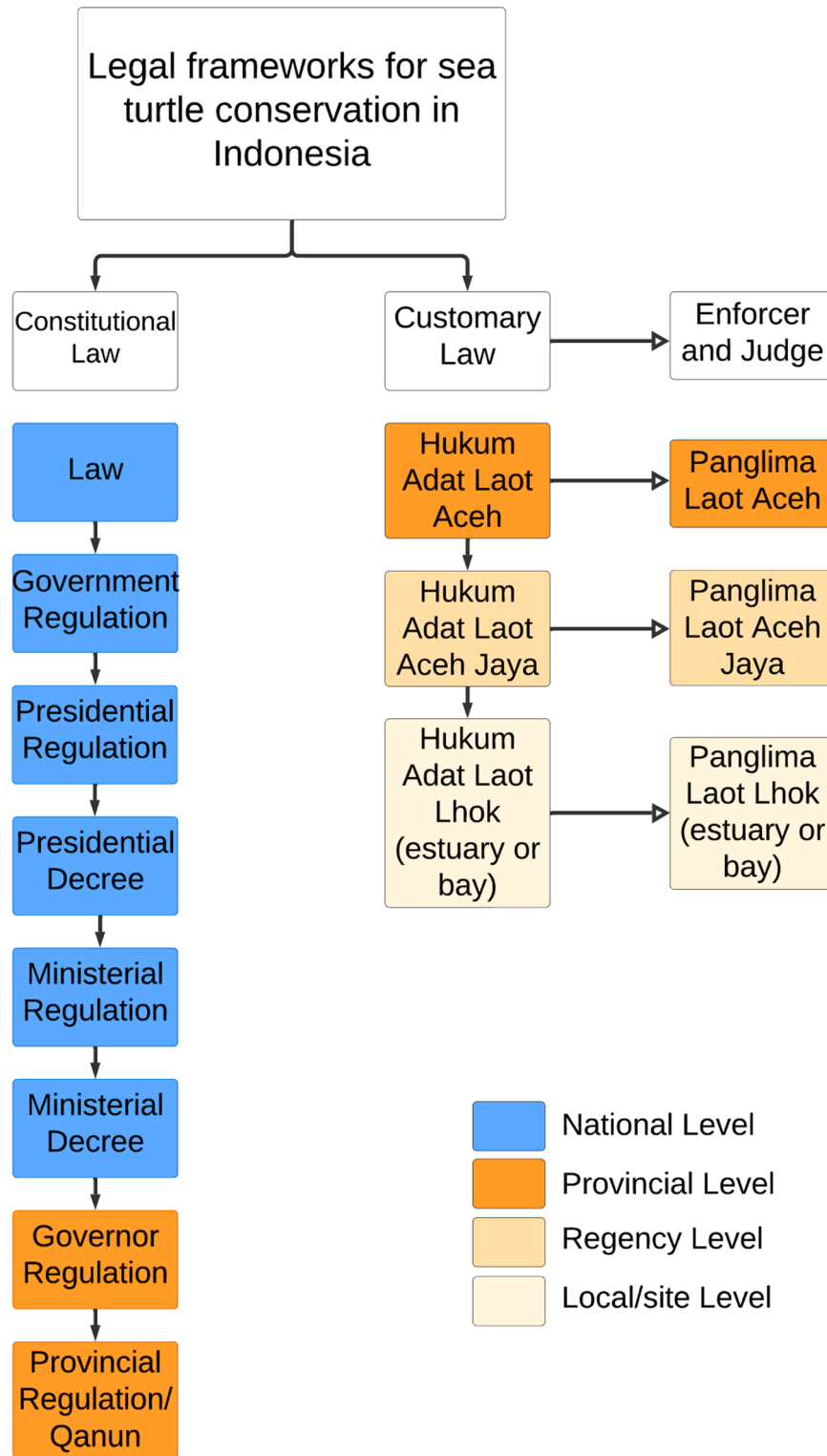


Fig. 4. Legal frameworks for sea turtle conservation in Indonesia. The figure illustrates two governance systems: constitutional law (left), showing the national to provincial legal hierarchy, and customary law (right), represented by Hukum Adat Laot in Aceh. Enforcement in the Hukum Adat Laot is led by the Panglima Laot at each jurisdictional level. Colour coding indicates governance level (national, provincial, regency, local/site).

summarised the core aspects (content analysis) of both laws to show the difference between the regulations.

3. Results

3.1. Institutional involvement in the management of sea turtles in the current constitutional regulations

Our findings highlight the complex and multi-level governance

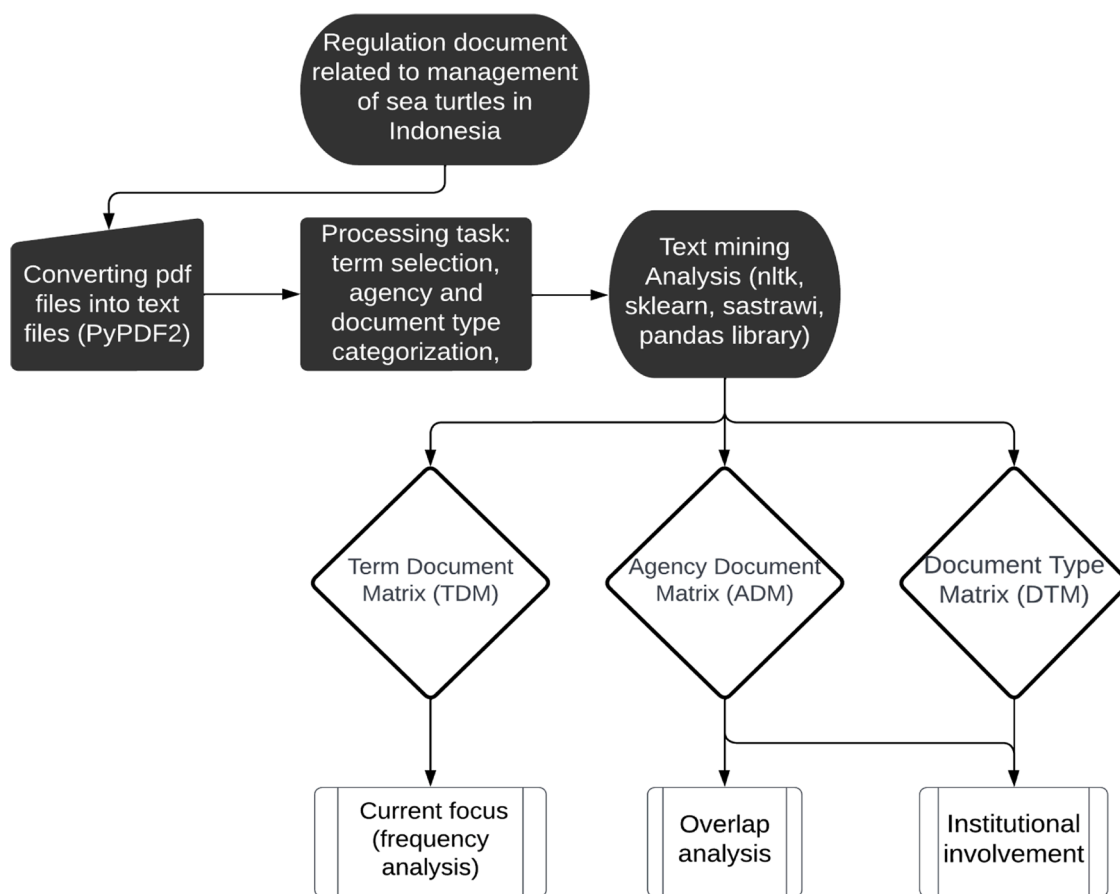


Fig. 5. Workflow of text mining analysis used to evaluate Indonesian sea turtle conservation regulations. PDF documents were converted to text, processed for term selection and classification, and analysed using NLP tools in Python 3 (NLTK, scikit-learn, Sastrawi, pandas). Three matrices were produced: the Term Document Matrix (TDM) for identifying current conservation focus, the Agency Document Matrix (ADM) for assessing institutional overlap, and the Document Type Matrix (DTM) for evaluating institutional involvement. These outputs informed frequency, overlap, and governance structure analyses.

structure of sea turtle conservation in Indonesia, where ministerial agencies play the most significant role, while regional governments have a lower but still notable involvement (Table 1). Based on the Agency Document Matrix (ADM) (S4), the Ministry of Maritime Affairs and Fisheries (MMAF) has the highest recognition and involvement score ($t = 60.5$), followed by the Ministry of Environment and Forestry (MoEF) ($t = 21.5$) and the National Research and Innovation Agency (BRIN) ($t = 18.5$), while the Ministry of Agriculture (MoA) has the lowest involvement ($t = 16.5$) (Table 1). At the regional level, the regency government ($t = 17.5$) is slightly more involved than the provincial government ($t = 15.5$), indicating a greater role in implementation.

From 1978 to 2022, various government institutions issued 88

national and eight provincial constitutional laws in Aceh related to sea turtle protection and management. These documents were categorised into different types of legislation: Laws (14), Government Regulations (12), Presidential Regulations (5), Presidential Decrees (3), Ministerial Regulations (18), Ministerial Decrees (36), Provincial Regulations (7), and Governor Regulations (1). Six institutions have been identified as key stakeholders in sea turtle management and protection since legal protections were first introduced in 1978 (Fig. S1). These findings underscore the challenges posed by regulatory fragmentation and overlapping mandates, which may lead to inconsistencies in implementation, enforcement gaps, and inefficiencies in conservation efforts. Given the involvement of multiple institutions across different

Table 1

Institutional involvement across different types of constitutional regulations related to sea turtle conservation in Indonesia (1978–2022). The total number of reviewed legal documents is indicated in parentheses for each regulation type (n). The recognition and involvement score (t) was determined using the Agency Document Matrix (ADM), which identifies institutions explicitly mentioned in the regulations as responsible for implementing specific provisions.

Agency	BRIN	MoA	MoEF	MMAF	Provincial Government	Regency Government
Law (n=14)	6.5	6.5	6.5	6.5	7.5	6.5
Government Regulation (n=12)	6.5	4.5	4.5	3.5	3.5	3.5
Presidential Regulation (n=5)	2	2	2	3	2	2
Presidential Decree (n=3)	1	1	2	1	1	1
Ministerial Regulation (n=18)	2	0	3	13	0	0
Ministerial Decree (n=36)	0	2	3	31	0	0
Provincial Regulation (n=7)	0.5	0.5	0.5	1.5	1.5	4.5
Governor Regulation (n=1)	0	0	0	1	0	0
recognition and involvement score (t)	18.5	16.5	21.5	60.5	15.5	17.5

Note: MMAF: Ministry of Maritime Affairs and Fisheries, MoEF: Ministry of Environment and Forestry, MoA: Ministry of Agriculture, BRIN: National Research and Innovation Agency.

levels of governance, stronger coordination mechanisms and policy alignment are crucial to enhancing conservation effectiveness.

3.2. Overlap in regulations and institutions in managing sea turtles

Our analysis revealed substantial regulatory and institutional overlap in sea turtle conservation governance, with notable variations across different conservation categories (Fig. 6). The ‘Habitat’ category exhibited the highest levels of overlap, with an average regulatory overlap of 41.55% and an institutional overlap of 79.63%, indicating a complex regulatory framework that could affect the implementation of sea turtle conservation. In contrast, the ‘Species’ category had the lowest overlap, with regulatory and institutional overlaps averaging 18.31%

and 59.72%, respectively. While lower institutional overlap suggests more streamlined management, lower regulatory overlap may indicate inadequate coverage of species-specific conservation measures, potentially leading to gaps in protection efforts.

From 47 key terms related to sea turtle conservation, we identified a complex pattern of regulatory (RO) and institutional (IO) overlaps, present in nearly all constitutional laws at both the national and Aceh levels. Multiple legal instruments and institutions frequently share overlapping mandates. In terms of regulatory overlap (RO), the term “protection” exhibited the highest overlap at 91.67% (S5), indicating that multiple regulations address this aspect. In contrast, the terms “shell” and “bycatch” showed no regulatory overlap (1.04%), as they were each covered by only a single regulation. Furthermore, in

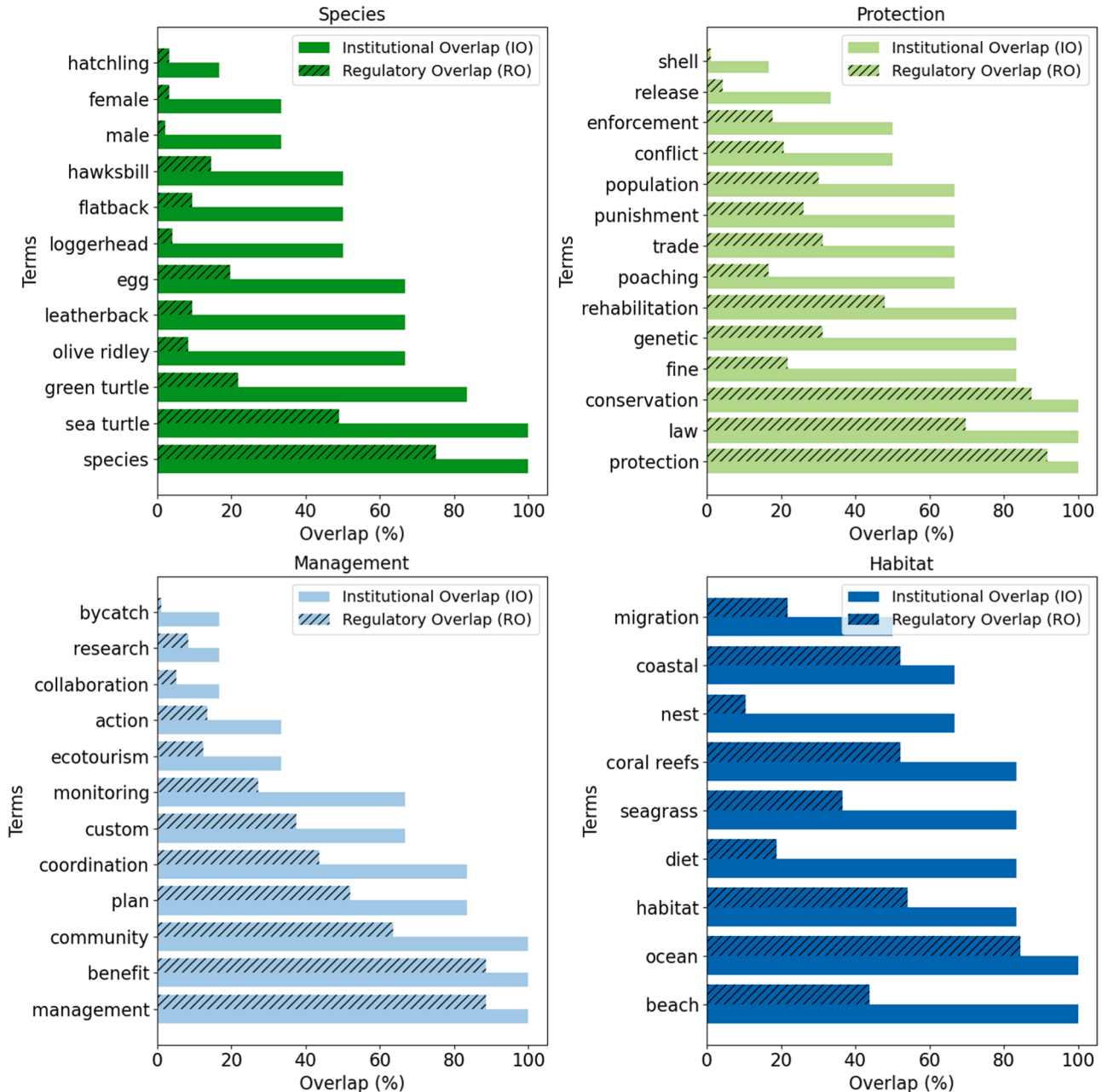


Fig. 6. Institutional and regulatory overlap per category was extracted from the overlap analysis on all legislation documents (Aceh and National) reviewed. Note: Regulatory Overlap represents the proportion of constitutional laws containing a specific term, reflecting the extent to which multiple regulations address the same issue. A 100% regulatory overlap indicates that all 94 reviewed documents address the same issue. Institutional Overlap represents the proportion of agencies responsible for terms related to sea turtle conservation, showing how many institutions share overlapping mandates for the same issue. A 100% institutional overlap indicates that all 6 institutions involved in sea turtle management are responsible for the same issue.

institutional overlap (IO), the terms “shell” and “bycatch”, along with “hatchlings”, “research”, and “collaboration”, were also only addressed by a single institution, indicating no institutional overlap. Conversely, ten other terms, including “species”, “sea turtles”, “protection”, “management”, and “conservation”, demonstrated complete institutional overlap (100%), highlighting potential redundancy in agency responsibilities.

3.3. Current focus for sea turtle management in Indonesia

Our analysis revealed that the current conservation focus for sea turtles in Indonesia is similar at both the national and Aceh (provincial)

levels across the four categories analysed: ‘Species’, ‘Habitat’, ‘Management’, and ‘Protection’. The ‘Species’ category had the lowest recognition rates, with only 5.12% in Aceh and 9.1% nationally (S6). In contrast, the ‘Management’ category, which includes the terms “benefit”, “plan”, and “community”, demonstrated the highest recognition across both levels of legislation, with Aceh laws recognising this category at 50.19% and national laws at 43.03%.

In addition, when examining the terms with the highest recognition rates per category, Aceh and National legislation differed significantly in the ‘Protection’ and ‘Management’ categories (Fig. 7). In Aceh, the terms “protection” (5.53%) and “conservation” (5.15%) were the most recognised in the ‘Protection’ category, whereas at the national level,

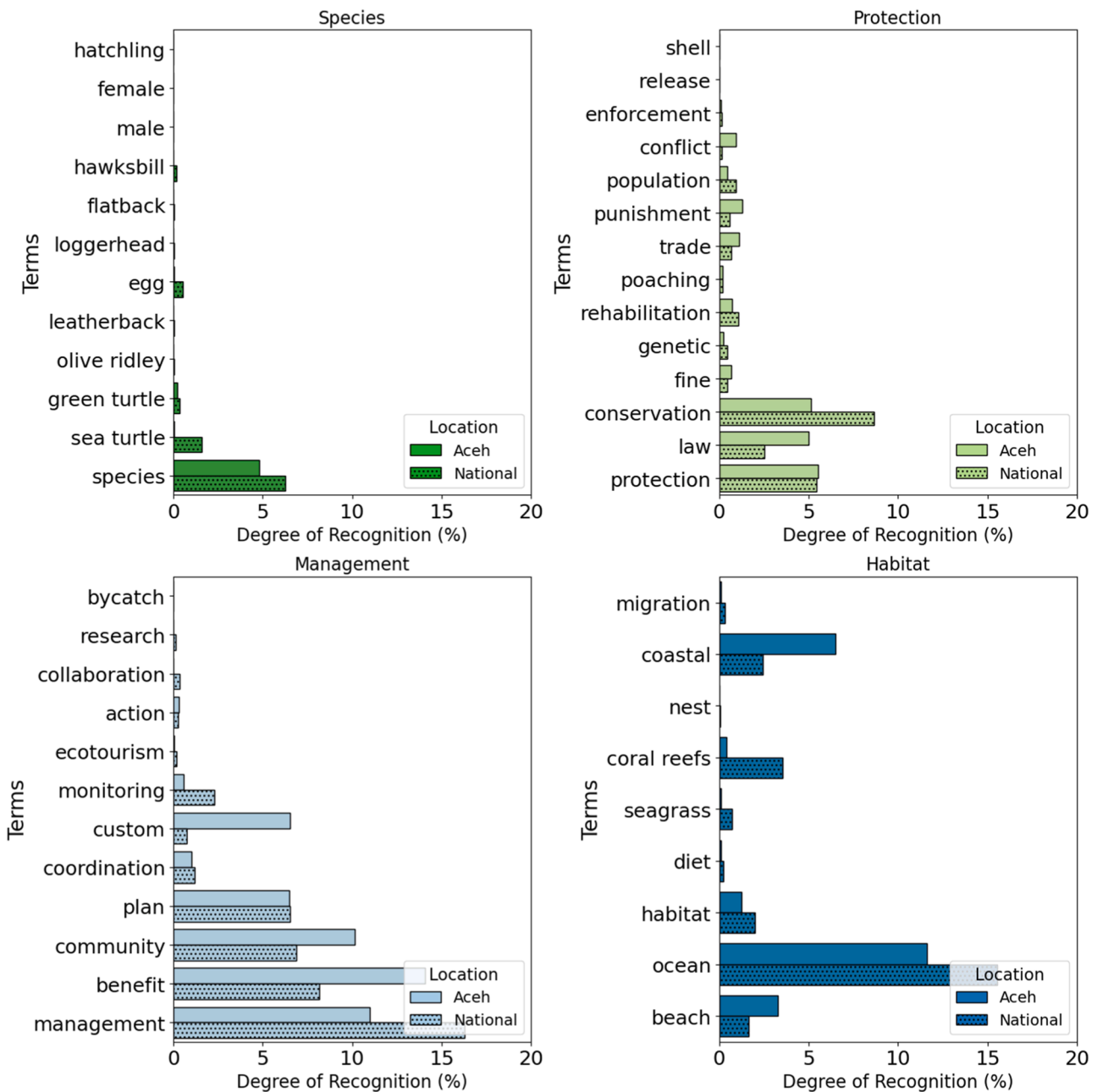


Fig. 7. The current focus of sea turtle management in Aceh and National laws. Recognition scores are calculated based on the frequency with which relevant terms appear within the text of each reviewed regulation, highlighting the legislative focus on different conservation aspects at both provincial (Aceh) and national levels. This figure highlights the recognition of key terms for sea turtle conservation in Aceh and National legislation. Significant legislative gaps were shown in species-related terms in both Aceh and National laws. While management-related terms received higher recognition, crucial aspects such as bycatch, research, and collaboration remained underrepresented. These findings underscore the need for a more balanced legislative approach to address gaps across all areas essential to supporting sea turtle conservation.

"conservation" (8.67%) was the primary focus. In the 'Management' category, Aceh emphasised the term "benefit" with the highest frequency at 14.0%, while at the national level, the term "management" appeared most frequently at 16.29%, primarily in reference to resource management. These differences likely reflect regional emphasis in the implementation of national conservation directives to local contexts rather than representing distinct or independent strategies.

Furthermore, in terms of life stage and habitat recognition, most terms in the 'Species' and 'Habitat' categories showed low recognition rates. In Aceh, 13 terms related to species and life stages ("olive ridley", "leatherback", "loggerhead", "flatback", "hawksbill", "hatchling", "male", and "female") were recorded with zero frequency. At the national level, these terms also showed almost zero recognition. Species-specific mentions were found only in the Ministry of Environment and Forestry Regulation No. P.106/MENLHK/SETJEN/KUM.1/12/2018 and the Ministry of Marine Affairs and Fisheries Decree No. 65 of 2022 concerning the National Action Plan for Sea Turtles 2022–2024, where sea

turtles are listed as protected species. However, neither regulation provides management directives tailored to specific species or life stages. In contrast, terms related to habitats were addressed frequently in both Aceh and National laws (S6). Terms such as "ocean", "coral reefs", "coastal", and "beach" were recognised at rates exceeding 1% in both jurisdictions, except for "coral reefs" in Aceh, which had a recognition score below 1%. These findings suggested that while habitat-related terms were more consistently addressed, significant gaps remained in the recognition of different life stages in both Aceh and National legislation.

3.4. Constitutional laws vs customary laws

Our assessment of gaps, overlap, and differences revealed distinct conservation priorities between Hukum Adat Laot and the six primary constitutional laws (Fig. 8). Hukum Adat Laot outperformed constitutional laws in the 'Species' and 'Habitat' categories, scoring 90% in each,

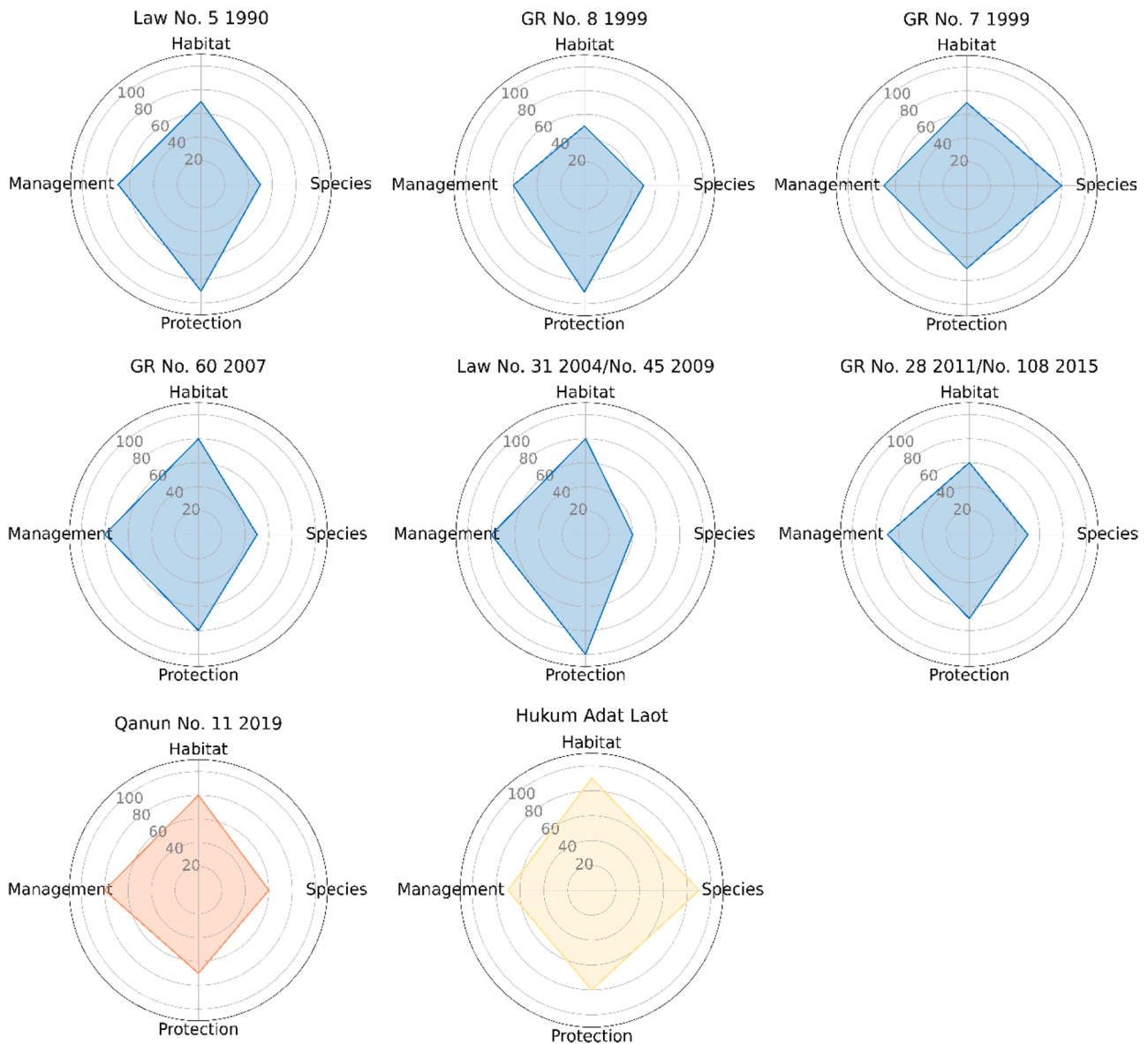


Fig. 8. Results of the comparative assessment of current regulations (constitutional laws and customary laws) in sea turtle conservation in Indonesia across four categories: Species, Habitat, Management, and Protection. The scores were derived using the EVIKA approach and the policy evaluation method to illustrate the comprehensiveness and specificity of each law in addressing the four conservation categories. Higher scores indicate stronger provisions or measures for sea turtle conservation (see S3 and S7).

Note: GR = Government Regulation.

demonstrating stronger provisions for species-specific conservation and habitat protection. Hukum Adat Laot explicitly addresses multiple life-history stages (S3, Q1a): it prohibits the capture of adult turtles at sea, regulates egg harvesting by requiring that some eggs remain in the nest and limiting collection strictly to personal consumption, and restricts access to nesting beaches during the nesting season to prevent disturbance. In addition, it protects nearshore foraging areas by prohibiting destructive fishing practices such as bombing and trawling in traditional fishing zones used by sea turtles (Table 2). Conversely, constitutional laws placed greater emphasis on the ‘Management’ and ‘Protection’ categories. Law No. 31/2004 (as amended by Law No. 45/2009) achieved a perfect score (100%) in ‘Protection’ due to its explicit prohibition on harmful fishing gear (S3, Q4c) and a clearly defined punishment system, including administrative and criminal sanctions for violations (S3, Q4d). In the ‘Management’ category, both Law No. 31/2004 and Government Regulation No. 60/2007 scored 80%, particularly for provisions requiring the development of management plans for marine species and habitats (S3, Q3e), allowing for limited sustainable utilisation of sea turtles under strict regulation (Q3d), and formally involving local communities in management activities and consultation processes (Q3b and Q3c). These results indicate that national legislation places a strong emphasis on formal governance mechanisms, regulatory compliance, and structured stakeholder engagement, contrasting with the more integrated ecological and customary approaches found in Hukum Adat Laot.

This distinction is further reflected in the governance structures of each framework. While national laws recognise customary law in principle—for example, by requiring traditional practices to be considered in marine protected area designations—they do not institutionalise community leadership in enforcement (Table 3). In contrast, Hukum Adat Laot, led by the Panglima Laot in coordination with local authorities, operates through a shared management model that integrates traditional ecological knowledge with government oversight (Table 3).

4. Discussion

Indonesia has established a comprehensive legal framework for sea turtle conservation, involving multiple institutions that contribute to policy development and management. Our evaluation of the current regulatory framework revealed that six institutions are involved in the protection and management of sea turtles under the issued constitutional laws. There is a significant overlap in regulations and institutional responsibilities across various aspects of sea turtle conservation, which may reflect the interconnected nature of sea turtle conservation but may also create challenges in coordination, clarity of responsibilities, and enforcement. When comparing the primary constitutional laws with the customary law of Hukum Adat Laot, we observed that different approaches to sea turtle conservation were taken. Hukum Adat Laot incorporated a narrower yet more targeted scope and shared management responsibilities between the government and local communities. These findings highlight the need for regulatory frameworks that adopt a more integrated and balanced approach and cover more life-history traits and habitat needs of sea turtles, combining the strengths of the current constitutional laws and customary laws to effectively address gaps and overlaps in sea turtle conservation efforts.

4.1. Conservation of sea turtles in Indonesia: policy framework and institutional roles

Among the six key institutions identified, the Ministry of Maritime Affairs and Fisheries (MMAF) received the highest recognition and involvement score. This finding was further supported by qualitative content analysis (Tables 1 and 2), which confirmed that MMAF is frequently assigned formal mandates in the legal texts. The Ministry of Environment and Forestry (MoEF), meanwhile, retains legal authority over protected species, including sea turtles, under Government

Table 2

Description of six primary national and one provincial constitutional laws for sea turtle conservation and local customary laws of Hukum Adat Laot Aceh Jaya that are used for assessment.

Regulation	Main message
Law No.5/1990 on Conservation of Living Natural Resources and Their Ecosystems	Regulates all aspects of the conservation of living natural resources and their ecosystems through the protection of life support systems, preservation of the diversity of plant and animal species and their ecosystems, and sustainable use of living natural resources and their ecosystems. It categorises the types of nature reserve and nature conservation areas. The law also divides species into protected and unprotected species. It explicitly forbids the use of protected species and regulates the utilisation of wildlife.
Government Regulation No. 7/1999 on Preservation of Flora and Fauna	Divides species into protected and unprotected (six species of sea turtles are protected). The preservation and management of wildlife and their habitat are done through in-situ and ex-situ.
Government Regulation No. 8/1999 on Utilisation of Wild Flora and Fauna	Utilisation of protected species only for research, captivity, and exhibition purposes with a permit from the Minister.
Law No. 31/2004 on Fisheries (Amended by Law No. 45/2009)	This law classifies sea turtles as "fish" and primarily addresses fisheries conservation. Its provisions for fishery conservation and the establishment of aquatic conservation areas indirectly benefit sea turtles.
Government Regulation No. 60/2007 on Fish Resources Conservation	Conservation of fish ecosystems related to sea turtles (sea, seagrass, coral reef, mangrove, and beach) is mentioned in this regulation. The designation of aquatic conservation areas is guided by several criteria: a. Ecological aspects (including biodiversity, uniqueness, migration corridors, spawning grounds, and nursery areas), b. Social and Cultural (including local wisdom and customary practices) and c. Economic value. The regulation also divides fish into protected and unprotected species.
Government Regulation No. 28/2011 on the Management of Nature Reserves and Nature Conservation Areas	It categorises Nature Reserves Areas into a. nature reserves; and b. wildlife sanctuaries, and Nature Conservation Areas into a. national park, b. forest park and nature tourism park. All types of nature reserves and nature conservation areas are managed by the government. The management of species and their habitats encompasses activities such as species identification and inventory, monitoring, habitat and population maintenance, rescue efforts, and research.
Qanun Aceh No. 11/2019 on Wildlife Management	Establishes a provincial legal framework for the conservation and management of wildlife and their habitats in Aceh, incorporating local wisdom and participatory governance. It outlines the designation of protected species (including sea turtles), mandates the development of a five-year strategy and action plan, and regulates in-situ and ex-situ habitat and population management. The Qanun also addresses human-wildlife conflict mitigation, community involvement (including Panglima Laot), research and innovation, funding, and strict prohibitions against harming, trading, or disturbing protected species and habitats. It acknowledges

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Table 2 (continued)

Regulation	Main message
Hukum Adat Laot Aceh Jaya	and empowers local institutions, including community rangers and customary leaders, to support wildlife protection efforts. The Hukum Adat Laot of Aceh Jaya regulates taboo days for going to sea, fishing practices for local fishermen, and the imposition of customary sanctions. It also includes provisions for social and environmental preservation, such as banning destructive fishing gear that harms coral reefs, prohibiting the capture of turtles and other government-protected species, and protecting coastal vegetation. Regarding turtles and their habitats, customary laws forbid fishing in the core zones of marine conservation areas and prohibit the capture or use of adult turtles. Harvesting of turtle eggs is permitted in specific areas (not in protected areas), with restrictions that require approximately 20 eggs, or 20% of the clutch, to be left in the nest to ensure natural hatching, and that collected eggs are used solely for personal consumption ^a .

^a Extracted from documentation of customary law records of Aceh Jaya 2022 (Abdullah et al., 2018; Mansur and Marzuki, 2018; Anas et al., 2022)

Regulation No. 7/1999. However, sea turtles are also classified as “fish” under Government Regulation No. 60/2007, placing them within MMAF’s jurisdiction (Sahri et al., 2020). This dual classification contributes to jurisdictional overlap and complicates species-level conservation. This overlap is also mirrored in habitat management responsibilities, where MMAF administers 10 national Marine Protected Areas (MPAs) covering 5.34 million ha (18.80%), surpassing MoEF, which manages 30 MPAs covering 4.57 million ha (16.04%), despite the majority of MPAs, 371 sites covering 18.51 million ha (65.16%), being under the authority of provincial governments but still subject to MMAF supervision (Meilana et al., 2023; Estradivari et al., 2022b). At the same time, our analysis shows a lack of clear species-specific management, which potentially could lead to gaps in implementation and enforcement (Reinsberg, 2024).

A further challenge is the limited availability of ecological data on sea turtle populations in Indonesia (Wallace et al., 2023). While some nesting and foraging habitats are under formal protection, monitoring data remain sparse and are concentrated in only a few sites (Maslim, 2016; Hitipeuw et al., 2007; Wiadnyana and Nastiti, 2013; Adnyana et al., 2008; Wiadnyana, 2004; Benson et al., 2007). Many other nesting and foraging areas fall outside formal protection, and their status and ecological importance remain poorly documented due to the lack of systematic surveys. Furthermore, our analysis revealed a regulatory emphasis on the ‘management’ category compared to the ‘habitat’, ‘species’, and ‘protection’ categories in both Aceh and National governance frameworks. This broad administrative focus may overlook key biological needs (Martín-López et al., 2009; Hausdorf, 2021). Terms related to the ‘species’ category had the lowest recognition scores in both Aceh and national governance frameworks, suggesting that life-history stages (e.g., eggs, hatchlings, juveniles, adults) are not explicitly addressed in conservation policies. Additionally, the classification of sea turtles as “fish” (ikan) in national legislation illustrates the lack of tailored legal protections for their unique biological and ecological requirements. Research has shown that species-focused conservation strategies are more effective in promoting long-term population resilience and adaptation to climate change than broad habitat protection alone (Hausdorf, 2021; Bowgen et al., 2022). Integrating species-specific ecological and biological considerations into legislation

Table 3

Summary of different core aspects of constitutional laws and customary laws related to sea turtle management and conservation.

Essential points related to sea turtle management and conservation	Constitutional laws ^a	Hukum adat laot ^b
Regulations are known by the local community	The socialisation of regulations is crucial, as many government-issued laws related to coastal communities and fisheries management require community awareness and understanding (Muawanah et al., 2018).	It’s common knowledge in the coastal community (Abdullah et al., 2018).
Formation of the regulation	Initiated by the Government.	Sourced from local wisdom in the lives of coastal communities regarding marine issues based on the principle that marine resources are a gift from God that has value for the lives of humans and other living creatures (Keliat et al., 2021).
Socialisation of regulation	It is limited due to budget constraints and the necessity to cover as many areas as possible across Indonesia (Muawanah et al., 2018).	It has been passed down from generation to generation through Panglima Laot, primarily via oral traditions and Islamic community practices (Abdullah et al., 2018)
Duration of regulation	The oldest primary regulation was issued in 1990, and its duration is long-term until it is amended or revoked.	It has existed as a cultural heritage since the Pasai Kingdom in 1292, rooted in Islamic Sharia, and has evolved, adapting to changing governance systems and incorporating ecological conservation strategies (Abdullah et al., 2018; Reni, 2018; Mujiburrahman et al., 2021; Utama et al., 2020).
Coverage of the regulation	The coverage area for all six primary regulations is national, meaning they apply to all levels of administrative areas across the country.	The coverage of Hukum Adat Laot is specific to areas known as Lhok or Muara (estuary), which delineate one coastal area from another (Keliat et al., 2021).
Scope of the issue	The constitutional laws encompass the management of habitats and species, focusing on the protection of rare species and ecosystems such as coastal areas, mangroves, coral reefs, and seagrass beds, which are critical for sea turtles.	Hukum Adat Laot mandates days of abstinence from the sea for approximately 60 days per year, including during Khanduri Laot ceremonies, every Friday, Eid al-Fitr and Eid al-Adha, Independence Day, and the Tsunami Memorial Day. The regulated fishing practices under this law apply strictly to fish and other marine resources, not sea turtles, as the capture of adult turtles is strictly prohibited. Hukum Adat Laot also enforces bycatch reduction measures, habitat preservation, and the limited utilisation of sea turtle eggs, which may

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Table 3 (continued)

Essential points related to sea turtle management and conservation	Constitutional laws ^a	Hukum adat laot ^b
Species-specific approach	Sea turtles as protected species and prohibit activities such as hunting, capturing, trading, or consuming turtles or their products, including eggs and shells. There is a lack of detail specific to individual species' biological or ecological needs.	only be collected under specific conditions and for personal consumption. In addition, the use of coastal trawls (pukat darat) is prohibited during the nesting season, as such activities may disturb nesting females attempting to reach the beach and disorient hatchlings making their way to the sea. The system also integrates social, economic, and cultural practices (Abdullah et al., 2018; Keliat et al., 2021; Anas et al., 2022). Hukum Adat Laot explicitly recognises different life-history stages of sea turtles, including nests, eggs, hatchlings, and feeding grounds, and applies stage-specific conservation measures. Nesting areas and feeding grounds are protected from destructive activities, while the collection of eggs is strictly regulated, allowing only limited use under specific conditions to ensure natural hatching success. Hatchlings are protected from human disturbance, and any bycatch of juveniles or adults is discouraged through traditional fishing regulations that prohibit the use of destructive gear and restrict fishing activities in known turtle habitats. Additionally, the capture of adult turtles is strictly prohibited (Anas et al., 2022).
Main conservation focus	Management of marine resources, habitat conservation, fisheries regulation, and enforcement of marine protected areas.	Habitat and species protection, including restrictions on fishing practices, bycatch reduction, and species-specific conservation measures.
The institution that is responsible for managing the habitat and species according to the regulations	Multiple institutions, namely the Ministry of Environment and Forestry, the Ministry of Maritime Affairs and Fisheries, the Ministry of Agriculture, the National Research and Innovation Agency, and the Provincial and Regency Government.	Panglima Laot, in collaboration with village heads, local marine and fisheries services at the district and provincial levels, and other relevant government institutions.
Penalty system	Fine and a jail sentence	Fine and prohibited from going to sea for a period of three to seven days, and all catches are confiscated.

^a based on six primary constitutional laws related to sea turtle conservation

^b based on Hukum Adat Laot in Aceh Jaya

would enhance the effectiveness of existing regulations.

4.2. Limited governance in some conservation initiatives: overlapping issues?

Our analysis revealed contrasting levels of institutional and regulatory overlap in sea turtle conservation, with the 'species' category showing the lowest overlap and the 'habitat' category the highest. The low overlap in the 'species' category suggests that fewer institutions and regulations specifically address species-level protections, potentially creating gaps in tailored conservation measures. While this may allow for more streamlined decision-making, it also indicates that species-specific protections receive less regulatory attention than habitat conservation. This is reflected in Indonesian sea turtle research, comprising only 1% of global studies, highlighting significant knowledge gaps (Robinson et al., 2023). In contrast, the high overlap in the 'habitat' category suggests that multiple institutions and legal frameworks govern habitat protection, often leading to administrative inefficiencies, jurisdictional conflicts, and enforcement challenges (Månsson et al., 2023; Rosendal, 2021; Haftel and Lenz, 2022). This complexity arises because sea turtles inhabit diverse areas, including marine protected areas, multi-use waters, and regions under different ministries and regional (provincial and district) governments (Estradivari et al., 2022a; Roberston et al., 2020). Studies on institutional overlap in global governance suggest that such conflicts arise when roles and mandates are not clearly defined, leading to policy fragmentation and delays in decision-making (Orsini et al., 2020; Haftel and Lenz, 2022; Faude and Fuss, 2020; Eilstrup-Sangiovanni, 2022; Sommerer et al., 2022). This overlap provides insights into how regulatory and institutional frameworks interacted, revealing the extent to which responsibilities for sea turtle conservation are shared—or duplicated—among agencies and legal instruments.

Despite these challenges, Indonesia has made notable progress in establishing legal protections for sea turtles. National regulations explicitly prioritise sea turtle conservation, and the designation of Marine Protected Areas (MPAs) has contributed to habitat protection. Additionally, Government Regulation No. 60/2007 on Fish Resources Conservation outlines ecological criteria for MPAs, indirectly benefiting sea turtles. In terms of species protection, illegal trade, poaching, and penalties for violations are clearly addressed in legislation, demonstrating an increasing commitment to enforcement and conservation efforts (Wallace et al., 2011; Martín-López et al., 2009; Campus et al., 2020). However, as observed in other conservation governance frameworks, simply having legal protections does not guarantee effective implementation if roles and enforcement mechanisms remain unclear (Sommerer et al., 2022; Kim, 2020).

This challenge is particularly evident in habitat and species conservation, where the Ministry of Maritime Affairs and Fisheries (MMAF) manages MPAs, while the Ministry of Environment and Forestry (MoEF) oversees biodiversity conservation, including protected species such as sea turtles. Similar governance conflicts have been observed in marine mammal conservation, where overlapping mandates between MoEF and MMAF hinder effective management (Sahri et al., 2020). Yet, high institutional overlap does not inherently lead to inefficiencies. In some cases, it can foster inter-agency collaboration, unlock funding opportunities, and enhance conservation outcomes, as seen in Australia's Great Barrier Reef governance, where state and federal agencies coordinate conservation efforts (Day and Dobbs, 2013; Day, 2017; Morrison, 2017). Similarly, the U.S. Endangered Species Act (ESA) aligns species protection with habitat conservation, ensuring clear institutional roles through coordinated management by NOAA Fisheries and the U.S. Fish and Wildlife Service (USFWS) (Brei et al., 2020; Moore et al., 2009; Fischman et al., 2021). To improve governance effectiveness, Indonesia could adopt a more structured coordination mechanism that clarifies institutional roles while leveraging overlapping jurisdictions for increased funding and collaborative enforcement efforts (Reinsberg, 2024; Reinsberg and Westerwinter, 2023).

4.3. Customary laws and filling the gaps

Indonesia's national and provincial conservation strategies often treat sea turtles as a homogeneous group, overlooking species-specific ecological differences. This is evident in the Decree of the Minister of Marine Affairs and Fisheries No. 65/2022, which outlines broad strategies but lacks detailed provisions for individual species. Our findings indicate that Hukum Adat Laot addresses key gaps in Indonesia's sea turtle conservation framework, related to 'species' and 'habitat' protection. Community-led conservation areas, such as those governed under Hukum Adat Laot, offer an opportunity to complement state-managed MPAs through Other Effective Area-Based Conservation Measures (OECMs) (Estradivari et al., 2024). While MPAs are state-managed conservation zones, OECMs, such as those under Hukum Adat Laot, operate through customary governance systems that regulate fishing, prohibit destructive practices, and protect key habitats (Abdullah et al., 2018; Mujiburrahman et al., 2021; Utama et al., 2020). However, most Hukum Adat Laot beaches do not fall within Indonesia's MPA network, meaning their conservation contributions are not formally acknowledged in national biodiversity targets. Research by Estradivari et al. (2022b) and (2024) highlights that incorporating OECMs into conservation planning could enhance ecological connectivity, expand protected area coverage, and support local governance structures. Recognising Hukum Adat Laot beaches as OECMs would integrate customary and state-led conservation efforts, ensuring that both traditional and scientific management approaches are effectively utilised. Our results further highlight the potential of integrating customary law to fill critical gaps in Indonesia's sea turtle conservation framework. This integration is already partly reflected in Aceh's Qanun No. 11/2019 on Wildlife Management, which formally recognises the role of Panglima Laot in supporting conservation enforcement and education. Rather than operating in parallel, Hukum Adat Laot functions as a complementary governance system within Aceh's provincial framework. Its formal acknowledgement at the provincial level illustrates how customary institutions can be legally incorporated into statutory conservation policy, providing a model for locally grounded, legally recognised conservation strategies.

Hukum Adat Laot, enforced by Panglima Laot, the traditional marine resource authority in Aceh, adopts a species-specific conservation strategy that is largely absent in national regulations (Abdullah et al., 2018). A key distinction is its explicit protection of critical habitats, such as coral reefs and nesting beaches, along with a strict prohibition on capturing adult sea turtles (Abdullah et al., 2018; Reni, 2018). This rule aligns with Sharia law, as Acehese communities consider the consumption of adult turtles haram, thereby reinforcing population stability by ensuring the protection of breeding individuals (Abdullah et al., 2018; Reni, 2018). The system has existed since the Pasai Kingdom in 1292, rooted in Islamic tradition, and has continuously adapted, responding to shifting governance contexts and gradually incorporating ecological conservation strategies (Utama et al., 2020). Enforcement is carried out through both formal and informal mechanisms: violators will be fined, have their catch confiscated, and be prohibited from going to sea for three to seven days. While these penalties signal community-based accountability, the limited duration of the fishing ban may not serve as a strong deterrent on its own. However, in tightly knit coastal communities, the reputational consequences of breaking adat, including potential social ostracism, may play a more significant role in ensuring compliance. Additionally, regulated egg collection is permitted under strict conditions, requiring at least 20% of eggs to remain in the nest to support natural hatching success. While this balances cultural traditions with conservation objectives, scientific concerns, such as disease transmission, temperature-dependent sex determination, and embryo vulnerability during egg relocation, require further evaluation (Swiggs et al., 2018; Kobayashi et al., 2018; Tomillo et al., 2012; Montero et al., 2019; Santidrián Tomillo et al., 2014; Santidrián Tomillo et al., 2015). A study from the Ostional Wildlife Refuge in Costa Rica

demonstrates that community-led conservation can successfully integrate species protection with sustainable use (Swiggs et al., 2018). In Ostional, local communities maintain nesting sites and engage in regulated egg collection for local trade and consumption, ensuring both conservation benefits and economic incentives. This model highlights how well-regulated customary governance can enhance conservation outcomes (Quimby, 2015; Yamani, 2019).

Another key finding is that Hukum Adat Laot fosters a community-led governance structure, with shared management responsibilities among Panglima Laot, local governments, and other stakeholders (Abdullah et al., 2018; Keliat et al., 2021). While institutional overlap is often considered a governance challenge, in this case, it may create opportunities for adaptive, decentralised conservation management. Unlike constitutional regulations, which operate under a hierarchical, top-down framework, customary law strengthens local enforcement and compliance. These findings are supported by studies demonstrating that conservation strategies involving local communities and traditional ecological knowledge are more effective in balancing ecological and socio-economic goals (Thorburn, 2000; Boli et al., 2014; Keliat et al., 2021; Yamani, 2019; Kusumawati and Huang, 2015; Karnad, 2017). However, collaboration between constitutional and customary frameworks remains limited. While some national regulations acknowledge the role of customary practices in marine resource management, formal integration is lacking (Priambodo, 2018; Quimby, 2015; Karepesina et al., 2013). Recognising Hukum Adat Laot and other customary governance systems as Other Effective Area-Based Conservation Measures (OECMs) under Indonesia's policy framework could enhance formal conservation efforts, ensuring that locally managed marine areas contribute to national biodiversity targets (Estradivari et al., 2024). Further assessment of customary laws in other regions where there are known large sea turtle populations (e.g. Berau in Kalimantan Timur, Tambraw in Papua Barat Daya and Pangumbahan, Sukabumi, Jawa Barat) would be useful for the larger framework of sea turtle protection in Indonesia.

To bridge governance gaps in sea turtle protection in Indonesia, it could be beneficial to aim for a more integrated conservation approach that combines the strengths of constitutional and customary laws (Keliat et al., 2021; Yamani, 2019; Karnad, 2017). Such an approach could extend the coverage and effectiveness of conservation efforts, particularly in regions where customary laws are either absent or insufficient. Recognising and formally incorporating customary governance structures, such as Panglima Laot, would enhance community engagement and ensure that conservation measures are tailored to regional ecological and cultural contexts. The integration of OECMs into national conservation policies would formalise customary conservation efforts, creating a more inclusive, adaptive, and species-specific framework for sea turtle protection (Estradivari et al., 2022b, 2024).

5. Conclusion and recommendation

Indonesia's efforts to conserve sea turtles are supported by a robust legal framework involving multiple institutions and laws, yet our analysis highlights unclear institutional mandates, overlapping jurisdictional roles, and limited species-specific protections for the different life-stages of sea turtles. While habitat conservation is prioritised, life-history traits and ecological needs of sea turtles remain underrepresented in national policies. In contrast, our case study on Hukum Adat Laot shows that local customary laws can demonstrate targeted, community-led strategies that emphasise species-specific habitats. These local governance systems could fill critical gaps in national frameworks by offering adaptive and culturally grounded conservation models, provided that their implementation is harmonised with national and provincial legal frameworks. Such alignment ensures both legal compliance and contextual relevance within Indonesia's diverse but unified legal system. Recognising and formally integrating Other Effective Area-Based Conservation Measures (OECMs) like Hukum Adat

Laot into national policy could enhance ecological connectivity, promote community engagement, and improve enforcement.

CRedit authorship contribution statement

Maslim As-singily: Writing – review & editing, Writing – original draft, Visualization, Validation, Software, Methodology, Investigation, Funding acquisition, Formal analysis, Data curation, Conceptualization. **Reindert Nijland:** Writing – review & editing, Supervision, Resources, Methodology, Conceptualization. **Leontine E. Becking:** Writing – review & editing, Validation, Supervision, Resources, Conceptualization.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Supplementary materials

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Data availability

Data will be made available on request.

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