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Spatial conservation prioritization on the endemic-rich island of Príncipe

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RESUMO ALARGADO

A crise de biodiversidade atualmente em curso é uma das principais preocupações dos conservacionistas em todo o mundo. Cerca de um milhão de espécies estão ameaçadas de extinção e uma grande parte dos ecossistemas estão degradados como consequência da atividade humana. A conservação baseada em áreas protegidas é uma estratégia chave para travar a perda da biodiversidade e tem contribuições importantes para o bem-estar humano, de tal forma que diversos acordos internacionais apelam à expansão da cobertura global das áreas protegidas. Para que as áreas de conservação existentes e novas sejam eficazes, é necessária a priorização dos sítios para garantir a cobertura das áreas mais críticas para a persistência da biodiversidade. Isto é especialmente importante nos trópicos, que abrigam alguns dos ecossistemas mais diversos e ameaçados. A priorização espacial é um método para identificar sítios com o maior valor ou potencial de conservação, a fim de contribuir para o planeamento estratégico e para a aplicação eficaz de ações de conservação em diferentes locais, tendo em conta a existência de recursos limitados.

O conceito de Alto Valor de Conservação (HCV, do inglês *High Conservation Value*) é uma ferramenta popular para a conservação nos setores agrícolas e florestais, e que é cada vez mais utilizada no planeamento da conservação para a identificação das áreas que possuem valores importantes de conservação num contexto ecológico e socio-cultural. Envolve a identificação dos HCVs, seguida do desenvolvimento de medidas de gestão e monitorização destinadas à preservação dos valores identificados ao longo do tempo. Neste trabalho a abordagem de HCV foi aplicada com o objetivo de identificar valores críticos das espécies, paisagens, ecossistemas e comunidades nas zonas costeiras e terrestres da ilha do Príncipe, para estabelecer prioridades de conservação a fim de informar a gestão do Parque Natural do Príncipe (PNP) e de orientar uma atribuição eficaz de medidas de conservação para além desta que é a única área protegida da ilha.

O Príncipe é uma pequena ilha oceânica no Golfo da Guiné, onde o isolamento e a topografia vulcânica acidentada deram origem a uma biodiversidade única. Principalmente devido à sua extraordinária concentração de espécies endémicas e às suas florestas tropicais bem preservadas, a relevância da ilha para a conservação da biodiversidade global é amplamente reconhecida. A riqueza biológica do Príncipe não só apoia a sua biodiversidade única, como também constrói a base para o bem-estar e a subsistência das comunidades locais, que dependem diretamente da natureza para satisfazer muitas das suas necessidades básicas. No entanto, o crescimento da população e a pressão humana ameaçam cada vez mais a biodiversidade, nomeadamente através da alteração do uso da terra, da sobre-exploração e da introdução de espécies. Várias iniciativas destinadas à conservação da biodiversidade extraordinária da ilha têm vindo a ser desenvolvidas, tais como a criação do Parque Natural do Príncipe (PNP) e o reconhecimento do Príncipe como Reserva da Biosfera pela UNESCO. No entanto, os esforços de conservação têm sido limitados pela escassez de recursos e capacidades locais. Especialmente quando se considera a pequena dimensão da ilha, há necessidade de identificar áreas prioritárias para orientar estratégias de conservação.

Com base em boas práticas gerais e experiências retiradas da avaliação do HCV em São Tomé, concebemos uma metodologia adaptada ao contexto local e identificámos HCVs de quatro categorias, nomeadamente diversidade de espécies (HCV 1), ecossistemas e mosaicos no nível da paisagem, e paisagens florestais intactas (HCV 2), ecossistemas e habitats (HCV 3), e necessidades das comunidades (HCV 5). Cada uma destas categorias foi avaliada com base num conjunto de critérios pré-determinados. A evidência empírica e a consulta de peritos levaram à identificação das espécies indicadoras da categoria HCV 1, que foi seguida pela compilação dos dados de ocorrência disponíveis, a partir de bases de dados de biodiversidade e de fontes muitas vezes não publicadas. Os ecossistemas e habitats mais importantes (HCV 2 e HCV 3) foram identificados através da interpretação visual de imagens aéreas combinadas com trabalho de campo e uma revisão de informação secundária, tais como estudos prévios e dados espaciais. Para localizar áreas que fornecem serviços de ecossistemas essenciais para os meios

de subsistência local (HCV 5) foi realizado um mapeamento participativo em 10 comunidades do Príncipe. A integração dos resultados das quatro categorias conduziu à definição de Áreas de HCV (HCVAs), que foram priorizadas com base na vulnerabilidade das espécies e na insubstituibilidade e variedade dos valores que desencadearam a classificação como HCVA.

Foram identificadas 31 espécies indicadoras de HCV 1, incluindo espécies ameaçadas, espécies endémicas, em especial as que têm distribuição limitada dentro da ilha, e espécies com habitats temporários importantes. Como HCV 2 foi qualificada a área contínua de floresta nativa da ilha, que está amplamente protegida da influência humana e constitui uma das maiores florestas mais intactas nas ilhas oceânicas do Golfo da Guiné. Os ecossistemas e habitats identificados como HCV 3 compreendem extensões de floresta nativa e floresta secundária bem preservadas, zonas húmidas raras, zonas montanhosas únicas e habitats-chave altamente localizados. No âmbito do HCV 5, identificámos áreas relevantes para a extração de recursos que são essenciais para o bem-estar das comunidades locais, incluindo água, madeira para construção, carvão, lenha, alimentos selvagens, plantas medicinais e caça. Esta primeira avaliação de HCV no Príncipe revelou 25 potenciais HCVAs, das quais 11 foram classificados como de máxima prioridade, 9 como de média e 5 como de baixa prioridade para conservação.

A maioria das HCVAs está localizada em áreas remotas e em altitude, com uma sobreposição forte com o PNP, embora também tenham sido identificadas algumas em locais que tinham sido largamente negligenciados por investigações anteriores. Os dados de distribuição das espécies mostraram concentrações importantes na parte sul do PNP, confirmando a relevância da floresta nativa da região montanhosa do sul da ilha como refúgio para a maioria da fauna e flora terrestre ameaçada. Os resultados também destacam a importância das florestas secundárias, que desempenham funções críticas na prestação de serviços dos ecossistemas às comunidades locais e como habitat de várias espécies endémicas, e que deveriam, portanto, receber mais atenção em futuras ações de conservação. Algumas espécies de plantas ameaçadas e endémicas foram registadas no norte da ilha, o que sugere que podem persistir em paisagens dominadas pela ação antrópica. Os resultados implicam que a topografia, o sistema de posse da terra e os padrões das copas das árvores são indicadores importantes da presença de HCVs nas partes menos estudadas do norte da ilha.

Este trabalho constitui a fase inicial do processo de HCV no Príncipe e serve de base para ações de seguimento, incluindo a verificação de potenciais HCVAs e de estudos adicionais, para garantir o desenvolvimento de medidas de gestão e monitorização eficazes. Identificamos potenciais desafios de gestão, particularmente no que diz respeito a conflitos entre as atividades de utilização de recursos naturais e a conservação da biodiversidade, e recomendamos algumas soluções, incluindo possíveis modelos de co-gestão.

O estudo mostra que a abordagem de HCV oferece várias oportunidades de cooperação e troca de conhecimentos entre diferentes partes interessadas e promove a tomada de decisões participativas. Este estudo sublinha também a necessidade crítica de mais investigação. As lacunas de conhecimento permanecem, em especial no que diz respeito à distribuição das espécies alvo, com um desequilíbrio da informação disponível entre grupos taxonómicos, à extensão e qualidade dos complexos ecossistemas florestais da ilha, bem como em relação às interações entre as atividades humanas e a natureza. A identificação de HCVs se beneficiará grandemente de uma expansão contínua, à medida que novos dados vão ficando disponíveis. Finalmente, a aplicação do conceito de HCV contribuiu para a revisão do zoneamento do PNP e dá pistas para o desenvolvimento de estratégias de conservação mais eficazes e equitativas, que equilibrem a proteção da biodiversidade e as necessidades das comunidades humanas.

Palavras-chave: Alto Valor de Conservação, biodiversidade tropical, planeamento de conservação, São Tomé e Príncipe, serviços de ecossistemas

ABSTRACT

Area-based conservation is a key strategy for halting biodiversity loss, and spatial prioritization enables the identification of critical sites for biodiversity to ensure strategic and effective conservation action. Príncipe is a small island of high relevance for conservation due to its endemic-rich ecosystems and its people relying on nature as an integral part of their daily lives, but increasing threats to biodiversity and growing human needs create a challenging scenario for conservation efforts. This work applies the High Conservation Value (HCV) approach to identify areas in Príncipe that hold important ecological and socio-cultural values, and to select priority sites for conservation, in order to inform the management of the existing protected area and the effective allocation of additional conservation efforts. Using remote sensing, empirical evidence from ground surveys and existing data, and expert opinion, 31 trigger species as well as key terrestrial and coastal ecosystems and habitats were identified, and their occurrence was mapped across the island. Areas relevant for local livelihoods were located through participatory mapping. This first HCV assessment in Príncipe revealed 25 potential HCV Areas (HCVAs), of which 11 were classified as top priorities based on species vulnerability, irreplaceability, and variety of HCVs. HCVAs are located mostly in remote and elevated areas, with a strong overlap with the existing protected area, although they were also identified in unprotected places that had been overlooked by previous studies. This study builds a baseline for future work, pointing out critical research needs, especially regarding the distribution of target species and ecosystems, as well as the understanding of human-nature interactions. The HCV approach contributed to improving protected area zoning and provides indications for developing more effective and equitable conservation strategies that balance biodiversity protection and human needs.

Keywords: conservation planning, ecosystem services, High Conservation Value, São Tomé and Príncipe, tropical biodiversity

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

CEPF	Critical Ecosystem Partnership Fund
CR	Critically Endangered (IUCN Red List)
EN	Endangered (IUCN Red List)
GBIF	Global Biodiversity Information Facility
GIS	Geographic Information System
HCV	High Conservation Value
HCVA	High Conservation Value Area
HCVNI	High Conservation Value National Interpretation
HCVRN	High Conservation Value Resource Network
INE	Instituto Nacional de Estatística
IUCN	International Union for Conservation of Nature
KBA	Key Biodiversity Area
NGO	Non-Governmental Organization
PNP	Príncipe Natural Park
SCP	Systematic Conservation Planning
TFSTP	Threatened Flora of São Tomé and Príncipe
VU	Vulnerable (IUCN Red List)

1 INTRODUCTION

1.1 Spatial conservation prioritization

The ongoing biodiversity crisis is a primary concern of conservationists around the globe. Up to one million species are at risk of extinction and three-quarters of the world's terrestrial ecosystems have been severely altered, caused by a wide range of human activities, including land use change and over-exploitation (IPBES 2019). Protected areas are a leading strategy for halting global biodiversity loss (Watson et al. 2014; MacKinnon et al. 2020; Maxwell et al. 2020), and international treaties call for the expansion of area-based conservation initiatives to 30% of the planet by 2030 to overcome the current trend (Secretariat of the CBD 2021). Moving forward, it is essential that existing and new conservation areas are effectively managed and governed as well as that they cover areas that are critical for the persistence of biodiversity (MacKinnon et al. 2021). This is especially important in the highly biodiverse tropics that are most at risk from human activity (IPBES 2019). Since resources are limited and not all ecosystems can be set aside for conservation, strategic planning is required to ensure targeting areas that contribute the most to the preservation of biodiversity (Langhammer et al. 2007; Kukkala & Moilanen 2013).

The concept of spatial conservation prioritization emerged in the early 1990s with the goal of locating sites that hold the highest conservation value or potential to allocate funds and action effectively and avoid misplaced conservation efforts (Moilanen 2012; Kukkala & Moilanen 2013). In contrast to historical establishments of protected areas that were rarely based on scientific assessments of biodiversity value or representativeness, but rather motivated by the protection of iconic wildlife or the scenic beauty of landscapes, spatial conservation prioritization provides a data-driven method for the selection of priority sites to inform strategic conservation (Brooks 2010; Watson et al. 2014). The approach is incorporated into the broader framework of systematic conservation planning (SCP) that combines biodiversity and implementation-relevant information to develop conservation measures. SCP involves the process of (i) defining explicit targets for conservation features, such as species, habitats or ecosystem services, and (ii) delivering actions to achieve these targets in the context of a variety of conservation planning problems (Margules & Pressey 2000; Moilanen 2012; Kukkala & Moilanen 2013). These assessments can account for numerous factors, such as cost-efficiency, by identifying areas that meet conservation targets at minimum costs; complementarity, following the idea that biodiversity features of different areas complement each other in achieving conservation goals; or ecological connectivity, aiming to sustain species movement and ecological processes (Watson et al. 2011; Kukkala & Moilanen 2013). Conservation planning software that uses algorithms to identify the best possible site selection based on a set of targets, such as "Zonation" (Lehtomäki & Moilanen 2013) and "Marxan" (Ball et al. 2009), is frequently used to aid decision making. Finally, SCP analyses are meant to guide on-the-ground interventions like the expansion of protected area networks, habitat restoration, maintenance, or other forms of management (Moilanen 2012; Kukkala & Moilanen 2013).

Approaches to identify global conservation priorities, such as Biodiversity Hotspots (BH, Myers et al. 2000), Global 200 Ecoregions (G200, Olson et al. 2001), and Key Biodiversity Areas (KBA, IUCN 2016), are widely used by international conservation organizations. Traditionally, such priority-setting frameworks have focused on the representation of biodiversity features, most notably species and ecosystems, but have largely overlooked including human values as a purpose of conservation (Brooks 2010).

1.2 High Conservation Values

"A High Conservation Value (HCV) is a biological, ecological, social, or cultural value of outstanding significance or critical importance" at the national, regional, or global level (Brown et al. 2013). Initially developed by the Forest Stewardship Council (FSC) in 1999 to promote sustainable forest management, the HCV concept has been widely used by agricultural and forestry certification schemes (e.g., Round Table on Sustainable Palm Oil, RSPO; Senior et al. 2015). In 2005, the HCV Resource Network (HCVRN), a consortium of NGOs, producer companies, and other practitioners, has widened the scope by redefining the concept from its forest-focused perspective to a tool that can be used in any kind of ecosystem. The approach has since gained popularity in other contexts, such as land use and conservation planning (Neugarten & Savy 2012). Finally, with the development of common assessment guidelines, the HCVRN provided a framework for the identification, management and monitoring of HCVs across different land use sectors and for various purposes (Brown et al. 2013; Brown & Senior 2014). The HCV approach is intended to be applicable in any context across the globe. However, definitions are often generic and brief and therefore have to be translated into the context of the study area to account for specific local conditions, which some countries have done through a national interpretation (HCVNI) of the guidelines (HCVRN 2019a).

A HCV assessment is a two-step process: (i) identification and (ii) management and monitoring. Following a set of predetermined criteria, HCVs that can be assigned to six categories (Fig. 1.1), spanning biodiversity values (from species to ecosystems, HCV 1-3), (supporting and regulating) ecosystem services (HCV 4), livelihoods (i.e., provisional ecosystem services, HCV 5), and cultural values (i.e., cultural ecosystem services, HCV 6), are identified (Brown et al. 2013). One essential

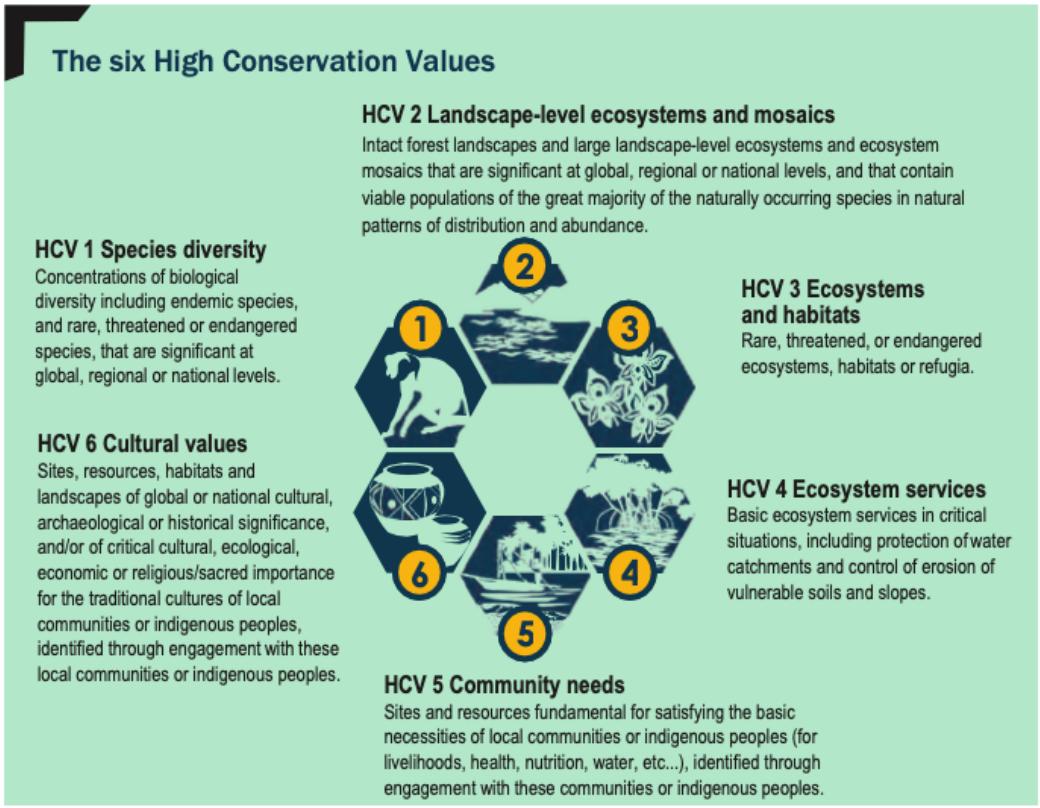


Fig. 1.1. The six types of HCVs (Brown et al. 2013).

element of the HCV identification is the gathering of all relevant information from various sources, including primary and secondary data, which is then integrated to make the best decision based on the current state of knowledge. This is done through the analysis of existing information and the collection of additional data through social and environmental surveys, complemented by expert consultation. The

engagement of various stakeholders is crucial throughout the process, to gather information on the local biodiversity and social conditions from researchers and NGOs, to inform governmental institutions about the project for potential cooperation, as well as for the participation of communities and the recognition of local and traditional knowledge (HCVRN 2019b). In cases of poor data, a precautionary approach should be applied, which allows assuming that a HCV is present if there are reasonable indications, such as expert opinion (Brown et al. 2013).

HCV Areas (HCVAs) are sites that hold one or more HCVs and are designed as management areas with the purpose to protect HCVs over time. Following their delineation, measures are developed, which aim at maintaining and, ideally, enhancing present values (ProForest 2008). This should be supplemented by an assessment of existing and potential threats to select appropriate management strategies. Lastly, a monitoring plan is being developed to ensure the effective implementation of management measures (Brown & Senior 2014).

A fundamental basis of the concept is that HCVAs are not exclusively intended for the designation of strictly protected areas that exclude human activity, but rather aim at finding a balance between environmental protection and the improvement of livelihoods (HCV Consortium for Indonesia 2009). Thus, the management of HCVAs can take various forms from total protection to controlled extraction of natural resources and co-management models with local communities or the private sector, as long as they are compatible with maintaining or enhancing identified values (Pollard 2005a; Brown & Senior 2014). Finally, the HCV approach is a practical tool to prioritize sites important to biodiversity and/or local communities for conservation and sustainable management (Brown et al. 2013).

1.3 Conservation on Príncipe Island

The island of Príncipe is part of the Democratic Republic of São Tomé and Príncipe in the Gulf of Guinea, Central Africa (Fig. 1.2). The two-island nation of 1,001 km^2 is Africa's second smallest state (CEPF 2015). Despite their small size, the oceanic islands harbor an outstanding biodiversity, making them a priority for global conservation. São Tomé and Príncipe is among the 200 priority ecoregions for global conservation (Olson et al. 2001) and forms part of the Guinean Forests of West Africa Biodiversity Hotspot (Myers et al. 2000). The islands constitute a Center of Plant Diversity (WWF & IUCN 1994-1997), and their forests were identified as Alliance for Zero Extinction (AZE) sites

Fig. 1.2. Position of São Tomé and Príncipe in the Gulf of Guinea. The inset map shows the area of the main map in relation to the African continent (Data sources: Esri et al. 2021; OCHA 2021).

(Alliance for Zero Extinction 2018). Furthermore, seven Key Biodiversity Areas (KBAs) have been identified in the country, of which two are in Príncipe: the forests in the south of the island (KBA Partnership 2020a) and the islets of Tinhosas, 23 km off the southwestern coast of Príncipe (KBA Partnership 2020b). The latter are also a Ramsar site (Ramsar 2006) and an Important Bird Area (IBA, BirdLife International 2021a), as they shelter the largest breeding seabird population in the eastern tropical Atlantic (Bollen et al. 2018). On a global level, the Natural Parks of São Tomé and Príncipe have been ranked as the 17th most important sites for the conservation of threatened amphibians, mammals, and birds, out of over 175,000 protected areas (Le Saout et al. 2013).

The islands host some of the highest concentrations of endemic species in the world, which is why they are often referred to as the "African Galapagos" (Melo & Ryan 2012). Due to its isolation – it lies more than 200 km off the coast of Gabon and has never been connected to the mainland – São Tomé and Príncipe has a typical low species richness but remarkable numbers of endemic species (CEPF 2015). Its avifauna is one of the most significant components of the endemism hotspot, even though the proportion of endemic species is also exceptionally high throughout other taxonomic groups (Jones 1994).

Príncipe alone harbors numerous endemic species, including at least 8 birds (25% of the resident species; de Lima & Melo 2021), seven reptiles (75%; Ceríaco et al. 2018, 2020, 2021), three amphibians (100%; Ceríaco et al. 2018), one shrew, and multiple invertebrates (Holyoak et al. 2020) and plants (Fauna & Flora International 2018). Among them are the Príncipe Thrush (*Turdus xanthorhynchus*) and the Obô Giant Snail (*Archachatina bicarinata*), which are often used as flagships for the conservation of the forests of the island (Rebelo 2020), as well as the largest treefrog in Africa (*Leptopelis palmatus*), a typical example of island gigantism (Jaynes et al. 2021). Apart from the terrestrial biodiversity, Príncipe has valuable coastal ecosystems and habitats, such as mangroves (Haroun et al. 2018), and beaches that provide important breeding grounds for three out of the seven extant species of sea turtles (Fundação Príncipe 2019b).

The biological wealth of Príncipe does not only support its unique biodiversity but also builds the basis of the wellbeing and livelihoods of the local population, which largely still relies directly on natural resources for their everyday living. Aside from fishing and agriculture, which are the dominant economic sectors of the island (Ministry of Infrastructure, Natural Resources and Environment 2015), the use of forest products is of great importance for local people. For instance, medicinal plants are a major source of healthcare for the remote communities of Príncipe as western medicine is barely accessible or affordable (Madureira 2008) and forest foods play an important role in providing nutrition (Fundação Príncipe 2019a).

São Tomé and Príncipe is classified as a Small Island Developing State with 67% of its population living below the national poverty line of 30 Sao Tomean Dobras (STD) per day (ca. €1.4), and it depends heavily on foreign aid (World Bank 2017). The rapidly growing population (UNFPA 2017) with increasing needs poses challenges for the country, which affects its natural heritage by contributing to habitat loss due to land conversion for agriculture, overexploitation, and the spread of invasive species (Dutton 1994; Dallimer et al. 2009; Guedes et al. 2021). Considering the small area of Príncipe, any reduction in habitat could put native species populations in jeopardy (Peet and Atkinson 1994). Consequently, many of the island endemics are threatened (IUCN 2021a), while many more are yet to be assessed, and new species of fauna and flora are still being discovered regularly (e.g., Verbelen et al. 2016; Fauna & Flora International 2018).

Various conservation efforts have been taken to preserve the unique biodiversity, primarily within the ECOFAC program, which has been promoting measures to improve natural resource governance and protected area management since the 1990s (ECOFAC6 2021), and through the local NGO Fundação Príncipe that has been leading projects aimed at the conservation of different groups, including birds, land snails, sea turtles, and flora, as well as sustainable livelihoods (Fundação Príncipe 2021). The first protected area, the Príncipe Natural Park (PNP), was legally recognized in 2006. It spans almost

half of the island, including two areas (Fig. 1.3): a large block in the south (ca. 6,903 ha) containing most of the remaining native and mature secondary forest, and a smaller block encompassing the secondary forest of Azeitona in the north (ca. 226 ha; Albuquerque & Carvalho 2015; Fundação Príncipe 2019a). Following the global protected area classification system by the International Union for Conservation of Nature (IUCN, Dudley 2008), the PNP can be assigned to two categories: II - National park (southern PNP block) and IV – Habitat/species management area (Azeitona forest; Albuquerque & Carvalho 2015). The zonation of the PNP is embedded in law 7/2006 that created the protected area (Assembleia Nacional 2006). Accordingly, the protected area comprises two types of zones: (i) a zone of integral preservation and (ii) a zone of controlled exploitation. The first functions as a nature reserve with the purpose to maintain undisturbed natural processes and ecosystem integrity and is limited to the use for research and monitoring purposes, which complies with the total protection zones of the PNP (Fig. 1.3). The second type complies with the partial protection zones of the PNP (Fig. 1.3), which allows the moderate use of natural resources, including subsistence-based traditional use and ecotourism. Finally, the PNP is divided into four zones according to their natural value and conservation need, with the level of protection determining the permitted activities inside each zone (Table 1.1; Albuquerque et al. 2009). Although not formally a part of the protected area, the zonation is complemented by a buffer zone aiming at the integration of conservation and sustainable use. The buffer zone is a strip extending to the north from the southern PNP block (Fig. 1.3), however, the entire rest of the island has characteristics of a buffer zone (Albuquerque & Carvalho 2015). The PNP is a cornerstone for conservation in Príncipe and the future of many species depends on its effective management (Rebelo 2020). However, implementation has been impeded by insufficient funding and staff, as well as by limited capacity for enforcement, monitoring and planning (Ministry of Public Works, Infrastructure, Natural Resources and Environment 2019). The management plan and zonation are now being revised due to the ending of the current 5-year management cycle (Albuquerque & Carvalho 2015).

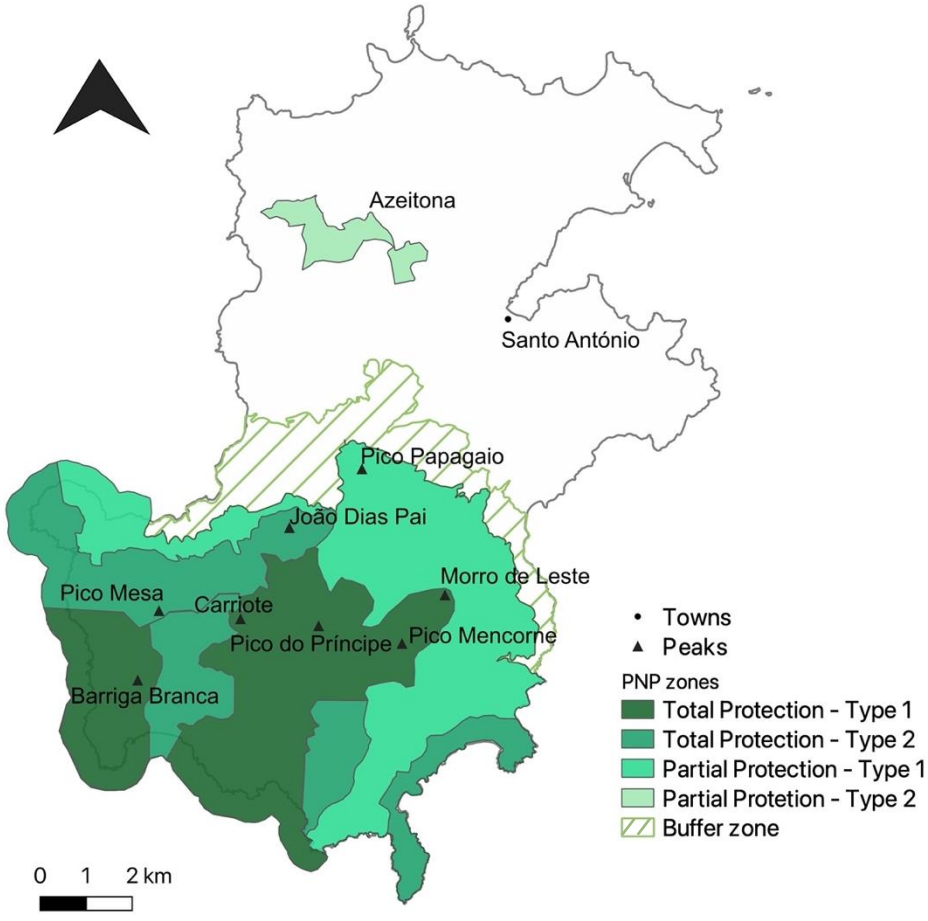


Fig. 1.3. Príncipe Island with PNP zones and major geographic features (Data source: UNEP-WCMC 2021).

Table 1.1. Characteristics and permitted activities within PNP zones (Albuquerque et al. 2009).

Zone	Characteristics	Permitted Activities
Total Protection – Type 1	- Flora and vegetation of exceptional value/endemism - Avifauna of exceptional value/endemism	- Scientific research - Monitoring of ecosystems
Total Protection – Type 2	- Flora and fauna of very high value and average sensitivity - Areas of native forest or maturing secondary forest - Areas of potential exceptional value but lacking more studies (birds, fish, other biological groups)	- Intensive biological/ecological studies - Controlled tourism (e.g., accompanied by park guide, with restrictions on routes, numbers of people, time of year) - Construction of small non-permanent structures to support visitation
Partial Protection – Type 1	- Ecosystems that have been or are currently used by communities in activities confliction with the protection of biodiversity, but whose recovery is critical to the management objectives of the most important areas of the park.	- Controlled use of medicinal species - Environmental tourism excursions with accredited guides or authorized by the park - Construction of small structures to support visitors
Partial Protection – Type 2	- Ecosystems that are currently used sustainably by communities, but with significant interest for the conservation of nature, biodiversity, and landscape.	- Construction of small infrastructure to support visitors or other activities permitted in the park, or as a factor of cultural heritage restoration (e.g., Roças) - Agriculture, forestry, and livestock, as approved by the board of management - Traditional local activities

Since 2012, Príncipe and its surrounding waters and islets are also recognized as UNESCO Biosphere Reserve, which promotes the island as an example of sustainable development under the Man and the Biosphere (MAB) program (UNESCO 2012).

Despite the high conservation interest and major scientific contributions within the last decades (e.g., Melo 2007; California Academy of Sciences 2016; Fauna & Flora International 2018), much of Príncipe's biodiversity had remained unexplored until recently, especially when it comes to its forest ecosystems (Fauna & Flora International 2018; de Lima & Melo 2021). The poor knowledge and scarce local capacity and resources hinder conservation efforts, meaning that further research and the design of approaches enhancing the participation of local communities in conservation practices are needed (Fundação Príncipe 2019a). Given the relevance of Príncipe for global biodiversity conservation, the present and projected threats, and the limited conservation resources, there is a need to identify where sites with critical biodiversity and social values are to guide conservation strategies. This concerns on one hand the PNP, which requires effective management implementation, but also conservation beyond the protected area, where human pressure on natural resources and the need for sustainable solutions to preserve nature and ensure benefits to local communities is growing (Fauna & Flora International 2018; Fundação Príncipe 2019a). In this regard, it is vital to improve spatial conservation planning, especially considering the small area of Príncipe.

1.4 Objectives

The present work constitutes the initial phase of the HCV process in Príncipe, carried out in collaboration between BirdLife International and Fundação Príncipe, and to be continued by the two organizations over the next years. The study aims to identify HCVAs in terrestrial and coastal ecosystems on Príncipe Island, to provide a foundation for site-based conservation prioritization. Namely, to improve the zonation and management of the PNP, and to inform the expansion of conservation and sustainable resource use beyond this protected area. In particular, it aims: 1) to identify sites with outstanding or critical species, landscape, and ecosystem values (HCV 1-3); 2) to identify sites that provide fundamental ecosystem services contributing to the wellbeing and livelihoods of local people (HCV 5); and finally, 3) to define HCVAs and identify levels of priority for conservation, integrating the distinct HCV categories.

2 METHODS

2.1 Study area

Príncipe Island has an area of 139 km^2 spanning over roughly 17 km from north to south and 8 km from west to east (Jones et al. 1991). The main island is surrounded by several small associated islets, including Boné de Jóquei, Mosteiros, and Tinhosas (Tinhosa Grande, Tinhosa Pequena and Tinhosinha). Príncipe is characterized by two distinct regions (Jones & Tye 2006): the relatively flat north, where most of the nearly 8,300 inhabitants of the island live (58/km^2), including the main urban area around the capital town Santo António (INE 2017); and the mountainous center and south, which is largely protected from human influence. This distinction is also reflected in the climatic conditions of the island. Príncipe has a typical equatorial climate with high temperatures and humidity, but heavy rainfall in the south can exceed 5000 mm while in the north it amounts to around 2000 mm per year (Jones et al. 1991).

Covered in dense forest and uninhabited when it was discovered by the Portuguese in 1471, large parts of the island have since been heavily modified, primarily by cash crop plantations that were spread throughout most of the accessible regions (Jones & Tye 2006). Shade plantations characterized by crops like cocoa and coffee that grow underneath the canopy of taller trees, which mimics the vertical layers of tropical rainforests, are still a common form of cultivation in São Tomé and Príncipe (de Lima et al. 2014). These plantations were responsible for the islands being the biggest global cocoa producer in the early 20th century but came largely at the expense of their lowland forests (Jones & Tye 2006). Besides the establishment of plantations, a campaign to eradicate the tsetse fly as vector for sleeping sickness, which took place between 1911 to 1914, had a significant impact, resulting in the clearing of 11% of the island and the draining of many swamps (da Silva 2019). Today, Príncipe's lowland forest has almost entirely vanished or been transformed, leaving behind a mosaic of agricultural land and shade plantations, of which many have been abandoned and overgrown by secondary forest (Dallimer et al. 2012). Although much of the secondary forest has been degraded, these novel ecosystems support a great diversity of plants, including many medicinal species, and serve as important habitats for some of the endemics (Dallimer et al. 2012; Fauna & Flora International 2018).

The southern landscape is shaped by steep volcanic slopes between deep valleys and imposing mountains, of which the highest, Pico do Príncipe, reaches 948 m (Jones & Tye 2006). Fortunately, because of the rugged terrain, most of the area was spared from heavy impacts by logging or agriculture, allowing the mountainous native forest to be preserved until today and still cover a sizeable portion of the island (Fauna & Flora International 2018). The south also harbors the most important biodiversity of the island: the vegetation is characterized by old trees that persisted over hundreds of years, it comprises probably one of the last intact lowland forests in the Gulf of Guinea (Fauna & Flora International 2018), and serves as a refuge for most of the endemic and threatened species, some of which are entirely restricted to this area (Rebelo 2020), such as the recently discovered Scops owl (*Otus* sp., Freitas 2019) and multiple plant species (Fauna & Flora International 2018).

A preliminary classification of Príncipe's remaining forest suggests distinguishing four forest types (Fauna & Flora International 2018), but their actual extent is still unknown and has never been mapped: (i) Semi-humid, mostly degraded secondary forest in the northern part of the island, (ii) Old secondary forest, found mainly at lower elevations (50-300 m) of the PNP, (iii) Coastal lowland to medium elevation (100-400 m) mature forest near the coast at Rio Porco, at higher elevations at Oquê Pipi, and on the way to Pico Mesa, which together comprises the most diverse forests of the island, and (iv) Central forest around Pico do Príncipe at medium to high elevations (250-650 m), which is poorly surveyed but shows some common characteristics with type iii.

2.2 HCV process

The HCV assessment process in Príncipe is following a series of steps that can be divided into four major phases: study design, data collection, data analysis, and follow-up actions going beyond this work (Fig. 2.1).

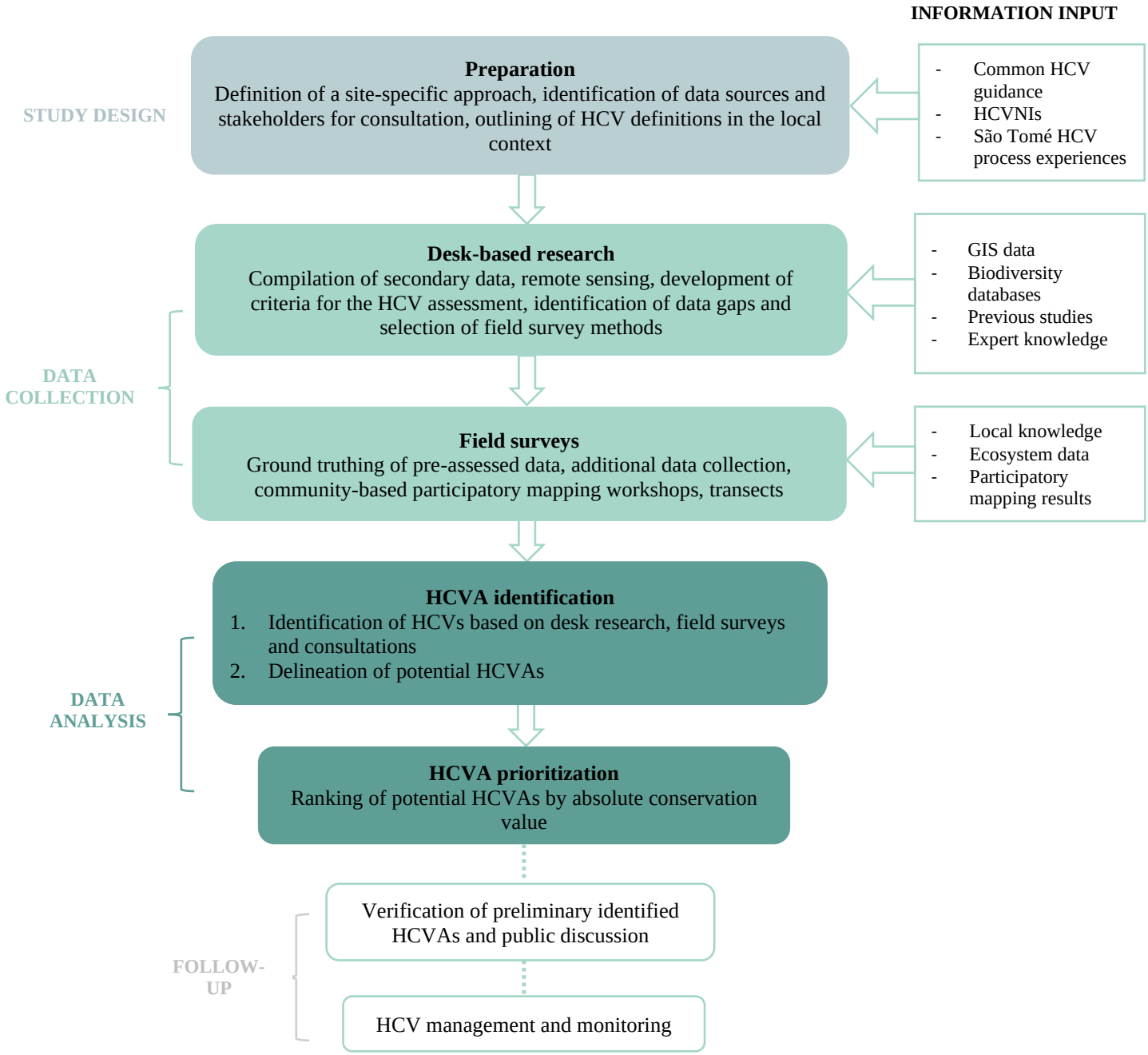


Fig. 2.1. Overview of the HCV process in Príncipe (adapted from Senior et al. 2015).

The first step of this process consisted of the design of the study including the definition of its purpose, objectives and scope as well as translating HCV procedures into the local context. As this is the first HCV assessment being conducted in Príncipe and, to date, explicit guidelines for the HCV identification do not exist for the country, a site-specific approach was developed based on common guidance (Brown et al. 2013), best practices from national interpretations (HCVNIs) of other countries as well as drawing from the experiences with identifying HCVs on the island of São Tomé (BirdLife International 2019; BirdLife International 2020; Ricardo de Lima, pers. comm.). Additionally, potential

stakeholders for consultation, such as experts from different areas (Table S3), organizations and institutions, as well as other key information sources were identified during this initial phase.

Following the preparation stage, existing information was gathered through desk-based research in the form of biodiversity data, published and unpublished literature, expert knowledge as well as spatial data, which have been continuously updated and reviewed throughout the entire process. Relevant geographic features that were not yet available were mapped through remote sensing using satellite imagery. The review of secondary data, such as spatial information and prior ecological and social surveys, served to obtain a general picture of the study area and assess the likelihood of present HCVs, which built the basis for the translation of general HCV categories and criteria into the local context. Another goal of the desk studies was to identify information gaps that required further data verification or collection on the ground.

After appropriate field survey methods were selected, primary data was collected through fieldwork carried out in Príncipe between March and May 2021.

The combined results from consultations, desk-based research and field studies were then analyzed to identify HCVs, followed by the delineation and prioritization of HCVAs. Finally, recommendations on follow-up actions were made, such as regarding the development of management measures aimed at the long-term conservation of identified values (Brown et al. 2013).

2.3 HCV identification

The following sections describe how common HCV categories were interpreted for the HCV assessment in Príncipe and which methods were used for the application of identification criteria. Because information to assess HCV 4 and 6 is scarce and difficult to obtain for Príncipe, this study focuses on the identification of areas that fit the criteria of HCV 1, 2, 3 and 5, which are split into several subcategories (Table 2.1),

Table 2.1. Revised HCV categories for Príncipe.

HCV 1 Species diversity	
HCV 1.1	Species classified as threatened according to IUCN Red List criteria
HCV 1.2	Hyperendemic species
HCV 1.3	Essential temporary habitats of threatened and endemic species
HCV 1.4	Protected areas
HCV 2 Landscape-level ecosystems and mosaics	
HCV 2.1	Large, intact ecosystems
HCV 2.2	Ecosystems with key landscape functions
HCV 3 Ecosystems and habitats	
HCV 3.1	Rare and well-preserved ecosystems
HCV 3.2	Key localized habitats of non-threatened and non-endemic species
HCV 5 Community needs	

2.3.1 HCV 1: Species diversity

HCV 1 aims to identify areas that hold significant concentrations of endemic and rare, threatened, or endangered (RTE) species (Brown et al. 2013).

Definition of criteria

For Príncipe, threatened (HCV 1.1) and endemic species with a very restricted range (HCV 1.2) as well as crucial localized habitats (HCV 1.3) and protected areas (HCV 1.4) were considered as qualifying under the HCV category 1. The criterion of rarity was not used, as suggested by common guidelines (Brown et al. 2013), since available data is insufficient to estimate the population size of many species.

HCV 1.1: Species classified as threatened according to IUCN Red List criteria

Threatened species were defined following the criteria of the IUCN Red List, namely species listed as Critically Endangered (CR), Endangered (EN) or Vulnerable (VU), or species for which experts suggest being assigned to one of those categories (IUCN 2021a). Threatened species that are widespread and abundant throughout the island were excluded since they are not useful for identifying priority sites.

HCV 1.2: Hyperendemic species

Since the majority of species endemic to the oceanic islands of the Gulf of Guinea can be found across many parts of Príncipe and, thus, do not serve as a good indicator for site-based prioritization, only hyperendemic species that are known to occur in only one or a few isolated locations were considered for HCV 1 (HCV Malaysia Toolkit Steering Committee 2018).

HCV 1.3: Essential temporary habitats of threatened and endemic species

This subcategory refers to localized habitats that are occupied on a daily, regular, or seasonal basis by threatened or endemic species, either for breeding, roosting, or migration (Brown et al. 2013). For non-endemic species, only sites with significant concentrations, i.e., having combined the top 75% of density values, qualify as HCV 1.3.

HCV 1.4: Protected areas

Under the precautionary approach, Príncipe was considered as having poor data on species distribution and, thus, protected areas were used as a proxy for significant concentrations of threatened and endemic species qualifying as HCV 1.4 (Brown et al. 2013).

Selecting species of interest

Based on published information and expert knowledge, a list of species that might trigger HCV 1 was compiled. This includes species classified as threatened by the IUCN Red List and, additionally, expert knowledge was used to evaluate the level of threat for species that have not yet been assessed or which are under review for the IUCN Red List. Furthermore, species and subspecies endemic to the Gulf of Guinea oceanic islands were considered when sufficient spatial data was available. This means that this assessment focused on mammals, birds, herpetofauna, vascular plants, and the Obô Giant Snail.

Sourcing species occurrence data

Occurrence data for species of interest was extracted from the Global Biodiversity Information Facility (GBIF) database, existing publications as well as unpublished information provided by experts. Additionally, relevant observations from ground surveys were used.

Treating spatial data

All species occurrence points were uploaded to QGIS version 3.16.8 (QGIS Development Team 2020), checked for accuracy, and cleaned by excluding records with a coordinate precision below 200 m (Zizka

et al. 2020). Spatial mismatches between coordinates and locality description or administrative boundaries were corrected or deleted. Coordinate duplicates (i.e., several records of the same species with identical coordinates) were also removed from the dataset since the evaluation of HCV 1 focused solely on species presence and did not consider abundance (Jin & Yang 2020).

Identification and mapping of HCV 1

The occurrence of HCV 1 trigger species, important localized habitats fulfilling the criteria of HCV 1, as well as protected areas were identified and mapped based on spatial data and literature review.

2.3.2 HCV 2: Landscape-level ecosystems and mosaics

HCV 2 includes intact landscape-level ecosystems supporting viable populations of naturally occurring species and ecosystem mosaics with key landscape functions (Brown et al. 2013)

Definition of criteria

As HCV of the category 2, relatively large and pristine ecosystems (HCV 2.1), as well as smaller ecosystems with buffer or connectivity functions (HCV 2.2), were considered (Brown et al. 2013).

HCV 2.1: Large, intact ecosystems

Due to the small size of Príncipe Island (139 km^2), the 500 km^2 threshold for the identification of large landscape-level ecosystems (Brown et al. 2013) cannot be applied; instead, ecosystems that are among the largest within the country or region were considered under this subcategory. As intact ecosystems, these should be relatively far from human disturbances such as roads and settlements, making them difficult to access and thus capable of maintaining ecological processes and dynamics, including the presence of the majority of naturally occurring species (Brown et al. 2013).

HCV 2.2: Ecosystems with key landscape functions

As HCV under this category qualify areas which function as buffers around the core zone of the PNP or of large, intact ecosystems (HCV 2.1) as well as corridors linking the PNP or large, intact ecosystems (HCV 2.1) to other areas of interest. Corridors can connect directly between two separate areas or through a series of smaller patches functioning as stepping stones.

Identification and mapping of HCV 2

Using available ecosystem information and GIS (Geographic Information System) data on land use, topography, and other geographic features (Table S4), relatively large and intact ecosystems were identified and mapped. Buffer and connectivity functions are only assigned as additional values to designated HCV Areas (see section 3.5).

2.3.3 HCV 3: Ecosystems and habitats

HCV 3 includes rare, threatened, or endangered ecosystems, habitats or refugia (Brown et al. 2013).

Definition of criteria

Ecosystems that are rare or in particularly good condition (HCV 3.1) as well as localized habitats of non-threatened and non-endemic species (HCV 3.2) are considered as HCV 3. The threat criterion was not included since the ecosystems of the island are not yet classified, mapped and surveyed with enough detail to allow threat assessments following international standards, such as those by the IUCN Red List of Ecosystems (IUCN 2021b).

HCV 3.1: Rare or well-preserved ecosystems

This subcategory refers to ecosystems that (i) either naturally cover very small areas because they depend on highly localized conditions or (ii) have little of their original extent remaining due to anthropogenic activity (Brown et al. 2013). Following the approach used in São Tomé, ecosystems that have been well preserved over time were also considered as HCV 3.1 (BirdLife International 2019).

HCV 3.2: Key localized habitats of non-threatened and non-endemic species

Localized habitats of species that do not meet the definition of HCV 1 but that play an important role in the functioning of ecosystems, such as breeding and roosting sites or isolated areas that act as ecological refugia for certain non-threatened or non-endemic species are an indication for the presence of HCVs of this subcategory (Brown et al. 2013; BirdLife International 2019). Significant regional habitats, i.e., sites supporting at least 10% of the population in the region of Príncipe (including associated islets), qualify under this subcategory.

Compilation and analysis of secondary data

Existing information on the ecosystems of Príncipe was compiled in the form of historical and recent maps, expert knowledge, and published information. Against the background of the very limited spatial information available, canopy patterns were mapped through the visual interpretation of Google Earth satellite imagery (Google Earth 2016-2020) in QGIS. Following that, the area outside of the PNP was classified according to the color and size of the canopy, since this is where information on land use is less reliable (Freitas 2019).

Ground truthing and additional data collection

Ground truthing was carried out with the goal to interpret potential habitat types identified on the pre-produced canopy map. Further data on the type and quality of the vegetation cover was collected using a GPS to mark transitions between land use types (Fig. S1). Based on the data collected during ground checks, aerial images (Esri et al. 2015; Google Earth 2016-2020), local knowledge and habitat information from prior vegetation surveys, the pre-existent land use map was updated (Table S4), and areas were assigned to one of the following classes: native forest, secondary forest (old and young secondary forest, including relatively recently abandoned plantations), plantation forest (active shade and timber plantations) and non-forested areas (Putz & Redford 2010).

Identification and mapping of HCV 3

Findings from the land use classification, ground surveys and secondary data evaluation were integrated to identify and map HCVs of the category 3. Some of the ecosystems and habitats that could trigger HCV 3, but which could not be covered during ground checks or required additional field studies were sampled by the Fundação Príncipe botanical team, providing information about species composition and habitat quality to support decision-making.

2.3.4 HCV 5: Community needs

HCV 5 refers to sites and resources that are important for the generation of provisioning ecosystem services contributing to the livelihoods and well-being of local communities (Brown et al. 2013).

Definition of criteria

Ecosystem services can be generally defined as the benefits that people obtain from nature (IPBES n.d.). As HCV 5 qualify areas relevant for provisioning ecosystem services that contribute to satisfying basic needs such as drinking water, nutrition, health, shelter, and livelihoods. Resources related to these

ecosystem services should be irreplaceable in the sense that local people depend on them to a degree that no alternatives are currently accessible or affordable (Brown et al. 2013). Therefore, based on previous resource use assessments (Fundação Príncipe 2019b; BirdLife International 2021b), the following were chosen as the most important provisioning ecosystem services that trigger HCV 5:

1) Water: used for various purposes such as drinking, cooking, bathing, and laundry
2) Wood: timber, firewood, and charcoal
3) Wild food products: foraged uncultivated plants and animals, such as fruits, vegetables, leaves, nuts, honey, and land snails
4) Medicinal plants: plants or parts of plants (roots, barks, leaves, etc.) used for traditional medicine
5) Hunting: targeting monkeys, feral pigs, civets, bats, and birds

Identification and mapping of HCV 5

Since the identification of HCV 5 must be carried out with the active participation of local people, important sites for the use of the five different natural resources were identified and mapped through participatory mapping workshops in selected communities (Puri 2010; HCVRN 2019b). In total, ten rural communities were surveyed (Fig. 2.2) and communities were chosen to represent existing diversity (small and big, coastal and non-coastal).

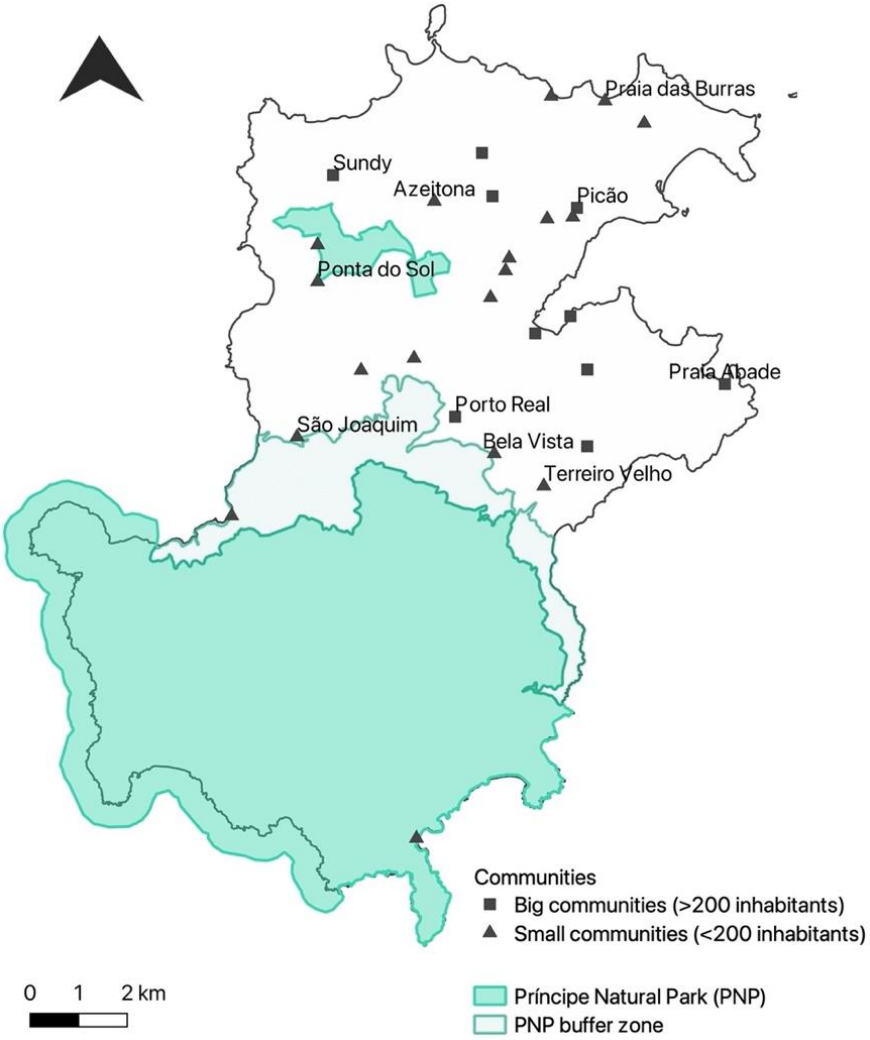


Fig. 2.2. Map of communities on Príncipe Island, showing communities selected for participatory mapping workshops with name labels (Data source: INE 2015).

In each community, a focal group was selected to participate in the meeting, making sure key subgroups were represented, namely traditional healers, hunters and people involved in the collection of wood (e.g., chainsaw operators, charcoal burners, carpenters) or other natural resources. Prior to the workshops, representatives of the communities were consulted to inform about the purpose of the meeting and to ensure consent. All workshops were carried out with at least one assistant from Fundação Príncipe with a good knowledge of the local terrain and the ability to interpret local terms mentioned by the participants (e.g., common names for species or local practices).

Before the start of the mapping, the aims of the work and the definition of technical terms were presented to each community. For the mapping exercise, participants were divided by gender, to ensure a balanced participation of women and men and assess gender-specific characteristics of resource use. Areas, where communities carried out resource use activities, were drawn on a satellite base map overlayed with remarkable geographic features to help the participants' interpretation (Fig. S2).

Additionally, participants were questioned about the resources and their use, such as which species were used, to link with information on HCV trigger species (Fig S3). Moreover, agricultural areas that do not formally qualify as HCV 5 were mapped (Fig. S4) since their localization provides valuable information about resource use characteristics and potential threats to biodiversity (HCV Consortium for Indonesia 2009).

The results of each workshop were scanned, georeferenced, and digitized in QGIS, and then combined to obtain one map showing all the sites relevant for each of the ecosystem services.

2.4 HCV Area delineation

HCV Areas (HCVAs) are defined as areas that contain at least one HCV. They are also referred to as 'HCV Management Areas', since they often combine several small locations of HCVs in a larger area to be practical for management (ProForest 2008; HCVRN 2019b). Ideally, HCVAs are delineated using boundaries that can be clearly identified on the ground and on maps (Neugarten & Savy 2012). In Príncipe, HCVAs were defined using natural boundaries, such as rivers, ridges or valleys, man-made structures, such as roads, and previously mapped areas (Table S4), such as the PNP or the 80 m buffer that legally defines coastal areas. For reasons of consistency, the same buffer was used around wetlands and areas without given limits. Based on topography and vegetation types, very large areas qualifying as HCV were divided into landscape units that each make up one HCVA.

HCVAs were not defined based on HCV 1.1 or 5, since the first was largely based on point occurrence data biased towards accessible areas, and the latter does not yet have robust information on the sustainability of resource use. Therefore, at this point, information relating to both these categories was only used to characterize HCVAs and incorporated into their prioritization. As stated before, HCV 2.2 was not used to define HCVAs alone but is considered as an added value.

2.5 HCV Area prioritization

To prioritize the sites holding the most important values among identified HCVAs, they were evaluated based on the principles of irreplaceability and vulnerability that are commonly used in prioritization schemes (Margules & Pressey 2000; Brooks 2010).

The priority ranking was established using three criteria: (I) Species-based vulnerability, (II) Irreplaceability, and (III) HCV variety (Table 2.2). The first two build on the concept of prioritizing KBAs (Langhammer et al. 2007), but since the objective of this work is to prioritize HCVAs holding the highest absolute values and not the prioritization for conservation action, the third KBA criterion, namely site-based vulnerability, was not applied. Instead, HCV variety was included as an additional context-specific criterion. Species-based vulnerability was obtained from the conservation status of HCV trigger species and species of interest, following the IUCN Red List or expert opinion.

Irreplaceability was defined by the availability of alternative sites (i.e., uniqueness) and the relative importance compared to alternative sites (Kukkala & Moilanen 2013), and it was estimated by valuing the abundance of species that had available data (i.e., species with temporary or localized habitats triggering HCV 1.3 and HCV 3.2) as well as ecosystem size and intactness. HCV variety was based on the number of different HCV categories (HCV 1,2,3 and 5) triggered at each site.

The maximum score assigned for each criterion was 'High' with an exception in the case of species-based vulnerability that had the extra score 'Extreme' for sites triggered by the presence of CR species, implying that sites with species facing the highest risk of extinction are weighted more heavily for prioritization. To obtain a final priority level, individual scores for each criterion were summed up and classified as top priority if they had a score of 8 or higher, medium priority if they had a score between 5 and 7, and low priority for any scores below that.

Table 2.2. Criteria and scores applied for HCVA prioritization.

Criteria	Trigger	Score
I. Species-based vulnerability	CR species	Extreme (4)
	EN species	High (3)
	VU species	Medium (2)
	NT/DD	Low (1)
	LC or no records	None (0)
II. Irreplaceability	High species abundance (when available); no or few alternative sites (e.g., habitats of hyper-endemic species; rare ecosystems); one of the largest ecosystems of its type; high intactness.	High (3)
	Medium species abundance; limited alternative sites; average ecosystem size; average intactness.	Medium (2)
	Low species abundance (when available); many alternative sites; one of the smallest ecosystems of its type; low intactness.	Low (1)
III. HCV variety	All 4 HCV categories triggered	High (3)
	2-3 HCV categories triggered	Medium (2)
	1 HCV category triggered	Low (1)

3 RESULTS

The next sections describe the HCVs identified for each category, based on which HCVAs were defined and prioritized (section 3.5).

3.1 HCV 1 – Species diversity

From a total of 85 species of interest (endemic and/or threatened), 31 taxa trigger HCV 1, including four birds, three reptiles, one mammal, one amphibian, one land snail, and 21 plants (Fig. 3.1, Table S1 & Table S2). Of those, 29 are threatened (HCV 1.1), one is hyperendemic (HCV 1.2) and four have critical temporary habitats (HCV 1.3). Among threatened species, 11 are Vulnerable (VU), 15 Endangered (EN) and three Critically Endangered (CR). The subspecies of the Príncipe Seedeater *Crithagra rufobrunnea fradei* was considered hyperendemic since it is restricted to the 30 ha Boné de Jóquei Islet, 3 km off the coast of Príncipe (Fig. 3.1.1). Important sea turtle nesting sites and two roosts of the endemic subspecies of the Egyptian Fruit Bat *Rousettus aegyptiacus princeps* were identified as essential temporary habitats.

The PNP had records for 91% of the species of interest (77 out of 85) and clearly qualifies as HCV 1.4 (Fig. 3.1).

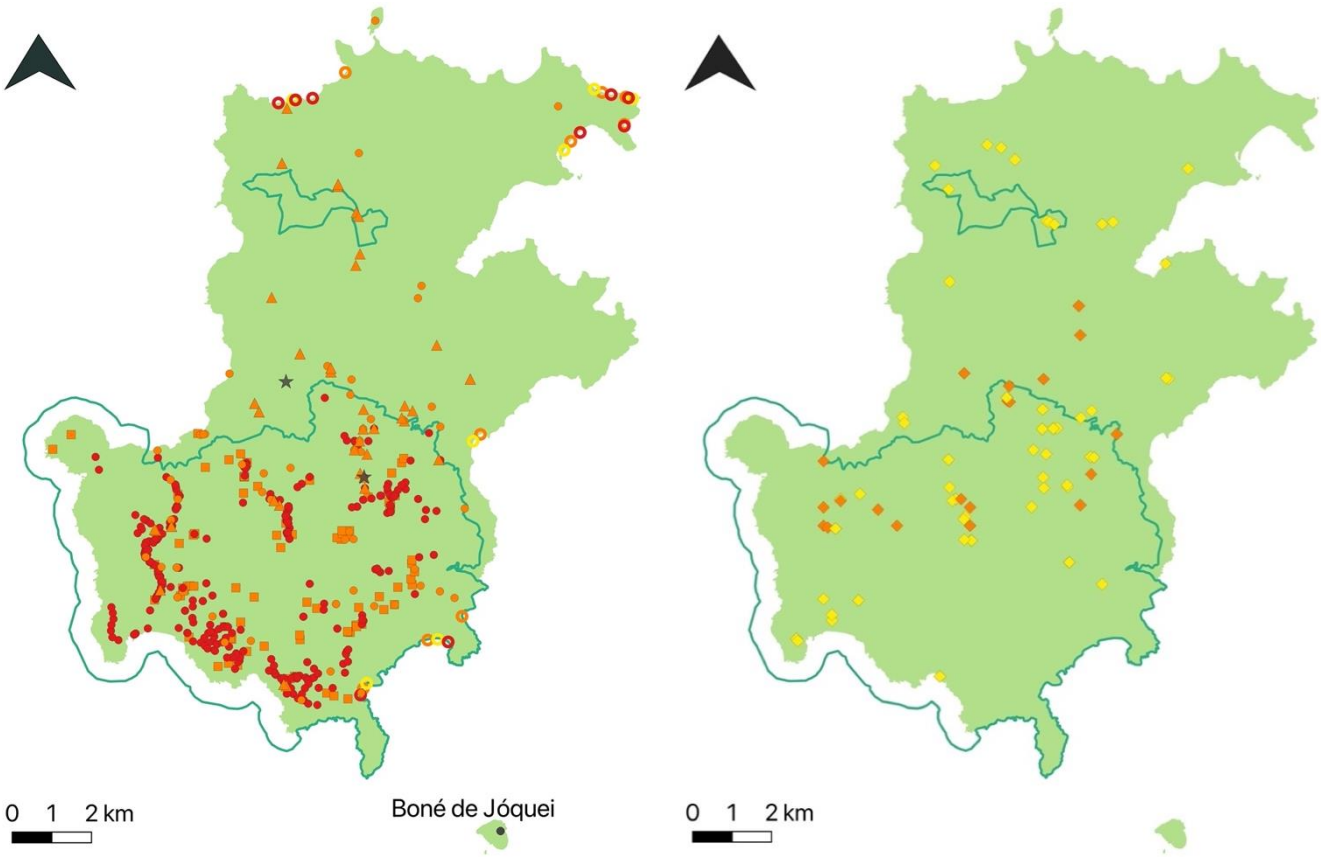


Fig. 3.1. Maps of Príncipe showing the confirmed locations of species that trigger HCV 1. Species are distinguished by taxonomic group (symbol type) and conservation status (color). Fauna is highlighted on the left, flora on the right (records from several species can overlap).

3.2 HCV 2 – Landscape-level ecosystems and mosaics

The continuous tract of native forest in the south of Príncipe spans over roughly 43 km^2 and constitutes one of the largest and best-preserved forest areas on the oceanic islands of the Gulf of Guinea (Jones et al. 1991). Given its ruggedness, difficult accessibility, and distance from roads and settlements, the area is largely sheltered from human interference (Fig. 3.2) and supports viable populations of most of the naturally occurring species, whereby qualifying as HCV 2.

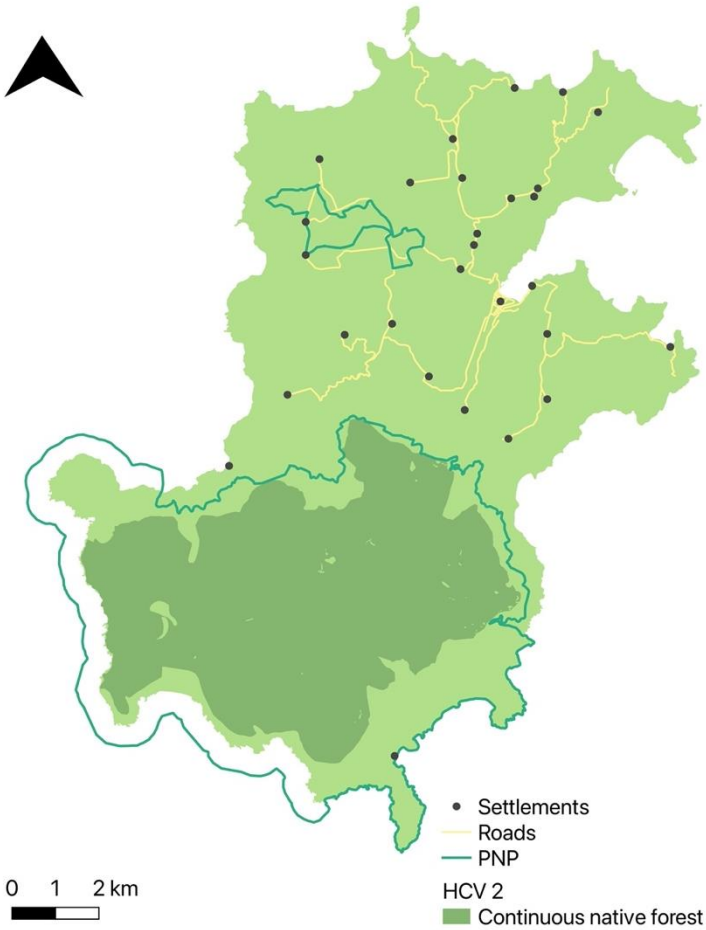


Fig. 3.2. Map of the continuous area of native forest that qualifies as HCV 2.

3.3 HCV 3 – Ecosystems and habitats

A wide range of ecosystems and habitats in Príncipe meet the criteria of HCV 3 (Table 3.1), including small areas of native and mature secondary forests, wetlands, inselbergs, and key localized habitats for species that do not trigger HCV 1.

Small areas of native forest persist on the southwestern hills and mountains, namely Morro Iola, Morro Fundão, Morro Caixão and Focinho de Cão (Fig. 3.4).

In the north and center of the island, a few secondary forests that are relatively well-preserved qualify as HCV 3. These can be found in the Azeitona forest PNP block and in the areas of Bom Bom, Praia Margarida, Quatro Caminhos and Morro Fugido (Fig. 3.4). The reclassified land use map shows that this portion of the island is dominated by secondary forest instead of shade plantations as previously suggested. This updated the proportion of the island covered by secondary forest to 52% while plantation forest only makes up 9%, in contrast to 29% secondary forest and 30% shade plantations from previous estimates (Fig. 3.3.).

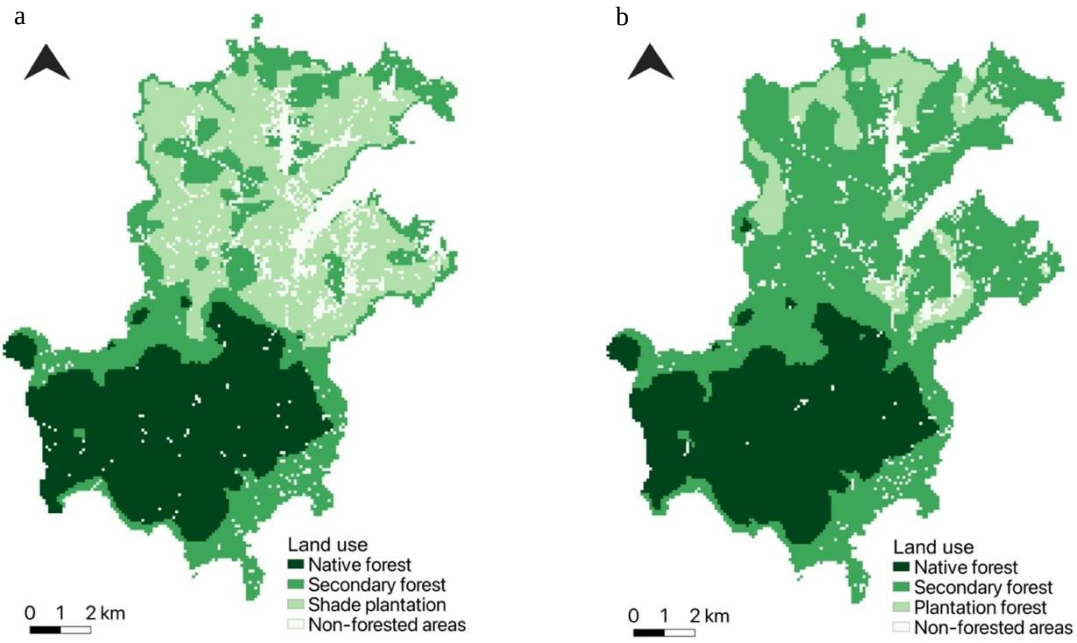


Fig. 3.3. (a) Pre-existent (Freitas 2019; Soares 2019) and (b) updated land use map (see methods in Table S3).

There are only a few very small terrestrial wetlands in Príncipe, which qualify as HCV 3. These include two swamps: one in a historical palm plantation near São Joaquim in the west, and one near Terra Prometida on the northern plateau (Fig. 3.4). Additionally, three very small mangroves at Praia Salgada, Praia Caixão, and Praia Grande were identified as HCV 3. The latter has a coastal lagoon, which, along with the lagoon at Praia das Burras, is the only one of its kind on the island (Fig. 3.4).

The complex topography of southern Príncipe encompasses inselbergs and similar formations that, due to their isolation, provide unique ecological conditions and qualify as HCV 3. This applies to Pico Mesa (Fig. 3.4), a 543 m high mountain with steep bare cliffs and a flat mountaintop covered by distinctive vegetation. Mountains with similar characteristics that potentially harbor rich floral assemblages but remain largely unexplored include Barriga Branca (612 m), João Dias Pai (644 m), Os Dois Irmãos (376 m) and Boné de Jóquei (305 m) (Fig. 3.4).

Several key localized habitats for non-threatened or non-endemic seabirds and bats were also identified as HCV 3. Seabird breeding sites are scattered along the coast of Príncipe and on associated islets. The Tinhosas islets hold remarkable numbers of several breeding species, including Sooty Tern *Onychoprion fuscatu,* Brown Booby *Sula leucogaster*, Black Noddy *Anous minutus* and Brown Noddy *Anous stolidus*. Boné de Jóquei and Bonézinho as well as Mosteiros, Ilhéus Portinho and the cliffs between Praia Banana and Praia Macaco are important regional breeding sites for White-tailed Tropicbirds *Phaethon lepturus ascensionis* (Fig. 3.4). One major roost of the Straw-colored Fruit Bat *Eidolon helvum* is sheltered in the southern native forest (Fig. 3.4).

Table 3.1. List of ecosystems and habitats under HCV 3.

Type	Ecosystem/Habitat	Well-preserved	Rare	Key habitat
Forest	Patches of native forest	X		
Forest	Mature secondary forest	X	X	
Wetlands	Swamps		X	
Coastal	Mangroves		X	
Coastal	Lagoons		X	
Montane	Inselbergs	X	X	
Non-HCV 1 species habitat	Seabird breeding sites			X
Non-HCV 1 species habitat	Bat roosts			X

Fig. 3.4. Map of Príncipe highlighting areas that qualify as HCV 3.

3.4 HCV 5 – Community needs

In total, 131 community members participated in the workshops (62 women and 69 men). The average age of participants was 38 years for both genders but ranged between 17 and 80 years for women, and between 18 and 65 years for men (Fig. 3.5). Most women worked in agriculture or were housewives, except in coastal communities, where nearly all participating women were fish traders, locally known as *palaiês de peixe*. Other women stated to be involved in small businesses, such as the collection and sale of forest products, like palm wine or land snails, as well as being members of cooperatives or associations, and students. Six were traditional healers or therapists (Fig. 3.6). Professions of male participants were diverse, most commonly in the areas of farming, fishing, palm wine tapping, charcoal production, massage therapy, transport, and security. A few were hunters, chain saw operators, teachers, or students (Fig. 3.6).

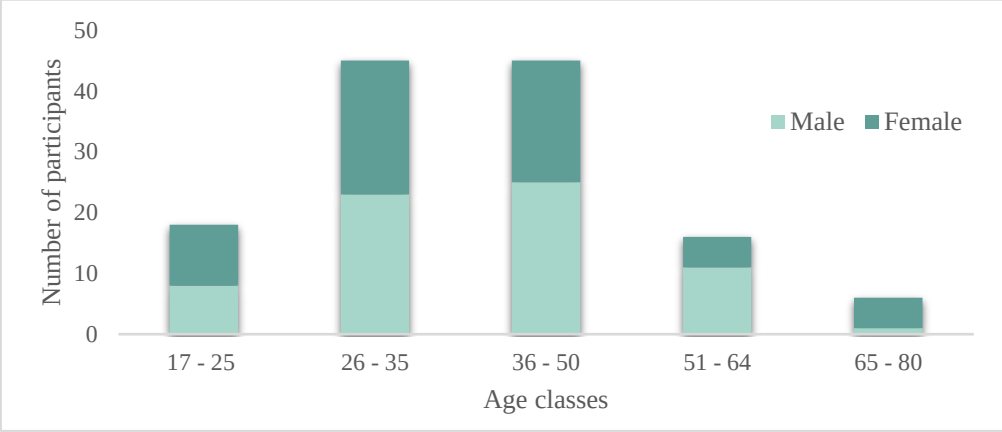


Fig. 3.5. Age structure of men and women that participated in the workshops.

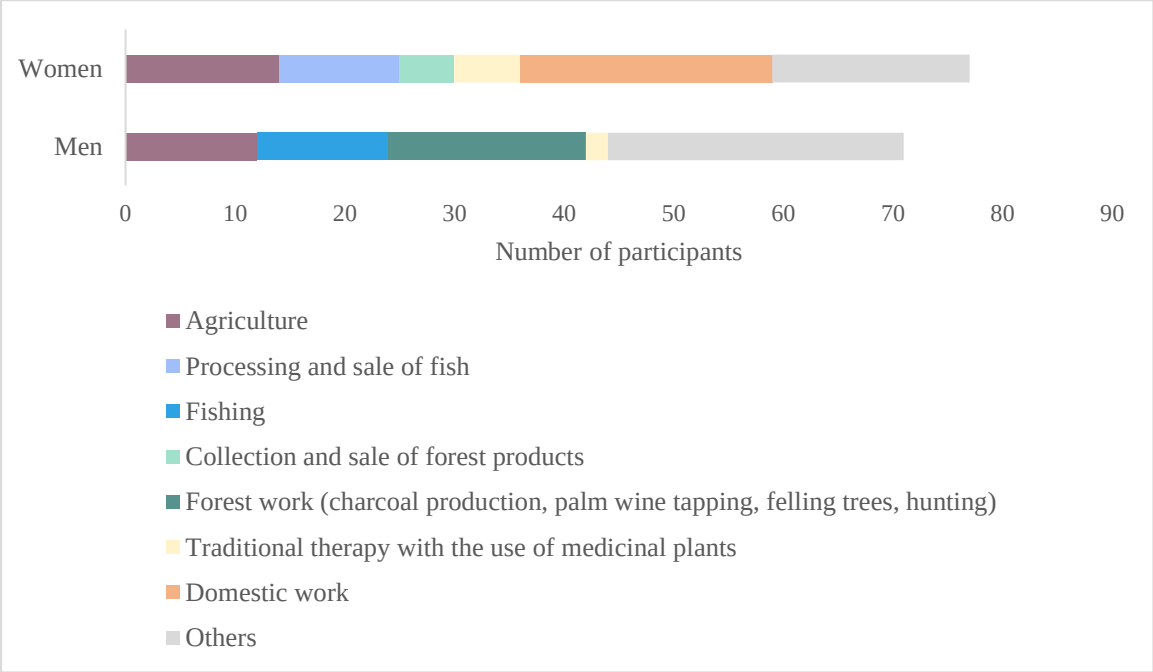


Fig. 3.6. Occupations of women and men that participated in the workshops. Participants can have several occupations.

Relevant observations regarding the use of the key provisioning ecosystem services assessed during the workshops are summarized below including a description of the spatial scale at which they were obtained. Resources are organized following previous research (BirdLife International 2021b) to allow for the comparison of results.

Water

All communities used nearby rivers and streams for freshwater (Fig. 3.7), and only a few had communal fountains. Laundry was usually done by women in nearby rivers. The communities of Ponta do Sol and Azeitona relied on the northern block of the PNP to obtain drinking water and for washing laundry, while the communities of São Joaquim, Bela Vista, Porto Real, and Terreiro Velho used the rivers draining from the southern block of the PNP (Fig. 3.7).

Wood

The extraction of timber, the production of charcoal, and the collection of firewood were activities carried out by all communities. People sourced charcoal and firewood mainly from forests near their communities (Fig. 3.8b & Fig. 3.8c), while timber was extracted across the island, often far from their own communities (Fig. 3.8a). This was especially the case in São Joaquim, Porto Real and Ponta do Sol. Activities to obtain wood products extended only slightly into the southern block of PNP, but the Azeitona portion of the PNP was used by the surrounding communities (Ponta do Sol, Azeitona and Sundy) for firewood and charcoal. While men were responsible for logging, collecting firewood was usually a task of the women, but both men and women were involved in the production of charcoal. From all assessed resources, timber and charcoal were some of the most frequently sold at local markets, rarely being exported to São Tomé. None of the species that were used as wood resources triggers HCV (Table S5).

Wild food products

Wild food products were important to all communities. Collected forest foods included fruits (e.g., "Fruta pão" *Artocarpus altilis*, "Pêssego de São Tomé" *Chytranthus mannii*), land snails, honey, as well as leaves (e.g., "Folha ponto" *Achyranthes aspera*, "Maquequê" *Solanum cytherea*) and spices (e.g., "Pau-pimenta" *Piper guineensis*, "Ossame" *Aframomum daniellii*) (Table S6), which are often used to prepare traditional dishes and medicine (Table S7).

Wild foods were gathered throughout the island but mostly outside the main block of the PNP (Fig. 3.9a). Only the harvest of the Obô Giant Snail extended into that area (Fig. 3.9b) but was only carried out in a few communities (Azeitona, Bela Vista, Ponta do Sol and Porto Real). Participants reported that it is difficult to encounter this species and that harvest efforts are too high, thus the widespread invasive West African Giant Snail *Archachatina marginata* has become the primary target. The latter was collected over a wide range (Fig. 3.9b), but community members noted that it became increasingly difficult to find this species in areas where it was once abundant. The importance of land snail collection varied between communities: members of a coastal community stated that they were not involved in this activity at all, others collected occasionally, while in specific communities, notably Porto Real, land snails were an essential natural resource.

According to the participants, the collection of honey from wild beehives was reserved for the members of the local beekeeping cooperative COOPAPIP (Cooperativa dos Apicultores da Ilha do Príncipe) and covered extensive areas of forest outside the PNP (Fig. 3.9c).

In contrast to other wild food products, the edible fruits of the endemic "Pessegueiro de São Tomé" *Chytranthus mannii* (VU, HCV 1.1. trigger) were stated to be very rare and only harvested occasionally in specific locations, often close to communities, where they were sometimes also planted (Fig. 3.9c).

Although all edible forest resources were sold on local markets and even shipped to São Tomé, they were mainly traded informally.

Medicinal Plants

Medicinal plants were widely used for various therapeutic purposes. They were collected mainly near communities, where they were often also cultivated in backyards (Fig. 3.10). São Joaquim and Porto Real were exceptions, using much wider ranges to obtain medicinal plants. Harvest areas barely overlapped with the PNP in the south, but the Azeitona block was used by the communities of Azeitona and Sundy. It was noticeable, that most participants working with traditional medicine were elderly people, while from the four people that did not have other additional occupations three were 70 years or older. Medicinal plant products were occasionally sold on local markets as well as to São Tomé. From the large variety of medicinal species, only the rarely used *Chytranthus mannii* triggers HCV 1.1 (Table S7).

Hunting

Hunting was practiced in all communities, although to very different extents: some focused on a small nearby area, while others had very large hunting grounds (Fig. 3.11). Overall, hunting had the largest range of all resources with hunters reaching far into the southern part of the island. Communities that covered the largest distances for hunting were São Joaquim, Terreiro Velho, Praia Abade and Porto Real. Hunting ranges were especially large for hunters targeting introduced mammals, such as feral pigs, Mona monkeys *Cercopithecus mona*, and African civets *Civettictis civetta*. The meat of these animals was sold locally, either by request or whenever the harvest exceeded household consumption. Small to medium-sized birds were mainly caught around the communities, often by children using slingshots and traps. Otherwise, hunting was exclusively carried out by adult men. Among the most hunted bird species were pigeons (including the endemic subspecies *Treron calva virescens*, and *Columba larvata principalis*, the endemic species *Columba malherbii*, and the introduced *Columba livia domestica*), the endemic Príncipe Golden-weaver *Ploceus princeps* and Starlings *Lamprotornis* spp. (one of which is an endemic species). Sometimes the Endangered Grey parrot *Psittacus erithacus* and kingfishers (both of which are endemic subspecies: *Halcyon malimbica dryas* and *Corythornis cristatus nais*) were targeted. None of the hunted bird species triggers HCV. Bats were often hunted near human settlements where they feed on fruits. Two additional bat hunting zones were mentioned: the cave at Morro Fundão, where the endemic subspecies of Egyptian Fruit Bat (HCV 1.3 trigger) roosts, is used at least by São Joaquim and Porto Real, while a small seasonal roost of the Straw-coloured Fruit Bat on the north coast near Praia Micotó is used by Azeitona inhabitants.

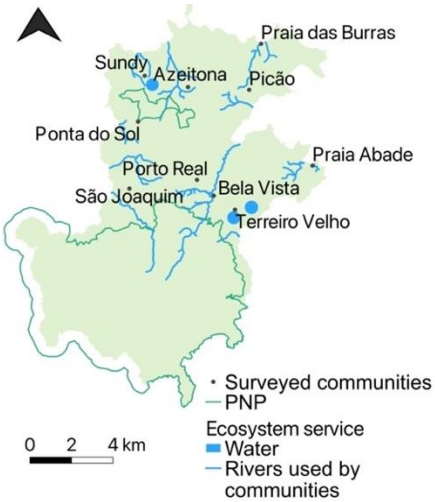


Fig. 3.7. Used water resources (lines = rivers, polygons = unidentified water usage areas).

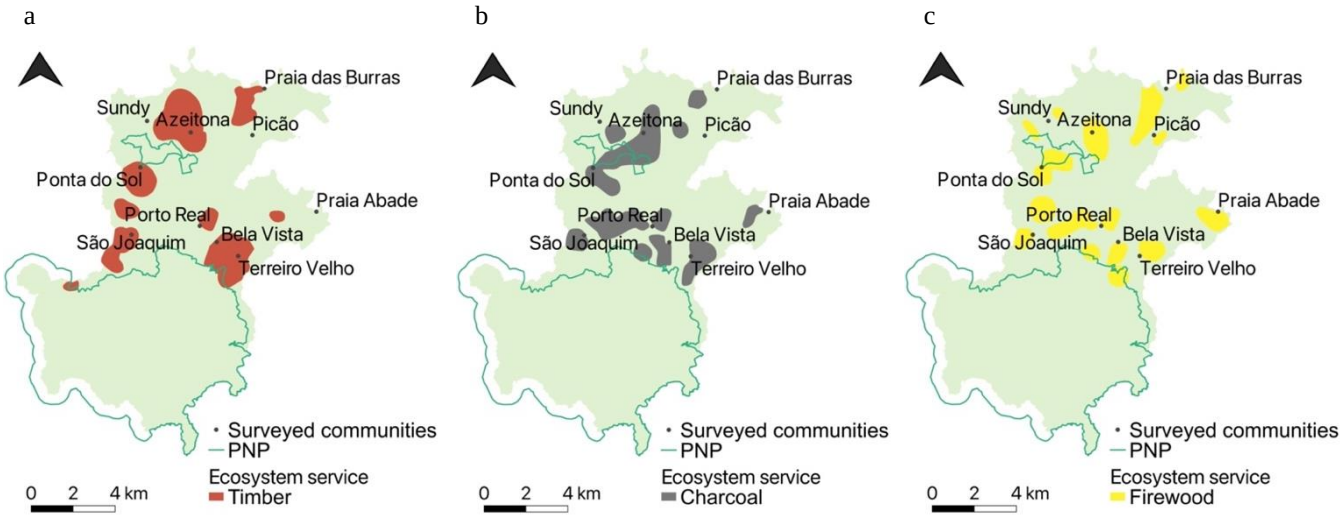


Fig. 3.8. Wood resource extraction areas: (a) timber, (b) charcoal and (c) firewood.

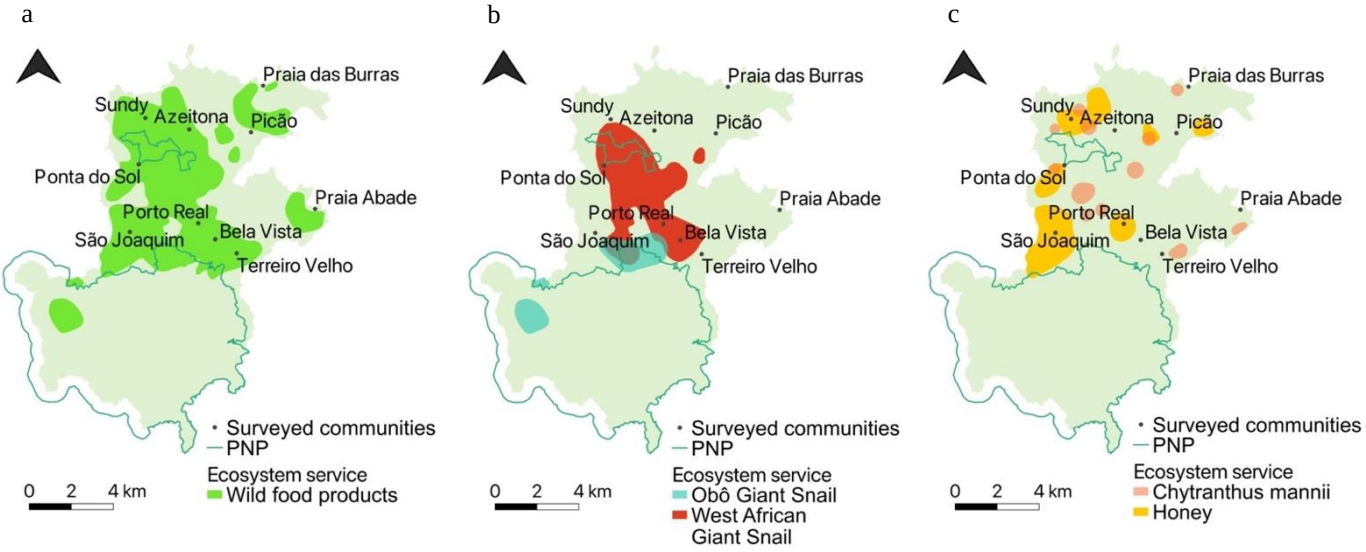


Fig. 3.9. Wild food product collection areas: (a) all wild foods, (b) land snails, (c) *Chytranthus mannii* and honey.

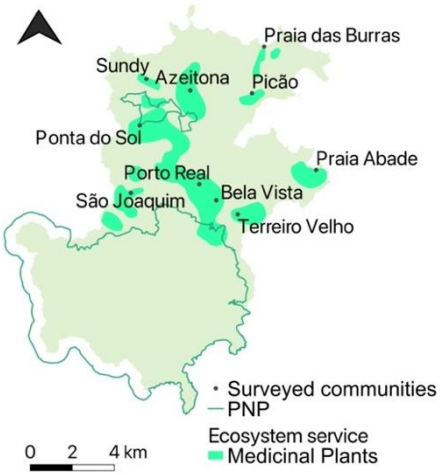


Fig. 3.10. Medicinal plant collection areas.

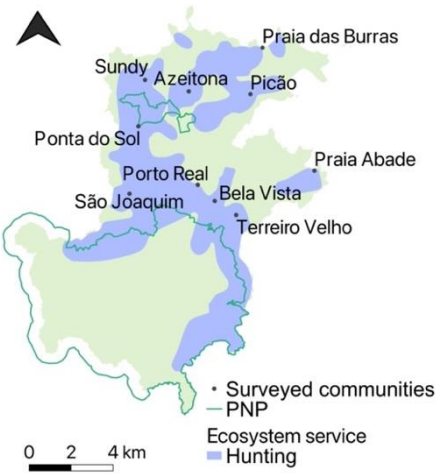


Fig. 3.11. Hunting grounds.

3.5 Potential HCV Areas

The integration of values from the different HCV categories resulted in the identification of 25 potential HCVAs in Príncipe (Fig. 3.12). These are concentrated mostly in the PNP, including eight in the southern block. Other HCVAs were localized in coastal areas scattered around the island, on hills and mountains in the center and on the associated islets. Of all HCVAs, 11 were identified as top conservation priority, nine as medium and five as low priority, though some require further research to verify prioritization levels (Table 3.2).

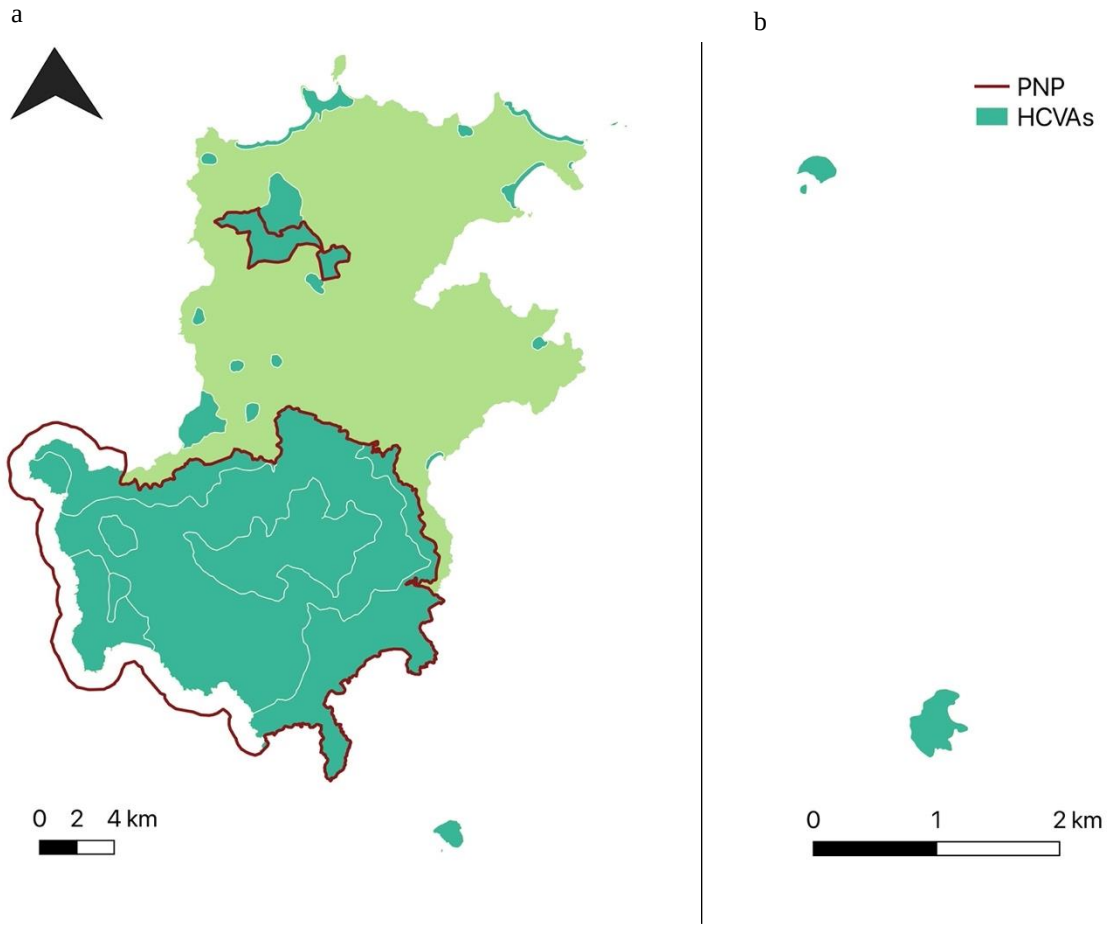
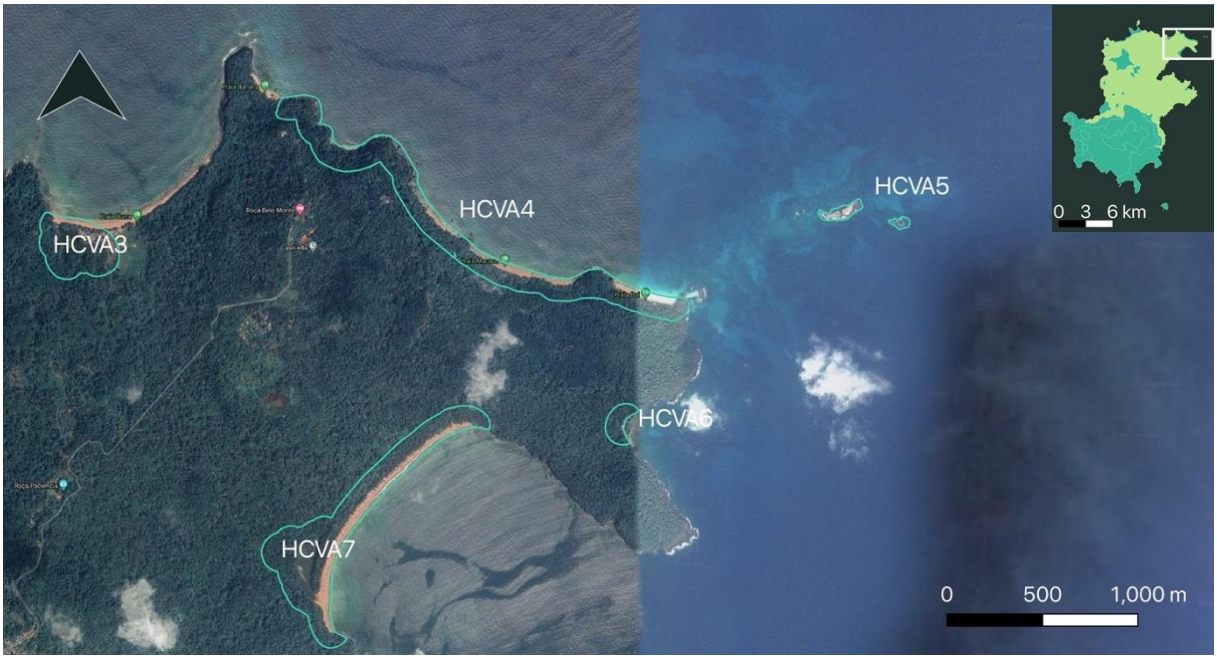


Fig. 3.12. Map of potential HCVAs in (a) Príncipe and (b) Tinhosas.

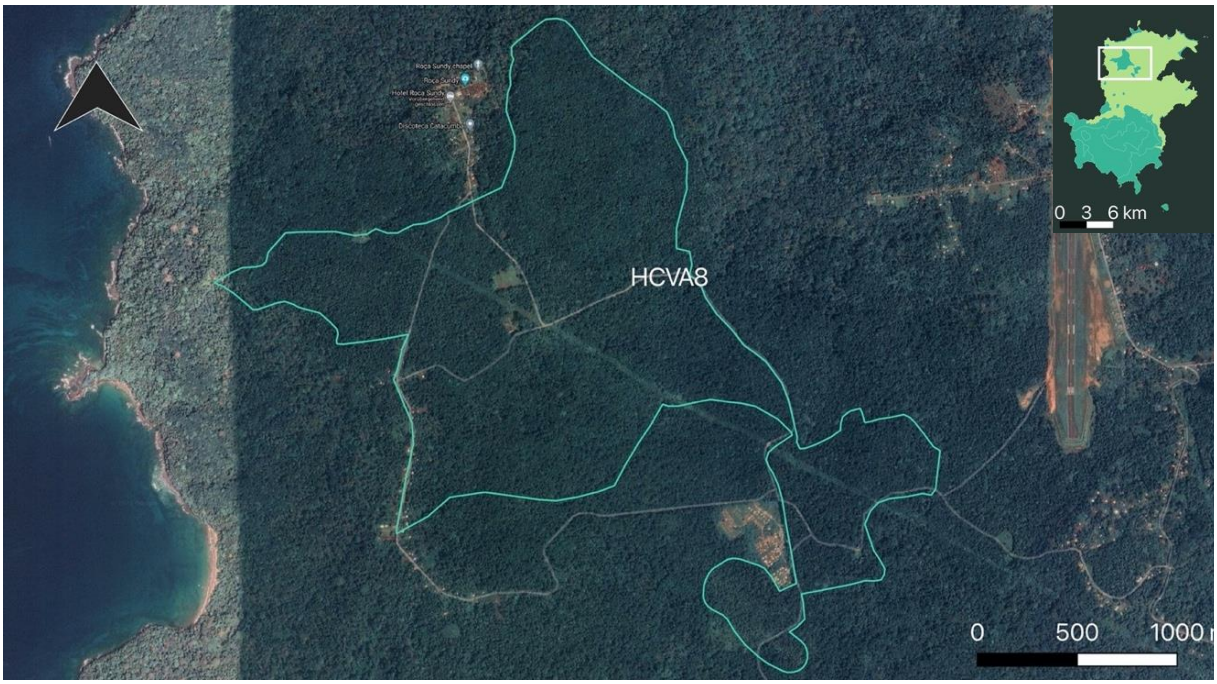
Table 3.2. Potential HCVAs identified in Príncipe. Sites are listed with an individual code and name. The column "HCV trigger" indicates the present values of each of the four categories: 1 – Species diversity (VU – Vulnerable; EN – Endangered; CR – Critically Endangered; end. – endemic; a list of further present species of interests is provided in Table S8), 2 – Landscape-level ecosystems and mosaics, 3 – Ecosystems and habitats, 5 – Community needs. Additional site characteristics are given, including size and potential threats, the latter was identified based on field observations (marked as *), secondary data and expert opinion. The column "Priority rank" shows suggested priority levels (1 – top, 2 – medium, 3 – low) for each HCVA, derived from the scores (0 – none, 1 – low, 2 – medium, 3 – high, 4 – extreme) assigned for the three prioritization criteria: I – Species-based vulnerability, II – Irreplaceability, III – HCV variety (see section 2.5) indicated in parentheses. Maps show the boundaries of each HCVA overlayed on a Google Earth satellite base map (Google Earth 2016-2020).

Code	Name	HCV trigger	Area (ha)	Potential threats	Priority
HCVA1	Praia Margarida forest	3 – Mature secondary forest 5 – Wild food products	11.2		2 (I: 0, II: 3, III: 2)
HCVA2	North coast between Praia Sundy and Bom Bom	1 – Sea turtle nesting site (*C. mydas*, EN; *D. coriacea*, VU; *E. imbricata*, CR) 3 – Mature secondary forest 5 – Hunting	85.4	Hunting of fruit bats (*E. helvum*) by local communities*, touristic development, sand extraction at Praia Ribeira Izé (Laura Benitez, pers. comm.)	1 (I: 4, II: 3, III: 2)

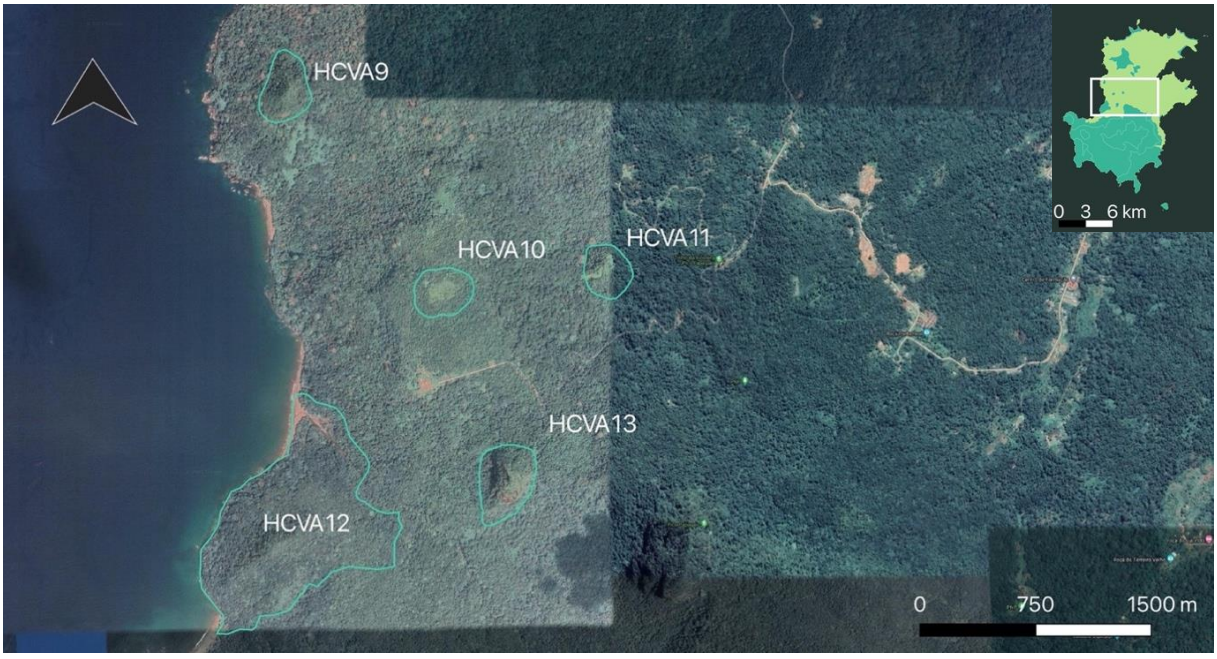
Code	Name	HCV trigger	Area (ha)	Potential threats	Priority
HCVA3	Praia das Burras	3 – Coastal lagoon 5 – Water, timber	10.9	Pollution of the lagoon through the adjacent settlement*	3 (I: 0, II: 2, III: 2)
HCVA4	Northeast coast between Praia Banana and Praia Boi	1 – Sea turtle nesting site (*C. mydas*, EN; *D. coriacea*, VU; *E. imbricata*, CR) 3 – Seabird breeding site (*P. lepturus ascensionis*, Bollen et al. 2018) 5 – Firewood	32.7	Touristic development*	1 (I: 4, II: 3, III: 2)
HCVA5	Mosteiros islets	3 – Seabird breeding site (*P. lepturus ascensionis*, Bollen et al. 2018)	1.7	Poaching of White-tailed tropicbirds (Bollen et al. 2018)	3 (I: 0, II: 2, III: 1)
HCVA6	Praia Uva	1 – Sea turtle nesting site (*C. mydas*, EN; *E. imbricata*, CR)	2.1		1 (I: 4, II: 3, III: 1)
HCVA7	Praia Grande	1 – Sea turtle nesting site (*C. mydas*, EN; *D. coriacea*, VU; *E. imbricata*, CR) 3 – Coastal lagoon, mangroves 5 – Wild food products, hunting	30.1	Loss of beach area due to the invasion of coconut trees, disposal of coconut shells and coastal erosion (Vanessa Schmitt, pers. comm.)	1 (I: 4, II: 3, III: 2)



Code	Name	HCV trigger	Area (ha)	Potential threats	Priority
HCVA8	Azeitona and Quatro Caminhos	1 – *C. hiernii var. hiernii* (VU, end.), *C. mannii* (VU, end.), *L. rozeirae* (VU, end.) *L. palmatus* (EN, end.), protected area 3 – Mature secondary forest 5 – Water, timber, charcoal, firewood, wild food products, medicinal plants, hunting	375	Building of a settlement at the boundaries of the PNP*, logging*, charcoal production*, wild food product collection (*C. mannii*)*, timber plantation at the margins of the swamp*, water draining at the swamp*, stone quarrying	1 (I: 3, II: 3, III: 2)



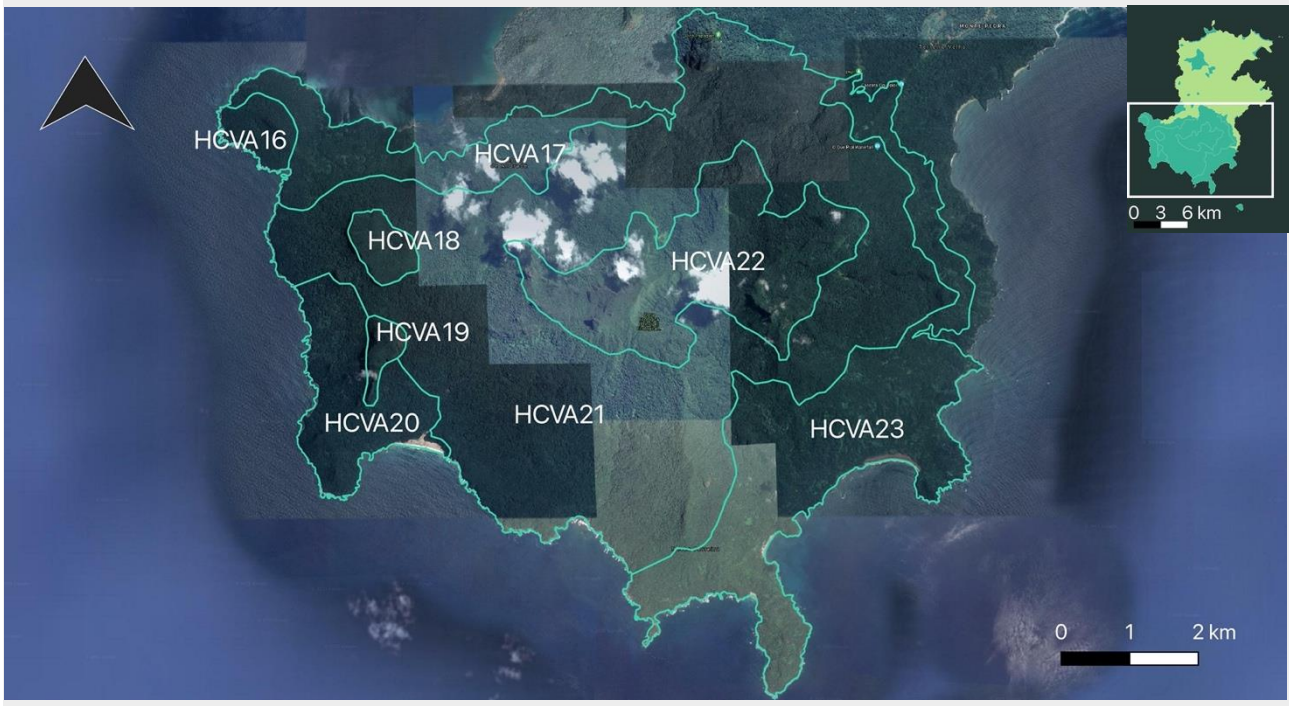
Code	Name	HCV trigger	Area (ha)	Potential threats	Priority
HCVA9	Morro Iola	3 – Native forest 5 – Wild food products, hunting	11.2	Agriculture*	2 (I: 0, II: 3, III: 2; further research underway)
HCVA10	Swamp São Joaquim	3 – Mature secondary forest 5 – Charcoal, wild food products, medicinal plants, hunting	9.9		3 (I: 0, II: 2, III: 2; further research needed)
HCVA11	Morro Fugido	3 – Mature secondary forest 5 – Charcoal, firewood, wild food products, hunting	8.5	Agriculture*, logging*	2 (I: 0, II: 3, III: 2; further research underway)
HCVA12	Morro Caixão and Praia Caixão	1 – *C. hiernii* (VU, end.), *Z. ficedulinus* (EN, end.) 3 – Native forest, mangroves 5 – Water, timber, charcoal, firewood, wild food products, medicinal plants, hunting	107.5	Cutting of mangroves for the extraction of tannin used for the dyeing of fishing nets*, logging*, charcoal production*	2 (I: 3, II: 2, III: 2; further research needed)
HCVA13	Morro Fundão	3 – Native forest, bat roost (probably *R. aegyptiacus princeps, end.)* 5 – Wild food products, hunting	15	Hunting of fruit bats (probably *R. aegyptiacus princeps*) by local communities*	2 (I: 0, II: 3, III: 2)



Code	Name	HCV trigger	Area (ha)	Potential threats	Priority
HCVA14	Praia Salgada	3 – Mangroves (Cravo 2021) 5 – Water, charcoal, firewood, wild food products, medicinal plants, hunting	10.4	Cutting of mangroves for the extraction of tannin used for the dyeing of fishing nets (Cravo 2021)	3 (I: 0, II: 2, III: 2)
HCVA15	Praia Abelha	1 – Sea turtle nesting site (*C. mydas*, EN; *D. coriacea*, VU; *E. imbricata*, CR) 5 – Timber, charcoal, hunting	7.8		2 (I: 3, II: 2, III: 2)

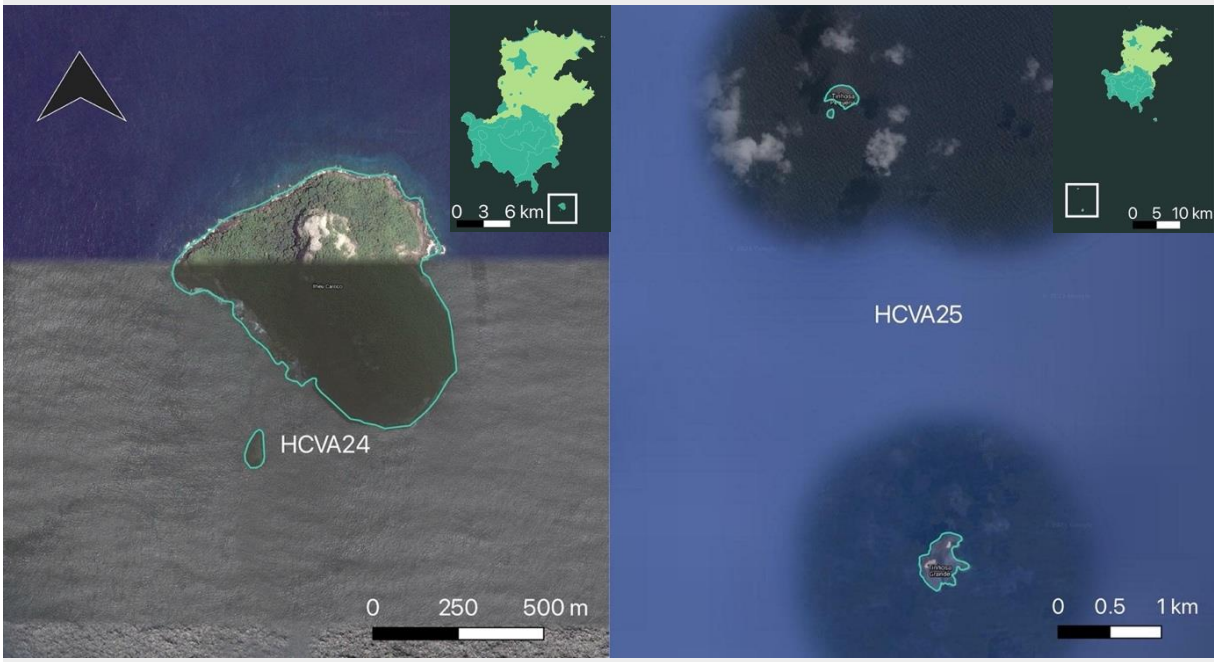
Code	Name	HCV trigger	Area (ha)	Potential threats	Priority
HCVA16	PNP - Focinho de Cão	1 – *A. bicarinata* (EN, end.), protected area 3 – Native forest	87.1		2 (I: 3, II: 2, III: 2; further research needed)
HCVA17	PNP - Northern tract	1 – *A. bicarinata* (EN, end.), *Otus* sp. (CR, end.), *T. xanthorhynchus* (CR, end.), *Z. ficedulinus* (EN, end.), protected area 2 – Large intact native forest, buffer around continuous native forest, corridor between continuous native forest and native forest patch at Focinho de Cão 3 – Mature secondary or native forest 5 – Timber, wild food products (Obô Giant Snail collection), hunting	440.3	Logging, sand extraction, livestock (Laura Benitez, pers. comm.)	1 (I: 4, II: 2, III: 3)
HCVA18	PNP – Pico Mesa	1 – *B. basifolata* (EN, end.), *B. fusialata var. principensis* (EN, end.), *C. calophylum* (EN, end.), *L. palmatus* (EN, end.), *L. rozeirae* (VU, end.), *R. dichotoma* (EN, end.), *T. xanthorhynchus* (CR, end.), occurrence of a new highly restricted plant species (probably CR; Fauna & Flora International 2018), protected area 2 – Large intact native forest 3 – Native forest, inselberg	47.4		1 (I: 4, II: 3, III: 2)
HCVA19	PNP – Barriga Branca	1 – Protected area 2 – Large intact native forest 3 – Native forest, inselberg	44.4		2 (I: 0, II: 3, III: 2; further research needed)
HCVA20	PNP - Southwestern tract	1 – *A. bicarinata* (EN, end.), *C. hiernii* (VU, end.), *C. mannii* (VU, end.), *D. bocageanum* (VU, end), *I. manteroana* (EN, end.), *L. palmatus* (EN, end.), *Otus* sp. (CR, end.), *P. thomensis* (VU, end.), *T. xanthorhynchus* (CR, end.), protected area 2 – Large intact native forest 3 – Mature secondary or native forest 5 – Timber, firewood, wild food products, medicinal plant, hunting	365.6		1 (I: 4, II: 2, III: 2; further research needed)
HCVA21	PNP - Lowland to medium elevation mature forest	1 - *A. bicarinata* (EN, end.), *A. eurysorum* (VU, end.), *B. basifolata* (EN, end.), *C. calophylum* (EN, end.), *C. hiernii* (VU, end.), *C. hiernii var. glandulosa* (EN, end.), *C. hiernii var. hiernii* (VU, end.), *D. bocageanum* (VU, end.), *D. occidentale* (VU, end.), *I. manteroana* (EN, end.), *L. palmatus* (EN, end.), *L. rozeirae* (VU, end.), *Otus* sp. (CR, end.), *P. grandis* (EN, end.), *P. principensis (EN, end.)*, *P. thomensis* (VU, end.), *P. quintasii* (VU, end.), *S. mannii* (VU, end.), *T. principensis* (EN, end.), *T. xanthorhynchus* (CR, end.), *Z. ficedulinus* (EN, end.), bat roost (*R. aegyptiacus princeps,* end.),	3178.2	Planned building of a dam at Rio Papagaio, touristic activity, invasive species, logging (Laura Benitez, pers. comm.), Obô Giant Snail collection*	1 (I: 4, II: 3, III: 3)

		occurrence of a new highly restricted plant species (probably EN; Fauna & Flora International 2018), protected area 2 – Large intact native forest 3 – Bat roost (*E. helvum*) 5 – Charcoal, firewood, wild food products (Obô Giant Snail collection), medicinal plants, hunting			
HCVA22	PNP - Central mountains	1 – *A. bicarinata* (EN, end.), *B. basifolata* (EN, end.), *C. hiernii* (VU, end.), *C. vagans* (EN, end.), *L. palmatus* (EN, end.), L. rozeirae (VU, end.), *Z. ficedulinus* (EN, end.), *T. principensis* (EN, end.), *T. xanthorhynchus* (CR, end.), protected area 2 – Large intact native forest 5 – Water	798.7	Logging (Laura Benitez, pers. comm.)	1 (I: 4, II: 3, III: 2; further research needed)
HCVA23	PNP – Southeastern tract	1 – *A. bicarinata* (EN, end.), *C. hiernii* (VU, end.), *Otus* sp. (CR, end.), *T. xanthorhynchus* (CR, end.), *Z. ficedulinus* (EN, end.), sea turtle nesting site (*C. mydas*, EN; *D. coriacea*, VU; *E. imbricata*, CR), protected area 2 – Large intact native forest, buffer around continuous native forest 3 – Mature secondary or native forest; seabird breeding site (*P. lepturus ascensionis*, Bollen et al. 2018) 5 – Timber, firewood, medicinal plants, hunting	1095.6	Settlement at Praia Seca and related threats e.g., logging, firewood collection, hunting, poaching of sea turtles, introduction of livestock	1 (I: 4, II: 3, III: 3)



Code	Name	HCV trigger	Area (ha)	Potential threats	Priority

HCVA24	Boné de Jóquei and Bonézinho	1 – *C. rufobrunnea fradei* (hyperendemic; Melo & O'Ryan 2007) 3 – Seabird breeding site (*P. lepturus ascensionis*; Bollen et al. 2018), inselberg	39.7	Poaching of Brown Boobies (Bollen et al. 2018)	2 (I: 0, II: 3, III: 2)
HCVA25	Tinhosas islets	3 – Seabird breeding site (*A. minutus*, *A. stolidus*, O. *fuscatus*, *S. leucogaster*; Bollen et al. 2018)	20.2	Poaching of Brown Boobies by fishermen, disturb-ance by landings on Tinhosas Grande, plastic pollution (Bollen et al. 2018)	3* (I: 0, II: 3, III: 1)



*This site was ranked as low priority since all present species are LC and only one type of HCV is triggered. The classification of Tinhosas, which hold the largest breeding seabird colony in the eastern tropical Atlantic (Bollen et al. 2018), should in no way be equated with a low conservation value since all HCVAs are priorities for conservation.

4 DISCUSSION

4.1 Priority sites for conservation on Príncipe Island

This study reveals 25 potential HCVAs in coastal and terrestrial zones as priority sites for conservation in Príncipe. HCVAs were identified based on biodiversity and socio-cultural values assigned to four categories: species diversity (HCV 1), landscape-level ecosystems and mosaics (HCV 2), ecosystems and habitats (HCV 3) and community needs (HCV 5). Due to incomplete information on the distribution of HCV 1.1 (threatened species) and on HCV 5, the boundaries of HCVAs were delineated based on the remaining HCV categories, consequently putting a greater emphasis on ecosystem and habitat values. Out of the 25 potential HCVAs, 16 trigger HCV 1, 7 trigger HCV 2, 22 trigger HCV 3 and 18 trigger HCV 5.

Biodiversity values

Available data confirms that most of the threatened terrestrial fauna (qualifying as HCV 1.1) of the island is restricted to the native forest in the southern block of the PNP (e.g., Freitas 2019; Fundação Príncipe 2019a; Rebelo 2020). Exceptions include the endemic Príncipe White-eye (*Zosterops ficedulinus*, EN), which has several records outside the PNP, and the endemic Príncipe Giant Tree Frog (*Leptopelis palmatus*, EN), which is the only amphibian that triggers HCV and that appears to occur primarily in the north, most likely due to sampling bias. There is less information on the distribution of plant species, and available records are also biased, namely towards accessible areas or areas that are relatively well-preserved (Fauna & Flora International 2018). Many plant species occurrences are in the southern portion of the PNP, even though several records from the north show that some of the threatened and endemic plant species can persist in human-dominated landscapes. Important sea turtle nesting grounds (qualifying as HCV 1.3) are scattered around the island, except on the west coast. Some of these coincide with areas of relatively high human interference, such as Praia Seca, which has a semi-permanent fishing community, and the beaches around Praia Sundy, which are popular tourist destinations.

The continuous area of native forest (qualifying as HCV 2) corresponds mostly to the submontane and montane areas in the PNP. However, it also includes lowland forests in the south that are of high conservation concern. Together, these areas (HCVA21 and HCVA22) seem to have the most important, endemic-rich biodiversity on the island (Fauna & Flora International 2018).

All inselbergs on the main island (qualifying as HCV 3) are in the mountainous southern portion of the PNP. Pico Mesa, for instance, is a mountain plateau, similar to the South American tepuis, that seems to harbor numerous distinct biodiversity elements (Fauna & Flora International 2018). Comparable conditions can be expected on other mountain tops, like Barriga Branca, for which there is no information due to their inaccessibility. Aside from that, most ecosystems that meet HCV 3 criteria are found in the north and center of Príncipe. Patches of mature secondary and native forest are all at higher elevations (Morro Iola, Morro Fugido, Morro Fundão and Morro Caixão) or on privately owned land (Praia Margarida forest, Bom Bom, part of Azeitona and Quatro Caminhos). Another interesting aspect is that, surprisingly, smaller tree canopies with smooth textures frequently correspond to better preserved forest, whereas large and heterogenous canopies often match with shade plantations or young secondary forests, where large tree species used for shading can be abundant, namely *Ceiba pentandra* (“Ocá”) and *Erythrina* sp. (“Eritrineira”) (Fig. S5). Topography, land tenure and canopy patterns are thus good clues to find the best-preserved areas in the northern and central portion of the island. Contrary to the results of a previous attempt to map land use in this area (Fauna & Flora International 2018), there are extensive tracts of secondary forest, and the distribution of plantations is rather restricted. The contrasting findings may be explained through a different distinction between the two land use types.

Namely, this study considered relatively recently abandoned plantations as secondary forest, whereas the previous one might have only defined plantations that were abandoned a long time ago as secondary forest. However, in this part of Príncipe where a heterogenous landscape has been shaped by human activity dating back to colonial times, the boundaries between forest types are hard to set. This underlines the importance of using clear forest definitions for land use classifications (Putz & Redford 2009).

Socio-cultural values

Participatory surveys revealed that socio-cultural values associated with important provisioning ecosystem services (HCV 5) are critical for meeting a wide range of basic needs of people in Príncipe, including nutrition (wild food products, hunting), health (water, medicinal plants), shelter (timber), and energy (charcoal, firewood).

At community-level, there were significant differences in the spatial extents at which resources were used. For coastal communities, which rely primarily on fishing for their livelihood, forest resources seem to play a secondary role, and are typically obtained from relatively small areas around the settlements. In larger and more remote communities, people tend to seek resources further away. In larger communities, higher demand could be a reason for the use of extensive areas (Mantey & Teye 2021), whereas in remote communities limited alternatives and poor access to markets might make them more reliant on forest products (Hlaing et al. 2017; Lax & Köthke 2017). This in turn could help explain why the remote communities near the PNP may be exploring resources in the protected area (Ministry of Infrastructure, Natural Resources and Environment 2015).

According to the results, water, wild food products, medicinal plants, and wood resources are mostly obtained around the communities, in the northern and central part of the island, while they are only extracted from the margins of the southern PNP block, occasionally extending into the partial protection zone (type 1). The hunting of introduced mammals and the harvest of Obô Giant Snails are the only activities that reach further into the PNP, namely into the partially (type 1) and totally protected zones (type 2 for hunting, and type 1 & 2 for snail collection). The Azeitona PNP block (partial protection type 2) is within the range for all assessed resource use activities.

Major logging zones were detected in the surroundings of Terreiro Velho, an area at the boundaries of the southern PNP block with many large trees, and São Joaquim, where a large forest area has been cleared recently. These areas seem to be used by nearby communities as well as by distant communities and have not been documented before. An area near Praia Caixão had been already identified as being important for charcoal production (Nuno 2021), but the area between the Azeitona forest and the airport is also heavily used for charcoal production. Charcoal and timber were the most traded forest resources in Príncipe, which might be linked to the strong dependency of local people on charcoal for fuel (Nuno 2021), and to the high commercial value of timber (Ministry of Infrastructure, Natural Resources and Environment 2015). The latter could also explain why loggers are willing to travel long distances to extract timber.

For snail collection, the results suggest that the endemic and threatened Obô Giant Snail (HCV 1.1 trigger) is being replaced by the introduced West African Giant Snail as the main target species for collectors (Fundação Príncipe 2019a). Both overexploitation and the expansion of the introduced species have been associated with the severe decline of the endemic Obô Giant Snail over the past 30 years (Dallimer & Melo 2010; Panisi et al. 2020).

The results reaffirm the importance of medicinal plants not only as natural remedies, due to their long tradition of use and to the difficult access to western medicine, but also – being a common element in the local diet – as a food source, and an important component of cultural identity (Madureira 2008). However, community surveys gave the impression that this tradition is disappearing, as most traditional therapists were very old. The loss of traditional knowledge and the lack of interested younger

generations to whom the elders could pass this tradition, is a known issue in the country (Madureira 2008).

The effects of hunting can vary greatly depending on the targeted species. Hunting of introduced mammals can help to mitigate the impact of invasive species and benefit native biodiversity, especially on islands where introduced mammals are a major cause for biodiversity loss (Jones et al. 2016), while it can also contribute to sustainable livelihoods and food provision. However, hunting of endemic or threatened species of birds and bats can pose a significant threat to the native fauna and flora (Carvalho et al. 2015). According to the findings, the most valued hunting resources are introduced mammals, such as Mona monkeys, civets and feral pigs, which are threatening the native biodiversity (Dutton 1994; Guedes et al. 2021). However, endemic birds and bats are also among hunted animals, including the Egyptian Fruit Bat (HCV 1.3 trigger species). It appears that in Príncipe birds are usually hunted opportunistically around the communities, often as a pastime for the youth, whereas bats can be targeted at greater distances in their roosts. Finally, both have a nutritional value for local communities, but at which extent these groups are really impacted by hunting, and thus actual contradictions with biodiversity values remain unclear and more research based on quantitative data is needed to gain better understanding of this issue.

HCV Areas

HCVAs of higher biodiversity value tend to occur in remote mountainous areas, largely overlapping with the PNP. This emphasizes once again that the preservation of the biodiversity of the island largely relies on the effective protection of the PNP (Melo 2007; Rebelo 2020). Beyond that, this study highlights the importance of ecosystems in the northern part of the island, which serve critical functions in the provision of ecosystems services to local communities, but also as habitat for various native species. Most of these areas have been overlooked by researchers and practitioners, and remain under-sampled for some groups, clearly deserving more attention by conservation efforts, especially because these ecosystems are also among the most vulnerable to human pressures.

Prioritization

Based on the values identified in each HCVA, 11 sites were classified as top priority, while 9 were considered medium and 5 were considered low priority (Table 4.1).

Table 4.1. Suggested priority levels for potential HCVAs in Príncipe.

Top priority	Medium priority	Low priority
HCVA2: North coast between Praia Sundy and Bom Bom	HCVA1: Praia Margarida forest	HCVA3: Praia das Burras
HCVA4: Northeast coast between Praia Banana and Praia Boi	HCVA9: Morro Iola	HCVA5: Mosteiros islets
HCVA6: Praia Uva	HCVA11: Morro Fugido	HCVA10: Swamp São Joaquim
HCVA7: Praia Grande	HCVA12: Morro Caixão and Praia Caixão	HCVA14: Praia Salgada
HCVA8: Azeitona and Quatro Caminhos	HCVA13: Morro Fundão	HCVA 25: Tinhosas islets*
HCVA17: PNP – Northern tract	HCVA15: Praia Abelha	
HCVA18: PNP – Pico Mesa	HCVA16: Focinho de Cão	
HCVA20: PNP – Southwestern tract	HCVA19: PNP – Barriga Branca	
HCVA21: PNP – Lowland to medium elevation mature forest	HCVA24: Boné de Jóquei and Bonézinho	
HCVA22: PNP – Central mountains		
HCVA23: PNP – Southeastern tract		

*The Tinhosas islets are widely acknowledged as a key area for conservation in the region (Ramsar 2006; Bollen et al. 2018; KBA Partnership 2020b; BirdLife International 2021a). Its importance should not be misinterpreted through the classification

as low priority which does not imply low relevance for conservation. The HCV approach puts a great focus on threatened and endemic species and is thus not very adequate to evaluate sites like Tinhosas, which are important for other aspects than threat and endemism (in this case large aggregations of breeding seabirds).

It is important to emphasize that all HCVAs are to be viewed as conservation priorities, and that the prioritization ranking merely informs which sites hold the absolute highest values according to HCV criteria.

The highest priorities correspond to high species-based vulnerability, irreplaceability, and variety of triggered HCVs, as sites classified as top priority typically reached high scores for the three criteria. All sites identified within the PNP with sufficient data were ranked as top priorities. Outside of the PNP, northern coastal areas were also defined as top priorities, mainly due to their importance for nesting sea turtles. Among medium priority sites are areas that received lower overall scores, while many of them have not yet been adequately researched, and thus their priority level still needs to be confirmed; for example, Barriga Branca (HCVA19) lies within the PNP and is expected to be a top priority, but this classification cannot be justified due to the absence of information on the species that can be found there, simply because the area is inaccessible. Finally, low priority HCVAs have the lowest total values, with some being relatively small and others having a strong focus on one type of HCV but not triggering other HCV categories, such as the seabird breeding sites at Tinhosas and Mosteiros.

The availability of data for HCVAs may have influenced priority setting, while the priority levels of sites with incomplete information may be underrated, whereas heavily sampled sites tend to be highlighted as higher priorities and, additionally, prioritization scores sometimes had to be estimated, which necessarily involves a certain degree of subjectivity.

4.2 Future work

The potential HCVAs proposed here were assessed based on the best available information bringing together multidisciplinary expertise from different conservation programs, researchers, and local stakeholders. Nonetheless, persisting knowledge gaps remain an obvious practical challenge.

There is an imbalance in available distribution data for different groups, with an almost complete absence of information for invertebrates (except for the Obô Giant Snail), terrestrial herps, mammals and aquatic species. Additionally, point occurrence data is biased towards the most accessible areas of Príncipe for many of these groups. It is critical to incorporate new information into the assessment as soon as it becomes available, for instance, to extend and improve the list of HCV trigger species, allowing for the inclusion of further criteria (e.g., rare species) and additional taxonomic groups. Furthermore, existing data should be continuously updated, for example, following the publication of IUCN Red List assessments.

Ecosystem classification and mapping efforts should be carried forward with a special focus on the complex forest ecosystems in the southern block of the PNP. Because the updated land use map produced by this work is only partially verified, it requires ongoing validation through ground truthing, particularly in the area outside of the PNP. The development of a system using clearly defined criteria for the identification of land use types would certainly improve this process. In addition to field surveys, the use of remote sensing data could provide a resource-efficient way to evaluate vegetation types, however, computational analyses are currently still limited due to relatively low resolution or inaccessibility of aerial imagery (e.g., satellite images or drone photography). The use of very high-resolution aerial images, combined with in-situ observations (Gascón & Eva 2014; Wich & Koh 2018; Lechner et al. 2020), would be a great step towards an extensive mapping and monitoring of the biodiversity of Príncipe.

Upcoming research should complement social surveys through a quantification and sustainability assessment of provisioning ecosystem services under HCV 5 (e.g., HCV Consortium for Indonesia 2009) to detect potential negative environmental impacts of current practices and respond with

appropriate action. Additionally, more data is needed on supporting, regulating and cultural ecosystem services, to complete the assessment through the identification of HCV 4 and HCV 6, which was not included in this study.

In the shorter term, follow-up work should focus on the verification of potential HCVAs through further on-the-ground evaluation. This includes the review of boundaries and the possibility to integrate small sites into bigger ones to achieve better manageable areas and reduce edge effects. Subsequently, priority levels will require constant updating, especially concerning sites with potentially underestimated values, since they are poorly sampled. Surveys targeting these areas, including hills (HCVA9, HCVA11, HCVA12, HCV16), wetlands (HCVA10) and remote areas (HCVA20 and HCVA22), should be a priority. Before management and monitoring plans are prepared, the proposed sites should be publicly discussed engaging all interest groups, from local communities to NGOs, the private sector, and governmental agencies, in order to obtain their contributions and approval (Fig. 2.1).

4.3 Management recommendations

This work provides information on the spatial distribution of key conservation areas in Príncipe, highlighting sites with the absolute highest values. However, this does not necessarily imply specific conservation action, such as that top priority areas should be targeted first or that their conservation need is more urgent than that of other HCVAs. To define management strategies, it will require an understanding not only of the relevance of existing values, but also of the vulnerability of each site (Pollard et al. 2005a), which relies on a comprehensive assessment of threats to HCVs (Brown & Senior 2014). Nonetheless, the findings of this study allow for general recommendations to guide future work using the HCV approach in Príncipe.

In relation to the PNP, some values seem to be inadequately covered by the existing zonation (Albuquerque et al. 2009). Thus, remaining pristine areas should receive the highest level of protection, namely the montane forests around Pico do Príncipe (HCVA20) and the mature forests at low to medium elevation (including large parts of HCVA21, and the forests on and around Pico Mesa, HCVA18), which have already been identified as potential management priorities (Fauna & Flora International 2018).

Although community members seemed to be aware of the limits of the PNP, resource use activities in the partial protection zone (type 1) should not be underestimated, even if they are of minor scale, since all of them besides the controlled use of medicinal species are prohibited or conditioned by law (Assembleia Nacional 2006; Albuquerque et al. 2009). More importantly, activities that extend illegally into the total protection zones should be considered for management planning, particularly hunting and the harvest of the Obô Giant Snail. Under national law, hunting is prohibited in all protected areas (Assembleia Nacional 2016). Given the evidence that a major threat to the endemic species in the park are invasive mammals such as civets, rats, and monkeys (Fundação Príncipe 2019a; Rebelo 2020; Guedes et al. 2021), instead of a general hunting ban, controlled hunting of invasive mammals should be promoted at least in partial protection zones. Although the outcomes of community surveys suggest that hunting in the PNP primarily affects invasive mammals, potential direct or indirect pressure on endemic and threatened species should be mitigated through the sensibilization of hunters about the consequences of hunting these species and fostering sustainable practices. Since the PNP regulation states that any activities which are harmful to the environment and the natural balance of the ecosystems within the protected area are prohibited, the collection of the threatened Obô Giant Snail should be explicitly banned within the entire park, which has been already demanded by previous studies addressing the status of this species, but has not been legally implemented until now (Dallimer & Melo 2010; Panisi et al. 2020).

Resource use in the Azeitona block of the PNP is generally in line with the allowed activities, but it has the potential to degrade the forest if carried out excessively and, thus, should be monitored to assess impacts and act accordingly. It might be obvious to consider including the area of Quatro

Caminhos in the Azeitona block of the PNP due to their direct proximity, which is however difficult since the boundaries of the PNP are determined by its legislation (Assembleia Nacional 2006; Albuquerque et al. 2009). In any case, fair participation of the local communities using the area is crucial and should be foreseen from the start of such planning, to ensure that their needs are integrated into the management of the areas.

Timber extraction and charcoal production are some of the most visible threats to potential HCVAs across the island. Given the high value of timber and charcoal, with major extraction areas close to the limits of the PNP and the likelihood of illegal logging spreading into the remote southern forests, there is a need for controlling these activities. For example, local people reported a shift in the locations where wood is cut for charcoal in recent years, mainly because preferably used tree species, such as "Muandim" *Pentaclethra macrophylla*, have become scarce in previously used areas (Nuno 2021). Moreover, Fauna & Flora International (2018) documented a profit-driven harvest intensification of medicinal plants with collectors expanding into protected areas since resources in easily accessible areas are already being depleted. Possible solutions include restricted access to resources and controlled use. Selective logging (e.g., limited to certain species, sizes, and areas), for example, can additionally benefit crop productivity when used in plantations to avoid overshading (Vieira 2018). Moreover, one community proposed replanting Muandim, the most frequently used species in charcoal production (Nuno 2021). Many participants of a countrywide survey also suggested replanting as a solution to ensure a more sustainable charcoal production in the future (Nuno 2021). Besides that, alternative materials to charcoal as fuel could be promoted, such as the use of coconut shells (which are abundant and pose a problem for nesting sea turtles) or the pods of *Pentaclethra macrophylla*. Cultivation of medicinal plants in agroforests together with crops like coffee and cocoa is an option to counteract the overharvest of threatened medicinal species, such as the endemic *C. mannii*, and other species of interest while providing natural medicine and food for local communities. To maintain the socio-cultural benefits that people derive from medicinal plants, it is also important that traditional knowledge and practices are recognized and valued through their integration into biodiversity conservation, as well as by engaging local people in sustainable resource use management (Ruheza & Kilugwe 2012). Overall, illegal and inadequate practices such as the hunting and collection of threatened and endemic species should be discouraged through awareness campaigns on negative impacts that go beyond flagship species and, if necessary, strengthened legislation and enforcement. Nevertheless, seeking early dialogue with local communities for a participatory development of conservation measures is key for preventing conflicts.

The perception of conservation initiatives by communities was overall positive. Usually, community members were aware of ongoing projects, respected them and even showed willingness to cooperate by bringing in their own ideas to improve social and environmental conditions. A major concern, however, was the creation of strictly protected conservation areas that exclude local residents and deprive them of their livelihoods. Instead, the HCV approach provides the opportunity to actively involve communities in the co-management of areas with different levels of protection and permitted uses. This could be particularly suitable for the HCVAs located outside of the PNP that are within the range of most community uses. Moreover, the management of HCVAs can take advantage of the synergies with other stakeholders, such as through partnerships between conservation organizations and the private sector. For the HCVAs identified within tourism concessions, this offers the chance to bring together conservation efforts and effectively sustainable business development.

4.4 The HCV approach as a tool for spatial conservation prioritization

The HCV concept is one of the most popular conservation tools in production landscapes (Senior et al. 2015), but its application in other contexts did not receive much attention yet. The identification of HCVAs in Príncipe revealed both benefits and shortcomings to using this approach as a tool for conservation prioritization.

A major advantage of the methodology is its holistic view that considers ecological and social factors of conservation. By addressing concerns that are relevant to a wide range of stakeholders, the concept does not only allow balancing different interests and promotes participatory decision-making but also creates opportunities for cooperation. Beyond that, the application of the approach in Príncipe showed that it fosters the exchange of knowledge between different conservation initiatives and that it can be linked to other prioritization schemes, such as KBAs. Whereas KBAs are globally important sites for biodiversity, the HCV approach is here being used to identify priorities for site-level conservation, going beyond species and ecosystems to include values for human populations (ecosystem services). However, there are some overlaps between the two frameworks that can be used as mutual advantages. For example, HCV data can inform KBA assessments, while the standardized criteria for the identification of KBAs can provide best practice for the development of HCV methods (Dudley et al. 2014; Smith et al. 2019). The HCV toolkit is often claimed to be very flexible in its application as the criteria can be adapted to any local conditions. This makes it also suitable for data-poor regions because it does not rely on empirical evidence alone but also considers alternative sources of information, such as expert opinion and local knowledge.

The flexibility of the HCV approach is at the same time criticized as one of its biggest weaknesses. The general nature of the HCV guidelines without uniform standards for criteria and thresholds leaves the interpretation of the concept largely up to the user, which increases the subjectivity and variability of HCV assessments (Senior et al. 2015). This is especially problematic in countries like São Tomé and Príncipe, which have no official national HCV interpretation. In this study it turned out that the HCV concept, despite the adaptability of criteria, is still limited mostly by data availability. In typical data-scarce tropical ecosystems, information on species, such as distribution, population size and density, is often scarce (Moilanen 2012; Senior et al. 2015), which makes it difficult to apply all criteria appropriately. In addition, the HCV concept is still very much rooted in its origins as a certification instrument in human-dominated environments, which added another challenge to the application in Príncipe, an endemism-hotspot that still retains many ecosystems with low human influence and that are of global relevance for biodiversity conservation. All this underlines that the careful definition of clear site-specific criteria taking the scale, purpose and local conditions into consideration, is an important basis of every HCV process. Continuous improvement of the methods and eventually the development of a consistent national interpretation of the concept in São Tomé and Príncipe, based on experiences drawn from both islands, would greatly facilitate future assessments.

This study is an example of how the HCV approach can be used to provide spatially explicit input for conservation planning and prioritization. As the first HCV assessment in Príncipe, it gives a comprehensive overview of the current situation and serves as an important baseline for follow-up work, as well as for future studies that will contribute to a better understanding of the island's unique biodiversity and of human-nature interactions. Beyond that, this work already had an impact by providing advisory input for the reformulation of the PNP zonation, as well as by contributing to the reassessment of KBAs in Príncipe. The study highlights the critical need to fill persisting knowledge gaps, such as those regarding the distribution of target species and of the complex tropical ecosystems of the island, to inform conservation strategies. Ultimately, for the HCV process to be successful, it requires collaborative effort to develop effective and equitable conservation approaches that benefit both biodiversity and people of Príncipe Island, and that beyond that can serve as a model for guiding the application of the HCV concept elsewhere.

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6 SUPPLEMENTARY MATERIAL

TABLES

Table S1. Faunal species of interest. Taxonomy, English names and endemism status were adopted from species checklists and scientific papers (Mammals: Juste & Ibañez 1994; Ceriáco et al. 2015. Birds: *Birds of the World* - Chantler & Boesman 2020; de Lima & Melo 2021. Herpetofauna: Ceríaco et al. 2018, 2020, 2021. Sea turtles: *IUCN Red List* - Seminoff 2004; Mortimer & Donnelly 2008; Wallace et al. 2013. Land snails: Holyoak et al. 2020). The endemism status is indicated as follows: Príncipe (P), São Tome and Príncipe (STP), Annobón (A), Bioko (B), Tinhosas Grande (TG), Boné de Jóquei (BdJ), subspecies ($_s$). Unpublished data is indicated as u.d.

Taxonomic group	Scientific name	Common name (English)	Endemism	Threatened		Hyper-endemic	Temporary habitats	HCV 1 species	Source of spatial data
				IUCN Red List	Suggested status				
Mammals	*Crocidura fingui* sp. nov.	Fingui White-toothed Shrew	P	-	-	-	-	-	Ceríaco et al. (2015) GBIF (status: 11/2020)
Mammals	*Pipistrellus (N.)* sp.	-	P $_s$	-	-	-	-	-	Jorge Palmeirim (u.d.)
Mammals	*Rousettus aegyptiacus princeps*	Egyptian Fruit Bat	P $_s$	-	-	-	X	X[1]	Jorge Palmeirim (u.d.) Fundação Príncipe 2021 (u.d.)
Birds	*Anabathmis hartlaubii*	Príncipe Sunbird	P	-	-	-	-	-	GBIF (status: 11/2020) Fundação Príncipe 2021 (u.d.) Filipa Soares (u.d.)
Birds	*Apus affinis bannermani*	Little Swift	STP & B $_s$	-	-	-	-	-	GBIF (status: 11/2020) Fundação Príncipe 2021 (u.d.) Filipa Soares (u.d.)
Birds	*Chrysococcyx cupreus insularum*	African Emerald Cuckoo	STP (& A) $_s$[2]	-	-	-	-	-	GBIF (status: 11/2020) Fundação Príncipe 2021 (u.d.) Filipa Soares (u.d.)
Birds	*Columba larvata principalis*	Lemon Dove	P $_s$	-	-	-	-	-	GBIF (status: 11/2020) Fundação Príncipe 2021 (u.d.) Filipa Soares (u.d.)
Birds	*Columba malherbii*	São Tomé Pigeon	STP & A	-	-	-	-	-	GBIF (status: 11/2020) Fundação Príncipe 2021 (u.d.) Filipa Soares (u.d.)
Birds	*Corythornis cristatus nais*	Príncipe Kingfisher	P $_s$	-	-	-	-	-	GBIF (status: 11/2020) Fundação Príncipe 2021 (u.d.)

Taxonomic group	Scientific name	Common name (English)	Endemism	Threatened		Hyper-endemic	Temporary habitats	HCV 1 species	Source of spatial data
				IUCN Red List	Suggested status				
									Filipa Soares (u.d.)
Birds	*Crithagra rufobrunnea fradei*	-	BdJ $_s$	-	-	X	-	X	GBIF (status: 11/2020)
Birds	*Crithagra rufobrunnea rufobrunnea*	Príncipe Seedeater	P $_s$	-	-	-	-	-	GBIF (status: 11/2020) Fundação Príncipe 2021 (u.d.) Filipa Soares (u.d.)
Birds	*Dicrurus modestus modestus*	Velvet-mantled Drongo	P $_s$	-	-	-	-	-	GBIF (status: 11/2020) Fundação Príncipe 2021 (u.d.) Filipa Soares (u.d.)
Birds	*Halcyon malimbica dryas*	Blue-breasted Kingfisher	P $_s$	-	-	-	-	-	GBIF (status: 11/2020) Fundação Príncipe 2021 (u.d.) Filipa Soares (u.d.)
Birds	*Lamprotornis ornatus*	Principe Starling	P	-	-	-	-	-	GBIF (status: 11/2020) Fundação Príncipe 2021 (u.d.) Filipa Soares (u.d.)
Birds	*Otus* sp.	Scops Owl	P	-	CR (Freitas 2019)	-	-	X	Barbara Freitas (u.d.) Fundação Príncipe 2021 (u.d.)
Birds	*Ploceus princeps*	Príncipe Golden Weaver	P	-	-	-	-	-	GBIF (status: 11/2020) Fundação Príncipe 2021 (u.d.) Filipa Soares (u.d.)
Birds	*Psittacus erithacus*[3]	Grey Parrot	-	EN[3]	-	-	-	-	GBIF (status: 11/2020) Fundação Príncipe 2021 (u.d.) Filipa Soares (u.d.)
Birds	*Sylvia dohrni*	Dohrn's Thrush-Babbler	P	-	-	-	-	-	GBIF (status: 11/2020) Fundação Príncipe 2021 (u.d.) Filipa Soares (u.d.)
Birds	*Treron calvus virescens*	African Green Pigeon	P $_s$	-	-	-	-	-	GBIF (status: 11/2020) Fundação Príncipe 2021 (u.d.) Filipa Soares (u.d.)
Birds	*Turdus xanthorhynchus*	Príncipe Thrush	P	CR	-	-	-	X	GBIF (status: 11/2020) Fundação Príncipe 2021 (u.d.)
Birds	*Zoonavena thomensis*	São Tomé Spinetail	STP	-	-	-	-	-	GBIF (status: 11/2020) Fundação Príncipe 2021 (u.d.) Filipa Soares (u.d.)

Taxonomic group	Scientific name	Common name (English)	Endemism	Threatened		Hyper-endemic	Temporary habitats	HCV 1 species	Source of spatial data
				IUCN Red List	Suggested status				
Birds	*Zosterops ficedulinus*	Príncipe White-eye	P	EN	-	-	-	X	GBIF (status: 11/2020) Fundação Príncipe 2021 (u.d.) Filipa Soares (u.d.)
Birds	*Zosterops leucophaeus*	Príncipe Speirops	P	-	-	-	-	-	GBIF (status: 11/2020) Fundação Príncipe 2021 (u.d.) Filipa Soares (u.d.)
Reptiles	*Chelonia mydas*	Green Turtle	-	EN	-	-	X	X	Fundação Príncipe 2019b, 2021 (u.d.)
Reptiles	*Dermochelys coriacea*	Leatherback Sea Turtle	-	VU	-	-	X	X	Fundação Príncipe 2019b, 2021 (u.d.)
Reptiles	*Eretmochelys imbricata*	Hawksbill Turtle	-	CR	-	-	X	X	Fundação Príncipe 2019b, 2021 (u.d.)
Reptiles	*Afrotyphlops elegans*	Elegant Worm Snake	P	-	-	-	-	-	GBIF (status: 11/2020) Fundação Príncipe 2021 (u.d.)
Reptiles	*Boaedon mendesi sp. nov.*	-	P	-	-	-	-	-	GBIF (status: 11/2020)
Reptiles	*Feylinia polylepis*	Manyscaled Feylinia	P	-	-	-	-	-	GBIF (status: 11/2020) Verburgt 2020 (u.d.) Fundação Príncipe 2021 (u.d.) Field observations
Reptiles	*Hapsidophrys principis*	Príncipe Green Snake	P	-	-	-	-	-	GBIF (status: 11/2020) Verburgt 2020 (u.d.) Fundação Príncipe 2021 (u.d.) Field observations
Reptiles	*Hemidactylus principensis*	-	P & TG	-	-	-	-	-	GBIF (status: 11/2020) Verburgt 2020 (u.d.) Fundação Príncipe 2021 (u.d.)
Reptiles	*Lygodactylus delicatus*	-	P s	-	-	-	-	-	GBIF (status: 11/2020) Verburgt 2020 (u.d.) Fundação Príncipe 2021 (u.d.)
Reptiles	*Panaspis africana*	Guinea Lidless Skink	P	–	-	-	-	-	GBIF (status: 11/2020) Verburgt 2020 (u.d.) Fundação Príncipe 2021 (u.d.)
Reptiles	*Trachylepis adamastor*	Adamastor Skink	P & TG	VU[5]	-	-	-	-	GBIF (status: 11/2020) Verburgt 2020 (u.d.)

Taxonomic group	Scientific name	Common name (English)	Endemism	Threatened		Hyper-endemic	Temporary habitats	HCV 1 species	Source of spatial data
				IUCN Red List	Suggested status				
Amphibians	*Hyperolius drewesi*	-	P	-	-	-	-	-	GBIF (status: 11/2020) Verburgt 2020 (u.d.) Fundação Príncipe 2021 (u.d.)
Amphibians	*Leptopelis palmatus*	Príncipe Giant Tree Frog	P	EN	-	-	-	X	GBIF (status: 11/2020) Verburgt 2020 (u.d.) Fundação Príncipe 2021 (u.d.)
Amphibians	*Phrynobatrachus dispar*	-	P	-	-	-	-	-	GBIF (status: 11/2020) Verburgt 2020 (u.d.) Fundação Príncipe 2021 (u.d.)
Gastropoda	*Archachatina bicarinata*	Obô Giant Snail	STP	VU	at least EN (Fundação Príncipe 2019a; Rebelo 2020)	-	-	X	Fundação Príncipe 2021 (u.d.; only records from alive animals were used)

[1] roosting sites qualify as HCV 1.3

[2] unclear if the Annobón population belongs to this subspecies (Payne 2020)

[3] unclear which taxon occurs in Príncipe (Melo & O'Ryan 2007); IUCN Red List status does not represent Príncipe population, species is widespread throughout the island

[4] uncertain if the Príncipe population represents a distinct taxon (Ceríaco et al. 2018)

[5] IUCN Red List status based on outdated information considering the populations on Tinhosas and Príncipe as belonging to two different subspecies, according to recent studies (Ceríaco et al. 2020) they are conspecific

Table S2. Floral species of interest. Taxonomy and endemism status are based on species checklists (Figueiredo et al. 2011; Klopper & Figueiredo 2013), the online database *Plants of the World*, *Threatened Flora of São Tomé and Príncipe* project data and expert knowledge (TFSTP, unpublished data). The endemism status is indicated as follows: Príncipe (P), São Tome and Príncipe (STP), Annobón (A), Gulf of Guinea (GG). Unpublished data is indicated as u.d.

Family	Scientific name	Endemism	Threatened		Hyper-endemic	HCV 1 species	Spatial data source
			IUCN Red List	Suggested status			
Annonaceae	*Greenwayodendron sp.nov. Sao Tome*	STP	-	-	-	-	TFSTP 2020 (u.d)
Apocynaceae	*Rauvolfia dichotoma*	STP	-	EN (TFSTP, u.d.)	-	X	TFSTP 2020 (u.d)
Apocynaceae	*Tabernaemontana stenosiphon*	STP	-	LC (TFSTP, u.d.)	-	-	TFSTP 2020 (u.d) GBIF (status: 05/2021)
Araliaceae	*Polyscias quintasii*	STP	EN	VU (TFSTP, u.d.)	-	X	TFSTP 2020 (u.d) GBIF (status: 05/2021) Fundação Príncipe 2021 (u.d.)
Aspleniaceae	*Asplenium eurysorum*	STP	-	VU (TFSTP, u.d.)	-	X	TFSTP 2020 (u.d)
Balsaminaceae	*Impatiens manteroana*	STP	-	EN (TFSTP, u.d.)	-	X	TFSTP 2020 (u.d)
Begoniaceae	*Begonia fusialata var. principensis*	P	-	EN (TFSTP, u.d.)	-	X	TFSTP 2020 (u.d) GBIF (status: 05/2021)
Commelinaceae	*Palisota pedicellata*	STP & A	-	LC (TFSTP, u.d.)	-	-	TFSTP 2020 (u.d) GBIF (status: 05/2021)
Costaceae	*Costus giganteus*	STP & A	-	NT (TFSTP, u.d.)	-	-	TFSTP 2020 (u.d)
Cyatheaceae	*Alsophila camerooniana var. currorii*	STP	-	-	-	-	TFSTP 2020 (u.d)
Cyperaceae	*Principina grandis*	STP	-	EN (TFSTP, u.d.)	-	X	TFSTP 2020 (u.d)
Dichapetalaceae	*Dichapetalum bocageanum*	STP	-	VU (TFSTP, u.d.)	-	X	TFSTP 2020 (u.d) GBIF (status: 05/2021) Fundação Príncipe 2021 (u.d.)
Euphorbiaceae	*Croton stelluliferus*	STP	VU	DD (TFSTP, u.d.)	-	-	TFSTP 2020 (u.d) GBIF (status: 05/2021) Fundação Príncipe 2021 (u.d.)
Euphorbiaceae	*Discoclaoxylon occidentale*	STP	VU	VU (TFSTP, u.d.)	-	X	TFSTP 2020 (u.d)
Euphorbiaceae	*Erythrococca columnaris*	P	VU	DD (TFSTP, u.d.)	-	-	TFSTP 2020 (u.d)
Euphorbiaceae	*Grossera elongata*	STP	VU	DD (TFSTP, u.d.)	-	-	TFSTP 2020 (u.d) GBIF (status: 05/2021)

Family	Scientific name	Endemism	Threatened		Hyper-endemic	HCV 1 species	Spatial data source
			IUCN Red List	Suggested status			
							Fundação Príncipe 2021 (u.d.)
Meliaceae	*Carapa gogo*	STP	-	-	-	-	TFSTP 2020 (u.d) GBIF (status: 05/2021)
Ochnaceae	*Campylospermum nutans*	STP	-	-	-	-	TFSTP 2020 (u.d) GBIF (status: 05/2021)
Orchidaceae	*Angraecum doratophyllum*	GG	EN	-	-	X	TFSTP 2020 (u.d)
Orchidaceae	*Brachycorythis basifoliata*	STP	EN	-	-	X	TFSTP 2020 (u.d)
Orchidaceae	*Bulbophyllum lizae*	STP	EN	-	-	X	TFSTP 2020 (u.d)
Orchidaceae	*Chamaeangis vagans*	STP	EN	-	-	X	TFSTP 2020 (u.d)
Orchidaceae	*Diaphananthe acuta*	STP	-	-	-	-	TFSTP 2020 (u.d)
Orchidaceae	*Diaphananthe papagayi*	P	-	-	-	-	GBIF (status: 05/2021)
Orchidaceae	*Habenaria letouzeyana*	P	-	-	-	-	TFSTP 2020 (u.d)
Orchidaceae	*Polystachya albescens subsp. principensis*	P	-	-	-	-	TFSTP 2020 (u.d) GBIF (status: 05/2021)
Orchidaceae	*Polystachya ridleyi*	GG	-	-	-	-	TFSTP 2020 (u.d)
Orchidaceae	*Polystachya setifera*	P	-	-	-	-	TFSTP 2020 (u.d) GBIF (status: 05/2021)
Orchidaceae	*Tridactyle aurantiopunctata*	P	-	-	-	-	GBIF (status: 05/2021)
Orchidaceae	*Tridactyle thomensis*	STP	-	-	-	-	TFSTP 2020 (u.d)
Pandanaceae	*Pandanus thomensis*	STP	-	VU (TFSTP, u.d.)	-	X	TFSTP 2020 (u.d)
Phyllanthaceae	*Maesobotrya glabrata*	STP	-	LC (TFSTP, u.d.)	-	-	TFSTP 2020 (u.d) GBIF (status: 05/2021) Fundação Príncipe 2021 (u.d.)
Rhamnaceae	*Lasiodiscus rozeirae*	STP	VU[1]	VU (TFSTP, u.d.)	-	X	GBIF (status: 05/2021) Fundação Príncipe 2021 (u.d.)
Rubiaceae	*Aidia quintasii*	STP	-	-	-	-	GBIF (status: 05/2021) Fundação Príncipe 2021 (u.d.)
Rubiaceae	*Bertiera pedicellata*	STP	-	NT (TFSTP, u.d.)	-	-	TFSTP 2020 (u.d)
Rubiaceae	*Chassalia hiernii*	STP	-	VU (TFSTP, u.d.))	-	X	TFSTP 2020 (u.d) GBIF (status: 05/2021)

Family	Scientific name	Endemism	Threatened		Hyper-endemic	HCV 1 species	Spatial data source
			IUCN Red List	Suggested status			
Rubiaceae	*Chassalia hiernii var. glandulosa*	P	-	EN (TFSTP, u.d.)	-	X	GBIF (status: 05/2021)
Rubiaceae	*Chassalia hiernii var. hiernii*	P	-	VU (TFSTP, u.d.)	-	X	GBIF (status: 05/2021) Fundação Príncipe 2021 (u.d.)
Rubiaceae	*Mussaenda tenuiflora principensis*	P	-	-	-	-	GBIF (status: 05/2021) Fundação Príncipe 2021 (u.d.)
Rubiaceae	*Pavetta monticola*	STP & A	VU[1]	NT (TFSTP, u.d.)	-	-	TFSTP 2020 (u.d) GBIF (status: 05/2021)
Rubiaceae	*Tarenna principensis*	STP	-	EN (TFSTP, u.d.)	-	X	TFSTP 2020 (u.d)
Sapindaceae	*Chytranthus mannii*	STP	-	VU (TFSTP, u.d.)	-	X	TFSTP 2020 (u.d) GBIF (status: 05/2021) Field observations
Sapotaceae	*Chrysophyllum calophyllum*	P	-	EN (TFSTP, u.d.)	-	X	TFSTP 2020 (u.d) GBIF (status: 05/2021)
Scrophulariaceae	*Thunbergianthus quintasii*	STP	-	LC (TFSTP, u.d.)	-	-	TFSTP 2020 (u.d)
Selaginellaceae	*Selaginella mannii*	STP	-	VU (TFSTP, u.d.)	-	X	TFSTP 2020 (u.d)
Thymelaeaceae	*Dicranolepis thomensis*	STP	-	NT (TFSTP, u.d.)	-	-	TFSTP 2020 (u.d)
Vitaceae	Leea tinctoria	STP	-	LC (TFSTP, u.d.)	-	-	TFSTP 2020 (u.d)

1 outdated IUCN Red List status, last assessed in 1998

Table S3. Consulted experts.

Name	Position	Organization/project	Relevant expertise
Bárbara B. Freitas	PhD student	Museo Nacional de Ciencias Naturales (MNCN), Madrid, Spain & Laboratoire Évolution et Diversité Biologique (EDB), Toulouse, France	*Otus* sp.
Davide Dias	Project supervisor – terrestrial conservation	Fundação Príncipe, Santo António, São Tomé and Príncipe	Botany, local knowledge
Filipa C. Soares	PhD student	Centre for Ecology, Evolution and Environmental Changes (cE3c), Faculty of Sciences (FCUL), University of Lisbon, Portugal	Avifauna
Jeremias Prazeres	Field assistant – terrestrial conservation	Fundação Príncipe, Santo António, São Tomé and Príncipe	Botany, local knowledge
Jorge M.M.M. Palmeirim	Associate professor	Department of Animal Biology, Faculty of Sciences (FCUL), University of Lisbon, Portugal	Bats
	Coordinator of the Tropical and Mediterranean Biodiversity research group (TMB)	Centre for Ecology, Evolution and Environmental Changes (cE3c), Faculty of Sciences (FCUL), University of Lisbon, Portugal	
Laura Benitez B.	Project Manager – terrestrial conservation	Fundação Príncipe/Fauna & Flora Internacional, Santo António, São Tomé and Príncipe	Botany
	Researcher	Threatened Flora of São Tomé and Príncipe project	
Luis M.P. Ceríaco	Head of collections and research	Museu de História Natural e da Ciência, University of Porto, Portugal	Herpetofauna, *C. fingui*
Osvaldo Lima	Field assistant – terrestrial conservation	Fundação Príncipe, Santo António, São Tomé and Príncipe	Botany, local knowledge
Ricardo F. de Lima	Post-doc researcher in the Tropical and Mediterranean Biodiversity research group (TMB)	Centre for Ecology, Evolution and Environmental Changes (cE3c), Faculty of Sciences (FCUL), University of Lisbon, Portugal	Biodiversity of São Tomé and Príncipe, HCV assessments
	Team member	Gulf of Guinea Biodiversity Center	
Tariq Stevart	Scientist and Coordinator of the West and Central Africa Program	Missouri Botanical Garden (MBG), St. Louis, USA	Tropical botany, HCV assessments
	Research Associate	Université Libre de Bruxelles & Botanic Garden Meise, Belgium	
	Principal Investigator	Threatened Flora of São Tomé and Príncipe project	
Vanessa Schmitt	Coordinator - sea turtle conservation project (ProTetuga)	Fundação Príncipe, Santo António, São Tomé and Príncipe	Sea turtles

Table S4. GIS datasets.

Dataset	Type	Nature	Source or method of acquisition
Príncipe boundaries	Administrative boundaries	Vector - polygon	Merged polygons of Príncipe Island (BirdLife International, unpublished data) and Tinhosas islets (Ramsar 2006, https://rsis.ramsar.org/ris/1632)
PNP boundaries and zones	Protected areas	Vector - polygon	Fixed polygons (BirdLife International, unpublished data)
Historical land use map (military map)	Land use	Raster	Georeferenced map (Ministério do Ultramar 1962)
Land use map	Land use	Raster	A pre-existent land use map (Sinclair and dos Santos, unpublished data) that has been already validated for the southern part of Príncipe (Freitas 2019) was updated based on fieldwork results (ground checks and participatory mapping), local knowledge of the Fundação Príncipe staff, satellite imagery (Google Earth 2016-2020), plantation concession maps (Vieira 2018) and habitat descriptions from prior vegetation surveys (Fundação Príncipe and Flora & Fauna International, unpublished data). Areas were assigned one out of four categories: native forest, secondary forest (including recently and long abandoned plantations), plantation forest (including active shade and timber plantations) and non-forested areas.
Topography	Terrain data	Raster (slope) and vector (altitude areas)	Altitude areas with 250 m intervals and slope were generated using a Shuttle Radar Topographic Mission (SRTM) 90 m resolution Digital Elevation Model (DEM) (CGIAR-CSI Consortium for Spatial Information, https:// srtm.csi.cgiar.org)
Rivers	Ecosystem features	Vector - lines	Digitized from a military map (Ministério do Ultramar 1962) and adjusted using QGIS satellite image base maps (Google Earth 2016-2020; World Imagery 2015)
Mangroves	Ecosystem features	Vector - points	Praia Salgada: Digitized from a georeferenced drone image (Cravo 2021) Praia Caixão & Praia Grande: Mapped based on GPS data from ground truthing
Lagoons	Ecosystem features	Vector - polygons	Digitized from satellite imagery (Google Earth 2016-2020) and drone images (Cravo 2021; Vieira 2018)
Swamps	Ecosystem features	Vector - polygons	Digitized from a georeferenced military map (Ministério do Ultramar 1962) and adjusted with GPS data from ground truthing
Peaks	Ecosystem features	Vector – points	Digitized based on a georeferenced military map (Ministério do Ultramar 1962) and a QGIS satellite image base map (Google Earth 2016-2020)
Roads and paths	Human features	Vector – lines	Sourced from OpenStreetMap (OSM) through the database of the World Food Programme (WFP) (https://geonode.wfp.org/ layers/geonode:stp_trs_roads_osm), clipped with the boundaries of Príncipe Island and adjusted using QGIS satellite image base maps (Google Earth 2016-2020; World Imagery 2015)
Villages and towns	Human features	Vector – points	Mapped based on data of the 2021 census (INE 2015), a QGIS satellite image base map (Google Earth 2016-2020) and local knowledge (Osvaldo Lima, pers. comm.)

Table S5. List of species used for timber, charcoal, or firewood. Scientific names were taken from a list of local plant species (Laura Benitez, pers. comm.) and from the *Annotated catalogue of the flowering plants of São Tomé and Príncipe* (Figueiredo et al. 2011). Local names can refer to several species. Most frequently mentioned species are marked in bold, unidentifiable species with a question mark (?).

Local name	Scientific name
Amoreira	*Milicia excelsa*
Cajueiro	*Anacardium occidentale*
Candeia	*Psydrax sanguinolenta* sp. nov.
Eritrineira	*Erythrina* sp.
Fruteira	*Artocarpus altilis*
Gofe	*Cecropia sp.*
Grigô	*Morinda lucida*
Jaqueira	*Artocarpus heterophyllus*
Marapião	***Zanthoxylum* spp.**
Muandim	***Pentaclethra macrophylla***
Pau borracha	*Mesogyne henriquesii*
Pau branco	*Tetrorchidium didymostemon*
Pau brigo	?
Pau caixão	*Pycnanthus angolensis*
Pau ferro	*Heisteria parvifolia or many other species*
Pau fuba	***Hannoa klaineana***
Pau leite	***Funtumia africana***

Table S6. List of species used as wild food products. Scientific names were taken from a list of local plant species (Laura Benitez, pers. comm.), the *Annotated catalogue of the flowering plants of São Tomé and Príncipe* (Figueiredo et al. 2011) and an ethnopharmacological study of medicinal plants from São Tomé and Príncipe (Madureira 2008). Local names can refer to several species. Most frequently mentioned species are marked in bold, HCV trigger species are underlined, unidentifiable species with a question mark (?).

Local name	Scientific name	Common name (English)
Banana	*Musa spp.*	Banana
Búzio d'Obô	*Archachatina bicarinata*	Obô Giant Snail
Búzio vermelho	***Archachatina marginata***	**West African Giant Snail**
Cajamanga	*Spondias dulcis*	-
Coco	***Cocos nucifera***	**Coconut**
Folha boba	?	?
Folha ponto	*Achyranthes aspera*	-
Fruta pão	***Artocarpus altilis***	**Breadfruit**
Inhame	***?***	**?**
Izaquente	*Treculia africana*	African Bread Fruit
Jaca	*Artocarpus heterophyllus*	Jackfruit
Libô da água	*Struchium sparganophora*	-
Mamão	*Carica papaya*	Papaya
Mandioca	***?***	**?**
Manga	*Mangifera indica*	Mango
Maquequê	*Solanum cytherea*	-
Matabala	*?*	?
Micócó	*Ocimum gratissimum var. gratissimum*	Wild basil
Ossame	*Aframomum daniellii*	-
Otage	*Gongronema latifolium*	-
Pau pimenta	*Piper guineensis*	Pepper
Pêssego de São Tomé	*Chytranthus mannii*	-
Pimenta	*?*	?
Safu	*Dacryodes edulis*	-

Table S7. List of medicinal plant species. Scientific names were taken from a list of local plant species (Laura Benitez, pers. comm.) and from the *Annotated catalogue of the flowering plants of São Tomé and Príncipe* (Figueiredo et al. 2011). Local names can refer to several species. Most frequently mentioned species are marked in bold, HCV trigger species are underlined, unidentifiable species with a question mark (?).

Local name	Scientific name
Alba caçu	?
Alfabeca	*Peperomia pellucida*
Alho d'obô	*Psychotria* sp.
Arruda	?
Bananeira	*Musa* spp.
Bengue	***Alchornea cordifolia***
Cajueiro	*Anacardium occidentale*
Cata grande	*Rauvolfia caffra*
Caroceiro	Terminalia catappa
Cidrela	*Cedrela odorata*
Chimon coiá	*Lagenaria breviflora*
Códó-qué	***Paullinia pinnata***
Coentro	*Eryngium foetidum*
Colima	*Lonchocarpus sericeus*
Coqueiro macho	*Cocos nucifera*
Figo porco	*Ficus* sp.
Folha boba	*?*
Folha bufu	?
Folha coedan	?
Folha da formiga	*Chamaesyce prostrata*
Folha da mina	*Kalanchoe* sp.
Folha do cão	?
Folha galo	*Achyranthes aspera*
Folha grau	?
Folha lambriga plasma	?
Folha malé	*Ageratum conyzoides* subsp. *conyzoides*
Folha malva	*Abutilon grandiflorum*
Folha matriz	?
Folha matruiz	?
Folha paucada	?
Folha ponto	***Achyranthes aspera***
Folha preta	*Datura metel*
Folha violeta	?
Gogô	*Carapa gogo* or *Anthonotha* sp.nov. or *Strephonema* sp.
Goiaba	*Psidium guajava*
Grigô	***Morinda lucida***
Izequentueiro	*Treculia africana*
Libô	*Vernonia amygdalina*
Libô da água	*Struchium sparganophora*
Libô-mucambú	*Vernonia amygdalina*
Lorna	?
Mablemebê	?
Macabali	*Elephantopus mollis*
Macamblará	*Craterispermum cerinanthum*
Mangueira	*Mangifera indica*
Manjoló	*Solenostemon monostachyus*
Maquequé	*Solanum macrocarpon*
Marapião	*Zanthoxylum* spp.
Margoso	*Elaeophorbia drupifera*
Martianzoche	***Memecylon myrianthum***
Matruço	***Chenopodium ambrosioides***
Micócó	***Ocimum gratissimum* var. *gratissimum***

Local name	Scientific name
Muandim	*Pentaclethra macrophylla*
Mucumbli	***Lannea welwitschii***
Mussanfi	*Cleome rutidosperma*
Ossame	*Aframomum daniellii*
Otage	*Gongronema latifolium*
Pau caixão	*Pycnanthus angolensis*
Pau nicolau	*Pauridiantha floribunda*
Pau pimenta	*Piper guineense*
Pau sangue	*Harungana madagascariensis*
Pau três	***Allophylus spp.***
Pessegueiro	***Chytranthus mannii***
Romanzeira	*Punica granatum*
Rundu maravé	?
Xtlofi	?

Table S8. Presence of further species of interest (endemic but not threatened or otherwise qualifying as HCV) in potential HCVAs.

HCVA	Fauna	Flora
HCVA1: Praia Margarida forest	*A. hartlaubii* *C. larvata principalis* *H. malimbica dryas* *P. princeps* *S. dohrni* *T. calvus virescens*	-
HCVA2: North coast between Praia Sundy and Bom Bom	*A. affinis bannermani* *A. hartlaubii* *C. cristatus nais* *C. larvata principalis* *C. malherbii* *C. rufobrunnea rufobrunnea* *D. modestus modestus* *H. drewesi* *H. malimbica dryas* *L. delicatus* *L. ornatus* *P. dispar* *P. erithacus* *P. prínceps* *R. aegyptiacus princeps* *S. dohrni* *T. calvus virescens* *Z. leucophaeus* *Z. thomensis*	- -
HCVA3: Praia das Burras	*P. africana*	-
HCVA4: Northeast coast between Praia Banana and Praia Boi	*A. affinis bannermani* *A. hartlaubii* *C. cristatus nais* *C. larvata principalis* *H. malimbica dryas* *L. ornatus* *Pipistrellus (N.)* sp. *P. erithacus* *P. princeps* *R. aegyptiacus princeps* *S. dohrni* *T. calvus virescens*	-

HCVA	Fauna	Flora
	Z. leucophaeus	
HCVA5: Mosteiros islets	-	-
HCVA6: Praia Uva	-	-
HCVA7: Praia Grande	-	-
HCVA8: Azeitona and Quatro Caminhos	*A. affinis bannermani* *A. hartlaubii* *B. bedrigae* *C. cristatus nais* *C. larvata principalis* *C. malherbii* *C. rufobrunnea rufobrunnea* *D. modestus modestus* *F. polylepis* *H. principensis* *H. drewesi* *H. malimbica dryas* *H. principis* *L. delicatus* *Pipistrellus (N.)* sp. *P. dispar* *P. erithacus* *P. princeps* *R. aegyptiacus princeps* *S. dohrni* *T. calvus virescens* *Z. leucophaeus* *Z. thomensis*	*C. nutans* *L. rozeirae* *M. glabrata*
HCVA9: Morro Iola	-	-
HCVA10: Swamp São Joaquim	-	-
HCVA11: Morro Fugido	-	-
HCVA12: Morro Caixão and Praia Caixão	*A. affinis bannermani* *A. hartlaubii* *C. cristatus nais* *C. cupreus insularum* *C. larvata principais* *C. malherbii* *C. rufobrunnea rufobrunnea* *H. malimbica dryas* *P. africana* *P. dispar* *P. erithacus* *P. princeps* *S. dohrni* *T. calvus virescens* *Z. leucophaeus*	*P. albescens ssp. principensis* *T. stenosiphon*
HCVA13: Morro Fundão	-	*C. nutans* *M. glabrata*
HCVA14: Praia Salgada	-	-
HCVA15: Praia Abelha	*A. hartlaubii* *P. princeps* *S. dohrni*	
HCVA16: PNP - Focinho de Cão	*A. hartlaubii* *C. cristatus nais* *C. rufobrunnea rufobrunnea* *H. malimbica dryas* *P. erithacus*	*D. thomensis*

HCVA	Fauna	Flora
	P. princeps *S. dohrni* *Z. leucophaeus*	
HCVA17: PNP - Northern tract	*A. hartlaubii* *B. bedrigae* *C. cristatus nais* *C. larvata principalis* *C. malherbii* *C. rufobrunnea rufobrunnea* *H. malimbica dryas* *P. erithacus* *P. princeps* *S. dohrni* *T. calvus virescens* *Z. leucophaeus*	*P. pedicellata*
HCVA18: PNP - Pico Mesa	*A. affinis bannermani* *A. hartlaubii* *C. cristatus nais* *C. larvata principalis* *C. malherbii* *C. rufobrunnea rufobrunnea* *H. drewesi* *H. malimbica dryas* *L. ornatus* *P. dispar* *P. erithacus* *P. princeps* *S. dohrni* *T. calvus virescens* *Z. leucophaeus* *Z. thomensis*	*B. pedicellata* *C. calophyllum* *C. nutans* *D. thomensis* *L. rozeirae* *M. glabrata* *P. monticola* *R. dichotoma* *T. stenosiphon*
HCVA19: PNP - Barriga Branca	-	-
HCVA20: PNP - Southwestern tract	*A. affinis bannermani* *A. hartlaubii* *C. cupreus insularum* *C. larvata principalis* *C. malherbii* *C. rufobrunnea rufobrunnea* *F. polylepis* *H. drewesi* *H. malimbica dryas* *H. principensis* *Pipistrellus (N.)* sp. *P. africana* *P. dispar* *P. erithacus* *P. princeps* *R. aegyptiacus princeps* *S. dohrni* *Z. leucophaeus*	*C. nutans* *G. elongata* *E. columnaris*
HCVA21: PNP – Lowland to medium elevation mature forest	*A. affinis bannermani* *A. elegans* *A. hartlaubii* *B. bedrigae* *C. cristatus nais* *C. cupreus insularum* *C. larvata principalis*	*A. camerooniana var. currorii* *A. quintasii* *C. gogo* *C. nutans* *C. stelluliferus* *D. acuta* *D. thomensis*

HCVA	Fauna	Flora
	C. malherbii *C. rufobrunnea rufobrunnea* *D. modestus modestus* *F. polylepis* *H. drewesi* *H. malimbica dryas* *H. principensis* *H. principis* *L. delicatus* *L. ornatus* *Pipistrellus (N.)* sp. *P. africana* *P. dispar* *P. erithacus* *P. princeps* *R. aegyptiacus princeps* *S. dohrni* *T. calvus virescens* *Z. leucophaeus* *Z. thomensis*	*E. columnaris* *Greenwayodendron sp.nov. Sao Tome* *G. elongata* *H. letouzeyana* *M. glabrata* *M. tenuiflora principensis* *P. albescens ssp. principensis* *P. pedicellata* *P. monticola* *T. aurantiopunctata* *T. stenosiphon*
HCVA22: PNP – Central mountains	*A. affinis bannermani* *A. hartlaubii* *C. cristatus nais* *C. fingui* *C. larvata principalis* *C. malherbii* *C. rufobrunnea rufobrunnea* *F. polylepis* *H. malimbica dryas* *P. africana* *P. dispar* *P. erithacus* *P. princeps* *S. dohrni* *T. calvus virescens* *Z. leucophaeus*	*A. quintasii* *C. nutans* *G. elongata* *H. letouzeyana* *M. glabrata* *P. albescens ssp. principensis* *P. monticola* *P. pedicellata* *T. stenosiphon*
HCVA23: PNP – Southeastern tract	*A. affinis bannermani* *A. hartlaubii* *C. cristatus nais* *C. cupreus insularum* *C. larvata principalis* *C. malherbii* *C. rufobrunnea rufobrunnea* *D. modestus modestus* *F. polylepis* *H. malimbica dryas* *H. principensis* *L. ornatus* *Pipistrellus (N.)* sp. *P. africana* *P. dispar* *P. erithacus* *R. aegyptiacus princeps* *S. dohrni* *T. calvus virescens* *Z. leucophaeus* *Z. thomensis*	*A. camerooniana var. currorii* *C. giganteus* *C. nutans* *C. stelluliferus* *G. elongata* *H. letouzeyana* *L. tinctoria* *M. glabrata* *P. albescens ssp. principensis* *P. pedicellata* *T. aurantiopunctata* *T. thomensis*

HCVA	Fauna	Flora
HCVA24: Boné de Jóquei and Bonézinho	*A. affinis bannermani* *H. malimbica dryas* *P. princeps*	-
HCVA25: Tinhosas islets	*H. principensis* *T. adamastor*	-

FIGURES

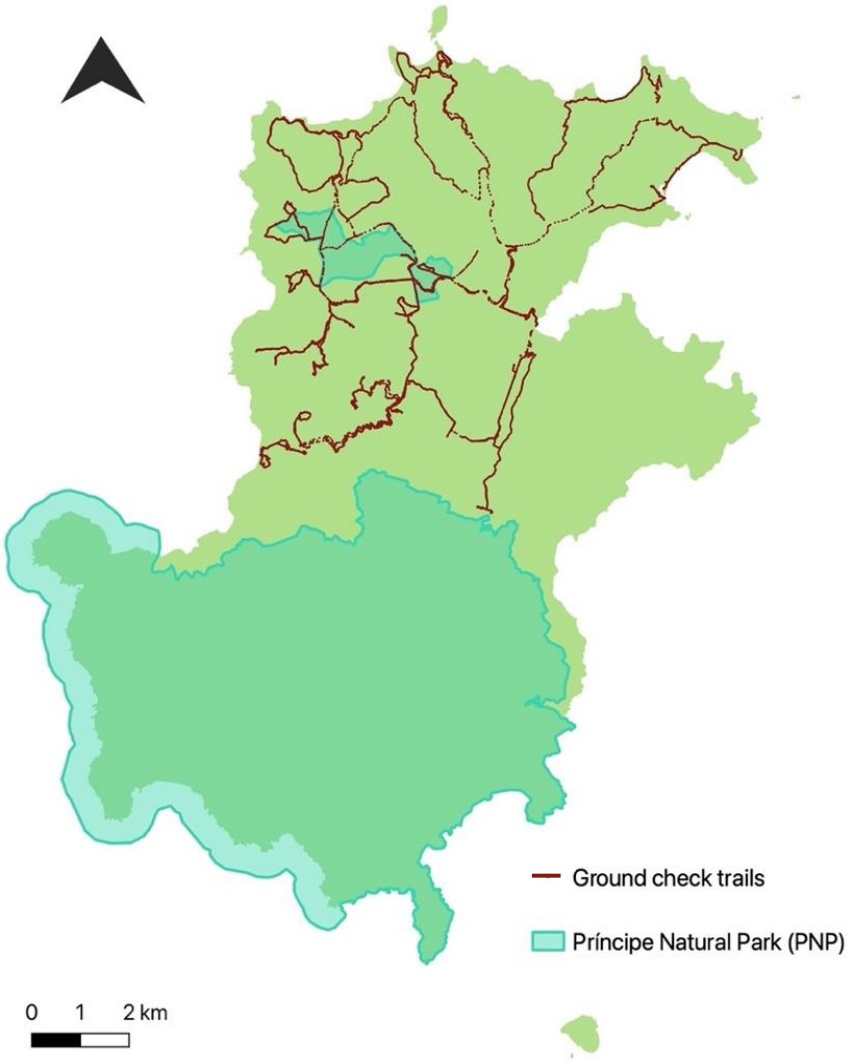


Fig. S1. Map of ground checks carried out during the fieldwork period in Príncipe.

Fig. S2. Base map used for participatory mapping workshops.

Comunidade:
Data:
Grupo:

Valor	Tipos presentes	É vendido?	**Nota** (sobre a localização, a forma como o recurso é utilizado, etc.)
Água	☐ Para beber, cozinhar ☐ Outros (tomar banho, lavar etc.)		
Madeira	☐ Para construção ☐ Lenha ☐ Carvão vegetal	☐ Mercado local ☐ Para São Tomé ☐ Exportação	Note principais espécies de madeira
Alimentos selvagens	☐ Pêssego ☐ Búzio d'Obô ☐ Búzio-vermelho ☐ Mel (como é recolhido?) Outros (liste os principais):	☐ Mercado local ☐ Para São Tomé ☐ Exportação	

1

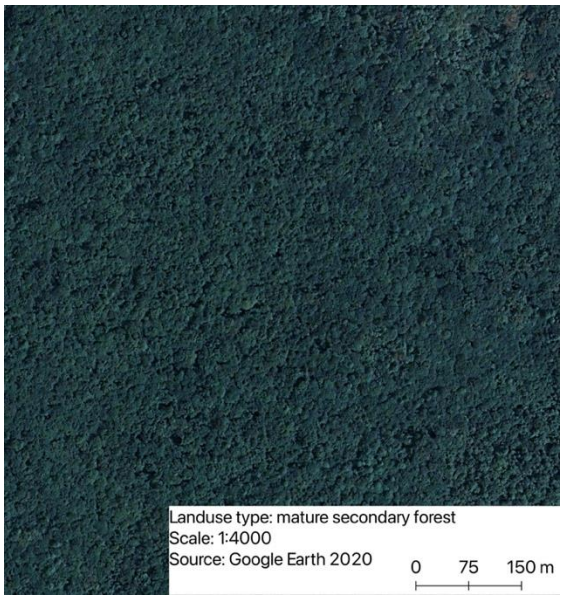
Plantas medicinais	☐ Pessegueiro ☐ Pau três ☐ Martim Jozche Outros (liste as principais):	☐ Mercado local ☐ Para São Tomé ☐ Exportação	
Caça	☐ Macacos ☐ Lagaias ☐ Morcegos ☐ Porcos selvagens ☐ Aves (p.ex. Tordo)	☐ Mercado local ☐ Para São Tomé ☐ Exportação	Note as principais espécies de aves, caso sejam caçadas
Agricultura	☐ Plantação da sombra (mapa: S) ☐ Plantação aberta (mapa: A)	☐ Mercado local ☐ Para São Tomé ☐ Exportação	

2

Fig. S3. Checklist for questions regarding resources used for participatory mapping workshops.

Fig. S4. Agricultural areas, not qualifying as HCV, mapped during participatory mapping workshops with local communities. Agricultural products were cultivated primarily around the communities in shade as well as in open plantations with major areas near the communities of Azeitona, Terreiro Velho, Ponta do Sol and Sundy. The only community where agriculture played a minor role was São Joaquim, which used only small areas for farming.

a



b

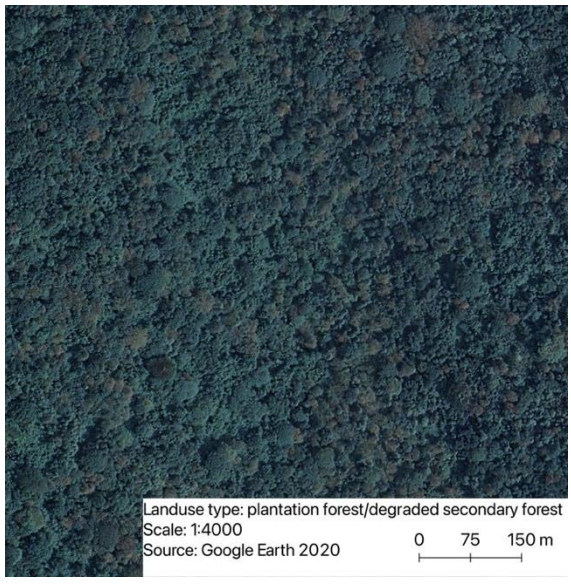


Fig. S5. Aerial images showing canopy patterns of (a) mature secondary forest and (b) plantation forest or degraded secondary forest.