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Bamboo biodiversity

Africa, Madagascar and the Americas

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THE INTERNATIONAL NETWORK FOR BAMBOO AND RATTAN (INBAR) is an international organization established by treaty in November 1997, dedicated to improving the social, economic, and environmental benefits of bamboo and rattan. INBAR connects a global network of partners from the government, private and not-for-profit sectors in over 50 countries to define and implement a global agenda for sustainable development through bamboo and rattan.

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Foreword

The bamboo plant supports an international trade, which (even according to our currently imperfect trade statistics) amounts to well over US$2 billion per year. International trade, however, forms only a part of bamboo usage, with domestic use estimated to account for at least 80 per cent of the total. Bamboo is thus a major world commodity.

Despite this, very little is known about the distribution and resources of bamboo. Certain bamboo species (e.g. Chinese Moso bamboo, *Phyllostachys edulis*) have formed the basis of major industrial development and have been domesticated into plantations. Perhaps 50 or 100 bamboo species are preferred for use and are undergoing some degree of domestication. However there are estimated to be nearly 1 500 species in total and the vast majority of these occur only in their native ranges, and many may have uses of local or wider significance that have yet to be documented. Unfortunately, as obligate components of forested ecosystems, their futures are bound up with the survival of their forest habitats. This work indicates that as forest ecosystems shrink under human pressure the survival of many potentially important bamboo species may be threatened.

This work is a first step towards quantifying existing resources of bamboo. Knowledge of the magnitude and distribution of these resources is a necessary precursor to planning and implementing conservation and sustainable management of bamboos in the wild.

The innovative approach used here can be applied to the study of other species associated with mapped ecosystems.

This study would not have been possible without collaboration between INBAR and UNEP-WCMC. It was the detailed map-based databases of UNEP-WCMC that made the development of the methodology possible. This study thus represents an excellent example of two organizations working together to combine their strengths.

Ian Hunter
Director General
International Network for Bamboo and Rattan

Preface

Wherever they occur, woody bamboos are of direct importance to people. They are used for everything from construction to irrigation systems, from musical instruments to food and fuel. Their greatest economic importance is in the Asia-Pacific region, but they are also fundamental to local economies in other regions of the world. Despite their value to humanity, we still know relatively little about most bamboos in the wild.

Bamboos are an ancient group of plants that play a distinctive role in the forest ecosystems of which they are a part. For example, they support a range of specialized and rare species, such as the greater bamboo lemur of Madagascar. This report (like its companion volume for the bamboos of the Asia-Pacific region) applies innovative approaches and analytical tools to expand our understanding of the ecological role of bamboos substantially. The authors have generated a revealing overview of the distribution of bamboos in Africa, Madagascar and the Americas, which provides the first sound basis for a description of their importance and an analysis of their conservation needs.

This work directly supports the *Global Strategy for Plant Conservation*, adopted under the Convention on Biological Diversity, which expressly recognizes the need for more knowledge on distribution and threats as a basic requirement for effective conservation measures. A Global Partnership for Plant Conservation has recently been formed to help implement the *Global Strategy*, and UNEP-WCMC is pleased to be one of its founding members. By assessing conservation status, identifying areas important for bamboo diversity and *in situ* conservation of threatened species, and providing information on the use of wild species, this report contributes directly to implementation of the *Global Strategy* and achievement of its targets.

Conserving such genetic resources as wild bamboos is an essential step towards solving the problems of poverty alleviation and sustainable development. Because of their many uses, bamboos exemplify the connection between biodiversity and livelihoods very clearly. This report will help range states to recognize, and value, the bamboo genetic resources on their own doorsteps, and to conserve them for future generations.

I welcome this opportunity to collaborate with INBAR, the world's bamboo and rattan trade network. I hope that our first analyses will form the basis for future in-depth assessments of bamboo resources and their conservation status. Bamboos are a fascinating group of plants that bring benefits to people everywhere; they should be conserved as an important resource for all our futures.

Mark Collins
Director
UNEP World Conservation Monitoring Centre

Bamboo biodiversity

Bamboos are distinct and fascinating plants, with a wide range of values and uses. Although their diversity and their importance are highest in, and have been best documented for, the Asia-Pacific region, they are also important in continental Africa, Madagascar and the Americas. Worldwide they are associated with unique elements of biodiversity, many with great conservation significance. They are important in local cultures and economies, and contribute to soil and water management. The purpose of the present study is to synthesize existing knowledge to provide an overview of the richness and distribution of woody bamboos in Africa, Madagascar and the Americas. It shows that a number of bamboo species in these regions are potentially threatened by the destruction of natural forest cover. Conservation and sustainable management of wild populations of bamboo should be a priority, especially where diversity is high or deforestation is a significant threat.

Bamboos are plants of global interest because of their distinctive life form, their ecological importance and the wide range of uses and values they have for humans. Woody bamboos are an ancient group of forest plants, which evolved in the lowland tropics of Gondwanaland during the Tertiary (Clark 1997).

Bamboos are a significant structural component of many forest ecosystems and play a major role in ecosystem dynamics through their distinctive cycles of mass flowering and subsequent die-off, which may increase the importance of fire (Keeley and Bond 1999). Inhabiting moister, more benign habitats in old-growth forests, bamboos are often associated with threatened plants, and there are many specialized animal species that depend upon them. There are also many little-known invertebrates specially adapted to the environment within hollow bamboo culms. These specialized relationships, which reflect a long history of co-evolution between bamboos and other species, can shed light on evolutionary and ecological processes.

Bamboos are multipurpose crops, with over 1 500 documented uses. Their most important traditional uses include housing, food and material for handicrafts. Worldwide, over 2.5 billion people trade in or use bamboo (INBAR 1999). Globally, domestic trade and subsistence use of bamboo are estimated to be worth US$4.5 billion per year, and export of bamboo generates another US$2.7 billion (INBAR 1999). The many uses and the economic importance of bamboo mean that it plays a considerable role in improving the livelihoods of rural poor people. The

In East Africa the 'Endangered' mountain bongo (*Tragelaphus euryceros* ssp. *isaaci*) relies on montane bamboo thickets for food and shelter during the dry season.

rural poor, especially women and children, harvest much of the bamboo used.

The extensive rhizome system of bamboos lies primarily in the top layers of soil, so bamboos often play a major role in stabilizing soils on slopes and river banks, preventing erosion and land slips. This also makes them important in securing the hydrological function of catchments and rivers. Many forest bamboos are characteristic of high-altitude ecosystems on steep slopes in zones of high seismic activity, so their role in soil stabilization may be critical.

The scientific, environmental, economic and social importance of bamboos means that it is essential that strategies be developed for their sustainable management. However, knowledge to support such planning is limited.

Bamboos are of conservation significance in their own right and may also serve as indicators of high biodiversity in other groups. As most bamboo species are forest plants, they are intrinsically vulnerable to deforestation. The vulnerability of some species is increased by the simultaneous flowering and subsequent death of entire populations in cycles of 20-120 years. A recent study (Bystriakova *et al.* 2003a,b) showed that around 40 per cent of bamboos in the Asia-Pacific region are potentially threatened due to the small amount of forest cover remaining within their natural ranges. Other authors have suggested that many bamboos in the Americas may be of conservation concern (Judziewicz *et al.* 1999), and the *1997 IUCN Red List of Threatened Plants* contained 12 species of woody bamboo from the Americas and one from Africa (Gillet and Walter 1998). However, there has as yet been little systematic evaluation of potentially threatened bamboos outside the Asia-Pacific region. In this work, we extend the approach used by Bystriakova *et al.* (2003a,b) to Africa, Madagascar and the Americas, to synthesize existing knowledge on bamboo distribution and identify bamboo species in the three focal regions that may be of conservation concern.

STATE OF KNOWLEDGE OF BAMBOOS, BAMBOO RESOURCES AND THEIR MANAGEMENT

Despite their importance, very little is known about bamboo distribution and resources, especially in natural forests. As a non-timber forest product, bamboo is not routinely included in forest inventories. According to the FAO (2001), statistical data on bamboo are available for the period 1954 to 1971 only. Today, very few countries monitor non-timber forest product (NTFP) supply and utilization at the national level. The difficulty of assessing bamboo (and other NTFP) resources and their use arises from:

- uncertainty associated with their taxonomy (see below);
- the large number of, and wide variation in, their uses at local, national and international levels;
- the fact that many bamboo products are used or marketed outside traditional economic structures;
- the lack of common terminology and units of measurement (FAO 2001).

The description of bamboos is an ongoing process; not only do new species remain to be discovered and described, many earlier descriptions and classifications of species are being revised. According to Ohrnberger (1999), the subfamily Bambusoideae (of the family Poaceae, or Gramineae) comprises both woody and herbaceous bamboos with 1 575 species altogether. In the most recent (and narrower) classification (Grass Phylogeny Working Group 2001) the subfamily Bambusoideae includes two tribes and approximately 1 200 species.

Although some bamboos have been the subject of a great deal of research, the majority of species are poorly known and much of their biology is incompletely understood. Resources to study bamboos scientifically have been and remain severely limited. Most international research funding and effort has focused on a relatively small set (38) of 'priority species' of bamboo that are commercially important and widely distributed (Williams and Rao 1994; Rao *et al.* 1998). Of these, most are native to the Asia-Pacific region, one (*Oxytenanthera abyssinica*) is an African species, none occurs in Madagascar and one (*Guadua angustifolia*) comes from South America. Consequently, research on biodiversity and conservation of forest bamboos has been especially limited in the three regions considered here.

Perhaps because of their great regional economic importance, the bamboos of the Asia-Pacific region have been more thoroughly investigated than those of other regions. The current understanding of their distribution and conservation status was summarized by Bystriakova *et al.* (2003a,b). Although those publications cover the majority of the world's 1 200 bamboo species, around 400 bamboo species and subspecies occur in other regions of the world and are less well known.

The purpose of the present study is to synthesize existing knowledge to provide an overview of the richness and distribution of woody bamboos in Africa, Madagascar and the Americas. In these three regions the economic potential of bamboo has not yet been explored and the role of bamboo resources in national economies is negligible. The uses of bamboo are mostly in the domestic field and small-scale construction. As a result, in the majority of African and American countries, information about bamboo resources, and their current and potential uses, is incomplete.

Against a background of poor knowledge of bamboo identification and distribution it is inevitable that the vast majority of bamboos have not been evaluated at all in terms of conservation status, and data deficiencies may limit the value of any *ad-hoc* assessments that have been made. Despite the growing importance of bamboos, few studies of the conservation status of individual species have been undertaken. The data compiled in this study are used to provide a preliminary assessment of their possible conservation status and are discussed in the light of the importance of bamboos for both conservation and human use.

SCOPE AND METHODS

To determine likely present distributions of bamboo species and to estimate the total area of remaining forest potentially containing bamboo, we compiled information on the distribution of bamboo species in each of the three study regions (Africa, Madagascar and the Americas) from the relevant taxonomic and floristic literature. This information was combined with regional data on remaining forest cover in the same process as used by Bystriakova *et al.* (2003a,b) for the bamboos of the Asia-Pacific region. The resulting maps for individual species were combined to show regional patterns of potential bamboo species richness.

This study was confined to woody bamboos, as these are most significant from the socio-economic point of view. We gathered data on nearly 400 species, belonging to 37 genera, which occur naturally in the three study regions. For each species bibliographic sources were searched to acquire data about its distribution. These data

Bamboo has many domestic and agricultural uses, ranging from musical instruments to construction of homes and of agricultural structures like this irrigation system in Madagascar.

were principally political units (country, province, locale), altitudinal range and forest type. They were entered into an Access database containing 13 fields and multiple records for each species (a total of 1 180 records). Although the information available in the bibliographic sources was variable, 966 records (82 per cent) contain information about altitudinal range (minimum and maximum altitude), and 952 records (81 per cent) have data about species distribution at the provincial level.

For each species in the database a single potential distribution map was generated using ArcView Geographic Information System (GIS) software to combine data on political units, altitude and forest type according to the information about natural distribution of the species. The information about the distribution of existing forest cover provided by UNEP-WCMC (Iremonger *et al.* 1997; UNEP-WCMC 2000) was used as a mask to eliminate areas not forested. When multiple data on altitudinal range existed for the same species, the broadest range was applied. The individual species maps were combined to generate maps of potential species richness and potential generic richness for each of the three study regions.

In an effort to validate the distributions obtained in this way, a limited number were compared visually with the point-distributions generated from herbarium specimen data held in the VAScular Tropicos (VAST) nomenclatural database of Missouri Botanical Garden (VAST 2003). In most cases, e.g. *Chusquea pohlii* (Map 3.23), *Arthrostylidium venezuelae* (Map 3.11) and *Chusquea scandens* (Map 3.24), the potential species distribution ranges generated by this study matched the maps of point locations very well. This suggests that this approach to modelling based on political units, altitude and forest is an

appropriate way to generate potential species distribution maps where data are limited. However, for a minority of species, e.g. *Guadua amplexifolia* (Map 3.28) and *Otatea acuminata* (Map 3.41), the range of point locations was larger than predicted by potential species distribution maps, suggesting that the source data on political units need verification. It is important to recognize that this study does not address the persistence of many bamboo species outside forests and in cultivation, or the potential beneficial effects of forest disturbance for some woody bamboo species (Judziewicz *et al.* 1999).

We gathered data on 388 species and subspecies that occur in Africa, Madagascar and the Americas, and mapped the potential current distributions of 379 individual bamboo species within natural forest. Thirty-seven genera occurring naturally in these regions were included in this study (Annex I).

BAMBOOS IN AFRICA

The lowest diversity of woody bamboos is found in Africa, where five species representing five genera occur (Table 1). Tanzania has the largest number of species followed by Malawi, Uganda and Zambia (Table 2). The greatest potential bamboo richness (two co-occurring species) is in East Africa, especially around Lake Victoria, and in southern Africa in Zambia and Zimbabwe (Figure 1), while the countries of West Africa have only a single species of woody bamboo (principally *Oxytenanthera abyssinica*).

Table 1. The five species of woody bamboo occurring in Africa, and the total area of forest within their range

Species	Area of potential occurrence (km^2)
Hickelia africana	1 174
Yushania alpina	202 019
Oreobambos buchwaldii	527 789
Oxytenanthera abyssinica	7 117 915
Thamnocalamus tessellatus	89 260

The low diversity of bamboo species in mainland Africa, compared with Asia, Madagascar and the Americas, may relate to past climatic variation on the continent. The ancestral woody bamboos are thought to have arisen in the wet forests of Gondwanaland (Clark 1997). It is possible that after the break-up of Gondwanaland isolated the African genera (Clayton and Renvoize 1999), climate and vegetation patterns in Africa have provided limited opportunities for their expansion and radiation within forest habitats, in contrast to genera on other continents.

Table 2. Numbers of species of Bambuseae occurring in the countries of Africa

Country/Territory	Number of naturally occurring species	Country/Territory	Number of naturally occurring species
Tanzania	4	Côte d'Ivoire	1
Malawi	3	Eritrea	1
Uganda	3	Gambia	1
Zambia	3	Ghana	1
Cameroon	2	Guinea	1
Congo	2	Guinea-Bissau	1
Democratic Republic of Congo	2	Kenya	1
Ethiopia	2	Mozambique	1
Sudan	2	Nigeria	1
Zimbabwe	2	Réunion	1
Angola	1	Rwanda	1
Benin	1	Senegal	1
Burundi	1	Sierra Leone	1
Central African Republic	1	South Africa	1
Comoro Islands	1	Togo	1

Source: Ohrnberger 1999.

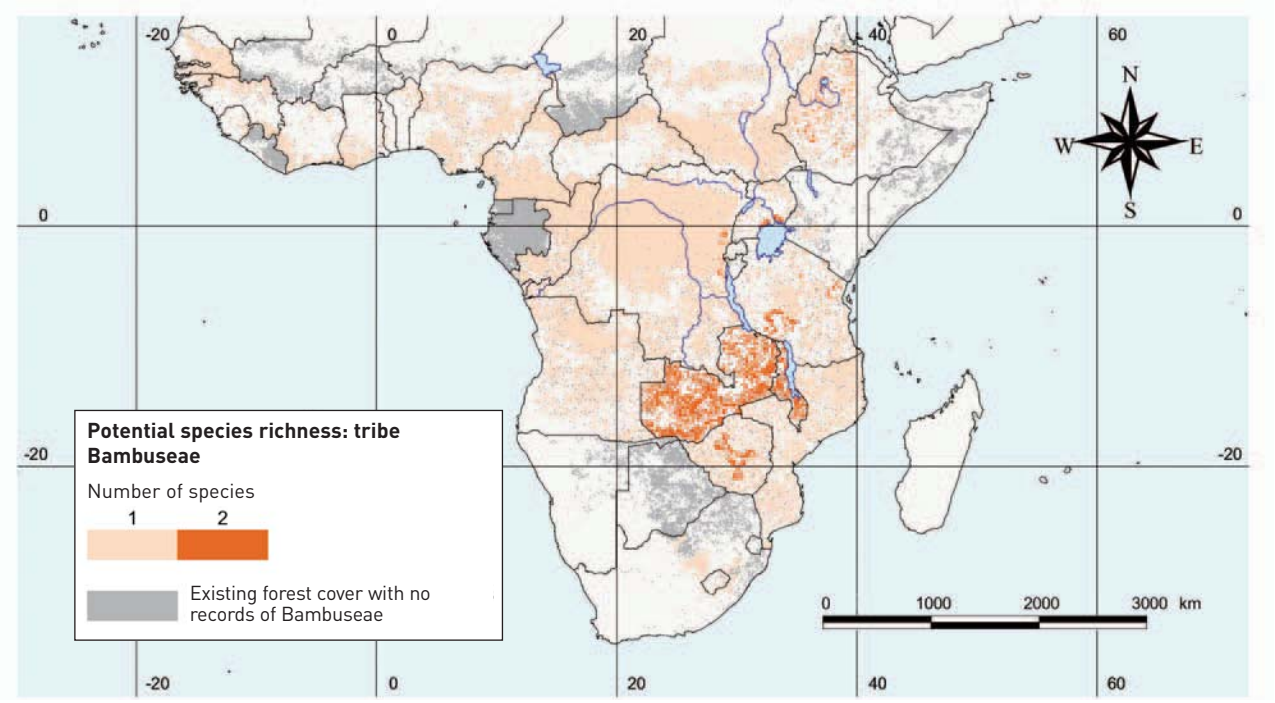

Figure 1. Map of potential bamboo species richness in Africa, derived by integrating the distributions of the five woody bamboo species that are native to the continent.

Conservation and biodiversity importance

Of the African bamboos mapped, only *Thamnocalamus tessellatus* has been listed by IUCN as of conservation concern (Annex II) (Gillet and Walter 1998; Hilton-Taylor 2000). According to our analysis, it currently has 89 260 km^2 of potential forest habitat remaining. Potentially of great concern but not presently red-listed, is *Hickelia africana*, which is especially limited in its current extent (Table 1), having little more than 1 000 km^2 of forest remaining within its range.

Despite their lack of diversity in Africa, bamboos play an important role in ecology and biodiversity conservation. In many places, especially at high altitude, African bamboo species form vast pure stands (Chihongo *et al.* 2000; Kigomo 1988), which provide important shelter and resources for some key species of conservation interest. For example, the eastern or mountain bongo (*Tragelaphus euryceros* ssp. *isaaci*) of the Aberdare Mountains in Kenya is considered by IUCN to be 'Endangered' (Antelope Taxon Advisory Group 2003). This large forest antelope spends the wet season in cloud forests lower down the mountains, but migrates to spend the dry season in the dense *Yushania alpina* thickets and open moorland 1 000 m further up the slopes. Effective protection of the surviving remnant populations of the mountain bongo in Kenya is critical to its survival in the wild. The conservation of bamboo forests is a vital part of such protection given their key role in sheltering the mountain bongo during the dry season.

Another close dependence between an endangered mammal and bamboo occurs with the eastern mountain gorilla (*Gorilla beringei beringei*). Mountain gorillas, which are classed as 'Endangered' (IUCN 2002), inhabit montane and bamboo forests in the eastern Democratic Republic of the Congo, Rwanda and southwestern Uganda (IGCP 2003). They eat large amounts of vegetation from more than 70 different plant species, including bamboo (Fossey and Harcourt 1977). When the bamboo plant sprouts in June and November, bamboo shoots can make up to 90 per cent of a gorilla's diet. An adult male can eat up to 35 kg of bamboo each day, and females about 18 kg (WWF 2003a).

Uses of bamboo

In terms of utilization, the most important African species are *Oreobambus buchwaldii*, *Oxytenanthera abyssinica* and *Yushania alpina* (Annex III and Annex V: Maps 1.1, 1.2 and 1.4). These are mostly harvested from the wild. For example, in Kenya only 0.6 per cent of total bamboo harvested is produced on farms (Ongugo *et al.* 2000).

African bamboos have not been exploited in pulp and paper production, or in any other large-scale bamboo

industry. The economic value of trade in bamboo products in Africa is negligible. Since the products are traded locally, statistics do not enter the national accounting systems (Chihongo *et al*. 2000).

Although there is little cultivation of bamboo and little or no international trade in bamboo from Africa, many bamboo products are used domestically and can be very significant in both household and local economies. Key bamboo uses include small-scale construction, handicrafts, residential fencing, horticultural flower farming, water pipes, farm props for banana plantations, furniture, and other minor cottage industry products like basketry and toothpicks (Chihongo *et al*. 2000). According to the results of a survey carried out in several Ethiopian states (Kelbessa *et al*. 2000), the majority of rural families were entirely dependent on raw bamboo for construction, household furniture and as a source of domestic energy. Where collecting and processing bamboo provides income, as for example in the production of toothpicks and incense sticks in Kenya, women are mainly involved in processing whereas men are involved in harvesting, transportation and processing (Ongugo *et al*. 2000).

In some parts of Africa, bamboo is also a source of food and drink. In Tanzania and Uganda, young shoots and seeds of *Oxytenanthera abyssinica*, a medium-size bamboo reaching 8-16 m in height, are consumed as food. The principal use of this species in Tanzania, however, is in the production of bamboo wine, also known as *ulanzi* (Chihongo *et al*. 2000; Kigomo 1988). Tips of young shoots are cut off and the stem portion bruised every morning and evening for about a week. The exudate from the bruises is collected and allowed to stand for two days to ferment. The resulting *ulanzi*, which is 5-5.5 per cent alcohol, is one of the principal forms of alcohol consumed in some areas (Willis 2003).

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Other roles of bamboo

The role of bamboo in conserving soil and protecting watersheds is also substantial in Africa. For example, in Kenya, *Yushania* (formerly *Arundinaria*) *alpina* is receiving attention from the government especially for catchment rehabilitation, regulation of water-flow and erosion control (Ongugo *et al*. 2000).

Conservation and management

The importance of bamboos and their products in local economies has led to overexploitation and a decline in the supply of bamboo from natural stands in some parts of Ethiopia and Tanzania (Chihongo *et al*. 2000). Approaches to reverse these trends have included efforts to establish introduced species. The Kenya Forestry Research Institute has introduced several bamboo species from Asian countries both to forest areas and on farmlands on an experimental basis (Ongugo *et al*. 2000; Kigomo 1999). A number of species, among them *Bambusa bambos*, *B. tulda*, *B. vulgaris*, *Dendrocalamus asper*, *D. brandisii*, *D. membranaceus*, *D. strictus*, *Phyllostachys pubescens* and *Thyrsostachys siamensis*, have been established successfully in several ecological zones.

Regulation has also been used as a means to ensure continued supply of bamboo in parts of Africa. In Uganda bamboo harvesting is allowed in some areas, but collectors have to obtain permits from the Forestry Department. In Kenya bamboo in state forests is protected, although controlled harvesting is allowed in places (Ongugo *et al*. 2000). A government ban on cutting bamboo was proclaimed in 1982 to control further indiscriminate cutting and to allow the overcut areas to regenerate to their full potential. Bamboo harvesting from state forests was allowed only with a special licence.

However, regulation is not always a successful approach. Even in Ugandan forest reserves with no legal public access, illegal harvesting of bamboo occurs (Esegu *et al*. 2000). Implementation of the government ban in Kenya has resulted in conditions that have encouraged corruption and made the bamboo resource unavailable to poor entrepreneurs. A rough comparison of the figures for the bamboo actually used and the official figures for harvested bamboo shows a difference of 88 per cent, which means that a large part of the bamboo used in Kenya is harvested illegally (Ongugo *et al*. 2000).

Further work is needed to identify appropriate mechanisms and regimes for managing bamboo resources, ensuring conservation of native bamboo populations and maintaining their roles in forest ecosystems.

BAMBOOS IN MADAGASCAR

Information about bamboos in Madagascar is far from complete. Although bamboos began to be described in Madagascar in 1828, there was a long hiatus during the latter half of the 19th century. Limited collection during the early 20th century permitted the description of a total of 27 species up to 1960. New collections between 1987 and 1996 permitted recent revisions of *Hickelia* and *Decaryochloa* and descriptions of three new genera, *Valiha*, *Cathariostachys* and *Sirochloa* (Dransfield 2000; Dransfield 2002). It is likely that additional revisions and some new species descriptions may be produced in the future.

At present, Madagascar is considered to have 33 species of woody bamboo and is therefore strikingly more rich in species than continental Africa. Thirty-two of those species are endemic and a single species, *Bambusa vulgaris*, is pantropical in distribution. As this last species is found principally near villages and along rivers, it is

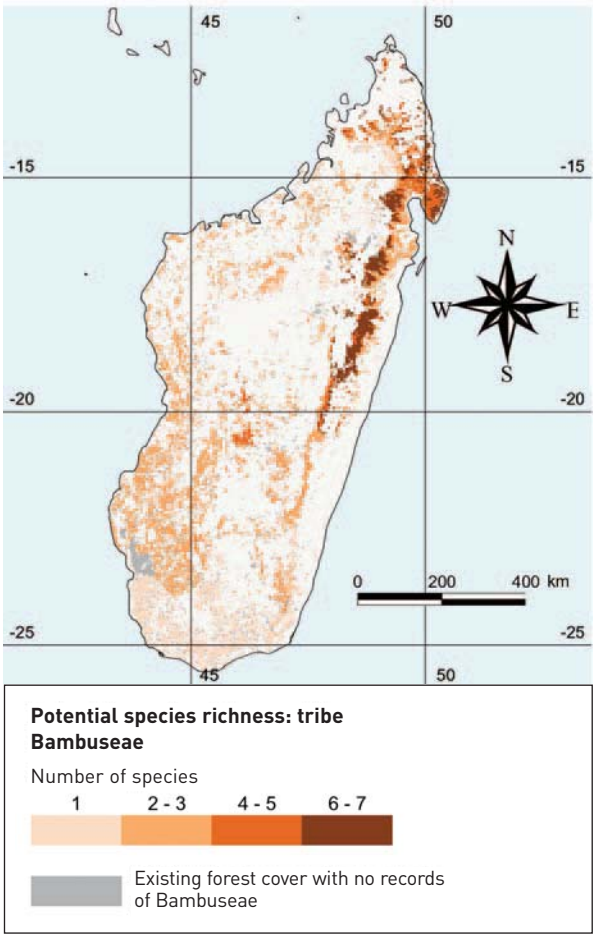

Figure 2. Map of potential species richness of woody bamboos in Madagascar, derived by integrating the distributions of the 33 native woody bamboo species, all of which are endemic to Madagascar.

possible that it is introduced. The richness and endemism of the woody bamboo flora of Madagascar reflects the island's long (c. 140 million years) isolation from other land masses and the resulting unique evolutionary pathways that have led to extremely high levels of endemism in both flora and fauna.

The majority of the native woody bamboos of Madagascar are found on the eastern escarpment where remnants of rainforest still exist (Figure 2). Some species also occur in the drier vegetation of the west. The maximum potential species richness in Madagascar identified by the present study was seven co-occurring species.

Conservation and biodiversity importance

In addition to being endemic, a number of Madagascar's woody bamboos have limited amounts of forest remaining within their quite localized ranges. Twenty-five of the Madagascan species have less than 20 000 km^2 of forest remaining within their ranges and as many as ten species have less than 2 000 km^2 of forest available to them (Figure 3 and Annex IV). Although the former criterion might be considered analogous to the threshold extent of occurrence used by IUCN as a basis for inclusion in the Red List, none of Madagascar's woody bamboos is currently listed by IUCN as a plant species of global conservation concern (Gillet and Walter 1998; Hilton-Taylor 2000).

Besides their endemism and potentially threatened status, a number of Madagascar's woody bamboos are fundamental to the survival of other species. The most extreme case may be that of the bamboo lemurs. There are three recognized species of bamboo lemur, each occupying a different habitat in Madagascar: the grey bamboo lemur (*Hapalemur griseus*), the greater bamboo lemur (*Hapalemur simus*) and the golden bamboo lemur (*Hapalemur aureus*). All these species are characteristic of forest with a high proportion of bamboo, and various parts of bamboo plants make up a large part of their diets. The grey bamboo lemur lives on the new shoots, leaf bases, and sometimes pith of several bamboo species (Garbutt 1999; Mittermeier *et al.* 1994). The rare greater bamboo lemur primarily consumes the pith of the giant bamboo, *Cathariostachys madagascariensis*, which contains high levels of cyanide (Garbutt 1999; Dransfield 2000). The golden bamboo lemur eats leaf bases and new shoots of the same bamboo species, as well as other non-woody bamboos (Garbutt 1999).

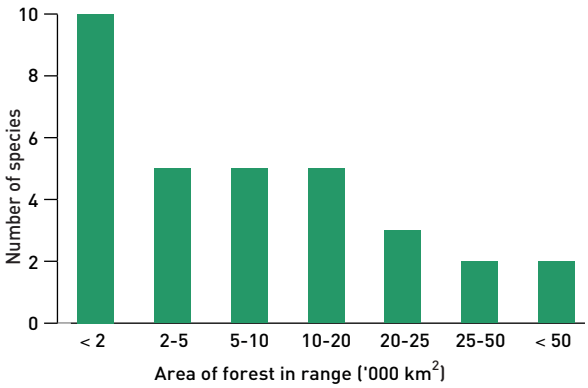

Figure 3. Number of bamboo species in Madagascar with different areas of forest remaining within their geographical ranges. Species that are dependent on forest and have less than 20 000 km^2 of forest in their ranges should be considered as threatened in any preliminary assessment of conservation status.

Although the bamboo lemurs are threatened by rainforest destruction, at least one group, the western grey bamboo lemur, may actually benefit from low levels of forest disturbance, which increase the density of bamboo. The grey bamboo lemurs are at relatively low risk (the eastern subspecies is classified as 'Lower Risk', and the western as 'Vulnerable'), but both the other two species are 'Critically Endangered' (Hilton-Taylor 2000).

Other animals besides lemurs are dependent on bamboo. There is a community of rainforest organisms that rely on so-called bamboo wells, cavities in fallen bamboo culms that fill with rainwater. Some use them for reproduction, others for shelter and to escape from potential predators. *Mantella laevigata*, a species of poison frog endemic to northeastern Madagascar, breeds in water-filled tree holes or broken bamboo. The frogs are found in association with *Bambusa vulgaris*, *Valiha diffusa* and other native bamboo species. The frogs' eggs often become food for other animals. For instance, crane flies (*Limonia renaudi*) lay eggs in the water of the same bamboo wells, and their larvae feed on the eggs of *Mantella* (Heying 2001).

The bamboo forests in the drier western part of Madagascar are the habitat of one of the most endangered reptiles in the world, which is also the rarest tortoise, the angonoka or ploughshare tortoise (*Geochelone yniphora*) (WWF 2003b).

Uses of bamboo

Bamboos are also extremely important to local communities in Madagascar. Nearly half of all households use bamboo domestically (Ferraro 2001): for construction and for items ranging from handicrafts to musical instruments. For example, the culms of *Valiha diffusa* are used for the construction of walls and roofs; they are split on one side and flattened, then woven into large panels. Bamboo is also used for flooring and fencing, and in irrigation systems. Water containers, fishing traps and poles, darts, baskets and storage containers are all made from a number of bamboo species. Culms of *Valiha* are used to make the traditional musical instrument, the tube zither or *valiha*, and those of another endemic genus, *Cathariostachys*, are used for making flutes (Dransfield 2000).

Much of the bamboo used domestically comes from secondary forests, and there are some plantations in and around villages. However, in some areas villages have depleted the available supply of bamboo nearby and residents must travel greater distances to obtain resources (Ferraro 2001).

Bamboo is traded domestically in Madagascar on a small scale, but not internationally.

Conservation and management

The destruction of native vegetation in Madagascar is a major problem, which has been recognized for a number of years. According to IUCN (1992), at least 80 per cent of the land surface of the island no longer has significant native woody plant cover. Green and Sussman (1990) calculated that all but 34 per cent of the eastern rainforests had been lost by 1985, and high rates of deforestation have continued. Conservation International estimates that less than 10 per cent of the original vegetation of Madagascar remains (Myers *et al*. 2000). The expansion of small-scale agriculture and the harvesting of wood for charcoal production and forest fires continue to threaten the remaining forests.

These alarming figures help to explain why so many of Madagascar's endemic woody bamboo species have little forest habitat remaining within their ranges. While some bamboos persist and may even proliferate in disturbed landscapes, others are less resilient and many of the species that depend on bamboos require a forest environment. Improving management of the 3 per cent of Madagascar currently officially protected (Conservation International 2003) should help to conserve many of the endemic bamboos. However more direct attention is needed to determine the conservation status of bamboo species and identify the priority actions for ensuring their conservation *in situ*.

BAMBOOS IN THE AMERICAS

The Americas are collectively much richer in bamboo species than either continental Africa or Madagascar, but have lower diversity than the Asia-Pacific region (Bystriakova *et al*. 2003a). There are currently 20 recognized genera of woody bamboos that are confined to the New World. Only *Arundinaria* occurs in both the Old and New Worlds. There are approximately 430 species of New World woody bamboos, of which more than 40 per cent belong to a single genus, *Chusquea* (Judziewicz *et al*. 1999).

The greatest diversity of bamboos in the New World is in South America. Brazil has nearly twice as many bamboo species as Venezuela and Colombia, which are in turn nearly twice as rich as the richest Mesoamerican countries (Costa Rica and Mexico; Table 3). The United States has only a single woody bamboo species, as do many Caribbean island nations.

Previous studies have identified the areas of highest bamboo diversity and endemism in the New World as Brazil, the northern and central Andes and Mexico, along with the still poorly known Guyana Highlands (Judziewicz *et al*. 1999). The results of our study confirm this and identify São Paulo state as the area with the

Table 3. Numbers of species of Bambuseae occurring in the countries of North, Central and South America

Country/Territory	No. of naturally occurring species	Country/Territory	No. of naturally occurring species	Country/Territory	No. of naturally occurring species
Brazil	134	Argentina	12	Uruguay	5
Venezuela	68	Guatemala	12	Suriname	4
Colombia	56	Honduras	8	Belize	3
Ecuador	41	El Salvador	7	Bahamas	1
Costa Rica	36	Haiti	7	Dominica	1
Peru	35	Nicaragua	7	French Guiana	1
Mexico	32	Trinidad and Tobago	7	Guadeloupe	1
Bolivia	20	Dominican Republic	6	Jamaica	1
Panama	19	Paraguay	6	Martinique	1
Chile	14	Guyana	5	United States	1
Cuba	13	Puerto Rico	5	Virgin Islands	1

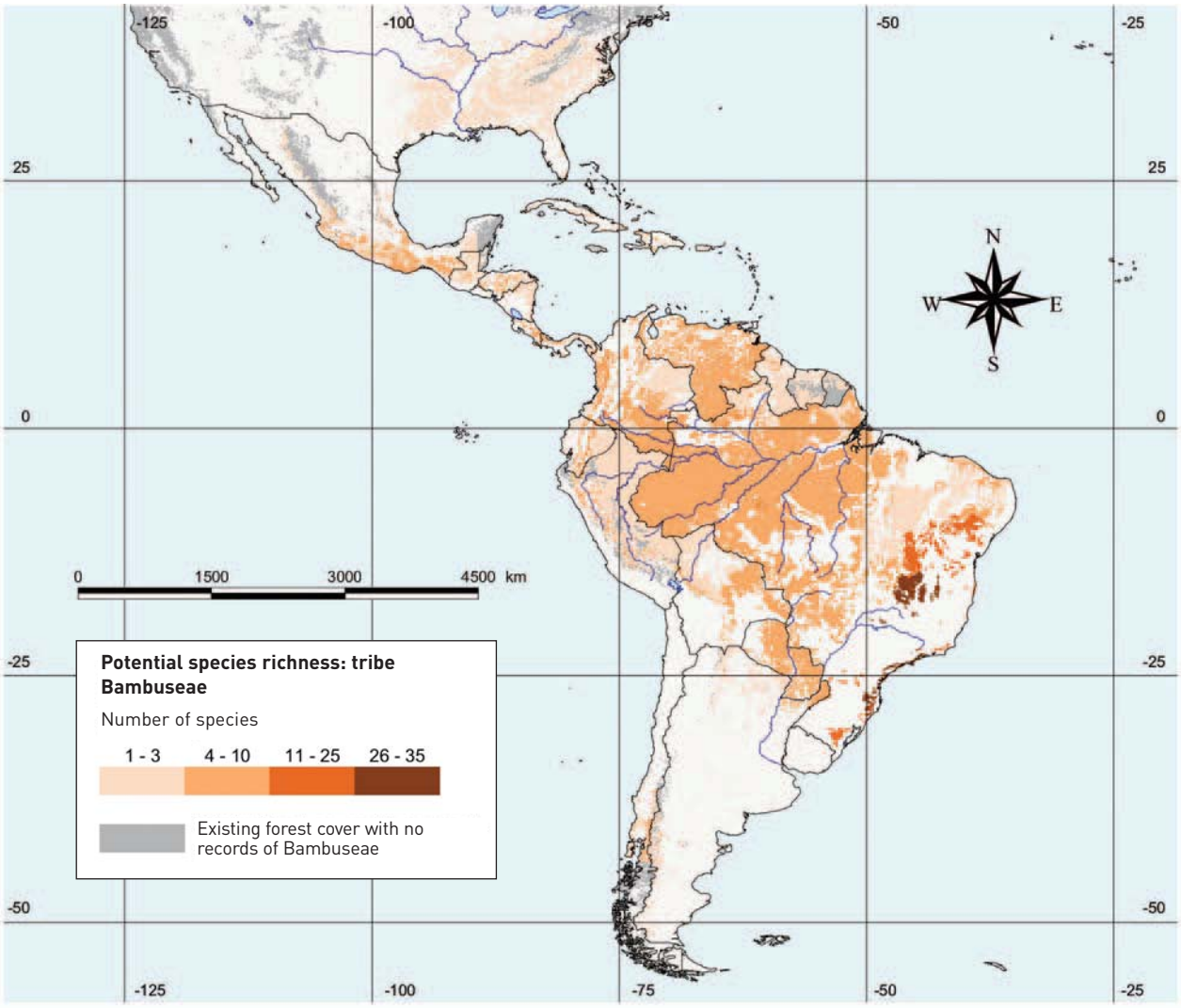

Figure 4. Map of potential species richness of woody bamboos in the Americas, derived by combining the distribution maps for 341 species native to the region.

largest number of potentially co-occurring woody bamboo species (35) (Figure 4).

At generic level, woody bamboo diversity appears to be concentrated in the Brazilian state of Minas Gerais (nine co-occurring genera), whereas other authors have reported higher generic diversity of all bamboos (woody and herbaceous combined) in the coastal state of Espírito Santo (Burman and Filgueiras 1993). Of the five monotypic genera in the Americas (*Arundinaria*, *Actinocladum*, *Athroostachys*, *Criciuma*, *Eremocaulon*), four coincide in an area covering the states of Mato Grosso, Bahia and Minas Gerais, Brazil (*Arundinaria* is distributed solely in the United States). This confirms the importance of the Atlantic Forest region for the diversity of woody bamboos in South America.

To a large degree, these patterns may reflect the state of knowledge as a result of the distribution of collecting effort (Burman and Filgueiras 1993), and the true pattern may yet prove to be somewhat different. However, they are consistent with suggestions that the Atlantic coastal zone may have provided diverse habitats that fostered bamboo evolution and/or facilitated bamboo survival during cold glacial maxima (Judziewicz *et al*. 1999).

Conservation and biodiversity importance

Currently, the IUCN Red List of 'Endangered' bamboos in the Americas comprises 20 species, among them 12 woody bamboos (see Annex II) (Gillet and Walter 1998; Hilton-Taylor 2000). The present study has identified nearly 200 New World woody bamboo species with less than 20 000 km^2 of forest remaining within their potential ranges (Annex IV). Ninety-five of these species occur where there are less than 2 000 km^2 of forest (Figure 5).

Throughout the Americas, woody bamboos are an important part of forested ecosystems and occur in almost homogeneous stands in some places. Bamboo-dominated areas in the Amazon region occupy between 121 000 and 180 000 km^2 (Nelson 1994; Judziewicz *et al*. 1999). This vegetation, which is dominated by bamboos of the genera *Guadua*, *Elytrostachys* and *Arthrostylidium*, is dense and often impenetrable because of the thorns of the bamboo. In northern South America, especially Colombia and Ecuador, the 'guadual' – dense bamboo forest dominated by *Guadua angustifolia* – is an important vegetation type at low to mid-altitude. This is often an important refuge for wildlife species from surrounding native hardwood forests that are being destroyed (Judziewicz *et al*. 1999).

The mechanism by which bamboos become dominant in these areas is unclear, though it is likely that clonal growth following disturbance by wind, fire and

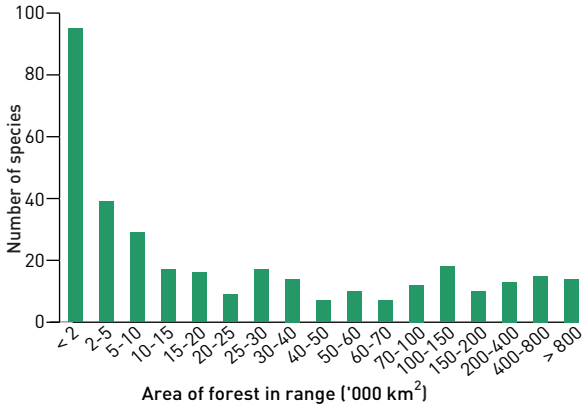

Figure 5. Number of bamboo species in the Americas with different areas of forest remaining within their geographical ranges. Species that are dependent on forest and have less than 20 000 km^2 of forest in their ranges should be considered as threatened in any preliminary assessment of conservation status.

landslips plays an important role. It has been suggested that bamboos may also significantly increase the potential for some types of natural disturbances (Keeley and Bond 1999). According to this hypothesis, mass mortality in bamboos after fruiting generates a widespread and synchronous fuel load that significantly increases the potential for wildfire. The resulting canopy disturbance both increases resources for seedling recruitment and resets the successional cycle to favour persistence of the new clones. The dense and rapid growth of woody bamboos may suppress the regeneration of other woody species (Clark 1995). The aggressive growth strategy of such species as *Guadua weberbaueri* and *G. sarcocarpa* can alter the normal forest succession process following small or large-scale forest disturbance. This may contribute to the high levels of endemism and species diversity evident in some regions where these species are prominent (Kirkby 2003). In some areas, woody bamboos have become invasive and dominate forest succession in abandoned cultivation, excluding regeneration of native tree species (WWF 2003c). Bamboos therefore play an important role in determining forest structure and dynamics.

Throughout the Americas, bamboo stands provide habitat and food for a wide range of mammals, birds, amphibians and invertebrates, many of which are of conservation concern. In South America, especially at higher altitudes and in the Atlantic Forest zone, several important mammals feed on bamboo. The spectacled bear (*Tremarctos ornatus*), which is classified as 'Vulnerable' by IUCN (Hilton-Taylor 2000), feeds opportunistically on

young shoots of bamboo (Judziewicz *et al*. 1999). 'Endangered' mountain tapirs (*Tapirus pinchaque*) eat considerable amounts of grasses, bamboo, sedges and bromeliads in their high-altitude habitats (Downer 1996). The 'Vulnerable' lowland tapir (*Tapirus terrestris*), which feeds on grasses and aquatic plants in the Amazon, consumes substantial amounts of bamboo leaves and twigs in the Atlantic Forest (Rodrigues *et al*. 1993).

At least four South American rodent species known as bamboo rats (*Dactylomys dactylinus*, *D. peruanus* and *D. boliviensis* in Amazonia and *Kannabateomys amblyonyx* in the Atlantic Forest) use bamboo patches as their principal habitat and also eat bamboo (Nowak 1995; Haemig 2003a,b).

At least 4-5 per cent of all the bird species that occur in Amazonia are dependent on bamboo, and 34 bird species are reported to be confined to bamboo thickets in at least one of the regions of Amazonia (Haemig 2003a). In the Atlantic Forest, which extends along the coast of eastern Brazil into neighbouring parts of Argentina and southeastern Paraguay, at least 27 bird species were reported to be confined almost entirely to large stands of bamboo, or most abundant where bamboo is common, or to forage most extensively on bamboo (Haemig 2003b). In at least one case, that of the uniform finch (*Haplospiza unicolor*), the life cycle of a bird species is synchronized with that of mast-seeding bamboos (*Chusquea* spp.), so that this finch breeds in the austral autumn rather than the austral spring (Haemig 2003b). Of the Atlantic Forest bird species associated with bamboo, 11 are of conservation concern (Table 4).

The water that accumulates in bamboo internodes provides important habitat for numerous invertebrates (Judziewicz *et al*. 1999) and some amphibians. Furthermore, evidence is emerging of complex ecological relationships between forest bamboos and ant species that inhabit their internodes and defend them from attack by herbivores (Davidson *et al*. 2003).

Canebrakes, dense stands of *Arundinaria gigantea*, were once widespread throughout the southeastern portion of the United States, where they provided shelter and resources for rare species such as the 'Critically Endangered' Bachmann's warbler (*Vermivora bachmanii*) and the now 'Extinct' Carolina Parakeet (*Conuropsis carolinensis*) (Judziewicz *et al*. 1999). Other species that rely on canebrakes include at least five species of butterfly, which require the cane as food during the caterpillar stage (Hendershott 2002). These important habitats have been much reduced by development, drainage and suppression of the fire regime that was important to their maintenance, with resulting adverse effects on the species that depend on them.

Table 4. Threatened bird species of the Atlantic Forest associated with bamboo

IUCN Red List status (Hilton-Taylor 2000)	Species
'Endangered'	Purple-winged ground-dove (*Claravis godefrida*)
	Fork-tailed tody-tyrant (*Hemitriccus furcatus*)
	Wied's tyrant-manakin (*Neopelma aurifrons*)
'Vulnerable'	Canebrake groundcreeper (*Clibanornis dendrocolaptoides*)
	White-bearded antshrike (*Biatas nigropectus*)
	Buffy-fronted seedeater (*Sporophila frontalis*)
	Temminck's seedeater (*Sporophila falcirostris*)
'Low Risk'/ 'Near Threatened'	White-browed foliage-gleaner (*Anabacerthia amaurotis*)
	Rufous-tailed antbird (*Drymophila genei*)
	Spotted bamboowren (*Psilorhamphus guttatus*)
	Blackish-blue seedeater (*Amaurospiza moesta*)

Source: After Haemig 2003b, IUCN http://www.birdlife.org/datazone/search/species_search.html.

Uses of bamboo

The Americas have never had a 'bamboo culture' in the way that Japan and China may be said to have had. The exploitation of native bamboo in Latin America is limited to the local use of species found close by. It is only in Colombia, Ecuador and Brazil that bamboo plays a more conspicuous role in the local economy (Londoño 2001). Nonetheless, bamboo is of local importance throughout the region, and many species are used.

The most useful species in Latin America are found in the genus *Guadua*, and there are several others in the native genera of *Apoclada*, *Aulonemia*, *Chusquea*, *Elytrostachys*, *Otatea* and *Rhipidocladum*. *Bambusa*, which has been introduced from Asia, is also extensively used. Cultivation of bamboos on a commercial scale is limited to only a few native (*Guadua angustifolia*, *G.*

German architect Jorg Stamm has successfully implemented several construction projects in Colombia. Among them is a bamboo bridge with a span of 52 m.

amplexifolia) and introduced (*Bambusa vulgaris*, *B. tuldoides*, *Phyllostachys aurea*) species (Londoño 2001).

Bamboo has a long history of use in construction in Central and South America, where it is a common part of the vernacular architecture. This is particularly widespread in southern Colombia and northern Ecuador, where bamboo (mostly *Guadua angustifolia*) has been extensively used in houses that have stood for 50-100 years on unstable sites such as steep slopes, earthquake-prone regions or swampy coastal areas that are frequently inundated (Gutierrez 2000).

Contemporary architects are also increasingly using bamboo. Through new techniques, bamboo has been combined with modern materials like reinforced concrete or steel to create some extraordinary structures including luxury housing, bridges and observation towers. These architects have made a deliberate attempt to increase social acceptance of bamboo and promote its adoption as an inexpensive and environmentally friendly building material among both rich and poor (Gutierrez 2000). Prefabricated panels made of flattened *Guadua* culms are distributed in Ecuador as part of low-cost housing programmes (Judziewicz *et al*. 1999).

Studies have been undertaken to explore the use of native South American bamboos for making paper, but the two *Guadua* species (*G. angustifolia* and *G. amplexifolia*) examined proved to have fibre lengths much inferior to *Bambusa vulgaris*. More than 100 000 ha of this introduced species are cultivated for paper production in Brazil, which is the only New World country to use bamboo for making paper (Judziewicz *et al*. 1999; Itapagé 2003).

Throughout the Americas indigenous people use woody bamboos to make handicrafts and musical instruments. Baskets, fans, utensils, toys, furniture and agricultural supports are all made from bamboos of different types. Musical instruments ranging from flutes to drums are also produced from bamboo. In particular, the pan pipes and quena flutes so characteristic of Andean music are made from cloud-forest bamboos, either *Aulonemia queko* or *Rhipidocladum harmonicum* (Judziewicz *et al*. 1999).

Though to a much lesser extent than in Asia, bamboos are a source of food both for humans and for livestock in the Americas. Indigenous groups eat the fruits and seeds of several species, and some use of bamboo shoots as food has been reported (Judziewicz *et al*. 1999). The bamboo of North American canebrakes has long been recognized as an especially rich forage and was much prized for this purpose by both aboriginal and colonial pastoralists (Hendershott 2002).

Annex III provides a summary based on published literature of the most used woody bamboos of the Americas and the purposes to which they are put in different parts of the region.

Conservation and management

In many parts of the New World, forest ecosystems were destroyed long ago or are currently under threat. The forests of the southeast United States were severely depleted during colonial times and reached their minimum extent around 1860. The rapid rate of forest loss in the Amazon has been well publicized in recent years. While vast tracts of forest still remain, the rate of deforestation has recently increased again (INPE 2002). The Atlantic Forest has been reduced to less than 8 per cent of its original area and is under continuing threat (Burman and Filgueiras 1993; Myers *et al*. 2000). These trends help to explain the high proportion of American bamboos that now have very limited areas of forest within their ranges.

These results suggest that many woody bamboos in the Americas are potentially threatened if they depend on forest habitat for their survival, and that carefully planned and implemented conservation measures are needed to ensure the continued survival of many bamboo species. Bamboo-dominated ecosystems need to be carefully assessed and monitored to ensure that their status is thoroughly understood and that measures are taken to protect them where needed. For example, forested canebrake communities in the United States are now listed as 'Critically Rare' by the National Biological Survey and as 'Globally Rare' by the Nature Conservancy (Hendershott 2002), prompting increased efforts for their protection and restoration. In other cases, the ecology of native bamboos as invasives in disturbed landscapes needs further investigation as does their role in

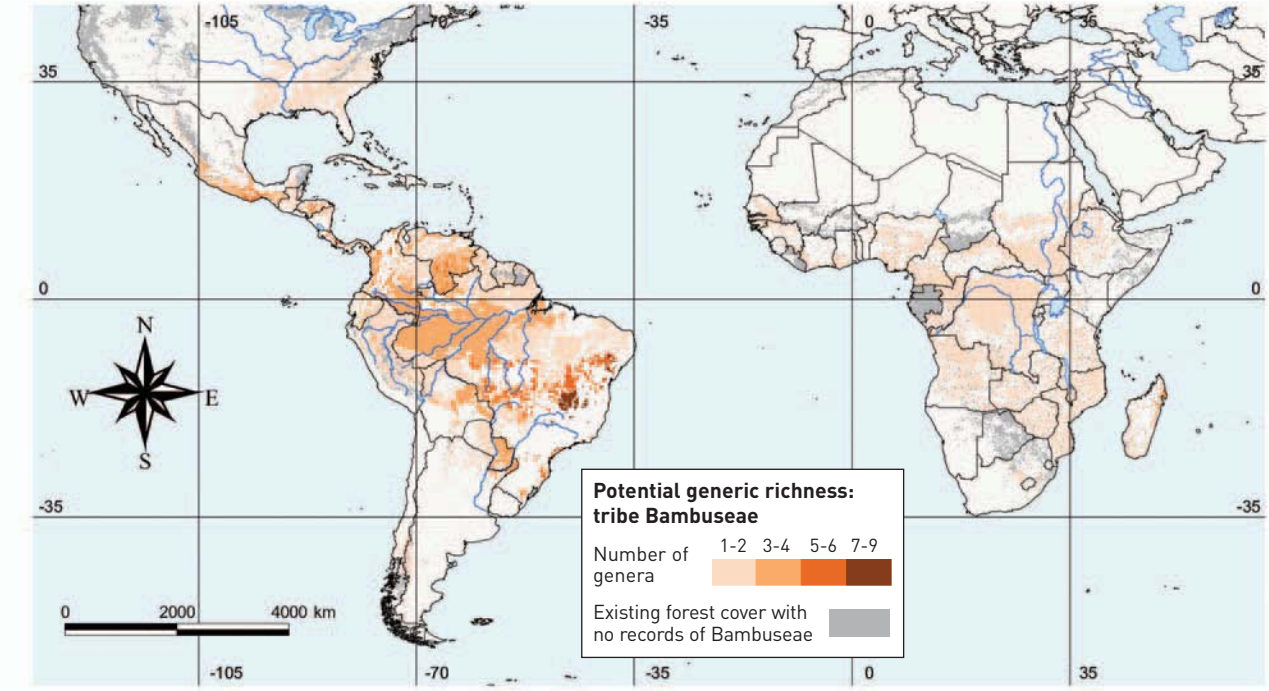

Figure 6. Distribution of potential generic richness of woody bamboos across the three study regions, derived by combining the distributions of 37 genera, and showing the strong concentration of generic diversity in eastern Brazil.

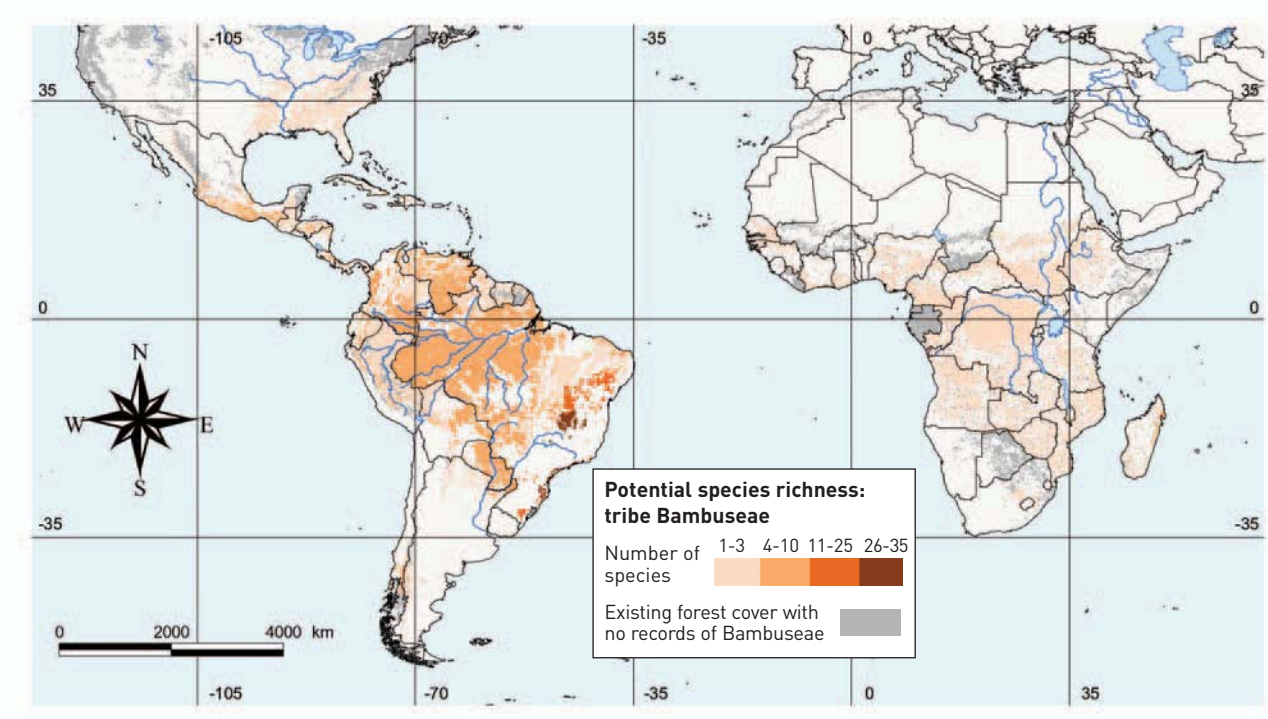

Figure 7. Distribution of potential species richness of woody bamboos across the three study regions, derived by combining the distributions of 379 species, and showing a pattern similar but not identical to that of generic richness.

The bamboo forests in western Madagascar are home to the world's rarest tortoise, the 'Endangered' angonoka or ploughshare tortoise (*Geochelone niphora*).

maintaining the dynamics and diversity of natural forests in this region.

CONCLUSIONS AND SUGGESTIONS FOR FURTHER WORK

This study has shown that many woody bamboos in Africa, Madagascar and the Americas may be of conservation concern, despite the fact that they are not presently included in global Red Lists. It has highlighted the richness and distinctiveness of the bamboos of Madagascar and the even greater richness of the Americas at both generic and species levels (Figures 6 and 7). The study has also made it clear that significant further effort will be required to assemble an accurate overview of the magnitude and distribution of woody bamboo resources in these regions. Such information is needed to support wise policy-making and management decisions, and to facilitate progress towards the conservation and management targets of the *Global Strategy for Plant Conservation* (CBD 2002). The actions needed to progress towards such a sound information base include:

1. Refining and validating species distributions based on (a) comparisons with the rapidly increasing digital resources of herbarium specimen data, and (b) incorporating climatic and soil data to improve species distribution models.

2. Strengthening the Red List assessments of bamboo species status, prioritizing the assessment of those species with the smallest estimated geographical ranges and least remaining habitat.

3. Extending the global list of priority bamboo species (cf. Rao *et al*. 1998) to take account of the utility and/or economic importance of bamboos from Africa, Madagascar and the Americas.

4. Filling information gaps, including taxonomic inconsistencies and inadequate knowledge of the distribution of woody bamboo species, and clarifying the ecological roles of woody bamboos, through research-based, national capacity-building and international collaboration.

5. Developing appropriate methods for assessing bamboo resources and the pressures on them, and incorporating these methods into NTFP elements of national forest inventories.

6. Assessing the value of existing reserves and reserve networks for conserving the biological diversity of bamboos.

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Annex I: Subtribes and genera of woody bamboos occurring naturally in Africa, Madagascar and the Americas

Subtribe	Genus	No. of species as in Ohrnberger, 1999	Distribution
Arundinariinae	*Arundinaria*	1	North America
Thamnocalaminae	*Thamnocalamus*	2	South Africa and Madagascar
	Yushania	6	Tropical Africa and Madagascar
Bambusinae	*Bambusa*	1	Madagascar
	Oreobambos	1	Tropical Africa
	Oxytenanthera	1	Tropical Africa
Melocanninae	*Cephalostachyum*	5	Madagascar
	Ochlandra	2	Madagascar
	Schizostachyum	3	Madagascar
Hickelinae	*Decaryochloa*	1	Madagascar
	Hickelia	4	Tropical Africa and Madagascar
	Hitchcockella	1	Madagascar
	Nastus	12	Madagascar
	Perrierbambus	2	Madagascar
Guaduinae	*Criciuma*	1	South America
	Eremocaulon	1	South America
	Guadua	37	Central and South America
	Olmeca	2	Central America
	Otatea	2	Central America
Chusqueinae	*Chusquea*	138	Central and South America
	Neurolepis	22	Central and South America
Arthrostylidiinae	*Actinocladum*	1	South America
	Alvimia	3	South America
	Apoclada	3	South America
	Arthrostylidium	22	Central and South America
	Athrostachys	1	South America
	Atractantha	5	South America
	Aulonemia	33	Central and South America
	Colanthelia	7	South America
	Elytrostachys	3	Central and South America
	Glaziophyton	1	South America
	Merostachys	34	Central and South America
	Myriocladus	13	South America
	Rhipidocladum	19	Central and South America

Source: according to Ohrnberger (1999). Dransfield (2000, 2002) has distinguished a further three genera from Madagascar.

Annex II: Bamboo species on the *1997 IUCN Red List of Threatened Plants*

Species name	Status	Distribution	Type
Chusquea aperta	Vulnerable	Mexico	Woody
Chusquea bilimekii	Vulnerable	Mexico	Woody
Chusquea fernandeziana	Vulnerable	Juan Fernandez	Woody
Chusquea latifolia	Endangered	Colombia	Woody
Chusquea longiligulata	Vulnerable	Costa Rica	Woody
Chusquea pohlii	Endangered	Costa Rica	Woody
Cryptochloa decumbens	Vulnerable	Panama	Herbaceous
Cryptochloa dressleri	Vulnerable	Panama	Herbaceous
Froesiochloa boutelouoides	Endangered	French Guiana	Herbaceous
Guadua calderoniana	Endangered	Brazil	Woody
Olmeca recta	Indeterminate	Mexico	Woody
Olmeca reflexa	Indeterminate	Mexico	Woody
Olyra filiformis	Endangered	Brazil	Herbaceous
Olyra latispicula	Endangered	Brazil	Herbaceous
Pariana parvispica	Vulnerable	Costa Rica	Herbaceous
Pariana strigosa	Endangered	Panama	Herbaceous
Rhipidocladum clarkiae	Endangered	Costa Rica	Woody
Rhipidocladum maxonii	Vulnerable	Costa Rica	Woody
Rhipidocladum pacuarense	Endangered	Costa Rica	Woody
Streptochaeta angustifolia	Extinct*	Brazil	Herbaceous
Thamnocalamus tessellatus	Rare	South Africa	Woody

* Taxa that are known no longer to exist in the wild after repeated searches of the type localities and other known or likely places.

Source: Gillet and Walter 1998.

Annex III: Useful native species of bamboo in Africa, Madagascar and the Americas

Table A. Useful native species of bamboo in Africa and Madagascar

Species name	Uses	Distribution
Bambusa vulgaris	Multiple uses	Madagascar
Cathariostachys madagascariensis	Water containers	Madagascar
Hickelia madagascariensis	Baskets	Madagascar
Oreobambos buchwaldii	Construction (80%), weaving (20%)	Africa, East
Oxytenanthera abyssinica	Wine (85%), construction (15%)	Africa
Valiha diffusa	Construction, musical instruments	Madagascar
Yushania alpina	Weaving (70%), construction (20%), furniture (5%), household items (5%)	Africa, East

Table B. Useful species of bamboo in the Americas

Species name	Uses	Distribution
Actinocladum verticillatum	Forage for cattle, skewers for barbecues, arrows by Indians	Brazil
Apoclada simplex	Construction, forage	Brazil
Arthrostylidium venezuelae	Basketry, crafts	Brazil, Costa Rica, Venezuela
Arundinaria gigantea	Fishing rods, basketry, mats, scaffolding, fodder	United States
Aulonemia longiaristata	Basketry	Colombia, Ecuador
Aulonemia patula	Construction, crafts	Colombia, Ecuador
Aulonemia queko	Ceiling rafters, musical instruments, crafts	Bolivia, Colombia, Ecuador
Chusquea culeou	Horticulture	Argentina, Chile
Chusquea longifolia	n/a	Guatemala
Chusquea nelsonii	n/a	Guatemala
Chusquea pittieri	Christmas decorations	Costa Rica
Chusquea scandens	Crafts	Colombia, Ecuador
Elytrostachys clavigera	Weaving	Costa Rica
Elytrostachys typica	Ceiling rafters	Colombia
Guadua amplexifolia	Construction	Colombia, Honduras, Mexico, Nicaragua, Venezuela
Guadua angustifolia	Construction	Central and South America
Guadua chacoensis	Construction	Argentina, Paraguay
Guadua glomerata	Crafts	French Guiana, Guyana, Suriname
Guadua latifolia	Crafts	French Guiana, Guyana, Suriname
Guadua longifolia	Various purposes	Mexico
Guadua macrostachya	Construction	Brazil, French Guiana, Guyana, Suriname
Guadua paniculata	Ceiling rafters	Bolivia, Honduras, Mexico, Paraguay
Guadua sarcocarpa	Construction	Peru
Guadua superba	Construction	Bolivia, Brazil, Colombia, Ecuador, Peru
Guadua tagoara	Ceiling rafters	Brazil
Guadua trinii	Construction	Argentina, Brazil, Uruguay
Guadua velutina	Construction	Mexico
Guadua weberbaueri	Ceiling rafters	French Guiana, Guyana, Peru, Suriname
Merostachys spp.	Handicrafts, basketwork, small-scale construction	Brazil
Neurolepis aperta	Roof-thatching	Colombia
Otatea acuminata	Crafts	Mexico
Otatea fimbriata	n/a	Honduras
Rhipidocladum geminatum	Crafts	Colombia, Ecuador
Rhipidocladum harmonicum	Musical instruments	Bolivia
Rhipidocladum racemiflorum	Crafts	Colombia, Ecuador

n/a: no information available

Source for both tables: Burman and Filgueiras 1993; Chihongo et al. *2000; Dransfield 2000; Judziewicz* et al. *1999; Londoño 2001; Ohrnberger 1999; Rao* et al. *1998.*

Annex IV: Woody bamboo species of Africa, Madagascar and the Americas with <20 000 km^2 of forest remaining within their ranges

0-500 KM^2 FOREST REMAINING WITHIN RANGE

Arthrostylidium angustifolium
Arthrostylidium banaoense
Arthrostylidium longiflorum
Arthrostylidium obtusatum
Arthrostylidium reflexum
Aulonemia chimantaensis
Aulonemia hirtula
Aulonemia humillima
Aulonemia laxa
Aulonemia patriae
Aulonemia purpurata
Aulonemia steyermarkii
Chusquea amistadensis
Chusquea caparaoensis
Chusquea deflexa
Chusquea effusa
Chusquea fernandeziana
Chusquea inamoena
Chusquea linearis
Chusquea longiligulata
Chusquea loxensis
Chusquea perligulata
Chusquea riosaltensis
Chusquea spathacea
Chusquea straminea
Chusquea subtessellata
Chusquea subtilis
Chusquea tomentosa
Chusquea tonduzii
Chusquea virgata
Chusquea vulcanalis
Guadua glaziovii
Hickelia perrieri
Merostachys polyantha
Myriocladus distantiflorus
Myriocladus involutus
Myriocladus neblinaensis
Myriocladus paludicolus
Myriocladus purpureus
Myriocladus steyermarkii
Myriocladus variabilis
Myriocladus wurdackii
Nastus tsaratananensis
Neurolepis asymmetrica
Neurolepis diversiglumis
Neurolepis laegaardii
Neurolepis stuebelii
Neurolepis tessellata
Neurolepis villosa
Rhipidocladum clarkiae
Rhipidocladum longispiculatum
Rhipidocladum panamense
Schizostachyum perrieri
Yushania humbertii
Yushania madagascariensis
Yushania marojejyensis

501-1 000 KM^2 FOREST REMAINING WITHIN RANGE

Arthrostylidium judziewiczii
Aulonemia pumila
Aulonemia viscosa
Chusquea deficiens
Chusquea maclurei
Chusquea talamancensis
Nastus ambrensis
Neurolepis nana
Neurolepis pittieri
Rhipidocladum maxonii

1 001-5 000 KM^2 FOREST REMAINING WITHIN RANGE

Alvimia auriculata
Alvimia gracilis
Alvimia lancifolia
Arthrostylidium distichum
Arthrostylidium ekmanii
Arthrostylidium fimbriatum
Arthrostylidium merostachyoides
Arthrostylidium pinifolium
Atractantha falcata
Atractantha radiata

Aulonemia amplissima
Aulonemia clarkiae
Aulonemia herzogiana
Aulonemia jauaensis
Aulonemia longiaristata
Aulonemia robusta
Aulonemia subpectinata
Aulonemia ulei
Cephalostachyum peclardii
Chusquea albilanata
Chusquea angustifolia
Chusquea barbata
Chusquea bilimekii
Chusquea delicatula
Chusquea depauperata
Chusquea erecta
Chusquea foliosa
Chusquea huantensis
Chusquea ibiramae
Chusquea leonardiorum
Chusquea ligulata
Chusquea neurophylla
Chusquea nudiramea
Chusquea palenae
Chusquea pohlii
Chusquea polyclados
Chusquea pulchella
Chusquea scabra
Chusquea smithii
Chusquea tarmensis
Chusquea tuberculosa
Chusquea wilkesii
Criciuma asymmetrica
Colanthelia rhizantha
Decaryochloa diadelpha
Elytrostachys typica
Guadua calderoniana
Hickelia africana
Merostachys argyronema
Merostachys filgueirasii
Merostachys glauca
Merostachys kleinii
Merostachys latifolia
Merostachys pauciflora
Merostachys pilifera
Myriocladus affinis
Myriocladus churunensis
Myriocladus confertus
Myriocladus exsertus
Myriocladus gracilis
Myriocladus longiramosus
Myriocladus maguirei
Myriocladus simplex
Nastus decaryanus
Nastus humbertianus
Nastus lokohoensis
Nastus manongarivensis
Nastus perrieri
Neurolepis acuminatissima
Neurolepis angusta
Neurolepis aristata
Neurolepis fimbriligulata
Neurolepis glomerata
Neurolepis mollis
Neurolepis petiolata
Neurolepis rigida
Neurolepis virgata
Neurolepis weberbaueri
Ochlandra perrieri
Rhipidocladum martinezii
Rhipidocladum pacuarense
Rhipidocladum prestoei
Yushania ambositrensis
Yushania perrieri

5 001 - 10 000 KM^2 FOREST REMAINING WITHIN RANGE

Arthrostylidium cubense
Arthrostylidium excelsum
Arthrostylidium urbanii
Arthrostylidium youngianum
Aulonemia gueko
Aulonemia radiata
Aulonemia ramosissima
Aulonemia setigera
Cephalostachyum perrieri
Chusquea abietifolia
Chusquea andina
Chusquea breviglumis
Chusquea falcata
Chusquea glauca
Chusquea latifolia
Chusquea lehmannii subsp. *Lehmannii*
Chusquea longipendula
Chusquea lorentziana
Chusquea nutans
Chusquea patens
Chusquea sclerophylla
Chusquea sneidernii
Chusquea spadicea
Chusquea urelytra

Chusquea wettsteinii
Guadua longifimbriata
Guadua ribbentropii
Hickelia alaotrensis
Merostachys retrorsa
Myriocladus paruensis
Nastus emirnensis
Nastus madagascariensis
Perrierbambus madagascariensis
Rhipidocladum geminatum

10 001 - 15 000 KM^2 FOREST REMAINING WITHIN RANGE

Apoclada cannavieira
Arthrostylidium haitiense
Arthrostylidium schomburgkii
Aulonemia effusa
Chusquea exasperata
Chusquea grandiflora
Chusquea lehmannii subsp. *farinosa*
Chusquea leptophylla
Chusquea longifolia
Chusquea muelleri
Chusquea peruviana
Chusquea purdieana
Chusquea subulata
Chusquea tenuiflora
Merostachys magellanica
Myriocladus cardonae
Nastus elongatus
Olmeca recta
Schizostachyum parvifolium

15 001 - 20 000 KM^2 FOREST REMAINING WITHIN RANGE

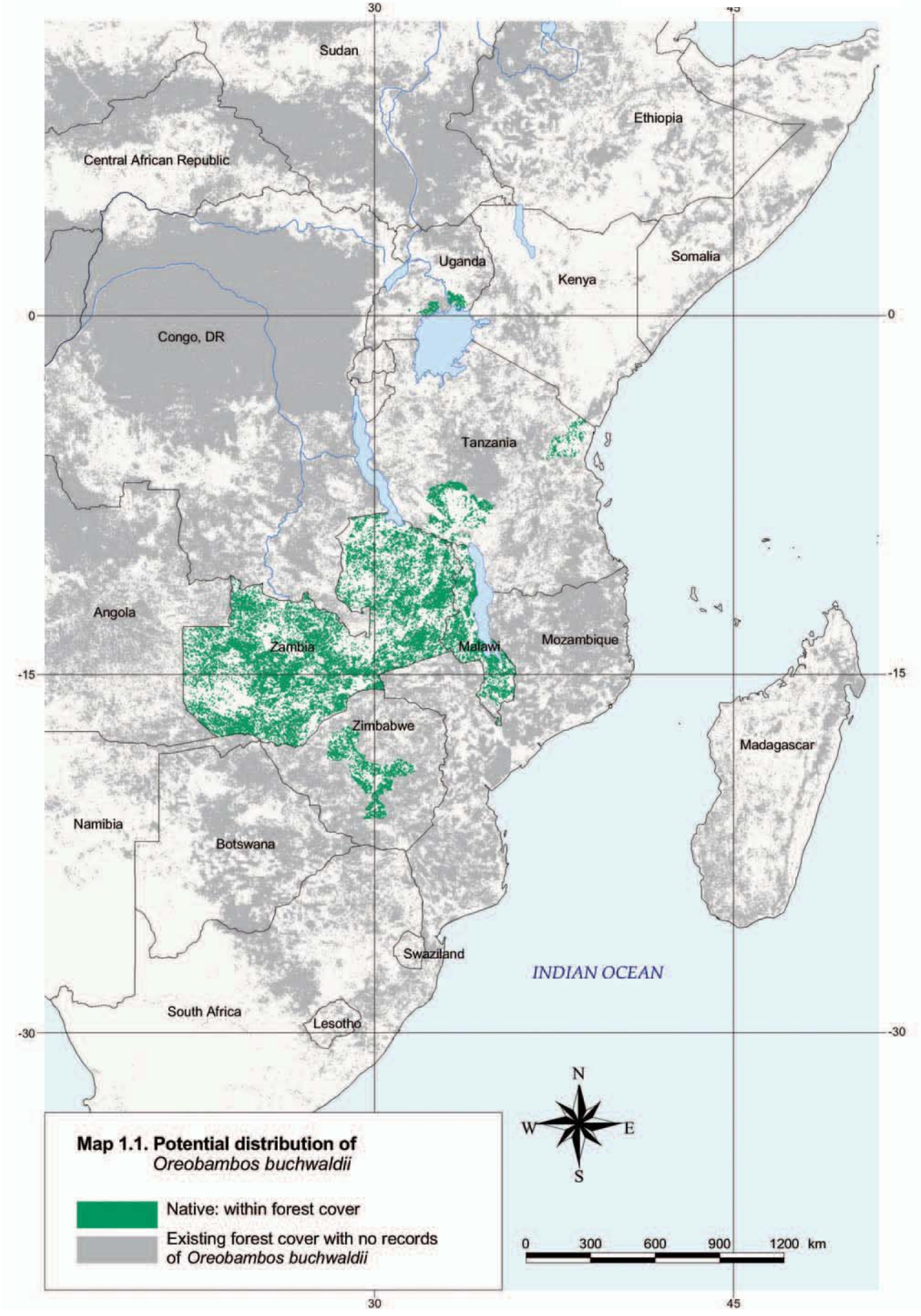
Arthrostylidium ecuadorense
Aulonemia haenkei
Aulonemia parviflora
Cephalostachyum madagascariense
Cephalostachyum viguieri
Chusquea anelytroides
Chusquea aspera
Chusquea cumingii
Chusquea londoniae
Chusquea nelsonii
Chusquea repens
Colanthelia macrostachya
Merostachys abadiana
Merostachys burchellii
Merostachys caucaiana
Merostachys fischeriana
Merostachys kunthii
Merostachys scandens
Ochlandra capitata

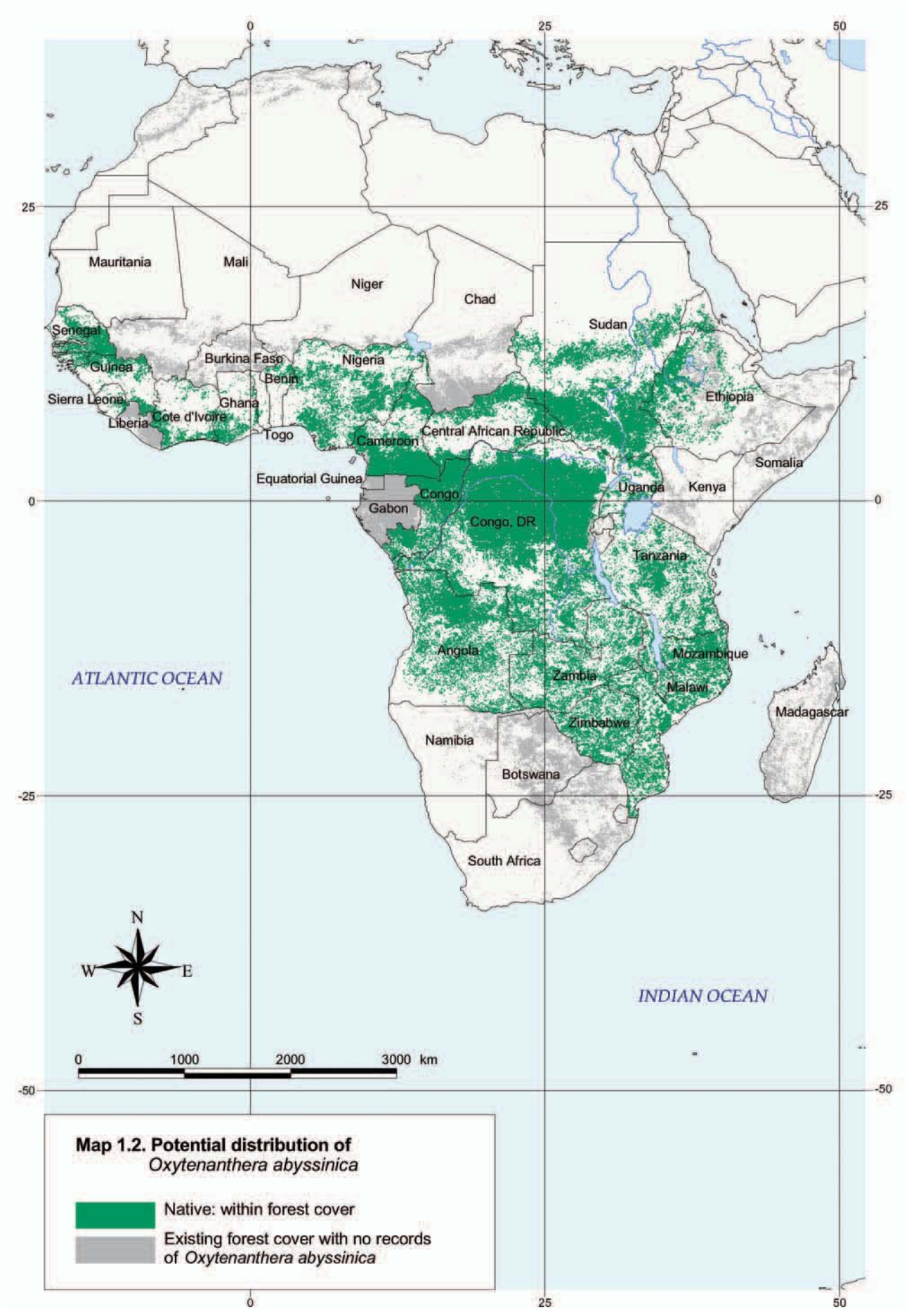
Annex V: Maps of potential distributions of woody bamboos in Africa, Madagascar and the Americas

Nine maps (highlighted purple) show potential distributions within remaining forest and species richness of selected genera. The remaining maps are of species that are useful (highlighted green), on current global Red Lists (brown), representative of monotypic genera, or have <20,000 km^2 of forest remaining within their ranges. Where more than one of these categories applies it is indicated in the comments column of the list.

Map no.	Genera/Species	Region	Comments
1.1	*Oreobambos buchwaldii*	Africa	Useful
1.2	*Oxytenanthera abyssinica*	Africa	Useful
1.3	*Thamnocalamus tessellatus*	Africa	IUCN Red List
1.4	*Yushania alpina*	Africa	Useful
2.1	*Nastus*	Madagascar	Genus
2.2	*Bambusa vulgaris*	Madagascar	Useful
2.3	*Cephalostachyum viguieri*	Madagascar	Less than 20 000 km^2 of remaining habitat
2.4	*Decaryochloa diadelpha*	Madagascar	Monotypic genus, less than 20 000 km^2 of remaining habitat
2.5	*Hickelia madagascariensis*	Madagascar	Useful
2.6	*Hitchcockella baronii*	Madagascar	Monotypic genus
3.1	*Arthrostylidium*	America	Genus
3.2	*Aulonemia*	America	Genus
3.3	*Chusquea*	America	Genus
3.4	*Guadua*	America	Genus
3.5	*Merostachys*	America	Genus
3.6	*Myriocladus*	America	Genus
3.7	*Neurolepis*	America	Genus
3.8	*Rhipidocladum*	America	Genus
3.9	*Actinocladum verticillatum*	America	Useful
3.10	*Apoclada simplex*	America	Useful
3.11	*Arthrostylidium venezuelae*	America	Useful
3.12	*Arundinaria gigantea*	America	Useful
3.13	*Athroostachys capitata*	America	Monotypic genus
3.14	*Aulonemia longiaristata*	America	Useful, less than 20 000 km^2 of remaining habitat
3.15	*Aulonemia patula*	America	Useful
3.16	*Chusquea aperta*	America	IUCN Red List
3.17	*Chusquea culeou*	America	Useful
3.18	*Chusquea latifolia*	America	IUCN Red List
3.19	*Chusquea longifolia*	America	Useful, less than 20 000 km^2 of remaining habitat
3.20	*Chusquea longiligulata*	America	IUCN Red List
3.21	*Chusquea nelsonii*	America	Useful, less than 20 000 km^2 of remaining habitat
3.22	*Chusquea pittieri*	America	Useful
3.23	*Chusquea pohlii*	America	IUCN Red List
3.24	*Chusquea scandens*	America	Useful
3.25	*Criciuma asymmetrica*	America	Monotypic genus, less than 20 000 km^2 of remaining habitat
3.26	*Elytrostachys clavigera*	America	Useful

3.27	*Eremocaulon aureofimbriatum*	America	Monotypic genus
3.28	*Guadua amplexifolia*	America	Useful
3.29	*Guadua angustifolia*	America	Useful
3.30	*Guadua glomerata*	America	Useful
3.31	*Guadua latifolia*	America	Useful
3.32	*Guadua longifolia*	America	Useful
3.33	*Guadua macrostachya*	America	Useful
3.34	*Guadua paniculata*	America	Useful
3.35	*Guadua tagoara*	America	Useful
3.36	*Guadua trinii*	America	Useful
3.37	*Guadua velutina*	America	Useful
3.38	*Neurolepis aperta*	America	Useful
3.39	*Olmeca recta*	America	IUCN Red List
3.40	*Olmeca reflexa*	America	IUCN Red List
3.41	*Otatea acuminata*	America	Useful
3.42	*Otatea fimbriata*	America	Useful
3.43	*Rhipidocladum clarkiae*	America	IUCN Red List
3.44	*Rhipidocladum harmonicum*	America	Useful
3.45	*Rhipidocladum maxonii*	America	IUCN Red List
3.46	*Rhipidocladum pacuarense*	America	IUCN Red List

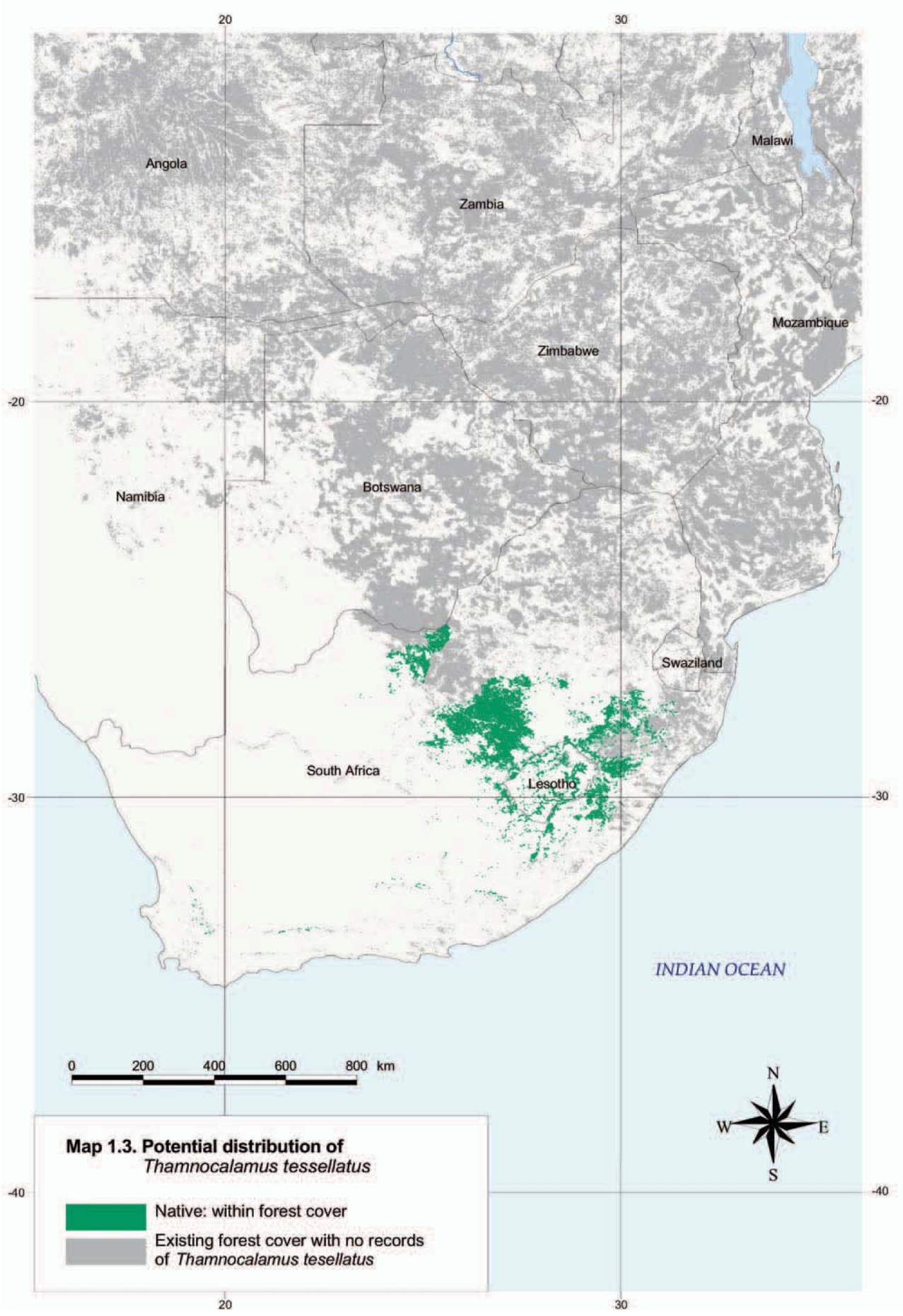

30
45
Sudan
Ethiopia
Central African Republic
Uganda
Somalia
Kenya
0
0
Congo, DR
Tanzania
Angola
Zambia
Malawi
Mozambique
-15
-15
Zimbabwe
Madagascar
Namibia
Botswana
Swaziland
INDIAN OCEAN
South Africa
Lesotho
-30
-30
30
45
N
W
E
S
0 300 600 900 1200 km
Map 1.1. Potential distribution of
Oreobambos buchwaldii
Native: within forest cover
Existing forest cover with no records
of Oreobambos buchwaldii



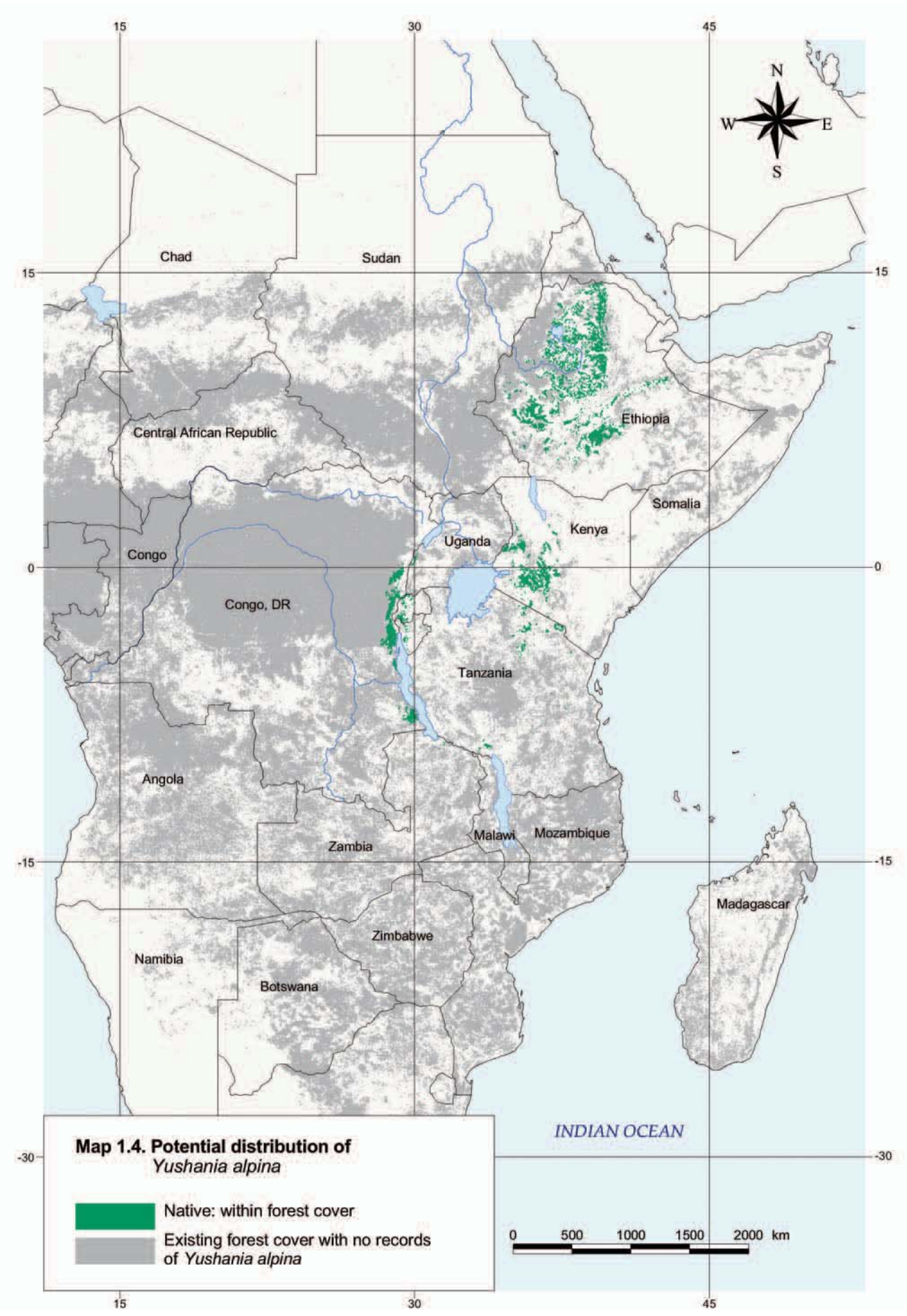
Map 1.2. Potential distribution of *Oxytenanthera abyssinica*

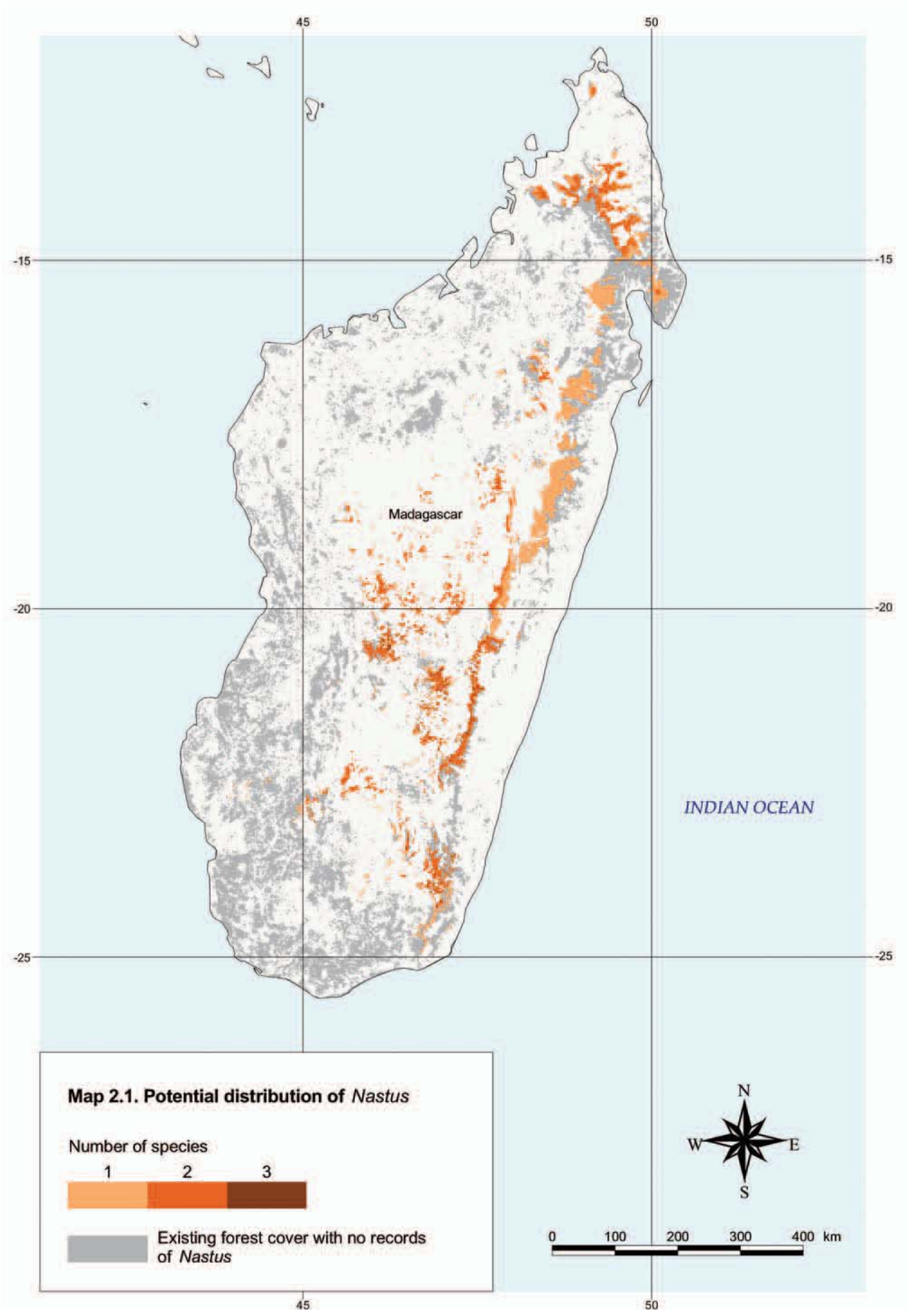
Native: within forest cover

Existing forest cover with no records of *Oxytenanthera abyssinica*

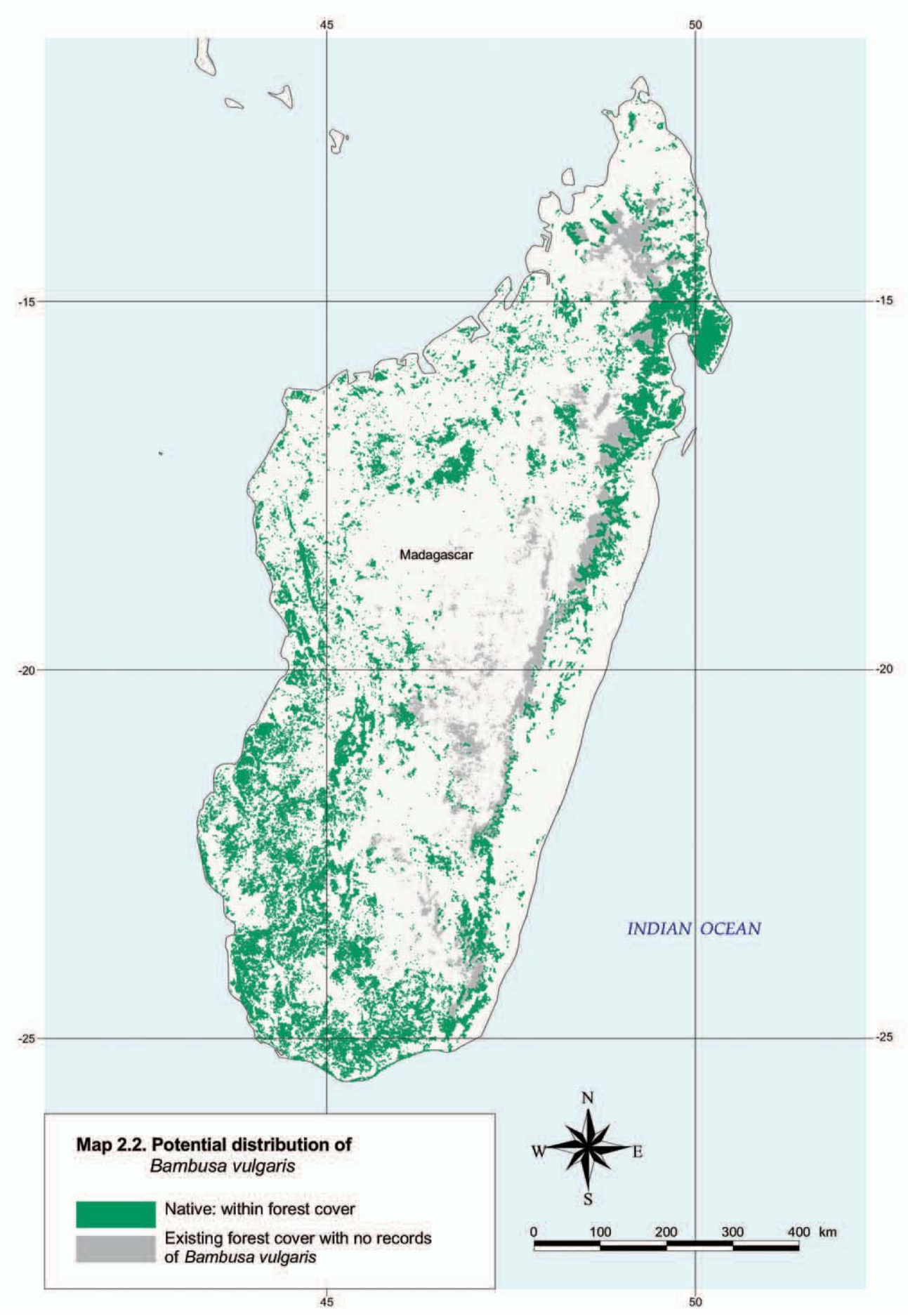


Map 1.3. Potential distribution of *Thamnocalamus tessellatus*

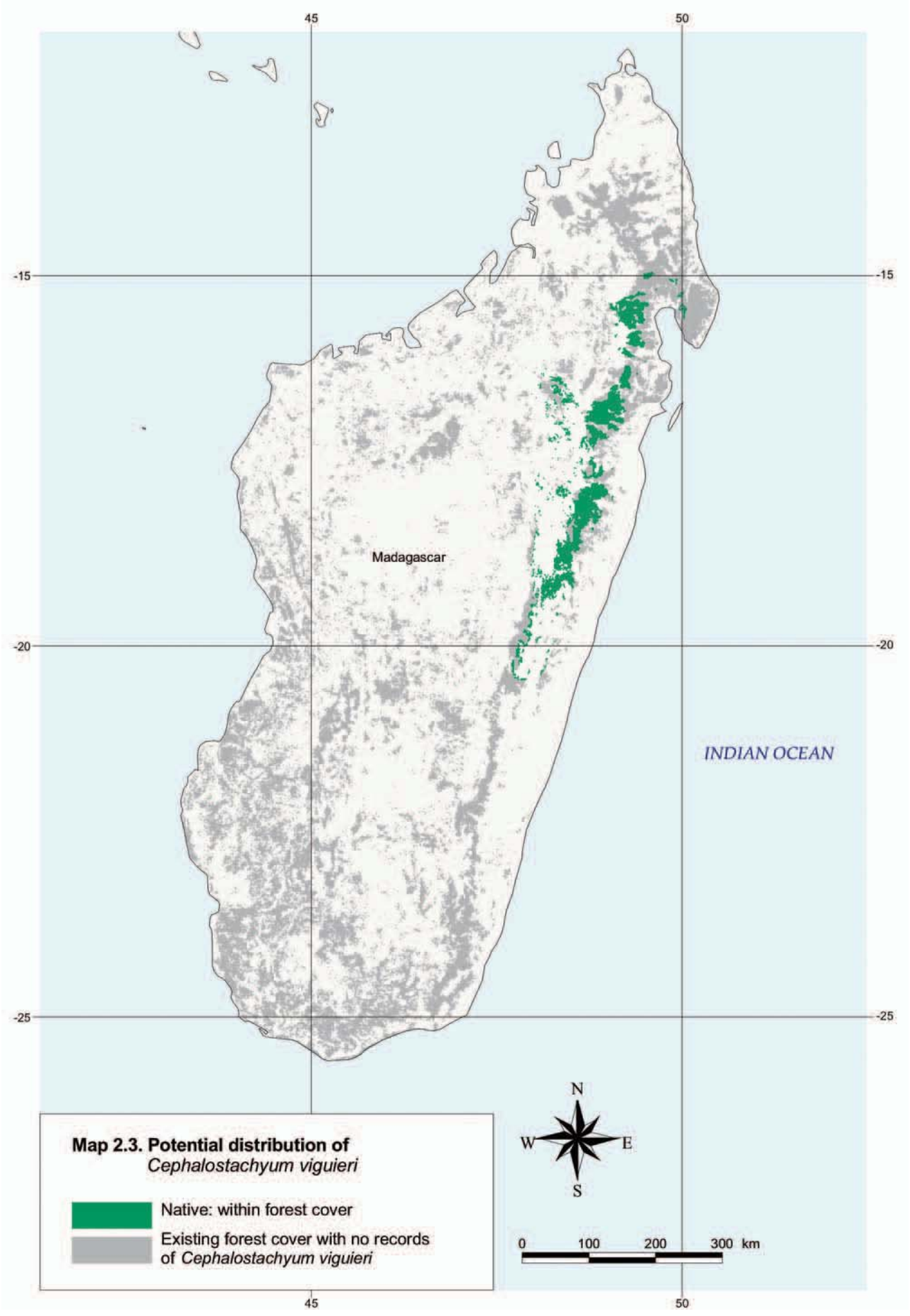

15
30
45
N
W
E
S
Chad
Sudan
15
Central African Republic
Ethiopia
Somalia
Kenya
Uganda
Congo
0
Congo, DR
Tanzania
Angola
Malawi
Mozambique
Zambia
-15
Madagascar
Zimbabwe
Namibia
Botswana
INDIAN OCEAN
-30
Map 1.4. Potential distribution of
Yushania alpina
Native: within forest cover
Existing forest cover with no records
of Yushania alpina
0 500 1000 1500 2000 km



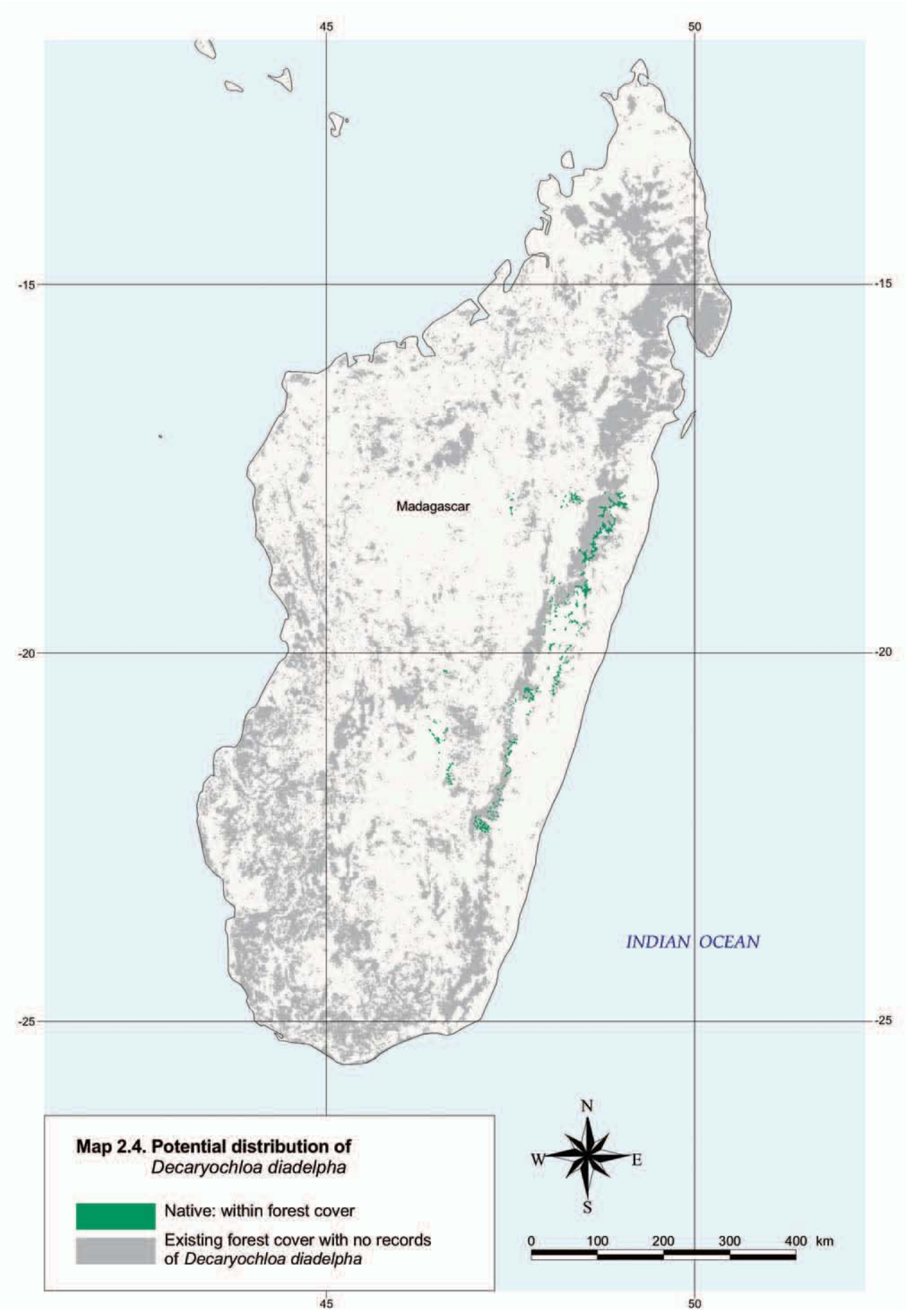
Map 2.1. Potential distribution of *Nastus*



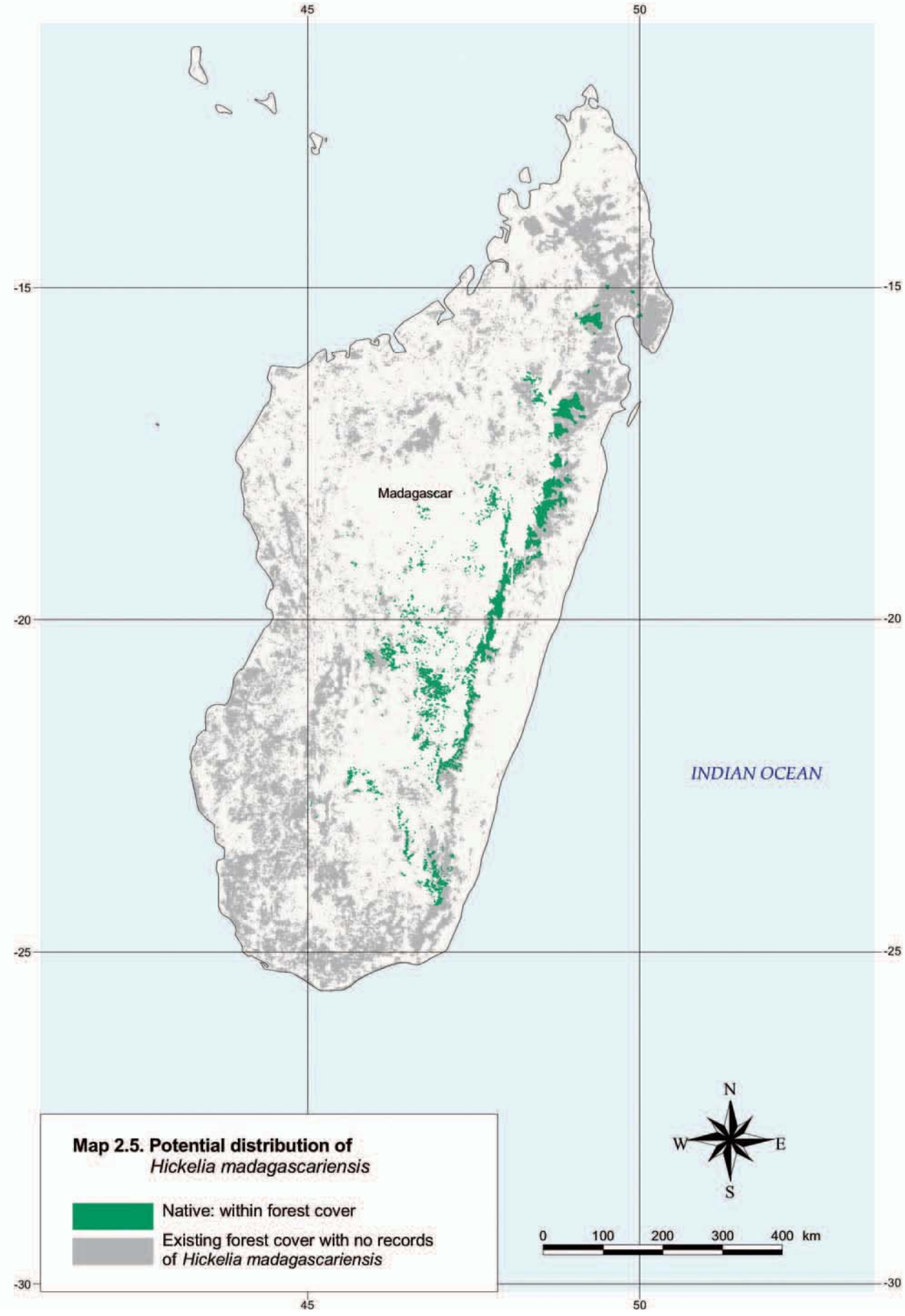
Map 2.2. Potential distribution of *Bambusa vulgaris*



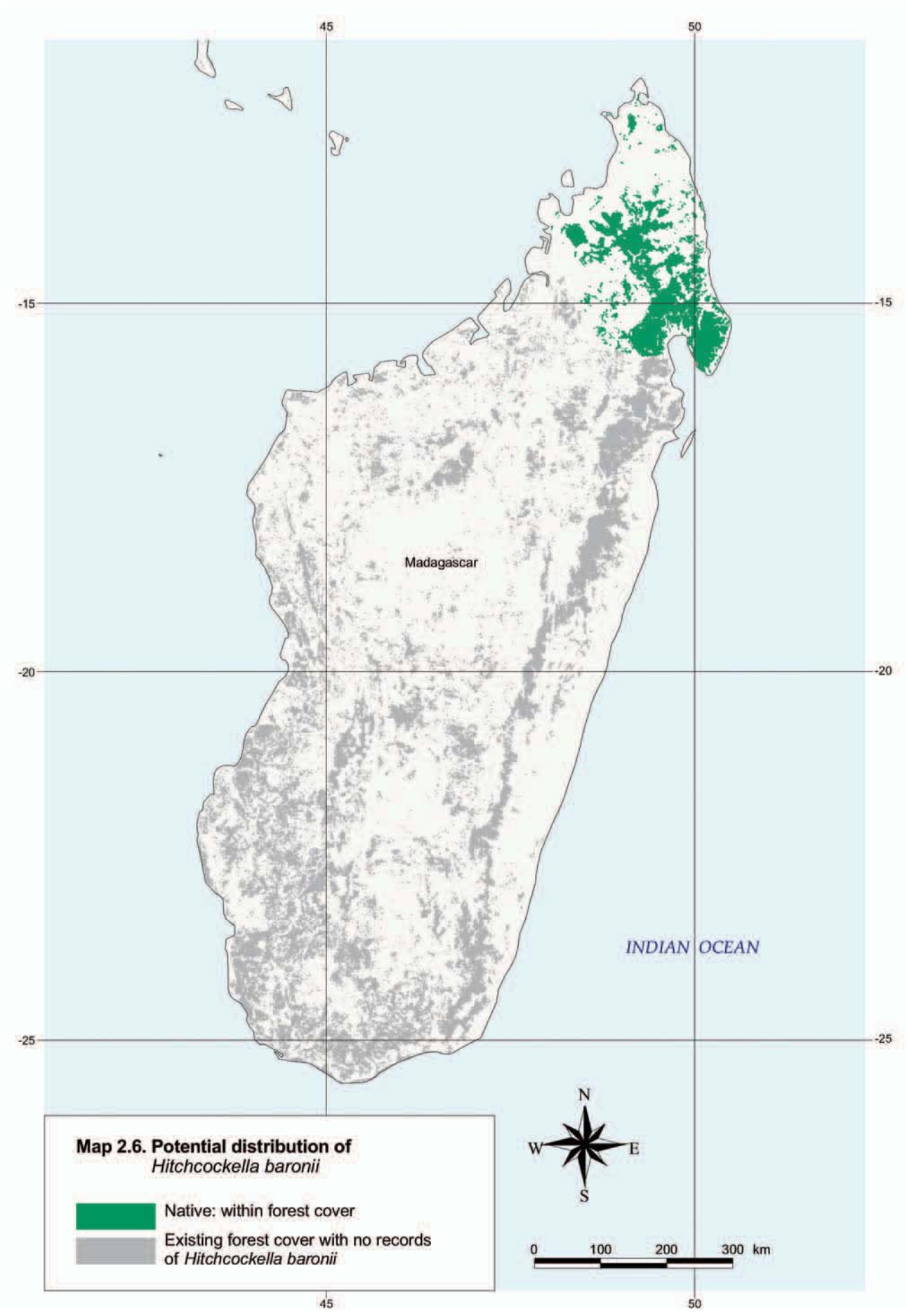
Map 2.3. Potential distribution of *Cephalostachyum viguieri*



Map 2.4. Potential distribution of *Decaryochloa diadelpha*



Map 2.5. Potential distribution of *Hickelia madagascariensis*



Map 2.6. Potential distribution of *Hitchcockella baronii*


-100
-75
-50
25
0
-25
-50
N
W
E
S
United States
Mexico
Cuba
Dominican Republic
Jamaica
Haiti
Belize
Honduras
Guatemala
El Salvador
Nicaragua
Panama
Costa Rica
Venezuela
Guyana
French Guiana
Colombia
Suriname
Ecuador
Brazil
Peru
Bolivia
Chile
Paraguay
Argentina
Uruguay
ATLANTIC OCEAN
PACIFIC OCEAN
Map 3.1. Potential distribution of *Arthrostylidium*
Number of species
1 - 2
3 - 4
5 - 6
7
Existing forest cover with no records of *Arthrostylidium*
0 500 1000 1500 2000 km


-100
-75
-50
25
0
-25
-50
United States
Mexico
ATLANTIC OCEAN
Cuba
Dominican Republic
Haiti
Jamaica
Belize
Guatemala
Honduras
El Salvador
Nicaragua
Panama
Costa Rica
Venezuela
Guyana
French Guiana
Suriname
Colombia
Ecuador
Peru
Brazil
PACIFIC OCEAN
Bolivia
Chile
Paraguay
Argentina
Uruguay
0 500 1000 1500 2000 km
Map 3.2. Potential distribution of *Aulonemia*
Number of species
1 2 3 4
Existing forest cover with no records of *Aulonemia*
N
W
E
S


-100
-75
-50
N
W
E
S
United States
ATLANTIC OCEAN
Mexico
25
Cuba
Dominican Republic
Belize
Jamaica
Haiti
Guatemala
Honduras
El Salvador
Nicaragua
Panama
Costa Rica
Venezuela
Guyana
French Guiana
Colombia
Suriname
0
Ecuador
Peru
Brazil
Bolivia
PACIFIC OCEAN
Chile
Paraguay
-25
Uruguay
Argentina
-50
0 500 1000 1500 2000 km
Map 3.3. Potential distribution of *Chusquea*
Number of species
1 - 2
3 - 4
5 - 9
10 - 14
Existing forest cover with no records of *Chusquea*
-75
-100
-75
-50

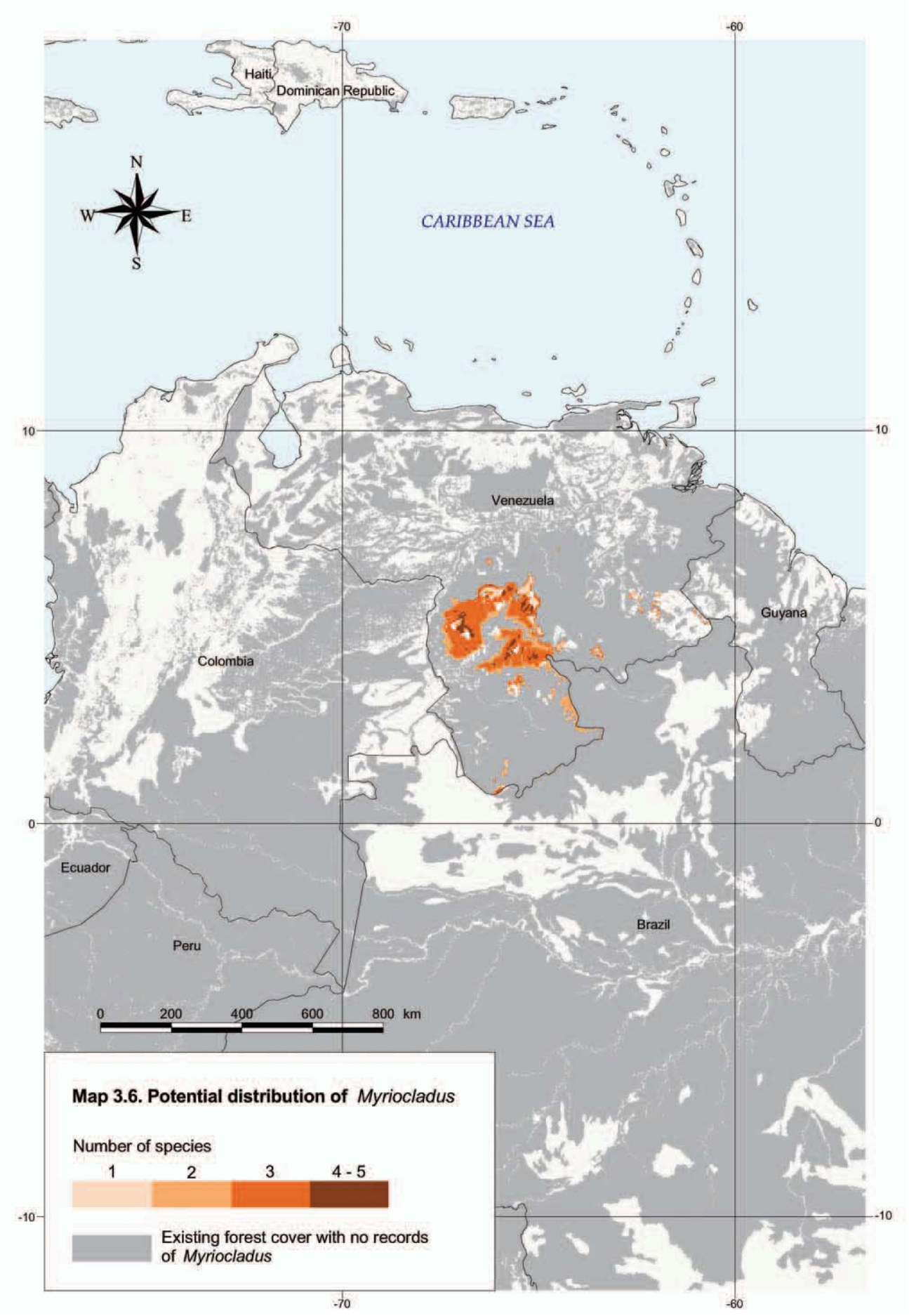

-100
-75
-50
25
0
-25
-50
-75
United States
ATLANTIC OCEAN
Mexico
Cuba
Dominican Republic
Belize
Jamaica
Haiti
Guatemala
Honduras
El Salvador
Nicaragua
Costa Rica
Panama
Venezuela
Guyana
French Guiana
Suriname
Colombia
Ecuador
Peru
Brazil
PACIFIC OCEAN
Bolivia
Chile
Paraguay
Uruguay
Argentina
0 500 1000 1500 2000 km
Map 3.4. Potential distribution of *Guadua*
Number of species
1 - 2
3 - 4
5 - 6
7
Existing forest cover with no records of *Guadua*
N
W
E
S

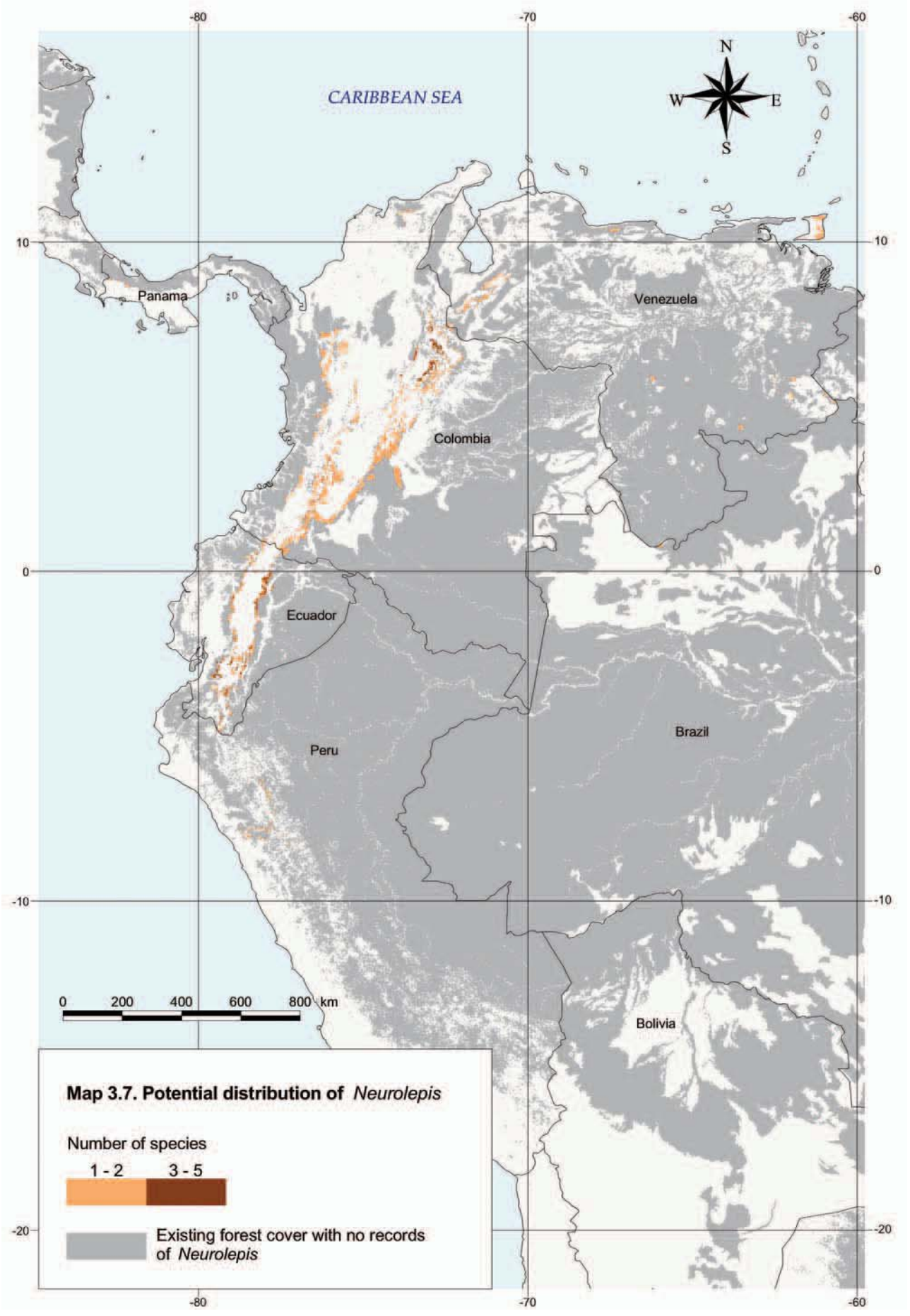
Map 3.5. Potential distribution of *Merostachys*

Number of species

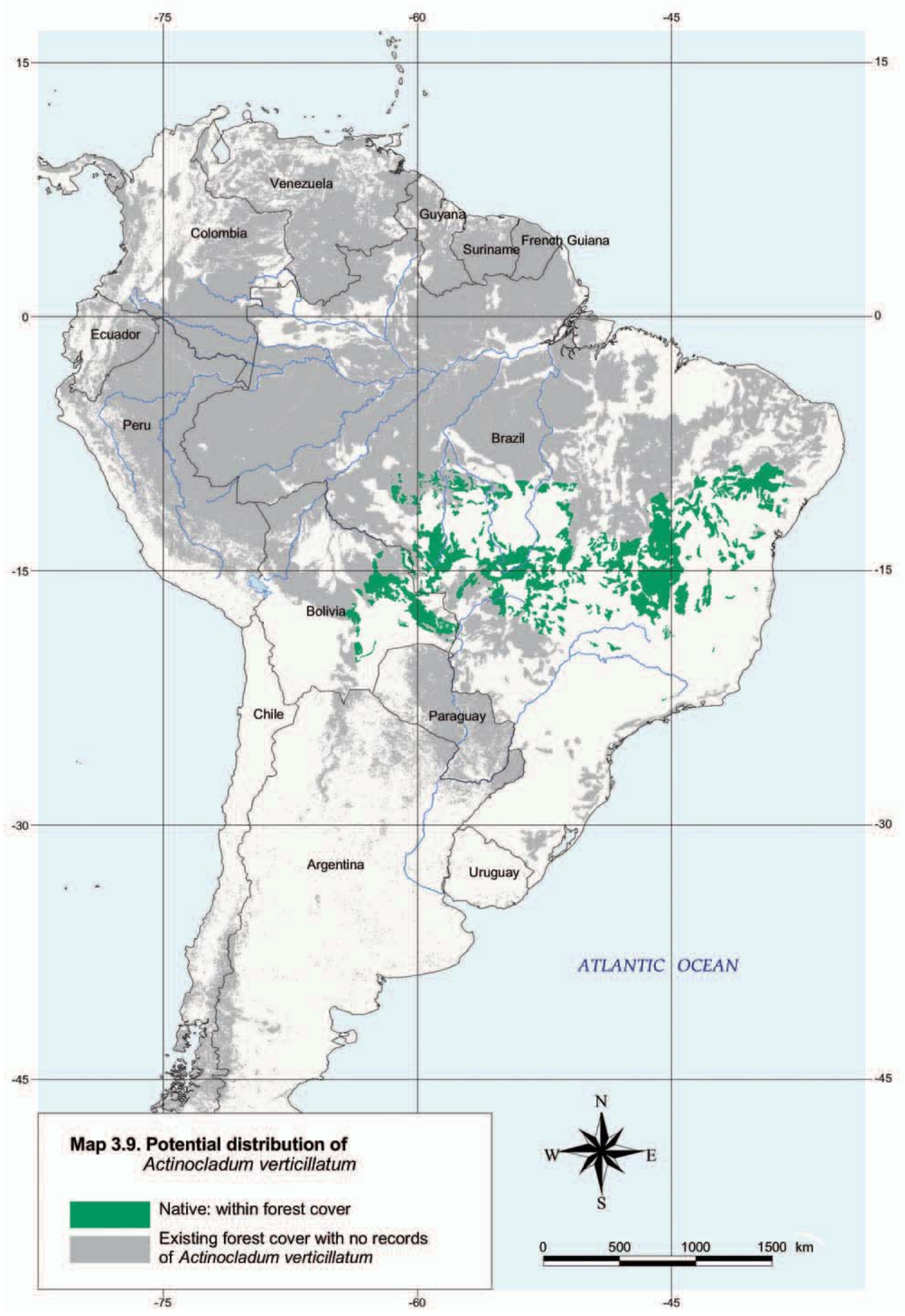
1 - 3 | 4 - 6 | 7 - 9 | 10 - 16

Existing forest cover with no records of *Merostachys*

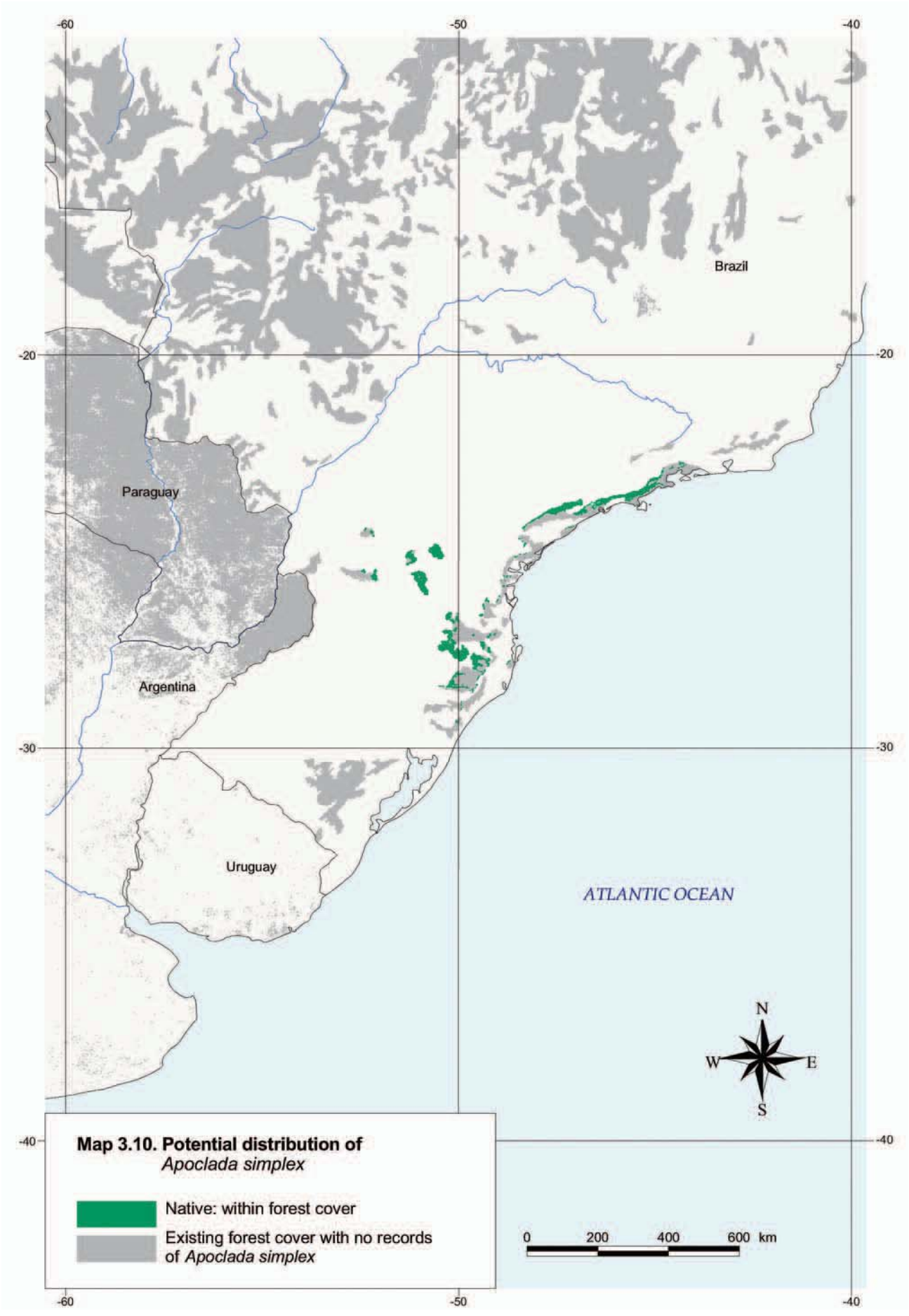

-70
-60
Haiti
Dominican Republic
N
W
E
S
CARIBBEAN SEA
10
Venezuela
Guyana
Colombia
0
Ecuador
Brazil
Peru
0 200 400 600 800 km
Map 3.6. Potential distribution of Myriocladus
Number of species
1 2 3 4 - 5
Existing forest cover with no records of Myriocladus
-10
-70
-60


CARIBBEAN SEA
N
W
E
S
-80
-70
-60
10
0
-10
-20
Panama
Venezuela
Colombia
Ecuador
Peru
Brazil
Bolivia
0 200 400 600 800 km
Map 3.7. Potential distribution of *Neurolepis*
Number of species
1 - 2
3 - 5
Existing forest cover with no records of *Neurolepis*


-100
-75
-50
25
0
-25
-50
-75
United States
ATLANTIC OCEAN
Mexico
Cuba
Dominican Republic
Haiti
Belize
Honduras
Guatemala
El Salvador
Nicaragua
Panama
Costa Rica
Venezuela
Guyana
French Guiana
Suriname
Colombia
Ecuador
Peru
Brazil
Bolivia
Chile
Paraguay
Argentina
Uruguay
PACIFIC OCEAN
0 500 1000 1500 2000 km
Map 3.8. Potential distribution of *Rhipidocladum*
Number of species
1 2 3 4
Existing forest cover with no records of *Rhipidocladum*
N
W
E
S



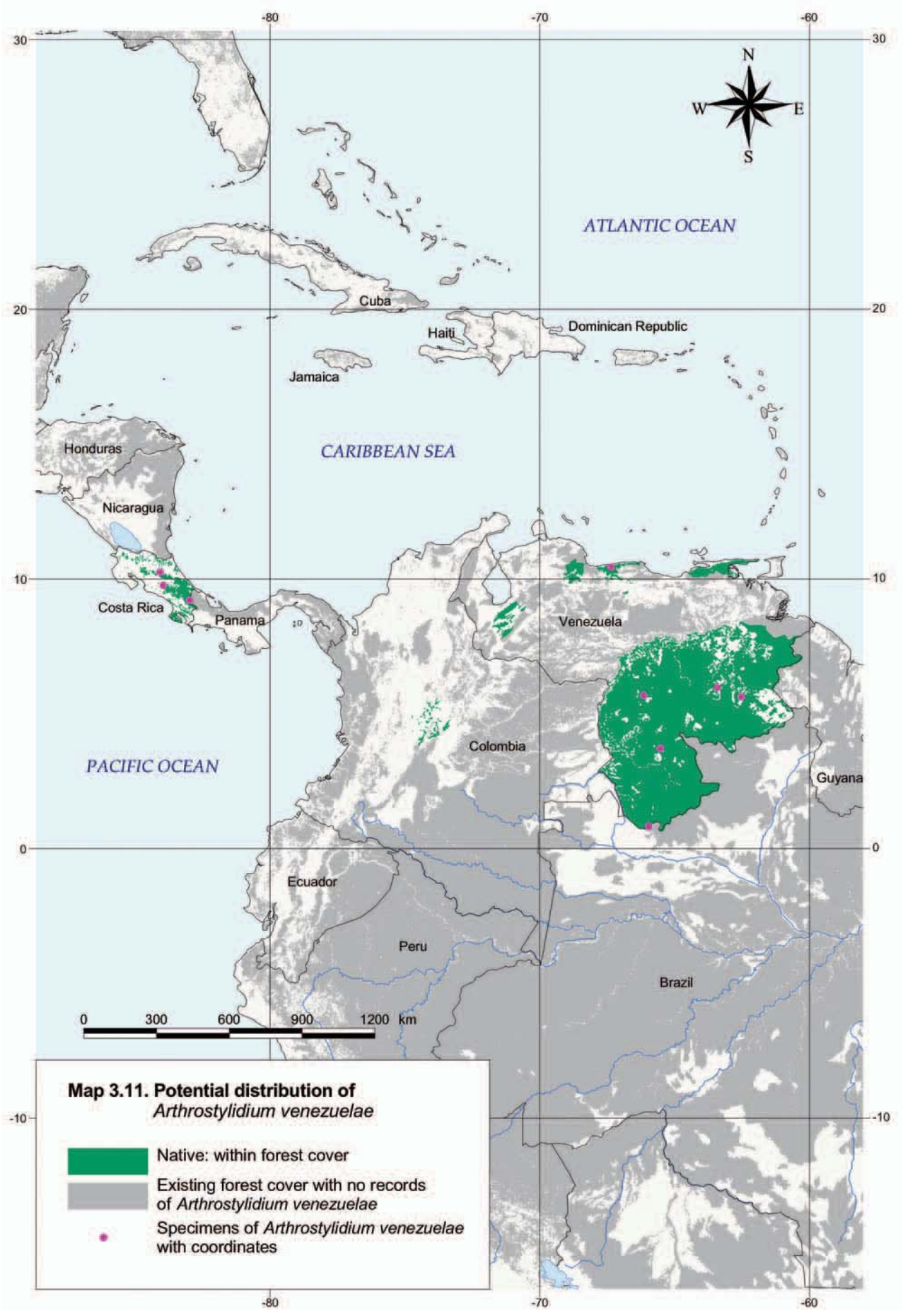
Map 3.9. Potential distribution of *Actinocladum verticillatum*



Map 3.10. Potential distribution of *Apoclada simplex*

Native: within forest cover

Existing forest cover with no records of *Apoclada simplex*

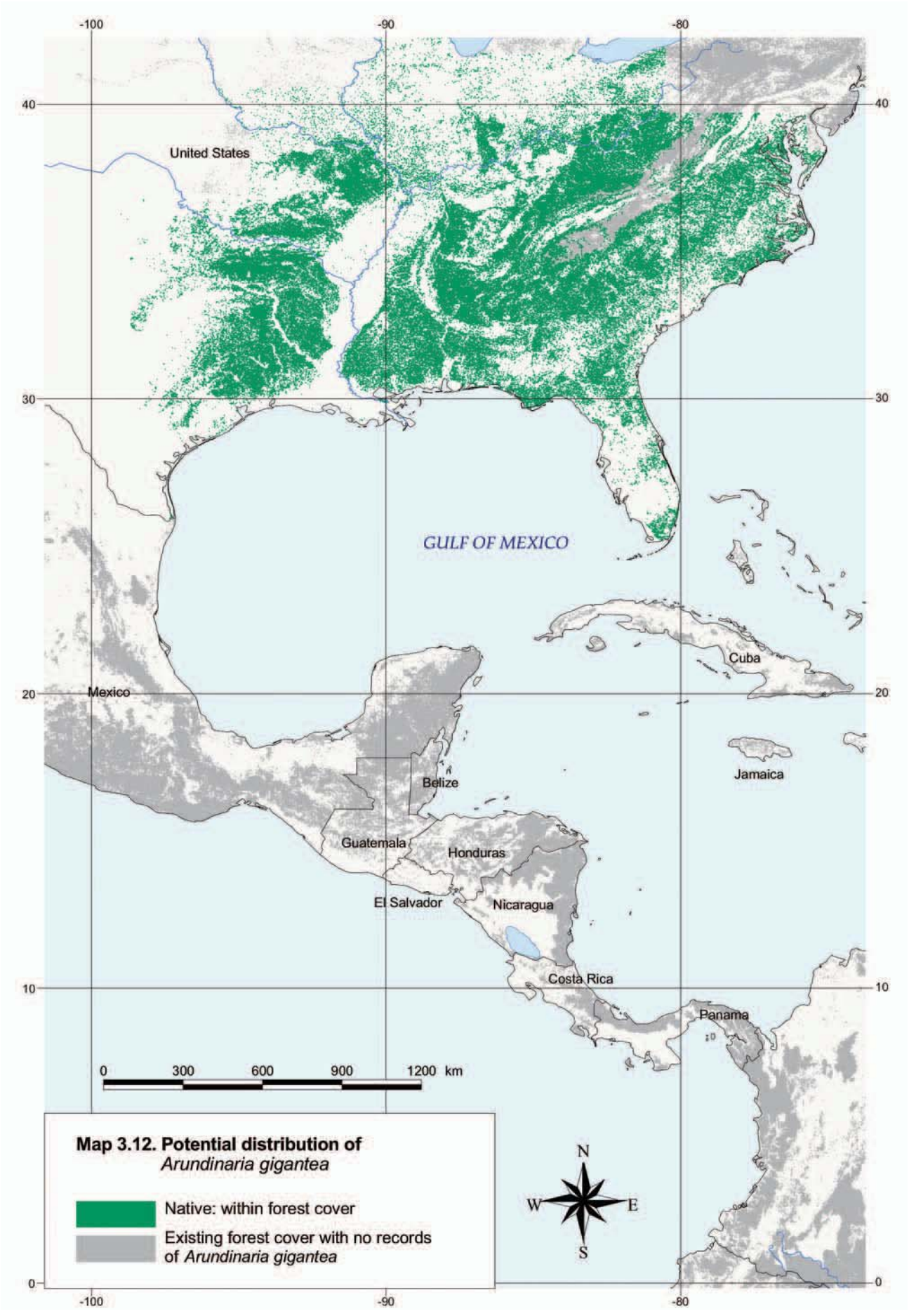


Map 3.11. Potential distribution of *Arthrostylidium venezuelae*

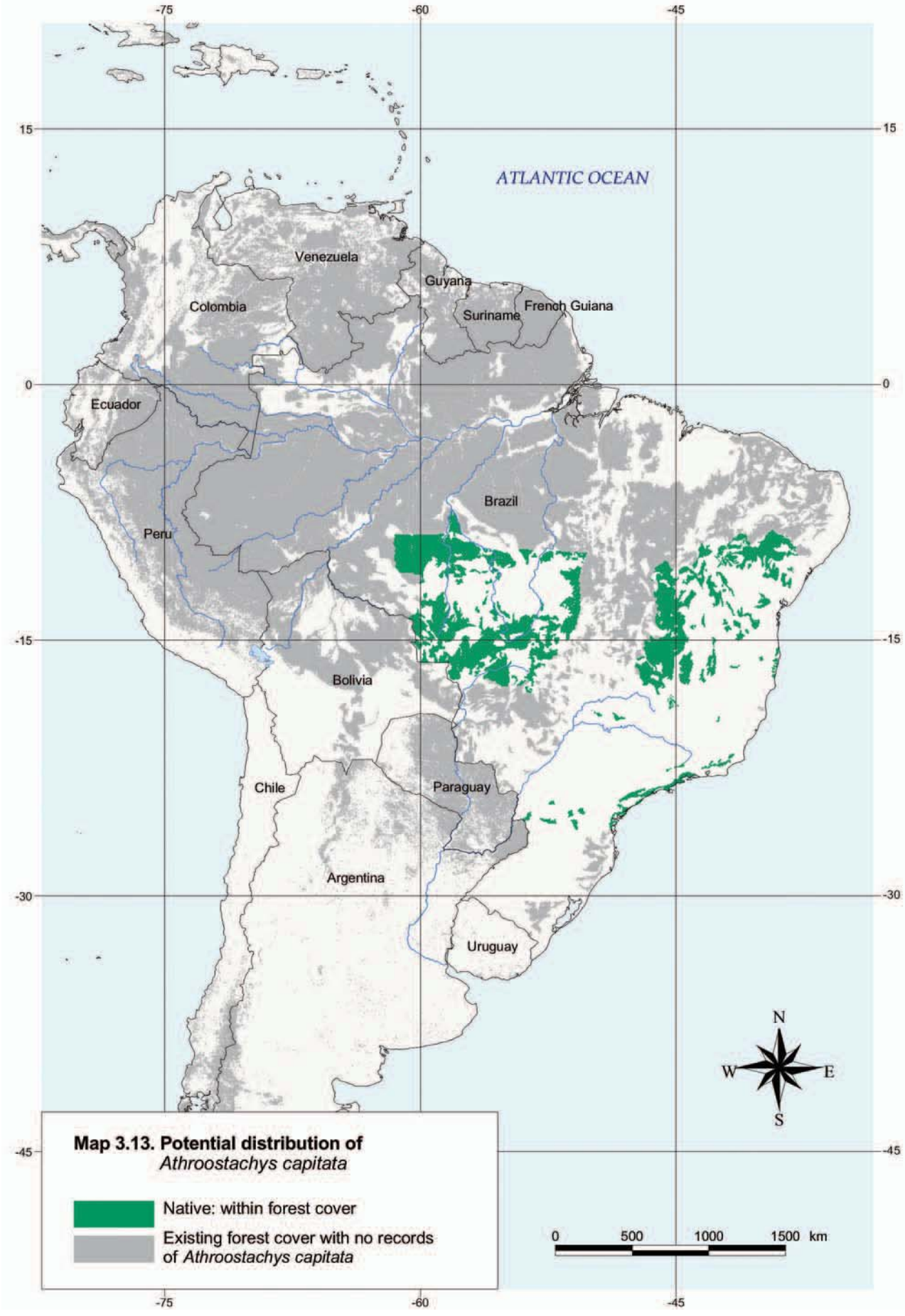
Native: within forest cover

Existing forest cover with no records of *Arthrostylidium venezuelae*

Specimens of *Arthrostylidium venezuelae* with coordinates



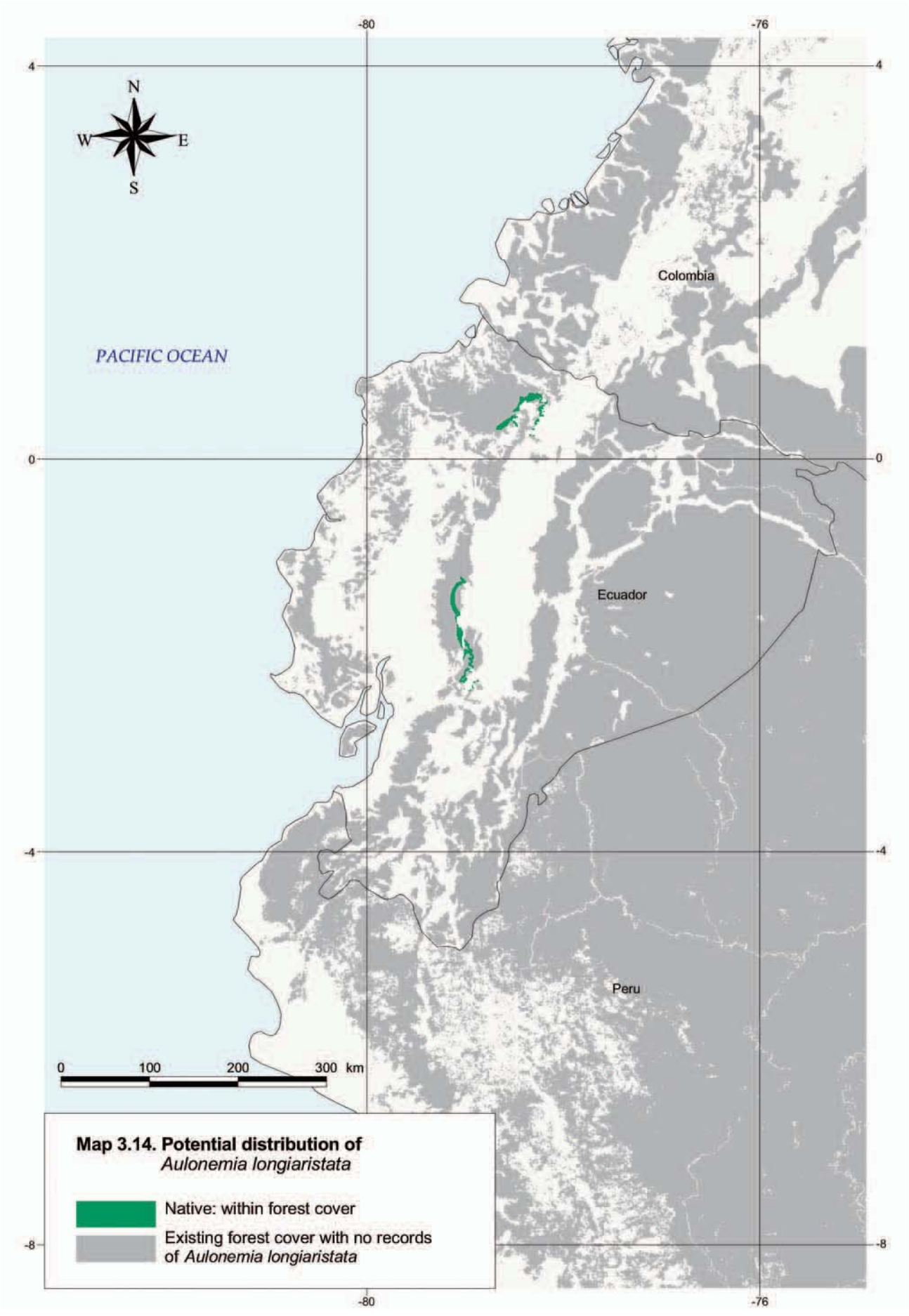
Map 3.12. Potential distribution of *Arundinaria gigantea*



Map 3.13. Potential distribution of *Athroostachys capitata*

Native: within forest cover

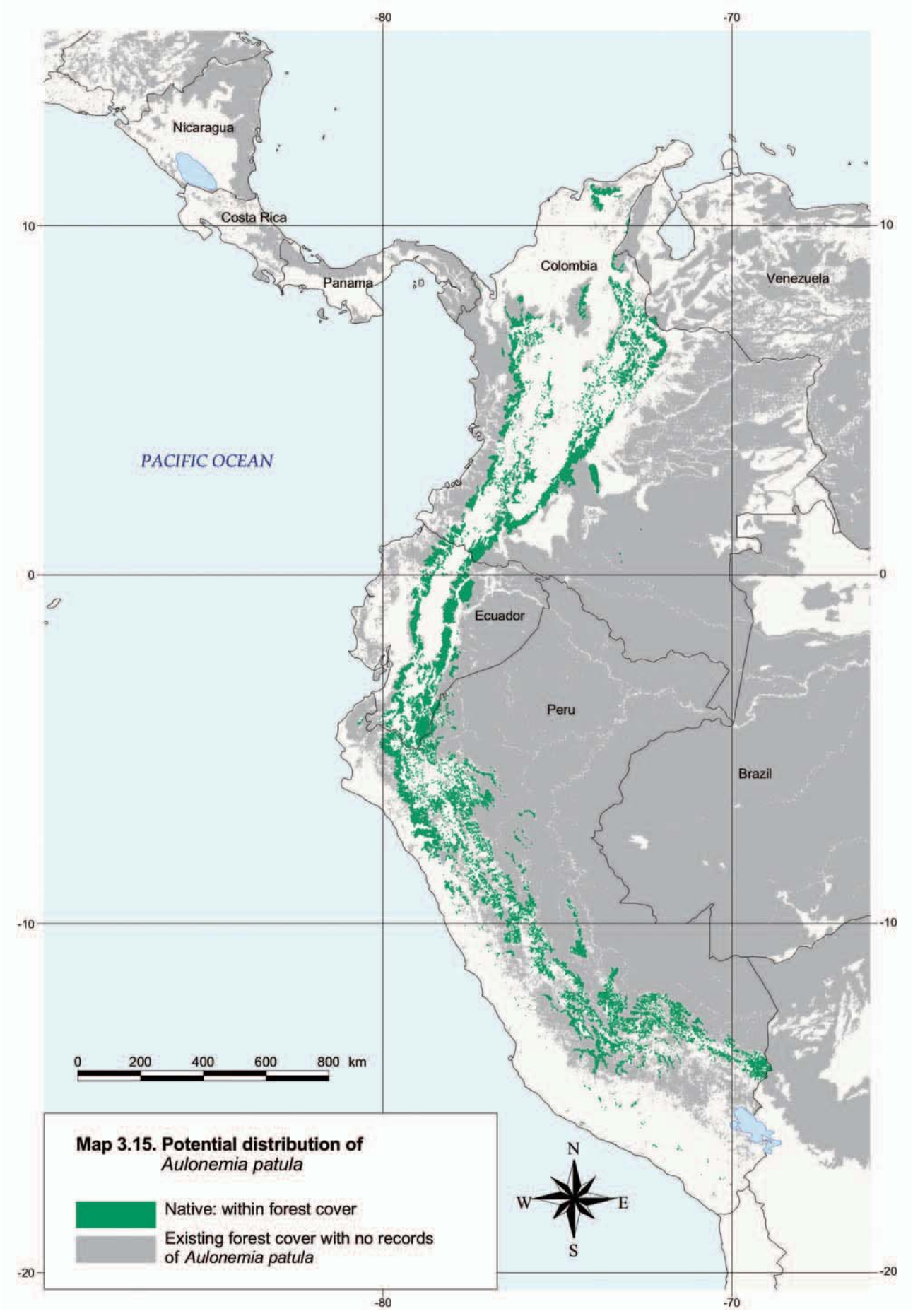
Existing forest cover with no records of *Athroostachys capitata*



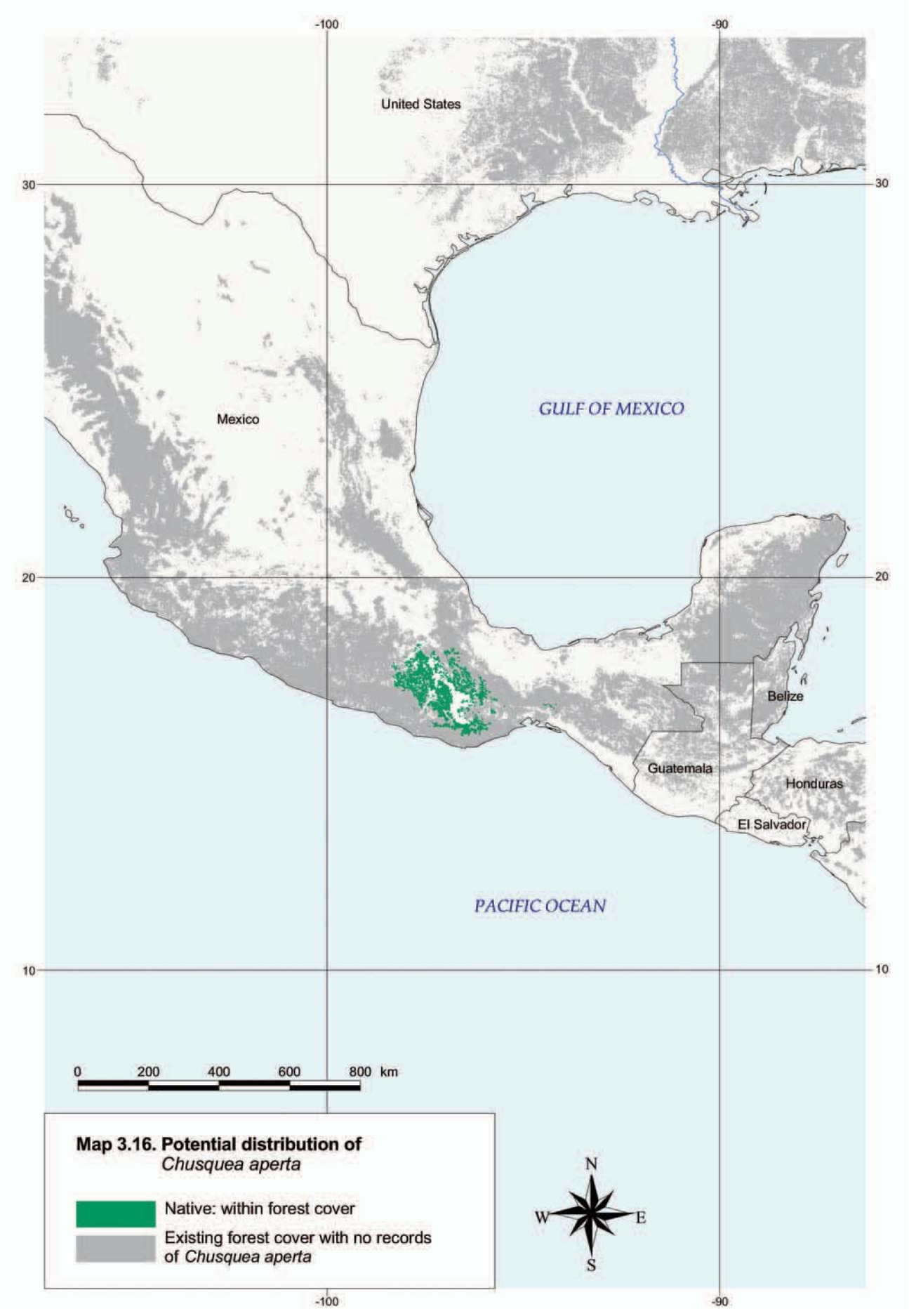
Map 3.14. Potential distribution of *Aulonemia longiaristata*

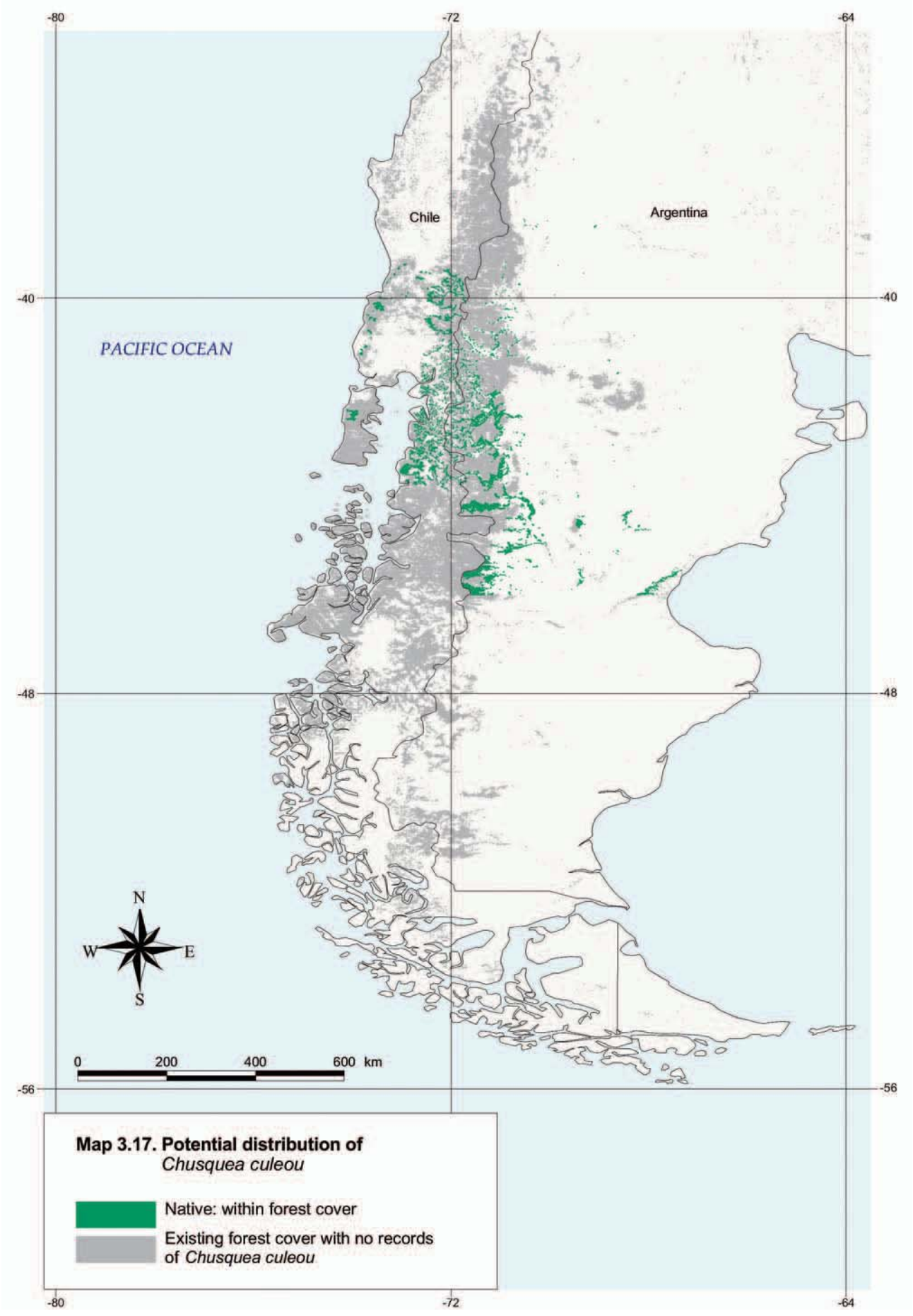
Native: within forest cover

Existing forest cover with no records of *Aulonemia longiaristata*



Map 3.15. Potential distribution of *Aulonemia patula*

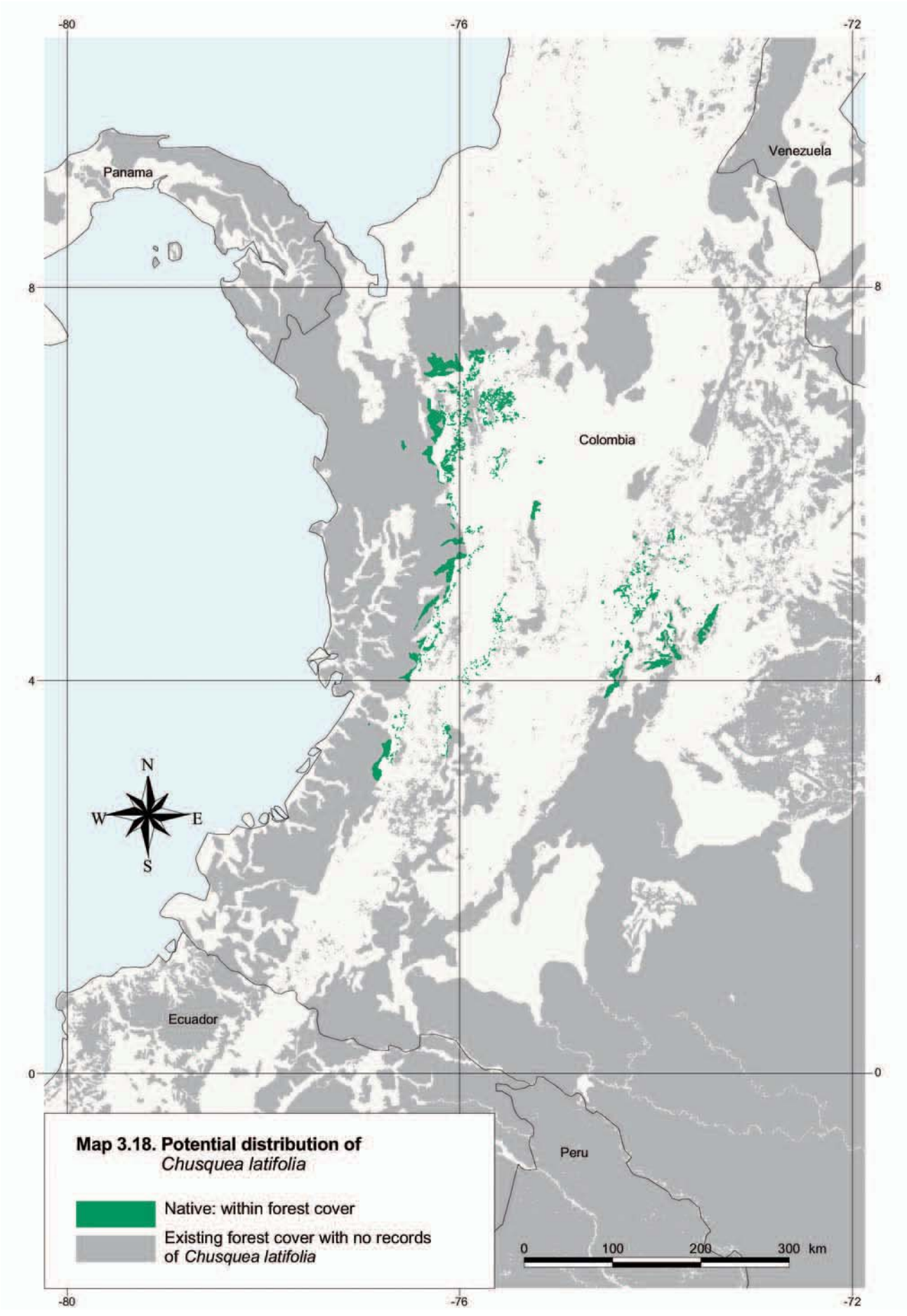

-100
-90
United States
30
30
Mexico
GULF OF MEXICO
20
20
Belize
Guatemala
Honduras
El Salvador
PACIFIC OCEAN
10
10
0 200 400 600 800 km
Map 3.16. Potential distribution of
Chusquea aperta
Native: within forest cover
Existing forest cover with no records
of Chusquea aperta
N
W
E
S
-100
-90



Map 3.17. Potential distribution of *Chusquea culeou*

Native: within forest cover

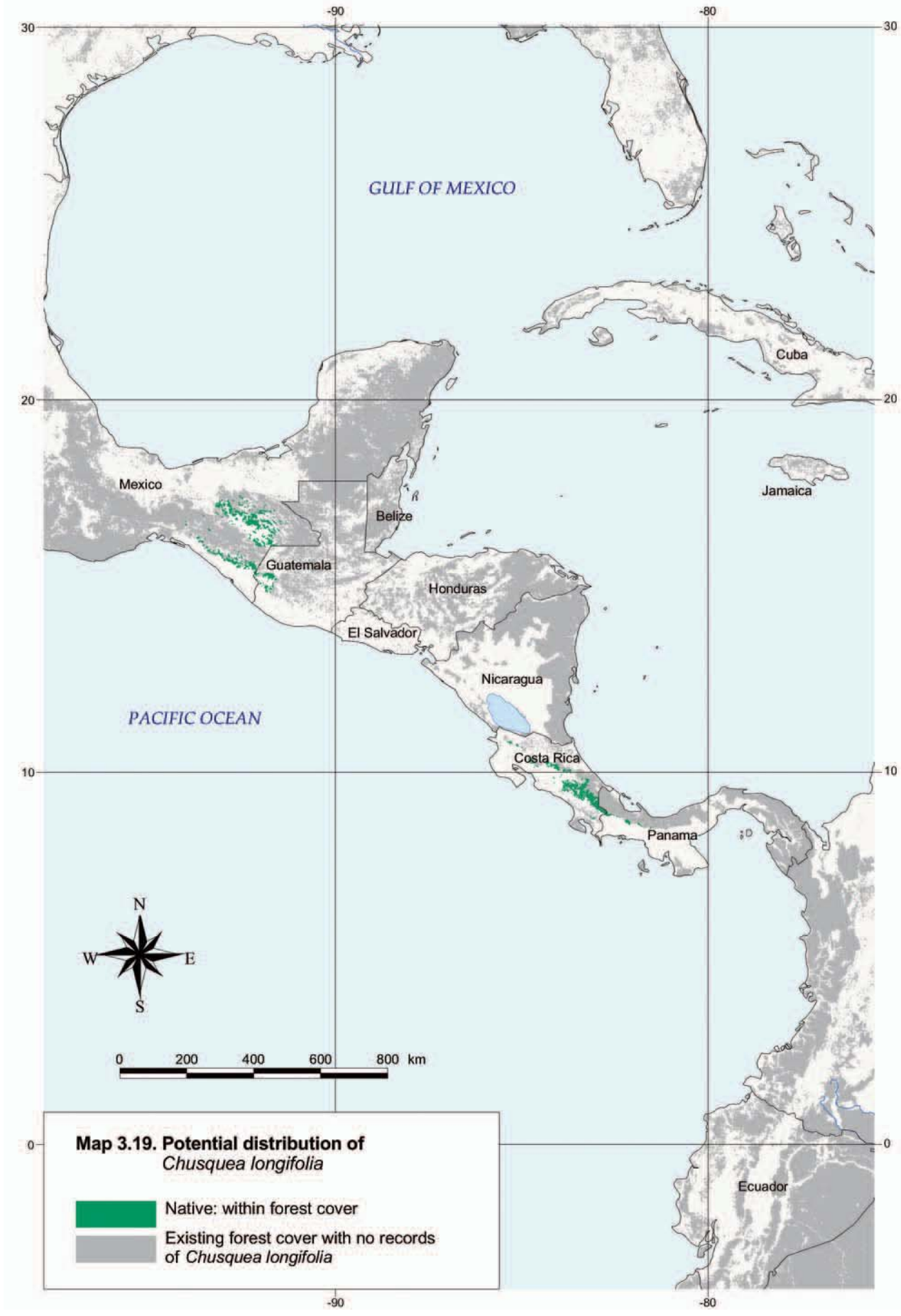
Existing forest cover with no records of *Chusquea culeou*



Map 3.18. Potential distribution of *Chusquea latifolia*

Native: within forest cover

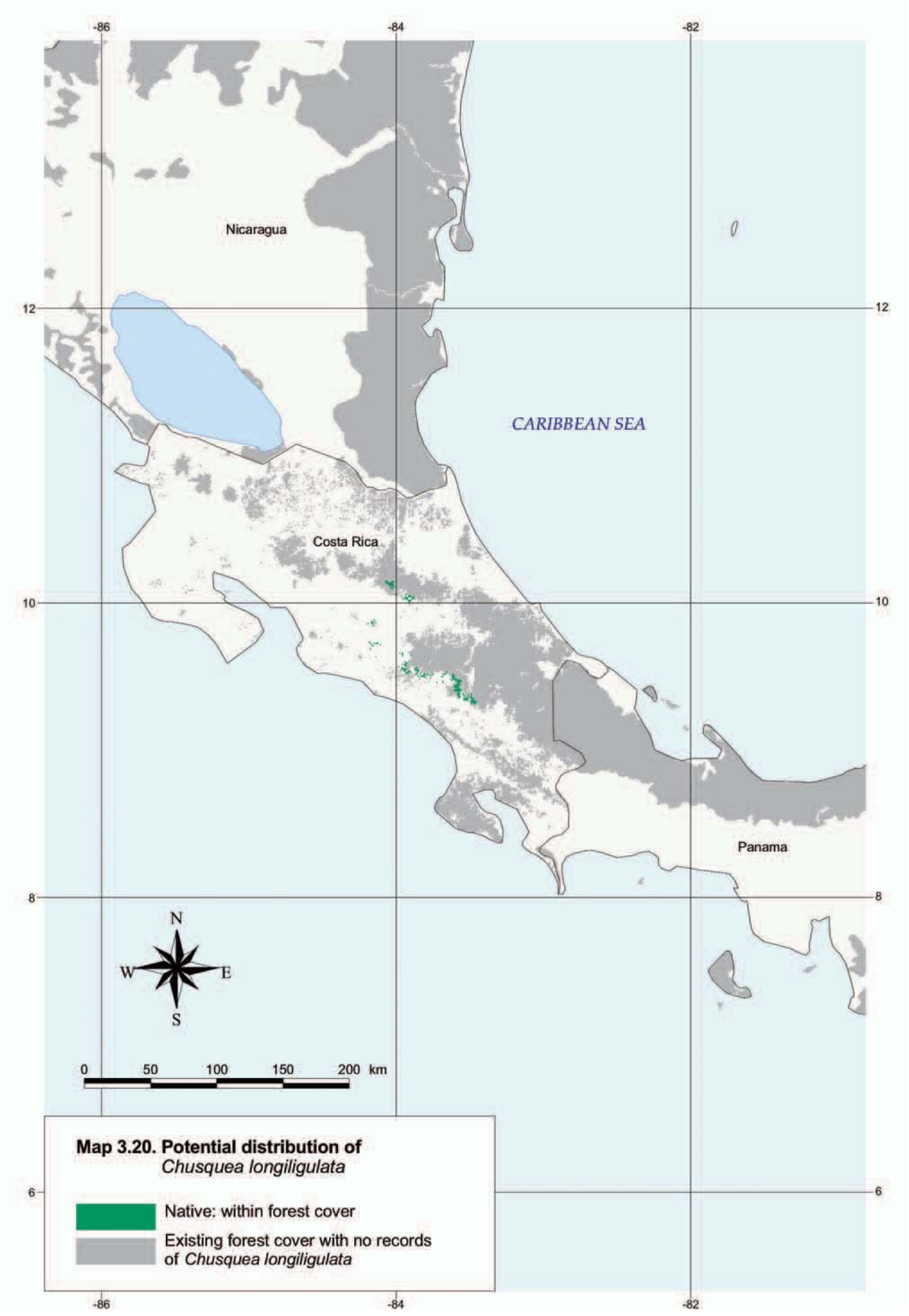
Existing forest cover with no records of *Chusquea latifolia*

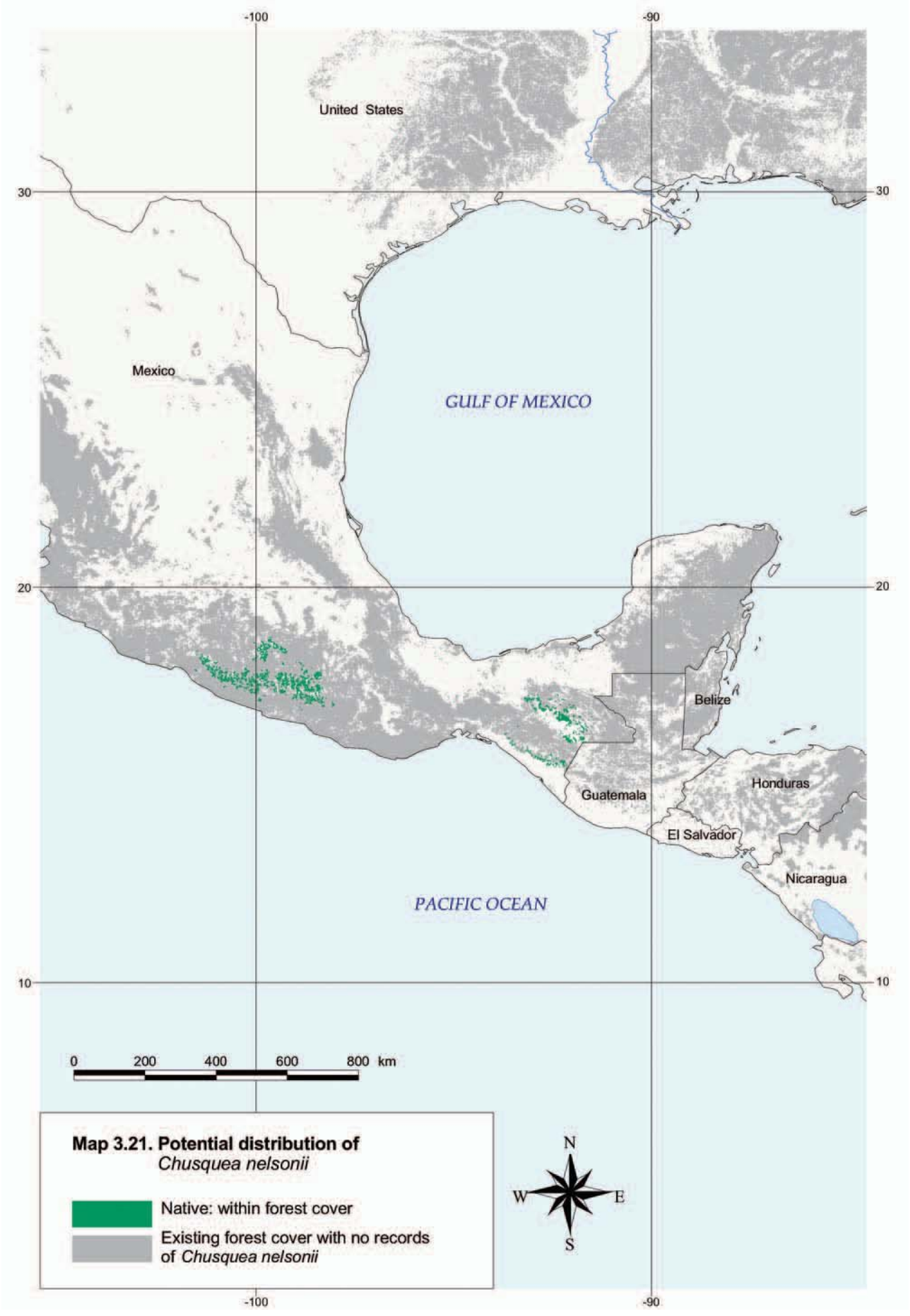


Map 3.19. Potential distribution of *Chusquea longifolia*

Native: within forest cover

Existing forest cover with no records of *Chusquea longifolia*

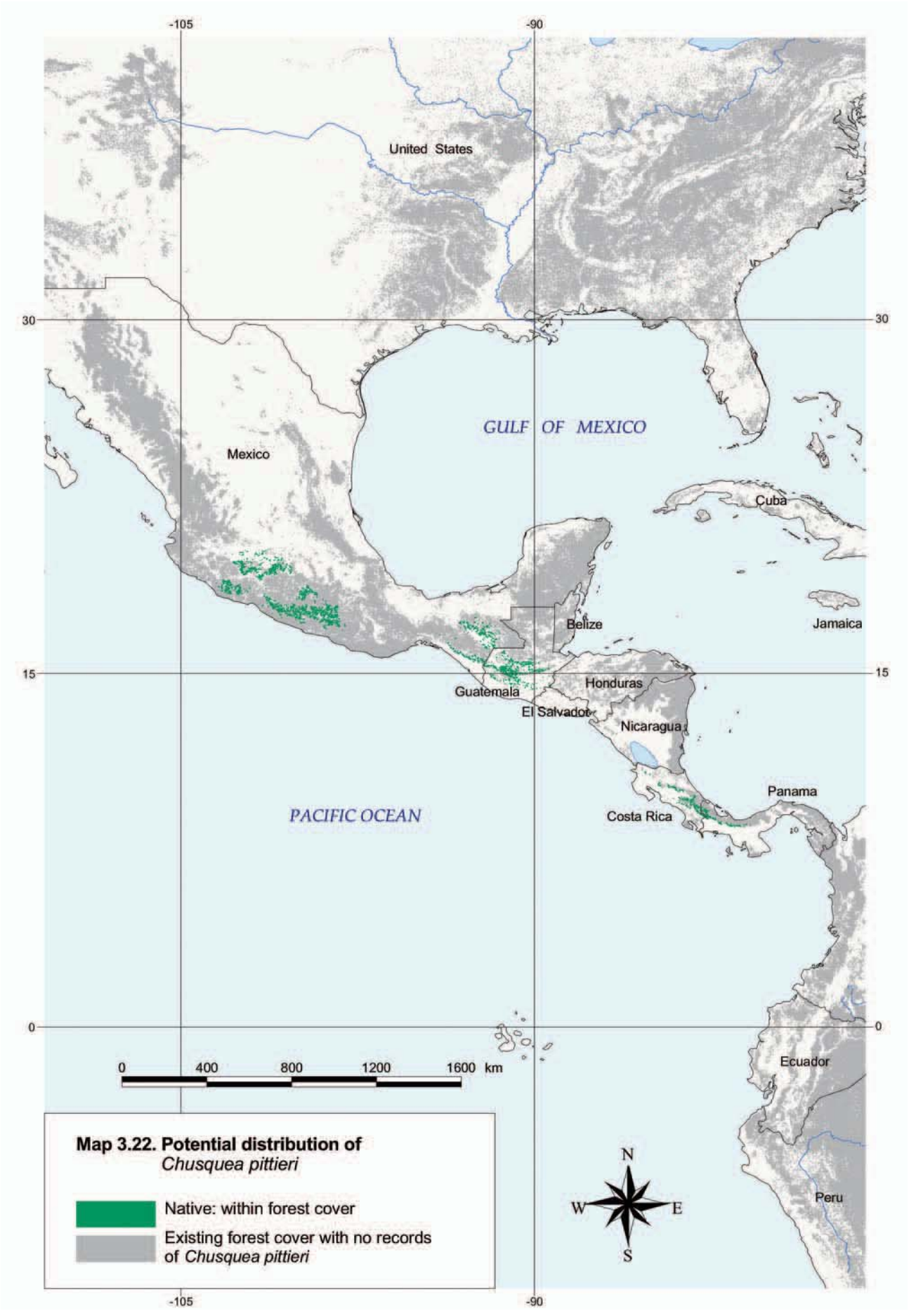

-86
-84
-82
12
10
8
6
Nicaragua
CARIBBEAN SEA
Costa Rica
Panama
N
W
E
S
0
50
100
150
200 km
Map 3.20. Potential distribution of
Chusquea longiligulata
Native: within forest cover
Existing forest cover with no records
of Chusquea longiligulata



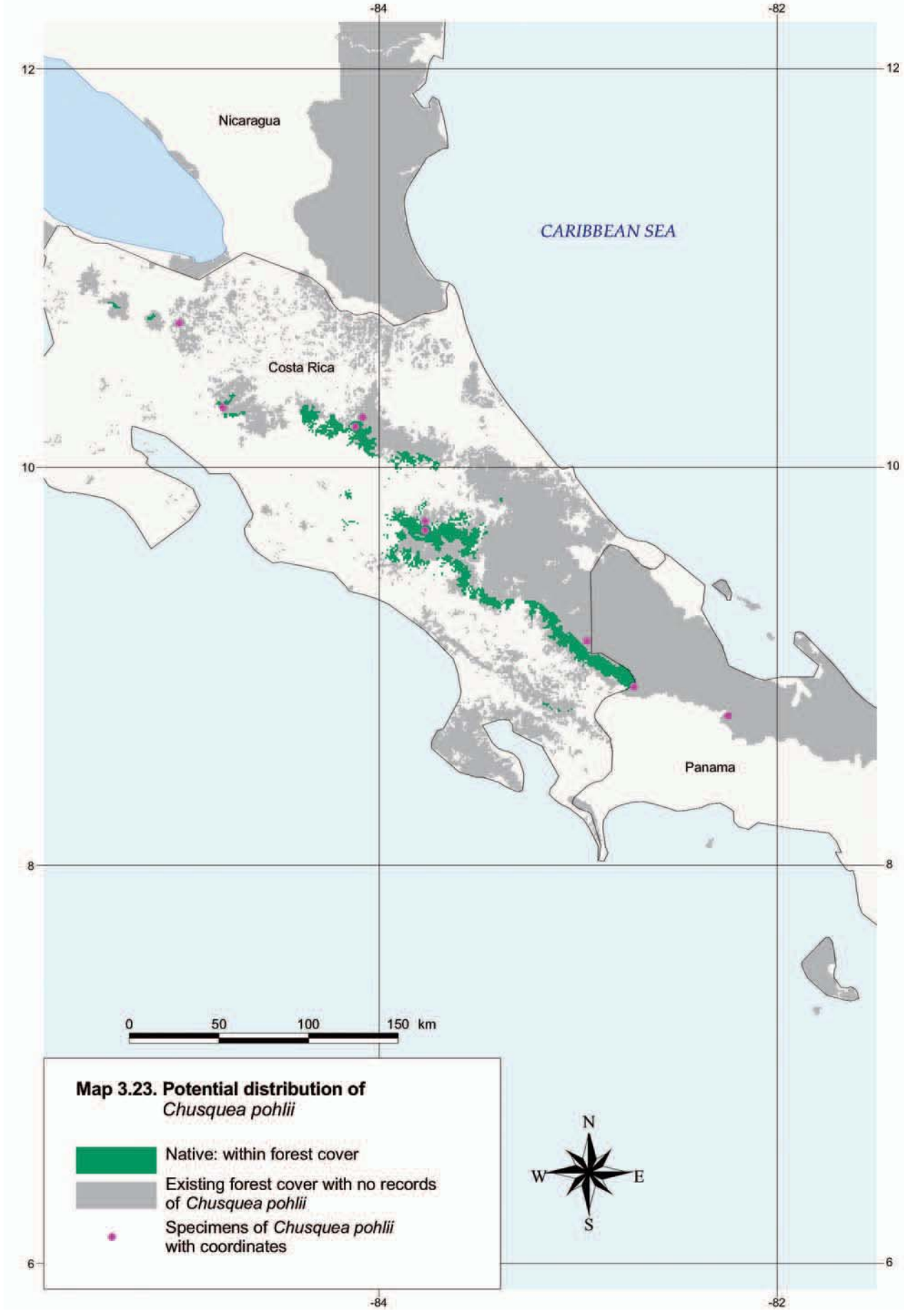
Map 3.21. Potential distribution of *Chusquea nelsonii*

Native: within forest cover

Existing forest cover with no records of *Chusquea nelsonii*



Map 3.22. Potential distribution of *Chusquea pittieri*

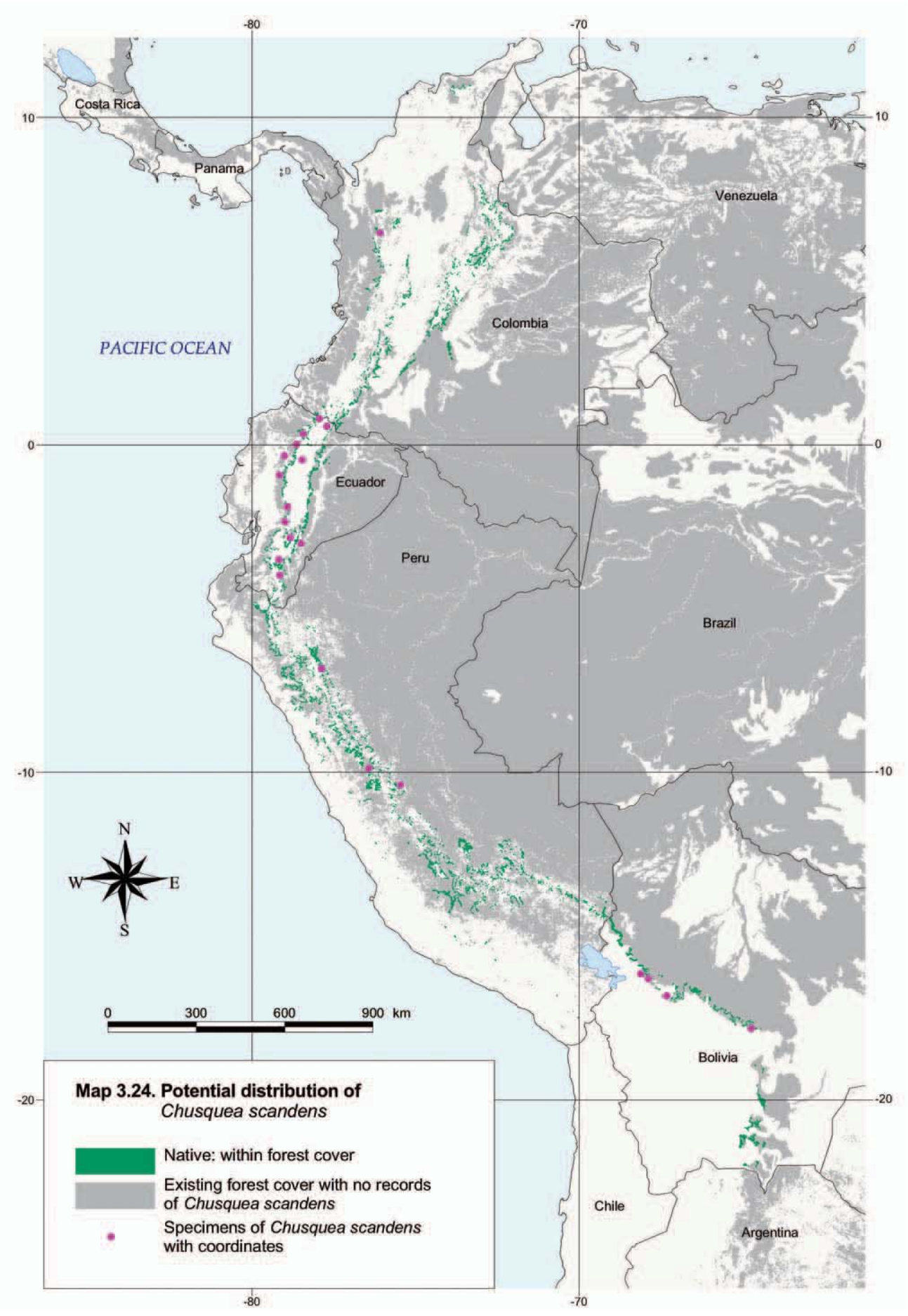


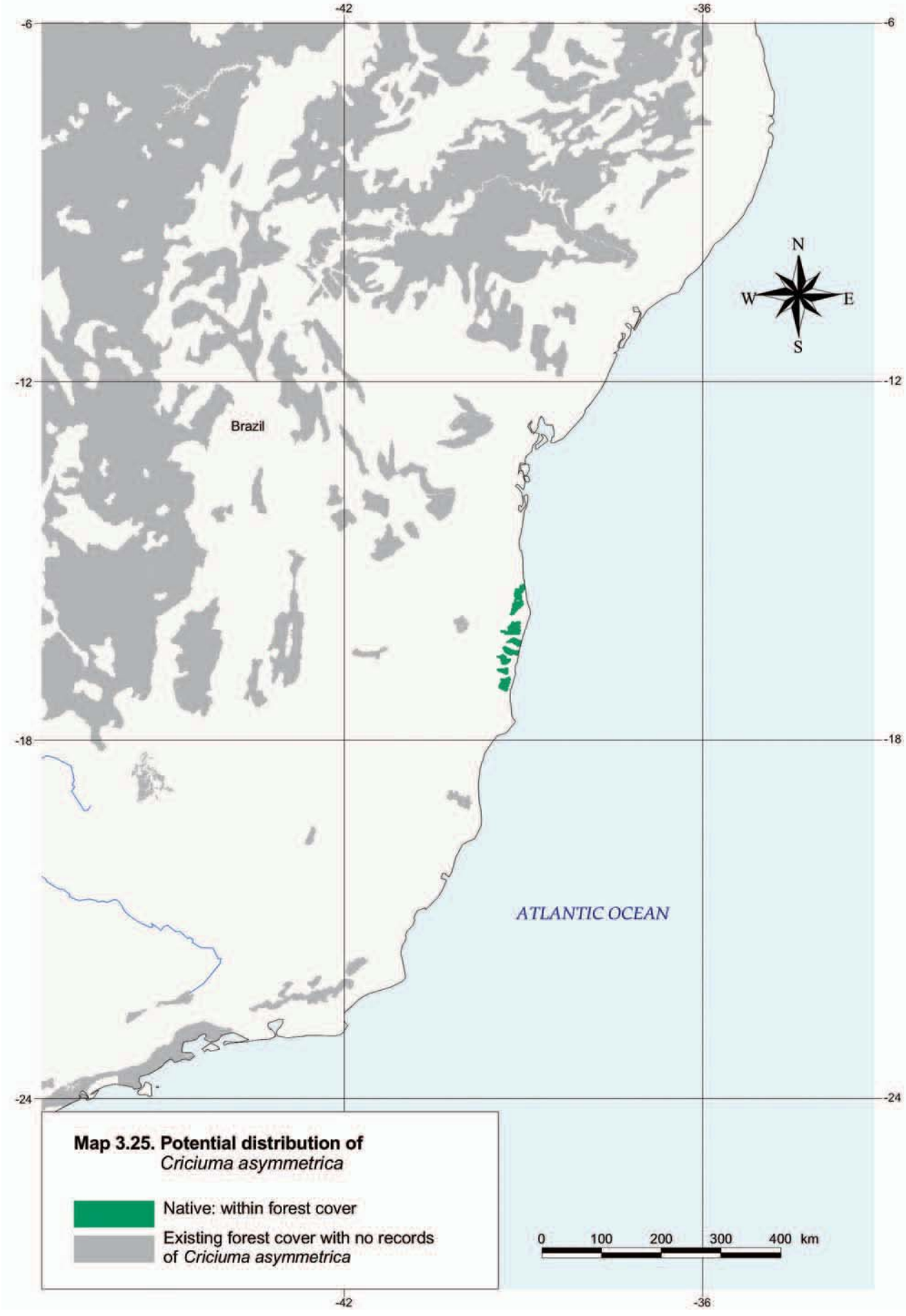
Map 3.23. Potential distribution of *Chusquea pohlii*

Native: within forest cover

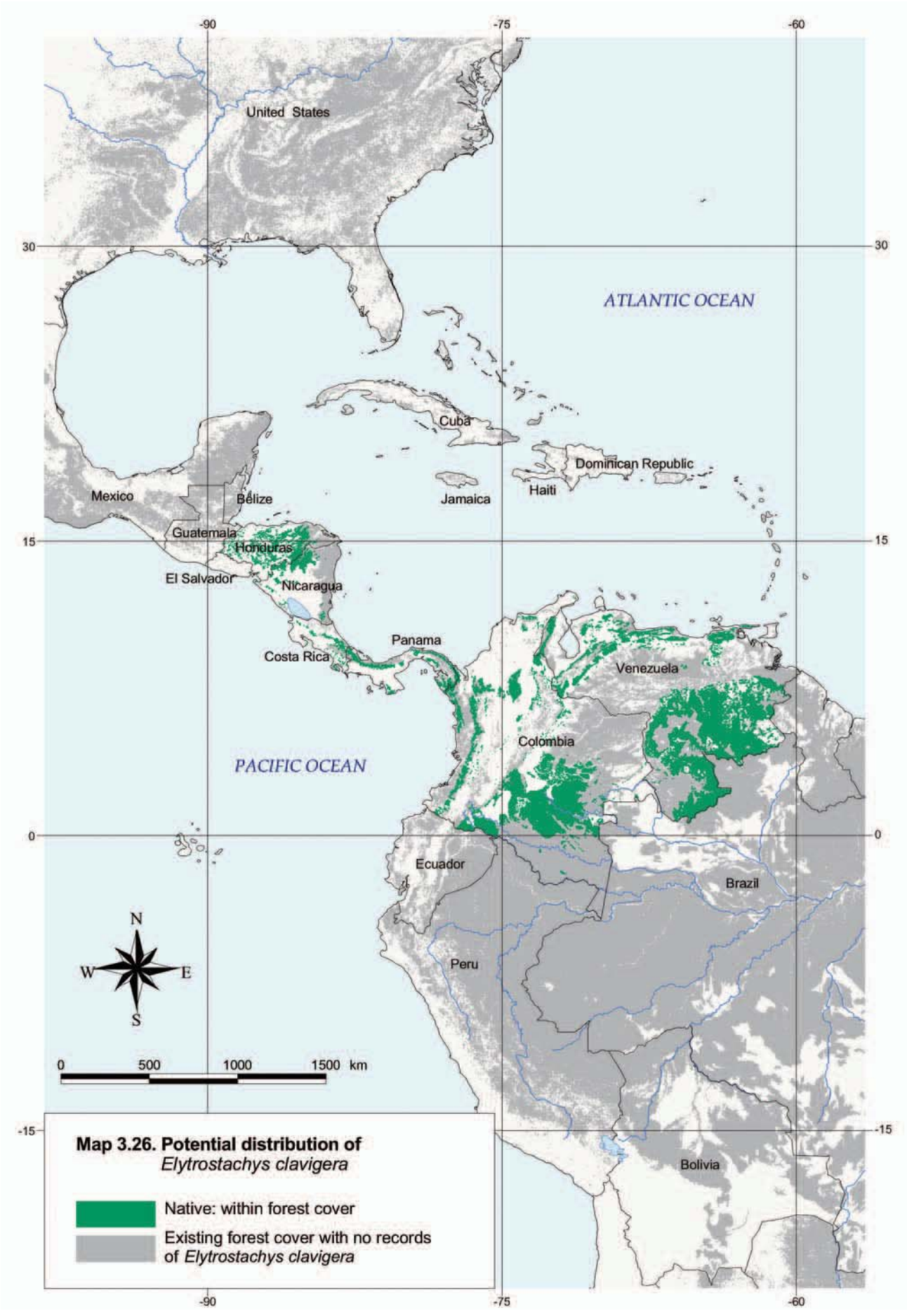
Existing forest cover with no records of *Chusquea pohlii*

Specimens of *Chusquea pohlii* with coordinates


-80
-70
10
0
-10
-20
Costa Rica
Panama
Venezuela
Colombia
PACIFIC OCEAN
Ecuador
Peru
Brazil
Bolivia
Chile
Argentina
N
W
E
S
0
300
600
900 km
Map 3.24. Potential distribution of *Chusquea scandens*
Native: within forest cover
Existing forest cover with no records of *Chusquea scandens*
Specimens of *Chusquea scandens* with coordinates



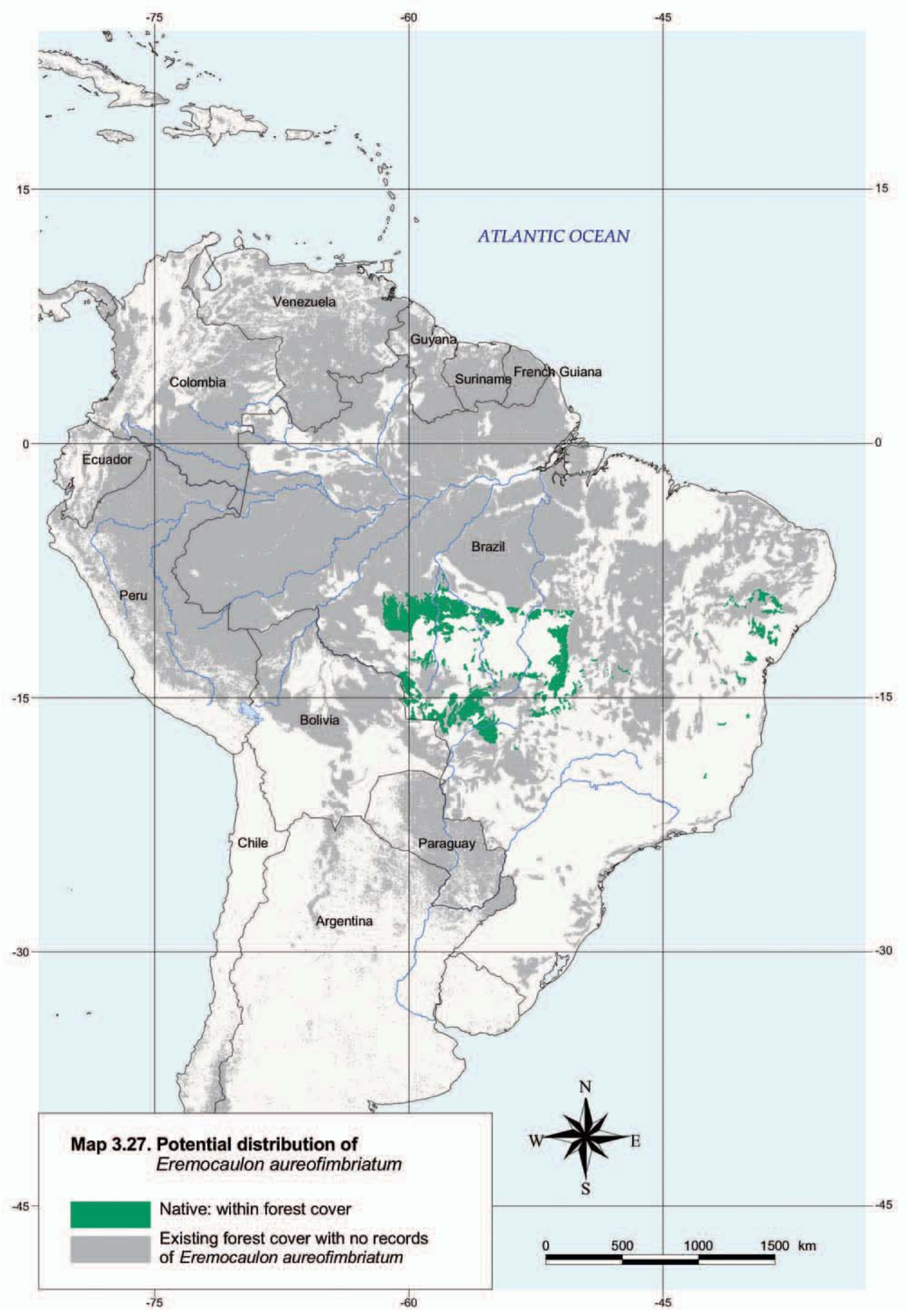
Map 3.25. Potential distribution of *Criciuma asymmetrica*



Map 3.26. Potential distribution of *Elytrostachys clavigera*

Native: within forest cover

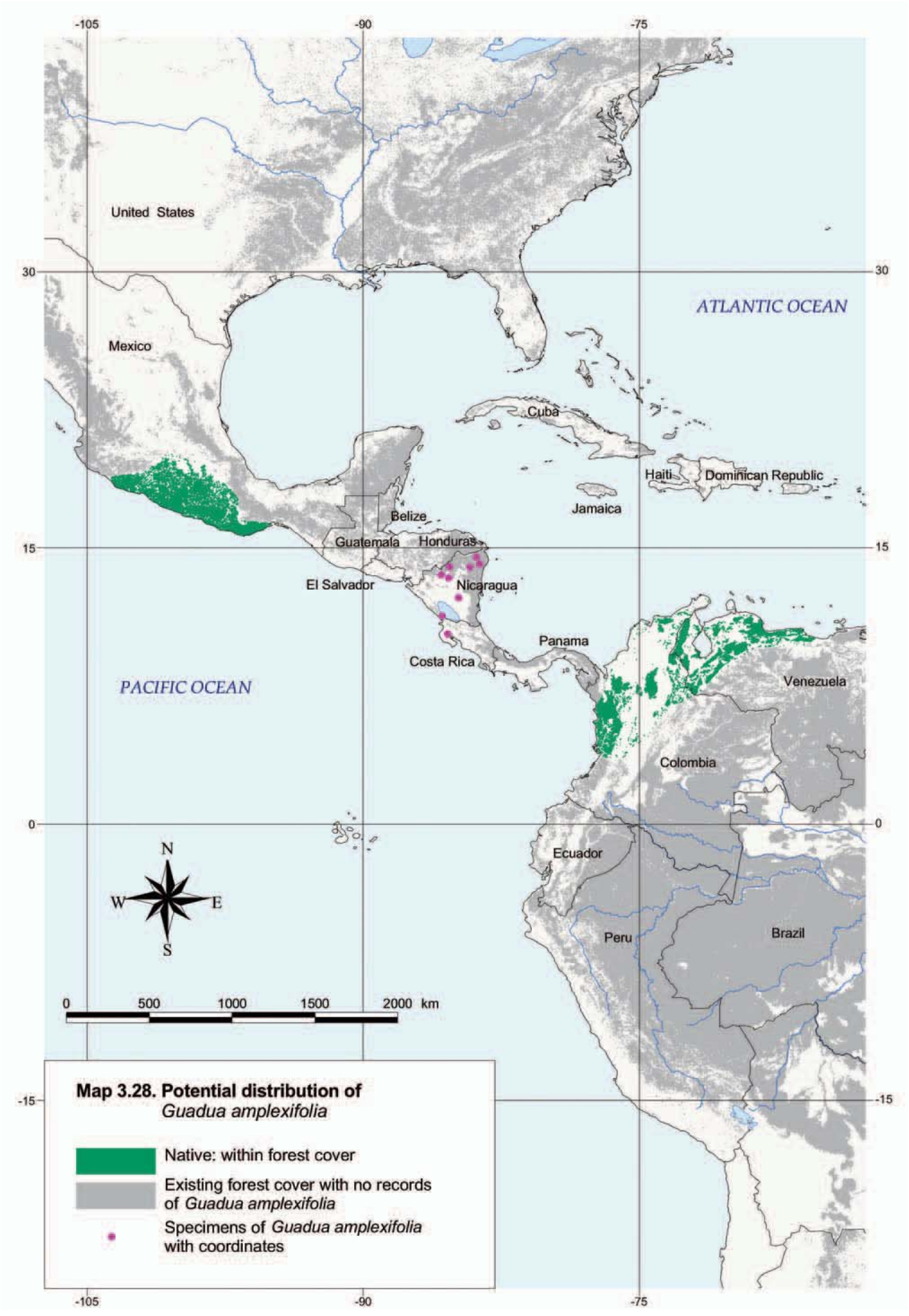
Existing forest cover with no records of *Elytrostachys clavigera*



Map 3.27. Potential distribution of *Eremocaulon aureofimbriatum*

Native: within forest cover

Existing forest cover with no records of *Eremocaulon aureofimbriatum*

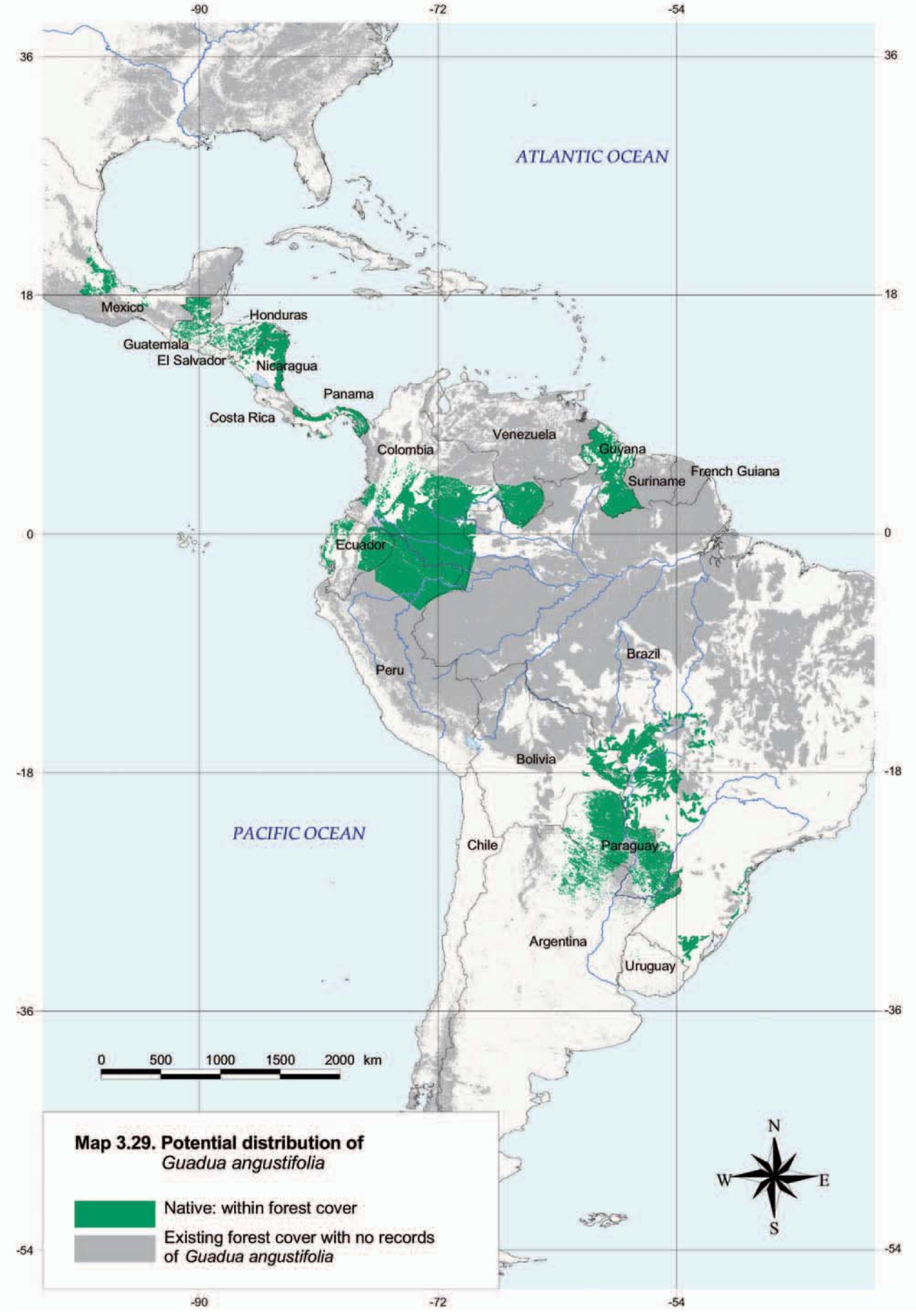


Map 3.28. Potential distribution of *Guadua amplexifolia*

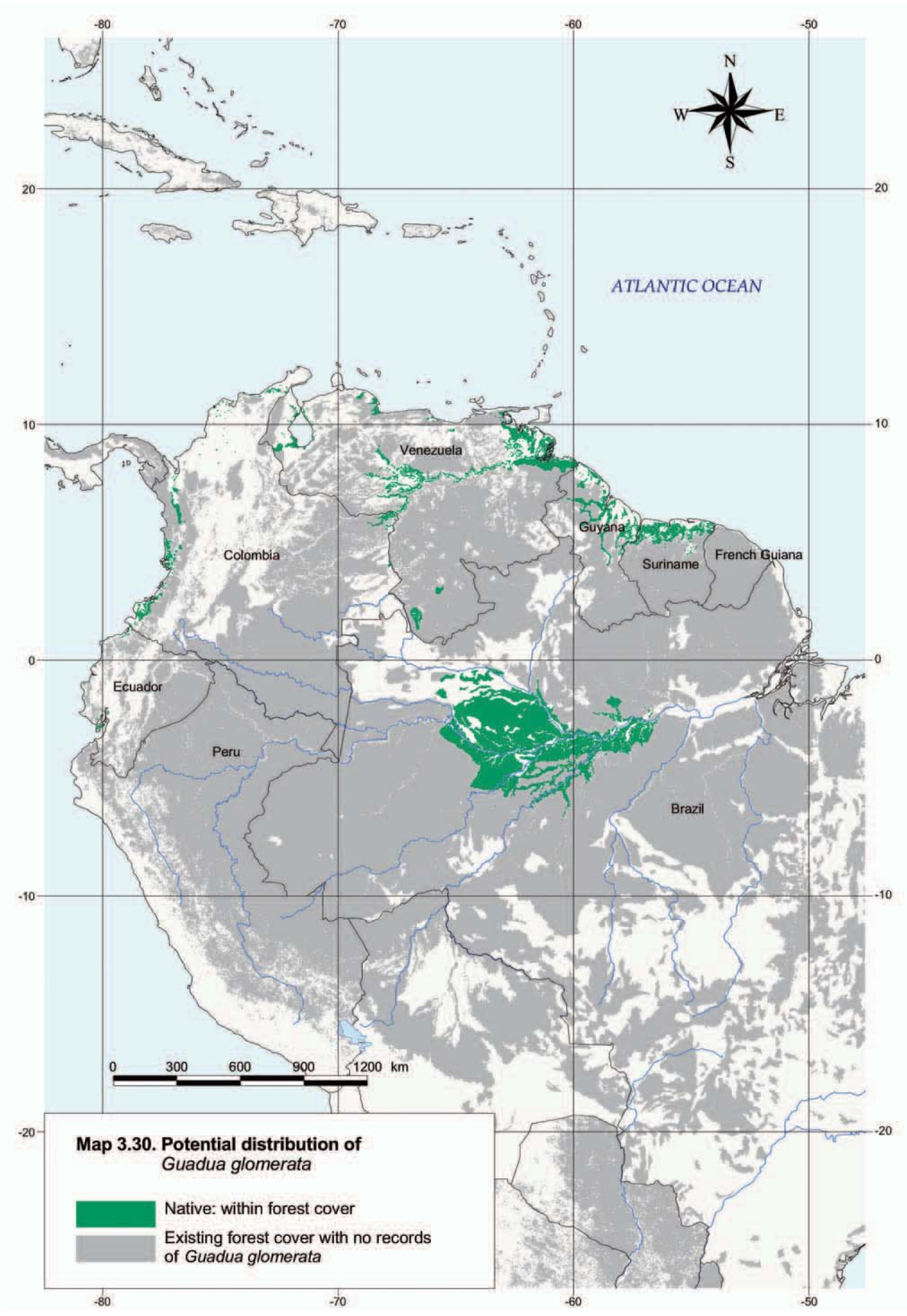
Native: within forest cover

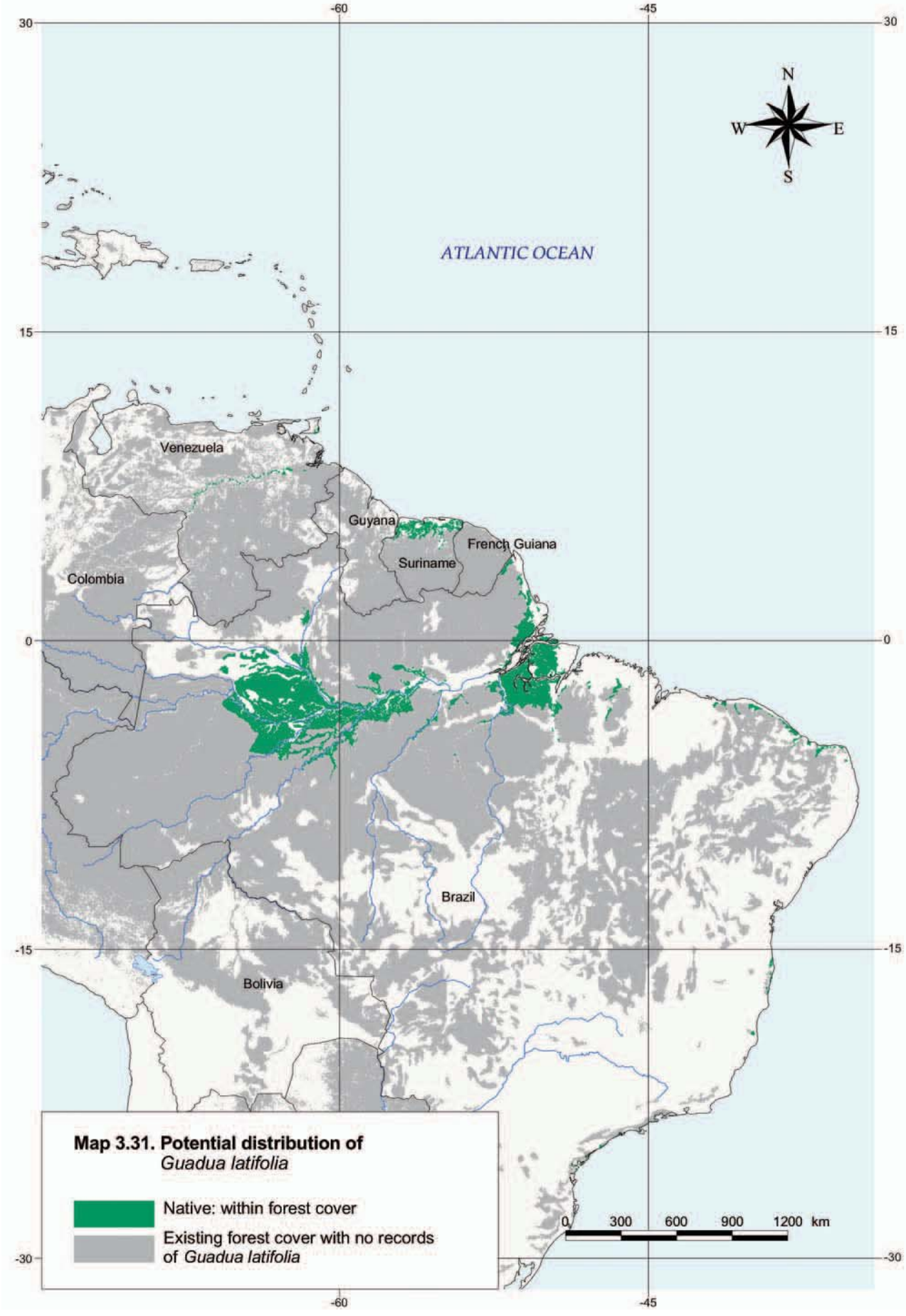
Existing forest cover with no records of *Guadua amplexifolia*

Specimens of *Guadua amplexifolia* with coordinates

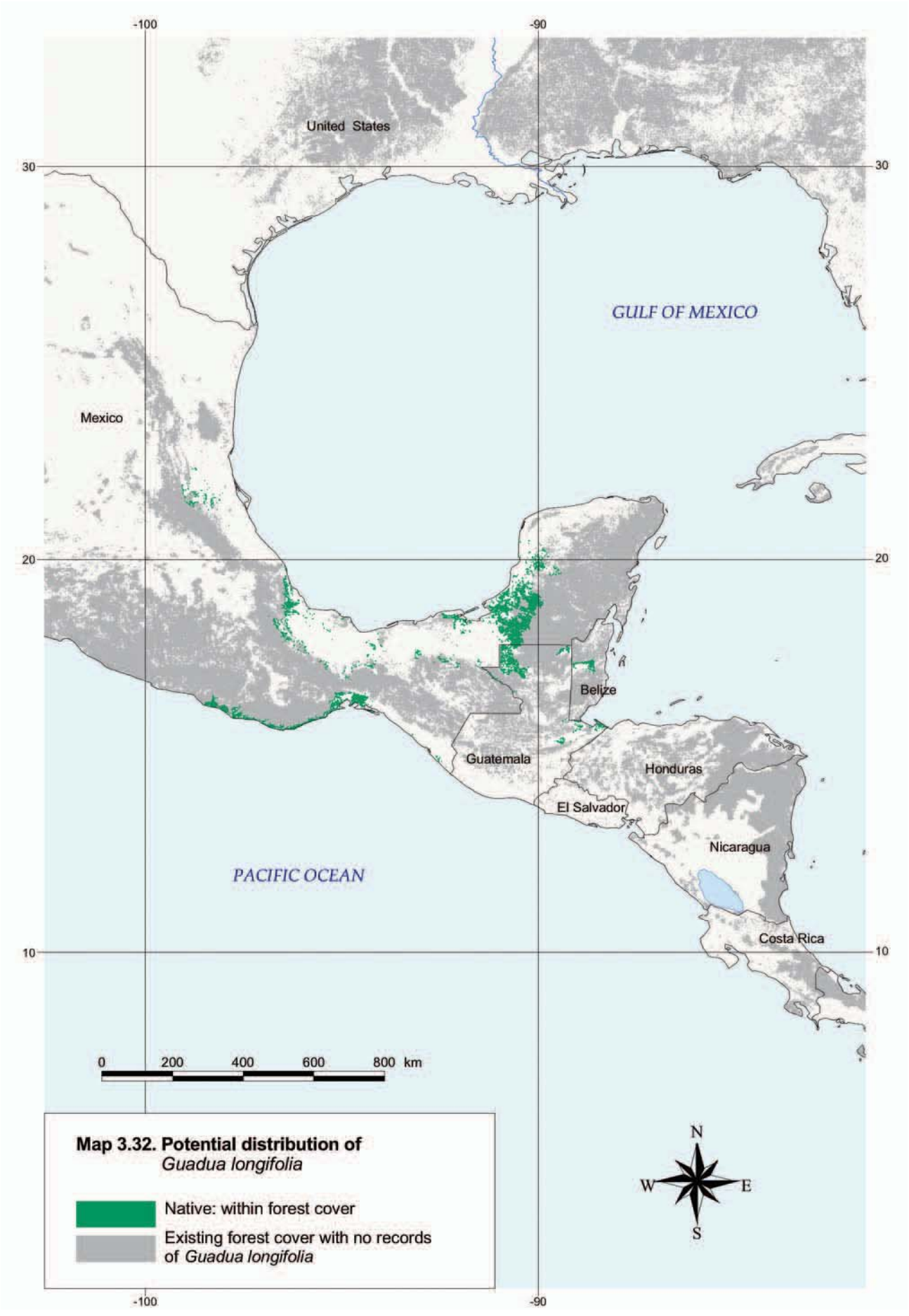


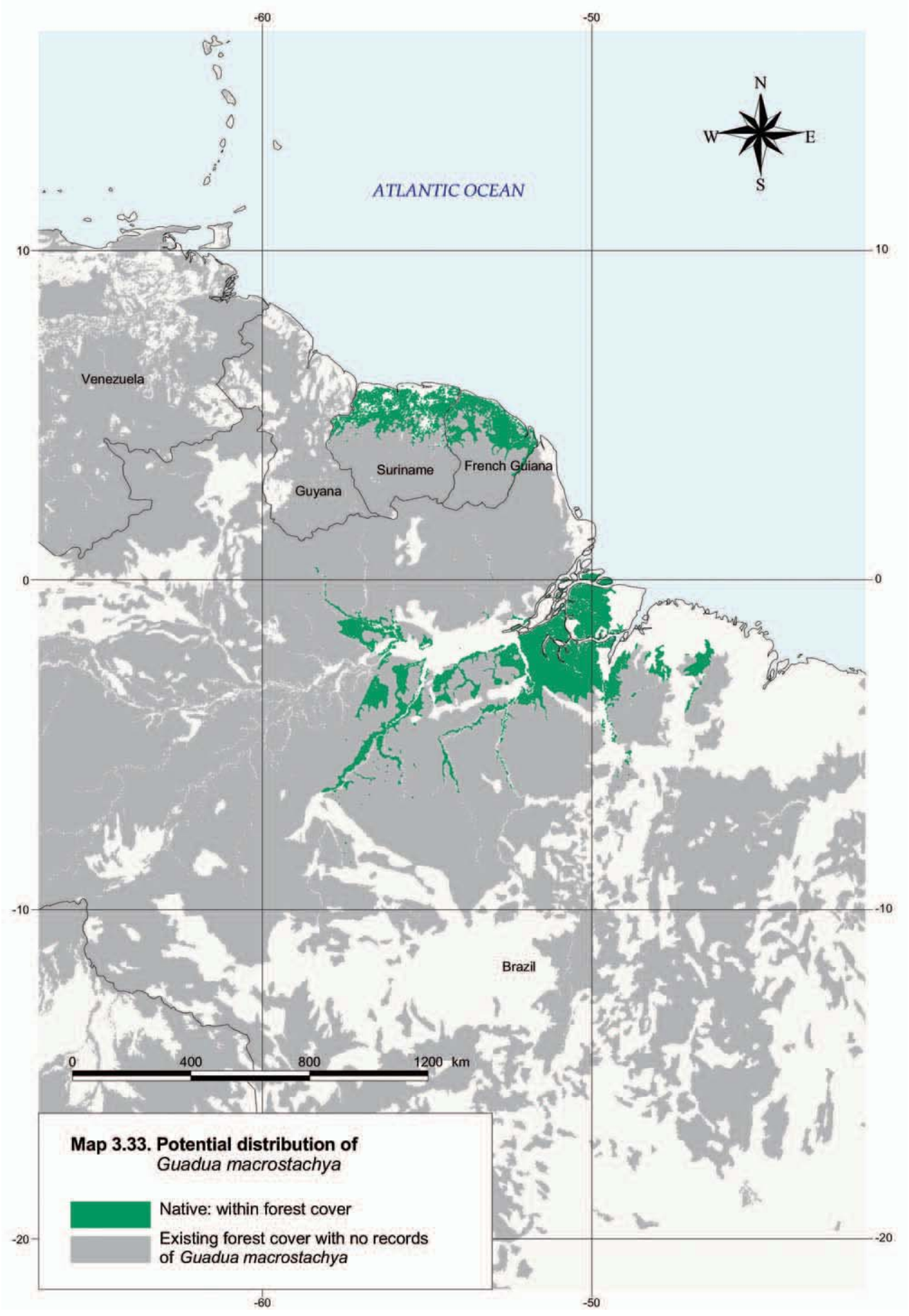
Map 3.29. Potential distribution of *Guadua angustifolia*


-80
-70
-60
-50
N
W
E
S
20
10
0
-10
-20
ATLANTIC OCEAN
Venezuela
Guyana
Suriname
French Guiana
Colombia
Ecuador
Peru
Brazil
0 300 600 900 1200 km
Map 3.30. Potential distribution of *Guadua glomerata*
Native: within forest cover
Existing forest cover with no records of *Guadua glomerata*



Map 3.31. Potential distribution of *Guadua latifolia*


-100
-90
30
20
10
United States
GULF OF MEXICO
Mexico
Belize
Guatemala
Honduras
El Salvador
Nicaragua
Costa Rica
PACIFIC OCEAN
0 200 400 600 800 km
N
W
E
S
Map 3.32. Potential distribution of *Guadua longifolia*
Native: within forest cover
Existing forest cover with no records of *Guadua longifolia*



Map 3.33. Potential distribution of *Guadua macrostachya*

Native: within forest cover

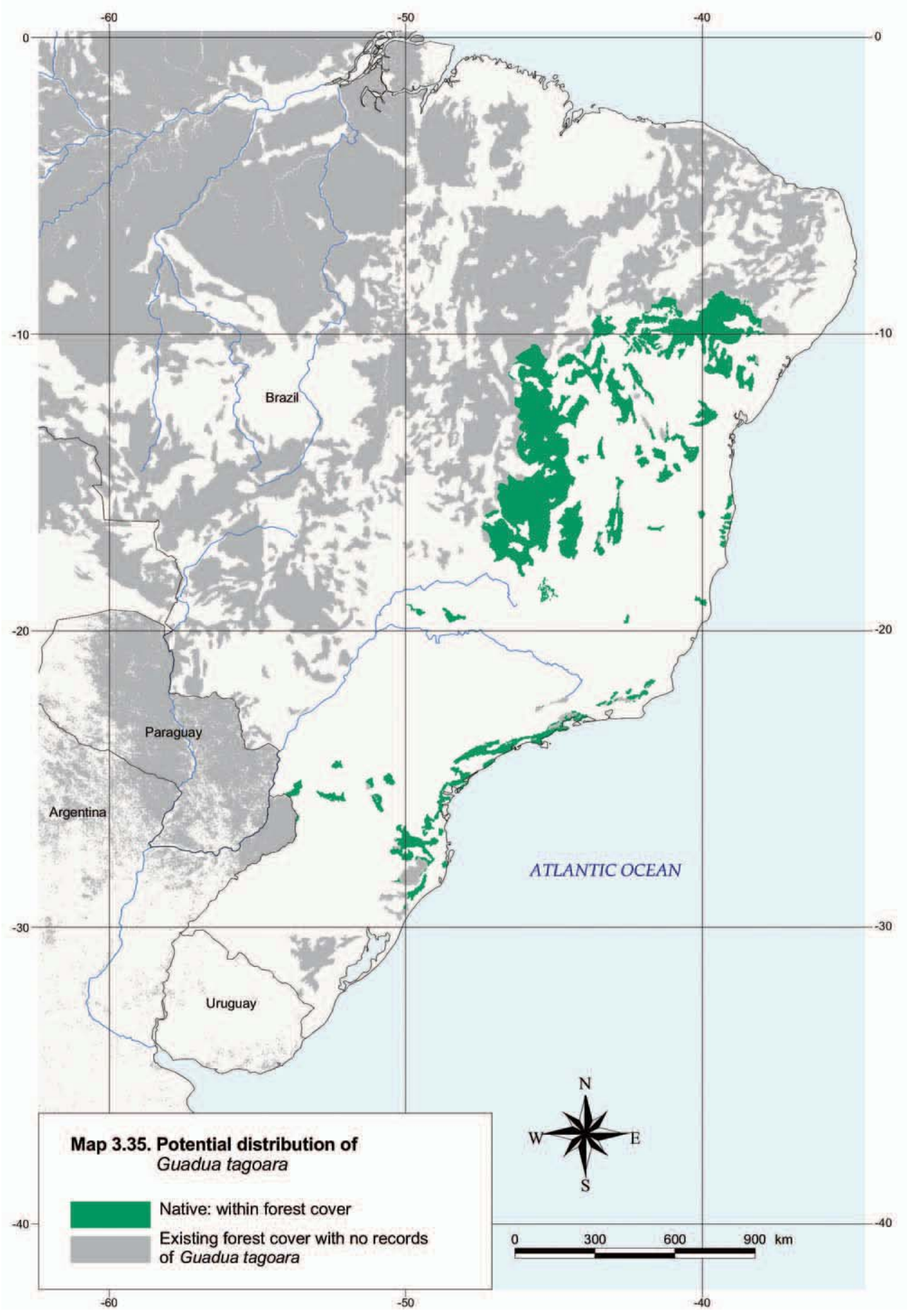
Existing forest cover with no records of *Guadua macrostachya*

Map 3.34. Potential distribution of *Guadua paniculata*

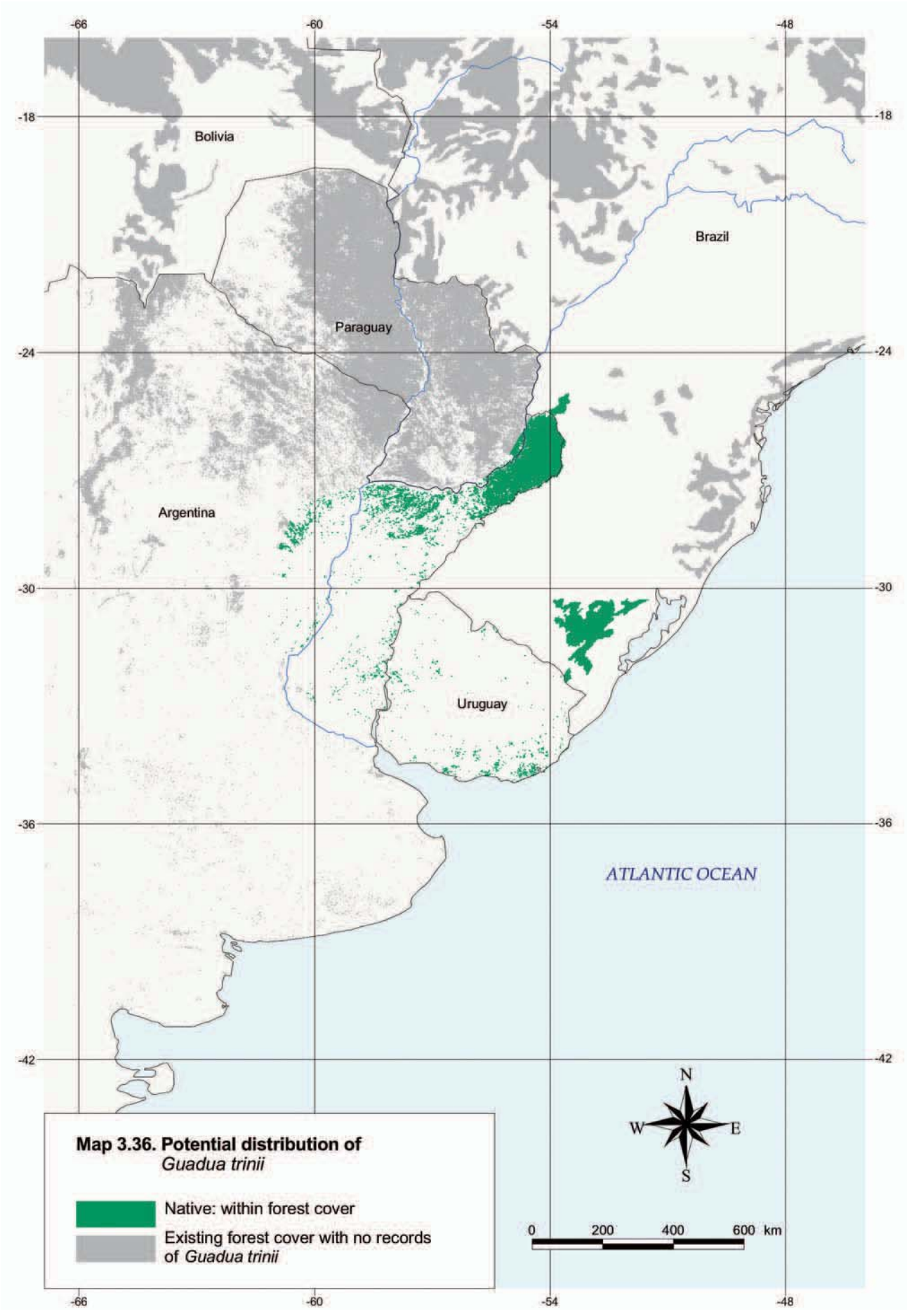
Native: within forest cover

Existing forest cover with no records of *Guadua paniculata*

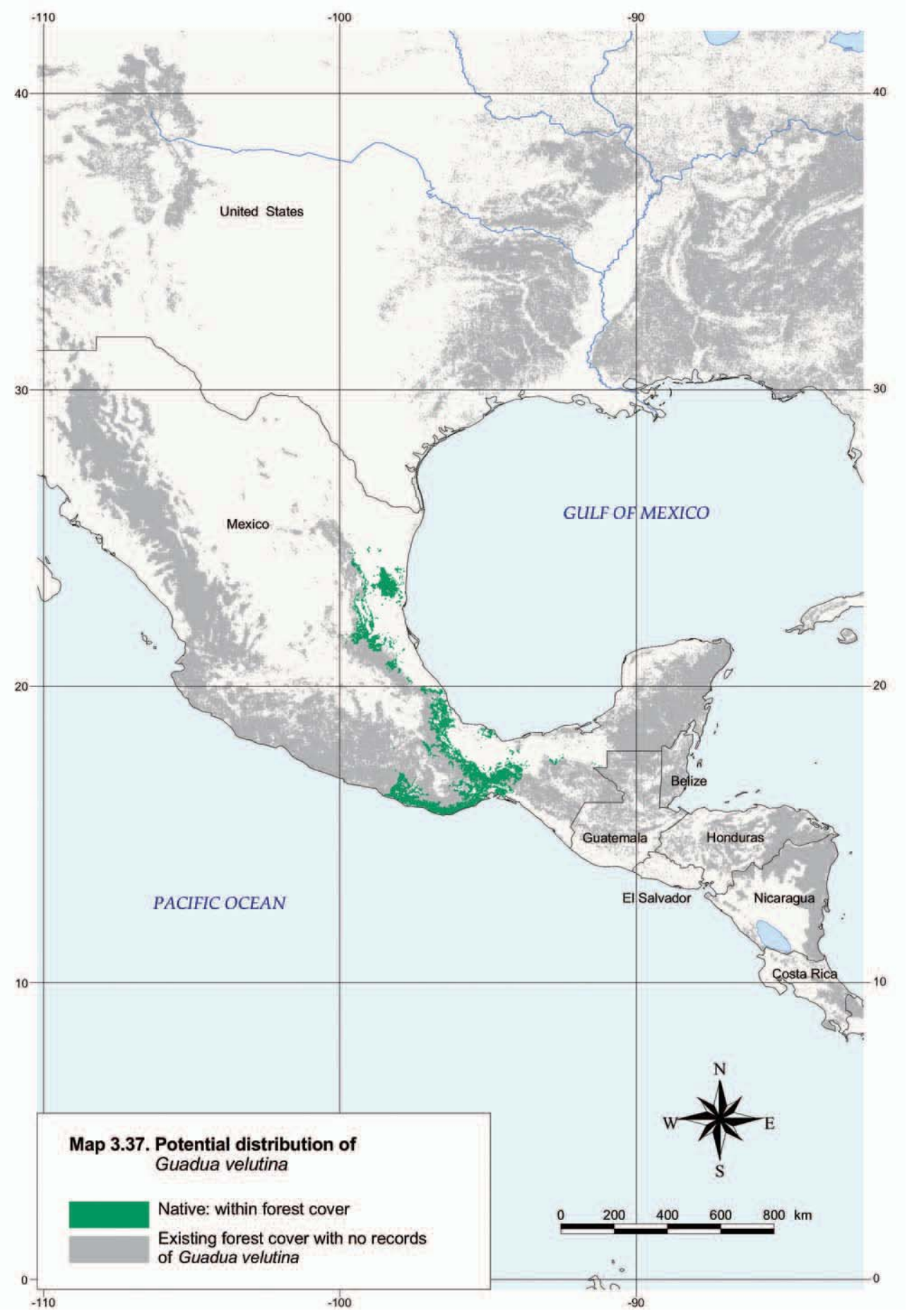
Specimens of *Guadua paniculata* with coordinates

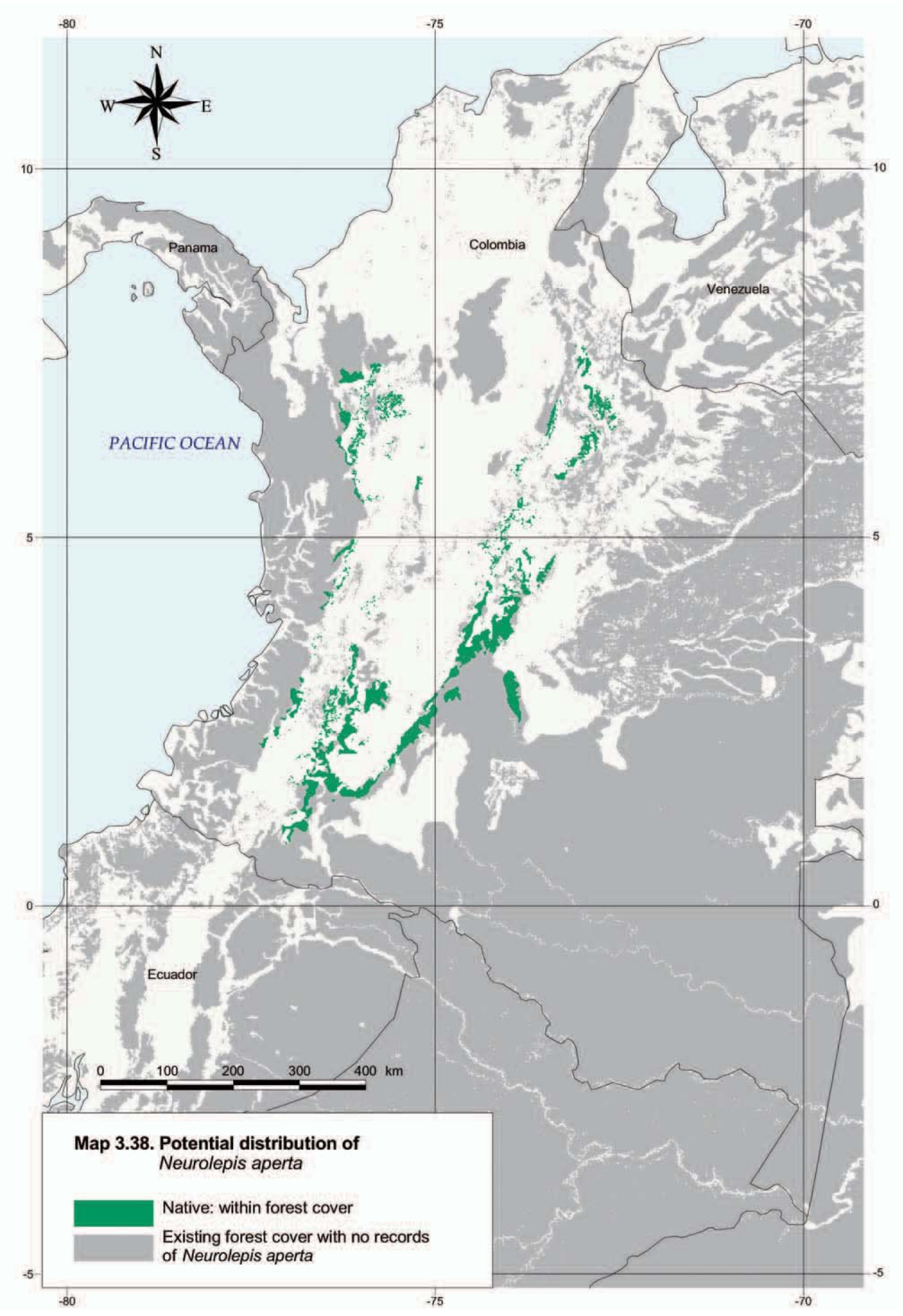


Map 3.35. Potential distribution of *Guadua tagoara*

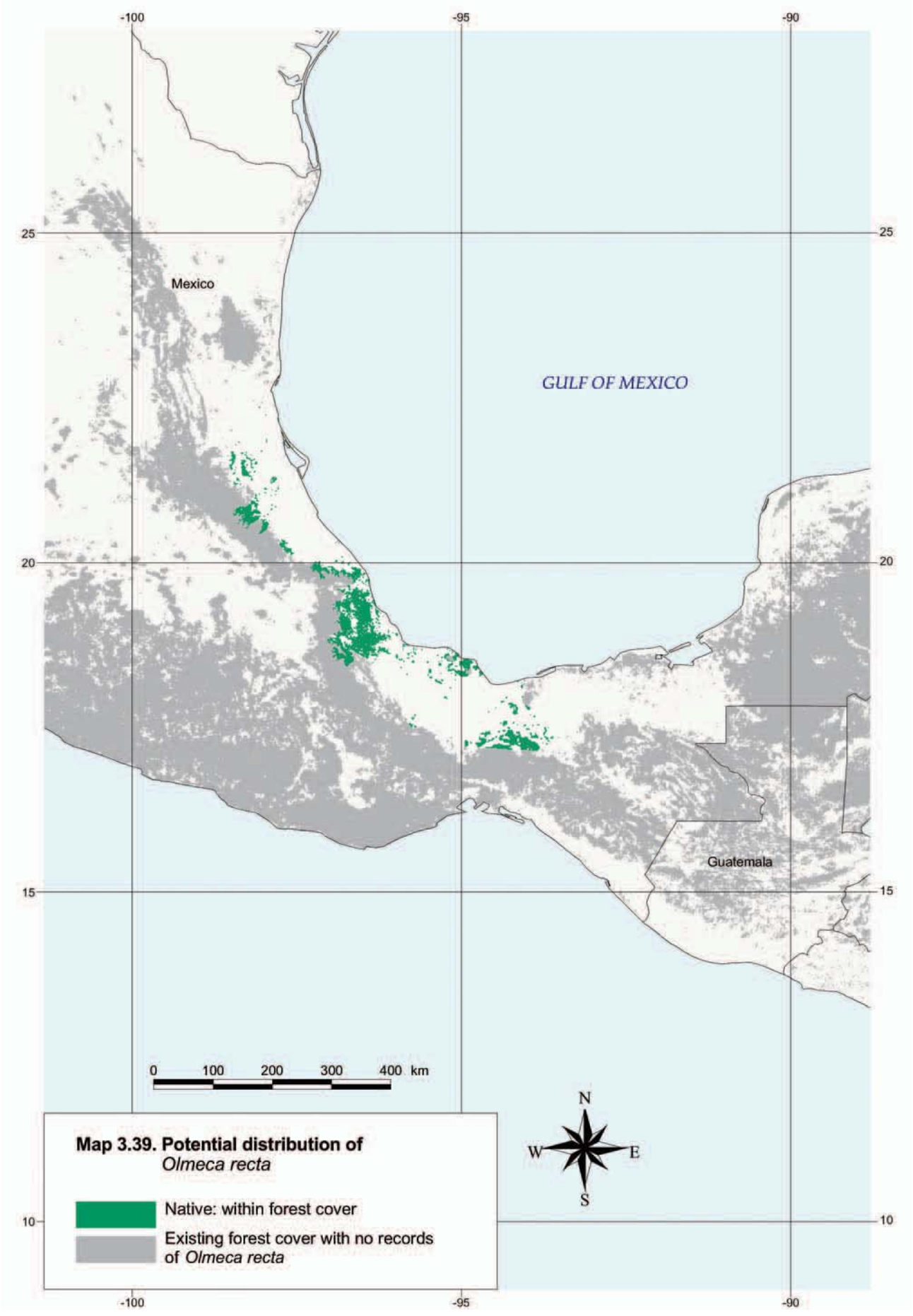


Map 3.36. Potential distribution of *Guadua trinii*

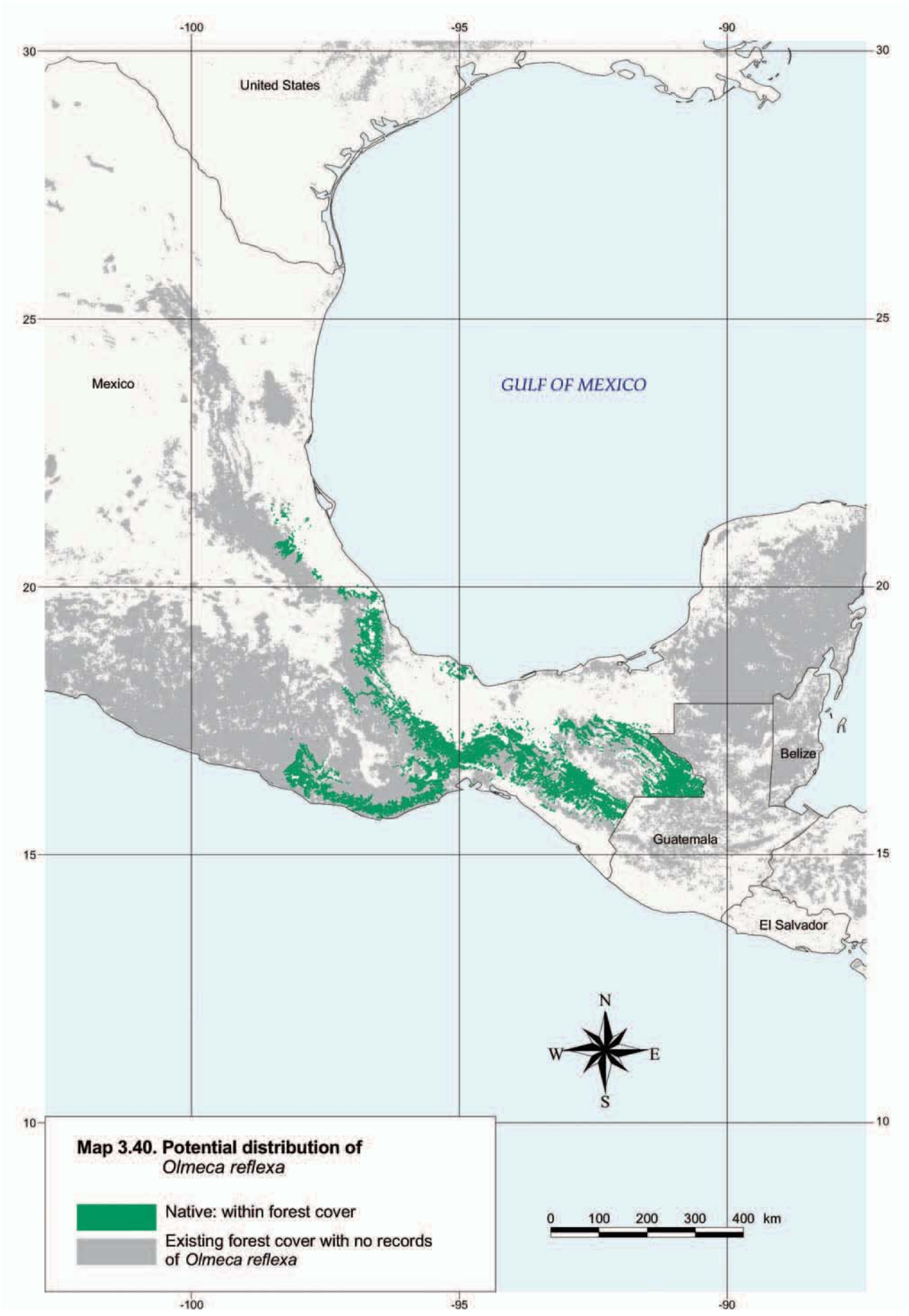

-110
-100
-90
40
30
20
10
0
United States
Mexico
GULF OF MEXICO
PACIFIC OCEAN
Belize
Guatemala
Honduras
El Salvador
Nicaragua
Costa Rica
N
W
E
S
0 200 400 600 800 km
Map 3.37. Potential distribution of *Guadua velutina*
Native: within forest cover
Existing forest cover with no records of *Guadua velutina*

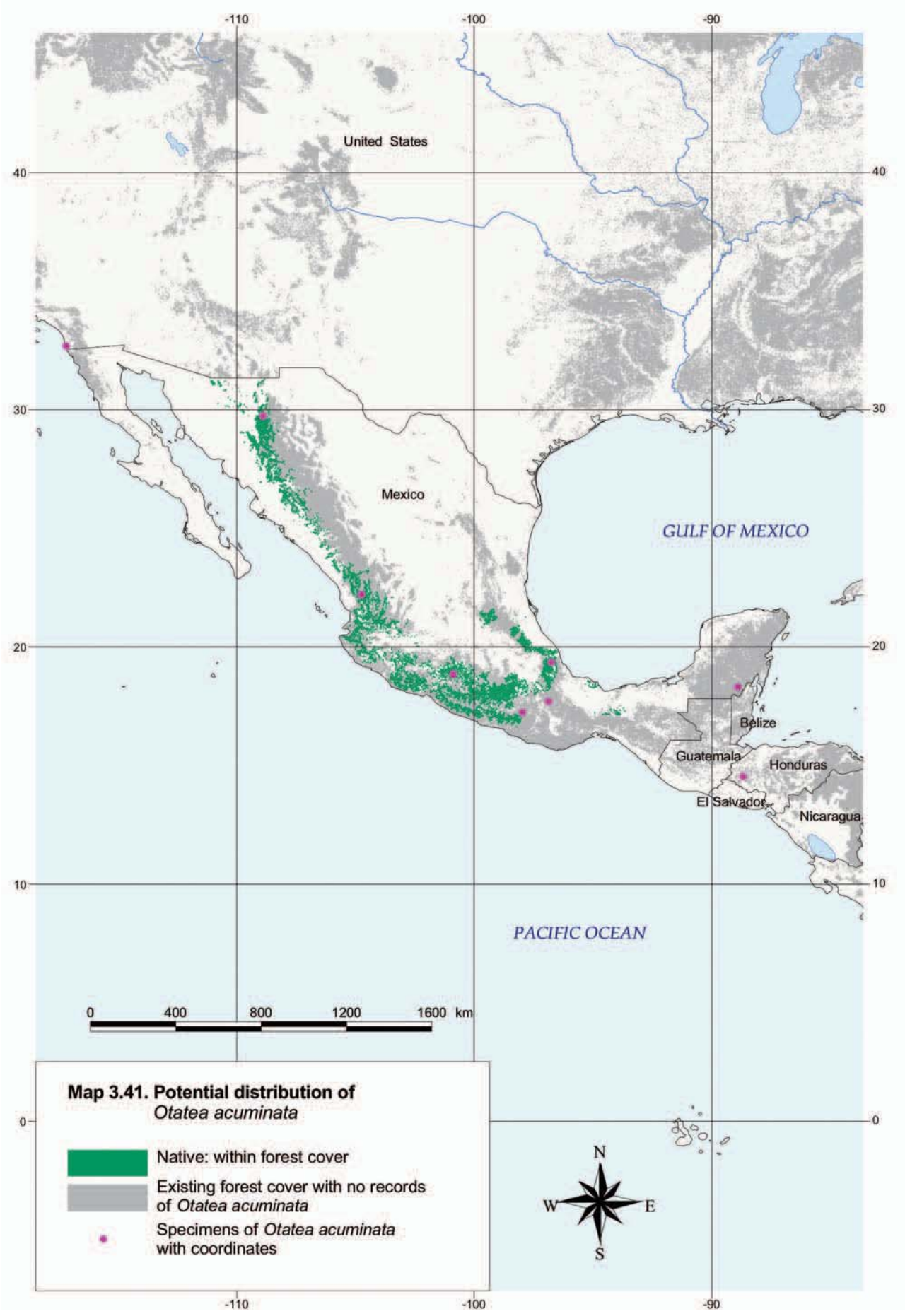


Map 3.38. Potential distribution of *Neurolepis aperta*



Map 3.39. Potential distribution of *Olmeca recta*


-100
-95
-90
30
25
20
15
10
United States
Mexico
GULF OF MEXICO
Belize
Guatemala
El Salvador
N
W
E
S
0 100 200 300 400 km
Map 3.40. Potential distribution of *Olmeca reflexa*
Native: within forest cover
Existing forest cover with no records of *Olmeca reflexa*

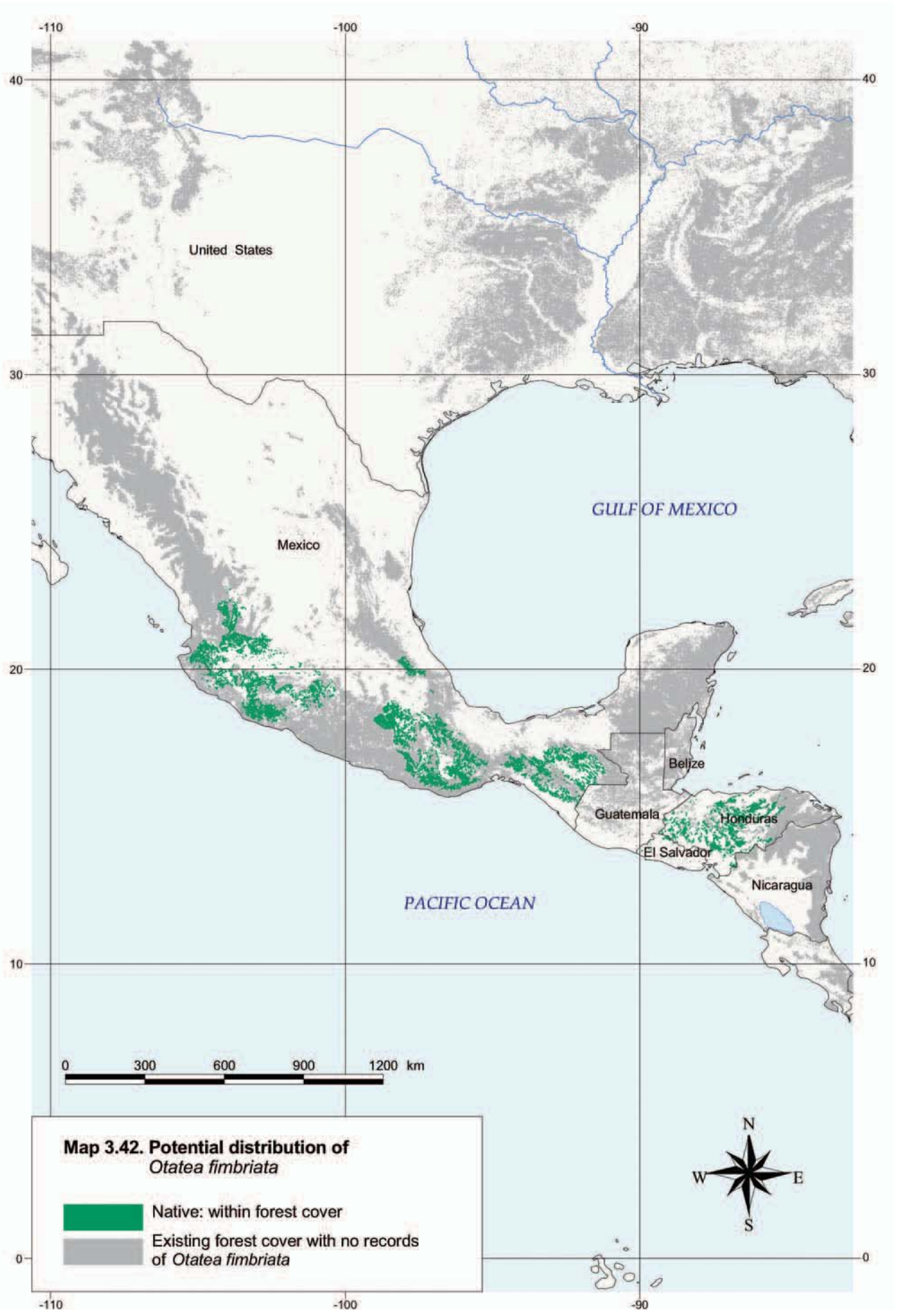


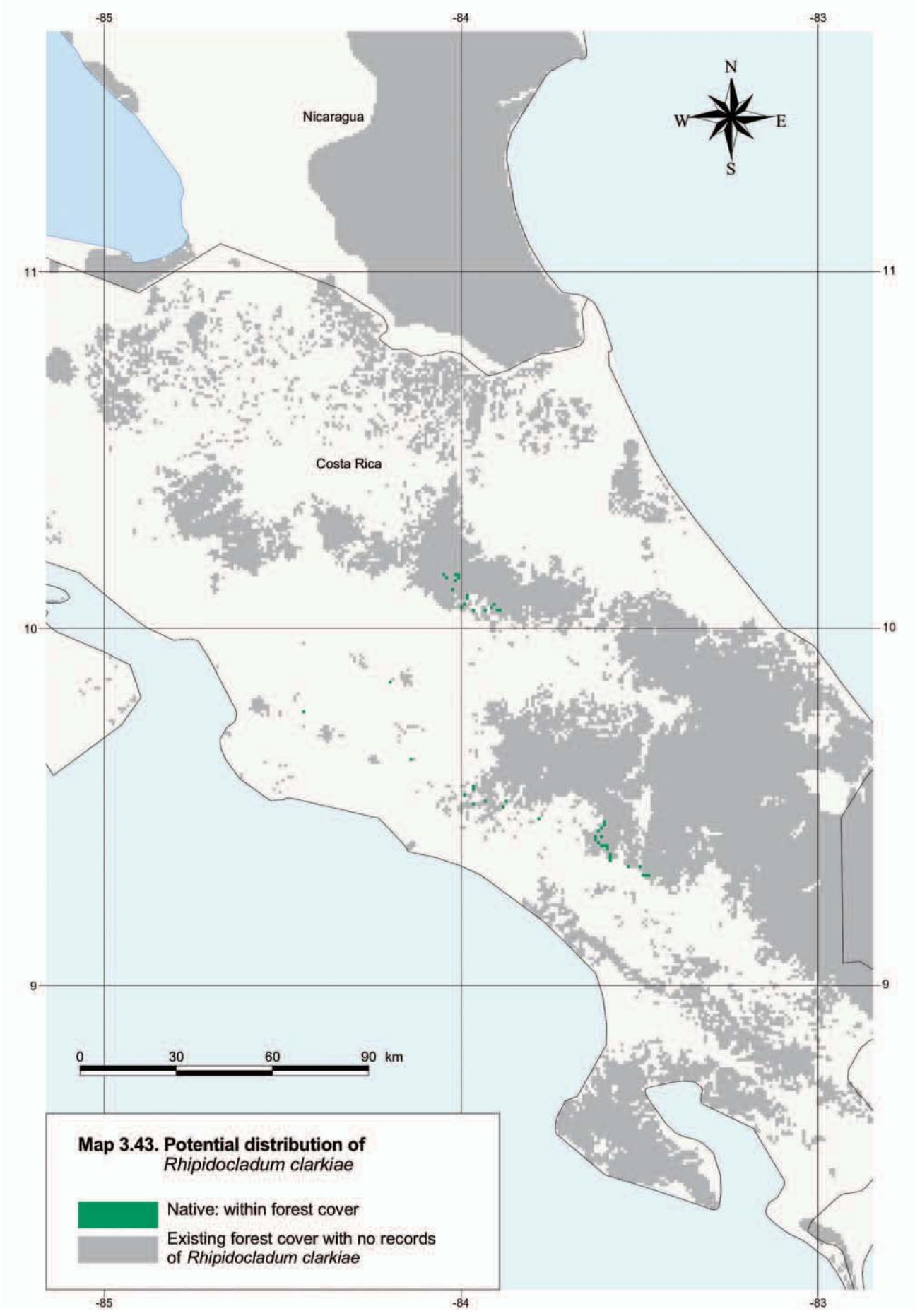
Map 3.41. Potential distribution of *Otatea acuminata*

Native: within forest cover

Existing forest cover with no records of *Otatea acuminata*

Specimens of *Otatea acuminata* with coordinates

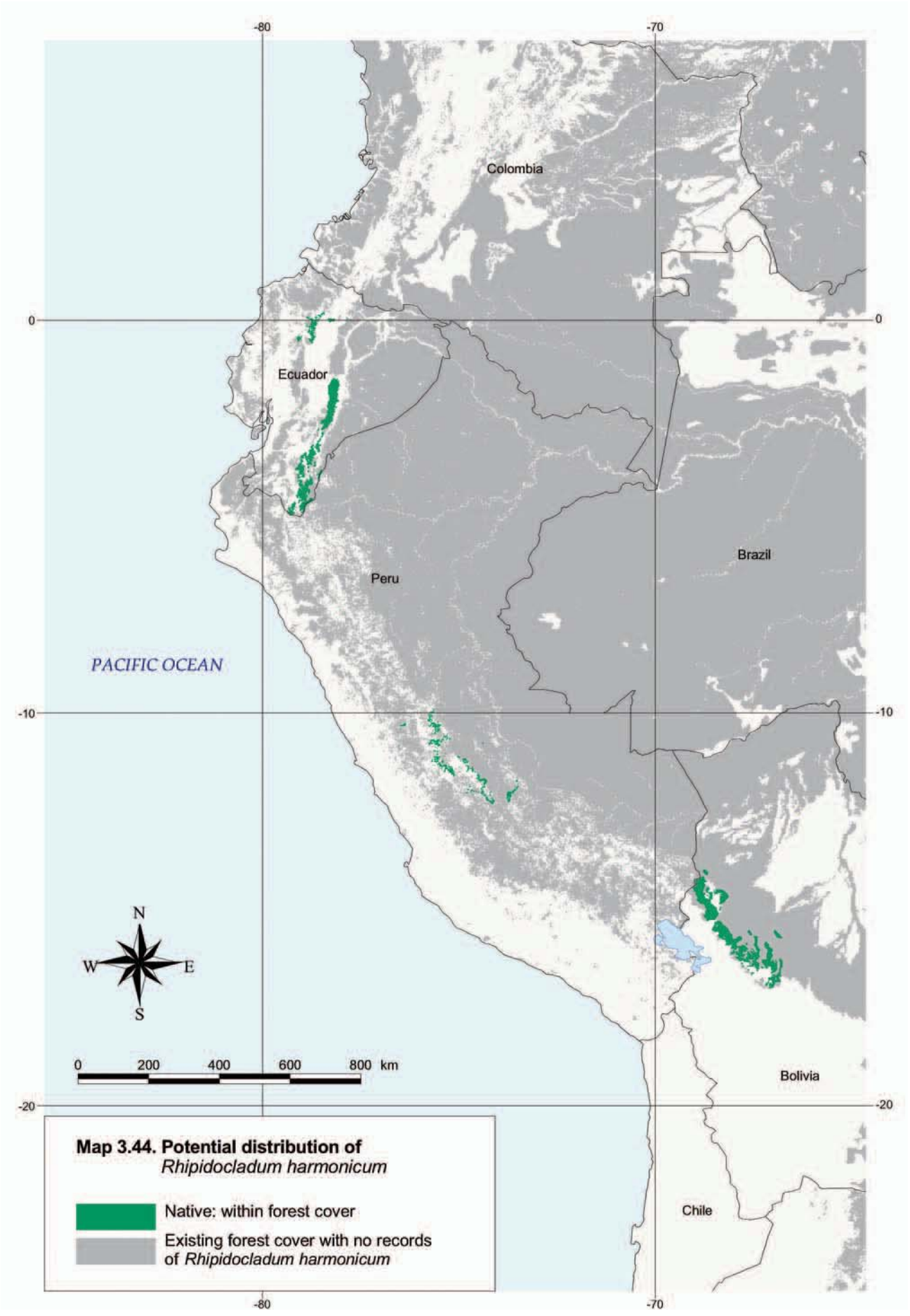

-110
-100
-90
40
30
20
10
0
United States
Mexico
GULF OF MEXICO
PACIFIC OCEAN
Belize
Guatemala
Honduras
El Salvador
Nicaragua
0 300 600 900 1200 km
N
W
E
S
Map 3.42. Potential distribution of *Otatea fimbriata*
Native: within forest cover
Existing forest cover with no records of *Otatea fimbriata*



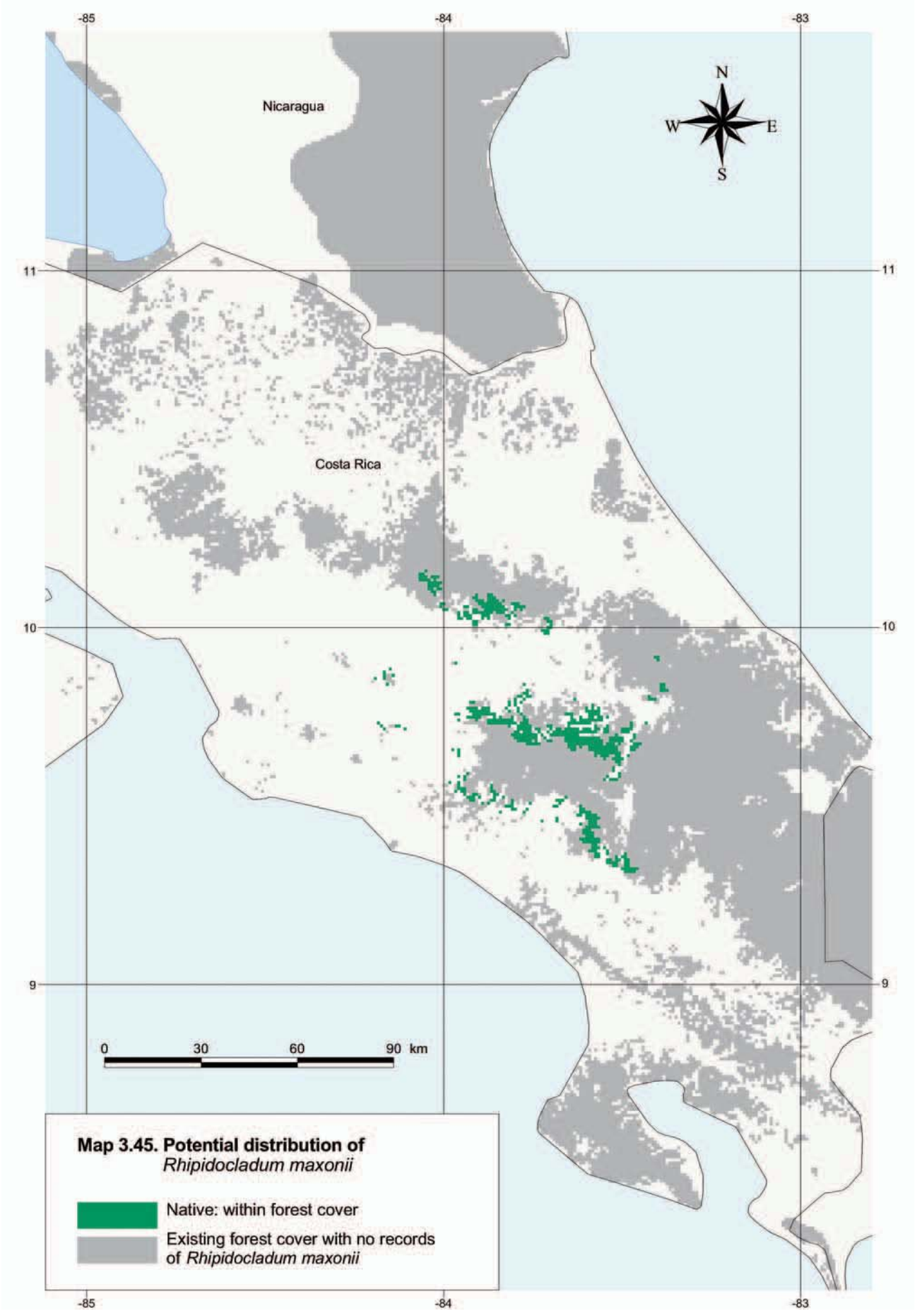
Map 3.43. Potential distribution of *Rhipidocladum clarkiae*

Native: within forest cover

Existing forest cover with no records of *Rhipidocladum clarkiae*



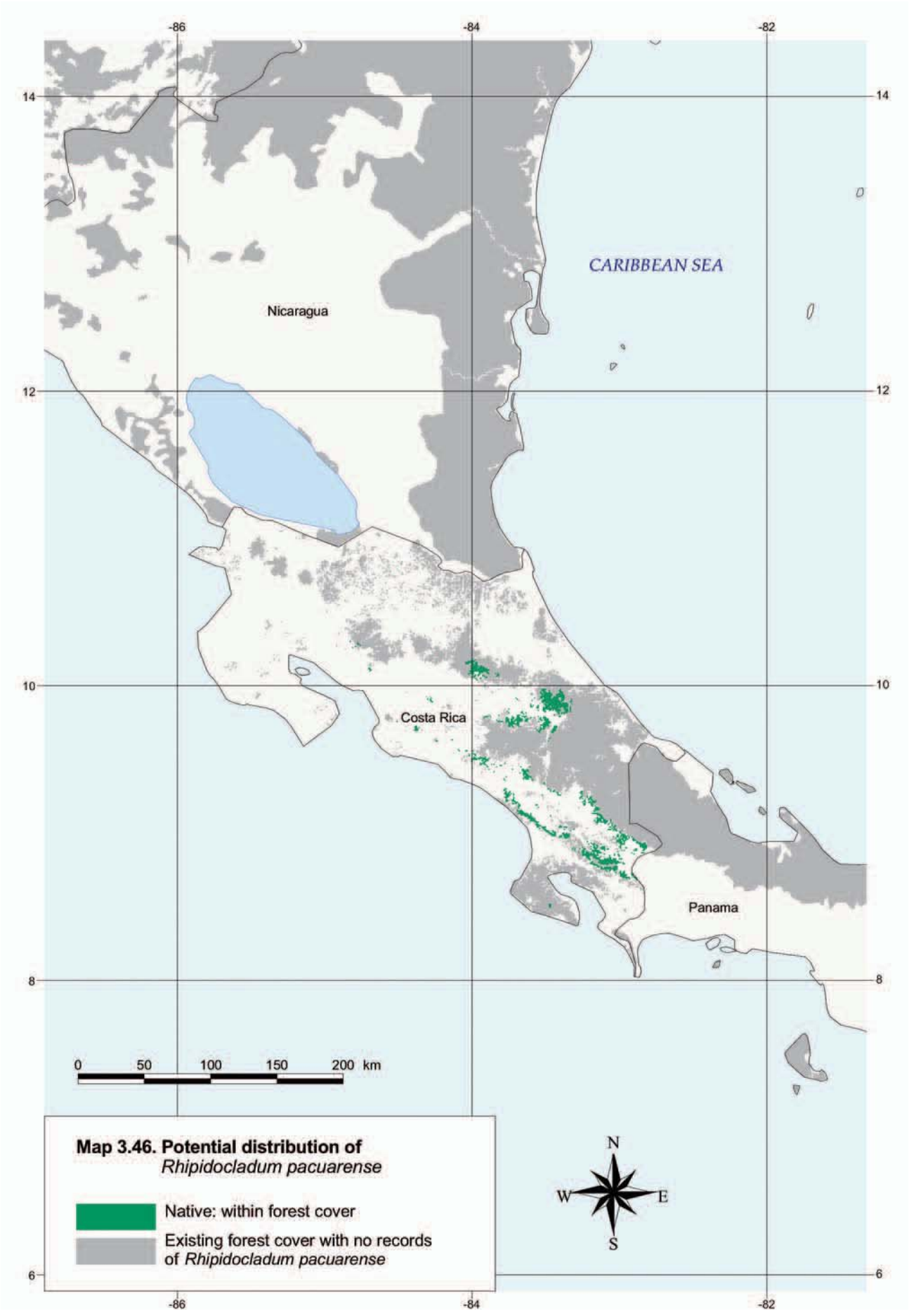
Map 3.44. Potential distribution of *Rhipidocladum harmonicum*



Map 3.45. Potential distribution of *Rhipidocladum maxonii*

Native: within forest cover

Existing forest cover with no records of *Rhipidocladum maxonii*



Map 3.46. Potential distribution of *Rhipidocladum pacuarense*

Native: within forest cover

Existing forest cover with no records of *Rhipidocladum pacuarense*

Front cover/title page: Bill Love/Blue Chameleon Ventures
Above: INBAR

Bamboo biodiversity

Africa, Madagascar and the Americas

Bamboos are distinct and fascinating plants, with a wide range of values and uses. They play a significant role in biodiversity conservation, are important to ecosystem dynamics, and contribute to soil and water management. They play an increasing role in local and world economies.

This study used an innovative approach to map potential current distributions of nearly 400 individual bamboo species that occur naturally within the remaining forests of Africa, Madagascar and the Americas. The maps were also combined to generate regional maps showing potential species and generic richness.

By quantifying the area of forest cover remaining within each species' range, this analysis shows that over half the species studied are potentially threatened by the destruction of natural forest cover. The situation is particularly alarming in Madagascar, where the woody bamboos are all endemic and 75 per cent of them have only very small amounts of forest remaining within their ranges. Conservation and sustainable management of wild populations of bamboo should be a priority in all three regions, especially where diversity is high or deforestation is a significant threat.

This report contributes to implementation of the *Global Strategy for Plant Conservation*, which aims to halt the current and continuing loss of plant diversity.

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