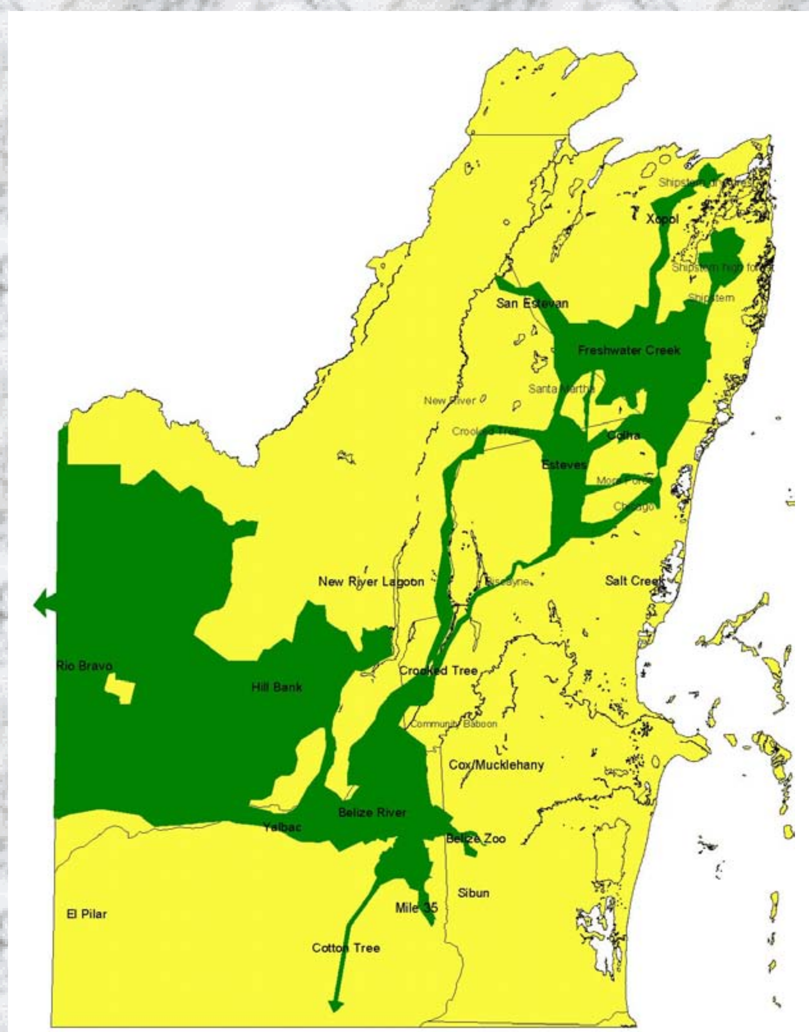
Feasibility Study of the Proposed Northern Belize Biological Corridors Project (NBBCP)

Volume I:
Main Report



Report to Programme for Belize
Presented by Jan Meerman
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Team:

Jan Meerman (Biodiversity Specialist): Principal Consultant. Responsible for team coordination, research of biological characteristics of the biological corridor routes. Report production.

Mary Vasquez (GIS specialist): GIS assistant responsible for GIS related issues, production of maps and database design.

Ellen McRae (Ornithologist, Aquatic Biologist): Responsible for monitoring program and strategy design. Research of biological characteristics of the biological corridor routes with specific attention for birds, watersheds and aquatic species.

Norman Arnold (Land consultant): Land tenure research. Responsible for research of land ownership patterns.

Tineke Boomsma (Social and Physical Geographer): Focus on land tenure, current and potential land use patterns.

Roger Wilson (Protected area specialist): General resource and support

LIST OF ACRONYMS

AFFWCFR	Association of Friends of Freshwater Creek Forest Reserve
BAS	Belize Audubon Society
BELRIV	Belize River Valley
C	Celcius
CCAD	Central American Commission of Environment and Development
CTWS	Crooked Tree Wildlife Sanctuary
DoE	Department of the Environment
EIA	Environmental Impact Assessment
F	Fahrenheit
GEF	Global Environmental Facility
GOB	Government of Belize
GPS	Global Positioning System
IUCN	World Conservation Union
LIC	Land Information Center
MBC	Mesoamerican Biological Corridor
NBBC	Northern Belize Biological Corridor
NBBCP	Northern Belize Biological Corridors Project
NGO	Non-Governmental Organization
NPAS	National Protected Areas System
ODA	Overseas Development Administration
PfB	Programme For Belize
RBCMA	Rio Bravo Conservation and Management Area
UNEP	United Nations Environmental Programme
SDA	Special Development Area
WB	World Bank

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1. SUMMARY AND RECOMMENDATIONS

This study showed that as much as 67 % of Northern Belize is still under some form of broadleaf forest cover. Nevertheless, it was found that there were very few viable options for linking the individual forested areas by means of (forest) corridors. Virtually all the potentially viable corridors were very narrow and under great human pressure. Without further action each of the identified corridors can be expected to cease functioning as such within the next decade.

The crossings over both the Northern and the Western Highways were found to be the most precarious. 2 viable primary crossings were identified along the Northern Highway and 3 of which 1 primary along the Western Highway.

The high traffic intensity on these highways will cause multiple deaths among wildlife attempting to cross. For this reason it is important to put “wildlife mirrors” along the sides of the road which reflect light from the headlights of oncoming traffic and thus warn wildlife of imminent danger.

Next to primary corridors, the study also recognizes “secondary corridors” and “supported corridors”. Secondary corridors are either second options in case the primary corridor fails or of secondary value to the corridor system as a whole. Supported corridors are important on a local scale but are not vital to the NBBC as such.

The Study clearly indicates the priority areas for both action and community involvement. It is recommended to restrict community activities to those communities that have an impact on the identified corridors.

For each corridor section a separate set of “challenges” have been identified. It is recommended that these challenges will be taken into account in the design of community participation projects.

The main challenge will be to implement some form of landuse planning on local and national government level. The Environmental Impact Assessment mechanism should be utilized to implement corridors in private developments

2 INTRODUCTION

The Northern Belize Biological Corridors Project (NBBCP) is being implemented by Programme for Belize. The project, funded by the Global Environment Facility (GEF) through the World Bank, is aimed at promoting biodiversity conservation and sustainable development in the Belize, Orange Walk and Corozal Districts. This objective will be achieved through the improved conservation of biodiversity in passages that link protected areas found in this region of the country, largely through actions taken by communities.

Careful analysis has yielded a network of preferred and an alternate corridor routes, with the Rio Bravo Conservation and Management Area forming the critical link for the system, not only in northern Belize but also in the rest of the country and across the western border.

2.1. The rationale for biological corridors.

Protected areas constitute the principal tool for biodiversity conservation. This approach – designating areas with particularly important characteristics or biological richness and placing them under management regimes that maintain those qualities – does, however, have shortcomings if employed as the sole conservation technique. Biological corridors have been proposed as a means of overcoming those problems.

The central issue is the fragmentation and eventual elimination of natural habitats, and their replacement by landscapes modified by man. This process is the most important cause of species loss in the current global extinction wave. Where natural habitat is already broken up, protected areas are perforce established in the residual natural areas and are thus isolated from each other and often small in extent. Where natural habitat is still extensive, as in Belize, the areas themselves are scattered but retain habitat connections beyond their boundaries. The fragmentation process is, however, only at an earlier stage. On-going trends in demographic growth, economic development, and land use change all indicate that the end-result in the foreseeable future will be the same – a scatter of protected areas of various sizes, isolated from each other, and themselves coming under increasing pressure.

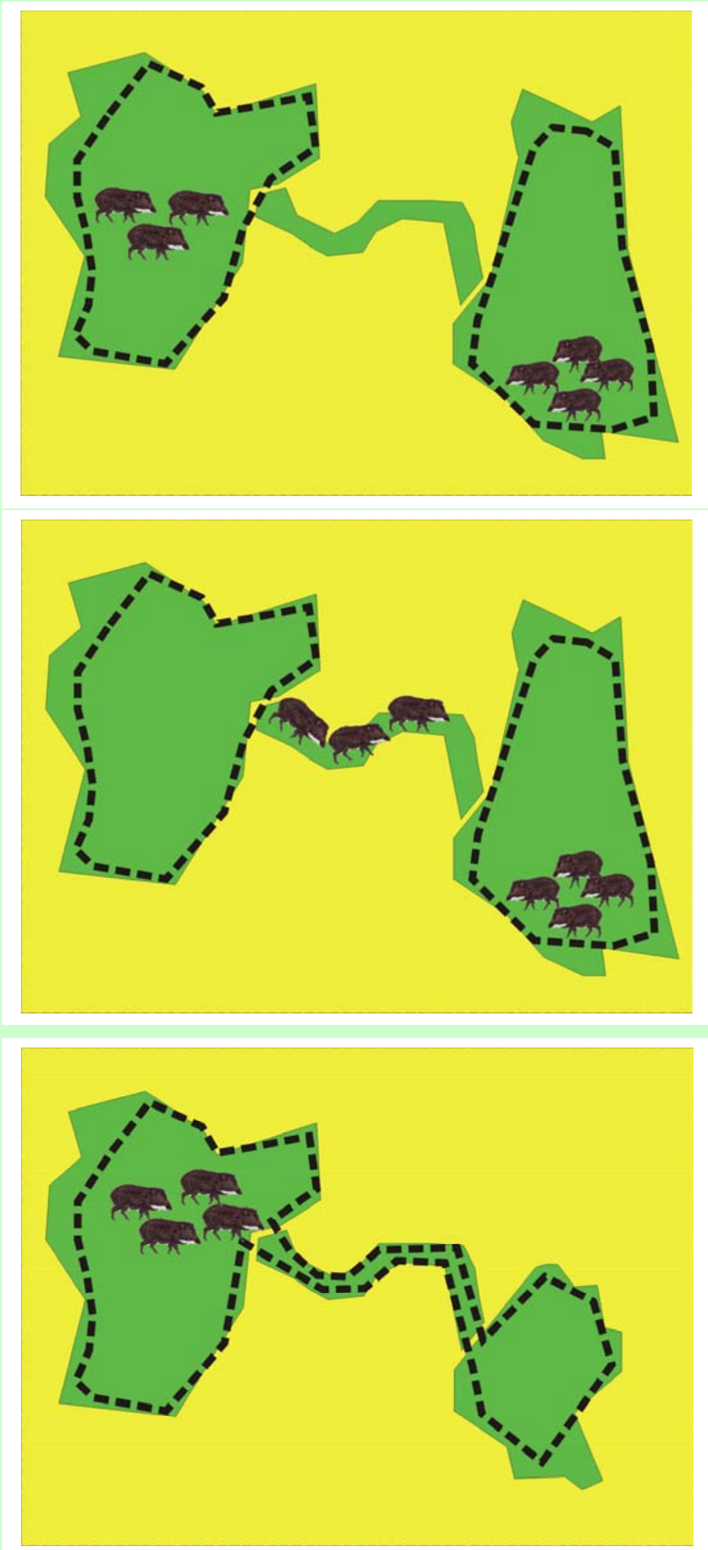
The problems lie in the ecological dynamics of smaller, fragmented, isolated habitat patches as against extensive, continuous, tracts. These have now been well-studied, using island biogeographical theory supported by field observations and experimentation. The basic phenomenon is that a given area can, in isolation, support a much less diverse biological community than the same area embedded within a larger extent of the same habitat. When isolated, the number of species therefore falls, rapidly at first but sustained for a long period of time, to a new, more impoverished, level. The degree to which this "relaxation" occurs is dependent on such factors as the area of the relict patch, the proximity of other similar patches, and the ability of individual species within the original community to traverse the intervening, now less hospitable, terrain. The actual dynamics are many and varied, and act in different ways with different species according to their ecology and population biology, but four major processes – often acting in combination – can be identified and illustrate the issue.

- Many populations of animals and plants are patchily distributed, and may simply not occur in remnant habitat fragments. There is an element of chance in this process, but the likelihood of loss increases as the area of habitat is reduced. The logical end-point is reached when no further habitat remains and all dependent species are eliminated. Species with specialised requirements are likely to be affected first. A rare species such Orange-breasted Falcon *Falco deiroleucus* that appears to need cliffs in extensive forest would, for instance, be lost if it happened that no such combination was included in the protected area system. Species that combine specialist requirements with limited dispersal capability are even more at risk.
- Even before this end point is reached, populations may fall below the minimum level (often reckoned at c. 1000 individuals) for long-term viability. In-breeding effects reduce vigour, and small, isolated, scattered populations become vulnerable to random events (e.g. fires, hurricanes, epidemics) or pressures (e.g. hunting) from which they could previously recover. Reduction in population density can even break up breeding strategies. Naturally wide-ranging but thinly distributed species, often top-predators, are likely to show these effects first. Again, the effect becomes more pronounced as the area is reduced.
- While the general habitat remains, critical elements of that habitat required by particular species at particular times may be lost. These requirements are often seasonal – food and water being obvious examples – and may only be needed for a short but critical period. Species engaging in regular movements, including long-distance migrants, where staging points on the migration routes are used briefly but are nonetheless essential, are cases in point. A similar process takes place where the habitat is changed in a way that renders it unsuitable – e.g. edge effects allowing penetration of competitors or causing micro-climatic changes. In both cases, the habitat may appear to have been conserved, but no longer provides all the characteristics essential for survival of certain members of the community.
- Although the number of species occupying a given area may be more or less constant, the actual species composition is not. There is always a degree of species turnover on a given site, with some species being lost and replaced by others that have immigrated into the area. Some populations may come and go in this way while others, especially those in marginal habitat, are only maintained by regular replenishment from a neighbouring source population. This is a physical version of the genetic interchange mentioned above, and is broken up by fragmentation and isolation. The local extinction then occurs without the corresponding replacement and local biodiversity is diminished.

The effects are compounded by reduced resilience in the natural system. Loss of certain community members results in an extinction cascade, as the species dependent upon them are also lost. Furthermore, the system also loses its ability to adapt to climate change, whether it occurs in medium to long-term cycles or unidirectionally. In the past, the adaptation has taken the form of major shifts in geographical range, often into “refugia” where populations can persist before expanding again as conditions ameliorate. Such shifts are frequent: species composition (but not species numbers) has altered significantly on Barro Colorado island over recent decades in response to a drying climate. - A good example of a medium-term response - and present species distributions are in large part explicable in terms of population movements during glacial periods. In both cases, however, the process assumes continuity of natural habitat through which the populations can move while a barrier to that movement results in extinction. Man-modified habitat now represents just such a barrier, created on an enormous scale and so likely to disrupt this natural adaptation process fundamentally. The potential for a yet greater extinction rate is much enhanced, even inevitable, by the combination of these man-made barriers and the triggering of significant climate change through anthropogenic greenhouse gas emission.

Protected area establishment, then, is a conservation strategy with definite limitations. These limitations may be reduced by protection of more and larger areas, especially when carefully selected, but cannot be removed entirely. Furthermore, the extent required stretches the limits of practicality. Current targets such as the 10-12% protected area coverage used by the World Conservation Union are indeed only targets where actual figures are very much lower. It has been reckoned that 25-75% protection of each ecosystem is a minimum requirement to conserve fully the biodiversity of the USA. Although the Belizean protected area system is one of the most comprehensive in the world (over 30% of national area, with full representation of all natural habitats to some degree), even this is almost certainly inadequate to ensure survival of all species in the country. The key issue is connectivity between the protected areas, and the response is to broaden the strategy by keeping protected areas as the core conservation sites but to promote actions in the wider landscape that link them up. These linkages are the biological corridors. Broad connecting stretches of natural habitat is the ideal, but corridors can operate at any scale and in any way that allows some form of interchange through the landscape and between core sites. Under these conditions, even a partial linkage is better than none. The concept is encapsulated in the definition used by the US Circuit Court of Appeals in 1990 - “ avenues along which wide-ranging species can travel, plants can propagate, genetic interchange can occur, population can move in response to environmental changes and natural disasters, and threatened species can be replenished from other areas.”

Box 1. Potential functioning of a corridor.



Three hypothetical forests (green), each surrounded by open habitat (yellow: agriculture, open savanna). Two of these forests are large enough to have a herd of Collared Peccaries, a species notorious for it's intolerance to habitat fragmentation (Top figure, normal home ranges of each herd indicated by a dotted line). The narrow forest in itself does not provide a suitable habitat (too small, not enough food) to have it's own resident herd of peccaries.

This narrow forest fragment, however, does provide the peccaries with enough cover to allow safe passage from one forest to the next (middle figure). Now the narrow forest, which in itself may be unsuitable habitat for long term survival, acts as a biological corridor for the two peccary populations, thus enabling genetic exchange and even re-colonisation should the species become extinct in one of the two forests.

A similar situation exists when only one of the three forests is big enough to house a herd of collared peccaries. In this case the forest corridor (bottom figure) allows the herd to include the medium sized forest fragment in its home range.

This latter situation clearly exists in the case of the Shipstern Forest, which in itself is too small to permanently house a herd of Collared Peccaries, but the natural, very narrow, Shipstern Corridor, allows them to travel back and forth between the Freshwater Creek Node and the Shipstern Forest.

2.2. Evolution and deployment of the biological corridor strategy

Biological corridors are not a new strategy and various well-established approaches actually involve their use without explicitly naming them. Conservation along flyways for migrant birds, involving establishment of protected areas in the breeding and wintering grounds plus staging points along the route, are essentially long-distance corridors. These have been utilised for wildfowl for many decades, and more recently for migrants in general. Protected areas designed to include altitudinal gradients, and dumb-bell shaped areas incorporating seasonally important areas connected by a narrower linkage, long used for wide-ranging herbivores, also employ corridor strategies. The recent change, however, is the move from using them as a specific strategy for certain species or situations to a general strategy for application wherever possible. They are now widely proposed throughout the world both on a local and regional scale, with the most ambitious in the western hemisphere. These include the Wildlands Project (USA), a recent initiative to link the protected areas within the Amazon Basin, and the Meso-American Biological Corridor. The latter, which forms the larger framework for the Belizean initiatives, envisages a corridor some 3200 km long, from Mexico to Panama, connecting key protected areas through a subregion of global megabiodiversity that spans territories of seven nations.

Much of the appeal of corridors appears to lie in their inherent flexibility as a conservation tool, creating a new vehicle for new ideas and approaches to conservation management that might be controversial in a core area but are very appropriate to improving the conservation status of lands outside its boundaries. This is especially true where the aim is to reconstitute some degree of connectivity within a landscape where natural habitat is already fragmented and much reduced in area. Corridor management can also be applied at any scale, as shown by the emphasis on hedgerows and roadside verges in creating connecting webs through areas of intensive agriculture. The principles also apply where the inevitability of human activity is incontestable but where management that marries that activity with conservation interests remains possible. Development of land use systems and revenue-generation that are sustainable and compatible with conservation interests are thus important elements of corridor creation. The whole range of forestry options from promoting wild elements within a plantation to limited timber harvest within a sustainable natural forest management regime fall within this category, as do the more intensive forms of recreational and eco-tourism development. Shifting focus from protecting the very best remaining examples of natural habitat (although they still constitute the core of the strategy and their creation remains the absolute priority where such areas still lie outside the protected area system) to the improvement of the present or foreseeable environmental quality of the lands that link them immediately broadens the scope of potential activity, connects with the concept of sustainable rural development, and escapes the sense of elitism and protectionism associated with orthodox reserves.

This interest is further enhanced by the variety of management systems such flexibility allows, and most especially the scope for public involvement. The human dimension is strongly stressed within corridor management, which, being primarily a support mechanism for the core areas, lends itself well to innovative community, voluntary, and private-sector initiatives at the local level. Even more usefully, it places these efforts in a larger framework directed towards a greater end rather than leaving them as a scatter of local initiatives, adding to the satisfaction of those involved as well as serving a crucial conservation purpose. In this sense it is a valuable instrument for moving beyond conservation awareness into mobilisation of public participation and creation of a strong constituency of interest in conservation issues. By being so well adapted to decentralised, local, private sector initiatives that, in their sum, operate at a landscape level, corridors tie themselves into the general movement towards a land stewardship ethic that is not necessarily government driven but that can even drive government.

Finally, corridors offer a means of circumventing the problem of the need for more area under conservation management to protect biodiversity and other environmental values and the increasing difficulty of extensive establishment of such sites under the more restrictive protected area management regimes. By keeping local community needs and aspirations at the centre, corridors “re-package” the conservation strategy in way that is aligned with current trends and thinking. It also provides a new route to conservation actions on non-national lands, often necessary to obtain comprehensive coverage but equally often excluded from national protected area systems. Corridors are not necessarily linear nature reserves but they do serve to conserve biodiversity, prevent erosion, protect water resources, provide forest and other wildland resources, give shelter, and provide recreational, tourism, and other economic opportunities, while helping protect the characteristics and investments made in the core sites they link.

All of these factors come together in the objectives of the Meso-American Biological Corridor which, under the larger aim of ensuring long-term conservation and sustainable use of ‘the most significant biological diversity of the Central American isthmus’, are to: ‘… improve scientific and technological knowledge as a basis for biodiversity conservation and sustainable use, strengthen the institutional capabilities for the management of protected areas, support the management of at least 14 priority protected areas, improve buffer zone management, create environmental legislation framework that ensures compatibility of national laws necessary for the operation of a Regional Protected Areas System, increase awareness and positive behaviour toward conservation among people, and ensure the sustainability of conservation activities through the evaluation and establishment of long-term self-financing mechanisms, including income generating activities” (UNEP Project Description). The flexibility of the corridor concept is also seen in the range of what constitutes an acceptable corridor – from single broad swathes of natural habitat, to webs of narrower connections through the landscape including those that only partly retain their natural qualities (e.g. agro-forestry approaches), to “archipelogos” of smaller protected areas that reduce isolation by creating stepping-stones between the main core sites. The concept has even, perhaps at the risk of taking a good idea too far, been applied to “conceptual corridors” linking widely separated communities from different cultures but with comparable approaches to land management so that they can make common cause to address their similar problems. Furthermore, that flexibility is demonstrated in the breadth of management approaches that can be encompassed, even along the same corridor, according to the potentials and possibilities. These include creation of local nature reserves, ecotourism and environmental education centres, establishment of sustainable timber harvesting and other natural forest products, rehabilitation of secondary forest patches, reforestation of pastures and steep lands, agro-forestry, establishment of shade trees over coffee, maintenance of riparian woodlands, and down to retention of relatively species-rich road verges, hedgerows and shelterbelts. Any action qualifies that retains and re-creates an element of biological connectivity in the landscape over and above what otherwise would be the case.

2.3. Do biological corridors really work?

Despite their wide application and intriguing possibilities, biological corridors do have their detractors. Fundamentally, their value as a conservation instrument is intuitive and their utility in any given case can be described as an act of faith. The central justification is that they provide connections but there is remarkably little science to indicate what actually takes place within them. Their biological functioning is certainly by no means proven. Indeed, when there is evidence that particular species, even unlikely ones, are more effective at dispersal than might be thought so the degree of isolation of protected areas may be less than assumed. In fact, corridors probably have to be designed around species specific dispersal behaviour patterns, may be better applied to some species rather than others, and are probably most safely presented in species-specific terms (e.g. Paseo Panthera for Central America, Grizzly Bears in the Rocky Mountains) in order to avoid charges that claims of comprehensive linkage are unsupported. The truth, as has already been noted, is that there is little theory to guide action, and that it is not presently possible to predict processes at a landscape level. Another criticism is that biological corridor creation may divert resources from the core areas they are meant to link, themselves under pressure to various degrees and often seriously. If the core areas are compromised, the rationale for connecting them is wholly undermined and the resources would therefore be better expended in their expansion and better management. In addition, and however repackaged the presentation, corridors still represent extension of constraints on land use over wider areas and thus provoke alarm is in some quarters. Some US lobbies are, for instance, extremely vocal in this regard and, although perhaps less well organised in expression, the general sentiment is certainly held more widely.

The corridor debate displays the tension between the specificity required by biological discipline as a science and the need of the conservationist, dealing as much with people and policy as with wildlife biology, to promote action on a partial information base that must, of necessity, be supplemented by intuition, subjectivity, and “best guess” to fill out the gaps in hard knowledge. For all that, the consensus is that corridors can only do good in conservation terms, even though their scientific basis remains weak. The sense of hedging the bets, implicit in the formulation of the Meso-American Biological Corridor, is therefore a valid strategy – whatever the justifications of a corridor, there is substantial value in using the concept as a vehicle for promoting better environmental management at both local and landscape level, and so achieving broader developmental aims than simply connecting core protected areas. Good will therefore come from the effort even if it is later found that only a limited number of species actually travel – physically or genetically - along them, as against using them in some other way. After all, protected areas are also intuitive instruments that have been shown to produce incomplete conservation outcomes – otherwise corridors would not be required – but that does not detract from their recognised value.

2.4. Savanna versus forest corridors

Maintenance or creation of biological corridors have general support among conservationists but there is a paucity of information on their effectiveness in achieving conservation purposes. Little is known in detail concerning the movement of animals within landscapes (Harrison, 1991) and there are few science-based guiding principles for the evaluation and design of habitat connections (Lindenmeyer & Nix, 1993). The bulk of the literature, however, discusses forests and rarely touches other habitats, while there is an implicit consensus that forested connections are preferable. In northern Belize one is presented with two broad categories of wild land – open savanna and more or less closed forest – and there is little hard evidence to suggest that forests are truly preferable to the extensive, open, formations. There are nonetheless both empirical and theoretical reasons to believe that forests are indeed the optimum choice.

Open habitats are usually highly dynamic and maintained by frequent disturbance (fire, storms, floods). Forest habitats are also subject to disturbances but much less frequently. As a result they are more stable, structurally more complex, and thus display higher biodiversity. A good floristic example is the total count of 67 tree species of all dimensions that was recorded on the 5000 ha of Rancho Dolores savannah (Bridgewater et al, 1997). This number is much lower compared with the 97 tree species (and limited only to those attaining 30+ cm dbh) recorded in 900 ha Rio Bravo Forest (PfB stock survey records, 1999). Many species are shared but it can safely be assumed that there are more species dependent on forest than on savanna. The same will be true for many other groups of organisms. Retained forest habitat is therefore important in the dispersion of this greater number of forest dependent species over the landscape. This assertion is backed by observations that, in searching for suitable habitat, individuals may experience higher mortality when forced to traverse ecologically unsuitable tracts (Harrison, 1991), while woodland links significantly facilitate bird movements across fragmented landscapes (Desrochers & Hannon, 1997). Furthermore, endangered species are often poor dispersers (Fahrig & Merriam, 1994) and those of conservation concern in Belize and Guatemala tend most often to be obligate forest species (Miller & Miller, 1997). Conversely, savanna species may be dependent on their specific habitat but are fewer in number, hold larger ranges, and also seem to be better dispersers. It has, for instance, been found that typical savanna species had successfully colonised a large cattle ranch in Cayo District even though the area was originally forested and still surrounded by forest (Meerman, 1998).

It seems then that forest corridors, including forest patches and galleries within savanna, agriculture, and other open areas, will give most advantage in terms of overall number of species and in the number of species of conservation concern that potentially benefit. Conservation of habitat for specialist savanna species is important but corridors appear less likely to be useful tools for achieving that objective.

This does not imply that savannas are to be ruled out completely for a biological corridor. As noted above, savannas are complex ecosystems with element such as forest patches and galleries. These elements do provide a degree of linkage, even only as “stepping stones”. For this reason savannas need to be considered especially in areas where a strict forest corridor does not exist.

The same is true to some extend for agricultural systems. It is definitely true that smallholder agriculture and shifting cultivation (milpa) create a vegetation mosaic that retains a degree of corridor functionality. But the truth of the matter is that there appears to be a trend to agricultural intensivation, with the extensively used agricultural landscape gradually being replaced by a more intensively used, treeless landscape.

2.5. Application of the corridor concept in Northern Belize

The Northern Biological Corridors Project is integrated with the larger, regional, Meso-American, Biological Corridor initiative. It therefore both links with the efforts undertaken under that project and shares its higher objectives.

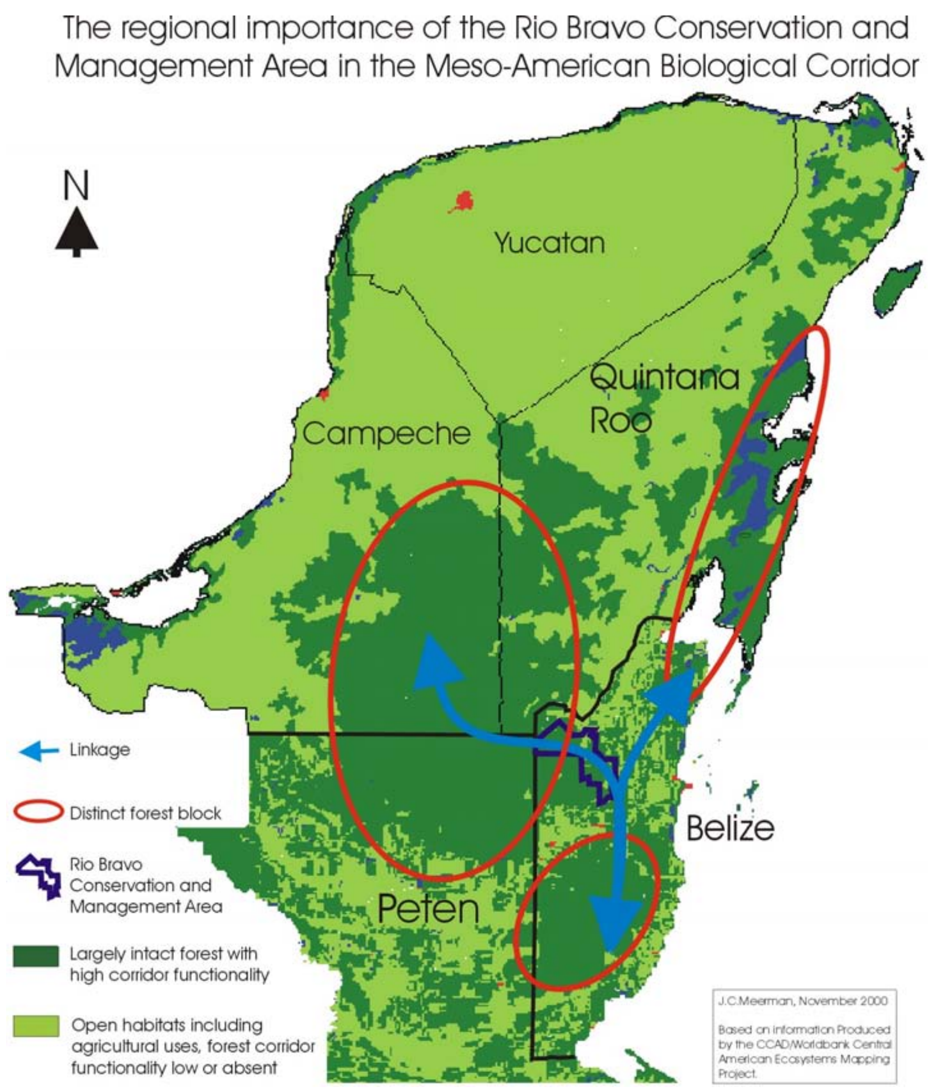


Figure 1. Generalized vegetation cover in the region, showing continuity of closed forest vegetation cover from the RBCMA to the Petén and into Campeche and Quintana Roo. The Maya mountain massif is largely isolated by agriculture in the Petén across the Guatemalan border.

In physical terms, the Rio Bravo Conservation and Management Area is a Belizean extension of the Petén/Calacmul forest block and thus, given that the Maya Mountain/Mountain Pine Ridge massif is now isolated by agriculture across the Guatemalan border, represents the critical connection into the main Meso-American corridor system (See figure 1). From the eastern Rio Bravo, there are habitat linkages across the Belize River Valley to the Maya Mountains, and across the northern plains to the other north Belizean reserves and eventually to the sea. A linkage to the Maya Mountains, undoubtedly the most biologically diverse of the natural areas of Belize, must represent the main target for a corridor, but connectivity to the smaller northern reserves and to the coastline, a logical corridor terminus, is also highly important. While the Bay of Chetumal constitutes a break, the corridor can also be conceived as being continued on its further Mexican shore to the Xian Ka'an Biosphere Reserve, and offshore into the marine systems of the barrier reef. The peculiarity of Belize is that these corridor linkages are largely still in existence, although becoming tenuous and broken at certain points. The task of corridor creation, then, is primarily one of preserving linkages, while the more complex and less effective approaches involving rehabilitation are applicable only at certain points, albeit critically important at those sites. Above all, most of the corridor length, and certainly the points where linkages are being broken, passes through areas where land use change is to be expected. The human dimension is therefore central.

Fortunately, although the long-term trends of demographic growth, agricultural expansion, and other economic developments are the forces breaking the corridor linkages, other socio-political trends in Belize are highly favourable for their maintenance. There is a general trend towards decentralisation, local empowerment, and local participation and direct control over local resources as against total dependence upon centralised authorities. There is also a wide support for and interest in conservation action, demonstrated by the formation of many local groups aiming at improved environmental management and conservation in ways that also serve local interests as perceived by the stakeholders themselves. In many cases, these interests include the development of economic opportunities or maintaining supply of local resources, but by no means in all. Some are aimed purely at creating local nature reserves or other amenities, and in most cases the economic opportunity is linked with the management of these sites, often through tourism. Finally, there is a growing sense of urgency for improved, cross-sectoral, management of natural resources, and even of incipient crisis if this is delayed. Such sub-themes can be detected, and are often stated explicitly, in recommendations developed by local experts concerning the need for sustainable forest management, coherent water resource management, integrated coastal zone management and, through the knock-on effects of failure to take appropriate action, to tourism, energy, and agriculture. It is interesting to note that these issues all arose in the analyses for the recent Climate Change Project not as potential problems but as current ones that could be expected to worsen as predicted changes took place. At this point, the arguments turn back towards the need for local, essentially non-governmental involvement by civil society as the most effective means of addressing the issues, a view that is shared by government itself and notably within the Forest Department. Finally, there is the realisation that the main economic mainstays of the country, agricultural exports and especially sugar, citrus and bananas are fragile and challenged in the international arena. Fresh and innovative approaches are called for, and especially those that confer benefits in the rural areas where economic and social indicators are least encouraging.

The combination of circumstances, therefore, is highly opportune for a corridor approach to conservation of environmental quality at a landscape level. Interestingly, though, it is less the biological functioning as a channel for movement of species and their genes, anyway the weakest area in the concept, that is immediately important, but its use as a framework for achieving broader objectives in terms of sustainable socio-economic development in rural areas while protecting environmental quality. This observation is of fundamental importance in project design, identification of indicators and measures of success, and in monitoring corridor functions. Although the corridors should **be** corridors, linking some set point to another, and serve conservation functions in terms of increased area under conservation management, in incorporating habitat types otherwise under- or un-represented in the national network, and in conserving habitat of vulnerable species, the social and economic aspects are almost equally important. These include such aspects as the variety of approaches attempted and their relative success, the degree to which community and other non-governmental management bodies achieve meaningful levels of participation, control, and replication of results, the long-term financial and managerial sustainability of the corridors, the degree to which those living in their proximity derive, and recognise that they derive, concrete benefits from them, and contribution corridors can make to national policy priorities.

3. CLIMATE CHANGE AND CORRIDORS

(Adapted from Bennet, 1999). There is increasing concern that anthropogenic changes to the composition of atmospheric gases may have significant impacts on the global climate. The presence of carbon dioxide (CO_2) in the atmosphere contributes to a natural 'greenhouse' effect, due to the atmosphere absorbing some of the energy radiated from Earth's surface, thus maintaining warmer conditions than if this energy all escaped. However, increased levels of CO_2 and other “greenhouse gases” (such as methane and chlorofluorocarbons) resulting from the burning of fossil fuels, deforestation and other activities, are predicted to enhance the greenhouse effect and warm the Earth's surface over future decades (Peters and Darling 1985). Such global warming is likely to cause a range of secondary effects, including changes in precipitation, winds, sea levels and ocean currents.

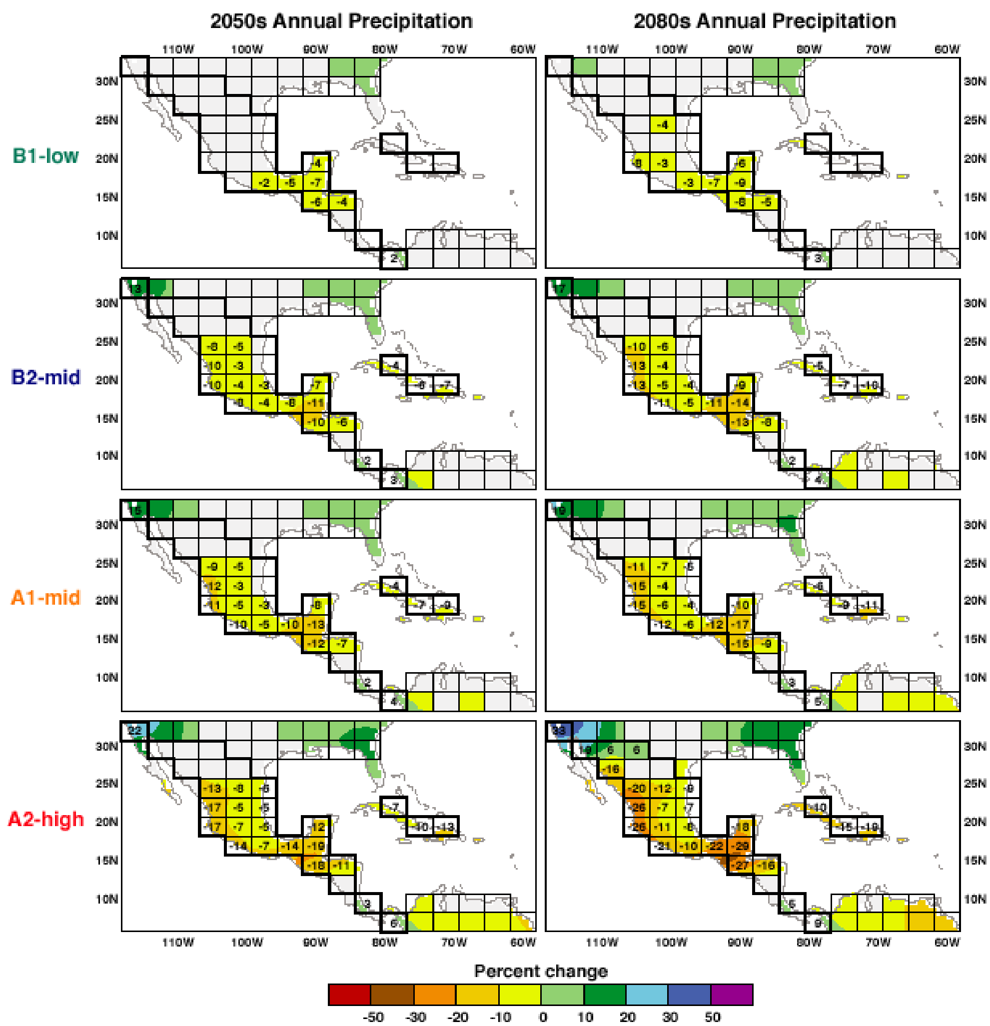


Figure 2. *Change in mean annual precipitation (per cent change from the average 1961-90 climate) for 30-year periods centered on the 2050s and the 2080s for each of the four scenarios. The printed numbers show the estimated change for each model land grid box over the region. Changes are only shown where they are large in relation to natural precipitation variability on 30-year time-scales.*

There is much uncertainty about the likely rate and magnitude of greenhouse-induced climate changes, especially at regional levels, but it is clear that there is the potential for significant impact on the status of flora and fauna throughout the world (peters and Darling 1985; Brereton *et al.* 1995; Hobbs and Hopkins 1991). Analyses of the climatic profiles presently occupied by plant and animal species, compared with future climatic conditions under various scenarios, suggest that the present geographic distributions of many species will be climatically unsuitable within a relatively short time (e.g. Brereton *et al.* 1995). If such changes eventuate, survival of species will depend upon their ability to adapt to new climatic conditions, or their capacity to shift their geographic distribution to track suitable climates. Those groups likely to be most affected include geographically localized taxa, peripheral or disjunct populations, specialized species, poor dispersers and genetically impoverished species (peters and Darling 1985).

Various scenarios exist. The Belize Climate Change Project used two scenarios, wetter and dryer. But according to most estimates, the climate in our part of Meso-America is most likely to get hotter and dryer. Estimates vary from 1.0 to 3.0°C (1.8 – 5.4°F) hotter in the next 50 years and from 4% to 19% dryer in the next 50 years (Hulme & Sheard, 1999)(Fig 2.). The consequences of these climate changes will be severe. For the corridor functionality it will mean that moist forests become dry forests and come to resemble the forest currently found in the Northern Shipstern Nature Reserve. The dry Shipstern Forests may make place for low thorn scrub. Bush fires will increase and savannas will expand at the cost of forests (Map 1b).

More recent estimates predict even stronger effects (see recent newspaper article in box). But no matter what estimate will prove to be correct, major and unpredictable shifts in habitats will occur. The prognosis in Map 1b is based only on the consultants' perception of susceptibility of the various, currently present vegetation types to a drying trend. Currently, the majority of Northern Belize is under some form of broadleaf forest cover (left map). This broadleaf forest cover is not uniform and the Belize Ecosystems map (Meerman & Sabido, in prep.) recognizes several types of broadleaf forest based on soil type, topography and water availability. These various types can be expected to vary in their susceptibility to climate changes and the associated stresses (drought, fire). Based on the general prognosis for increased drought and the consultants' perception of the susceptibility of each ecosystem to increased drought, a prognosis has been made for the year 2050 (right-hand map). Clearly, the (largely evergreen) broadleaf forest can be expected to be replaced by dry (but also broadleaf) forest, which is likely drought-deciduous. Also it can be expected that as a result of an increase in savanna fires, the savanna ecosystem will expand at the cost of both pine forests and scrub forests.

These changes will be the result of the direct consequences of global warming only. The prognosis in the right-hand map does not take into account an increase in human activities. This increase in human activities will mostly be as a result of increased population growth. In the same period the population may be expected to increase by 440 %, resulting in a dramatic increase of the amount of land in

Box 2: Earth will get hotter than feared

John Vidal
*The **Guardian Weekly** 2-11-2000, page 1*

Leading climate scientists now agree that human pollution, mainly from fossil fuels, has added substantially to global warming in the past 50 years and that the Earth is likely to get far hotter than previously predicted.

A summary of the 1,000-page final draft of research by the Intergovernmental Panel on Climate Change - a United Nations-sponsored group made up of the world's leading atmosphere scientists - has been sent to governments. It is expected to add urgency to this month's talks on global climate change in The Hague.

The report suggests that the upper range of warming over the next century could be far higher than estimated in 1995. Its worst-case scenario envisages the average global temperature rising by 6C (11F) above the 1990 level. Average temperatures today are 5C (9F) higher than they were at the end of the last ice age. Five years ago the panel predicted that average temperatures would, at worst, rise by 3C (6.3F).

The leaked document is the first major update of climate prediction since 1995, when the panel concluded that there was "a discernible human influence" on the Earth's climate because of the greenhouse effect -caused by the buildup of heat-trapping chemicals in the atmosphere.

The panel has concluded that the burning of fossil fuels and emission of man-made chemicals has "contributed substantially to the observed warming over the last 50 years". The scientists also believe that temperatures could rise far higher and faster than previously predicted if emissions are not curtailed.

Evidence of increased warming has been found in retreating glaciers, thinning polar sea ice, increased precipitation and the big rise in weather-related natural disasters.

Global warming will deeply affect poor countries, leading to huge numbers of refugees, crop failures, and extreme weather. Most emissions of carbon dioxide are from rich countries. The United States is responsible for 23% of CO<->2</-> emissions; Britain's 3% is equal to that from all of Africa.

agriculture. More detailed models need to be designed in order to better predict habitat changes and incorporate this in the management of the biological corridor.

It has been suggested that linkages may have an important conservation role in response to climate change (Harris and Scheck 1991; Hobbs and Hopkins 1991; Noss 1993). First, in some situations linkages may assist plant and animal species to extend their geographic range to track suitable climatic conditions. However, great caution is warranted before concluding that linkages will fulfill this role.

For most species, especially plants, the rate of range expansion required to respond to projected climate change is much greater than that known to have occurred historically or revealed by paleoecological analyses (Hobbs and Hopkins 1991; Noss 1993).

Range expansion may be limited by ecological or anthropogenic factors despite the maintenance of seemingly suitable linkages. For example, climatic conditions may become more suitable in adjacent areas, but differing geological substrates and soil nutrient levels may be unsuitable for the plant species concerned.

Many species are dependent on complex ecological interrelationships with other plants and animals, and consequently an effective range shift would require migration of assemblages of co-adapted plants and animals. The geographic location and necessary dimensions of linkages for such biotic migrations are not known, but it is likely that vast tracts of continuous natural habitat would be required.

Linkages across elevational gradients are those most likely to facilitate effective range shifts because the geographic displacement needed to track climate change is much less than at uniform elevations as is the case in Northern Belize.

Second, linkages have a potentially important role in countering climate change by maintaining the continuity of species' populations throughout their *present geographic range,* thus maximizing a species' ability to persist within those parts of its range where climatic conditions may remain suitable. Redistribution within an existing range is more feasible than range shifts to new areas.

Third, linkages also have a role in countering climate change by interconnecting existing reserves and protected areas in order to maximize the resilience of the present conservation network. Those linkages that maintain large contiguous habitats or that maintain continuity of several reserves along an environmental gradient are likely to be most valuable in this regard. Large populations and those that span environmentally diverse areas are likely to have greater demographic and genetic capacity to respond to changing conditions.

In the light of present uncertainty about the nature and magnitude of future climate change and its potential impacts, it appears that maintaining and restoring linkages are prudent measures that have conservation benefits regardless of the exact nature of impending climate change.

4. GENERAL DESCRIPTION NORTHERN BELIZE

4.1. Project area

Northern Belize consists of four administrative districts: Corozal, Orange Walk, Belize and Cayo. Together they cover 6,177 sq miles (16,000 km²) or 69.7% of the country (Fig 3). In population these four districts are estimated (1998 estimates) to have 191,840 human inhabitants or 80% of the Belize total. The majority of this population lives in the towns: Belmopan, Belize City, Corozal Town, Orange Walk Town and San Ignacio (the latter not within the actual project area). The two largest towns in Belize are Belize City and Orange Walk Town. However, there is a nationwide trend for the urban population to grow faster than the rural population. In 1998 the share of the rural population nationally was 52% while in 1991, this was still only 46%. The population is not evenly distributed over the 4 districts. There are distinct centers of population in the Northwestern Corozal district, north of Belize City and along the Western Highway (Fig 4).

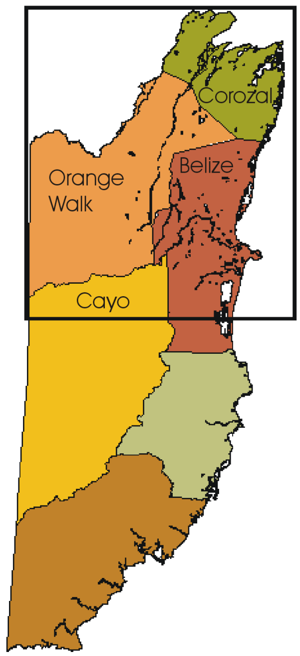


Figure 3. Belize districts with project area indicated (square).

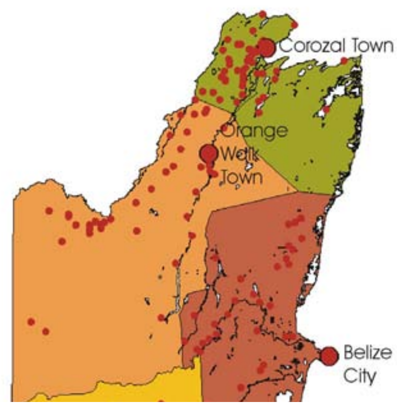


Figure 4. Project area with distribution of population centers

For the purposes of this study, Northern Belize has been defined as all that part north of Belmopan (17°15’ N, fig 4). In other words; all of Corozal and Orange Walk, but only parts of the Belize and Cayo districts are included. The project area thus confined constitutes slightly less than half of Belize.

4.2. Morphology and climate

4.2.1. General

Most of Northern Belize is flat and low. Only in the extreme west, hills appear but only limited areas reach above 656 ft (200 m). Due to the calcareous geology, rivers are relatively rare. The main rivers are the Rio Hondo (forming the border with Mexico), the New River and the Belize River.

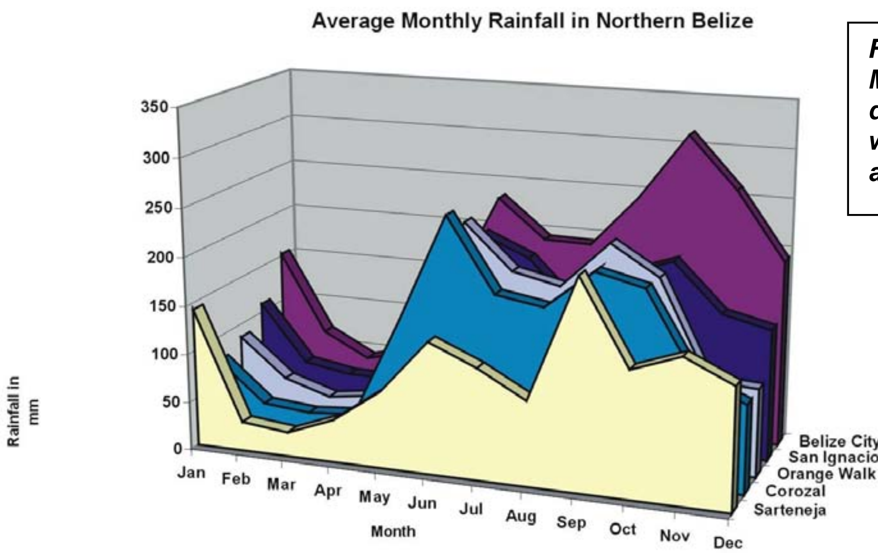


Figure 5. Average Monthly Rainfall at different locations within the project area

Northern Belize is the driest part of Belize. Average annual rainfall is limited to approximately 50’ (1250 mm) in the Northeast, 60’ (1500 mm) in the west to 80’ (2000 mm) in the southeast (fig. 5.).

4.2.2. Hurricanes

One of the more dramatic climatological influences experienced in the project area are hurricanes. Only a very small portion of the hurricanes recorded in the Atlantic Ocean and the Caribbean during the last hundred years, reached Belize. But nevertheless, the number affecting northern Belize is still imposing. During this century alone, a total of 10 hurricanes have been recorded for the project area and when they occur the effects can be devastating.

Most hurricanes track across the country from east to west. The exceptionally devastating hurricane Hattie in 1961, with estimated winds of over 150 mph (225 kmh), affected much of the country and followed a northeast to southwest track. All the areas, which received silvicultural tending in the 1920s to encourage mahogany regeneration and growth, were damaged or destroyed. All the Forest Department plantations were been more or less damaged (ODA, 1989).

A number of Forest Department reports, and publications from other tropical countries, indicate the changes in forest composition, which hurricanes can cause. Damage generally increases with tree size. Heavily branched and heavily foliaged species suffer more than those with light open crowns. However, trees with very light timber, though strong for their weight, can be completely destroyed. Trees, which shed their leaves and small branches at relatively low wind speeds, appear to suffer less damage and to be able to recover faster than those without these characteristics.

Name hurricane	Year
Not named	1916
Not named	1921
Not named	1931
Not named	1934
Not named	1934
Not named	1942
Janet	1955
Hattie	1961
Edith	1971
Keith	2000

Table 1. Hurricanes affecting the project area during the past century.

A rapid and preliminary assessment of wind hazard has been made in order to establish the intervals between hurricanes and the damage caused (adapted from ODA, 1989). The risk analysis takes the data from 1901 through 2000, 100 years with 10 hurricanes. The average interval for the project area is 10 years but intervals have varied from two in a single year to 29 years. Hurricane Hattie in 1961 caused severe damage over a swathe 50 miles (80 km) wide in the southern part of the project area. However, it seems reasonable to take a lower figure of 15 miles (25 km) for the more common and less severe hurricanes. If the project area is 95 miles (140 km) north to south and hurricanes conveniently strike at equal spacing without overlap, severe damage at any one place might be caused at intervals of 95/15 x 10 = 63 years. This time is sufficient to grow a good-sized tropical tree on the better soils, but it also demonstrates the dynamic processes that affect the ecosystems in northern Belize.

However, the repeated damage noted in the Forest Department's annual reports shows that the damage sustained is not as evenly spread as suggested here. The return period has been less than 11 years in some areas and the existence of very large trees in other parts of Belize shows that the risk is highly variable.

A further overview of hurricane damage to the forest sector is given in Lindo (1967) and Friesner (1993). In 1989, the ODA team reported that some forests in Belize still showed sign of hurricane Hattie, even after more than a quarter of a century. Meerman and Williams (1995) mentioned that on the southern Maya Mountain Divide, nearly all big trees had broken crowns, indicating past hurricane damage. Also the broadleaf forests along the Upper Macal in the Cayo district still show the effects of hurricane damage (Pers. obs.).

Hurricane destruction alters the structure of the forest. It is assumed that most of Belize's forests are "Hurricane Climax Forests" since nearly all areas are eventually hit. Perhaps averaging no more than once every few hundred years on a given site, this is frequent enough to influence structure or species composition. In other tropical forests regions such as Costa Rica or the Amazon Basin, where hurricanes virtually never occur, the forest is taller with more prominent emergent trees and a less tangled understory (Kamstra et al., 1996). Good examples of what the forest can be without the influence of hurricanes are found in sheltered valleys as described by

Kamstra et al. (1996) for the Cockscomb basin (which were also outside logging influence). Also Meerman & Williams (1995) reported impressive forests in sheltered and un-logged locations in the southern Maya Mountains.

Brokaw and Walker (1991) give a summary of the extensive literature on the effects of hurricanes on forest ecosystems. The general consensus is that damage to forests is principally through defoliation, although uprooting and snapping are common. Large trees are more susceptible to damage than small ones and the damage they sustained considerably reduced upper canopy cover resulting in light penetration to the understory and stimulating growth of advance regeneration and recruitment of pioneer species (although, in some cases, recovery is mostly through resprouting). While damage may be extensive, actual tree mortality is usually minimal. Forest structure and dynamics can be affected for decades. But general biodiversity is usually not greatly affected. The general trend suggests that hurricanes are not catastrophic events for the forest. But note that the definition of "damage" will differ between foresters and ecologists!

Through the impact of hurricanes a large number of lightgaps is created in the affected forests, these lightgaps are colonized by light demanding pioneer species and the species composition of the resulting forest is clearly skewed towards species that are light-demanding (and often wind-dispersed). It has been argued that abundant stocks of Mahogany are the result of past hurricane impacts (Bird, 1998).

4.2.3. Floods

Flooding rivers are a frequent phenomenon in all of the project area's lowland. For northern Belize, such floods are usually associated with the passage of tropical waves or hurricanes. The floods caused by the passage of hurricane Keith in 2000 were a dramatic demonstration of the potential impact. In hilly areas, violent floodcurrents damage the vegetation along rivers and thus maintain a dynamic system of secondary growth (most notably along the Sibun River). This, nutrient rich, riverine (often herbaceous) scrub is a favored feeding ground for large mammals such as Tapir.

Since this disturbance should be considered natural, normal floodings should not be perceived as a threat to the health and stability of the natural vegetation. Effects of flooding on terrestrial fauna are largely undocumented but in the case of the 2000 floods, this impact must have been substantial.

4.3. Habitats

The basis for the ecosystems identification used for this project was the draft Ecosystems map for Belize (Meerman & Sabido, in prep. Central American Ecosystems Mapping: Belize). This ecosystems map recognizes 36 different ecosystems and major landuses for Northern Belize.

Table 2. Ecosystems of Northern Belize

Ecosystems / landuse	%
Broadleaf forest	67.3%
Agriculture	17.5%
Savanna	5.9%
Mangroves	2.5%
Reedlands	1.8%
Scrub forest	1.7%
Salt marsh	1.0%
Water	1.0%
Disturbed shrubland	0.7%
Urban	0.3%
Dry forest	0.1%
Pine Forests	0.1%

For the purpose of the current study, this large number of ecosystems was deemed unpractical to work with and various similar vegetation types (e.g. closed broadleaf forest formations) were lumped together which led to a considerable simplification of the overall ecosystem classification.

It is interesting to note that based on these data, as much as 67 % of the project area is still under some form of broadleaf forest cover. Considerable areas are also used for agriculture (both intensive and extensive), especially in the Western Corozal, Northern Orange Walk and Northern Cayo districts. Noticeable is also the extend of the savanna ecosystem. Belizean savannas are very complex in composition and appearance. Often very wet but subject to seasonal drought and always subject to wildfires.

Biogeographically, northern Belize can be divided in two more or less distinct regions:

- **Yucatán region**

Encompasses the Corozal District, in the northeast of the country, and most prominently the Shipstern Nature Reserve area. Although this area is relatively species poor, it contains a few typical Yucatán endemics and quite a few plant and animal species that so far are only known from this area.

- **Petén region**

In the northwest of Belize, this section encompasses the Orange Walk District, the northern part of the Cayo District and much of the Belize District. Towards the east, in the Belize District, the distinction between the two regions becomes less clear.

Two further biogeographical regions can be recognized in the Southern half of Belize. The distinction between the four biogeographical regions is most noticeable on the floristic, invertebrate and smaller vertebrate levels. Larger animals, such as most mammals seem less restricted to a certain biogeographical region.

See also the section on biological data within the “description of the individual corridor sections”

5. META-DATA

Basis for the ecosystems identification used for this project was the draft Ecosystems map for Belize (Meerman & Sabido, in prep. Central American Ecosystems Mapping: Belize).

In addition, a number of Landsat TM images was used to interpretate vegetation patterns:

Landsat TM Path 19 Row 47 4-XII-1998 in Erdas v7.4 format (Bands 374)
Landsat TM Path 19 Row 48 15-IX-1998 in Erdas v7.4 format (Bands 374)
Landsat TM Path 19 Row 48 15-IX-1998 in Erdas v7.4 format (Bands 453)

The first two mages could not be geo-referenced and were of general low quality (mainly as a result of heavy cloud cover). As a result, only for the Western and Southern most sections of Belize were fairly recent images available. The area covered by this image is delineated in ArcView theme "satellite cover". For the remainder of Northern Belize only a 1993 hardcopy Landsat TM composite at a scale of 1:250.000 was available. This copy was prepared by DHV consultants BV, Holland and composed of spectral bands 4,5 and 3.

For those areas for which digital Landsat TM imagery was available, the Iremonger and Brokaw (1995) polygons were verified and where needed re-digitized directly on the computer screen using ArcView 3.1. This method proved most satisfactory.

As a result of the limited availability of original, digitized Landsat TM data, the main method used to verify polygon size, shape and attributes was visual, either directly from hardcopy or from scanned hardcopy on screen, using CorelDraw 8 software. The polygons thus created were later translated into ArcView 3.1. format.

The minimal practical polygon size was found to be approximately 10 ha and only very few even smaller polygons were created.

For the specific purpose of the current project, a number of visits was conducted. The main aim of these fieldvisits was to bring more clarity in the complexity of the Belizean lowland savannas versus closed forest. At each site data were collected conform the field form provided by the Central America Ecosystems Monitoring Database version 2.3. GPS data were collected using a Garmin GPS 12, Map datum NAD 27 Central. Reading latitude and longitude in 1000's of minutes. Digital images of the sites were procured with an Olympus D-340L digital camera. No other special equipment was used. Identification of species occurred in the field. Only positively identified species were recorded. Only in cases where dominant species could not be identified, specimens were collected for later identification in the laboratory. Literature used to identify plant specimens was primarily the Flora of Guatemala by Standley et al. (1946-1978). Nomenclature was adapted to newer insights whenever possible.

All field data were entered in the accompanying Northern Belize Biological Corridor Monitoring Database, using a Microsoft Access platform.

An aerial survey was carried out on September 20, 2000. Following the route of the proposed corridor(s) (Map 5). Pictures were taken using a Canon SLR camera with 40 – 80 mm zoom lens.

Land tenure data were initially obtained using a LIC Land Classification map (Draft 7, July 2000. LIC). Since digital data were not made available, a 1: 300.000 hardcopy was scanned and the relevant features where then re-digitized using an on-screen method. The resulting map was then manually enhanced with (older) estate information, which was obtained from estate maps in the possession of the subconsultant. This method, although accurate enough for the purpose of the current project, created an un-quantified degree of error. Therefore, the maximum scale to which this map can be enlarged is 1:250,000. Also, the ArcView data that resulted from this effort cannot be considered to give an accurate presentation of landownership. Consequently, the data generated and presented here are not to be used outside the current project.

The potential corridors generated for this project were produced using the on-screen digitizing method with the 2000 ecosystems map as basis but also using data obtained during field visits and from the aerial overflight.

6. RESULTS

6.1. Biodiversity data collection

Biodiversity data of the project area is available in a variety of literature and survey reports (Bijleveld, 1990, 1998; Brokaw & Mallory, 1991, 1993; England, 2000; Greenfield and Thomerson, 1997; McRae, 2000; Meerman, 1993; Meerman & Boomsma, 1993; Reichelt and Philcox, 1995; Vallely, & Whitman; Walker and Walker, 2000). This and additional data has been incorporated in the Belize Biodiversity Information System (http://fwie.fw.vt.edu/WCS/index.html, Miller and Miller, 2000).

Unfortunately, much of this data has reference to a limited number of sites, mostly protected areas. The Shipstern Nature Reserve is probably the most comprehensively document site within the proposed biological corridor system (Meerman & Boomsma, 1993). Otherwise, there are large data-gaps and fieldwork in the second phase of the consultancy will attempt to cover at least some of these gaps.

Vegetation data is available within the new ecosystems map of Belize currently being prepared as part of a separate WorldBank assignment (Meerman & Sabido, in prep.). Vegetation data collected as part of the current corridor study is being stored in an Access database originally designed for the above mentioned vegetation mapping project.

6.2. Land tenure patterns

The collection of land tenure data has proven the most problematic component of the current study. GIS data on the subject do exist but were not made available for the project in a digital format. Manual gathering has proven to be too time consuming and therefore too costly. As a result of this unexpected problem, the land tenure data remain incomplete. The results as presented here have been obtained by manually re-digitizing a land-tenure hardcopy obtained from LIC with numerous additions proposed by some of the subconsultants. This has lead to minor inaccuracies but none that are deemed significant for the purpose of the project. More detrimental is the absence of the coverage data originally attached to the digital coverage.

6.3. Most appropriate corridor route

The most appropriate corridor routes were identified during a desk-top study following the steps described below.

Step 1: A draft version of the new Belize Vegetation Map (Meerman & Sabido, in prep.) was used to identify areas with the highest corridor functionality (closed forest). Similar vegetation types were lumped to create a Generalized Vegetation Map of Northern Belize. On this map (1A) closed broadleaf forests are indicated in green and these are assumed to have the highest corridor functionality. Areas in yellow indicate areas largely under agriculture (both intensive mechanize and extensive non-mechanized). These together with urban areas plus large water bodies are considered the to have the lowest corridor functionality. Savannas have been marked separately and should be seen as an ecosystem with intermediate corridor functionality.

Step 2: Overlaid on this map are the human settlements in the project area. Around each settlement, a circle is drawn in yellow representing a zone of high human impact (Habitat alteration, hunting, pollution, noise, general disturbance etc.)(Map 2. High Human Impact). Each settlement has received a 5km “buffer”. This system is rather arbitrary but together with the areas under agriculture, which are also in yellow, this map is a good visual presentation of the direct impacts of a human settlement on its surroundings. This “buffer” is based on the findings of Smith (1997) who demonstrated that forests within 4 km of villages and roads are at the greatest risk of clearing and degradation. We had similar experiences in the Toledo district (Boomsma, 1999).

The main inconsistency of the map lies in the fact that there is no differentiation between General Agriculture and Shifting Cultivation which would seem important for corridor functionality. The overflight however, has shown that many areas considered under shifting cultivation area actually reverting to a more permanent form of agriculture with less and less natural vegetation remaining. Nevertheless the fact remains that small holder agriculture has a higher corridor functionality than large scale mechanized agriculture which has a very low value.

Step 3: Strictly based on the corridor functionality and the amount of human impact, potential corridors show up very clearly on this map of human impact. Based on this the proposed corridor system could be drawn up. This map (Map 3A. The Northern Belize Biological Corridors) shows large areas with more or less intact habitat (called “nodes”) which are linked by corridors. These nodes should be regarded as large “stepping stones” even without connecting corridors. Each corridor is classified according to its viability (human influence, habitat types), and value to the Northern Belize Biological Corridor Concept. As a result the map shows a network of corridors rather than a single route. Some of the corridors drawn clearly represent preferred routes while other are more alternate routes. This distinction is not always clear and in many cases is would seem best to assume two primary corridors to achieve the same linkage in order to minimize the risk of corridor failure. It should be noted that, although linkage of protected areas is one of the main objectives of the current project, this map does not automatically attempt to link protected areas. Instead it links forested areas by means of forested corridors. Rationale for this was that protected areas do not necessarily have a habitat type conducive to a biological corridor (see discussion in chapter 2.4. “Savanna versus forest corridors”.

Step 4. A layer showing protected areas (Map 3B) adds a new dimension to the corridor design. It should be noted that there is a certain degree of overlap between node areas and protected areas. More or less obvious are the routes connecting the various protected areas.

Step 5: The 1992 Agricultural Land Value coverage by King et al. was overlaid. This map shows the agricultural value of the major part of the project area (Map 6A). The rationale for this is that it appeared unreasonable to expect that high quality agricultural land (Class 1) would remain undeveloped for long. Corridor planning through areas with substantial amounts of class 1 agricultural land it therefore not considered sustainable. Notice that Agricultural land value 1 is virtually restricted to the Belize River Node (Map 6B). Map 6C is the same as Map 6B but with a protected areas overlay.

Step 6. A new layer showing large estates on the Land Tenure Map gives an indication with the number and type of landowners (including GOB) that the proposed Northern Biological Corridor will have to deal with (Map 4A & 4B). These maps will be a valuable tool to identify high priority areas for community outreach and participation. A good example is the community of Santa Martha along the old northern highway. This community sits right in the middle of one of the biologically suitable corridors. Since there are few alterative routes in this area, this community becomes a prime candidate for community involvement.

6.4. Case study: Mile 31, Western Highway

There are two potential links of the Northern Biological Corridor with the wildlands of Southern Belize. One crosses the Western Highway between the Belize Zoo and the Jih Chan development and from there connects to the Sibun River Corridor and from there to the private Runaway Creek protected area. This connection is very important but relies on savanna-scrubland vegetation patches, which may provide a challenge for strict high-forest organisms.

The best link on the landscape level is situated between miles 35 and 36. This corridor is precariously narrow and posed problems for it's long term viability due to the fact that most of the land in the area is private and likely to be developed in the future.

The acquisition of the Hamze property by the Government of Belize for the purpose of the construction of a Satellite town opens a new perspective for the establishment and maintenance of this important corridor link. The construction of this Satellite Town may sound incompatible with the corridor idea but this is not exactly true. The town itself has been planned on "savanna" which in itself is less suitable to serve as a biological corridor in the Belizean context. The broadleaf sections of the previous "Hamze" block will be left undeveloped under the current plans and this serves the corridor purpose perfectly. The resulting corridor will still be frightfully narrow (approx. 1 km at it's narrowest point), but if well managed, should still be able to maintain most of its current biological functions. This corridor could be incorporated in the "green spaces" associated with the Satellite Town and even see some moderate development in the form of trails, picnic spots etc.

The accompanying maps (Figure 6) clearly show how those corridor linkages could work, even without affecting the basic design of the Satellite Town. The main issue at the moment is that this corridor is being recognized and it's integrity formalized in the design of the Satellite Town.

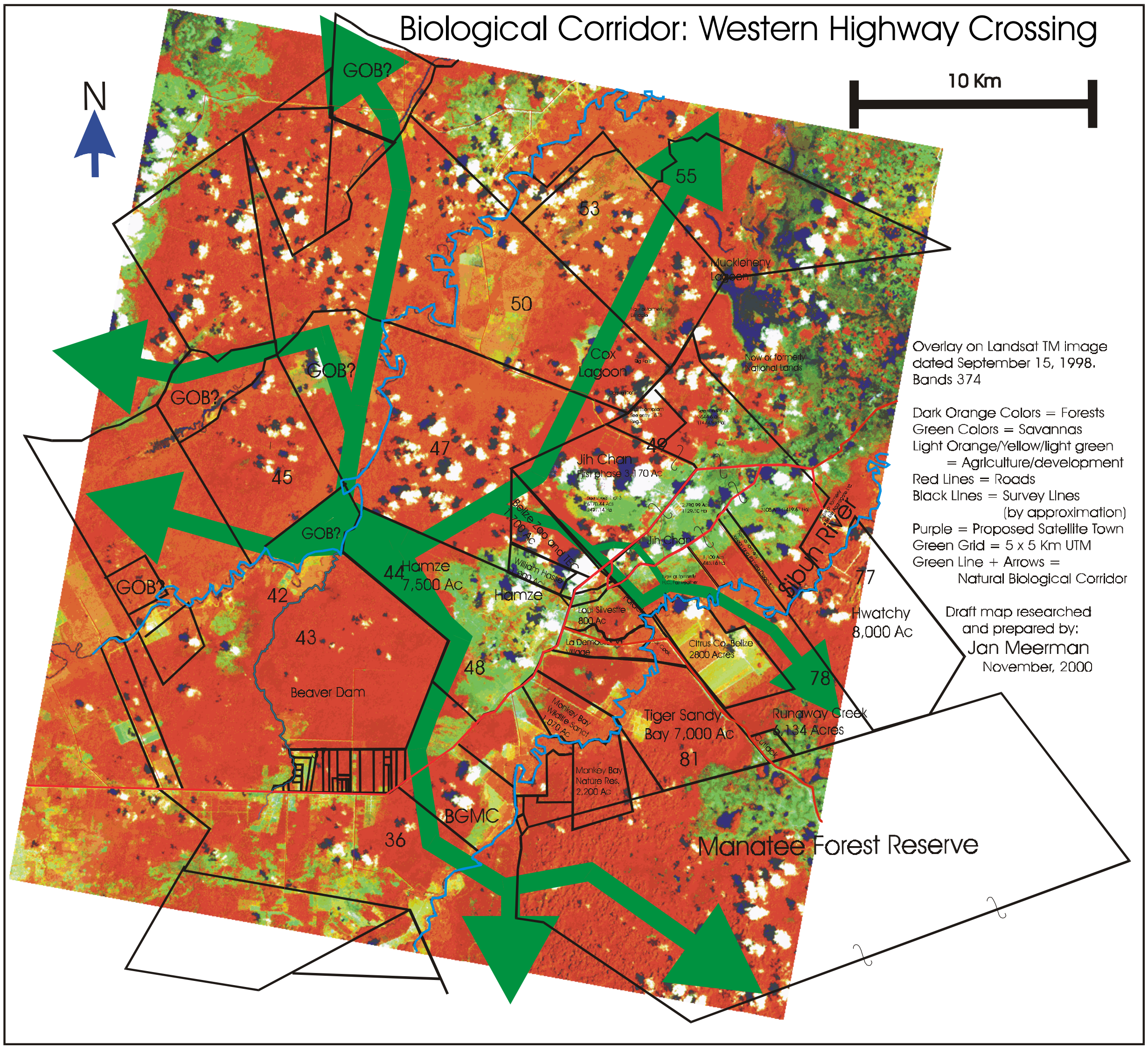


Figure 6. Detail map of the potential western highway crossings and their links.

Some weak links remain, especially where the corridor crosses private land (The company BGMC owns the land adjacent to the Hamze property, as well as the land

SE of the highway). But here private initiative and the conservation community should try to make solutions. The government of Belize could assist in finding those solutions by possibly providing incentives for landowners willing to assist in the corridor project. But above all government could assist in using the EIA mechanism as an important tool. Already, some EIA's have been prepared that incorporated the corridor concept. Not all have been directly appropriate to the current corridor but future development plans in the area should be taking into account this Northern Biological Corridor and incorporate it in their design and the EIA mechanism is the perfect tool to implement this.

7. DESCRIPTION OF THE INDIVIDUAL CORRIDOR SECTIONS.

7.1. Terminology

On the following pages, the entire corridor is described from north to south by its individual components. These components are named on the accompanying maps. The individual components are classified along the following lines:

- **Node**: Area of largely intact habitat (not necessarily a protected area). Large enough to have a fully functional ecosystem with a full complement of organisms adapted to the particular habitat. But a node is not necessarily large enough to maintain this function without corridors between them allowing movement of wildlife. Node areas are a very important element in the corridor system. If a node does not overlap with a protected area, it may be important to obtain protected status for at least part of the node.
- **Primary corridor**: Strip of habitat linking node areas. Most corridors will have not enough space to have a fully functional ecosystem with a full complement of organisms adapted to the particular habitat. Especially animals in need of large home ranges will have difficulty to set up permanent territories in such narrow corridors. Movement from node to node however, is facilitated. A corridor is a primary corridor if, of the choices available, it provides the best options for this movement. This based not only on vegetation type, but also considering current and potential human landuse.
- **Secondary corridor**: Similar to the primary corridor but chances for success (free movement of organisms) is less than in a primary corridor. Investment in secondary corridors is recommended when funds and other resources allow this.
- **Supported corridor**: A supported corridor is a corridor that is linked with the Northern Biological Corridor but is not essential to it. These corridors can be very important on a local scale but should not draw away attention and resources from the main corridor.

7.2. Biological data.

For most components of the proposed corridor, no or no specifically defined biological data are available. Sources for such biological data are the Belize Biodiversity Information System, which is managed by the Wildlife Conservation Society and can be accessed on the web. This is undoubtedly the most comprehensive biological data source in Belize. This database contained records of 985 different animal species (including insects) of Belize north of 17° 30’ N. Additional data were obtained from gray literature, EIA reports and data collected as part of the current project.

Lists with species numbers and lists of “unique species” (not necessarily endemics) are given for each section for which information was available. A “unique” species is a species that is not listed for any of the other investigated areas. Therefore, these species are not necessarily endemics of even unique in the Belizean context. A general overview is presented in table 3 below.

Table 3. Number of recorded animal species per selected area. Between brackets are those species that are, within Northern Belize, reported only from the specific area. The map numbers represent the 1:50.000 DOS map quadrants.

Map numbers:	**3+6**	**5**	**11**	**10+15**	**8, 9, 13 + 14**	**20**
1.1.1.1 Area	**(Shipstern NR)**	**(Freshwater Creek FR)**	**(Esteves Node)**	**(Crooked Tree WS)**	**(Rio Bravo Node)**	**(Monkey Bay + Belize River Node)**
Odonata	59 (17)	17 (1)	No records	No records	85 (38)	9 (0)
Butterflies	119 (25)	54 (3)	No records	No records	64 (10)	54 (0)
Inland fishes	18 (6)	21 (2)	14 (0)	33 (0)	26 (0)	8 (0)
Amphibians	13 (0)	5 (0)	8 (0)	No records	21 (4)	12 (0)
Reptiles	64 (6)	19 (0)	20 (0)	2 (0)	30 (4)	37 (0)
Birds	247 (3)	196 (0)	193 (0)	406 (1)	406 (19)	220 (0)
Mammals	39 (1)	1 (0)	41 (0)	54 (1)	69 (12)	18 (0)
Total	559	313	276	495	701	358
Unique spp.	(58 = 10%)	(6 = 2%)	(0 = 0%)	(2 = 0%)	(87 = 12%)	(0 = 0%)

Although the data presented above are far from complete it is interesting to note that both the Shipstern Nature Reserve (SNR) and the Rio Bravo Node have a relatively high number of "unique" species, which do not show up in species lists of other areas in northern Belize. In the case of the SNR this high number is undoubtedly a consequence of the more pronounced Yucatecan (+ some marine) influence here compared with the rest of Belize. This applies specifically to the Shipstern Dry Forest. This Shipstern Dry Forest presents a rather unique ecosystem within the Belizean context. In the case of the Rio Bravo Node the high number of "unique" specimens must be explained by its large size and high level of research but also by its overall higher biodiversity here compared with any of the other investigated areas of Northern Belize.

Maintaining linkages between these two relatively rich areas through viable biological corridors (and maintaining linkages with the ecosystems of Southern Belize) is the best guarantee for a continued flow of species as ecosystems change (as a result of natural disasters, global warming or human influences).

Future research will no doubt reveal that the biological distinction between Rio Bravo and Shipstern is less pronounced than it now seems. Both the bajos of Rio Bravo (seasonally the driest habitat with a natural scrubby architecture) and the ancient Maya sites have characteristics similar to the habitats found in the Shipstern area. These small, dry, ecosystems are now holding "Yucatecan" species at the limits of their range, are actually a form of refugium at this time and could be "stepping stones" or even centers of future expansion.

7.3. Descriptions

The following pages list all corridor components per section from north to south. The general format per section is as follows:

Location: Geographic location description.

1:50,000 DOS map number: Regular E755 series DOS maps as available for all of Belize. These maps divide Belize in 0°15' squares (approximately 28 x 27 km).

Vegetation types: Describes the vegetation as in the draft Belize Ecosystems Map (Meerman & Sabido, in prep). Some name nomenclature changes may apply as the Central American Ecosystems Mapping effort finalizes.

Connections: Describes links between nodes and/or corridors.

Number of recorded animal species: Tentative number of species recorded from the node/corridor with sources. These data are more an indication of what is known of the area rather than the actual species diversity.

Number of "unique" species: Number of animal species that - within the corridor system- have been reported only from this section.

List of unique species: Lists animal species that - within the corridor system- have been reported only from this section. These lists are not definitive.

Landownership: Tentative description of the types of landownership present in the section.

Communities: Communities found in and near the section.

NGO: NGO's active in or near the section.

Landuse: Generalized description of the landuse in the section.

Agricultural value: Describes the agricultural land values according to King et al.1992.

Challenges: Lists the section specific challenges that will be encountered in the establishment of the NBBC.

Shipstern Dry Forest Node

Location: North eastern tip of the Corozal District, north of Shipstern Lagoon.

1:50,000 DOS map number: 3

Vegetation types:
- Tropical semi-deciduous broadleaf lowland forest,
- Microphyllous drought-deciduous lowland forest..

Connections: Linked with Freshwater Creek node through the Xopol corridor.

Number of recorded animal species: 559. The flora and fauna of the Shipstern Nature Reserve is well documented (Meerman & Boomsma 1993, Bijleveld 1998)

Number of "unique" species: 58 (or 10%) of the total recorded species have not (yet) been recorded from any of the other investigated areas in Northern Belize. This high level of "uniqueness" is undoubtedly a consequence of the more pronounced Yucatecan influence compared to the rest of Belize.

List of unique species:

Order	*Family*	*Common name*	*Scientific name*
Pisces	Rivulidae – Rivulids	Mangrove rivulus	*Rivulus marmoratus*
Pisces	Poecilidae – Livebearers	Mangrove molly	*Poecilia orri*
Pisces	Gerreidae – Mojarras	Yellofin mojarra	*Gerres cinereus*
Pisces	Sparidae – Porgies	Southern sheeps head	*Archosargus probatocephalus aries*
Pisces	Sciaenidae – Drums	Ground croaker	*Bairdiella ronchus*
Pisces	Tetraodontidae – puffers	Checkered puffer	*Sphoeroides testudineus*
Reptilia	Phrynosomatidae - Spiny lizards	Lundell's spiny lizard	*Sceloporus lundelli*
Reptilia	Scincidae – Skinks	Sumichrast's skink	*Eumeces sumichrasti*
Reptilia	Colubridae - Colubrid snakes	Yellow-bellied snake	*Coniophanes fissidens*
Reptilia	Colubridae - Colubrid snakes	Faded black-striped snake	*Coniophanes schmidti*
Reptilia	Colubridae - Colubrid snakes	Many lined snake	*Conophis lineatus*
Reptilia	Colubridae - Colubrid snakes	Yucatan white-lipped snake	*Symphimus mayae*
Aves	Flamingos - Phoenicopteridae	American Flamingo	*Phoenicopterus rubber*
Aves	Sandpipers And Allies – Scolopacidae	Least Tern	*Sterna antillarum*
Aves	Fluvicoline Flycatchers – Fluvicoliinae	Greater Pewee	*Contopus pertinax*
Mamalia	Mustelidae - Weasel Family	Spotted Skunk	*Spilogale putorius yucatanensis*
Odonata	Coenagrionidae		*Enacantha caribbea*
Odonata	Aeshnidae		*Anax amazili*
Odonata	Aeshnidae		*Anax concolor*
Odonata	Aeshnidae		*Coryphaeschna apeora*

Odonata	Aeshnidae	*Coryphaeschna diapyra*
Odonata	Aeshnidae	*Coryphaeschna secreta*
Odonata	Aeshnidae	*Coryphaeschna viriditas*
Odonata	Aeshnidae	*Gynacantha mexicana*
Odonata	Aeshnidae	*Gynacantha nervosa*
Odonata	Aeshnidae	*Triacanthagyna septima*
Odonata	Gomphidae	*Aphylla protracta*
Odonata	Libellulidae	*Brachymesia furcata*
Odonata	Libellulidae	*Erythrodiplax berenice*
Odonata	Libellulidae	*Idiataphe cubensis*
Odonata	Libellulidae	*Miathyria Marcella*
Odonata	Libellulidae	*Micrathyria hagenii*
Odonata	Libellulidae	*Tramea abdominalis*
Lepidoptera	Papilionidae	*Battus philenor acauda*
Lepidoptera	Papilionidae	*Mimoides ilus branchus*
Lepidoptera	Papilionidae	*Heraclides torquatus tolus*
Lepidoptera	Papilionidae	*Heraclides astyalus pallas*
Lepidoptera	Papilionidae	*Pterourus menatius victorinus*
Lepidoptera	Pieridae	*Melete isandra*
Lepidoptera	Pieridae	*Itaballia demophile calydonia*
Lepidoptera	Pieridae	*Ganyra josephina josepha*
Lepidoptera	Pieridae	*Eurema boisduvaliana*
Lepidoptera	Pieridae	*Eurema dina westwoodi*
Lepidoptera	Pieridae	*Eurema lisa lisa*
Lepidoptera	Pieridae	*Eurema nicippe*
Lepidoptera	Nymphalidae	*Anthanassa ptolyca*
Lepidoptera	Nymphalidae	*Castilia myia*
Lepidoptera	Nymphalidae	*Hamadryas honorina*
Lepidoptera	Nymphalidae	*Myscelia ethusa ethusa*
Lepidoptera	Nymphalidae	*Adelpha naxia*
Lepidoptera	Nymphalidae	*Adelpha fessonia*
Lepidoptera	Nymphalidae	*Doxocopa pavon*
Lepidoptera	Nymphalidae	*Prepona gnorima*
Lepidoptera	Nymphalidae	*Siderone marthesia*
Lepidoptera	Nymphalidae	*Zaretis callidryas*
Lepidoptera	Nymphalidae	*Consul electra*
Lepidoptera	Nymphalidae	*Fountainea glycerium*
Lepidoptera	Nymphalidae	*Cepheuptychia glaucina*

Landownership:
Shipstern dry forest: Shipstern Nature Reserve (Private: International Tropical Conservation Foundation). Private: Robin Cruickshank,

Communities:
Sarteneja: Includes the Shipstern Forest in its sphere of influence.
Chunox: No traditional claims but some attempts to extend sphere of influence.

NGO: ITCF (Shipstern Nature Reserve = SNR).

Landuse:
Agriculture near Sarteneja, protected in SNR, threatened by development on Cruickshank property.

Agricultural value:
Shipstern dry forest: 2, 4 & 5

Challenges:
1) Negotiate with Cruickshank to get voluntary protection of the dry forests on his property.
2) Involve community of Sarteneja in the management of the dry forest within the agricultural areas

Shipstern Nature Reserve HQ with surrounding Shipstern Dry Forest.

Shipstern High Forest Node

<u>Location</u>: North Eastern tip of the Corozal District. southeast of the Shipstern lagoon.

<u>1:50,000 DOS map number</u>: 6

<u>Vegetation types</u>:
- Tropical evergreen seasonal broadleaf lowland forest over calcareous soils: Northeastern Variant.
- Tropical evergreen seasonal swamp forest of N. Belize: High variant.

<u>Connections</u>: Linked with Freshwater Creek node through the Shipstern corridor.

<u>Number of recorded animal species</u>: The flora and fauna of the Shipstern high forest is less well documented than that of the Shipstern dry forest (Meerman & Boomsma 1993, Bijleveld 1998).

<u>Number of “unique” species</u>: See Shipstern dry forest.

<u>List of unique species</u>: See Shipstern dry forest.

<u>Landownership</u>:
Shipstern Nature Reserve (Private: International Tropical Conservation Foundation). Private: Sealey Family in Fireburn, Government (GOB Acquisition from Singer/Zymurgy) and Private: Corozal Timber.

<u>Communities</u>:
Shipstern village: Abandoned after hurricane Janet in 1955. Most people moved to Sarteneja.
Sarteneja: Includes the Shipstern Forest in its sphere of influence.
Fireburn: One extended family (Sealey).
Chunox: No traditional claims but some attempts to extend sphere of influence.

<u>NGO</u>: ITCF (Shipstern Nature Reserve); Wildtracks

<u>Landuse</u>:
Shipstern high forest: Protected in SNR, Some milpa farming in Sealey/GOB section, and logging in the Corozal Timber section.

<u>Agricultural value</u>: 2

Challenges:
Work with GOB and Fireburn Community to get maximum protection of the entire Shipstern high forest, including archaeological sites.

Shipstern High Forest east of Fireburn with Shipstern Lagoon in the background. The clearing in the center is a logging operation.

Xopol Corridor

Location: Eastern Corozal District, west of the Shipstern Lagoon.

1:50,000 DOS map number: 3 & 6.

Vegetation types:
Currently still surrounded by largely intact habitat but agricultural activities expanding.

- Tropical evergreen seasonal broadleaf lowland forest over calcareous soils: Northeastern Variant.
- Tropical evergreen seasonal swamp forest of N. Belize: High variant.
- Evergreen broad-leaved scrub dominated by Leguminous shrubs.

Connections: Connects the Shipstern Dry Forest Node with the Freshwater Creek Node.

Number of recorded animal species: No specific information available

Number of "unique" species: No specific information available.

List of unique species: No specific information available.

Landownership: GOB, ITCF/Shipstern Nature Reserve (Xopol enclave), Little Belize Mennonite Community, Corozal Timber, Other Private.

Communities: Sarteneja is extending its sphere of influence along the main road to Chunox.
Chunox has farming interests in the area (2 patches along the road from Chunox to the Shipstern Lagoon.
Little Belize is a Mennonite community, which may be expected to convert all arable land into intensive cultivation. Landholdings appear to be increasing.

NGO: ITCF (Shipstern Nature Reserve)

Landuse: Logging, Agriculture on the better soils.

Agricultural value: 2. King et al's (1992) classification of Agricultural value 2 is probably not appropriate in much of northeastern Belize. Soil-depth and drought are main limiting factors

Challenges: Work with Chunox farmers and Mennonites of Little Belize to maintain corridor functionality.

Xopol enclave (Shipstern Nature Reserve). Shipstern Lagoon in the background.

New agricultural clearings in the Xopol Corridor. Shipstern Lagoon in the top left corner.

Shipstern Corridor

Location: Eastern Corozal District.

1:50,000 DOS map number: 6

Vegetation types: Very narrow strip of forest (Tropical evergreen seasonal swamp forest of N. Belize: High variant) surrounded by Marine Salt Marsh and Permanently Waterlogged Freshwater Mangrove Scrubs.

Connections: Links the Shipstern High Forest with the Freshwater Creek Node

Number of recorded animal species: No records available.

Number of "unique" species: No records available.

List of unique species: No records available.

Landownership: Corozal Timber.

Communities: No traditional claims but Fireburn is the nearest community.

NGO: ITCF (Shipstern Nature Reserve), Wildtracks.

Landuse: Used as access for logging in the Shipstern high forest.

Agricultural value: 2. Agricultural value 2 is unrealistic due to the shallow soils, and narrow shape.

Challenges: No immediate threats, but this link is vital to the full ecological functioning of the Shipstern high forest. Maintenance of this link is therefore of importance.

Shipstern corridor as seen from the east. The very narrow strip of high forest is clearly visible.

Freshwater Creek Node

Location: Largest part situated in the northeastern Corozal District. A small section is in the Orange Walk District.

1:50,000 DOS map number: 5.

Vegetation types: Tropical evergreen seasonal broadleaf lowland forest over calcareous soils: Northeastern Variant (largely).

Connections: Radiating from this node there are corridors that link it with the Shipstern dry forest node, the Shipstern high forest node, the Esteves node and the New River Corridor.

Number of recorded animal species: 313. Inventory by Reichelt & Wilcox (1995).

Number of "unique" species: 6.

List of unique species:

Order	*Family*	*Common name*	*Sientific name*
Pisces	Cypronodontidae - killifishes	Ocelated killifish	1 Floridichthys polyommus
Pisces	Gobiidae – Gobies	Crested goby	*Lophiogobius cyprinoides*
Odonata	Gomphidae		*Phyllogomphoides suasus*
Lepidoptera	Nymphalidae		*Zaretis ellops*
Lepidoptera	Nymphalidae		*Memphis oenomais*
Lepidoptera	Nymphalidae		*Memphis hedemanni*

Landownership: Freshwater Creek Forest Reserve forms the core of this node but also includes sections of large private holdings (i.e. Corozal Timber).

Communities: San Estevan is the most important community. Its sugar cane farming practices have led to de-reservation of the western section of the FWCFR.

NGO: Friends of Freshwater Creek.

Landuse: Mostly logging. Probably some isolated Milpa. Western fringes severely impacted by sugar cane farming. Honeycamp Lagoon, once proposed as national park is now being subdivided for housing purposes.

Agricultural value: 2, 4 and some 5

Challenges: This large block of relatively undisturbed habitat is of central importance to the maintenance of biological values in Northeastern Belize. Further reduction of the Freshwater Creek Forest Reserve would be detrimental to this purpose. Freshwater Creek Forest Reserve has a management plan. Continued implementation of that plan is of great importance.

Freshwater Creek Forest Reserve

San Estevan Corridor

Location: Corozal and Orange Walk districts.

1:50,000 DOS map number: 4 & 5

Vegetation types: Narrow section of more or less intact habitat through sugar cane cultivation.

- Tropical evergreen seasonal broadleaf lowland forest over calcareous soils: Northeastern Variant
- Tropical evergreen seasonal swamp forest of N. Belize: High variant
- Predominantly tall herbaceous reedland.

Connections: This San Estevan corridor is not essential for the Northern Biological Corridor but provides a link between the Freshwater Creek Node and the New River Corridor.

Number of recorded animal species: No records available.

Number of "unique" species: No records available.

List of unique species: No records available.

Landownership: Private leases

Communities: San Estevan

NGO: Friends of Freshwater Creek

Landuse: Farming (Sugar Cane) in the general area. Whole corridor impacted to some extend by this activity but still functional.

Agricultural value: 2, 4 and 5.

Challenges: Low priority.

Santa Martha Corridors

Location: Orange Walk District.

1:50,000 DOS map number: 5 & 11

Vegetation types: Surrounded by short-grass savanna in the west, mixed mangrove scrub to the east and agriculture in the center.
- Tropical evergreen seasonal broadleaf lowland forest over calcareous soils: Northeastern Variant
- Tropical evergreen seasonal swamp forest of N. Belize: Low variant.

Connections: Connects the Freshwater Creek Node with the Esteves Node. Split in two separate corridors: west and east of Santa Martha. Both corridor sections are flanking the Santa Martha agriculture area.

Number of recorded animal species: No records

Number of "unique" species: No records

List of unique species: No records

Landownership: Private (lease)?

Communities: Santa Martha

NGO: ?

Landuse: Small scale farming in the general area.

Agricultural value: 4.

Challenges: Work with Santa Martha community to maintain as much possible the corridor functionality of this very important link.

Agricultural Mosaic north of Santa Martha along the old Northern Highway. This landscape still has a reasonable corridor functionality but increasing agricultural intensivation will result in a more and more open landscape.

Colha Corridor

Location: Belize District.

1:50,000 DOS map number: 11.

Vegetation types: Narrow broadleaf corridor trough an area with mixed mangrove scrub and riverine Mangrove.

- Tropical evergreen seasonal broadleaf lowland forest over calcareous soils: Northeastern Variant
- Tropical evergreen seasonal swamp forest of N. Belize: High variant
- Mixed mangrove scrub
- Riverine mangrove forest.

Connections: Connects the Freshwater Creek Node with the Esteves Node.

Number of recorded animal species: No records

Number of "unique" species: No records

List of unique species: No records

Landownership: Various private owners

Communities: Maskal and Bomba.

NGO: ?

Landuse: Logging, secondary forest products, probably some milpa farming.

Agricultural value: 2, 4 and 5.

Challenges: Work with nearby communities to maintain as much possible the corridor functionality of this very important link.

Colha corridor. Clearly visible is the cleared path for the high tension transmission line. The old N. Higway is just visible in the left. In the background a large herbaceous swamp with mangrove.

Colha corridor from a different angle.

Esteves Node

Location: Largely in the Belize District wedged between the Old Northern Highway and the New Northern Higway. Northern section in the Orange Walk district.

1:50,000 DOS map number: 11

Vegetation types:

- Tropical evergreen seasonal broadleaf lowland forest over calcareous soils: Central-eastern Variant
- Tropical evergreen seasonal swamp forest of N. Belize: High variant
- Tropical evergreen seasonal swamp forest of N. Belize: Low variant
- Short-grass savanna with needle-leaf lowland open forest.

Connections: Crucially important node area. Radiating from this node there are corridors that link it with the Freshwater Creek Node, and the Crooked Tree Corridor. Without vital parts of this node intact, the Entire Northern Belize Corridor would fail.

Number of recorded animal species: 276.

Number of "unique" species: None recorded

List of unique species: None recorded

Landownership: Largely British American Cattle Company, some GOB?. Includes Western Maskal Agricultural Layout for small holder farming, but soil quality very low.

Communities: Maskal, Chicago, Rockstone Pond.

NGO: ?

Landuse: Logging, some small holder farming.

Agricultural value: 4 & 5.

More Force/Chicago Corridors

Location: Belize District.

1:50,000 DOS map number: 11

Vegetation types: Corridors through partly intact habitat but restricted by Short-grass savanna and agricultural activities.

- Tropical evergreen seasonal broadleaf lowland forest over calcareous soils: Central-eastern Variant
- Tropical evergreen seasonal swamp forest of N. Belize: High variant.

Connections: Secondary corridors with heavy human impact factors (Agriculture). Connects the Freshwater Creek Node with the Esteves Node. Has merits as link with the Salt Creek Corridor.

Number of recorded animal species: No records

Number of "unique" species: No records

List of unique species: No records

Landownership: Private + GOB

Communities: Maskal, Bomba, Chicago, Rockstone Pond, Corozalito.

NGO: ?

Landuse: Logging, small scale farming.

Agricultural value: 4.

Challenges: Low priority

Biscayne Corridor

Location: Belize District.

1:50,000 DOS map number: 11, 15 and 16.

Vegetation types:
- Tropical evergreen seasonal broadleaf lowland forest over calcareous soils: Central-eastern Variant
- Tropical evergreen seasonal swamp forest of N. Belize: High variant
- Tropical evergreen seasonal swamp forest of N. Belize: Low variant.

Connections: The links between the Belize River Node and the Esteves Node are too weak to depend on a single corridor. This corridor is therefore important as backup for the Crooked Tree Corridor. Connects the Esteves Node with the southern leg of the Crook Tree Corridor. Has merits as link with the Jones Lagoon section of the Crooked Tree Wildlife Sanctuary.

Number of recorded animal species: No records

Number of "unique" species: No records

List of unique species: No records

Landownership: Private + GOB

Communities: Rockstone Pond, Biscayne, Lemonal.

NGO: ?

Landuse: Logging, small scale farming.

Agricultural value: 4 & 5

Challenges: It is important to establish a working relationship with the community of Biscayne in order to maintain corridor functionality of the Northern Highway Crossing that incorporates part of the agricultural area of this community.

The high traffic intensity will cause multiple deaths among wildlife attempting to cross. For this reason it is important to put "wildlife mirrors" along the sides of the road which reflect light from the headlights of oncoming traffic and thus warn wildlife of imminent danger.

Biscayne corridor across the New Northern Highway. Looking towards the Esteves node in the east. Much of the land adjacent to the Highway is now private (or leased) property. But development is minimal.

Salt Creek Corridor

Location: Belize District.

1:50,000 DOS map number: 11 + 16

Vegetation types: This corridor is restricted towards the east by Marine Salt Marsh and various mangrove communities. The more favorable broadleaf forests to the west are impacted by agricultural activities. Tropical evergreen seasonal broadleaf lowland forest over calcareous soils: Central-eastern Variant.

Connections: Supported corridor with links of secondary quality to the Freshwater Creek and Esteves nodes.

Number of recorded animal species: No records

Number of "unique" species: No records

List of unique species: No records

Landownership: Mostly private including many small holder farm parcels.

Communities: Corozalito, Chicago, Salt Creek.

NGO: ?

Landuse: Logging, milpa farming, secondary forest products.

Agricultural value: 4

Challenges: This corridor was not researched since it is of low priority to the NBBC.

Crooked Tree Corridor

Location: Belize District.

1:50,000 DOS map number: 10 + 15

Vegetation types: Narrow strip of broadleaf forest wedged between less favorable habitats such as short-grass savanna and tall herbaceous reedland.

- Tropical evergreen seasonal broadleaf lowland forest over calcareous soils: Central-eastern Variant
- Tropical evergreen seasonal swamp forest of N. Belize: High variant
- Tropical evergreen seasonal swamp forest of N. Belize: Low variant
- Evergreen broad-leaved scrub with much Miconia spp.
- Short-grass savanna with needle-leaf lowland open forest
- Short-grass savanna with shrubs
- Predominantly tall herbaceous reedland.

Connections: One of the longest individual corridors in the entire system. Links the Esteves node with the Belize River node following the Spanish Creek and the high land along the western arm of the Crooked Tree Lagoon. Through the New River Lagoon Corridor it links with the New River Corridor. Link between the Western Crooked Tree Lagoon and the Esteves Node is mostly through savanna type habitats. However, some good gallery forests occur along creeks in the Revenge Lagoon Area. Increase of savanna fires (combined with climate change?) may endanger this link. Also subdivision of the Revenge Lagoon area poses some threat.

Number of recorded animal species: 495

Number of "unique" species: None reported

List of unique species: None reported

Landownership: Partly protect through the Crooked Tree Wildlife Sanctuary but this includes only wetlands up to the maximum high water level. Partly in the proposed New River Lagoon protected area. Much ill-defined private property adjacent or even in these protected areas. Large landholdings by the British American Cattle Company.

Communities: Crooked Tree, Lemonal, Rancho Dolores.

NGO: Programme for Belize, Belize Audubon Society.

Landuse: Fishing, grazing. Smallholder agriculture on the higher land.

Agricultural value: 3, 4 and 5.

Challenges: Work with listed communities and other landowners to maintain this most important corridor. Creation of " bufferzones" along the narrower section of this corridor is desirable.

The high traffic intensity will cause multiple deaths among wildlife attempting to cross. For this reason it is important to put “wildlife mirrors” along the sides of the road which reflect light from the headlights of oncoming traffic and thus warn wildlife of imminent danger.

New Northern Highway Crossing looking towards Orange Walk

Gallery forest linking New Northern Highway Crossing with Crooked Tree Lagoon

High forest on the west shores of the western arm of Crooked Tree Lagoon. In the background the New River Lagoon

High forest on the west shores of the western arm of Crooked Tree Lagoon interrupted by Tourist lodge development. In the background the New River Lagoon

Lemonal along the Spanish Creek. In the Background the New River Lagoon and the Hill Bank Node.

Spanish Creek linking the Crooked Tree area with the Belize River Node

New River Corridor

Location: Orange Walk and Corozal District.

1:50,000 DOS map number: 2, 4, 5, 10 + 15.

Vegetation types: Very long and narrow strip of broadleaf forest surrounded by less favorable habitats, but mostly by agriculture.

- Tropical evergreen seasonal broadleaf lowland forest over calcareous soils: Central-western Variant
- Tropical (or subtropical) evergreen seasonal alluvial forest
- Tropical evergreen seasonal swamp forest of N. Belize: High variant
- Tropical evergreen seasonal swamp forest of N. Belize: Low variant
- Evergreen broad-leaved scrub with much Miconia spp.
- Predominantly tall herbaceous reedland.

Connections: Supported corridor linking the Crooked Tree Corridor with the proposed New River Lagoon Protected area, the Lamanai archaeological reserve and the entire New River.

Number of recorded animal species: No specific data for the total corridor. The Lamanai area has been well researched (unpublished reports).

Number of "unique" species: No specific data available for the entire corriodor.

List of unique species: No specific data available for the entire corridor.

Landownership: Varied. Technically the 66ft corridor cannot be developed but in urban and agricultural areas this may have taken place anyway.

Communities: San Pablo, Indian Church, Fireburn, Shipyard, Guinea Grass, Carmelita, Tower Hill, Palmar, Orange Walk, Trial Farm, San Estevan, Caledonia, Santa Cruz, Benque Viejo, Estrella, Libertad, Pueblo Nuevo, Corozal.

NGO: ?

Landuse: Tourism, Fishing, Residential, Smallholder agriculture on the higher land, Intensive agriculture, Conservation.

Agricultural value: 3, 4 and 5.

Challenges: Not a priority under the current project. But a very important area because of its high value for tourism. Local projects aimed at the conservation of this corridor should be encouraged and involve not only the local communities but also the tourism interests in the area.

Hill Bank Node

Location: Orange Walk District. See detail map 3.

1:50,000 DOS map number: 14 & 15

Vegetation types:
- Tropical evergreen seasonal broadleaf lowland forest over calcareous soils: Central-western Variant
- Tropical evergreen seasonal swamp forest of N. Belize: High variant
- Evergreen broad-leaved scrub dominated by Leguminous shrubs.

Connections: Forms a semi-unit with the Rio Bravo node but habitat not contiguous within the RBCMA. Within the RBCMA separated from the main Rio Bravo Node by the Booths River ecosystems which present a barrier for forest obligates. Its true connection is over the Gallon Jug Agro Industries property. Is connected with the Belize River Node through the Ramgoat Corridor. Also largely contiguous with the entire Yalbac region through which it will be important to maintain corridors as this area gets developed.

Number of recorded animal species: See the lists for the Rio Bravo Node Area.

Number of "unique" species: See the lists for the Rio Bravo Node.

List of unique species: See the lists for the Rio Bravo Node.

Landownership: Largely managed as part of the Rio Bravo Conservation Management Area.

Communities: Rancho Dolores.

NGO: Programme for Belize.

Landuse: Logging, Tourism, Conservation.

Agricultural value: 3.

Challenges: To maintain connectivity between the adjacent Rio Bravo Node.

Rio Bravo Node

Location: Mostly western Orange Walk district. Some Cayo district in the south.

1:50,000 DOS map number: 8, 9, 13, 14.

Vegetation types:
- Mostly: Tropical evergreen seasonal broadleaf lowland forest over calcareous soils: Northwestern Variant.
- Also: Tropical evergreen seasonal broadleaf lowland forest over calcareous soils: Central-western Variant
- Tropical (or subtropical) evergreen seasonal alluvial forest
- Tropical evergreen seasonal swamp forest of N. Belize: High variant
- Evergreen broad-leaved scrub dominated by Leguminous shrubs.

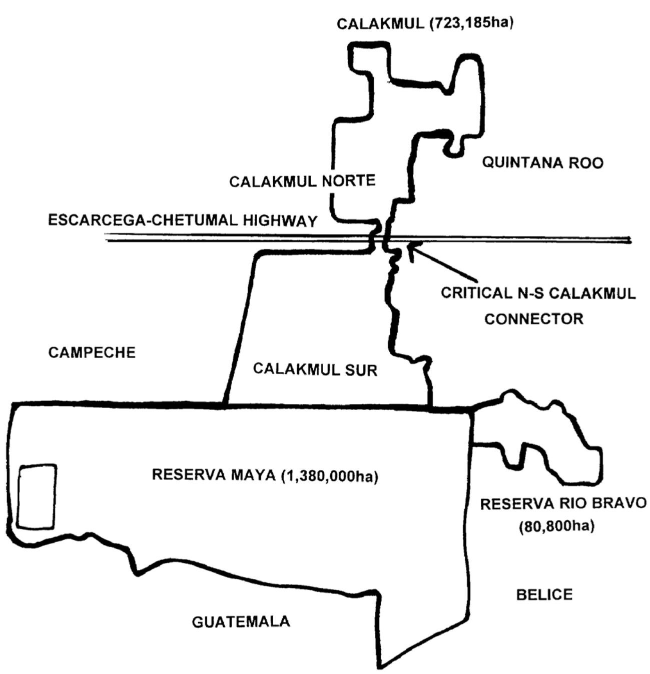


Figure 7. Protected areas in Guatemala and Mexico linked with the RBCMA.

Connections: Contiguous with the Maya Biosphere Reserve (Petén, Guatemala) and the Calakmul Protected Area (Campeche, Mexico). Contiguous also with the Yalbac area and the Gallon Jug Agro Industries property. The current management of the latter is conducive to the maintenance of its biodiversity. However, the long term future of both the Yalbac and the Gallon Jug area is not entirely certain. For this reason a "Gallon Jug" corridor is important to maintain habitat connectivity between the Western Section of the RBCMA and the Hill Bank Node.

Number of recorded animal species: 701, The Rio Bravo Management Area is well researched.

Number of "unique" species: 87 (or 12%) of the recorded species has not (yet) been recorded from other areas in Northern Belize. Since the level of endemism is low (compared to the Shipstern node) this high percentage of "uniqueness" must be explained by the overall higher biodiversity than in any of the other investigated areas of Northern Belize.

List of unique species:

Order	Family	Common name	Sientific name
Amphibia	*Leptodactylidae – Rainfrogs*	*Lowland rainfrog*	*Eleutherodactylus rhodopis*
Amphibia	*Leptodactylidae – Rainfrogs*	*Central American rainfrog*	*Eleutherodactylus rugulosus*
Amphibia	*Leptodactylidae – Rainfrogs*	*Gulf chirping frog*	*Eleutherodactylus leprus*
Amphibia	*Hylidae – Treefrogs*	*Hourglass treefrog*	*Hyla ebraccata*
Reptilia	*Corytophanidae - Casque headed lizards*	*Smooth-headed helmeted basilisk*	*Corytophanes cristatus*
Reptilia	*Polychrotidae – Anoles*	*Greater scaly anole*	*Anolis tropidonotus*
Reptilia	*Colubridae - Colubrid snakes*	*Middle American earth snake*	*Adelphicos quadrivirgatus*
Reptilia	*Viperidae - Pitvipers and Rattlesnakes*	*Eyelash palm pitviper*	*Bothriechis schlegelii*
Aves	*Swans, Geese And Ducks – Anatidae*	*Northern Shoveler*	*Anas cyanoptera*
Aves	*Kites, Hawks, Eagles And Allies – Accipitridae*	*Sharp-shinned Hawk*	*Accipiter striatus chionogaster*
Aves	*Kites, Hawks, Eagles And Allies – Accipitridae*	*Bicolored Hawk*	*Accipiter bicolor bicolor*
Aves	*Kites, Hawks, Eagles And Allies – Accipitridae*	*Zone-tailed Hawk*	*Buteo albonotatus*
Aves	*Kites, Hawks, Eagles And Allies – Accipitridae*	*Crested Eagle*	*Morphnus guianensis*
Aves	*Kites, Hawks, Eagles And Allies – Accipitridae*	*Harpy Eagle*	*Harpia harpyja*
Aves	*Rails, Gallinules And Allies Rallidae*	*Gray-breasted Crake*	*Laterallus exilis*
Aves	*Sandpipers And Allies – Scolopacidae*	*Sooty Tern*	*Sterna fuscata*
Aves	*Typical Owls – Strigidae*	*Spectacled Owl*	*Pulsatrix perspicillata*
Aves	*Tyrannulets, Elaenias And Allies – Elaeniinae*	*Paltry Tyrannulet*	*Zimmerius vilissimus*
Aves	*Wrens – Troglodytidae*	*Plain Wren*	*Thryothorus modestus*
Aves	*Wrens – Troglodytidae*	*Nightingale Wren*	*Microcerculus philomela*
Aves	*Wood Warblers - Parulidae*	*Tropical Parula*	*Parula pitiayumi*
Aves	*Wood Warblers - Parulidae*	*Rufous-capped Warbler*	*Basileuterus rufifrons*
Aves	*Tanagers – Thraupidae*	*Green Honeycreeper*	*Chlorophanes spiza*
Aves	*Tanagers – Thraupidae*	*Western Tanager*	*Piranga ludoviciana*
Aves	*Tanagers – Thraupidae*	*White-winged Tanager*	*Piranga leucoptera*
Aves	*Emberizines – Emberizidae*	*Slate-colored Seedeater*	*Sporophila schistacea*
Aves	*Emberizines – Emberizidae*	*Yellow-faced Grassquit*	*Tiaris olivacea*
Mamalia	*Sac-winged Bats - Emballonuridae*	*Shaggy Bat*	*Centronycteris centralis*
Mamalia	*Tail-less Fruit Bats – Stenodermatinae*	*Velvety fruit-eating bat*	*Enchisthenes hartii*
Mamalia	*Tailed Leaf-nosed Bats – Phyllostomiinae*	*Woolly False Vampire Bat*	*Chrotopterus auritus auritus*
Mamalia	*Tailed Leaf-nosed Bats –*	*Pygmy Round-eared Bat*	*Tonatia saurophila bakeri*

	Phyllostomiinae		
Mamalia	*Tailed Leaf-nosed Bats – Phyllostomiinae*	*Greater False Vampire Bat*	*Vampyrum spectrum*
Mamalia	*Plain-nosed Bats - Vespertilionidae*	*Central American Yellow Bat*	*Rhogeessa tumida*
Mamalia	*Spider Monkeys – Atelinae*	*Central-American Spider-Monkey*	*Ateles geoffroyi*
Mamalia	*Mustelidae - Weasel Family*	*Grison*	*Galictis vittata canaster*
Mamalia	*Deer – Cervidae*	*Gray Brocket Deer*	*Mazama pandora*
Mamalia	*Spiny Pocket Mouse – Heteromyidae*	*Forest Spiny Pocket Mouse*	*Heteromys desmarestianus desmarestianus*
Mamalia	*New World Mice and Rats – Sigmodontinae*	*Rusty Rice Rat*	*Oryzomys rostratus megadon*
Mamalia	*New World Mice and Rats – Sigmodontinae*	*Northern Climbing Rat*	*Tylomys nudicaudus nudicaudus*
Odonata	Calopterygidae		*Hetaerina occisa*
Odonata	Calopterygidae		*Hetaerina pilula*
Odonata	Calopterygidae		*Hetaerina titia*
Odonata	Megapodagrionidae		*Heteragrion alienum*
Odonata	Pseudostigmatidae		*Pseudostigma aberrans*
Odonata	Platystictidae		*Palaemnema desiderata*
Odonata	Protoneuridae		*Neoneura amelia*
Odonata	Protoneuridae		*Neoneura paya*
Odonata	Protoneuridae		*Protoneura aurantiaca*
Odonata	Protoneuridae		*Protoneura cupida*
Odonata	Protoneuridae		*Psaironeura remissa*
Odonata	Coenagrionidae		*Acanthagrion quadratum*
Odonata	Coenagrionidae		*Argia oculata*
Odonata	Coenagrionidae		*Argia oenea*
Odonata	Coenagrionidae		*Argia pulla*
Odonata	Coenagrionidae		*Argia translata*
Odonata	Coenagrionidae		*Enallagma novaehispaniae*
Odonata	Coenagrionidae		*Ischnura capreolus*
Odonata	Coenagrionidae		*Ischnura posita acicularis*
Odonata	Coenagrionidae		*Telebasis boomsmae*
Odonata	Coenagrionidae		*Telebasis collopistes*
Odonata	Coenagrionidae		*Telebasis filiola*
Odonata	Coenagrionidae		*Telebasis griffinii*
Odonata	Aeshnidae		*Triacanthagyna satyrus*
Odonata	Gomphidae		*Agriogomphus tumens*
Odonata	Gomphidae		*Erpetogomphus ophibolus*
Odonata	Gomphidae		*Phyllogomphoides duodentatus*
Odonata	Gomphidae		*Phyllogomphoides pugnifer*
Odonata	Libellulidae		*Brechmorhoga praecox*
Odonata	Libellulidae		*Dythemis multipunctata*
Odonata	Libellulidae		*Erythemis plebeja*
Odonata	Libellulidae		*Idiataphe amazonica*
Odonata	Libellulidae		*Libellula herculea*

Odonata	Libellulidae	*Macrothemis musiva*
Odonata	Libellulidae	*Macrothemis tessellata*
Odonata	Libellulidae	*Micrathyria aequalis*
Odonata	Libellulidae	*Micrathyria ocellata*
Odonata	Libellulidae	*Tauriphila argo*
Lepidoptera	Libytheidae	*Libytheana carinenta mexicana*
Lepidoptera	Nymphalidae	*Oleria paula*
Lepidoptera	Nymphalidae	*Eueides aliphera gracilis*
Lepidoptera	Nymphalidae	*Chlosyne janais*
Lepidoptera	Nymphalidae	*Anthanassa ardys*
Lepidoptera	Nymphalidae	*Nica flavilla canthara*
Lepidoptera	Nymphalidae	*Catonophele numilia esite*
Lepidoptera	Nymphalidae	*Memphis artacaena*
Lepidoptera	Nymphalidae	*Morpho polyphemus luna*
Lepidoptera	Nymphalidae	*Yphtimoides remissa*

Landownership: Two main holdings: Rio Bravo Conservation Management Area (PfB = Programme for Belize) and Gallon Jug Agro Industries (Barry Bowen).

Communities: Gallon Jug, Silvester, Los Tambos, Spanish Lookout.

NGO: Programme For Belize

Landuse: Conservation management, Selective logging, Tourism. Intensive agriculture around Gallon Jug.

Agricultural value: 2, 3, 4 & 5

Challenges: Work towards a more permanent conservation commitment of the Gallon Jug area and maintain sufficient corridor connectivity on the Yalbac lands.

Yalbac corridor

Location: Cayo District.

1:50,000 DOS map number: 25.

Vegetation types: Mostly: Tropical evergreen seasonal broadleaf lowland forest over calcareous soils: Northwestern Variant.

Connections: Links through (presently) intact habitat. Links the Belize River Node and the Rio Bravo Node with protected areas such as the bi-national El Pilar Archaeological Reserve and Terra Nova Forest Reserve.

Number of recorded animal species: No specific records.

Number of “unique” species: No specific records.

List of unique species: No specific records.

Landownership: Terra Nova Forest Reserve, Large private landholdings (Yalbac estate?), Spanish Lookout Mennonites.

Communities: Valley of Peace, Yalbac Farms, Los Tambos, Spanish Lookout.

NGO: Traditional Healers.

Landuse: Logging, milpa farming. Intensive farming encroaching.

Agricultural value: 2, 3, 4 and 5.

Challenges: Work towards a corridor-friendly development plan with present and future owners. Use the EIA mechanism as a tool to create corridors in development plans. The Terra Nova Reserve will likely undergo partial de-reservation.

Belize River Node area

Location: Cayo District.

1:50,000 DOS map number: 20

Vegetation types:
- Tropical evergreen seasonal broadleaf lowland forest over calcareous soils: Northwestern Variant
- Tropical evergreen seasonal broadleaf lowland forest over calcareous soils: Central-eastern Variant
- Tropical evergreen seasonal broadleaf lowland forest over calcareous soils: Belize River Variant
- Tropical evergreen seasonal broadleaf lowland forest over calcium-rich alluvium
- Tropical evergreen seasonal swamp forest of N. Belize: High variant
- Predominantly graminoid reedland.

Number of recorded animal species: For the whole map block (including Monkey Bay Wildlife Reserves): 358 spp. Data incomplete.

Number of "unique" species: None identified.

List of unique species: NA.

Landownership: All in private hands, some as very large holdings.

Communities: More Tomorrow, Valley of Peace, Cotton Tree, Cotton Tree Bank, Beaver Dam, Saint Matthews, La Democracia, New Satellite town.

NGO: ?

Landuse: Logging.

Agricultural value: Substantial amounts of class 1, also class 2, 3, 4 and 5.

Challenges: A highly important node area. Is vital to the linking of the Northeastern and Belize conservation areas with the Rio Bravo Area in the west and the rest of Belize in the south. Problems are large land holdings and large –undeveloped- areas of first grade agricultural land. While intact conservation of the entire node may not be feasible, it is important to work with current and future landowners to develop a corridor-friendly development plan with present and future owners. There are "natural corridors" over less suitable landtypes. Use the EIA mechanism as a tool to create corridors in development plans.

High forests of the Belize River Node

Mile 35 Corridor

Location: Cayo district.

1:50,000 DOS map number: 20

Vegetation types:

- Tropical evergreen seasonal broadleaf lowland forest over calcareous soils: Belize River Variant
- Tropical evergreen seasonal swamp forest of N. Belize: High variant.

Connections: Links the Belize River Node with the Sibun River Corridor. Partly runs across the land appropriated by GOB for construction of a new satellite town. Crosses the Western Highway between Miles 35 and 36. Provides the best habitat links of all three Western Highway crossing options.

Number of recorded animal species: 358. Surveys conducted as parts of EIA's by Meerman (1998) and McRae (2000). In spite of human accessibility, the area is rich in larger wildlife. Important Tapir habitat.

Number of "unique" species: None reported.

List of unique species: None reported.

Landownership: GOB, Beaver Dam County (Chinese consortium), BGMC.

Communities: Beaver Dam, St. Matthews Village, [Satellite Town]

NGO: Monkey Bay

Landuse: Logging, partly being developed (Subdivision, farming).

Agricultural value: 3, 4 and 5.

Challenges: Work with GOB to have the broadleaf sections of the former Hamze property declared as biological corridor and incorporate this corridor in the Satellite town design. For the other properties, it is important work on a corridor-friendly development plan with present and future owners. Use the EIA mechanism as a tool to create corridors in development plans. Purchase of vital sections may be contemplated.

Actual link with Sibun River is complicated by Citrus groves along the river. Mature citrus may provide some form of corridor functionality.

The high traffic intensity will cause multiple deaths among wildlife attempting to cross. For this reason it is important to put "wildlife mirrors" along the sides of the road which reflect light from the headlights of oncoming traffic and thus warn wildlife of imminent danger.

MI 35 along the W. Highway. Note the high tension line along the northern edge of the highway.

Mile 35 along the Western Highway as seen from the south. Savanna
area in the far back is the location for the new satellite town

Cotton Tree Corridor

Location: Cayo district.

1:50,000 DOS map number: 20

Vegetation types:
- Tropical evergreen seasonal broadleaf lowland forest over calcareous soils: Belize River Variant
- Tropical evergreen seasonal broadleaf hill forest over calcareous soils: In rolling terrain.

Connections: Secondary corridor connecting the Belize River Node with the Sibun River Corridor. Starting along the lower reaches of the Beaver Dam Creek and crossing the Western Highway near Cotton Tree.

Number of recorded animal species: No records

Number of "unique" species: No records

List of unique species: No records

Landownership: Beaver Dam Country (Chinese consortium), And other mostly Chinese owners.

Communities: Cotton Tree, Beaver Dam, Salvapan, Las Flores

NGO: SWA

Landuse: Housing development, Some milpa farming.

Agricultural value: 2, 3 and 4.

Challenges: Although no priority, it is important to reserve this corridor as third option for a Western Highway crossing. Integrity threatened by agricultural encroachment originating in small settlements around Belmopan.

Agricultural expansion of the Belmopan "satellite communities" Salvapan and Las Flores. Left in the Background is Belmopan.

Belize Zoo Corridor

Location: Cayo and Belize Districts.

1:50,000 DOS map number: 20 + 21

Vegetation types:
- Tropical evergreen seasonal broadleaf lowland forest over calcareous soils: Central-eastern Variant
- Evergreen broad-leaved scrub with much Miconia spp.

Connections: This secondary, two pronged, corridor connects the Belize River Node with the Sibun River Corridor and the Runaway Creek Works. Follows the Belize Zoo property and crosses the Western Higway at the Jih Chan property.

Number of recorded animal species: No records

Number of "unique" species: No records

List of unique species: No records

Landownership: Belize Zoo & TEC, Jih Chan, H. C. Fairweather, Zoological Society of Milwaukee County (Runaway Creek).

Communities: La Democracia, Jih Chan.

NGO: Belize Zoo and TEC, Zoological Society of Milwaukee County, SWA.

Landuse: Conservation, Logging, Farming including Citrus, Housing development.

Agricultural value: 2, 3, 4 and 5.

Challenges: Although a secondary corridor, the fragility of the Mile 35 corridor makes it important to implement this corridor simultaneously. Work on a corridor-friendly development plan with present and future owners. Use the EIA mechanism as a tool to create corridors in development plans. The potential construction of a solid waste dump in this particular may endanger this option but on the other hand, using the EIA tool, the corridor may be declared as part of the mitigation measures.

The high traffic intensity will cause multiple deaths among wildlife attempting to cross. For this reason it is important to put "wildlife mirrors" along the sides of the road which reflect light from the headlights of oncoming traffic and thus warn wildlife of imminent danger.

Western Higwaycrossing just east of the Belize Zoo looking towards the Sibun

Belize Zoo Corridor looking north as seen from the Sibun River and Runaway Creek

Baboon Sanctuary Corridor

Location: Belize District, along the Belize River.

1:50,000 DOS map number: 15 & 20.

Vegetation types: Tropical evergreen seasonal broadleaf lowland forest over calcium-rich alluvium.

Connections: Supported corridor with links to the Belize River Node and the Cox/Mucklehany corridor.

Number of recorded animal species: 250 species

Number of "unique" species: No analysis

List of unique species: No analysis

Landownership: Private, joined in a voluntary agreement.

Communities: Willows Bank, Double Head Cabage, Bermudian Landing, Isabella Bank, Flowers Bank.

NGO: Community Baboon Sanctuary, BelRiv, Belize Audubon Society.

Landuse: Farming, residential

Agricultural value: 2 & 3.

Challenges: Very important area because it's tourism value and ongoing grass-roots conservation projects. But not a direct priority for the functioning of the NBBC.

Cox/Mucklehany Corridor

Location: Belize District.

1:50,000 DOS map number: 16, 20 & 21.

Vegetation types:
- Tropical evergreen seasonal broadleaf lowland forest over calcareous soils: Central-eastern Variant
- Tropical evergreen seasonal alluvial forest.

Connections: Supported corridor with links to the Belize River Node and the Baboon Sanctuary corridor. Follows the Mussel Creek and the southern banks of the Belize River.

Number of recorded animal species: 224

Number of "unique" species: No analysis

List of unique species: No analysis

Landownership: Private

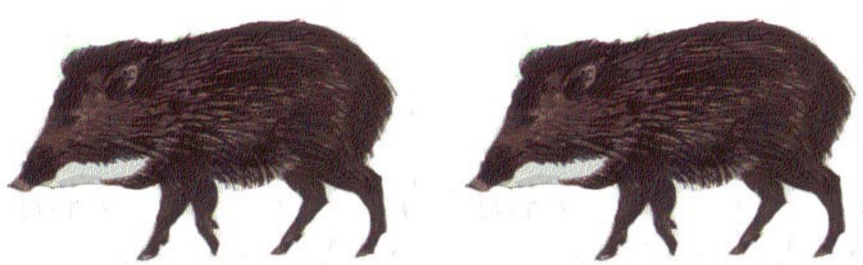
Communities: Willows Bank, Double Head Cabage, Bermudian Landing, Isabella Bank, Flowers Bank, Davis/Grace Bank, Burrell Boom.

NGO: Monkey Bay, Community Baboon Sanctuary, BelRiv.

Landuse: Small scale farming, Milpa.

Agricultural value: 3 & 4.

Challenges: Includes areas of high conservation value but not a direct priority for the functioning of the NBBC.



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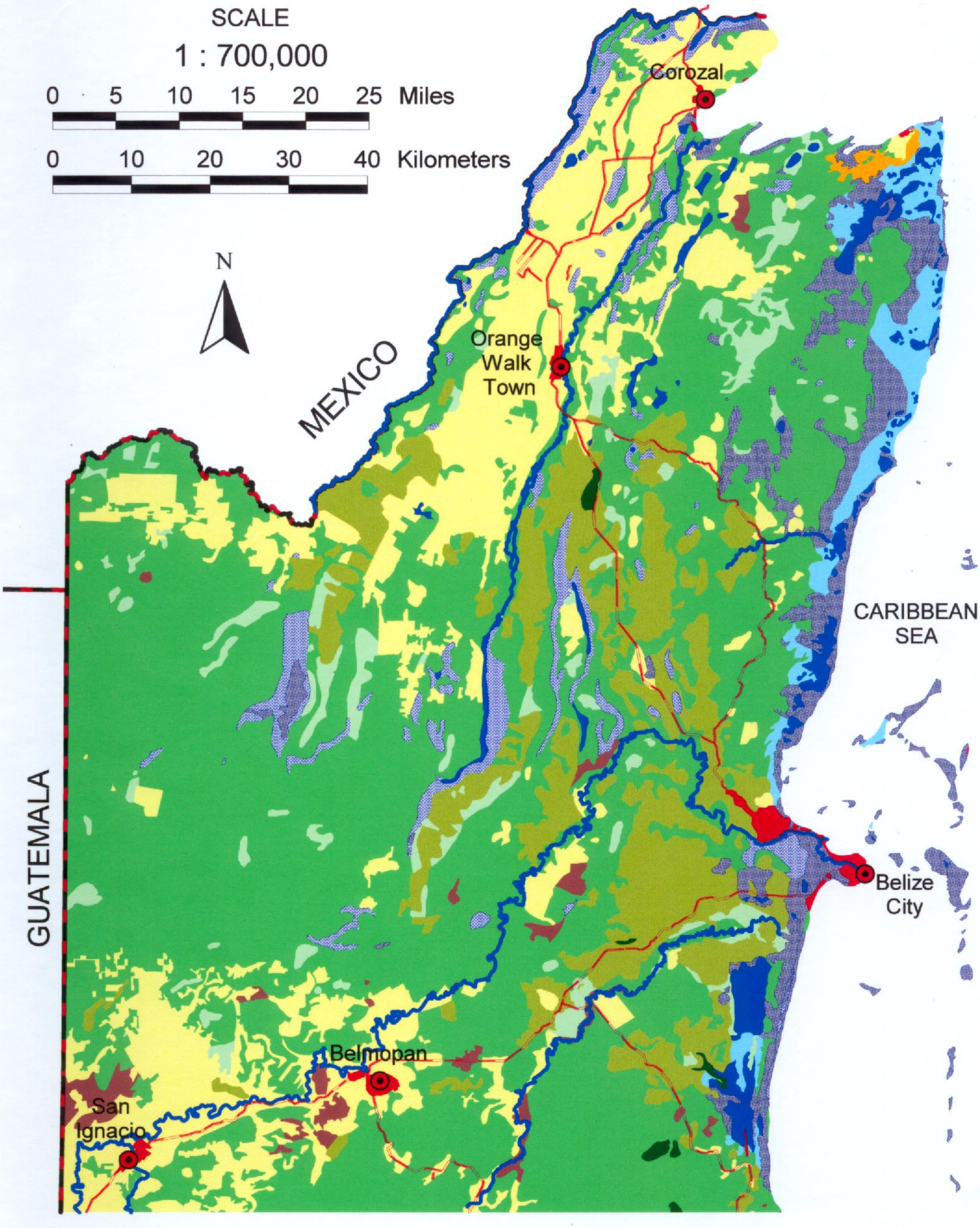
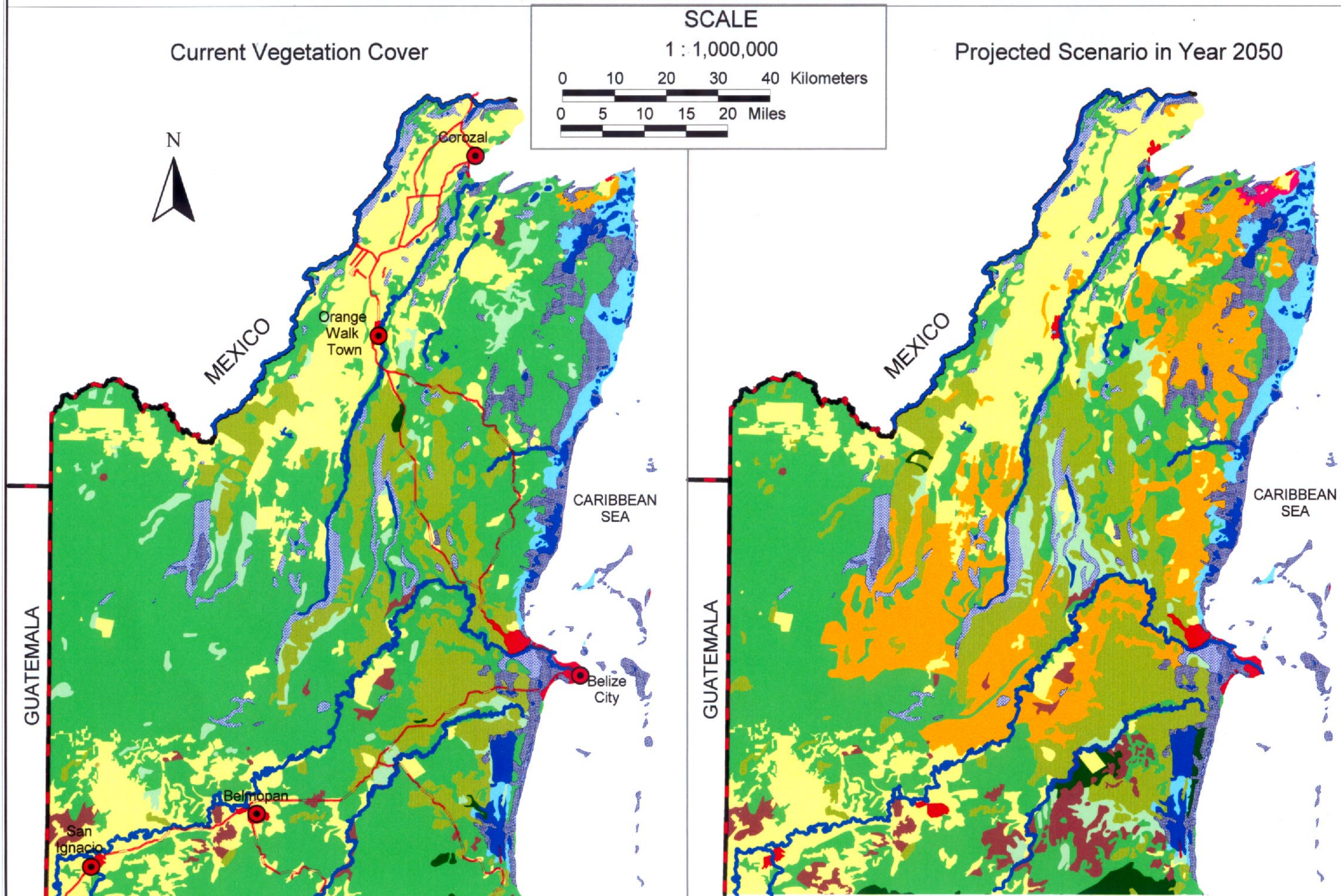
Legend for Maps 1A, 1B, and 2
Vegetation and Land Use Categories
Agriculture and high human impact
Broadleaf forest
Disturbed shrubland
Dry forest
Mangrove
Pine forest
Reedland
Salt marsh
Savanna
Scrub forest
Urban
Water body
Thorn scrub
City or Town
Village
Major road
Minor road
Major river
International border

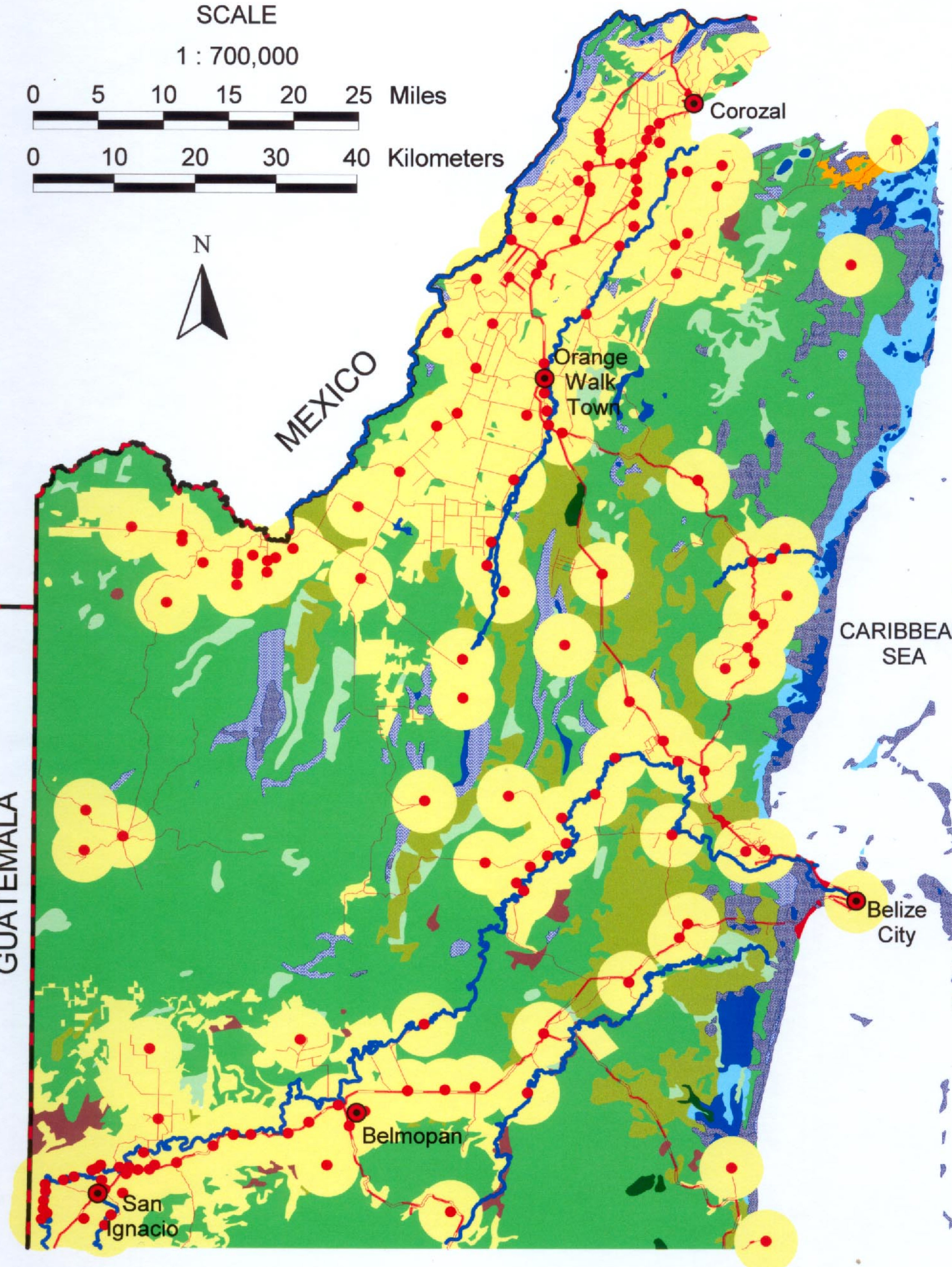
Map 1A: Vegetation and Land Use of Northern Belize



Map 1B: Comparison of Current Vegetation Cover of Northern Belize with Projected Scenario in Year 2050

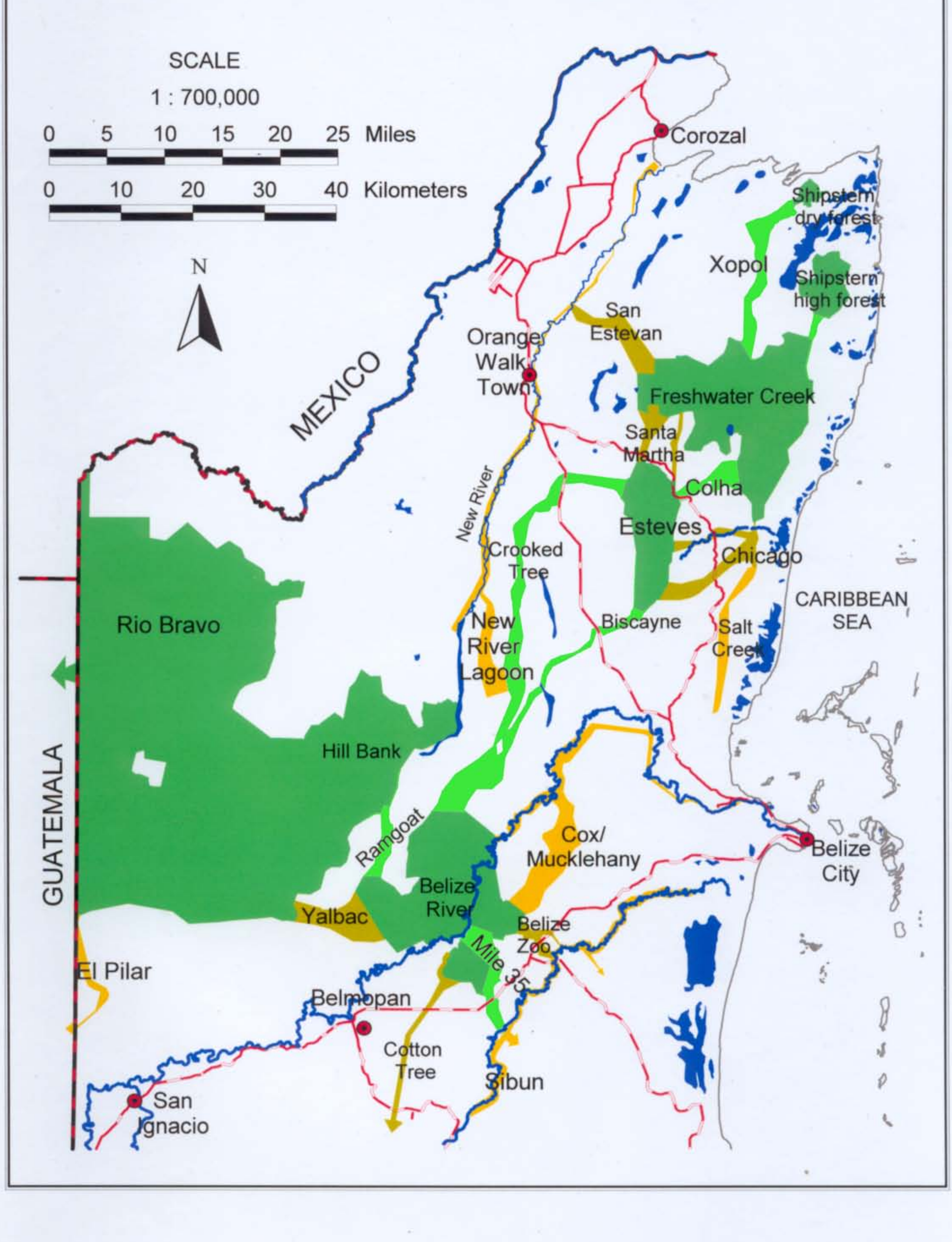


Map 2: Areas of Potentially High Human Impact in Northern Belize

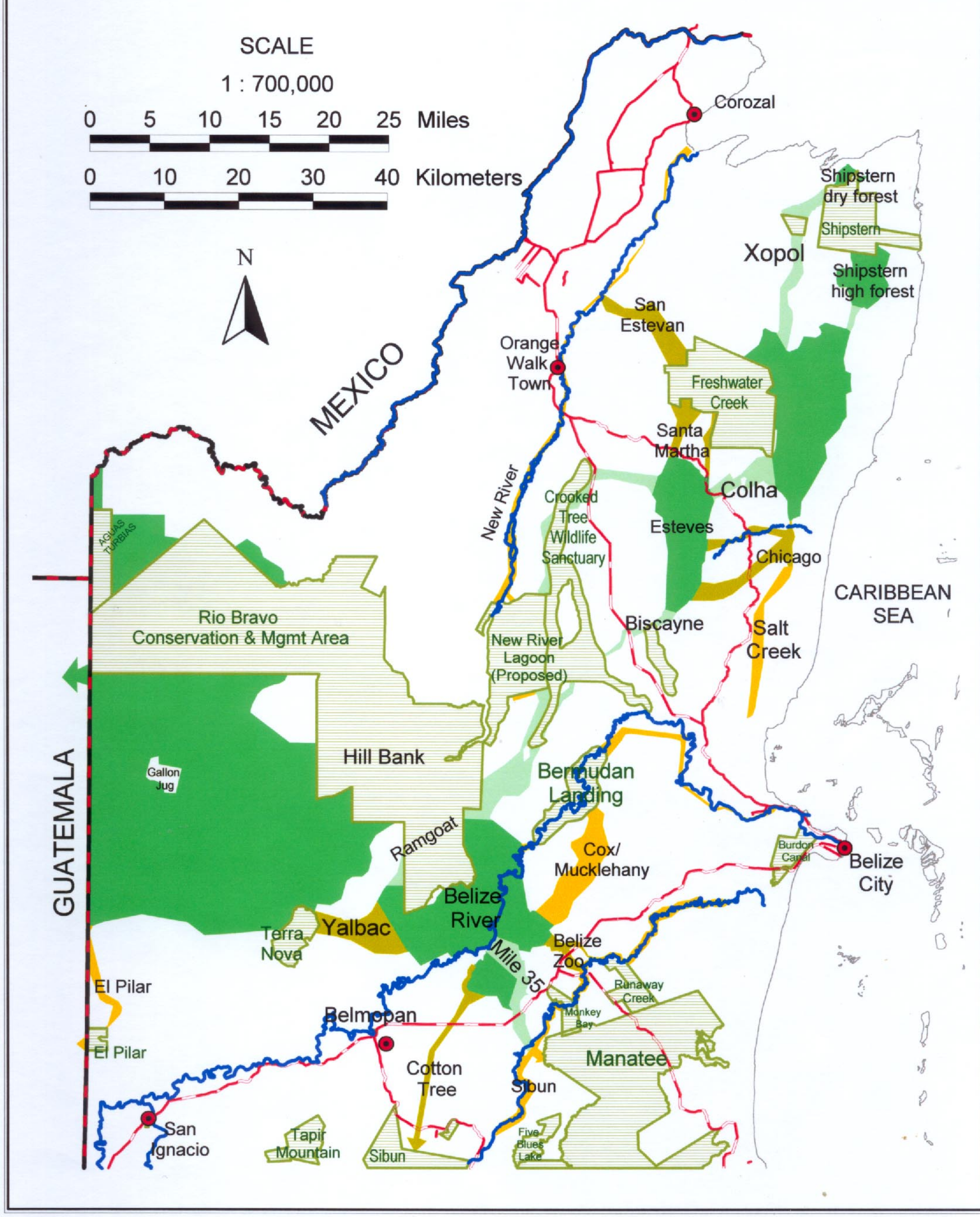


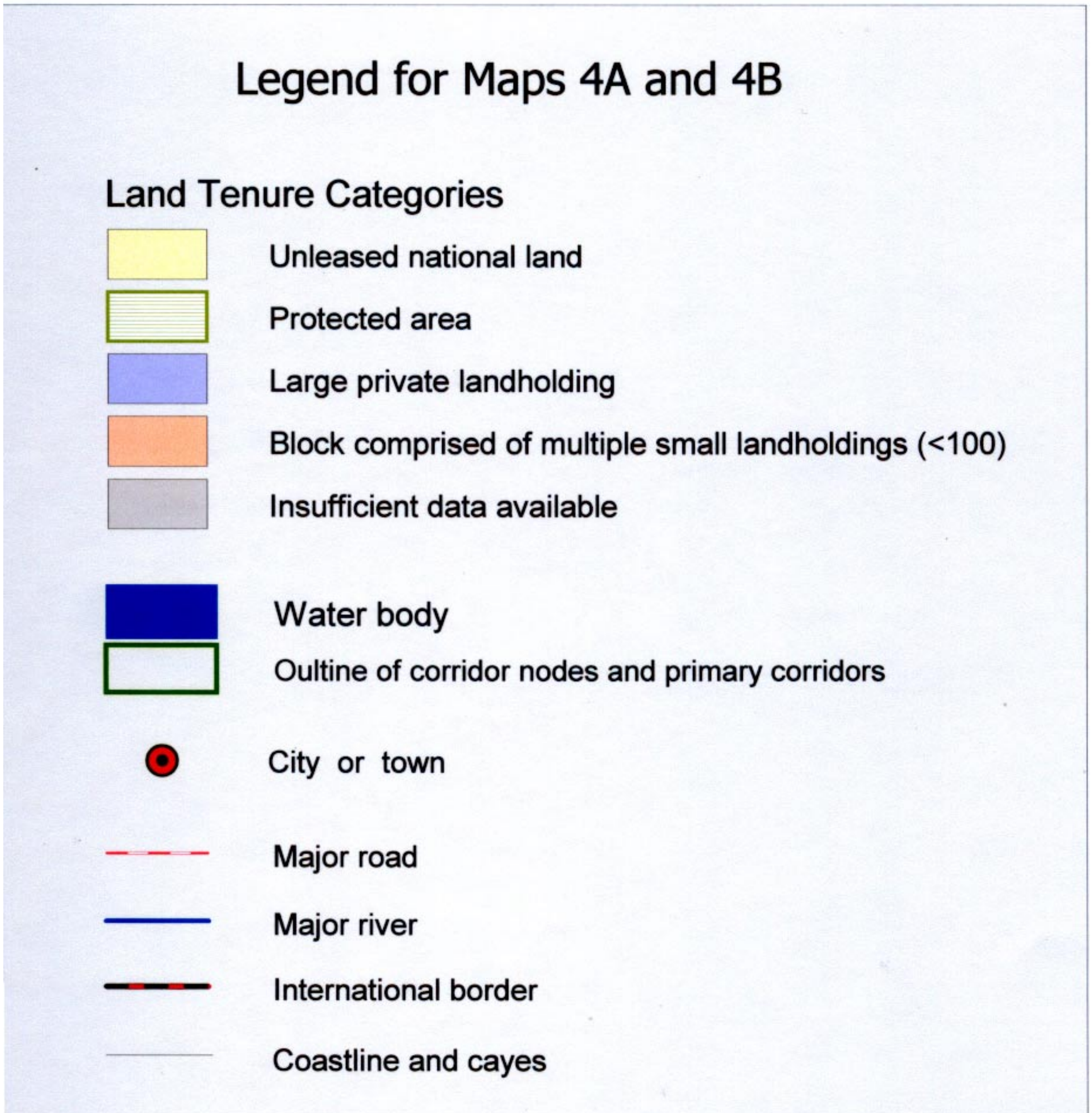

Legend for Maps 3A, 3B, and 5
Biological Corridors
Node
Primary corridor
Secondary corridor
Supported link
Protected area
Water body
City or town
Flight path
Major road
Major river
International border
Coastline and cayes

Map 3A: The Northern Belize Biological Corridors

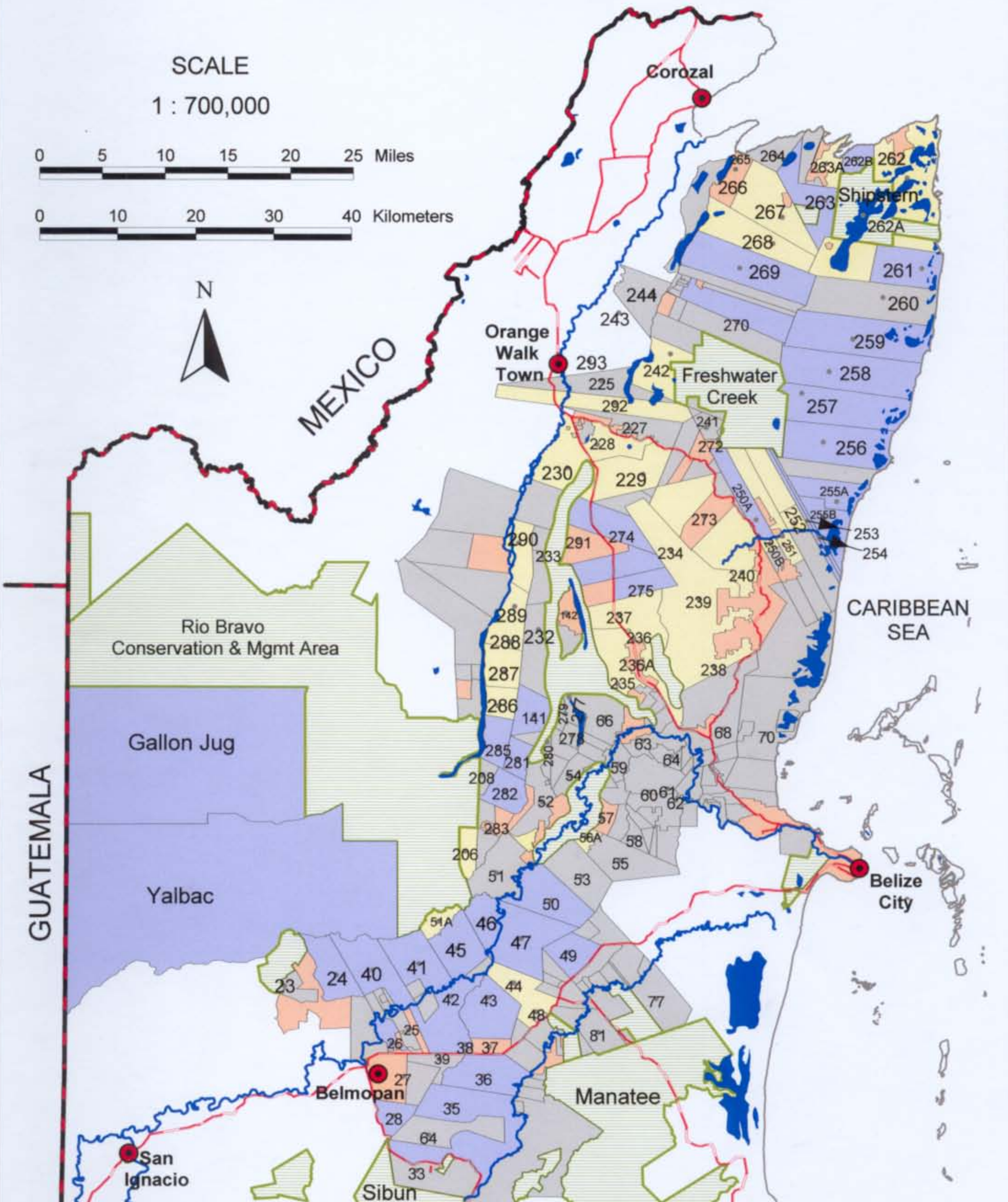


Map 3B: The Northern Belize Biological Corridors and Protected Areas



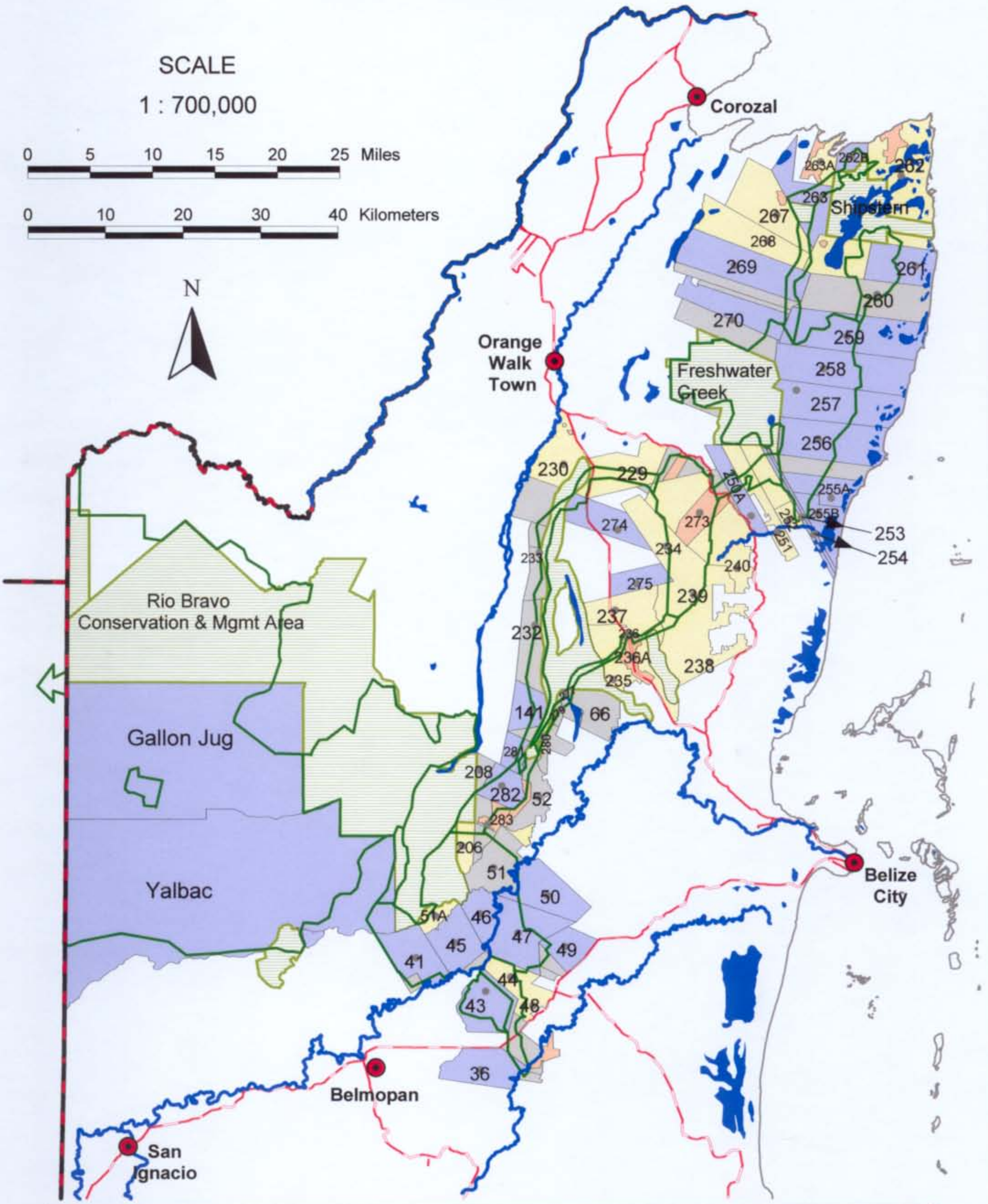

Legend for Maps 4A and 4B
Land Tenure Categories
Unleased national land
Protected area
Large private landholding
Block comprised of multiple small landholdings (<100)
Insufficient data available
Water body
Oultine of corridor nodes and primary corridors
City or town
Major road
Major river
International border
Coastline and cayes

Map 4A: Schematic Representation of Land Tenure Categories in Areas Relevant to the Corridor



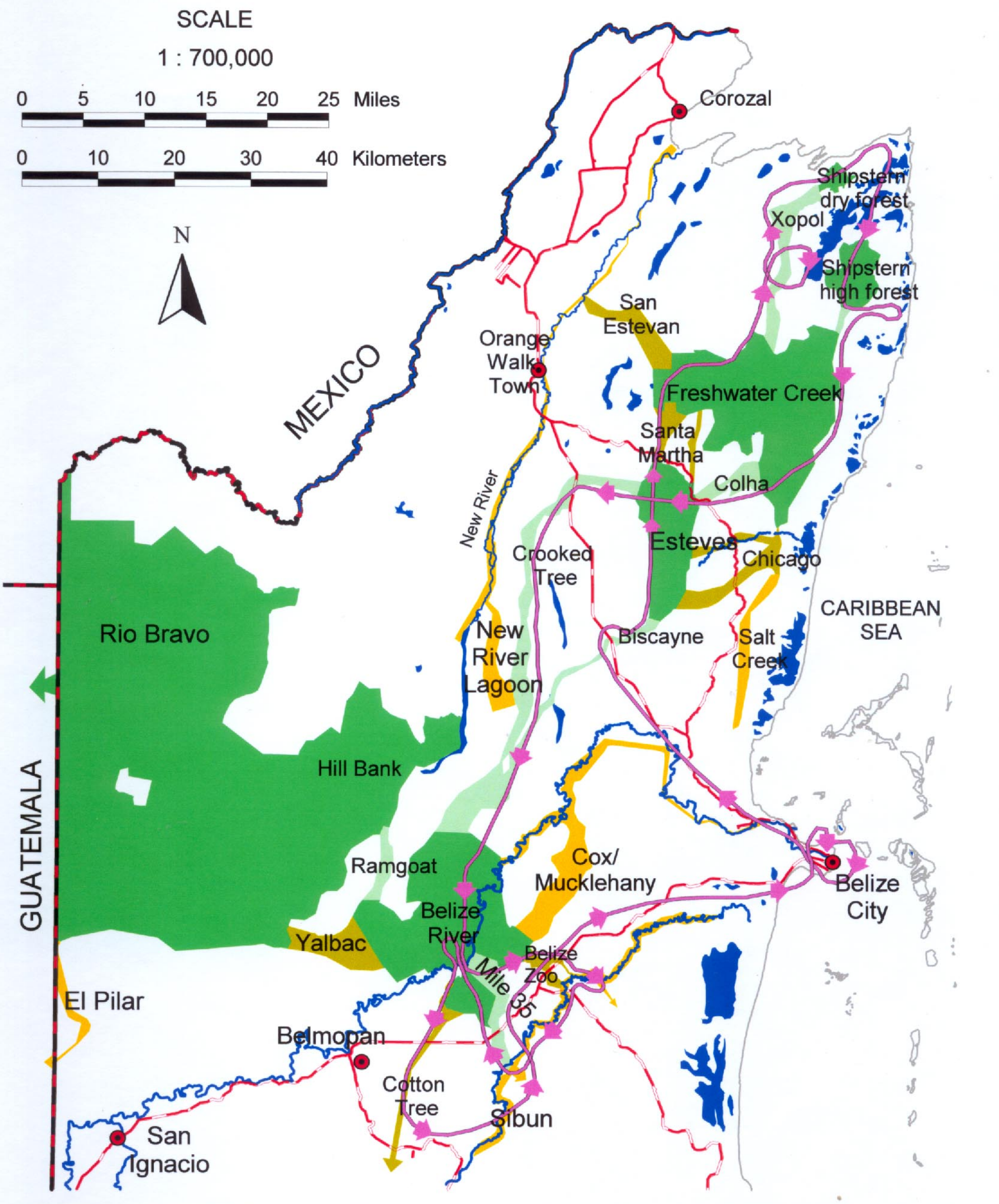
This map in no manner represents land tenure status in Belize. Its use must be in consultation with the Commissioner of Lands and Survey Department.
Protected area boundaries are in accordance with the relevant Statutory Instrument and current only up to July 2000.

Map 4B: Schematic Representation of Land Tenure within the Corridor



This map in no manner represents land tenure status in Belize. Its use must be in consultation with the Commissioner of Lands and Survey Department.
Protected area boundaries are in accordance with the relevant Statutory Instrument and current only up to July 2000.

Map 5: Flight Path over the Northern Belize Biological Corridors



Legend for Maps 6A, 6B, and 6C

Agricultural values

1 - High

2

3

4

5 - Low

Oultine of corridor nodes and primary corridors

Protected area

Water body

City or town

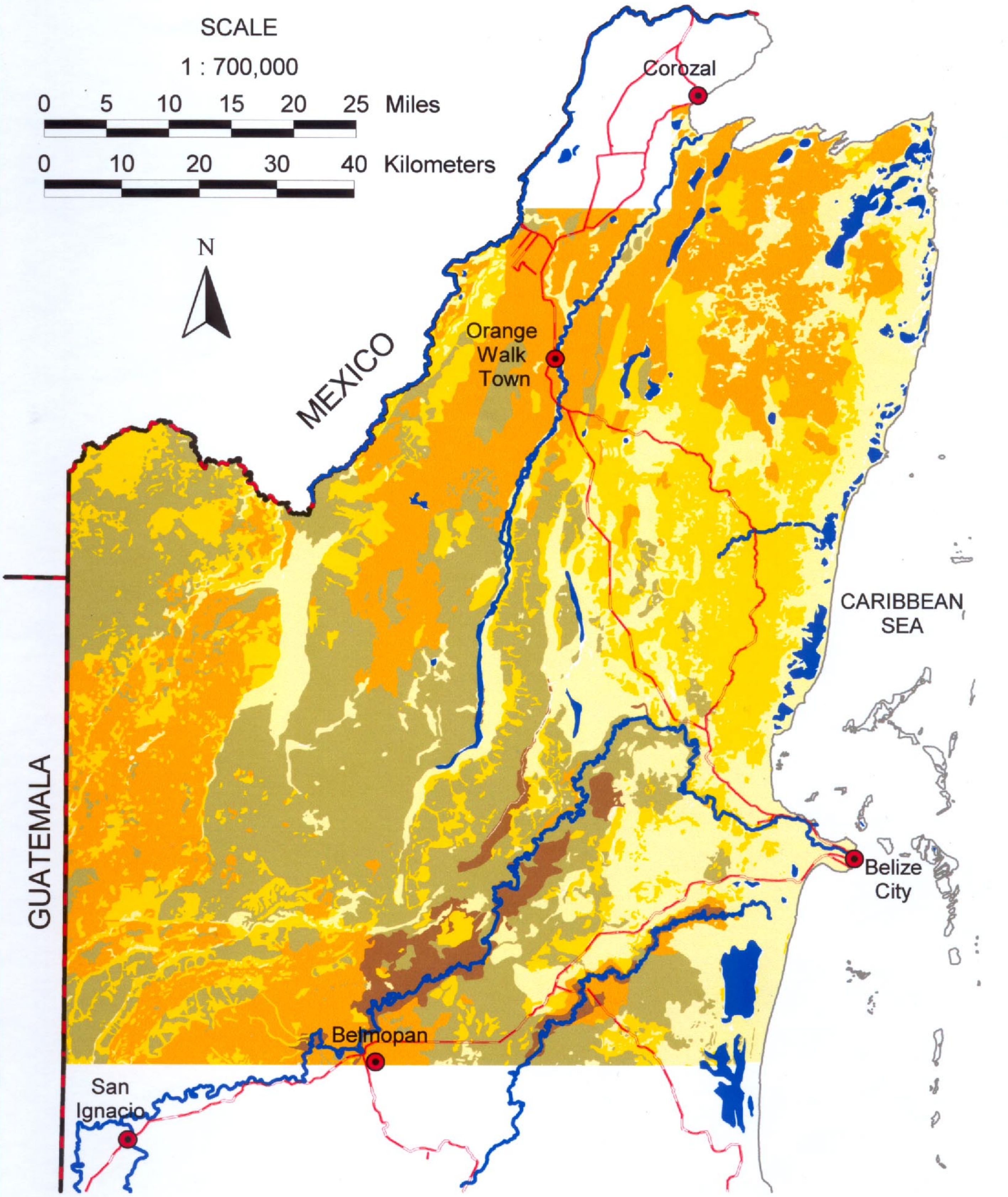
Major road

Major river

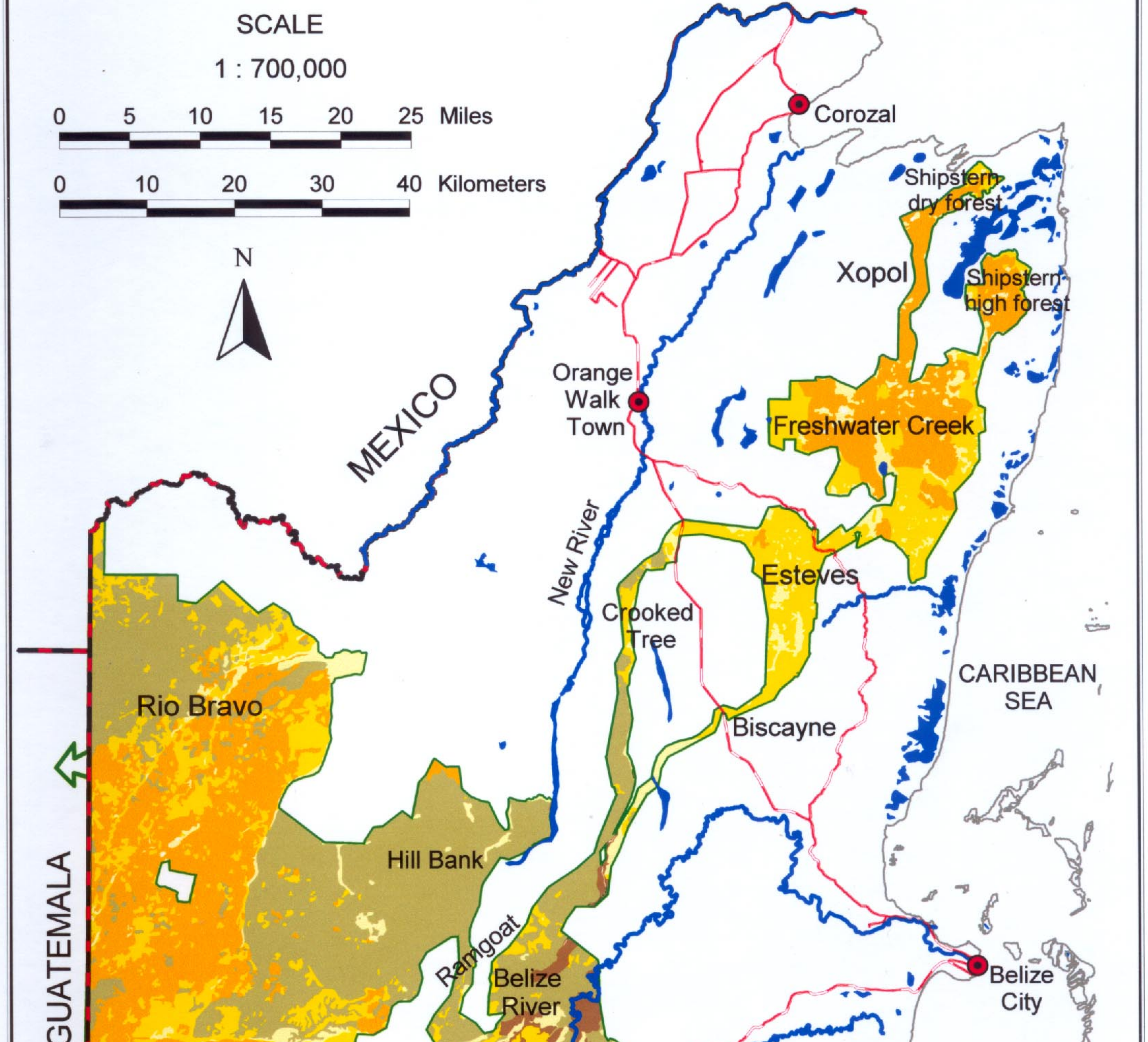
International border

Coastline and cayes

Map 6A: Agricultural Land Values of Northern Belize
(after King et al. 1992)



Map 6B: Agricultural Land Values within the Corridor Nodes and Primary Corridors (after King et al. 1992)



Map 6C: Agricultural Land Values (King et al.) within the Corridor Nodes and Primary Corridors Showing Protected Areas Coverage