**Appendix 4.** Conceptual framework

In figure S13 we show the conceptual framework that guides our study. As discussed by (Lambin et al., 2003), land cover changes are caused by several interacting factors, however, in a general way, we can distinguish direct and indirect causes of change.

Direct causes, also known as proximate drivers of change, are activities that modify directly forest cover. Thus, infrastructure extension, agricultural expansion, and wood extraction are classified as proximate drivers of forest change (Geist and Lambin, 2002). In turn, the action of these activities depends on other factors that operate at higher scales and in a more diffuse way (Lambin and Meyfroidt, 2011), the so-called underlying drivers of change. Underlying drivers correspond to demographic, economic, technological, political, and cultural factors that modulate proximate drivers and therefore, modify indirectly forest cover (Geist and Lambin, 2001). For example, demographic factors, such as population growth, might promote deforestation by increasing the demand for land for infrastructure- 

Figure S13: The relationship between underlying and proximate drivers of forest spatial changes and their potential implications to biodiversity. Underlying drivers act on proximate drivers by fostering or inhibiting the execution of the different human activities. In turn, proximate drivers modify directly forest cover which causes the forest spatial changes: forest loss, forest regrowth, and forest fragmentation. Protected areas, whose main purpose is to preserve biomes and biodiversity, are influenced by the underlying and proximate drivers and therefore, their conservation outcomes are affected by the socio-economic context where they exist. Our conceptual framework is based on Geist and Lambin (2001).

development or by demand a higher amount of resources for feeding. On the other hand, international trade promotes deforestation in the Amazonian for producing commodities. Furthermore, a shift in the economic opportunities associated with forest transition dynamics has consequences in lowering the deforestation rates (Rudel et al., 2005). Policies that promote the development of agricultural activities might promote deforestation (Klepeis and Vance, 2009). Examples of studies that document the effect of underlying drivers on forest loss (Aide et al., 2013), forest regrowth (Borda‐Niño et al., 2020), and fragmentation (Liu et al., 2016) can be found in the literature.

The conservation status of protected areas is affected by intrinsic factors such as limited budget or failure in management implementation (Leverington et al., 2010); and also by extrinsic factors such as the socioeconomic context where they are located (Laurance et al., 2012). For example, protected areas in countries with higher human welfare have experienced a lower increase in anthropogenic pressure (Geldmann et al., 2019). Besides that, higher deforestation pressure has been recorded in protected areas under the influence of high population growth (Wittemyer et al., 2008) high population density (Figueroa et al., 2009) and high influence of road network (Barber et al., 2014). In contrast, protected areas with the development of ecotourism activities (Vuohelainen et al., 2012) and with a high presence of indigenous people (Figueroa et al., 2009) have experienced low deforestation pressures. If we consider that almost the third part of global protected areas are influenced by high anthropogenic pressure (Jones et al., 2018), then, understanding the causes that drive forest spatial changes is paramount to provide management alternatives that help to improve the conservation status of protected areas.

It is important to remark that despite that biophysical variables can modify forest cover (e.g. storms, droughts, landslides, etc.) we do not include these variables in our conceptual framework because we consider that the effect of anthropogenic variables has a higher extension, frequency, and impact (Curtis et al., 2018).

Our study explores the effect of some demographic and economical underlying drivers on forest spatial changes (i.e. forest loss, forest regrowth, and forest fragmentation) in nineteen biosphere reserves located in the Mesoamerican territory. Particularly, we evaluate the effect of population growth rate, population density, rural settlements density, distance to cities (a proxy of the access to markets), and non-farm occupation.

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