Anthropogenic climate change and the loss or degradation of vegetation cover are key threats to global biodiversity and ecosystem health. However, little is known of how these two important drivers of change on ecosystems will combine in the future to further threaten global biodiversity. This is of particular importance in the tropics, where global biodiversity is concentrated and there is ongoing habitat modification. Thailand is within the Indomalayan biodiversity hotspot and although there is an extensive and reasonably well managed protected area network there has been a high level of historical and ongoing land-cover change. There is limited information on how climate and land-cover changes will impact on the future vulnerability of biodiversity in Thailand. To help address this knowledge gap, this study uses a powerful combination of a collation of existing bird occurrence data, systematic standardised field surveys and spatial modelling to examine the potential future impacts of changes in both land-cover and climate on the spatial patterns of species distributions, species richness and population size for Thailand’s forest birds. The study evaluates the vulnerability to global change of individual species and geographic regions under a range of future climate and land cover scenarios.

This thesis investigates the vulnerability of Thailand’s forest bird species to climate change and land-cover change in three stages. Firstly, current patterns of species distribution, abundance and assemblage structure were examined using a combination of a collation of existing bird occurrence data and standardized field surveys. A total of 827 standardized transect surveys of bird assemblages were carried out at 96 transects of 32 sites across Thailand and recorded a total of 431 species of birds. Sampling was conducted in five different mountain ranges spanning the available latitudinal (5° 47’ - 18° 32’N) and elevational (100-2500 m asl) gradients of closed forest to maximize the coverage of environmental space.

The field survey data was used in Chapter 2 to examine the relationships between assemblage structure and elevational/temperature gradients. Individual species distributions and assemblage structure of forest birds were strongly and consistently associated with the elevational/temperature gradient with a predictable change in species composition and abundance with increasing elevation. However, despite the strong pattern of assemblage
change, there was surprisingly little evidence of any consistent elevational species richness pattern. There was a tendency for species richness within forest to be lower at the low-elevation with some indication of slightly increasing species richness up to 500m, plateauing across mid-elevations (500-1500m) and slightly declining above 1500m. Another clear pattern was the biogeographically difference in assemblage structure with a clear separation between the southern assemblages present in Hala Bala (Sundaic species) and the rest of Thailand dominated by Indochinese species. The demonstration of such clear elevational/temperature gradients in assemblages of birds right across Thailand suggests that it is highly likely that as global temperatures increase there will be significant shifts in the distribution of these assemblages and the potential for significant impacts on biodiversity.

Chapter 3 used the combined datasets from both field surveys and the collation of existing data from other sources to produce high-resolution species distribution maps for all species. Species distribution models were used to explore the relationships between bird distributions and assemblage structure and environmental variables of climate and land cover. Maximum temperature, annual mean temperature, and rainfall seasonality were the most consistently important climatic factors related to species distributions. Models based purely on land cover performed poorly in comparison to climatic models, however, when both climatic and land-cover variables were included into the species distribution models, land cover was the most consistently important variable, followed by maximum temperature, annual mean temperature, and rainfall seasonality.

Chapter 4 used the species distribution models produced in Chapter 3 to examine the potential impacts of projected climatic change on Thailand’s forest bird species. Overall, the projections predict a massive loss in the population size of most species and a lesser decline in distribution area. Using an index of total population size based on summed environmental suitability for each species distribution model (an index to measure effects on species conservation status under IUCN criteria A3), the results predict that over 85% of bird species assessed will become threatened in Thailand, while only 5% become threatened using purely range size criteria (IUCN criteria B1). This has significant implications for the widespread use of range size in projecting future vulnerability of biodiversity to climate change and emphasizes that indices of total population size are more biologically meaningful and provide a more sensitive and realistic assessment of vulnerability based on the both the spatial extent
and spatial pattern of habitat quality. Not surprisingly, impacts are greatest in high elevation assemblages across Thailand.

Chapter 5 explores the combined impacts of projected future change in both climate and land cover by evaluating the vulnerability of individual species under a range of future climate and land cover scenarios. Species distribution models for each species from previous chapters were projected into a range of future environmental scenarios in three combinations: climate change only (from Chapter 4), land-cover change only, and climate change combined with land-cover change. Four scenarios of future climate change were used (representative concentration pathways - RCP 2.6, 4.5, 6.0, and 8.5) from the Fifth IPCC Assessment Report (AR5). Four future scenarios of land cover change were used that vary based on a combination of predicted on population and economic policy (mild, moderate, severe, and most severe) were used for land-cover based on the Thailand strategic planning for the next 20 years with assumed each separate development scenario that policy would continue.

Chapter 5 demonstrates that there will potentially be a large decrease in species richness in lowland areas of Thailand and increased species richness in the uplands, particularly in the protected highland areas of western Thailand. This was associated with the maintenance of forest cover in protected areas, concomitant with a shift in species distributions into higher elevation areas. Climate change models predicted much larger negative impacts on species richness, species distributions and population size than did land-cover change models. The combination of business-as-usual global emissions combined with ongoing land cover change could be devastating with up to 95% of all forest birds species becoming threatened and of these approximately 85% becoming critically endangered and potentially extinct in Thailand due to complete loss of suitable environment. The analyses identify species and geographic areas that are most vulnerable and areas where protection of upland refugial forest cover will provide some resilience to some species.

It is imperative that environmental management and policy makers utilise this information to strategically plan the most effective adaptation actions aimed at maintaining functional ecosystems in the face of serious climatic and land cover changes. By understanding the combined and individual effects of climate and land-cover change, effective conservation approaches could be designed and implemented, but only if there is a concerted global and local effort that combines global emission reduction, adaptive forest management and the
design of strategically selected protected area networks to help increase the resilience for the high number of species at risk in a rapidly changing world.