Climate Change and Biodiversity in Melanesia

Series editors:
Stephen J. Leisz and J. Burke Burnett

Predicting the effects of climate change on Melanesian bird populations: the constraints of too many variables and too few data

Andrew L. Mack
Carnegie Museum of Natural History

CCBM Paper 9

Funding provided by:
John D. and Catherine T. MacArthur Foundation

Bishop Museum Technical Report 42(9)
January 2009

This paper is produced as part of the Climate Change and Biodiversity in Melanesia Project, funded by the John D. and Catherine T. MacArthur Foundation. The aim of this project is to assess the vulnerability of Melanesian marine and terrestrial ecosystems to projected climate changes. The CCBM Paper Series, listed below, are published as part of the larger Bishop Museum Technical Report Series.

Paper No.	Author	Title
1	Kelvin Richards and Axel Timmermann, IPRC, SOEST, University of Hawaii	Climate change projections for the Southwestern Pacific with a focus on Melanesia
2	Peter G. Brewer, Monterey Bay Aquarium Research Institute	Climate Change and Biodiversity in Melanesia: Biophysical science – ocean acidification
3	Dan A. Polhemus, Department of Natural Sciences, Bishop Museum	Climate change in New Guinea and its potential effects on freshwater ecosystems
4	Geoffrey Hope, The Australian National University	Palaeoecology and resilience in Melanesia: How can palaeoecology contribute to climate change response planning?
5	Steve Coles, Department of Natural Sciences, Bishop Museum	Potential Climate Change Impacts on Corals and Coral Reefs in Melanesia from Bleaching Events and Ocean Acidification
6	Terry J. Donaldson, University of Guam Marine Laboratory	Climate Change and Biodiversity in Melanesia: Implications for and impacts upon reef fishes
7	Rodney V. Salm and Elizabeth Mcleod, The Nature Conservancy	Climate Change Impacts on Ecosystem Resilience and MPA Management in Melanesia
8	Shelley A. James, Department of Natural Sciences, Bishop Museum	Climate Change Impacts on Native Plant Communities in Melanesia
9	Andrew L. Mack, Carnegie Museum of Natural History	Predicting the effects of climate change on Melanesian bird populations: probing the darkness with a broken flashlight

Introduction

Earth's climate is changing as the result of human-released greenhouse gases. Nearly all scientists not employed by the petroleum or coal industry agree with this statement. After that, scientific consensus breaks down on the specific details of climate projections and implications. We know things are changing and conservationists are hoping to be *proactive* and predict those changes so they can put in place conservation interventions that will enable as much biodiversity to survive as climate changes (Araŭjo and Rahbek 2006).

Developing specific conservation interventions will depend on the accuracy of scientific projections. Given the relative scarcity of conservation funding – particularly for a biologically poorly-understood region such as Melanesia – there is a significant trade-off between conservation planning and implementing conservation interventions. In terms of conservation of birds in Melanesia there are three broad constraints that prevent reliable projections at this time. Before delving into a more specific discussion of avian conservation, I want to emphasize the limitations to predictive conservation.

Major Constraint #1: Limitations of climate change models

Models of climate change mostly work at very large scales – continental to regional. They provide broad general scenarios assuming different levels of greenhouse gases or other input variables. The effects of the input assumptions can greatly alter projections. Because climate modeling usually applies to large area global or hemispheric scales it is difficult to make projections with even a moderate level of certainty on smaller regional or sub-regional scales that would be relevant to bird conservation in Melanesia. Many species have very restricted ranges, either on small islands or small areas in the larger islands. It is impossible to make specific terrestrial temperature or rainfall change projections that are relevant to such a fine scale. Projections of broader-scale phenomena such as sea level changes or sea-surface temperatures may indeed be possible (and of great value), but predicting whether or not a particular rain shadow will continue to exist on a single mountain, or if a pocket of savanna will still be seasonally dry is not possible, nor is such precision likely for the foreseeable future, if ever. For species of restricted ranges often the best science can offer is to predict they will experience some form of climatic change, and that those changes may alter their habitats.

Major Constraint #2: Limitations of knowing how predicted changes will affect habitats

Many bird species have specific biological habitat requirements. A certain palm might be the necessary food plant to get through the lean season. Certain species of large trees might be required for nesting. Some minimum number of sunny days might be necessary for the maintenance of an insect prey base. Even if fine-scale climate projections existed that indicate how climate will change in a particular area, we cannot then predict how that will affect crucial biotic factors in the bird's environment. Will a slight change in relative humidity cause that palm population to die out? Will increased storms cause large trees to fall? Will an increase in average cloud cover result in reduced insect availability? We have no data upon which to predict habitat effects even if we did have reliable predictive models for the climate changes.

Moreover, scientific understanding of Melanesian ecology – including such factors as specific habitat requirements – is poor relative to other more well-studied high biodiversity areas such as Amazonia. Predicting how climate change will affect complex ecological relationships that exist is also currently impossible because science does not yet have a sufficient understanding of things such as biological habitat requirements. While greater efforts to enhance this understanding of Melanesian ecology would help enormously, because systems of knowledge are always incomplete, this would still be insufficient to allow accurate conservation planning based on climate change projections.

Major Constraint #3: Limitations of our knowledge of Melanesian-Pacific birds and their ecology

The Melanesian-Pacific region constitutes perhaps the poorest-studied biotic region in the world (Mack and Dumbacher 2007). The level of ornithology is at the stage of working out alpha taxonomy, and new species are still being found (e.g., Dumbacher et al. 2003, Beehler et al. 2007). More importantly, almost no phylogeographic or biochemical phylogenetic studies have been done in the region. When such studies have been undertaken, they suggest there are many more cryptic species in the Melanesian fauna than previously thought (Dumbacher unpublished data). Although knowledge of avian alpha taxonomy is probably well ahead of most other major taxa in Melanesia, it is still highly deficient compared to most of the world. If we have a hard time defining what are species, it will be even harder to define how to conserve those species in the face of changing climate.

Discussion of Major Constraints #1–3:

The threat to any species depends generally on three factors: (1) resilience, or the species' ability to persist through environmental change; (2) adaptability, or the species' ability to adapt to changing environmental factors; and (3) mobility, or the species' ability to move from declining habitat to areas of suitable or improving habitat. These are all unknowns for nearly all birds in Melanesia.

In this White Paper, I consider the potential impacts of climate change on populations of birds in Melanesia. We do not really know how distinct many populations are; with more research on their population genetics, some populations of what are currently categorized as single species are likely to be shown as valid distinct species (e.g., Dumbacher et al. 2003).

Equally deficient is our knowledge of avian ecology and population biology in the region (Mack and Dumbacher 2007). Almost no long-term studies have been made of any population of birds in Melanesia. We have a rough idea of distributions, but in most cases, no measure of population numbers. Similarly, there are few measures of major factors such as longevity, dispersal ability, reproductive rates, etc., that are necessary for predicting the impact of any change in climate. Assessing the conservation status of potentially threatened species is difficult (e.g., Mack and Wright 1998) even without the additional factor of climate change.

We thus have at least three severe limitations: we cannot predict the climatic changes on a relevant scale, we cannot predict how changing climate will affect key biotic variables, and lastly, we know so little of Melanesian birds that we do not currently know what is necessary for their conservation *even without climate change.* The research necessary to address these limitations cannot be conducted quickly enough to provide the needed information on a time scale that would be helpful to conservation. We are left with the very unsatisfying prospect of being unable to make relevant predictions within the time things will be changing.

What is left, then, is only to examine in general terms the factors that would affect conservation planning for birds in Melanesia. We can enumerate the factors that we think will influence bird populations as climates change in the region . Here I discuss the most important factors that I believe will impact birds in the Pacific.

I draw most of my discussion from the New Guinea Region (NGR), including associated offshore islands in Papua New Guinea (PNG) and the Indonesian province of Papua (P). I concentrate on this geographic area because this region, which spans from the smallest atolls through to the largest islands, includes most of the factors that will be relevant elsewhere in Melanesia and the Pacific. It has the greatest elevational span and thus the greatest heterogeneity of habitats. It has the greatest diversity of species and it shares most of the avian genera found on other islands of the Pacific. Finally, the human cultural diversity of the New Guinea region is great and provides a good surrogate for cultures in the rest of Pacific.

I will discuss each factor separately and then conclude with some synthesis and recommendations for conservation action in the Pacific in relation to the conservation of avifauna. These factors are not presented in degree of importance, which will vary by geography and species.

Species with small distributions or specialized habitat requirements

Species with small distributions face three barriers to survival in the face of climate change.

1. In a time of changing environmental conditions, a small or specific habitat is the most likely to face stresses or be eliminated. Of course, it is also possible that environmental changes could make a specialized habitat more widespread (and thus more favorable to restricted range or specialized species). However, given the many ways climate can change, and by definition the specific needs of a

specialized habitat, most climate changes will result in diminishment of the surface area of specialized habitats.

2. Simple geometry dictates that small areas, even those of irregular shape, will have smaller perimeters. These perimeters are the ecotones where habitats could potentially shift along an elevational gradient given enough time. For example, the linear ecotone between lowland forest and hill forest will be greater than that of high elfin forest and alpine meadow.
3. Species with limited distribution generally have smaller population sizes concentrated in smaller geographic areas. This makes them more vulnerable to change than species with large population size and large distributions.

One measure of a species' habitat specificity is the span of its elevational distribution. For a variety of reasons (e.g., competitors, lack of resources, temperature tolerance, etc.), species with narrow ranges presumably cannot occupy as broad a range of habitats as generalist species. Using literature for the birds of New Guinea (numerous sources not listed here) I recorded the lowest and highest elevations within which a species occurs (see Figure 1). Naturally this does not mean these species are uniformly distributed across the breadth of these two figures. But it is a fairly conservative predictor if we want to generously predict the elevational range in which a species might possibly persist.[1] For example, a species known from an elevational band only 120 m wide is considered more vulnerable than one that spans 1200 m. The broader the elevational breadth, the greater the number of habitats there are in which a species has populations, and therefore perhaps the greater the plasticity of its habitat requirements.

In this analysis I examined the distributions of 582 primarily terrestrial or freshwater species. To facilitate comparison, I did not include pelagic or marine species, even though presumably these are quite vulnerable to changes in currents, water temperature, prey base etc. More than half the birds in the sample have elevational amplitudes of less than 1200 m (Figure 1). Given that we have few real measures of vulnerability, I made a best estimate of vulnerability showing 53.4% of the sample are strongly to moderately vulnerable to climate change impacts based on their elevational amplitudes (Figure 2).

[1] Note that for clarity this analysis assumes a more-or-less linear climate change in which habitat shifts more or less evenly along an elevational gradient; however, there is evidence to suggest that actual patterns of climate change may well be more chaotic and disjunct, with changes in community structures and range jumps.

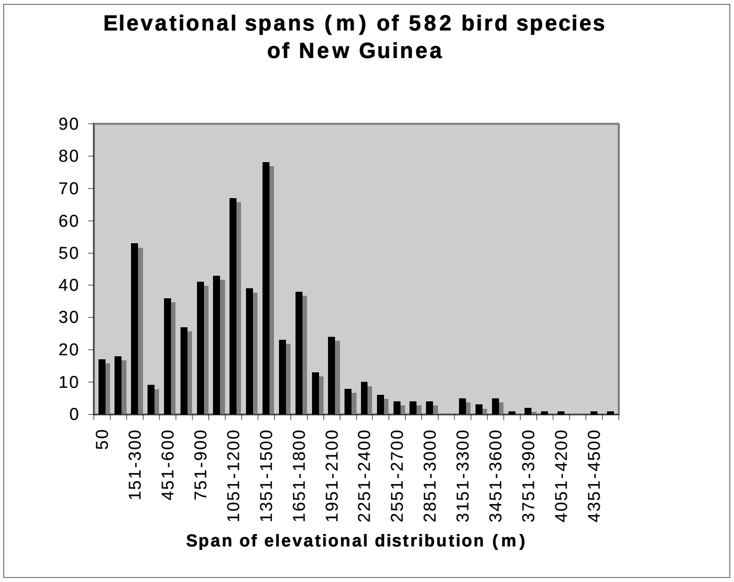

Figure 1. The elevational amplitude of 582 species of birds found in mainland New Guinea. The distribution is skewed to the left, illustrating the smaller amplitudes that will be more susceptible to habitat change.

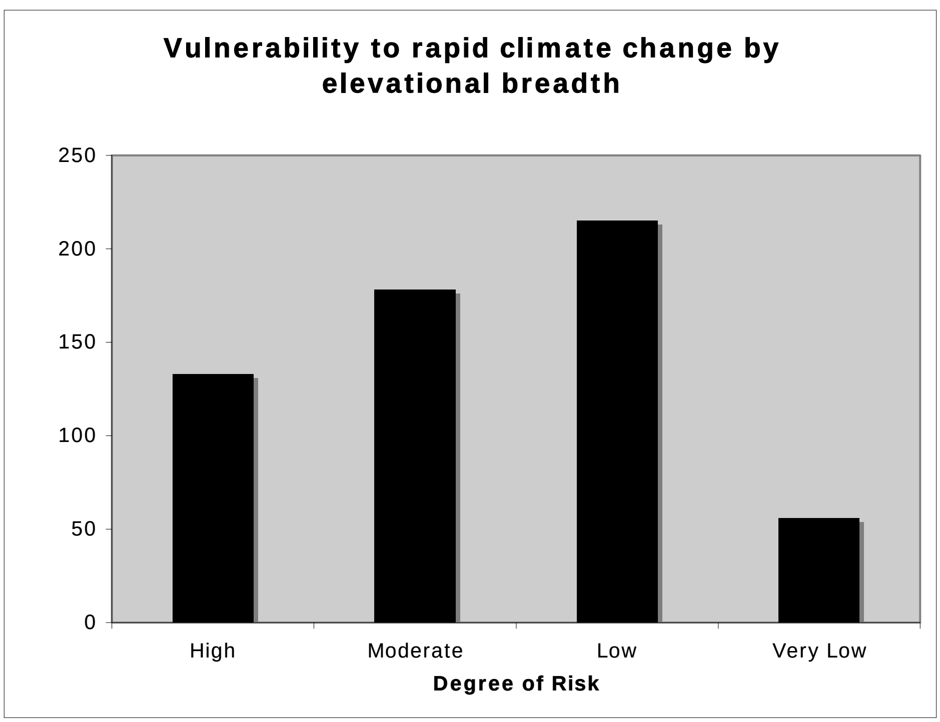

Figure 2. Vulnerability of species due to rapid climate shifts based upon the amplitude of their known elevations. Data were collected on highest and lowest known elevation of 582 bird species occurring in New Guinea and associated major islands (Bismark Arch., Trobriand Islands, Raja Ampat, Biak/Yapen, et al.). “High risk” was defined as species

with amplitudes of 600 m or less; “moderate risk” as those with elevational amplitudes of 600-1200 m, “low risk” as those whose distributions span 1200 to 2100 m, and “very low risk” as those spanning more than 2100 m.

The amplitude of elevational distribution is of course but one variable in the multi-dimensional space that defines a habitat and niche within the habitat. Other variables such as annual rainfall, temperature, humidity, etc., also define the niche space of an organism. Environmental change in any of such variables that exceeds a species' tolerance would change a suitable location to being unsuitable.

Species on small islands

Melanesia is comprised of thousands of islands, ranging from the second largest island in the world, New Guinea, to tiny atolls and sand bars that barely protrude above sea level. Most of the smaller islands have birds living on them. Some, even with virtually no vegetation or fresh water, are still important to birds as nesting sites (e.g. terns).

Island species face particular challenges with climate change. The adjoining habitat, open sea, is usually unsuitable for survival. Birds cannot shift along a gradient as montane species might. Island populations can only emigrate to other islands, often across vast distances of ocean, if their island becomes unsuitable. Many species cannot readily move among islands like this. The high rates of endemism and island subspecies (e.g., the Monarcha flycatchers) indicates that movement and gene flow among the islands has been limited for long periods of time.

Species at high elevations

Areas of habitat decrease as you rise in elevation for the simple reason that mountains are wider at their base than their peaks. This means species at higher elevations have less area in real terms of km^2 than those at lower elevations.

I used the data on elevational ranges of species found in Papua New Guinea and used the area of PNG in 200 m intervals to calculate the *theoretical potential* area for a species within its elevational bounds. I say “potential” because clearly a species that is known to occur between, say, 1500 to 2700 m does not occur at that elevation on every mountain in the NGR. Many species are much more limited, often to just one or a few mountain ranges, for example the endemics of PNG's Huon Peninsula. However for the sake of demonstration, I plotted the data for 532 species in PNG to graphically show that as the lower bound of a species distribution increases in elevation, the potential area to it decreases dramatically (see Figure 3).

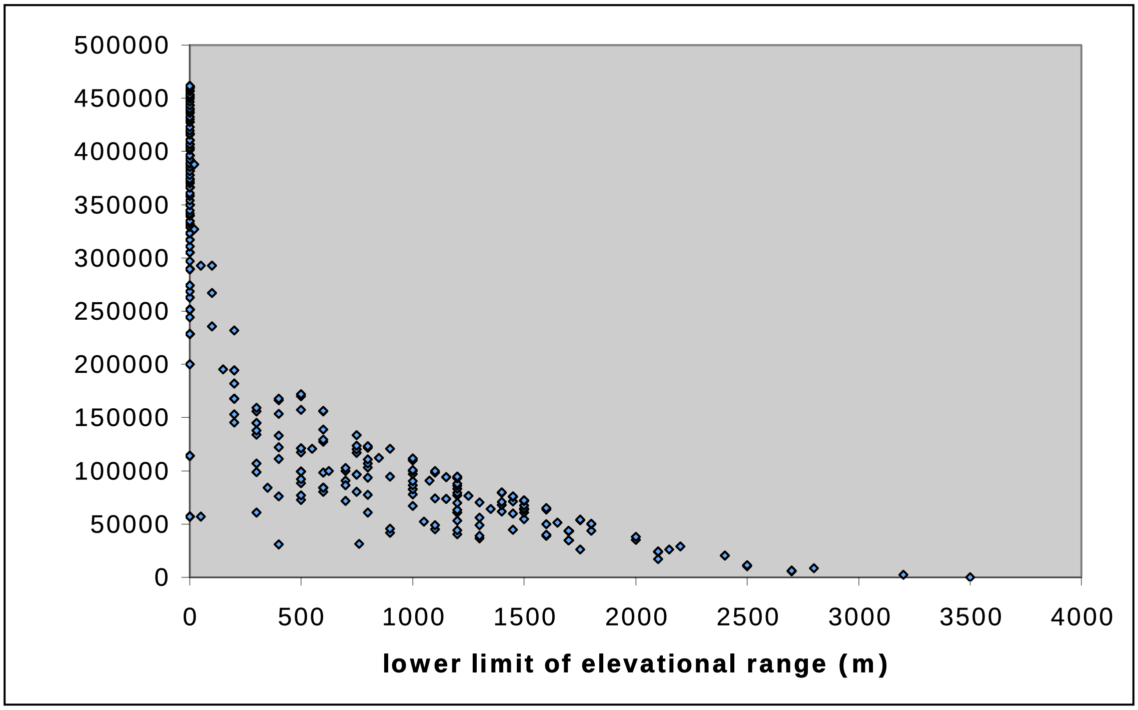

Figure 3. The potential area of the elevational zone occupied by 532 species of PNG birds (Y axis) plotted by the lower limit of their distribution (X axis). The figure clearly shows the shrinking area available to species as one moves from widespread lowland species on the left to montane species in the middle region to high alpine species on the far right.

Species on isolated ranges or peaks

New Guinea has a large number of isolated mountain ranges, like those of the Huon Peninsula, Adelberts, Fojas, etc. Many of these have endemic bird species. Birds on isolated ranges may be more vulnerable than ones with simply limited distribution (isolated species by definition also have a limited distribution). Elevational zones on isolated ranges and massifs are often compressed due to the Massenerhebung Effect. Isolated ranges are by definition not contiguous with other montane environments. Thus as climate change causes changes in environments, taxa on isolated ranges will be less able to move to any similarly suitable habitat. It is also important to note that this factor will be even more pronounced on the mountains of smaller islands, like Normanby or Vitu Levi in Fiji, because similar habitat simply does not exist without the species moving to another island.

Species with immobile to slowly-dispersing (cf. birds) ecological needs

Many bird species are mobile enough to disperse at a pace that could keep them within their required climatic bounds (temperature and humidity) simply by flying to new locations. However, the problem is likely to be that many avian species have strong dependencies on certain non-avian species that do not shift in distribution so easily. Fruiting trees and flowering plants are not as mobile as the avian frugivores and nectarivores that depend on them as keystone resources. Dispersal of keystone plant resources depends upon factors such as seed dispersal and establishment requirements. Moreover, many plants have long generation times to reach maturity, and so while birds might be able to disperse easily to different elevations or latitudes, the plants they depend upon might take centuries to move the same distance.

Increased burning during droughts and expansion of grasslands

Some climate change model projections include more frequent and more severe El Niño-like events. In the western Pacific these often lead to severe droughts, as witnessed in both PNG and Papua in 1997-98. During the 97-98 drought, atypically large and hotter wildfires were much more common. Extensive areas of lowland forest that normally rarely experienced forest fires burned in 97-98.

In the upper montane valleys where anthropogenic burning of grasslands is common in the dry season, what would normally have been small grassfires spread into the boundaries of the forest causing massive die-offs, and the overall area of burning was more extensive than usual – many of these can still be seen in the highlands today. Drought also increases the potential of burning in high elevation grasslands and alpine areas, which in normal conditions are always moist enough so that fires, if they occur, do not cover large areas. During droughts, however, this balance is altered. In 97-98 large areas of Mt. Wilhelm and Mt. Michael burned (personal observation). There are many endemics, including birds, that are confined to these small islands of habitat. The synergism between drought and increased burning by humans could likely push species to extirpation in high grasslands, even if they could otherwise have survived drought and climate change.

Each fire incursion into the forest expands the grasslands and reduces forest area, effectively shifting the grassland-forest boundary. Recurrent anthropogenic burning, even in years of normal precipitation, prevents the forest boundary from recovering. Increasing demographic pressure in these areas is one driving factor, but if combined with increased ENSO variability (i.e. drought), the problem will be further compounded and significant habitat reductions can be expected in midmontane areas. Midmontane forest habitat is already vastly reduced due to anthropogenic clearing, putting increased vulnerability on some species such as the Blue Bird of paradise (*Paradisaea rudolphi)*. Increased burning, exacerbated by potential rainfall variability caused by climate change, places such species at even greater risk.

Changes in food availability and predictability

Our information on phenology[2] and food production in Pacific forests is scant. Eighty percent or more of the flora of islands are dispersed by birds and bats (Fall 2007). Many birds have movements, often over large areas, to track the availability of fruit, seed, or nectar resources. Lorikeets make large movements and can appear suddenly in an area when certain trees come in to flower, disappearing just as quickly when flowering ends. The same applies for many frugivorous species such as pigeons and doves. For populations of such species to be sustained, their food resources over a large area must be reliable and predictable, particularly through any bottlenecks of low food availability or "lean seasons." Thus even if some parts of a population's range remain intact and viable in the face of climate change, if alterations occur elsewhere that could either depress food availability or alter the timing of its availability, such populations could experience significant reductions. It is important to remember that many birds and bats in the Pacific, especially frugivores and nectarivores, forage vast areas over time, utilizing different patches or islands when food can be found there. Any regional disruption in the multi-year cycles these species rely upon could impact the entire, more widespread population.

Changes in food predictability depress reproductive success

Reproduction in most birds is timed to coincide with peak food availability, or just ahead of peak so that fledglings experience optimal foraging success. This is important because reproduction places extreme demands on altricial[3] birds that provide food for their young. It also is important that young and inexperienced fledglings learn to forage when food is most available. Thus relatively minor changes in seasonality or food availability can significantly depress reproductive success. Even changes that might not be sufficient to kill adult birds are often sufficient to prevent reproduction success. Obviously, if this occurs often enough populations will decline over time as adults senesce and there is no new recruitment to replace them.

Changes in distributions of birds can bring new species into contact.

It is likely that many species of birds will be able to shift their distributions in response to changing climate and habitats. However, not all species will shift concurrently and in equal directions. This will mean that avian community structure will change. New competitors will move into areas, perhaps displacing or replacing taxa they historically did not compete with. Species that are more adaptable will expand their distributions; often these may be the very same taxa that might outcompete specialist species with limited distributions.

---

[2] The timing of naturally occurring phenomena. For example, the fruiting patterns of different trees, or the mating seasons of various birds.

[3] Incapable of moving around independently soon after hatching.

As well as shifting the competition milieu, shifting community composition could carry new avian diseases and parasites to species and populations that do not carry immunity. The extinction of myriad native Hawaiian birds was caused by the inadvertent introduction of several strains of avian malaria, brought about by the arrival of non-native caged birds to Hawaii. Similarly, medium- to high-elevations in Melanesia are historically malaria-free, but rising temperatures may drive the movement of parasites or pathogens to immunologically naïve populations of birds. Based on the Hawaii experience, it is reasonable to conclude that this factor may contribute to extinction pressures in Melanesia and the Pacific Islands.

Increase hunting by humans due to climate change.

Local agricultural systems in Melanesia lack the technological attributes of Western agriculture that enhance productive stability. It is reasonable therefore to speculate that future climate change-induced alterations in temperature, rainfall, fire suppression, or even mobility of garden pests may contribute to agricultural decline or failure in Melanesia. Throughout the Pacific, large populations are dependent on their gardens for sustenance, supplemented with protein from fish and wildlife. If gardens fail, people will hunt more than normal, adding pressure on avian populations. It is not only a matter of survival for people to hunt more; if their gardens have failed, they often simply have more free time to hunt. As more people (e.g., children) hunt, they move further afield looking for game during times of low garden success, thereby depleting bird populations that might normally act as source areas for heavily-hunted areas closer to villages and settlements. Moreover, common hunting practices often include starting fires, either to flush game from grass or smoke them from hollow trees. These hunting fires often burn out of control and exacerbate the effects of fire discussed previously.

Impacts due to changes outside of New Guinea

Over seventy species of birds migrate in and out or through New Guinea regularly. Some Australian species migrate to New Guinea in the austral winter season. Populations of these species are obviously subject to changes in their breeding grounds. Not only might their populations increase or decrease due to changes in breeding areas, but these changes might also affect the timing of their arrival and departure in New Guinea. Complications may occur if the arrival of migratory populations happens to occur at a moment when food resources might not be as plentiful as was historically the case. For example, large numbers of little curlews aggregate on some of the mudflat regions in the Gulf of Papua that result from seasonal tides. Should the timing of curlew migration change too much, they could arrive at a time when the necessary prey for stopover refueling is not adequately abundant. If migrant forest birds change their timing in New Guinea due to climate effects in Australia, then they might have more overlap with breeding competitors in New Guinea, or arrive at a time when food is more or less abundant.

Direct changes due to sea level changes

A recent model of sea level change in New Guinea (Legra et al. 2008) shows two scenarios based on proposed sea level increases of 1 and 6 m. Their projections show several large lowland areas becoming inundated, particularly in southeast Papua in the Merauke area. Thus substantial areas of the largest island in the Pacific – to say nothing of smaller islands – could be submerged with only a one meter increase in sea level. The social, economic, and biological effects of sea-level rise on many small and low-lying islands across the Pacific will be devastating. In many areas this is not simply a matter of impacts on birds; in some areas we can expect the complete extirpation of all terrestrial life and the services those ecosystems provide to humans.

Even modest changes in sea level, if they happen too fast or are exacerbated by high storm surges, have the potential to wipe out extensive mangrove habitats. This will have many implications including destabilized shorelines. Among the most obvious and direct impacts include those on the many birds that live in mangrove habitats. Mangroves are some of the most productive ecosystems in the world, and support a vibrant community of birds ranging from fantails and birds of paradise to large herons. Many species are mangrove specialists and these would be the most vulnerable, but widespread loss of mangroves would affect population dynamics of many species that also occur in other aquatic habitats.

Changing sea levels and storm surges could eliminate, shift, or alter many of the mudflat regions that are important migratory destinations and stopovers for transient species. Species like the Bristle-thighed Curlews (Numenius tahitiensis) that winter on small Pacific Islands could be severely impacted. The effect of changing sea levels on many species of migratory shorebirds and resident coastal species could be dramatic.

Changes in ocean currents

Very little attention has been devoted to the potential impacts of changing ocean current patterns on pelagic bird species. In some El Niño years there have been well-documented massive die-offs and breeding failure of pelagic bird populations. For example, in late 1997 the Peruvian Guanay Cormorants (*Phalacrocorax bougainvilli*), which are important producers of guano, dropped from an estimated 6.8 million to 1.8 million individuals when the cold Humboldt Current in the eastern Pacific moved further offshore from coastal South America. Changes in ocean currents in other parts of the Pacific presumably also have some impact on pelagic birds. Non-breeding birds are freer to wander and track food availability, but nesting birds need to be able to reach food within a time frame that allows them to relieve the mate that is incubating eggs or brooding young. Some tropical-nesting species could be affected. For example, little is known of the rare Heinroth's Shearwater (*Puffinus heinrothi*) that possibly breeds on high elevations on Bougainville and Kolombangara.

Direct physiological costs from heating or cooling in altered climates

Birds have high metabolic rates and a relatively low capacity for fat storage. They have the highest possible body temperatures in a homoeotherm[4]. Birds often exist right on the margin of what is physiologically possible. Changes in temperature that require extra energy input, either for heating or cooling can push birds past their energetic limits more easily than larger homeotherms with lower metabolic rates. Some birds have the ability to enter torpor when conditions are unfavorable (too cold or rainy), but this is only a temporary solution if food and warmth are not soon available. Anthropogenic climate change implies both rising temperatures as well as increased climate variability (i.e. extremes). Prolonged frosts or low temperatures accompanying rain can kill birds. Many tropical birds have much narrower physiological boundaries than temperate species that are better adapted for widely changing temperatures on both annual and daily cycles.

Impacts due to severe weather

Models of climate change predict more cyclones and severe weather in the western Pacific. Such storms can have devastating impacts on birds and bats on small islands (Esselstyn et al. 2006) When severe tropical cyclone Larry hit the tropical coast of Queensland in 2006, there were massive impacts on the vegetation that would affect food availability for forest birds (Pohlmnan and Goosem 2007)). While some birds probably were able to move to undisturbed parts of Queensland, others such as flightless cassowaries were very stressed, and many perished (Les Moore, personal communication) . Cyclones that hit small islands can devastate a major portion of the food base. Many birds cannot simply fly to an unaffected island in the vastness of the Pacific. Normally such cyclones are infrequent and populations can rebound from few survivors. However, if there is an increase in the severity and frequency of tropical storms in the western Pacific, there is a strong possibility that some bird populations could fail if there is not adequate time to rebound between storms. This effect could be most pronounced for specialist and rare species.

Cascading effects due to displacement of humans.

In addition to the previous fifteen climate change factors that could affect birds in the Pacific, there is a final factor that will have devastating effects on many avian populations and birds. Flooding, storms, frosts, droughts all cause untold human misery. One way humans respond to these conditions is to emigrate. Populations will move further inland and further uphill in response to storm surge. This will lead to new habitat modification and forest clearance. Depending on human population impacts and how societies react to climate change, many currently secure bird populations could come into direct competition with humans for habitat and food resources.

[4] Warm-blooded organism, or more specifically, an organism able to maintain its body temperature within a limited range and independent from ambient temperature.

Summary, Comments, and Conclusions

I have briefly described three major limitations in our ability to predict how impending climate change will affect bird populations in Melanesia. I have also illustrated sixteen ways in which climate change can lead to significant population changes in Melanesian birds. Such changes will usually be downward, though it is conceivable that a few resilient and adaptable species will benefit from these changes and increase their numbers.

The common thread that weaves throughout all these factors and considerations is the fact that scientific data needed to understand these variables are so inadequate that attempts to address climate change impacts on biodiversity through long-term regional conservation planning exercises is impossible. The input variables in terms of how climate will change Melanesia are so broad, and our understanding of birds' ecological requirements, resilience and adaptability so lacking, that specific, technical conservation interventions seem not only to be pointless, but arguably a waste of scarce conservation resources.

It is important for donors to recognize what can and should be done about planning for climate change, and what could be ineffective uses of scarce conservation funds. Some conservation practitioners seem to see climate change mainly as a new opportunity to raise funds; donors can expect a burgeoning number of proposals to "look at climate change in relation to X". But workshops, additional modeling, and priority-setting exercises should not be vehicles for organizations to simply secure substantial funding without having to fully implement on-the-ground programs with and through local communities, which is and will remain the *sine qua non* for successful conservation everywhere in Melanesia.

Does this mean we retreat and allow things to play out however they will and just live with a new, less biodiverse world in fifty years? My answer would be a categorical no. What is needed now are interventions that allow for our ignorance and try to accommodate for as many of the variables, seen and unforeseen, as possible. Because of our broad ignorance, heavy investment in planning and prediction are at best pointless, and – because they could be based on incorrect initial assumptions – possibly detrimental at worst. Without reliable input data, conservation planning predictions are a waste of time and resources.

Conservation in the decades ahead will rely heavily on our abilities to respond quickly and prudently to changes as they appear. In other words, as the biological input data become better, conservationists should be poised and in place with the resources to respond. In Melanesia, the fastest response will only come from Melanesians. Decision-making and policy recommendations coming out of the U.S. or Europe will have only limited effectiveness. Immediate investment should be made to develop and enhance institutional and individual capacity in Melanesian countries to provide them with the knowledge, skills, and tools they need to manage and adapt their conservation programs in response to climate change. **The foremost and most effective action**

conservationists can take now to mitigate the coming crisis is to prepare the national conservation communities so they are more capable to deal with the unknowns ahead.

Attention to building national conservation capacity in the Pacific has been largely ignored by the major conservation organizations. Had efforts and investments on this front been more focused in the past two decades, this White Paper could have been written mostly by Melanesian experts. The sad reality that most conservation experts on the Melanesia region live outside the region reflects a major failure of the conservation community in the past three decades.

What is certain is that if Melanesia's terrestrial and marine habitats are degraded or destroyed through other direct human activities – logging, conversion for agriculture, over-fishing, invasive species, etc. – the resilience those ecosystems possess and that they require to adapt successfully to impending climate change will be seriously diminished. Lacking perfect information on how to design immaculate climate change-related conservation interventions, the best thing we can do is to do what we have already been doing – protect as much habitat as possible – but to do it more effectively than we have in the past. This is the challenge.

There are other conservation steps that can be taken based on the sixteen criteria outlined above. Protected areas should be large, have elevational gradients, habitat diversity, areas unlikely to be settled by displaced people, etc. Such recommendations are easy to make and appear in greater detail throughout the entire document. The point that should be reinforced is that no conservation intervention can succeed in Melanesia if it is not driven by Melanesians. American conservation NGOs cannot simply stand up in a Melanesian parliament and say what needs to be done, nor can they stay in-country for decades executing and adapting complex management plans. In the end, **it all boils down to ensuring that the nations of the Pacific have the human capacity and the will to execute conservation actions, whatever they be. Without that capacity, nearly all recommendations are doomed to fail along with nearly all Western-driven conservation in the region thus far.** Community-based conservation must be replaced with community-driven conservation if the endeavor is to succeed.

References

Araủjo, M.B. and Rahbek, C., 2006. How does climate change affect biodiversity? *Science* 313: 1396-1397.

Beehler, B.M., Prawiradilaga, D.M., de Fretes, Y., and Kemp, N. 2007. A new species of smoky honeyeater (Meliphagidae: Melipotes) from western New Guinea. *Auk* 124: 1000-1009.

Dumbacher, J.P., T.K. Pratt, and R.C. Fleischer. 2003. Phylogeny of the owlet-nightjars (Aves: Aegothelidae) based on mitochondrial DNA sequence. *Molecular Phylogenetics and Evolution* **29**:540-549.

Esselstyn, J.A., Amar, A. and Janeke, D. 2006. Impact of post-typhoon hunting on Mariana fruit bats (*Pteropus mariannus*). *Pacific Science* 60: 531-539.

Fall, P.L., Drezner, T.D. and Franklin, J. 2007. Dispersal ecology of the lowland rain forest in the Vava'u island group, Kingdom of Tonga. *New Zealand Journal of Botany* 45: 393-417.

Legra, L., X. Li, and A.T. Peterson. 2008. Biodiversity consequences to sea level change in New Guinea. *Pacific Conservation Biology* 14: 191-199.

Mack. A.L. and Dumbacher, J. 2007. Birds of Papua. pgs. 654-688 in: A.J. Marshall and B.M. Beehler, (Eds.), *The Ecology of Papua*. Singapore, Periplus Editions.

Mack**,** A.L. and D.D. Wright. 1998. Status and conservation of the threatened Vulturine Parrot, Psittrichas fulgidus. *Bird Conservation International* 8: 185-194.

Pohlman, C. and M. Goosem. 2007. The effects of Severe Tropical Cyclone Larry on rainforest vegetation and understorey microclimate adjacent to powerlines, highways and streams in the Wet Tropic World Heritage Area. Report to the Marine and Tropical Science Research Facility. Reef and Rainforest Research Centre, Ltd. 47pp.