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# A Descriptive Study of the Realm of Zoology and Climate Change

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***Abstract:***
*Even without the expected loss of species, groups, and ecosystems due to climate change, this descriptive paper addresses Australia's dwindling biological diversity. This makes climate change beneficial for zoology students in their undergraduate and graduate studies for field biological research. These students are required to work on short-term projects in the field for several months to two years. This study investigates if such initiatives are in line with native Australian species' responses to climate change. There are not many concrete findings, however the research is important for supporting longer-term research.*
***Keywords:*** *Biological diversity, climate change.*

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## I. Introduction:

Australia's biological diversity was under decline prior to climate change. 90 species are endangered, or one-third of them. While most unlisted species lack the data necessary to categorise them, one in six species have adequate information to determine their classification (CANA, undated a).

***Climate change, defined as***: *"Variation in either the mean state of the climate or in its variability, persisting for an extended period, typically decades or longer. It encompasses temperature increase (global warming), sea-level rise, changes in precipitation patterns and increased frequencies of extreme events. Each of these phenomena can impact on biological diversity"*will increase biological diversity threats (biodiversity). Studying the effects of climate change on any animal species is more difficult because of the tension between the requirement for long-term studies to support the investigation of those effects (Parmesan and Yohe 2003) and the short-term nature of student research and research funding bodies. The paucity of knowledge regarding the bioclimate envelopes of many species exacerbates this intricacy (Arajo and Rahbek, 2006). Additionally, there are frequently few data available on how Australian native fauna and their associated ecosystems respond to naturally occurring climatic fluctuations and/or the confounding effects of other anthropogenic influences (such as urbanisation, habitat fragmentation, and river regulation). Therefore, studies spanning the biology of animal species (phenology), their relationship with their environment (autecology), and the ecological interrelationships among communities of organisms (synecology) over several generations are necessary to even identify the potential impacts of climate change on native species in the Australian environment. Due to the lack of comprehensive data, students have a wide range of project possibilities that could contribute directly or indirectly to the study of the effects of climate change by deepening understanding of the target species or group. They may, however, be constrained to dealing with hypotheses and research questions that can be tested on short-term datasets and only serve as a secondary source of input for climate change research, for instance by adding to datasets linked to projections of the impact of climate change (cf., Thomas et al., 2004; Elith et al., 2006). A different strategy is to concentrate research efforts on expanding upon long-established datasets (e.g., Recher et al., 2009; Lunney, 1987; Dickman et al., 2001; Mahon et al., 1998). In a variety of environments, from tropical marine systems to polar terrestrial regions, spanning a range of ecosystems, there is strong evidence that taxonomic distributions have already changed in response to climate change (e.g., Walther et al., 2002; Parmesan and Yohe, 2003; Root et al., 2003; Perry et al., 2005). It is therefore possible to monitor changes in a species' characteristics as a result of climate change by using research programmes that concentrate on obtaining data on species, particularly those that are little characterised. It would be predicted that results from studies of widely dispersed species that cross gradients - altitudinal, latitudinal, and/or longitudinal - would be especially helpful to support such predictions (e.g., Shoo et al., 2005a, 2006). Particularly interesting species are those whose range expansion has the potential to change ecosystems because of conflict (predation, prey, conflict) with the species' dispersal. This frequently happens when a taxon's leading edge invades another taxon's (or taxa's) lagging edge of its range when climatic conditions change and they interact. With the southward biome shift toward the pole (for Australia) and upward in elevation, this is projected to be of greatest concern. The capability for a species to maintain viable populations might be better predicted by developing or enhancing knowledge of the species that would enable prediction of its ability to live the physical environment generated by climate change (see e.g., Matthews et al., 2012). Short-term studies needed by students pursuing research training would easily fit into this field and allow for the testing of hypotheses about how populations in estuarine and marine ecosystems might be impacted by climate change and ocean acidification (Findlay et al., 2010). Studying the target species in conditions of adversity could be a useful strategy for supporting predictions. However, because graduate students are expected to complete workable projects within a set amount of time, organising such a project is challenging. If anything other than observation were to be tried, there might also be problems with ethical study conduct under severe cases. This is because animals who are restrained must not experience additional stress (e.g., trapping, tagging). However, incidental observations made in the field as a result of unexpected extremes may prove to be a useful addition to our understanding of the effects of climate change. For instance, habitat quality is the main factor in koala health (Phascolarctos cinereus) because they are specialised folivores of Eucalptus species (Moore and Foley 2000). (Martin and Handasyde 1999). However, later scorching conditions caused several of the koalas released into Brisbane Forest Park's eucalypt woodland to pass away. Those who survived left the eucalypt woodland and proceeded closer to the watercourse's bank, where they took cover in dense non-eucalypt vegetation, primarily Melaleuca spp., until the heatwave passed (J. Howard, pers. comm.). The local population of koalas would not have been expected to be impacted by the loss of this habitat as a result of climate change. In such cases, it is unlikely that the koalas' deaths brought on by severe weather shortly after release were caused by habitat degradation. The impact of climate change may be more clearly demonstrated in other environments. For instance, data from field research on the effects of naturally occurring CO2 elevations, such as those caused by volcanic CO2 vents in shallow coastal waters off the Italian island of Ischia and in Papua New Guinea, would enable assessments of the impact on communities using a natural pH gradient. Such field-based studies, however, are uncommon and typically carried out by research teams in remote locations with abundant resources. These teams may mix student projects, but they are the exception rather than the rule (Hall Spencer et al., 2008; Fabricius et al., 2011). However, many phenological studies will offer baseline information alongside testing hypotheses designed to produce quick research results or, if enough information is available, contribute to studies of how these species respond to environmental change. For instance, there is strong evidence that yearly recurring lifecycle events may be climate change sensitive. Such responses may have an adverse effect on trophic interactions, such as by upsetting the structure of the food chain, which may disturb ecosystem function. This is what Edwards and Richardson (2004) saw happen among the North Sea marine plankton in response to climate change. They discovered distinct alterations in the pelagic population, which led to an incongruence between tropic levels and functional categories. They assumed that these modifications might ultimately result in alterations to the ecology. However, there is strong evidence that repeating lifecycle events, which occur annually, are susceptible to climate change (Edwards and Richardson, 2004). Graduate research programmes can be influenced by variations in migration patterns, breeding patterns, and sex ratios in animals where sex determination is temperature-dependent. For instance, it's probable that species with temperature dependent sex determination (TSD) won't be able to develop quickly enough to offset unfavourable effects of climate change. It has been demonstrated that climatic warming has an impact on the breeding phenology of turtles whose sex determination is so dependent on temperature (Schwanz and Jansen 2008). According to a study of the reactions of 59 species of fish where TSD has been (at least) implicitly asserted, fish with TSD changed their sex ratio in response to temperature increases of just 1-2°C. Fish sex ratios in both marine and freshwater species shifted to favour males. There were significant alterations in the sex ratio with rising temperatures for several of the species shown to have sex chromosomes (Ospoina and Piferrer 2008). Changes in sex ratios may affect community structure in maritime habitats where there is natural upwelling, as described in Hall-Spencer et al. (2008) and Fabricius et al. (2011). The timing of breeding and changes in migration patterns can also shed light on how taxa are affected by climate change. This kind of research is particularly suitable for birds (see e.g., Walther et al., 2002).

These include:

- ❖ Having little relief makes it difficult for species to move between climate zones;
- ❖ aridity and little yearly precipitation throughout most of the continent;
- ❖ widespread, ongoing degradation, loss, and habitat fragmentation in both aquatic and terrestrial ecosystems as a result of pressures from human development and alien pests and plants; and
- ❖ With limited geographic and climatic ranges, there is a high percentage of native plants and animals. Regional climate change, species reactions, and ecological responses were yet unclear, according to Hilbert et al. (2007).

Another obstacle was the inability to calculate and foresee how potential repercussions might affect certain species or ecosystems (few have considered the genetic consequences of change; however see e.g., Bradshaw and Holzapfel 2006; Gienapp et al., 2008; Visser 2008). It is challenging to study these results since diverse animal species and populations are impacted by climate change (e.g., ecosystem restructuring, irreparable change or loss; physiological effects; relationships and behaviour; changes in body size; species distribution; development and genetic change; shifts in the timing of events [e.g., breeding, migration], and altitudinal shifts in range).

***For example***, Due to climate change, short-distance migratory birds arrive earlier than usual. Long-distance, late-season migrants respond to global warming in a more varied way, but many do not seem to have changed the date of their arrival. Such fluctuation is challenging to identify due to regional range variability and natural variations in species abundance (Walther et al., 2002). At a study of the barnacle Semibalanusbalanoides, surface sea water temperature predominated above a threshold temperature (13.18°C), with pH having a significant impact on the population only in the southern end of its territory (Findlay et al., 2010). Numerous of these crucial signs of climate change, such as ecosystem disruption, changes in body size, species distribution, timing of events, and altitudinal shifts in species range, call for extensive, ongoing longitudinal field studies with a significant historical component that (preferably) goes back to pre-anthropogenic climate warming. To address these issues, the researcher must identify systematic patterns across several species and geographical areas (Parmesan and Yohe 2003). In terrestrial ecosystems compared to marine ecosystems and in Northern Hemisphere systems compared to Australian systems, comprehensive datasets are more common. There are few such databases in Australia (although see, for example, Bradley et al., 1991; Recher, 1997; Wood and Recher, 2004), and none for marine environments. For instance, changes in bird populations for "numerous" bird species over the last 30-60 years are available for the UK (Walther et al., 2002). (Underwood, 1997). It is an important field of research to assist biodiversity management with long-term warming, despite the outliers, the absence of long-term databases for the majority of Australian species, and the difficulties and limits of zoological studies connected to climate change. Most of this research will be done by study participants in courses that need a few months to three years of research (Shea, 1993, for instance, from herpetology).

**Projects Potential Graduate For Students:**

The need for long-term studies and the short-term focus of student research and research funding bodies make it difficult to study the impacts of climate change on any animal species (Parmesan and Yohe 2003). This challenge is exacerbated by the fact that many species lack knowledge on their bioclimate envelope (Arajo and Rahbek, 2006). Additionally, there is limited information on how native fauna and ecosystems in Australia react to climatic changes and other anthropogenic stressors like urbanisation, habitat loss, and river management. Investigations must thus take into account phenology, autecology, and synecology over a number of generations in order to identify the potential consequences of climate change on native Australian species. Due to the lack of comprehensive data, students have a wide range of project options that could either directly or indirectly advance our understanding of the causes and effects of climate change. However, they might only be able to deal with theories and research problems that can be evaluated using recent datasets, and they might only contribute to the study of climate change through enhancing forecasting-related datasets (cf., Thomas et al., 2004; Elith et al., 2006). Long-term datasets can be used as a foundation for research (e.g., Recher et al., 2009; Lunney, 1987; Dickman et al., 2001; Mahon et al., 1998). Globally, the effects of climate change have already changed the taxonomic distribution of arctic terrestrial habitats, tropical marine ecosystems, and other ecosystems (e.g., Walther et al., 2002; Parmesan and Yohe, 2003; Root et al., 2003; Perry et al., 2005). Thus, studies on species, particularly those with poor characterizations, can aid in the monitoring of climate change. Such predictions should be supported by research on widely distributed species that travel over gradients (altitudinal, latitudinal, and/or longitudinal) (e.g., Shoo et al., 2005a, 2006). Species with expanding ranges that could cause ecosystems to change owing to competition (predation, prey, and competition with dispersal) are particularly interesting. The leading edge of the taxon expands into new areas as climatic conditions change, invading the lagging edge of another taxon (or taxa), and interacting. Particularly worrisome is anticipated to be the southerly biome shift toward the pole (for Australia) and upward elevation. It will be easier to project a species' ability to sustain a sustainable population if we can better comprehend it and predict how it will adapt to the physical environment brought on by climate change (see e.g., Matthews et al., 2012). This area is perfect for short-term projects needed by research trainees to test hypotheses regarding how populations in estuarine and marine environments may be impacted by climate change and ocean acidification (Findlay et al., 2010). Forecasts may be supported by research on the target species in challenging conditions. The organisation of such a project is challenging because graduate students are required to submit projects on time. The integrity of research may be jeopardised if methods other than observation are tried to the limit. to prevent tied animals from becoming stressed (e.g., trapping, tagging). Unexpected extremes, however, might offer important field observations on the effects of climate change. A specialised folivore of Eucalptus species, the koala

Phascolarctos cinereus, is dependent on habitat quality (Moore and Foley 2000). (1999, Martin and Handasyde). Some of the introduced koalas to Brisbane Forest Park's eucalypt woodland perished in heatwaves. The survivors fled the eucalypt forests and moved down catchment to the stream, where they sheltered until the heatwave subsided in dense non-eucalypt species vegetation, predominantly Melaleuca spp (J. Howard, pers. comm.). The local koala population was not harmed by climate change because its habitat was destroyed. Under these circumstances, it is unlikely that koalas died by severe weather soon after being released would have been attributed to habitat degradation. Other habitats might more clearly display climate change. Communities may estimate the effect using a natural pH gradient if field study on the effects of naturally high CO2 was conducted, for example, on the effects of volcanic CO2 vents in shallow coastal waters around Ischia, Italy, and Papua New Guinea. Field studies are uncommon and typically conducted by research teams in remote locations with ample resources, allowing for the integration of student projects (Hall Spencer et al., 2008; Fabricius et al., 2011). However, many phenological studies offer baseline information while testing hypotheses to generate results for immediate research or, if sufficient information is available, contribute to research on how these species react to environmental change. There is evidence that annual lifecycle events may be impacted by climate change. Ecosystems might suffer from altered trophic interactions or food web patterns. According to Edwards and Richardson, the North Sea's marine plankton has been impacted by climate change (2004). The pelagic community displayed different alterations that didn't correspond to functional categories and tropic levels. They predicted how these changes would affect the ecology. There is compelling evidence that annual lifecycle events are impacted by climate change (Edwards and Richardson, 2004). Graduate study opportunities are provided by variations in migratory, breeding, and sex ratio in temperature-dependent animals. It's possible that animals with temperature-dependent sex determination (TSD) won't develop quickly enough to cope with climate change. The phenology of turtle reproduction, which depends on temperature to determine sex, is impacted by climate change (Schwanz and Jansen 2008). The sex ratio changed at just 1-2°C in 59 fish species where TSD has been implied. Male dominance develops in both marine and freshwater fish. Numerous organisms with sex chromosomes experienced changes in sex ratios as a result of temperature (Ospoina and Piferrer 2008). Sex ratios may change in areas with natural upwelling, according to Hall-Spencer et al. (2008) and Fabricius et al. (2011), which could have an impact on community organisation. Taxa's response to climate change can also be seen in their migration and breeding patterns. This research is effective with birds (see e.g., Walther et al., 2002).

## II. Conclusions:

The development and/or consolidation of research sites as observatories for extensive, long-term study in regions most impacted by climate change (for example, paired sites at high and low altitude) will advance our understanding of the spatial and temporal patterns of species and community life cycles in key regions. These areas should not be the focus of climate change study. Understanding specific "observatories" is essential for understanding ecosystems, but a thorough investigation of Australia's greatest diversity of species and environmental factors is also required. Funding should prioritise quality over a focal region ('observatory') or species status because any field research on native species and their communities has the potential to further our understanding of how climate change is affecting the Australian environment (e.g., threatened species). As Parmesan and Yohe (2003) propose for ongoing longitudinal field studies to evaluate the effects of climate warnings, their real value to climate change research will be in supplying data to better modelling, even though they will increase knowledge of species and communities. Students can do climate change field research in maritime environments as well. Field research has been influenced by laboratory research. It is debatable whether this warrants worry because laboratory results might not translate to the field (marine or terrestrial), and doing so could have unforeseen consequences (Ross et al., 2012). The longer timeline required to measure the effects of climate change does not match the short-term research requirements of enterprise colleges and institutions, which seek results. We contend that students studying wildlife field zoology may have less opportunities to track a reaction to climate change through time and comprehend its effects on Australian native fauna whether they pursue undergraduate or graduate research degrees. By supplying baseline data or quantitatively modelling variables to estimate climate change, students typically contribute to climate change research. If the latter is the case, mathematical modelling and quantitative skills must be emphasised in undergraduate biology degree programmes.

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