Climate Change Adaptation Research Grants Program
- Marine Biodiversity and Resources Projects

Project title:
Human adaptation options to increase resilience of conservation-dependent seabirds and marine mammals impacted by climate change

Principal investigators: Dr Alistair Hobday
Lead organisation: CSIRO

Objectives:

1. Connect researchers, managers and policy makers, to focus on climate-ready monitoring and adaptation options for conservation-dependent seabirds and marine mammals.
2. Link ongoing monitoring programs around Australia for seabirds and marine mammals with relevant wildlife and conservation management agencies.
3. Extract climate signals for selected time series around Australia using cutting-edge statistical approaches.
4. Develop protocols for monitoring impacts of environmental variation on indicator species and develop an indicator suite of spatial and temporal metrics for climate change impacts.
5. Combine the indicator metrics to develop multi-species productivity indicators for Australian regions.
6. Provide practical adaptation guidelines for science and management, including on-ground monitoring protocols

Methods:
This project addresses the NARP Conservation Priority: How should conservation managers and planners adapt their practices to ameliorate climate change risks and enhance adaptation options? What intervention strategies will increase system resilience and improve the time within which biological systems can adjust to a future climate?

Conservation managers need information on species status as part of EPBC Act, and to underpin threat management. A number of major seabird/shorebird and marine mammal research programs around Australia have a population monitoring component – but these may be enhanced in order to be more useful for detecting impacts of climate change, and for monitoring potential adaptation efforts.

Populations of threatened species can be impacted by both climate and other threatening processes (such as fishing, pollution, or disturbance). It is important to be able to attribute the population changes to climate or other processes in order to undertake the correct adaptation response. For example, there are some existing long-term seabird data already available but few have been used to look for climate signals – seabirds are among the most surveyed of all marine taxa, making them ideal for studies of this type. Similar datasets exist for fur seals and sea lions, and dugongs. In addition, where possible, other key data sets will be used to investigate potential climate induced changes to key habitats and resources essential to each taxonomic group.

Time series that will be useful will need to include basic reproductive demographics, and adult/juvenile survival information.

In a first workshop, these time series will be analysed for a climate signal (variability and change) with researchers analysing their own data (see the attachment for the location and length of data sets we have assembled through the participation of the co-investigators. Data analysis will be completed by the participating researchers and will represent their in-kind contribution. Statistical assistance and environmental datasets will be provided by the project team. Three levels of analysis are possible, based on the information contained in each dataset. These methods will be developed and agreed at an initial workshop, and then statistical support and environmental analyses provided to continue the analyses.

1. Identification of relationship with environmental signals for selected indicator metrics derived from the existing time series (e.g. timing of breeding, offspring weights, breeding success). This will involve for example, detrending time series data to look at residuals, as population trends can mask the climate signal. We will then determine appropriate environmental drivers for each region, using spatial correlation methods and a range of environmental variables. We will assess the significance level of relationships with correlation analysis and cross-validation (leave-one-out cross validation methods maximise the information content, particularly when time series are of the order of 20 years). For datasets that are not based on population size, rather of life-cycle timing (e.g. breeding dates), we will consider both the long-term trends and year-to-year variability (i.e. detrended data) to determine the relative influence of climate trends (log term change) and climate variability (interannual signal). As suggested in the review of the EOI for this project, this may also allow identification of "tipping points or thresholds" in the historical variation that are useful for projecting a future impact.

2. Cutting edge statistical modelling to determine current drivers, and to predict future trends.
For those variables with significant environmental drivers, multiple regression models will be built using the significant variables. Prediction of the future trend in the biological variables will be undertaken by using environmental values derived from raw and downscaled Global Climate Models (GCMs). These are currently used for a number of projects in which the Principal Investigators are involved (Hobday and Chambers).

3. Demographic modelling to explore the relative impact of climate and other stressors, and the effects of management actions.
Each dataset will progress to the highest level possible, based on discussion with the data owner and capability. In scoping this project with researchers around Australia, we have already identified data sets that will only be useful at Level 1, and others that are likely to be considered at Level 3. Level 3 data sets are those where an estimate of total population size exist (e.g. Shy Albatross, see Map in appendix).

Researchers will then work with the support of the project team to continue analysis after the conclusion of the first workshop. Statistical and data support will be provided by the core project team.

A second workshop will be held with researchers and conservation managers to explore the options for enhancing adaptation potential for monitoring, management, and species. We emphasize that a range of adaptation options may be possible, and will consider how to enhance autonomous adaptation and improve directed adaptation. Three outputs from the discussion and lessons learned from the group and the analyses that are undertaken (and some potential adaptation options) are envisaged:

1. Adaptation guidelines for scientists: Researchers may need to adapt how they monitor their colonies to better attribute changes to process and best practice monitoring standards for climate change will be developed by the team following the workshops and a review of national and international approaches.

2. Adaptation guidelines for conservation managers: Declines or increases in population size may be due to climate rather than other anthropogenic impacts (e.g. fisheries); attribution is needed before management action can be taken. Managers may also choose to adapt their response plans, based on the climate response that is observed for these species. For example:

- Predictions of the start of the breeding season in Little Penguins are used by the Phillip Island Nature Park to better manage their human resources (e.g. when to conduct research on off-shore islands) (Cullen et al 2009; Chambers et al 2010)

- Changes in breeding dates may require managers to change the periods of time when protection or restrictions to access colonies are implemented.
- For managers of seabird colonies the increased likelihood of wildfire (projected under warmer and drier climate) could result in adaptation options such as improving fire response times, and associated resource availability, and appropriate habitat management (e.g. planting of fire-retardant vegetation, Chambers et al. 2009).
- Vegetation responses to climate change may greatly impact the breeding success of burrow nesting seabirds and weed eradication programs may need to be targeted accordingly.
- The monitoring of the health and reproductive performance of seal colonies may inform managers for mediating negative impacts of eco-tourism at breeding colonies (numbers of visits; exclusion zones etc.) and potential zoonotic events (i.e. diseases that can be transmitted from animals to people or vica versa).

3. Adaptation options for seabird and marine mammal species challenged by climate change. Intervention options to enhance species adaptation to climate change may be enhanced if the causal climate factor can be identified. In the case of marine turtles, for example, a number of adaptation options are possible, including beach shading, beach nourishment, protection of vulnerable sites) (Fuentes et al 2009). Adaptation options for threatened seals and seabirds have received limited attention (e.g. seabirds - Chambers et al 2009), and so will be work-shopped as part of this project. Examples of adaptation options to date have included:

- Provision of nest boxes designed to reduce overheating of nesting penguins (Chambers et al 2009)
- Supplementing nesting material to enhance breeding success for shy albatross (Alderman, unpublished)
- Disease treatment at albatross (Alderman, pers. comm.) and fur seal/sea lion (Arnould pers.comm.) colonies.

Finally, development of a multi-species index will be undertaken pending the outcomes of the analysis on individual time-series. Standardised time series from individual colonies will be combined regionally to generate a multi-species index that can be used to track the result of adaptation responses at a general level, while the individual time-series will continue to be used to follow the outcome of species-specific adaptation responses to climate change. Similar multi-species indices of “top predator productivity” are used as environmental monitoring tools in other parts of the world (e.g. salmon in NW Pacific) and are particularly used by managers to put “anecdotal information into context” (http://www.nwfsc.noaa.gov/research/divisions/fed/oeip/a-ecinhome.cfm). Ongoing collection of marine bird and mammal data may contribute to the ecosystem component of the IMOS Bluewater and Climate Node.