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This project arose from a need to conduct a number of risk assessments to facilitate the management of AWCs wildlife sanctuaries.

Implications for managers

This approach described in this paper will allow natural resources managers to work through a process to conduct a structured risk assessment. The approach has clear steps and terminology and is designed to minimise issues that can often arise through the elicitation of expert opinion. The approach provides a method to quantify opinions and associated uncertainty and to aggregate that information in such a way as to allow managers to prioritise risks and to then conceptualise them.

Summary

Where data and information are lacking, structured expert risk assessments can provide a powerful tool to progress natural resource planning. In many situations, practitioners make informal assessments of risk within small groups that typically constitute employees. In this study we report on three small (in terms of experts) structured expert-based risk assessment case studies conducted by expert employees of a not-for-profit organisation (Australian Wildlife Conservancy) to demonstrate the utility of the approach. The case studies were carried out for three wildlife sanctuaries managed by AWC: Faure Island, Karakamia, and Paruna. The likelihood that a set of direct risk factors would cause management failure for sets of important wildlife elements in the three sanctuaries was elicited from the small group of ecological experts. The analysis was couched in terms of a management aim to not lose species from each wildlife element over the management period of 25 years with current management. The experts believed, in particular, that increasing temperature and decreasing water availability associated with climate change was likely to impact significantly upon the vegetation elements and water-reliant fauna associated with the sanctuaries. Some vegetation elements were also thought likely to be at risk of over-grazing, unsuitable fire regimes and, in some cases, disease. In addition to predation by exotic predators at one sanctuary, the experts identified additional direct risk factors for various fauna elements associated with expected changes to the vegetation elements, including reduction in food availability, nesting habitat, and generally important life media. From the risk analyses, a preliminary conceptual model was developed to underpin monitoring and to indicate areas for possible management intervention and research. The case studies demonstrate that even in a small workplace team, structured risk assessments can be efficiently accomplished and can provide expedient and transparent information that effectively captures and aggregates the views of the experts.

Keywords: Structured expert risk analysis, direct risk factors, wildlife elements, threatening process, natural resource planning.

Introduction

Given the complexity of many natural systems (Pahl-Wostl 2007; Kuuluvainen 2009), reaching targets for natural resource management (NRM) can be challenging, especially when considering the many different threatening processes that can operate simultaneously (Margules and Pressey 2000), and the almost inevitable resource limitations. Further, the data required to inform NRM is often incomplete (may be in the process of being collected which may take decades), missing, and/or imperfect (Kuhnert *et al.* 2010; Metcalf and Wallace 2013). Even without the required data and information, managers still need to manage, set targets, and to assess the likelihood of meeting targets (Metcalf and Wallace 2013). Understanding the likelihood of meeting targets will, in turn, require progress to be made in key management steps, such as modelling the degree of risk to key system elements associated with various threatening processes (Kuhnert *et al.* 2010).

Where data is lacking and numerous possible risk factors require assessment and prioritisation for management, expert elicitation approaches can provide an excellent basis to adaptively plan and enact management (Kuhnert *et al.* 2010) — as long as the management system and its elements for management are clearly defined, management timeframes are established, and goals (and any related targets) are set (Wallace 2012). Importantly, the information collected from experts must be done in such a way as to minimise biases relating to issues such as framing (people reaching different conclusions from the same information as a consequence of how it was presented), anchoring (insufficient modification of judgment from a preceding anchor), halo effects (perceptions being influenced by an alternative perception or attribute), and linguistic uncertainty (language-based misunderstandings; McBride *et al.* 2012). Nonetheless, expert assessments allow complex situations to be examined. The resulting information can be used to develop conceptual models, which in turn, can be used to guide monitoring and research, and to form the basis to progress adaptive management programs (Williams *et al.* 2009). Through adaptive management, the initial assessment of risk and the ensuing conceptual models can be updated with new information, reducing uncertainty, increasing understanding, and improving management effectiveness (Williams *et al.* 2009). For on ground practitioners, understanding the risks associated with a complex system can be challenging, especially when time is limited and there is only a small group of experts (typically employees) available, and there is a high likelihood of biases relating to issues such as framing and anchoring, halo effects, etc (McBride *et al.* 2012). In this situation, the group of employees will often make an informal assessment of risks that may be strongly biased by a smaller number of individuals, and will presumably be based upon previous experience, literature, and personal opinion.

The Australian Wildlife Conservancy (AWC) is a not-for-profit organisation that focuses on securing and managing parcels of land for wildlife conservation. In Western Australia, AWC has several properties, three of which, Paruna, Karakamia, and Faure Island Wildlife Sanctuaries (Fig. 1), are the focus of this paper. In 2015, AWC embarked on a nation-wide program to develop plans for monitoring the status and trend of conservation assets of their sanctuaries, with a focus on identifying important wildlife elements and key threatening processes (Kanowski *et al.* 2018). The planning was typically conducted at a regional level by small groups of AWC ecologists. To facilitate this process, a structured risk assessment by a small group (n=4) of employee ecologists (i.e. the experts) was undertaken for the three abovementioned sanctuaries to prioritise risks to the wildlife elements. A key aim of the risk analysis was to develop a preliminary conceptual model to underpin management planning.

In the face of considerable uncertainty and insufficient information for a quantitative assessment, the risk assessment approach developed by Smith et al. (2015) was employed. This approach makes use of expert opinions (in our case AWC ecologists), captured via the Interval Agreement Approach (IAA) of Wagner et al. (2014). The approach allows experts to independently and anonymously estimate the likelihood that each of a series of direct risk factors will cause target failure for specific wildlife elements. The approach developed by Smith et al. (2015) has not been tested using a small number of experts (e.g. a workplace with a limited number of experts who are also co-workers), a situation we regard as more typical than not in the NRM sector. This approach should help to minimise biases likely to be common in this kind of situation (i.e. framing and linguistic uncertainty), providing a more representative depiction of the experts' beliefs and the levels of uncertainty as a group.

There are a number of key differences between the methods described here and other risk assessment approaches. The approach applied here is designed to fit into the values planning framework outlined by Wallace (2012) and Wallace et al. (2016) and strives to reduce the mixing of means and ends (Gregory *et al.* 2012) and category mistakes (Wallace and Jago 2017). As an example of differences between this approach and another popular planning framework, Step 2 in the Conservation Action Planning Approach (The Nature Conservancy 2007) asks users to define focal conservation targets (*sensu*, wildlife elements in this approach), but then mixes system elements (Ecological Communities and Species) with a group that is a combination of elements and processes (Ecological Systems). In our approach, system elements are clearly differentiated from system processes, thus avoiding one source of category mistakes (Wallace and Jago 2017) which, once made, will inevitably permeate throughout the entire planning exercise. Additionally, unlike other planning approaches such as the Conservation Action Planning (The Nature Conservancy 2007) that use a ranking system (i.e. low, medium, high, very high) the interval agreement approach does not assume an equal distance between ranks and also efficiently captures uncertainty in people's opinions (Wallace *et al.* 2016). Additionally, the risk assessment results and the resulting conceptual model can be further incorporated into many of the various approaches to prioritization (e.g., Peterson *et al.* 2013) free from the issues described above.

This paper, therefore, reports on the results of the three risk assessments (one for each sanctuary) to provide case studies to demonstrate the utility of the approach for on ground practitioners, even with a small number of time-poor experts as is the case here.

Methods

Preparation for the risk assessment

Smith et al. (2015) developed a structured risk analysis that steps through a methodology to collect expert opinion (and associated uncertainty) using the IAA. By doing so, the expert opinions can be quantified in such a way as to minimise issues relating to the various biases that are often associated with expert elicitations (McBride *et al.* 2012). The steps include: (1), defining clear management goals, (2) defining specific temporal and spatial scales, (3) identifying important system elements, (4) classifying direct risk factors, (5) defining a clear aim for the analysis, (6) qualifying current management practices, (7) applying a suitable methodology for capturing, aggregating, and analysing data and any associated uncertainties, and (8) suitably documenting and communicating the information.

AWC has a clear management goal, to conserve Australian native species and the habitats in which they live. The four AWC experts met and then interacted via email to clarify the management boundaries and timeframe, identify a series of key wildlife elements (Supporting Information) and to develop, by modifying the one used by Smith et al. (2015), a direct risk factor table (Table 1). The experts had similar training and experience and were all very familiar with the sanctuaries of interest, the associated wildlife elements, and were suitably well versed in the processes likely to threaten the wildlife elements.

As an organisation, AWC is structured such that most sanctuaries have a dedicated team of operational staff whose primary role is to conduct on-ground management (i.e. problem animal and plant control, burning, etc). Prior to the analysis, the experts and the operational staff met for around one hour to qualify the current management on each of the three sanctuaries, such that all experts had a comparable and detailed understanding of current management.

During this stage of the process, the experts also developed a management aim for the risk analysis. Specifically, for each risk factor-wildlife element combination each expert asked themselves:

With current management, what is the likelihood that the risk factor will cause the loss of a species from the wildlife element over the management period of 25 years?

The expert elicitation — identifying the most important risk factors

The elicitation approach used in this study combines the methods of Speirs-Bridge et al. (2010), Metcalf and Wallace (2013), and Wagner et al. (2014), and is detailed in Smith at al. (2015). To conduct the analysis, each expert (the authors) worked individually and anonymously. Experts drew an ellipse on a scale (ranging from 0 to 1) to encode their beliefs about the likelihood that each direct risk factor would cause target failure (i.e. the extinction of one or more species) for each wildlife element over the management period. Refer to Smith et al. (2015) for a full and detailed description (with examples) of the IAA approach.

The location of the ellipse along the scale represented their estimate of the likelihood that the risk factor will cause target failure and the width of the ellipse captured their uncertainty. Experts were provided with several non-related examples (to avoid any anchoring) by MS as training and then individually worked through several real estimates to ensure they understood the approach and the associated terminology. The experts then conducted the remaining estimations independently over the following two weeks, without seeking any additional information or advice while conducting the estimations. An independent staff member (i.e. not involved in the elicitation) entered the data into an analysis excel file taken from Smith et al. (2015). MS then collated the aggregated information and presented it to the experts for review.

The analysis excel file provided by Smith et al. (2015) aggregates each expert's ellipse for each risk factor-element combination using the Interval Agreement Approach of Wagner et al. (2014). We have also included an R-script (with a 'toy' data set) that can be used to aggregate the ellipse data and produce graphs (Supplementary Material). The area encapsulated by each resulting distribution provides an estimate of the levels of uncertainty (referred to as spread; Pourabdollah *et al.* 2015) and the height of the graph indicates the level of agreement among the experts about that relationship (Fig. 2). The mean of the maximum importance and its associated spread (or area under the graph; Fig. 2) was calculated for each risk factor-wildlife element combination. Information from each risk assessment was used to generate a model to conceptualise the most important direct risk factors and associated and important 'higher order' processes for the wildlife elements in each sanctuary, with current management.

Results

The outputs of the analyses were reviewed by the experts who expressed their satisfaction with the results and the process used to generate them. The outputs were then given to the operational managers, who also expressed their satisfaction with the results and with the interpretation made by the experts. This provided an opportunity for the key people to express any issues or additional thoughts.

The results show that many risk factors across the three sanctuaries were thought to be important by the experts (Fig. 3). However, a loss of ground water and hyperthermia (through increasing temperatures associated with of a changing climate) were clearly thought to be particularly major issues for each sanctuary over the management period (Fig. 3) and especially their impacts upon species in many of the vegetation elements. In addition to a changing climate, any changes in vegetation was also thought likely to then have secondary impacts in terms of the availability of life media, nesting habitat and food for many species (Fig. 3). The vegetation was also typically thought to be under threat from over-grazing (particularly by macropods) and in some instances competition with weed species (i.e. through direct factors such as a lack of light). Of note, key species likely to cause over-grazing at Karakamia are the reintroduced Tammar Wallaby (*Macropus eugenii*) and at Faure, the introduced Boodie (*Bettongia lesueur*).

At Karakamia and Paruna, disease was considered an important risk factor for species susceptible to *Phytophthora cinnamomi* in some of the vegetation elements (especially the woodland elements). Species reliant on surface water, e.g. amphibians and water birds, at Karakamia and Paruna Sanctuaries were believed to be at considerable risk of losing access to suitable surface water (in terms of quality and quantity; Fig. 3). This also reflects concern about a warming and drying climate. Predation by non-native species was believed to be a major risk for critical-weight-range mammals at Paruna.

Risk factor-element combinations of low importance typically had high certainty (Fig. 3). This likely reflects two processes. First, as importance approaches zero, the distribution surrounding it effectively becomes a 1-tailed distribution (i.e. cannot go lower than zero). Second, the experts were often very confident about risk factors that were deemed to be of low importance for the management scenario. Many of the more important risk factor-element combinations fell into the high agreement/moderate certainty and high agreement/low certainty end of the spectrum (Fig. 3). As importance increases away from zero, it is more likely to have a more 2-tailed distribution, thus increasing the area under the curve and the estimated spread.

The risk analyses were used to create a preliminary conceptual model for the management of the sanctuaries (Fig. 4). Initially, to ease interpretation and communication, only the risk factor-element combinations thought to be the most important were included in the conceptual model. However, the model can be increased in complexity as required and the risk factor-element combinations not currently included have a rating that can be referred to should new issues be detected through additional research, planning, and/or monitoring. Also, of note, shorebirds were not included in the conceptual model as the risk factors believed likely to impact upon those elements would rely on dealing with much broader issues relating to the availability of food in non-Australian waters and to global changes in sea water quality and levels.

The conceptual model can be ‘live’ documents which not only provide a basis to develop appropriate monitoring programs for the elements and key threatening processes, but also provide a mechanism to identify areas where management may be most practicably targeted and where research is most required (Fig. 4). Thus, hopefully over time, they will serve to increase understanding of the linkages between different management activities, changes in key processes, and responses of important system elements.

Discussion

In this paper we provide three case studies that demonstrate the utility of using a structured risk analysis approach to inform management planning. We show that the approach can be used even in small work places with only a few experts. The case studies presented here represent real-world and typical examples (i.e. organisations are often time poor and have a limited number of experts to input into the planning process). By using the expert elicitation process, the experts were able to identify a number of important direct risk factors for the priority wildlife elements at each of the three sanctuaries. These results and process used to generate them were readily accepted by the experts and were consequently used to develop a preliminary conceptual model. The model was built around the risk factors (and associated threatening processes) shown to be most important for monitoring and where appropriate, additional research and management. By developing the conceptual model and using it to underpin management, the longer-term effectiveness of the approach can, and will, be assessed (i.e. if it is eventually deemed to have contributed sufficiently to the organisation's capacity to meet management goals and targets).

The risk analysis has clearly identified a high belief in the vulnerability of species in many of the vegetation elements to a range of risk factors: decreasing availability of water, climate warming, over-grazing, and disease. Alteration to vegetation composition and structure as a result of changes in temperature and rainfall (or climate change), in addition to the effects of disease and over-grazing, has been broadly recognised as major issue for some time now (Hughes 2003; Pettit *et al.* 2015). Similarly the interacting effects between climate change, vegetation composition and structure, and habitat suitability for fauna is now well established (Pettorelli *et al.* 2005; Pettorelli *et al.* 2011). Preventing change in temperature and rainfall at the scale of a wildlife sanctuary will be a difficult, perhaps impossible, endeavour. The most likely scenario is that the vegetation will go through some form of change resulting in concomitant, but perhaps also uncertain change in invertebrate and vertebrate fauna (Hughes 2003). However, some management actions may help to mitigate the effects of climate change; for example the maintenance of appropriate fire regimes (Dale *et al.* 2001) and control of invasive species (Rahel *et al.* 2008). Additionally, new management approaches are the focus of considerable research and in due course it may be possible to better ameliorate the impacts of a changing climate in many natural systems (Halofsky *et al.* 2018). Target areas for such research have been identified in the conceptual model (Fig. 4).

From the analysis, a series of management activities can now be developed and scrutinised in terms of effectiveness, feasibility, and cost (Reside *et al.* 2018) and a targeted research strategy can be developed. For the case-study sanctuaries, we suggest that research to better understand issues that relate to management of wildlife elements in a period of climate change (i.e. risks associated with the availability of water, food and important life media, fire, over-grazing, and hyperthermia) will be important and should be given a high priority. Issues relating to predation by cats and foxes is important for Paruna, even with current management, and as such, increased and/or improved control efforts are warranted.

Conclusion

The work presented here relies upon the use of the IAA (Wagner *et al.* 2014) which has been employed previously as a method to quickly and effectively capture and aggregate people's beliefs (Smith *et al.* 2015; Smith *et al.* 2016; Wallace *et al.* 2016). Ongoing research by the Lab for Uncertainty in Data and Decision Making at the University of Nottingham (headed by Christian Wagner; http://www.lucidresearch.org/ - last checked 23/09/2019) is increasingly providing empirical support for the notion that the IAA can effectively capture people's beliefs along with any associated uncertainty. For these reasons, and as demonstrated here, we argue that the approach can be employed by small groups of experts to expediently, transparently, and effectively assess risk levels to key system elements and to bring a degree of clarity and agreement to a complex situation as part of what should be standard planning. Importantly, where there is strong disagreement among experts, a discourse can ensue, allowing for an exploration of the different individual opinions, causes of uncertainty, and possible solutions to the differing opinions.

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Table 1. Direct risk factors used in the expert analysis.

Risk factor category	Direct risk factor	Examples
Physical and chemical factors	Acidity/alkalinity	• Contaminants in wetlands may cause death of organisms by changing pH, or disturbance of acid sulphate soils causing acidification.
	Concentration of heavy metals	• As above
	Concentration of hormones	• Increased contaminants through run-off into wetlands may cause death or alter fecundity of organisms.
	Concentration of nitrogen	• As above.
	Concentration of other toxins	• As above.
	Concentration of phosphorus	• As above.
	Poisoning (pesticides/herbicides)	• Mortality after exposure to herbicides or insecticides through ‘aerial’ drift from neighbouring properties or through application by operational staff. • Movement of pesticides or herbicides into wetland areas.
	Poisoning (ingestion of toxins)	• Ingestion of poison baits.
	Toxic species	• Death of animal through consumption of a toxic species.
	Salinity	• Rising saline ground waters and/or increasing salinity of inflows.
	Physical damage (fire)	• Destruction of organisms by fire.
	Physical damage (other than fire)	• Death of organisms via some form of physical disturbance (e.g., bulldozing an entire population of a plant species with a very restricted distribution)
	Temperature (or Hyperthermia; expressed as periods of time with unsustainable temperatures)	• With increasing temperature extremes, there is increasing potential for unsustainable mortality in the more susceptible species.

Risk factor category	Direct risk factor	Examples
Resources	Lack of food (starvation)	• Mortality through starvation following death of trees that provide food for a species. .This may occur after over-grazing, including by overpopulated reintroduced mammals.
	Lack of surface water leading to dehydration and inappropriate hydro-period	• For some species, extended summer droughts may cause death due to a lack of surface water • Some species may have a requirement for some minimum amount of water in the landscape
	Lack of ground water	• Warming drying climate may lower groundwater tables to such an extent that vegetation experiences high levels of drought related mortality
	Life media	• Soil removal undermining the stability of trees. • Inadequate resting media for a mammal species. For example, the removal of low vegetation by fire may result in insufficient rest media for woylies. So on the one hand, the removal of vegetation is a direct risk factor for the plants, but the removal of associated resting media is a direct risk factor for the mammals. However, if the loss of resting media means that the mammals are more readily preyed upon, then the direct risk factor will be predation. For this risk factor, the lack of nesting media would have to directly cause mortality (perhaps through stress) or possibly emigration away from the sanctuary. • Soil compaction by feral herbivores means plants cannot establish. • Weeds can take up physical space so natives cannot grow. • Where a species monopolises an area (i.e. introduced or native species preventing other species from using a territory), the direct risk factor may be physical injury from fighting, lack of food, nesting habitat, or predation. However, this may be important if the animals die from stress (bearing in mind that things like heat stress are covered elsewhere).
	Oxygen deficit	• Rising water tables may drown vegetation.
	Light deficit	• Lack of light penetration in water bodies may cause photosynthetic failure. • Weeds shade native plants, stealing their access to light
Disease/predation/etc	Disease, parasites	• Diseases causing plant death. • Introduction of a disease via animal reintroduction.
	Grazing	• Over-grazing causing unsustainable mortality in particular plant species. This is really a form of predation, but for the sake of convenience, keep this as a separate direct risk factor
	Predation	• Death of mammals/reptiles/birds to predation
Reproduction	Lack of mates – loss of fecundity (e.g., senescence)	• Possibly senescence (resulting from a lack of required trigger) or reduced availability of mates due to high death rates and/or low immigration in one sex but not the other.
	Lack of compatible mates	• Reduced genetic diversity following excessive death and/or low immigration may result in individuals not able to find genetically compatible mates or inviable offspring resulting from genetically incompatible mating.

Risk factor category	Direct risk factor	Examples
	Lack of nesting habitat	• Reduced availability of nesting habitat due to loss of vegetation, hollow logs for birds, etc.

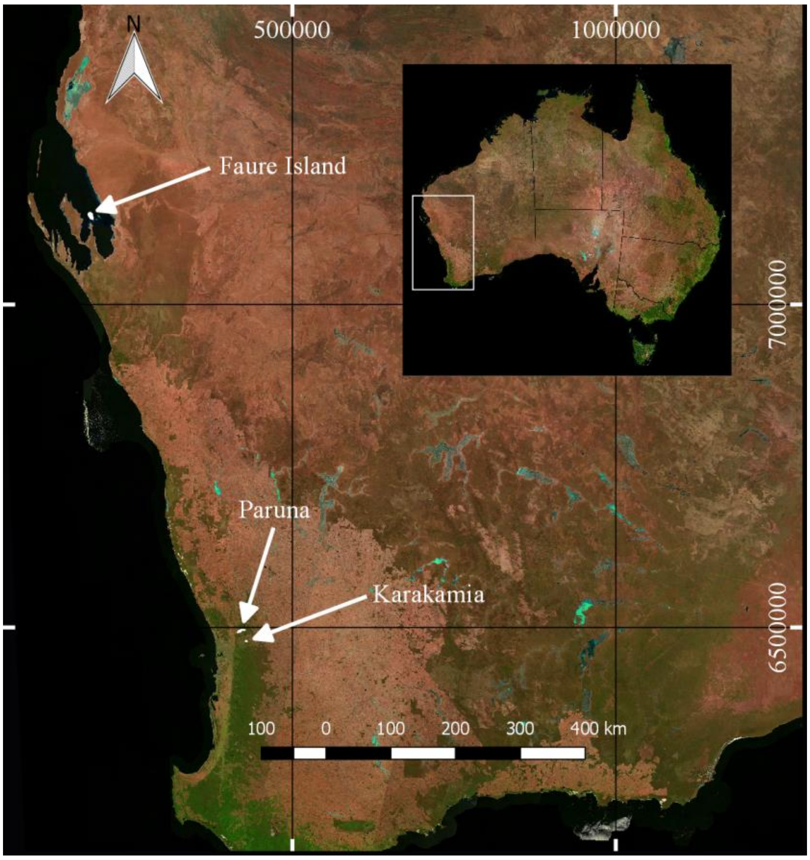


Figure 1. The location of the three AWC wildlife sanctuaries.

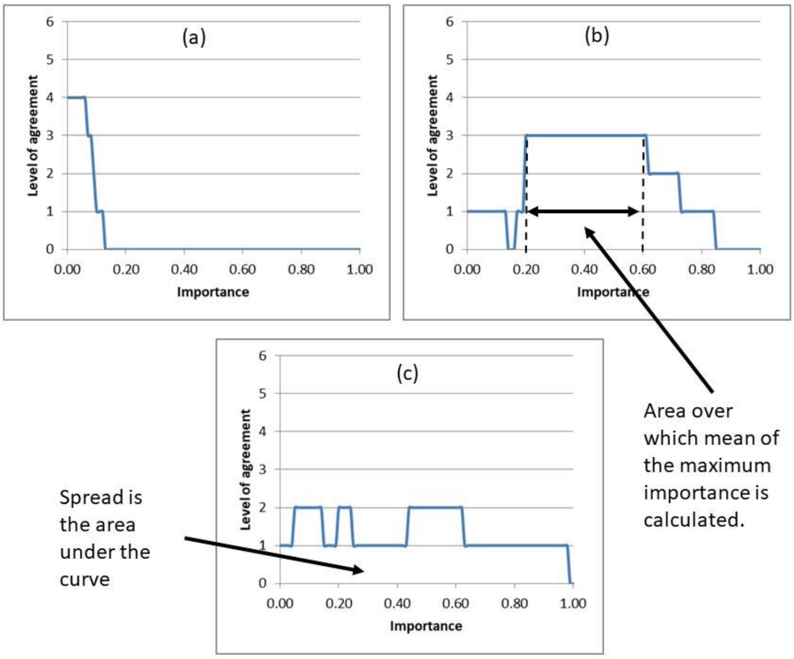
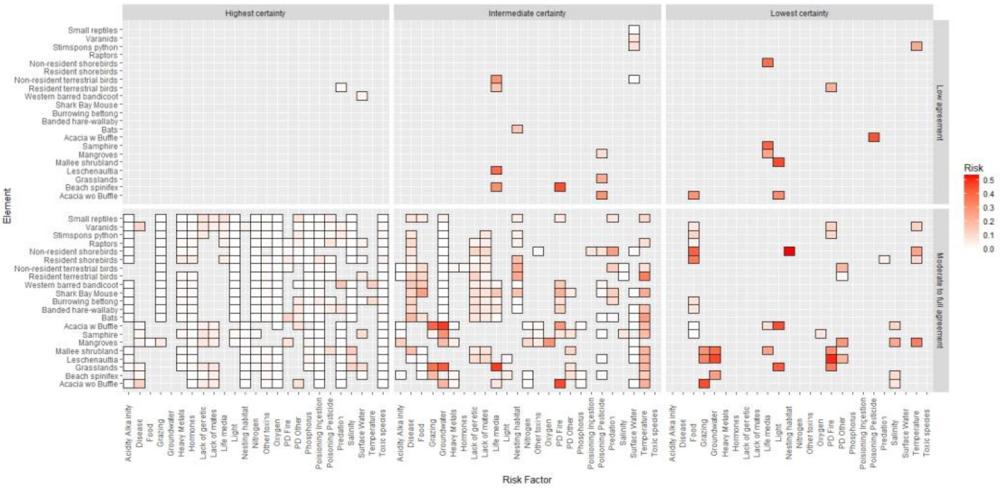
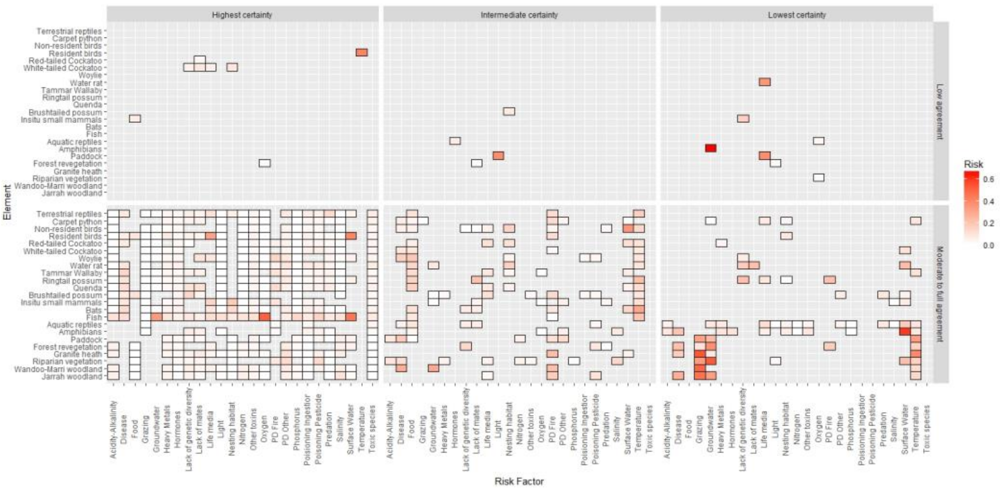


Figure 2. Examples of different aggregation results: (a) high certainty/high agreement, (b) moderate agreement/moderate certainty, and (c) bimodal with low agreement and high uncertainty. The average maximum importance was calculated across the range of maximum importance estimates (b) and spread as the area under the curve (c).


Highest certainty
Intermediate certainty
Lowest certainty
Small reptiles
Varanids
Stimspons python
Raptors
Non-resident shorebirds
Resident shorebirds
Non-resident terrestrial birds
Resident terrestrial birds
Western barred bandicoot
Shark Bay Mouse
Burrowing bettong
Banded hare-wallaby
Bats
Acacia w Buffle
Samphire
Mangroves
Mallee shrubland
Leschenaultia
Grasslands
Beach spinifex
Acacia wo Buffle
Element
Low agreement
Moderate to full agreement
Risk
0.5
0.4
0.3
0.2
0.1
0.0
Acidity Alkalinity
Disease
Food
Grazing
Groundwater
Heavy Metals
Hormones
Lack of genetic
Lack of mates
Life media
Light
Nesting habitat
Nitrogen
Other toxins
Oxygen
PD Fire
PD Other
Phosphorus
Poisoning Ingestion
Poisoning Pesticide
Predation
Salinity
Surface Water
Temperature
Toxic species
Risk Factor


Highest certainty
Intermediate certainty
Lowest certainty
Terrestrial reptiles
Carpet python
Non-resident birds
Resident birds
Red-tailed Cockatoo
White-tailed Cockatoo
Woylie
Water rat
Tammar Wallaby
Ringtail possum
Quenda
Brushtailed possum
Insitu small mammals
Bats
Fish
Aquatic reptiles
Amphibians
Paddock
Forest revegetation
Granite heath
Riparian vegetation
Wandoo-Marri woodland
Jarrah woodland
Element
Low agreement
Moderate to full agreement
Risk
0.6
0.4
0.2
0.0
Acidity-Alkalinity
Disease
Food
Grazing
Groundwater
Heavy Metals
Hormones
Lack of genetic diversity
Lack of mates
Life media
Light
Nesting habitat
Nitrogen
Other toxins
Oxygen
PD Fire
PD Other
Phosphorus
Poisoning Ingestion
Poisoning Pesticide
Predation
Salinity
Surface Water
Temperature
Toxic species
Risk Factor

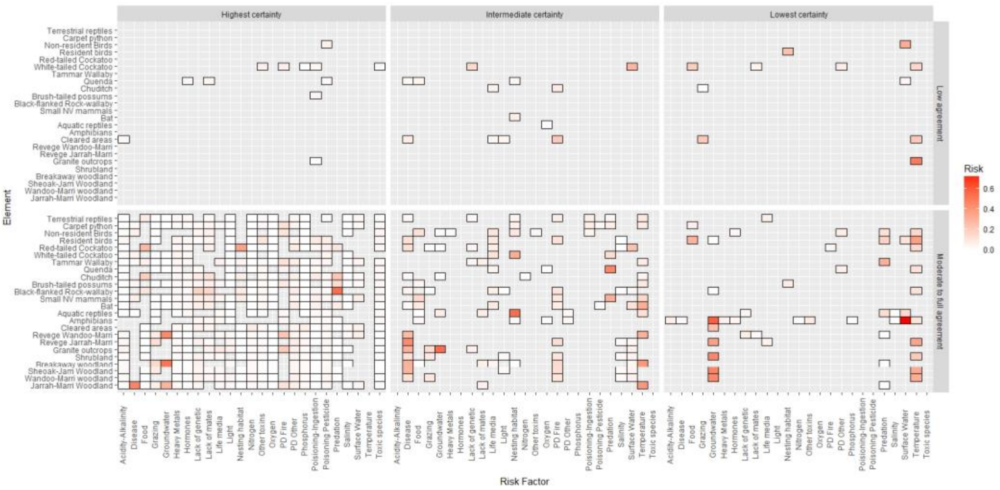

Highest certainty
Intermediate certainty
Lowest certainty
Terrestrial reptiles
Carpet python
Non-resident Birds
Resident birds
Red-tailed Cockatoo
White-tailed Cockatoo
Tammar Wallaby
Quenda
Chuditch
Brush-tailed possums
Black-flanked Rock-wallaby
Small NV mammals
Bat
Aquatic reptiles
Amphibians
Cleared areas
Revege Wandoo-Marri
Revege Jarrah-Marri
Granite outcrops
Shrubland
Breakaway woodland
Sheoak-Jam Woodland
Wandoo-Marri woodland
Jarrah-Marri Woodland
Element
Low agreement
Moderate to full agreement
Risk
0.6
0.4
0.2
0.0
Acidity-Alkalinity
Disease
Food
Grazing
Groundwater
Heavy Metals
Hormones
Lack of genetic
Lack of mates
Life media
Light
Nesting habitat
Nitrogen
Other toxins
Oxygen
PD Fire
PD Other
Phosphorus
Poisoning-Ingestion
Poisoning Pesticide
Predation
Salinity
Surface Water
Temperature
Toxic species
Risk Factor

Figure 3. Results from expert risk analysis for Faure Island (top), Karakamia (middle), and Paruna (bottom) Wildlife Sanctuaries. Cell shading indicates the aggregated importance estimate (mean of the maximum; the darker red the box, the greater the believed risk factor importance) and the analysis has been subset into three equal levels or certainty (left to right, higher spread = less certainty) and two equal levels of agreement (top to bottom).

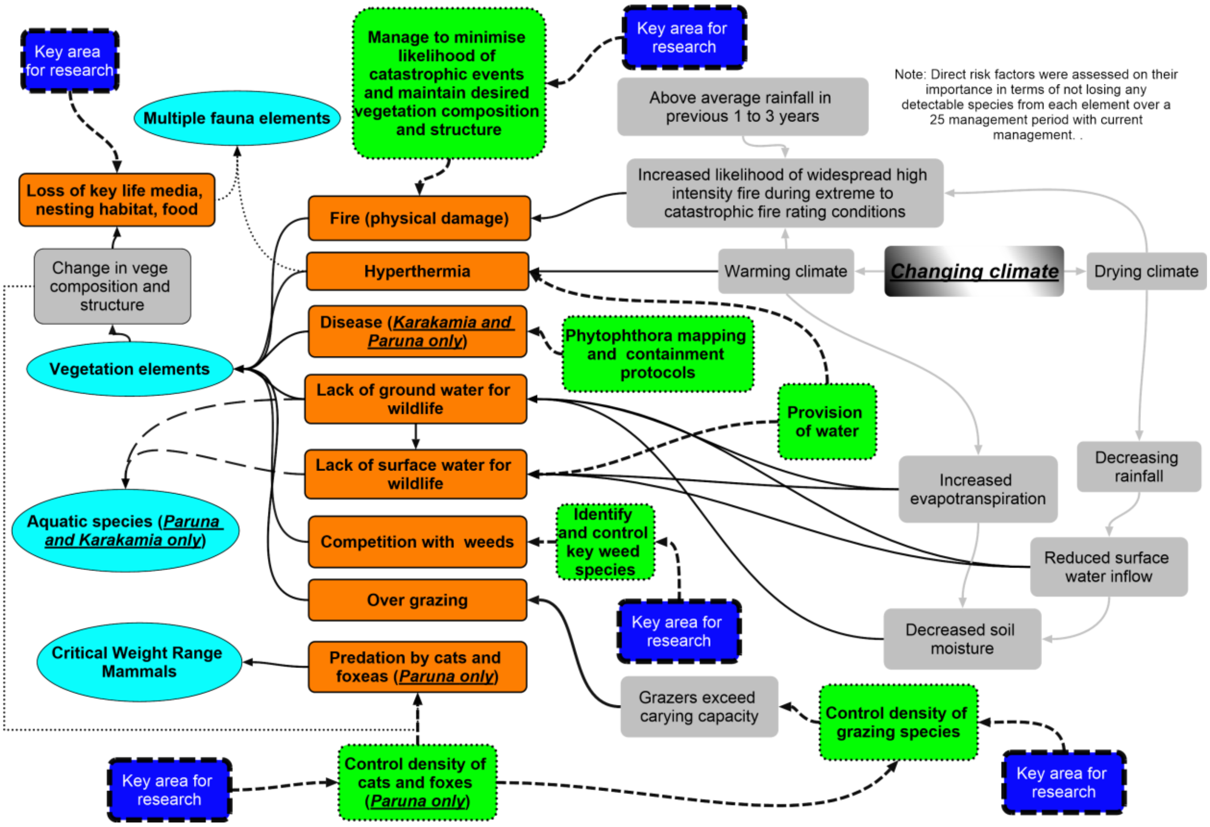


Figure 4. Conceptual model generated for the three wildlife sanctuaries from the risk analyses. Orange boxes with solid border= direct risk factors, blue ovals = key wildlife elements, green boxes with thick dotted border = areas where management intervention may be most feasible/effective, blue boxes with thick dashed lines = key areas for research, grey boxes with no borders = linkages among key processes that surround the risk factors. Lines are styled to ease interpretation only.