

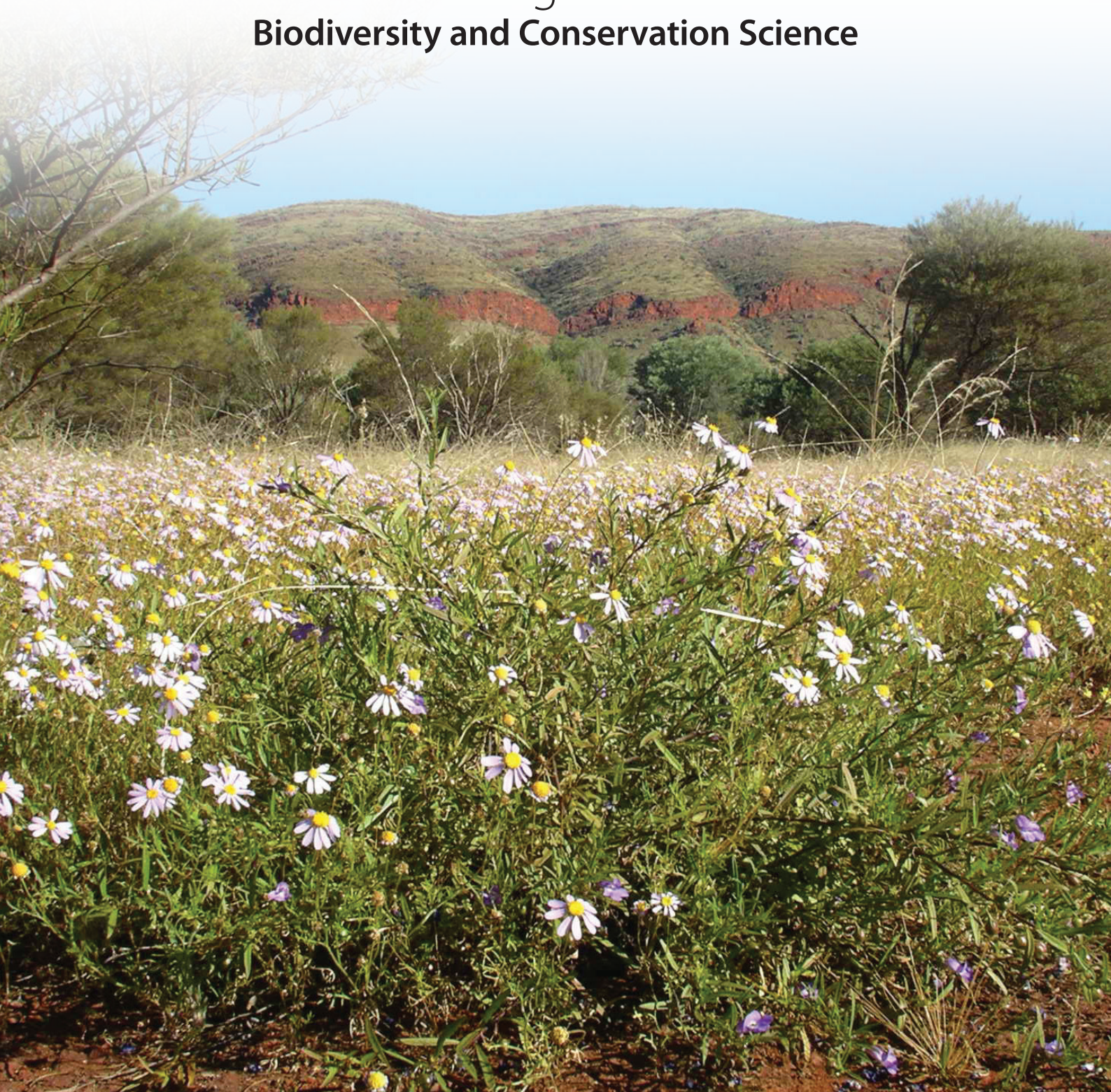

GOVERNMENT OF WESTERN AUSTRALIA

Department of **Biodiversity, Conservation and Attractions**

Report

Science Strategic Plan 2018–21

Biodiversity and Conservation Science



Science Strategic Plan 2018–21 Report

This report identifies the contribution Biodiversity and Conservation Science has made to delivering outcomes of the Science Strategic Plan 2018-21.

Vision

Scientific excellence informing biodiversity conservation.

Purpose

This Strategic Plan describes the key goals that science will deliver to support the Strategic Directions of the Department of Biodiversity, Conservation and Attractions. The Plan directs the underlying scientific programs, and describes the priorities and approach for these programs and the supporting business processes.

Values

The Department of Biodiversity, Conservation and Attractions values our staff, community, and visitors by providing excellent customer service and ensuring a collaborative workforce based on integrity, diversity and accountability. Science undertaken in the department will be collaborative, innovative, ethical and outcome driven.

Strategic Intent

Science contributes to delivering the department's Strategic Directions for Biodiversity and Conservation, Natural and Cultural Values, Fire Management, Our Community and Partners, and Our People.

Science Delivery

Science in the Department of Biodiversity, Conservation and Attractions is undertaken in accordance with the departmental Science Policy, where science refers to scientific research, scientific monitoring and science communication undertaken in relation to the biological, physical, and social environments.

Biodiversity and Conservation Science coordinates and delivers science in the Department of Biodiversity, Conservation and Attractions, providing science and biodiversity knowledge to support the function of the Parks and Wildlife Service, Botanic Gardens and Parks Authority, Zoological Parks Authority and Rottnest Island Authority.

More information is available at www.dbca.wa.gov.au/science

Contents

The Strategic Intent of the Department of Biodiversity, Conservation and Attractions identifies six Strategic Directions and the Science Strategic Plan identified delivery against five of these: Biodiversity and Conservation, Natural and Cultural Values, Fire Management, Our Community and Partners, and Our People. This report presents the BCS achievements against these five Strategic Directions according to the Themes and Goals identified for each Strategic Direction in the Science Strategic Plan.

Biodiversity and Conservation

Fire management

Natural and cultural values

Our community and partners

Our people

Biodiversity and conservation

Conserve, restore and manage flora and fauna, ecosystems and landscapes using world-recognised science and best practice management.

Strategic Theme Biodiversity knowledge

Strategic Goal Adequate knowledge of biodiversity is available to support the department's conservation and management of terrestrial, estuarine and marine ecosystems.

Approach	Achievements
Conduct biological survey, including genetic survey, in priority management areas, and for key species and ecological communities.	■ Survey of species and ecosystems has been undertaken in terrestrial, estuarine and marine systems leading to new biodiversity distribution data and vegetation mapping that will be used as baselines for future monitoring, designing and prioritising management actions, assessing conservation status of species and communities, and assessment of environmental impact. ■ Knowledge of priority flora across the Mid-west, Wheatbelt, Pilbara (La Grange), Kimberley (Typhonium communites) and South Coast Regions was improved with surveys of 43 Priority plant species resulting in the discovery of 32 new populations. ■ Ecosystem surveys were carried out, including key areas such as Kimberley Mound Springs, Lake Carnegie, Fortescue Marsh, Walyarta and the Fitzroy Valley, as well as the south-west gypsum soil flora. ■ Surveys of benthic habitat in Eighty Mile Beach Marine Park, corals in the Dampier Archipelago, macroalgal habitats and cryptobenthic fish communities at Ningaloo Marine Park, and dolphins in the Pilbara, have provided information to inform planning of long-term monitoring and identification of key habitats for marine fauna. ■ Genetic analyses were undertaken across 13 genera and 132 plant taxa to resolve taxonomic uncertainties in cryptic species, hybrids and species complexes, clarify taxonomic or management units for threatened flora, as well as resolve broader phylogenetic relationships. Genetic surveys of multiple threatened fauna has informed their effective conservation management, both on and off reserve, and at local and landscape scales.
Maintain collections and undertake taxonomic research to support biodiversity knowledge.	■ The Western Australian Herbarium continued to manage, curate and expand a comprehensive, adequate and representative research and archive collection of specimens of plant, algae and fungi taxa found in Western Australia with 30,568 specimens added to the collection, increasing the size to 820,961 catalogued items, representing more than 18,500 taxa. In addition, 149,000 specimen records were edited to reflect current taxonomy. ■ Taxonomic research has improved knowledge of Western Australia's biodiversity through taxonomic descriptions, keys and floras. In the terrestrial flora 193 taxa, including 86 conservation listed taxa endemic to Western Australia, were named and documented with descriptions, illustrations and conservation status assessed. In the marine environment descriptions of 7 genera and 88 species new to science were published. ■ Improved taxonomy enables consistent identification across projects and researchers and assists with understanding conservation status of species.
Effectively acquire and share knowledge of biodiversity.	■ Biodiversity information was made available through public facing data portals, such as NatureMap and Florabase, though information on the website and via publications. ■ The Reference Herbarium continued to provide a critical resource for conservation with 4,500 visits by users from industry and the public to undertake plant identifications. ■ Wetland evaluation methodology was published and is available with field sheet proformas on the website. ■ A review of wetland location, extent and values was completed for the Swan Coastal Plain and incorporated into the Wetlands Evaluation Swan Coastal Plain dataset that is a basis for decision making in planning. ■ Plant trait information was collated for incorporation into emerging databases.

Biodiversity and conservation

Conserve, restore and manage flora and fauna, ecosystems and landscapes using world-recognised science and best practice management.

Strategic Theme Conservation of threatened species and ecological communities

Strategic Goal Biodiversity conservation and recovery programs are based on scientific knowledge.

Approach	Achievements
Undertake research to address knowledge gaps for threatened species and ecological communities.	■ Knowledge gaps to inform effective species recovery were addressed for multiple threatened fauna, providing a clearer understanding of threats, primarily in relation to introduced predators. Improved knowledge of distribution, abundance and habitat requirements was obtained for the bilby, northern quoll, night parrot and Gilbert's potoroo. Information on impacts of threats has provided knowledge for improved management for northern quoll and bilby. ■ A decision support process has been developed to provide a robust and transparent assessment of the value of translocation for improving species conservation outcomes relative to the cost to source populations from harvesting. ■ Research in fauna reconstruction on Dirk Hartog Island continued with the release of six species and various innovations being trialled to facilitate the success of translocations in establishing self-perpetuating populations. Monitoring of rangelands reconstruction at Matuwa has indicated that some species are unlikely to successfully establish outside a fenced enclosure in the presence of introduced predators. ■ Research in spatial analysis developed environmental variables, undertook modelling and tested new techniques to inform and provide inputs to develop knowledge of the distribution and potential habitat of threatened species and ecosystems. Spatial analysis of occurrence of threatened and priority flora, and intensity of threats to flora, provided evidence for identification and prioritisation of hotspots for flora conservation and management actions. ■ Research identified that fire prior to planting increases survival and growth of translocated seedlings, and that fencing increases seedling survival and irrigation increases growth and fecundity. Genetic studies provided information to support seed sourcing strategies for translocations of three threatened taxa. A decision support tool and benefit cost model were developed for prioritisation of threatened species translocations. ■ Studies of the effects of fire interval and *Phytophthora* dieback on population trends for 26 Threatened and Priority flora in the Stirling Range National Park provided critical information on the impacts of 2018 and 2019 fires and priorities for species recovery through translocation. ■ Assessments of habitat were undertaken to inform management of threatened species, including hydrology of wetlands used by Australasian bittern, food resources in Western Swamp Tortoise translocation sites and vegetation of ground parrot translocation sites.
Assess conservation status of species and ecological communities.	■ The assessment of recommended TEC rankings for 65 ecological communities was completed. Reviews of older threatened flora listings have been undertaken to be consistent with current criteria. ■ Listing assessments or reassessments were completed for 18 species and recommendations of Threatened Species Scientific Committee accepted by the Minister for Environment resulting in changes to the status of listed species. A further five fauna and 23 flora status reviews were undertaken and nominations prepared. ■ Changes were made to the status of 56 species under the EPBC Act as part of the process to align threatened species listed under the EPBC Act with threatened species listed under the BC Act, bring the total of changes to 105 species since the MOU was signed in 2015.

Biodiversity and conservation

Conserve, restore and manage flora and fauna, ecosystems and landscapes using world-recognised science and best practice management.

Approach	Achievements
Provide scientific basis for monitoring of threatened species and ecological communities.	■ Targeted surveys have increased our understanding of the distribution of some species believed to be in decline or that are data deficient. Innovative monitoring techniques and platforms utilising new technologies have significantly improved ability to track population trends and use of less invasive techniques, such as cameras replacing live trapping. Spatially explicit mark/recapture analyses combined with cameras, have provided robust estimates of abundance for many fauna species. ■ Development of an R program for analysing and visualising camera trap data has streamlined reporting. ■ Trials of scat DNA as a non-invasive approach to fauna monitoring has been shown to be effective for a number of species. Monitoring of bilby populations through DNA analysis shows they fluctuate but appear stable with the Kimberley confirmed as a stronghold for the species. ■ Eleven recovery plans were completed covering 21 species or ecological communities. This includes the first two Interim Recovery Plans produced under the Biodiversity Conservation Act 2016. ■ CALM Act plans are in place for all 12 Ramsar wetlands within conservation estate. These plans provide for the environmental values to be maintained and ensure that the State can meet its reporting obligations to the Commonwealth under the Ramsar convention.
Undertake ex-situ conservation.	■ The breed for release programs at Perth Zoo contributed to the conservation of target species in the wild, with 33 Numbats bred and 34 released, 100 Dibblers bred and 93 released, 169 Western swamp tortoises bred and 120 released, 17 White-bellied frogs bred and 330 head-started and released, and 169 Orange-bellied frogs head-started and released. ■ Seed conservation continued to insure against extinction and loss of genetic diversity with 388 new seed collections from 116 threatened flora and 71 priority flora lodged in the Western Australian Seed Centre. The Centre now holds 3900 collections of conservation significant plant species representing 345 Threatened taxa (80% of listed Threatened species) and 736 Priority taxa (23% of listed Priority species). Targeted testing of over 40 seed collections that had been in storage for over 25 years found that there was no evidence of viability decline for most of the collection. Seeds from the collection were used in translocations of 34 threatened flora. ■ Orchidaceae collections targeted threatened species for the Swan Region in 2020. Collections from this region included seeds of five species and fungi from three species. Further collections were made of seed of 49 species, including nine new species, and 87 fungal isolates. ■ Staff contributed to national guidelines for seed collection and storage, and conservation translocations.

Biodiversity and conservation

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Strategic Theme Management of invasive species and pathogens

Strategic Goal Invasive species and pathogen management methods are evidence based and effective.

Approach	Achievements
Assess risks and threats of invasive species and pathogens.	■ Assessment of disease was undertaken in wild western grey kangaroos and Carnaby's cockatoo. ■ Improved understanding of the distribution of introduced fish has enabled management to target effort to minimise further extension of the invasive peral cichlid in the Canning River through inter-agency collaboration with DPIRD. Survey has improved knowledge of the spread and population sizes of redclaw crayfish and provided an understanding of their impact. ■ Population viability analysis undertaken identified twig and stem cankers as a major threat to diversity of *Banksia* species on the south coast. Several outbreaks of tree pests were investigated and reported to inform management.
Improve effectiveness of monitoring and management of invasive species and pathogens.	■ Adaptive management experiments evaluated weed control methods to inform recovery of threatened flora. ■ Successful eradication of feral cats from Dirk Hartog Island demonstrates the effectiveness of feral cat management approaches where reinvasion can be controlled.
Identify and pursue advances in effective invasive species and pathogen management methods.	■ Advances in use of camera monitoring, occupancy modelling and track indices of introduced predators have improved approaches to effectively monitor changes in response to control. ■ Development of distribution models are informing management of feral cats. Research shows Eradicat can be safely applied in the presence of the northern quoll, which provides evidence to support this as an option for operational application in the Pilbara. ■ Innovative approaches based on conditioned taste aversion has been trialled to reduce the impacts of cane toads. ■ Development of spatial modelling of feral herbivore locations in selected parks of the Pilbara and analysis of feral herbivore movement on the Fortescue Marsh is informing better management. Collaboration with DPIRD in the application of thermal scanner technology to detect feral pigs has improved understanding of the locations of feral pigs in forested areas. ■ The potential of remotely sensed observations over time was investigated to identify possible *phytophthora* locations due to changes in vegetation cover response. Genomics identified multiple sources and introductions of the environmental weed stinking passionflower across northern Australia providing critical information for identifying potential biocontrol agents. ■ Methods have been developed to track marine turtle hatchlings and their predators (fishes, gulls, rats and crabs) over fine spatial scales.

Biodiversity and conservation

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Strategic Theme Pressures and threats to ecosystem composition, function and values

Strategic Goal Understanding of the effects and opportunities for mitigation of pressures and threats to terrestrial, estuarine and marine ecosystems and associated values.

Approach	Achievements
Understand the pressures and threats acting on ecosystems, including altered fire and hydrological regimes, fragmentation, recreational activities, commercial operations, pollution, habitat loss, and grazing pressure.	■ Monitoring to evaluate water quality and ecological health (fish communities and seagrass) has been undertaken on a regular basis to inform management of the Swan Canning Riverpark. Issues identified through monitoring, including harmful algae, and unexpected low indices of condition in fish communities or seagrass, have been investigated to understand if these are anomalies or issues of concern. A robust contaminant baseline has been collated to inform the assessment of development applications, understand the potential for biological harm, and inform safe consumption of fish and crustaceans from the estuary. ■ Time-series data has been collected on the pressures that influence key ecological values of WA's marine reserves, including the condition, disturbance and/or degradation, of key ecological values in marine reserves. Long-term monitoring data shows temporal trends in the relative significance and impact of pressures such as fishing, water temperature and habitat change, and how key ecological values of marine reserve have responded to these pressures. Identified pressures that influence key ecological values in waters of the Dampier Archipelago were identified. Remote sensing based mangrove monitoring in marine parks expanded to the Pilbara and Kimberley and automation was implemented. ■ Risk assessment model of Flatback Turtle rookeries and at sea habitats was implemented to identify areas of conservation concern. ■ The second round of sampling at FORESTCHECK sites was published. Research to understand the factors influencing changes in populations of mammals in the Upper Warren area is informing timber harvesting and other management activities. ■ Research improved understanding of the hydrological functioning of critical wetland ground water dependent ecosystems at Walyarta springs, Muir-Byenup wetlands, Lake Toolibin, Brixton Street wetlands and Ashfield Flats, especially in relation to current or future groundwater availability, water quality and climate-change. ■ Understanding and measurement of historical states, change and recovery were aided by time series analysis of decadal satellite imagery for Forestcheck sites, Fitzgerald River National Park banksia collapse, south-west forest condition, buffel grass on Dirk Hartog Island, degradation in rangelands, seagrass in heatwave conditions, and wetland habitat availability. ■ Development of habitat variables was used to examine the effects of urbanisation on quenda populations, and spatial analysis was undertaken to support connectivity modelling of Pilbara mammals. ■ Long term ecological monitoring of the Eastern Stirling Range Montane Heath and Thicket TEC provided critical information for an IUCN Red List assessment of the community as Critically Endangered and was used to identify priorities for management and recovery following fires in 2018 and 2019.
Develop and evaluate effectiveness of mitigation strategies to inform management planning and conservation of species and ecosystems.	■ Soil nutrient pools were identified and released through soil drenching to reverse chlorotic decline syndrome in key eucalypt species in Kings Park. ■ Research into harmful algal approaches has provided greater understanding of blooms and tools and approaches for mitigation, and guided incident response. Necropsy and pathology of deceased dolphins were undertaken to investigate aetiology and inform management relative to anthropogenic versus natural causes. ■ Modelling of long-term wetland depth data using remote sensing is providing new tools for monitoring the hydrological regimes of wetlands and potential mitigation of impacts. ■ Analysis of high levels of predation on turtle hatchlings around coastal infrastructures with artificial lights provided information for the development of the National Light Pollution guideline. ■ Spatial and statistical analysis of fine-scale burnt areas produced over historical and current timeframes was used to inform planning and reporting for burn prescriptions for the Pilbara, Western Desert and Great Victoria Desert. Change in vegetation cover on Bernier and Dorre Islands over 30 years identified the response due to goat removal and relationships with rainfall and fire were established. ■ A landscape genetic approach has provided a means of identifying wildlife corridors for improved management of mammals in the Pilbara. ■ Understanding habitat use and how fish communities respond to changes in oxygen dynamics has provided information to support habitat management, mitigation and rehabilitation.

Biodiversity and conservation

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Strategic Theme Impacts of climate change on biodiversity and ecosystem function

Strategic Goal Impacts of climate change on biodiversity are better understood and adaptation strategies are incorporated into conservation management and planning.

Approach	Achievements
Undertake research and monitoring to advance knowledge on the vulnerability of species and ecosystems to climate change.	■ Research into fire regimes and ecosystem change to improve the understanding of impacts of climate change on response to fire showed that current use of the forecast hourly maximum Forest Fire Danger Index is appropriate and alternative methods offer little benefit. Improved understanding of fire weather and fire danger assessment and communication, and how climate change is affecting the fire environment of south-west WA, is informing fire management priorities. A framework to predict the potential impacts of changes in season of fire on plant population persistence based on plant traits has been developed ■ Spatial analysis has provided greater understanding of the extent and degree of impacts including drought in the northern jarrah forest, and analysis of climate change impacts on temperature and rainfall delineated hotspots for conservation management where flora and threats most strongly co-occur. Investigations are contributing to knowledge on the causes of decline in forest trees, including interacting effects of fire, fire management and climate change, and impacts of climate-change on forest ecosystems. An improved understanding of the interplay between climate, soil water storage and tree water use showed the potential for severe stress in key species of the Banksia woodland. ■ Climate-related stresses on marine reserves, including Ningaloo Marine Park and seagrass at Shark Bay, are being monitored over time to understand vulnerability. The relationship and temporal length of above average sea surface temperatures were determined to adversely affect seagrass cover density. The response of seagrass in Shark Bay to extreme climatic events was assessed through growth trials, controlled environment tank trials and population genomic studies. A study of the impacts of heat stress and acidification on intertidal corals targeted by fishers in the aquarium trade highlighted the vulnerability of these corals to climate change. A study to determine pivotal sex-determination temperatures in turtles is informing risk assessment of all WA turtle rookeries. ■ Research provided information on the impacts of a drying microclimate on thermal and desiccation tolerance of the critically endangered white-bellied frogs, and the impact that a drying and warming climate is having on habitat suitability for the species. Work contributed to a Climate Change Vulnerability Assessment Framework and Guideline for Ramsar sites in Australia. ■ Responses of wetland invertebrates to declining rainfall in the Wheatbelt were analysed using data collected under the State Salinity Strategy. ■ Identification of ecosystem responses observed in satellite imagery and not explained by short term impacts were provided to inform monitoring and reporting in the Forest Management Plan and marine monitoring.
Develop and evaluate effectiveness of adaptation strategies for incorporation into management planning, management of threatened species and communities, and sustainable use of natural resources.	■ Assessment of stand management practices has shown positive hydrological and silvicultural outcomes in the jarrah and karri forests. Genetic analyses provided guidance on the selection of seed provenances suitable for revegetation in a changing climate and implementation of climate adaption strategies. Combination of genetic analysis, ecophysiology and seed germination trials have provided information on the effects of projected climate change and informed approaches for adaptation of marri and jarrah. ■ Studies of granite inselberg floras showed high levels of species turnover between granite outcrops, indicating the need to protect multiple inselbergs across the entire climate gradient of the region. ■ Climate driven hydrodynamics have been shown to have an impact on riparian values in the upper Swan-Canning Riverpark and adaptation strategies have been proposed. Improved understanding of ecological responses to river flows, and the impact of impoundments, such as dams and reservoirs, has improved the delivery of water provisions to protect aquatic biodiversity in a drying climate. ■ Information has been developed on potential management options to assist marine species and communities to respond and recover from periodic climate impacts like coral bleaching.

Biodiversity and conservation

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Strategic Theme Ecological restoration

Strategic Goal Best practice scientific advice is available to inform restoration of degraded and disturbed ecosystems.

Approach	Achievements
Develop knowledge and capability to undertake ecological restoration, including fauna reconstruction.	■ Completed global survey of direct seeding challenges to inform design of direct seeding machinery. Designed and constructed commercial-scale seed flaming devices and developed seed flaming methods for 20 species to improve seed geometry for direct seeding. Developed a range of seed enhancement methods including seed coating for native grasses, priming seeds with beneficial soil cyanobacteria, flash flaming, to improve seed handling and germination. ■ Demonstrated inoculation soil with cyanobacteria improves quality mine waste substrates and extruded seed pellets overcome soil hydrophobicity and seedling emergence barriers. Identified benefits of inorganic amendments for improving seedling survival in mine waste substrates, and determined optimum sowing depth for Triodia seed and the impacts of soil rock content on emergence. ■ Analysis of soil substrates and soil fungal and bacterial communities showed the trajectories in mine-site restoration providing information on linking restoration practices to biodiversity outcomes. The demographic, seed and microsite limitations to recruitment in restoration were determined. Dormancy and germination requirements were resolved for 30 desert species, and seed priming methods were developed for Pilbara species. A global review of seed enhancement technology was undertaken to improve applications in restoration. ■ Genetic analysis of restoration plantings showed the effectiveness of seed sourcing strategies in establishing genetically viable populations with effective mating system dynamics.
Develop best practice guidelines for use in restoration and rehabilitation.	■ Staff contributed to revised national seedbank and germplasm guidelines and scientific input was provided for development of an Operations Manual for Western Australian Seed Centre at Kings Park. Guidelines for seed dormancy and germination testing for industry and restoration practitioners was published. ■ A Vegetation Restoration manual was developed for mine closure planning. Information for industry on seed processing and storage, germination and enhancement, and soil quality assessment was provided in 20 Fact Sheets and eight Case Studies. An interim technical guide has been formulated for iron ore mines for use by industry partners as a framework for developing completion criteria for mine closure and rehabilitation. ■ Genetic studies have provided guidance on seed provenencing for revegetation projects in the forest areas and in the Pilbara. ■ Innovative monitoring approaches have been applied to better understand the effects of reintroduced fauna on Dirk Hartog Island and Matuwa ecosystems. Change in vegetation cover on Dirk Hartog Island was monitored to demonstrate response to management actions. Development of remote sending techniques was undertaken to assess restoration in environments including banksia woodland, desert spinifex and mulga rangelands. ■ Critical datasets and advice have been provided to ensure the success of habitat enhancement and mussel reef restoration approaches.

Biodiversity and conservation

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Strategic Theme Availability of scientific information for evidence-based decision making

Strategic Goal Scientific knowledge is available to inform adaptive management and decision making. Conservation advice is based on scientific information.

Approach	Achievements
Effective communication of scientific knowledge and information to policy and decision makers through appropriate processes.	■ Specialist scientific advice was provided to departmental staff and NGOs to inform conservation activities and adaptive management. Specialist scientific advice was provided to ensure that the best evidence-based scientific knowledge available is used to inform environmental impact assessment processes. ■ Procedures have been implemented to process applications for authorisations to take or disturb threatened species or modify a Threatened Ecological Community under sections 40 and 45 of the Biodiversity Conservation Act. Authorisations were issued for 446 threatened flora and 495 threatened fauna. ■ Staff contributed expertise and scientific information to recovery team meetings, and provided support to regional conservation programs. ■ Data on flora, fauna, ecological communities and wetlands has been provided to state and local government bodies, Aboriginal groups and other NGO's, and to commercial parties. ■ New interactive keys for identification of plant taxa were made available though Florabase. ■ Critical advice has been provided on permitting and development approvals to support planning for the Swan Canning Riverpark. ■ Rivers and Estuaries Science have provided a critical role in incident response delivering scientific advice to management on issues occurring and contributing to essential response monitoring. ■ Provided scientific advice and input to development of the DBCA Bushfire Risk Management Framework and Strategy.
Undertake research and monitoring to address gaps in biodiversity knowledge and support decision making.	■ Monitoring of the outcomes of a relocation of kangaroos from the peri-urban interface was undertaken and demonstrated the challenges of management of urban populations. ■ Monitoring of 49 marine reserves is in place with place and time-series data being collected to inform management. ■ Strategic management of the Swan Canning Riverpark has been supported by the monitoring and reporting activities. Regular reporting on water quality conditions and science outcomes have been provided to the public through web-reporting and traditional media. ■ Integrating and scaling from plot-based field measurements and remotely piloted aircraft system imagery to satellite imagery provided a pathway for understanding the impacts of increased regional aridity across the Fitzgerald River National Park, with potential broader application to monitoring vegetation change elsewhere in the conservation estate. ■ Spatial models were developed to inform decision making. These were applied to predicting sandalwood occurrence, ecological value of Swan Coastal Plain wetlands, land cover in the Western Desert and land use in the Swan and Canning Rivers.

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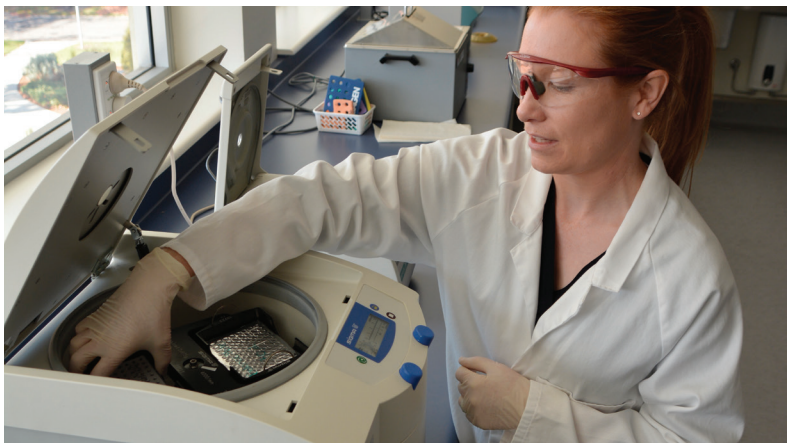
Strategic Theme Innovative science and effective use of technology

Strategic Goal Science is innovative and agile in assessing and adopting new technologies and methodologies, where appropriate.

Approach	Achievements
Identify and realise opportunities for adoption of technical advances and innovative approaches for conservation.	■ The use of new innovative technologies has been adopted by many terrestrial and aquatic science projects, resulting in significant improvements in efficiency and effectiveness of research programs. In animal science, due to reduced handling and disturbance, the use of these technologies also has had animal welfare benefits. ■ Use of camera traps to monitor numbats showed the value of this approach for the species that is difficult to monitor. ■ GIS-based, multi-criteria evaluation method was used to complete a review of wetland values and extent across an area of 376,000 hectares of the Swan Coastal Plain and incorporated into the draft Wetlands. ■ Geophysics and stable isotope methods have been used to understand hydrological functioning of groundwater dependant ecosystems, including threatened ecological communities. ■ Methods utilising high resolution airborne and satellite imagery with machine learning algorithms were developed to provide mapping of plantation stocking rates, land cover mapping and carbon potential. Utilised Sentinel-2 satellite imagery and time series analysis to improve ability to address cloudy and poor-quality imagery. A ground-truthed remote sensing analysis product has been developed to assess and report on fire severity. ■ Technical advances in genomics have been adopted for plant and animal studies providing greater power to determine species relationships, identify subspecies and conservation units, detect gene flow and genetic structure, and understand population processes. ■ Technical advances in genomics have been adopted for plant and animal studies providing greater power to determine species relationships, identify subspecies and conservation units, detect gene flow and genetic structure, and understand population processes. ■ Drone capture and processing methods were developed to improve field data capture of vegetation cover and structure and for effective surveys. Linkages between remotely sensed data and leaf and canopy level plant function were established for a range of Banksia woodland species. Methods for effective use of drones for determining vegetation condition and mapping boundaries of Threatened Ecological Communities were developed. ■ eDNA is an emerging and potentially powerful monitoring tool in aquatic and terrestrial environments and has been trialled to survey coral and fish diversity, to detect and monitor aquatic species, and for survey and monitoring of invertebrates across a fire chronosequence using FORESTCHECK sites. ■ Direct seeding machinery applicable to restoration post-mining landscapes was designed, constructed and tested. Respirometry tools were developed to assess seed behaviour and longevity during storage. ■ Acoustic technologies have proven valuable for monitoring fish movement and providing evidence of improved river management approaches.



Biodiversity and conservation

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Strategic Theme Effective data management

Strategic Goal Data is effectively captured, curated and accessible to support conservation, management and decision-making.

Approach	Achievements
Continue development of up-to-date, integrated and accessible data catalogues and databases.	■ The Biodiversity Information Office (BIO) has been established in DBCA to make Western Australian biodiversity data more discoverable, accessible, and useable. BIO has made progress on designing a biodiversity data platform to mobilise biodiversity data from all environment-related sectors, including government, industry, research, and the community. ■ The Western Australian Herbarium continued to provide up to date taxonomic information and species distribution data as well as plant identification resources through Florabase and other linked data portals (Australasian Virtual Herbarium and Atlas of Living Australia) with over 123 million herbarium data records downloaded. More than 5,400 high resolution images of Western Australian Herbarium specimens were captured and shared with departmental staff and industry consultants and a further 757 high resolution images of type specimens were captured and shared with the online Global Plants Initiative. A major new version of Florabase was developed, incorporating enhanced search functions and interactive specimen distribution maps. ■ Progress was made on a new database housing data on threatened species and ecological communities, and hard copy records were digitised. ■ A new database for Land for Wildlife properties was developed.
Implement best practice techniques for capture, storage and reuse data.	■ Analysis products, code and catalogues have been developed and published on appropriate platforms. ■ Marine monitoring data is effectively stored and managed and has been used in national and international 'big data' collaborations. Dolphin survey data is now stored in a single database to manage cetacean survey data. ■ Annual Reports and Recommendations for future captive breeding for numbats, dibblers and western swamp turtles were made to the Species Management Plan co-ordinator of the Australasian Zoo and Aquarium Association in each year. Animal husbandry and health records, and species management record were updated and maintained. ■ Work to identify the necessary traits for a fire response attribute database has commenced and data is being integrated into a national database. ■ Data continues to be maintained in the Animal Ethics Committee database to support the legislative requirements. Covenant Program landholder details and site-specific information are maintained in a Microsoft Access Database, spatial shapefile dataset and Corporate electronic filing. Information in the translocation database has supported improved understanding of species translocations. ■ Progress has been made on development of a fire regime information tool, including approaches to fire regime interrogation, and incorporation of fire severity data. ■ Innovative field data capture tools have been produced to send data on turtles directly from the field to databases removing the risk of data transcription errors. ■ 29 Data Sharing Agreements were made with external organisations to enhance the value of data collected by BCS staff." ■ The Threatened and Priority Flora database, Threatened Fauna Database and Threatened and Priority Ecological Communities database was shared with other decision makers across government to ensure protection of these State biodiversity assets.

Fire Management

Protecting communities and natural values from bushfires.

Strategic Theme Fire science to inform fire management and biodiversity conservation

Strategic Goal Best available scientific information is used for integrated fire management to protect communities and natural values

Approach	Achievements
Undertake science to guide evidence-based decision making and develop approaches to integrated fire management.	■ Population dynamics relative to time since fire have provided an insight into the tolerance of key species to varying fire regimes. Documentation of fuel and dynamics and components is increasing the understanding biophysical drivers of fuel dynamics in Banksia woodlands and tolerance of species to varying fire regimes in to inform nuanced fire management planning. ■ A novel field assessment tool has been developed assessing soil temperatures during fire. ■ Population viability analysis provided critical information for fire management of a threatened Banksia. ■ Research in urban bushland remnants confirms that fire with no subsequent weed management is often a degrading process leading to increased weed invasion, while fire with weed management may be a restorative process with native regeneration and same or lower weed cover. ■ Investigation of functional traits and environmental factors associated with plant invasions in Kimberley savannas showed that weeds are strong competitors and has informed the implementation of prescribed burning as a tool for the management of tropical riparian savanna weeds.
Develop fire behaviour models for priority ecosystems.	■ Fire metrics are informing prescribed burn planning and assessment and historical fire regime analysis is aiding extension of burn record in sediment cores. Fuel load information is being further developed by accurate information on burn history, spinifex fuel load model and fire severity assessments. Airborne thermal camera technology has been operationalised for burn security. Improved satellite imagery was made available on the Firewatch website. ■ Practices for managing impacts to threatened fauna have been incorporated into the prescribed burning program. Advice has been provided to land managers to ensure that informed decisions are made when considering fire management strategies.
Understand effects of variation in fire regimes on species, ecosystems and landscapes.	■ Research has demonstrated that fine-scale temporal turnover of jarrah forest understory vegetation assemblages is independent of fire regime. New conceptual analysis of long-term ecosystem dynamics has been developed for semi-arid obligate seeder woodlands to guide fire management and reinforced the need to minimise fire occurrence in the Great Western Woodlands. ■ Research has established links between implementation of prescribed burning mosaics, reduced extent of late dry season wildfires, and benefits to threatened Kimberley savanna mammal abundance and richness.
Understand interactions between fire regimes and other threatening processes, including climate change.	■ Ongoing collaboration with national programs modelling emergent fire behaviour and weather feedback is producing predictive products to guide prescribed burn planning and fire suppression response. ■ Understanding the effects of biophysical drivers and prescribed burning on fuel dynamics in Banksia woodlands is providing information to refine fire management priorities. ■ Monitoring of mammal assemblages has demonstrated negative impacts of feral cats and feral herbivores, reduced shrub cover, and negative impacts of cane toads on mammals via reptilian trophic cascades.
Review prescribed burning and bushfire incidents to inform future decision making through scenario modelling.	■ Reconstruction and analysis of December 2019 Yanchep Bushfire have led to insights on coastal weather influences and preceding fire history and severity. A severity map for the Yanchep fire linked to fuel age was produced. ■ Fuel and fire behaviour assessments have been conducted during burn implementations.

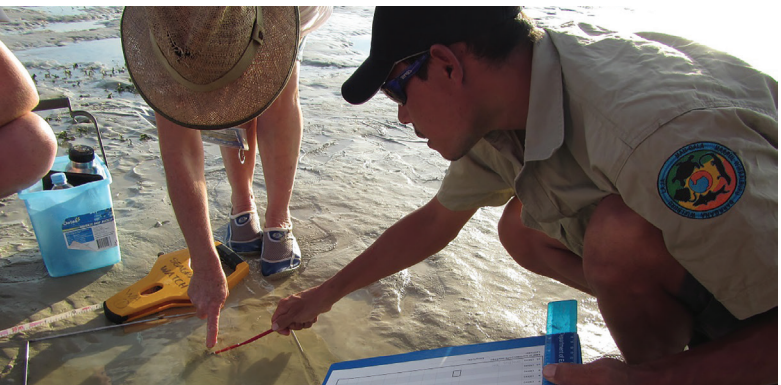
Natural and cultural values

Connecting people and communities to parks, natural areas, Aboriginal culture, plants and animals.

Strategic Theme Community engagement in science

Strategic Goal Community is engaged, understands and supports biodiversity and conservation science.

Approach	Achievements
Communicate the conservation outcomes of science to the general community and key stakeholders/ partners.	■ Regular social media posts were made across the BCS twitter account, the Herbarium Facebook and Twitter accounts, and the Facebook and Twitter accounts of ZPA, BGPA and Parks and Wildlife Service. Media interviews were used to provide science information to the public. Media statements from the Minister and from the Department were released for major science outcomes. ■ BCS Information Sheets were produced, and popular articles were published in Landscope, Plants for Park, and various other outlets. ■ Science seminars, presentation and webinars were delivered to a range of audiences, including as part of the Kings Park Festival program. ■ Ongoing engagement with community groups and local councils through specific projects and through presentations. ■ Information on fire science findings provided to the public and scientific community, supporting the case that DBCA is endeavouring to manage its estate responsibly and in an aware and balanced way provided to the public and scientific community, supporting the case that DBCA is endeavouring to manage its estate responsibly and in an aware and balanced way. ■ Staff are members of State and National working groups and committees in fire predictive services, aviation services and bushfire research, and contributed to State and National workshops on bushfire recovery and weed management. ■ Staff chaired Recovery Teams, and facilitated collaboration between Recovery Team chairs to share ideas and improve operation of the teams. Research on threatened species was presented at recovery team meetings. ■ Staff provided expert scientific advice to support the development of strategic-level Regional Conservation Plans and advice to resolve emerging issues.
Contribute science information to interpretive programs in national parks, protected areas and natural attractions.	■ Science information and biodiversity knowledge was provided to support interpretive programs in national parks and reserves, and at Kings Park.
Pursue opportunities for community engagement in science, including supporting citizen science projects.	■ Volunteer opportunities were provided though community groups such as Gilbert's Potoroo Action Group, Friends of the Fitzgerald River National Park and Project Numbat. ■ Effective relationships were established with Friends of Fitzgerald River National Park to support fire research. ■ The Land for Wildlife Program continued its partnership with Natural resource Management groups and 59 new applicants were registered, with 42 processed by NRM partners. ■ Community engagement in conservation was facilitated though registering 50 covenants, and facilitating transfers of existing covenants to ensure new land owners are welcomed to the program.



Natural and cultural values

Connecting people and communities to parks, natural areas, Aboriginal culture, plants and animals.

Strategic Theme Social science

Strategic Goal Improve knowledge of how people respond to, and interact with, the natural environment.

Approach	Achievements
Undertake research programs to understand community values, attitudes, and perceptions about biodiversity and conservation, and people's interactions with the natural environment.	■ Structured decision-making has been undertaken for implicitly accounting for environmental, social and economic benefits of fauna conservation research outcomes.
Integrate social and biological sciences in investigations into visitor usage, risks and impacts.	■ Human use within of marine parks and community attitudes to marine protected areas, has been collected in conjunction with the WAMSI Ningaloo and Kimberley marine research programs. This information has been integrated into marine science monitoring and research to understand how human activities effect ecological values in marine parks.

Our community and partners

Building positive and meaningful partnerships to achieve results.

Strategic Theme Engagement with traditional owners

Strategic Goal Traditional owners are involved in knowledge sharing and delivering science projects.

Approach	Achievements
Engage with traditional owners in joint management to undertake science projects.	■ Indigenous Ranger groups and Traditional Owners have been engaged in field operations. These collaborations have provided opportunities for two-way learning with the Robe-River Kuruma Aboriginal Corporation, Wiluna Community School and MKK IPA Management Team, Bidyadanga, Yawuru, Martu, Nyikina Mangala, Gooniyandi, Kija, Ngurrara and Bunuba Aboriginal representative groups, and Kimberley Indigenous Ranger groups, including Balanggarra, Wunambal-Gaambera and Wiling. ■ Training and assistance was provided to facilitate the establishment of the Minyma Uninypa seed laboratory at Tjuntjuntjara, including providing the skills to enable the community to undertake seed collection and processing. ■ Two fauna management programs for indigenous ranger groups have been undertaken. Accredited training opportunities have also been provided. ■ Satellite imagery maps have facilitated engagement with Kanyirninpa Jukurrpa and Desert Support Services over the Martu and Birriliburu lands. Worked with traditional owners on country to develop an understanding how the habitats of mangrove density and seagrass presence change over time in the Pilbara and Kimberley. ■ Ngadju rangers have assisted in sampling across 100 sites across for a fire chronosequence study. Collaboration with Balanggarra Aboriginal Corporation and rangers in developing optimal burning programs for threatened Gouldian finches in the East Kimberley ■ Marine science and training collaborations were established with Miriuwung Gajerrong, Dambimangari, Yawuru Aboriginal Corporation and Ngarluma Aboriginal Corporation.
Provide scientific input to the Department's Aboriginal engagement processes.	■ Provided training to traditional owner joint managers on marine monitoring and research methods to assist them to undertake long-term management activities on conservation estate. ■ Collaborated with the Wirrapanda Foundation and conducted indigenous hunting workshops in the Kimberley.

Strategic Theme Collaboration with science providers, science users and other stakeholders

Strategic Goal Effective science partnerships enhance provision of biodiversity and conservation science.

Approach	Achievements
Collaborate with other science providers, government agencies, industry and NGOs to undertake science where it is aligned with the Department's strategic directions.	■ Maintained and strengthened existing partnerships with BoM, CSIRO, DFES, AFAC, UWA, ECU, AIMS, Curtin and Murdoch University. New collaborative research partnerships established with a range of science providers including, Geosciences Australia, University of New South Wales and Australian National University. ■ Students were engaged in science projects at PhD, Masters, Honours, Summer Scholarship and 3rd year intern level from all five WA universities, and universities from other states. Students and other groups were engaged through research facility tours.. ■ Supported the operations of the Threatened Species Scientific Committee and Threatened Ecological Communities Scientific Committee, and the Animal Ethics Committee. ■ Ongoing engagement with Commonwealth government through the Common Assessment Method process to align state and Commonwealth threatened species lists. ■ Effectively communicated research outcomes with mining industry partners and other stakeholders through annual reports and meetings.

Our People

Building a valued, collaborative and respectful workforce

Strategic Theme Science operates with a collaborative culture

Strategic Goal Effective engagement among all staff to ensure science supports the department's conservation and management functions

Approach	Achievements
Undertake effective communication and engagement with all departmental staff to achieve departmental goals	■ Monitoring and evaluation personnel have been involved in Kimberley regional and district decision making relating to fire monitoring and planning. ■ Staff have provided advice and information to all divisions and branches in Parks and Wildlife Service and Zoological Parks Authority, Botanic Gardens and Parks Authority, and Rottnest Island Authority. ■ Information and advice related was provided for development of management plans for marine and terrestrial parks and reserves, environmental impact assessments in terrestrial, coastal and marine environments, conservation programs for threatened species and threatened ecological communities, management of the Swan-Canning Riverpark, and applications for research permits. ■ Scientific information and advice was provided to Director General, Corporate Executive and the Minister's Office on contentious issues. ■ Staff served on DBCA committees and contributed to departmental programs.
Engage with operational staff to identify and address knowledge gaps and ensure science outcomes are incorporated into management	■ Staff co-ordinated region-based workshops and gave presentations on research findings and plans. ■ Regional Priority Research Projects were co-designed and implemented with every region. ■ Adaptive management experiments assessing efficacy of threatened flora recovery actions and translocations were implemented with regional staff in Mid-west, Swan, Wheatbelt and South Coast Regions. ■ Perth Zoo Science staff participated in Perth Zoo and DBCA planning activities. Kings Park Science staff engaged with staff from BGPA to share scientific knowledge and information. Rivers and Estuaries Science staff engaged with Rivers and Estuaries Branch to communicate science for management of the Swan-Canning Riverpark. ■ A WA Fire Science discussion group was established to pro-actively discuss research and new and relevant publications amongst BCS researchers, university academics and staff, DFES and DBCA regional ecologists impacts by fire science.

Our People

Building a valued, collaborative and respectful workforce

Strategic Theme Corporate science knowledge

Strategic Goal Corporate science knowledge is retained, shared and accessible.

Approach	Achievements
Ensure staff input to corporate data systems to enable access for knowledge sharing.	■ Spatial datasets are published to the GIS corporate data menu and DataWA as appropriate and R packages are published to the DBCA Github. ■ Monitoring data is incorporated annually into BioSys database. Data files are lodged in the Data Catalogue. ■ Progressed the migration of data to Sharepoint.
Provide opportunities for mentoring, leadership and transfer of knowledge.	■ Program Leaders and senior staff engaged with other staff to provide mentoring and development opportunities, and share expertise and knowledge.

Strategic Theme Highly skilled workforce

Strategic Goal Delivery of high quality science by skilled staff.

Approach	Achievements
Foster an innovative and agile culture among staff.	■ Staff engaged in trialling innovative methodologies and developed new approaches to research questions. ■ Staff were engaged in new areas of research, including structured decision making and eDNA methodologies. ■ A risk assessment approach was developed for assessment of impact to threatened species and ecological communities and provision of advice.
Provide training and career development opportunities for staff, and foster a respectful workforce where diversity is valued.	■ Staff participated in conference and workshops to develop their skills. ■ Staff were provided with opportunities at operate at higher levels to back-fill vacancies. ■ Staff gained skills contributing directly to fire-fighting activities through pre-formed teams.

Our key brands

PARKS AND WILDLIFE SERVICE

ROTTNEST IS

Perth Zoo SAVING WILDLIFE

BOTANIC GARDENS & PARKS AUTHORITY

underpinned by

Biodiversity and Conservation Science

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