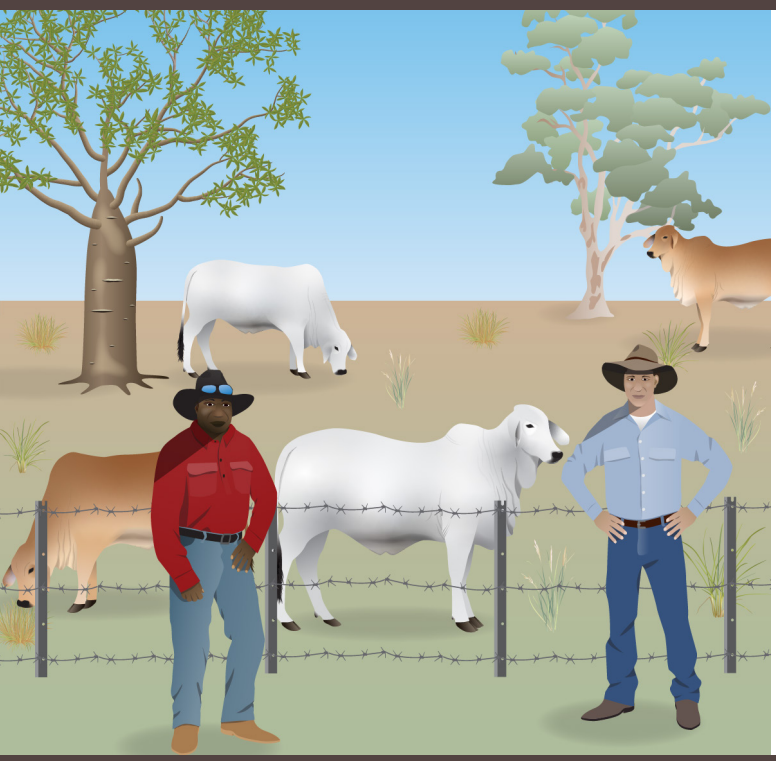
Northern Australia Environmental Resources Hub

National Environmental Science Programme



2020 Annual Report

Australian Government

National Environmental Science Program

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Front cover: Conceptual diagrams featuring science communication symbols (image: NESP Northern Australia Hub.
Back cover: Northern Australia river (photo: NESP Northern Australia Hub).

This report is available for download from the NESP Northern Australia Environmental Resources Hub website: nespnorthern.edu.au

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1 January 2020 – 31 December 2020

Hub name: Northern Australia Environmental Resources

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- University of Western Australia
- Charles Darwin University
- James Cook University
- Griffith University
- CSIRO
- NAILSMA
- NT DEPWS
- Qld DES
- WA DBCA

Hub Leader certification

As Hub Leader, I certify that I have taken adequate steps to reasonably assure myself that:

- each required report component is attached;
- the contents of each component of the report is complete and accurate in all material respects;
- funds have been used for the purpose for which they were provided and all funding conditions have been met, recipient and other contributions have been received, and appropriate oversight has been maintained of Hub projects, their progress, performance and budgets during the reporting period;
- all relevant risks to project delivery have been notified to the Department in this and previous reports and that appropriate steps are being taken to manage those risks;
- the Hub and its sub-contractors have current workers compensation and public liability insurances, as required under the Funding Agreement; and
- any carryover of project funds has been allocated to projects in the next reporting period or financial year in accordance with the approved Research Plan or funds identified for refund to the Department.

Signed: 

Hub Leader Name: Professor Michael Douglas

Date: 6 May 2021

Hub Steering Committee Chair certification

As steering committee chair, I certify that any issues of concern or matters raised during steering committee meetings where the draft progress report was discussed have been adequately resolved, amended or incorporated into the final report submitted to the Department.

Signed: 

Hub Steering Committee Chair Name: John Childs

Date: 6 May 2021

Letter from the Hub Leader

I am pleased to submit this 2020 Annual Report for the National Environmental Science Program (NESP) Northern Australia Environmental Resources Hub, which updates the Interim report submitted in September 2020 that was prepared as a consequence of disruptions to the program caused by the Covid-19 pandemic.

Northern Australia is a region with relatively little existing baseline data and a highly variable wet season. In an era when so many other studies are 'desktop', the fact that many Hub projects have been collecting multiple years of field data is significant. This work is making a major contribution to both on-ground management and policy outcomes and we believe this will continue to do so for many years to come, after this current Hub is completed.

All of our current projects were designed to fill clearly defined knowledge gaps and needs for policy-makers, Traditional Owners, land managers and other research users. We identified these gaps with the help of long-term partnerships and collaborations with people across northern Australia, which has ensured each project understands the timeline and data needs of their research users to maximise the impact of Northern Hub projects.

We scoped the majority of our projects with a direct line of communication to relevant policy areas of federal, state and territory governments, and this is having major benefits for the uptake of research outputs. Our engagement with the Australian Government Department of Agriculture, Water and the Environment (DAWE) and the Department of the Prime Minister and Cabinet (PMC) has been impressive across many of our projects and has facilitated the uptake of project outputs.

The processes of reporting back to co-researchers and sharing final outputs with research users has become critical for the Hub in the remaining months of the program. Strengthening and appropriate sharing of knowledge has been an underpinning principle of all the Northern Hub projects. The benefits of this approach were highlighted in the recent release of the Our Knowledge Our Way in caring for Country Best Practice Guidelines, compiled and edited by researchers from CSIRO and the North Australian Indigenous Land and Sea Management Alliance (NAILSMA). These best-practice guidelines give a voice to Indigenous land and sea managers who have found new ways to strengthen their knowledge and build partnerships for knowledge sharing in caring for Country. The webcast of the release was attended by over 1,100 people, and the video of the event is increasing this reach even further.

In addition to these guidelines, all our projects have sought to strengthen the capacity of ranger groups, Traditional Owners and other land managers through their involvement in Northern Hub research. James Cook University (JCU) has been leading a multi-Hub NESP project assessing the 2015 mangrove dieback in the Gulf of Carpentaria and monitoring whether recovery is occurring. Indigenous ranger groups along the northern Australian coastline are in the best position to ensure ongoing monitoring of mangrove condition. To equip them with the necessary skills, the research team has produced a user guide for these ranger groups.

Effectively sharing knowledge and results from our research is at the heart of all Hub projects. Our projects were co-designed to meet the scientific needs of research users in northern Australia and to have wider applicability across Australia. More recently, we've begun to capture the impact of this work through recorded stories that highlight how our research is being used.

Hub research led by Charles Darwin University has developed a potentially breakthrough tool for a threatened species: a test that detects the environmental DNA (eDNA) of the endangered Gouldian finch (*Erythrura gouldiae*) in water collected from the small pools where they cluster to drink.

The use of eDNA has proven valuable for monitoring both threatened species and the species that threaten them, in both terrestrial and aquatic settings. Another project led by JCU has shown the effectiveness of using eDNA to monitor cane toads. This research showed that eDNA can be used to detect the presence of a single cane toad for a few days after it arrives at a new location, even if it only visited a water body for as little as five minutes. This finding means that Indigenous rangers and land managers in remote areas are able to help track the invasion of cane toads by collecting a water sample from small ponds and puddles during the day, rather than searching for cane toads at night.

The Tjuwaliyn Wagiman Aboriginal Corporation/Tropical Rivers and Coastal Knowledge (TRaCK)/NESP Water Conservation Project, one of our long-term collaborations that has guided how Northern Hub projects engage with Indigenous people – was recognised for its significance at the Territory Natural Resource Management (NRM) 2020 awards. The project received two awards, for the Best Collaboration in NRM and Best Research. The project is a 16-year collaboration that has investigated the links between fish and flows in the Gurwardagun (Daly River).

The lessons from the Wagiman collaboration have meant that combining Indigenous ecological knowledge, western science and technology has been a focus of many Hub projects. The Bininj/Mungguy Healthy Country Indicators team was also recognised for their collaborative work using artificial intelligence in Kakadu National Park as a finalist at the Territory Natural Resource Management (NRM) awards. This project was also recognised as a finalist in the Australian Museum's Eureka Prize for STEM Inclusion and it was awarded a CSIRO Land and Water Impact Award. Other collaborations with Traditional Owners have increased our understanding of the mostly positive effects of knowledge sharing through Indigenous land and sea management programs, as well as helping water planners and managers to consider Aboriginal peoples' custodial responsibilities for country, not just their ecological knowledge.

In late 2020 the successful bidders for NESP 2 Hubs were announced, including the Resilient Landscapes Hub. This new Hub will develop in 2021 under a leadership team made up of Northern Hub partners and our alumni including me (Hub Leader), Stephen van Leeuwen (Deputy Hub Leader and Senior Indigenous Facilitator) and Samantha Setterfield, Natalie Stoeckl, Stuart Bunn, Dan Metcalfe and Andrew Krockenberger (Regional Node Leaders). The Resilient Landscapes Hub will build on the long-standing partnerships across northern Australia and will foster new collaborations among researchers and land and water managers right across the country over the next seven years. It will also provide further opportunities to build on our long-term Indigenous collaborations across the country to deliver applied research and incorporate the lessons we've learned over the last 15 years through our Commonwealth Environmental Research Facility (CERF), National Environment Research Program (NERP) and NESP Hubs.

Building upon existing relationships has ensured that project teams have been able to regularly update users throughout projects in formats that suit them best. This has meant that research users have understood the importance of our research, but also had access to useful data throughout the life of the Hub – not just once a project is finished. Many of our research users have attested to our research's usefulness, which can be watched in our Research for Impact videos. We have also diversified our science communication with the 100+ symbols available for download in our graphics library. We celebrated NAIDOC Week and Science Week in 2020 through the respective themes of *Always Was, Always Will Be* and *Deep Blue: innovations for the future of our oceans*.

As we move towards the wrapping up and transitional phase of the program, we continue our focus on ensuring our existing research ends up in the hands of those people who can use it best. This approach lays the groundwork for ensuring our next round of projects continues to support practical solutions to environmental problems while building on these successes with action that makes a positive difference on the ground.

Our knowledge brokering team has planned a schedule for the promotion of outputs that will be progressively delivered up to 30 September 2021, when the final program report is due to be delivered to the Commonwealth. Because of the extended impact of Covid-19 restrictions into 2021, in a number of jurisdictions we are not planning on face-to-face meetings or seminars, and instead will have a focus on online delivery accompanied by news media, social media and webinar events. In 2021, travel permitting, we will conduct tailored briefings and short seminars in Canberra with line areas of the Department that are the target audiences of our research.

The end date for research activities under the Hub is 30 June 2021, including all fieldwork, data analysis and completion of project outputs. Noting that under the Head Agreement the date for delivery of a final program report to the Commonwealth is the 30 September 2021, there will necessarily be activities to be undertaken post 30 June 2021 to support this reporting requirement.

We have also made commitments regarding communication, engagement and reporting back to our partners and stakeholders. Primarily because of the impact of Covid on travel, a number of these activities are now unable to be completed by the 30 June 2021.

Given these circumstances we propose that (providing NESP funding has been contracted, committed or expended prior to the 30 June 2021) project activities around final communication, engagement and reporting to stakeholders and partners will also occur during the 3-month period between 1 July 2021 and 30 September 2021.

We also have contingency plans in the event that new waves or outbreaks of Covid-19 result in the extension of existing closures or the re-introduction of closures to travel. We will be receiving an updated report from project leaders in March of 2021 that will be evaluated by the REC and our knowledge brokering team in revising and updating our planning and timetable for the delivery of final project outputs. In the event we have to review any final outputs then this will be done in conjunction with the agreement of our identified research users.

We will prepare a high-quality, publishable (online) final report for the program as a whole that summarises major achievements and highlights research impact through case studies. This will be finalised after June 2021 to allow for the inclusion of final synthesis projects, and the summation or reporting against program performance indicators. Our website will continue as the main source of project-level information and repository for individual projects outputs.

In 2020, the K&A team produced a wide range of products as listed below, increasing our focus on communicating project outputs, and increasing our media presence:

- 6 project factsheets (start-up, wrap-up and project updates)
- 6 project reports
- 7 case studies on research impact
- 1 annual report
- 1 interim report
- 3 newsletters
- 14 videos
- 7 alternative publications (guidelines, posters etc.)
- 36 news articles
- 18 Northern Hub research/people profiles
- 4 project webpages
- 78 Facebook posts
- 114 Tweets
- 100+ graphical symbols
- 364 users registered for symbol library
- 9 media releases.

Our Hub Steering Committee (HSC) continues to provide strong support and guidance to the Program. In 2020, the HSC met on two occasions, in May to approve the 2019 Annual Report and to review the impact of Covid-19 on project progress, and in September to review the additional Interim Milestone Report for the Commonwealth.

Recent and upcoming highlights incude two webinars we have delivered to the DAWE Wetlands team to commemorate the 50th anniversary of the Ramsar agreement. Michele Burford, Justin Perry, and Cathy Robinson delivered webinars that were very well-attended and each webinar kicked off with their respective impact videos that got great feedback – really highlighting the value of producing these videos with an emphasis on user uptake.

Upcoming events include the Northern Australia Food Futures and Developing Northern Australia conferences – we are taking the lead on representing multiple Hubs/NESP at these events. We are also organising a Gulf roadshow report-back to stakeholders in mid-June for multiple projects in Nth Queensland. A Kakadu symposium has been scheduled for mid-June subject to Covid travel restrictions and Traditional Owner availability.

I am pleased to submit the Annual report for the NESP Northern Australia Environmental Resources Hub for 2020.

Michael Douglas

Hub Leader

Research

Progress against research plan

From the Kimberley to Kakadu and across to Cape York, the Hub is undertaking research to support the sustainable development of Australia's unique northern environments. The Hub's research is delivering new knowledge, tools and partnerships to inform practical solutions as the region responds to the northern Australia development agenda.

Over 2020, the Northern Australia Environmental Resources Hub made substantial progress towards delivering its final objectives and outcomes. The Hub is partnering with governments, communities and industry to improve the capacity to manage and monitor Australia's unique northern environments. The Hub's research is informing practical solutions to the region's major environmental challenges. Research is focusing on:

- landscape-scale studies covering savanna, rainforest and aquatic ecosystems and biodiversity
- new knowledge to support land and water planning for urban, agricultural, and infrastructure development
- improving and supporting Indigenous land management including Indigenous Protected Areas
- delivering across a range of disciplines to underpin management effectiveness in Kakadu National Park

Because of the expected impact of Covid-19, in March 2020 we wrote to the Commonwealth requesting an extension to the final deadline for the NESP Northern Australia Environmental Resources Hub to 30 June 2021. We believed that the Hub would face significant difficulties in completing the majority of its projects in 2020 because of the disruption to our projects by Covid-19 lockdowns. Our request for an extension was subsequently granted and a revision to the Head Agreement with Charles Darwin University was signed on 29 October 2020. We have since completed sub-contract variations with our partners to extend the program through to 30 June 2021.

Our portfolio of projects is delivering a comprehensive and diverse set of research outputs for our policy and management partners. Currently the Hub has 27 active projects (including five synthesis projects) underway across northern Australia, in the Kimberley, Top End, Gulf of Carpentaria and Cape York Peninsula. These projects are all on target to be completed by 30 June 2021. The Hub has an additional 12 completed projects. Attachment A provides a project-by-project description of the status of our projects including the impact of Covid-19, as reported in the Interim Annual Report submitted in September 2020. More detailed information is also available on the project pages of our website.

With the addition of the synthesis projects approved out of session in 2019 and funding approved under Research Plan Version 6, the Hub will have either completed, or be undertaking, projects that address each of the 16 Hub research priorities, as revised by the Commonwealth in May 2017.

Research projects

Attachment A lists the projects funded under the Northern Australia Environmental Resources Hub and provides information on the project status, information on outputs and links to products for all projects (where available). Exceptions to the NESP Data Management and Accessibility Guidelines are also noted there.

2020 project highlights

The process of reporting back to co-researchers and sharing final outputs with research users will become critical for the Hub in the coming months. Strengthening and appropriate sharing of knowledge has been an underpinning principle of all the NESP Northern Hub projects.

Our Knowledge Our Way Guidelines

The benefits of this approach were highlighted in the recent release of the *Our Knowledge Our Way in caring for Country best practice guidelines,* compiled and edited by researchers from CSIRO and the North Australian Indigenous Land and Sea Management Alliance. These best-practice guidelines give a voice to Indigenous land and sea managers who have found good ways to strengthen their knowledge and build partnerships for knowledge sharing in caring for land and sea Country. The webcast of the release was attended by over 1,100 people and the video of the event is increasing this reach even further. In addition to these guidelines, all our projects have sought to strengthen the capacity of ranger groups, Traditional Owners and other land managers through their involvement in NESP Northern Hub research.

The guidelines on *Our Knowledge Our Way in caring for Country* showcase Indigenous-led approaches to strengthening and sharing our knowledge for land and sea management. Indigenous Australians' rights of ownership and management have been recognised over nearly half of Australia and their knowledge systems connect them to their Country and cultures. As significant landowners, managers and custodians, Indigenous peoples are applying their knowledge in caring for Country, generating many benefits. Indigenous peoples are learning from each about how to build on these successes. Researchers and policy-makers tasked with solving Australia's complex environmental challenges are noticing many beneficial outcomes from Indigenous peoples applying their knowledge in management and are seeking ways to grow these positive impacts.

The guidelines are based on 23 Australian case studies, submitted by Indigenous people and their representative bodies, that show how *Our Knowledge Our Way in caring for Country* can be supported through:

- **strengthening Indigenous knowledge** – including through creating and maintaining access to land and sea Country; ensuring strong cultural government of Indigenous knowledge; and keeping and revitalising knowledge, language and culture through programs and practice
- **strong partnerships** – that enable the building of respect and appreciation for Indigenous knowledge; development of protocols to guide knowledge sharing; and engaging with the principles of free, prior and informed consent
- **sharing and weaving knowledge** – Indigenous managers often weave knowledge to manage new and complex land and sea management issues. Indigenous-led and co-developed tools are most appropriate, and those that promote inter-generational transfer of knowledge are highly valued
- **Indigenous networks** – national and global networks that promote Indigenous knowledge practices are important as they offer peer-to-peer learning opportunities for Indigenous land and sea management practitioners. They support:
    - learning about good partners, projects and approaches to keep knowledge strong
    - learning from others about best-practice protocols and processes for managing partnerships.

Over 100 Indigenous individuals and organisations, including partners, co-authors, case-study providers and reviewers contributed to the development of the best-practice guidelines.

Indigenous managers mangrove monitoring handbook

Since the unprecedented mangrove dieback in 2015 in the Gulf of Carpentaria, James Cook University's Dr Norm Duke has been leading a multi-Hub NESP project assessing the mangrove dieback and monitoring whether recovery is occurring**.** To support this, the research team has produced a guide for Indigenous ranger groups along the northern Australian coastline to monitor mangrove condition, using the MangroveWatch standardised shoreline assessment method. This guide establishes all the components and equipment settings required for groups to contribute standardised data to improve understanding of large-scale patterns in the Gulf's important ecosystems.

The sheer scale of the Gulf of Carpentaria coastline means that regular monitoring is a challenge. Through this project, Dr Duke has aerially surveyed 2,633km of Gulf coastline, but ongoing monitoring is critical to understanding mangrove recovery and identifying other unusual dieback events. This work has also been supported by the Tropical Water Quality Hub, Earth Systems and Climate Change Hub and Marine Biodiversity Hub.

Using eDNA to track endangered birds

It's one of the great conundrums of conservation management, that often the animal species of most concern are the most difficult and time-consuming to find. Some of these species are rare, while others are cryptic, hiding high in the canopy or deep in their burrows. Some are highly mobile, never staying in one place for too long. Others avoid the traps traditionally used by scientists to monitor animal populations.

Research funded by our Hub has developed a potentially breakthrough tool for one species: a test that detects the environmental DNA (eDNA) of the Gouldian finch *(Erythrura gouldiae)* in water collected from the small pools where they cluster to drink. It is the first time that an eDNA test has been successfully used to detect a threatened bird species.

Despite their rainbow colouring, Gouldian finches are difficult to find. They are highly mobile and sparsely scattered across the landscape, often occurring in mixed flocks with other seed-eating birds. But, as a listed threatened species, the impact on Gouldian finches and their habitat must be considered in proposals for new developments. NT Department of Environment, Parks and Water Security (DEPWS) will use the eDNA test as part of their regional surveys that provide baseline information for proposed development activities.

The eDNA test was developed and validated through collaboration between Charles Darwin University (CDU), the University of Western Australia (UWA), DEPWS and Jawoyn Rangers. The project exemplified the power of NESP research to foster partnerships between organisations whose expertise ranged from genome sequencing to operational bird surveys to Indigenous knowledge of country.

The research was led by CDU Professor Karen Gibb. UWA Professor Simon Jarman and his team designed the two-in-one quantitative polymerase chain reaction (qPCR) test that recognises and makes multiple copies of a specific region of mitochondrial DNA found in estrildid finches and a species-specific probe to detect Gouldian finch DNA.

Researchers at CDU then further developed the eDNA test in the lab before trialling it in aviaries at the Northern Territory Wildlife Park (DEPWS). The final hurdle was validating the eDNA test under field conditions. In late 2018, researchers from DEPWS and Jawoyn Rangers collected water samples from Yinberrie Hills, where Gouldian finches have been monitored since 1996. This data allowed the validation of eDNA detected in water samples against concurrent observations of the finches drinking.

Using eDNA for early detection of cane toad invasions

New research conducted at James Cook University (JCU) by our Hub has found environmental DNA (eDNA) can be used to detect the presence of a single cane toad for a few days after it arrives at a new location, even if it only visited a waterbody for as little as five minutes.

The research means that Indigenous rangers and citizen scientists in remote areas will be able to help track the invasion of cane toads by collecting a water sample from small ponds and puddles during the day, rather than searching for cane toads at night.

Cane toads have spread through Queensland and the Northern Territory and are rapidly advancing through the Kimberley region in Western Australia. Cane toads are lethal to Australia's native animals when eaten, causing population declines of more than a dozen native predator species in northern Australia, including the northern quoll and large reptiles like goannas.

"Tracking the arrival of cane toads into a new area is a challenge. They are active at night, and the low number of cane toads at the invasion front means they are difficult to detect using traditional survey methods that rely on either seeing, hearing or catching an animal," said research leader Dr Cecilia Villacorta-Rath.

In recent years, analysing water samples for a species' eDNA has proven to be a powerful tool for detecting difficult-to-find species. Animals regularly shed their DNA in the environment, through skin cells, slime, urine and faeces.

Although cane toads don't live in the water, they do need to come to water once a day to hydrate, explained co-researcher Professor Damien Burrows. "The average time it takes for a cane toad to hydrate is five minutes. We wanted to know if we could use eDNA to detect a single cane toad that might visit a waterbody for five minutes and then leave," he said.

JCU and the Torres Strait Regional Authority (TSRA) have a long-standing mutually beneficial partnership spanning many years. TSRA provides invaluable assistance to connect JCU scientists with Torres Strait communities. TSRA Chairperson Mr Pedro Papau Stephen said the technique is already helping them monitor cane toads.

"Indigenous rangers collect water samples from islands across the Torres Strait which we send to JCU to test for cane toad DNA. We are trying to stop cane toads from reaching the outer islands so being able to tell from a water sample whether a cane toad has been in a creek is another tool in our efforts to stop the spread of toads."

Productivity sources in Gulf river floodplains

In the Gulf of Carpentaria, wet season floods replenish river channels and floodplain wetlands, and kickstart the growth of algae and other aquatic vegetation that form the base of aquatic food webs. Ensuring environmentally sustainable development of the Gulf's water resources requires an understanding of how proposed water extraction will affect the productivity of floodplain habitats.

In new research published in *Ecological Indicators,* Hub researchers used remotely sensed data to trace how floodwaters create 'hotspots' of aquatic plant growth on the Gilbert River's floodplains. They found that while both river flows and local rainfall contribute to floodplain inundation, river flows were a better indicator of floodplain productivity.

This means that it is more important to focus on upstream water infrastructure that reduces river flows from the Gilbert's upstream catchment. This may reduce floodplain inundation in the lower catchment, leading to a loss of productivity in the wetland ecosystems that support freshwater fish, such as juvenile barramundi.

Fitzroy River algal sources

New Hub research, published in *Hydrobiologia* and led by Dr Ryan Burrows of Griffith University, has found that algal biofilms – submerged, nutrient-dense mats of single-celled algae that form the basis of many aquatic food webs – thrive in the shallow, warm and light-filled runs and riffles found along the Kimberley's Fitzroy River in the dry season. They are particularly productive in areas where nitrogen-rich groundwater upwells and mixes with river water.

With water allocation planning for the Fitzroy River catchment currently underway, it's essential that we understand the conditions that promote the productivity of algal biofilms, and hence the river's food webs, all the way from microscopic algae through to metre-long barramundi. Water regulation and extraction that either reduces dry-season flows along the river, or lowers groundwater levels beneath the river's main channel, would reduce algal production in places identified as biofilm 'hotspots'.

Threatened species data portal

A new data portal from Hub researchers will allow free access to information on more than 1400 rare, threatened and other plants and animals of conservation concern found across northern Australia**.** The new portal provides access to maps of species distributions and shows where each species is most vulnerable to potential threats such as climate change, disease, changes in fire intensity, invasive species and the expansion of mining and agriculture.

Prior to this project, there was little information available for many species of conservation concern in northern Australia. With proposals for mining and agricultural development increasing across the region, this new information will assist government agencies and Indigenous land managers to make more informed decisions. "The data management system has been designed so that the data and maps can be accessed in a flexible way," said Dr Pintor from James Cook University, who led the project.

The researchers used statistical models to map where there is suitable habitat for each species and where they are most vulnerable to extinction, based on their exposure and sensitivity to 11 threatening processes. Both the data used to create the models and the maps generated from the models can be accessed via the data portal.

Ranger mine rehabilitation

The rehabilitated mine sites and Top End animals research has produced templates for setting specific targets for the animals expected to be found on rehabilitated mine sites in northern Australia. The approach provides guidance for rehabilitation managers on which species to select for monitoring, their attributes to be assessed, the type and number of reference sites to choose, and ensuring that sampling methods are repeatable and robust.

Performance against milestones

Performance against funding agreement milestones

All milestones for the period (and to date) have been met as per Funding Agreement Milestones 26 to 29, including the delivery and acceptance of the 2019 Annual Report, and the delivery and acceptance by the Commonwealth of an additional Interim Milestone Report on 29 October 2020.

Performance against the Research Plan milestones

Information on project progress and performance is provided in Attachment A.

Measuring success

The National Environmental Science Program (NESP) is a long-term commitment to support environmental and climate research. The key objective of the NESP is to improve our understanding of Australia's environment through collaborative research that delivers accessible results and informs decision-making. The focus of NESP is on practical and applied research that informs on-ground action and that will yield measurable improvements to the environment.

The program will build on its predecessors – the National Environmental Research Program and the Australian Climate Change Science Program – in securing for decision-makers the best available information to support understanding, managing and conserving Australia's environment.

The NESP is delivered through multi-disciplinary research Hubs or consortia, hosted by Australian research institutions. The NESP seeks to achieve its objective by supporting research that:

- is practical and applied and informs on-ground action
- addresses the needs of the Australian Government and other stakeholders by supporting and informing evidence-based policy and improving management of the Australian environment
- is innovative and internationally recognised
- enhances Australia's environmental research capacity
- is collaborative and builds critical mass by drawing on multiple disciplines, research institutions and organisations to address challenging research questions
- produces meaningful results accessible to government, industry and the community
- includes synthesis and analysis of existing knowledge
- builds relationships between scientists and policy-makers to encourage collaborative problem-solving on environmental issues.

NESP end-users will be a broad range of stakeholders whose decisions may impact on the environment, and include the Australian Government, state governments, industry, business, community groups and Indigenous land managers (or Indigenous Communities).

The intended outcomes of the NESP are:

- enhanced understanding of, and capacity to manage and conserve Australia's environment
- improved climate and weather information for Australia through a greater understanding of the drivers of Australia's climate
- timely research that is used by policy and decision-makers to answer questions and provide solutions to problems
- research outcomes that are communicated clearly to end-users and the general public, and stored in a manner that is discoverable and accessible.

Table 1. Quantitative performance measures.

Key performance indicator	Hub result for 12-mth period (numerical only)	Explanation (if any)
1. Percent of projects (active or completed in the reporting period) for which there is a research-user actively engaged in the project?	**100%**	To better ensure that project outputs meet the needs of research users, and are incorporated into policy and/or management, each project is required to enter into a research user agreement that is signed off by project leaders and the principal research users. The Research User Agreement specifies the outputs that will be produced by the project and the timeline and format for delivery of those outputs. The principal research user commits to making use of the outputs for specific policy and planning objectives. The Agreement also specifies the preferred method of engagement of the research users in the project.
2. Percent of projects approved under RPV6 in which research-users were actively involved in project design?	**100%**	In preparing Research Plan Version 6 we consulted with Commonwealth, State and Territory agencies relevant to the project. We ensured that in the drafting of each project plan research-users were explicitly identified and consulted.
3. Number of research outputs provided to end users **on time**[1] and as identified in the Research Plan	**7**	This is a collation from Hub project milestone reports where they have reported research outputs completed on time. Includes projects 1.3.2, 1.5, 2.7, 6.3.3, 1.6, 2.3, 3.3, 4.3, 4.5, 5.4, 5.5
4. Proportion of research outputs provided to end users **on time** and as identified in the Research Plan	**100%**	The projects that have been completed under the program have all completed their outputs, and these are available on our website, or through other on-line sources.
5. Number of instances of where the hub has used NESP-generated information from another NESP hub.	**7**	Projects 2.5, 2.7, 4.3, 4.5, 5.5 and 5.6 reported using NESP generated information from another Hub, the TSR Hub and ESCC Hub.
6. Number of peer reviewed NESP-funded publications during the reporting period	**37**	Includes 4 papers that are in review. Includes projects 1.3.1, 1.3.2, 1.3.3, 1.4, 1.5, 1.6, 2.3, 2.5, 2.7, 3.6, 4.3, 4.5, 5.5, 6.1, 6.3.3
7. Number of NESP research citations in other researchers' publications during the reporting period	**14**	Projects 2.7, 4.3 and 4.5 reported citations.

[1] On time – delivered on the date the outputs were expected to be delivered

Key performance indicator	Hub result for 12-mth period (numerical only)	Explanation (if any)
8. Number of researchers, including PhD and Post-Doc positions engaged as a result of NESP (total, Full-time equivalent) during the reporting period	**41 FTE**	Includes at least 120 individuals across all projects.
9. Number of data sets provided to the Hub, or made publicly available, by third parties for the purposes of informing NESP research	**32**	Projects 1.3.2, 1.3.3, 1.4, 1.5, 2.4, 2.5, 2.7, 2.9, 2.10, 3.5, 3.6, 3.7, 4.3, 4.6, 5.6, 5.5, 6.3.3 have reported datasets from third parties.
10. Percentage of data sets made publically available under open licence by the Hub	**95+%**	Our project leaders and researchers have been advised of their obligations in relation to data management. We have prepared a Hub protocol titled *Ensuring Open Access* that has been included in orientation workshops held in Qld, WA and the NT. Some datasets are restricted because they involve social research responses from individuals, involve culturally sensitive Indigenous knowledge, or the location of threatened species. Attachment A reports on data sets that are produced as outputs to projects.
11. Percentage of NESP research outputs (including publications, data and metadata) that are discoverable and accessible in accordance with NESP data accessibility requirements and the funding agreement.	**95+%**	Our project leaders and researchers have been advised of their obligations in relation to data management. We have prepared a Hub protocol titled *Ensuring Open Access* that has been included in orientation workshops held in Qld, WA and the NT. 61 research outputs from projects were reported in 2020.
12. Number and FTE of Indigenous people employed in a project (separate into full and part time positions).	**88 part time positions (approx. 10 FTE equivalent)**	88 individuals including permanent, casual and one-off engagements. Includes projects 1.5, 1.6, 3.5, 3.6, 5.5, 5.6, and 6.2.
13. Number of Indigenous researchers/graduates/post-graduate/PhD/Post Doc Positions in projects.	**15**	Projects 2.7 and 5.5.
14. Number of Indigenous people trained in the use of environmental management tools and techniques.	**98**	A number of projects reported training and education targeted towards Indigenous people, including 1.6, 2.5, 2.6, 3.5, 3.6, 4.3 and 5.5.

Key performance indicator	Hub result for 12-mth period (numerical only)	Explanation (if any)
15. The number of management tools for Indigenous waters and land that benefitted from NESP research and outcomes (including but not limited to Plans of Management for IPAs, Co/Joint managed parks, Marine Park Plans of Management, Conservation Agreements).	**16**	Projects 1.3.1, 1.5, 1.6, 2.5, 2.6, 4.3 and 5.5 reported the provision of management tools.
16. Number and type of communication products that have been used to communicate research with Indigenous people.	**13**	Four projects reported the provision of communication products: 1.6, 2.5, 4.5, and 5.5.
17. Number of research, knowledge-sharing and communication events held with Indigenous communities.	**32**	Despite Covid limitations twelve projects had communication events with Indigenous communities, 1.3.1, 1.4, 1.5, 1.6, 2.5, 3.6, 4.3, 4.5, 4.6, 5.5, 5.6, and 6.3.5.
18. Number of public events, conference presentations, jointly authored/published papers with Indigenous participants/contributors.	**11**	Five projects held events/ jointly authored papers with Indigenous participants/ contributors: 1.5, 1.6, 2.5, 4.3, and 5.5

NESP impact stories

NESP impact stories are provided at Attachment B. These stories showcase the contribution of NESP-funded research to the environment, the economy, society, culture, public policy, and quality of life, beyond contributions to academia.

NESP impact stories are particularly useful to demonstrate:

- how the research conducted by the Hub has been used to inform on-ground action or policy
- how the Hub has collaborated with research users to better understand decision-makers needs or the key question research needs to address
- how the Hub used innovative approaches to connect science with policy/decision-making
- how the Hub is successfully including Indigenous Australians in the work of the Hub
- how the Hub has improved the national environmental information base.

The following impact stories are outlined in Attachment B:

1. What a catch! Understanding links between Gulf river flows and fisheries
2. Strengthening and sharing knowledge for land and sea management
3. Using AI to protect baby turtles from feral pigs
4. Engagement is a two-way street: creating symbols for science communication
5. A giant leap forward in detecting unwanted visitors
6. Shoring up food supplies for migratory birds

Hub-level risk management

All risks identified in the Hub risk management plan are being actively managed. Management processes are in place for the ongoing management of risk, through the Hub Leadership Group, Research Executive Committee, Hub Steering Committee and at the project leadership level.

The most significant actions in 2020 have occurred around the impact of Covid-19, that has required an update to our risk assessment plan as follows.

Table 2. Update to risk assessment plan due to Covid-19 impacts.

Risk	Consequence	Likelihood	Rating	Risk response strategy
Briefly describe the risk that could affect whether the objective is achieved	*Minor *Moderate *High *Major *Critical	*Rare *Unlikely *Possible *Likely *Highly likely	*Low *Medium *High	*Avoid *Reduce *Transfer/share *Accept
Research projects and communications activities, milestones and outputs are delayed due to the impact of the Covid-19 pandemic	Major	Highly likely	High	Reduce
Proposed risk treatment	• Continuously inform project leaders of National/ State and Territory travel restrictions and other responsibilities • Regular milestone reporting from individual project leaders as to Covid 19 impact on project outputs • Advise Commonwealth and HSC of probable impact on research • Hold special REC meeting/s to agree on and implement course of action • Allow internal project reallocation of resources where necessary • Revise project outputs only where absolutely necessary and re-negotiate Research User Agreements			

Financial information

Annual financial reporting

Financial information for the Northern Australia Environmental Resources Hub is provided at Attachment C and includes:

- income and expenditure statement
- recipient and other contribution statement
- asset schedule
- audit report

Finance tracking

The Hub's budget and finances are tracking to be fully expended by the end of the program extension of 30 June 2021. The Hub has allocated all of its research funds of $19.2 million and our budgetary and financial management position will enable us to complete all program activities, including communication and engagement, in the final stages of the Program's lifecycle (see attached Financial Statement up to 30 December 2020).

As a consequence of Covid-19 and the extension of the program to 30 June 2021, we have utilised what budget flexibility we have remaining to manage its impact. As approved by the Hub Steering Committee at its meeting on 6 May 2020, we instigated the internal reallocation of funds within projects and the shifting of any unexpended funds across projects as required.

We have extended the contracts of our knowledge brokering and communications team to 31 August 2021 and our three regional coordinators in the Kimberley, Kakadu and North Queensland to 30 June 2021 to allow for the communication of final project outputs, final reporting, organisation of seminars and workshops and other logistical support to projects and stakeholders.

Northern Australia Environmental Resources Hub

National Environmental Science Programme

www.nespnorthern.edu.au

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