A Ranger's Handbook

Introduction to Feral Pigs

Managing Feral Pigs for Biodiversity Conservation in Cape York

Balkanu

Cape York Development Corporation P/L

This series of handbooks helps you choose suitable methods for the control of feral pigs and the monitoring of their impacts on biodiversity in your region. The techniques they describe have been used on Cape York Peninsula, Australia, but the ideas can be applied in similar environments in other regions.

To choose what will work best in your area, it is important to understand the techniques that are available and their limitations. These handbooks provide a brief overview of the available options.

There are multiple techniques for both control and monitoring. Often the best approach for successful control is a combination of techniques (as opposed to just one). Knowing what impacts you want to monitor will drive your decision for a monitoring technique.

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Using the Handbooks

These handbooks are intended to help ranger groups across Cape York Peninsula select feral pig control and monitoring techniques suitable to their region. However, they are not restricted to Cape York or ranger groups, and the themes can be applied in different landscapes and scenarios. The information in these handbooks is the result of a five-year Australian Government funded, Biodiversity Fund project to control and monitor feral pigs in the Archer River Basin in Cape York Peninsula, Australia. We aim to provide lessons from our own errors, successes and our constantly evolving management and monitoring techniques.

The set of 12 handbooks provides information on feral pigs, marine turtles and methods for various control and monitoring techniques. It does not provide any workplace, health and safety (WHS) recommendations and assumes each group has their own WHS policies in place. The 12 handbooks are separated into four categories, titled as below:

Introduction

- Introduction to Feral Pigs

Control

- Aerial and Ground Shooting
- Feeders, Trapping and 1080 Baiting
- Exclusion and Spit Fencing

Monitoring

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- Data Management

Feral Pigs and Control

Background

Before settlers arrived, there were no animals with hooves (ungulates) in Australia. The native Australian animals roaming the landscape caused little damage to the environment with their soft, padded feet. The introduction of ungulates caused a rapid decline in the health of country.

Domestic pigs (*Sus scrofa*), were brought to Australia on the First Fleet as a food source. They came to Queensland in 1865 when Brisbane was settled. Inevitably, wherever settlement spread and pigs were taken, some escaped, quickly building a feral population that dispersed along watercourses and across the landscape. In New South Wales, feral pigs were considered a pest by the 1880s.

Feral pigs are now distributed throughout Queensland and are considered habitat generalists colonising all biogeographical regions, and even some urban areas. Population levels and distribution are influenced by availability of water, food and cover, and the effectiveness of control programs. Pigs are great survivors, physically very tough and with a higher intelligence than dogs. They can thrive in a variety of habitats and environmental conditions.

The general community attitude towards feral pigs varies from viewing them as a major agricultural and environmental pest and an exotic disease liability, to a food, economic and recreational resource for Aboriginal and other rural communities. These contrasting opinions can lead to conflict within a community. However, managing pigs for both conservation outcomes and human consumption is increasingly accepted as both practical and appropriate, provided activities are undertaken sensibly and in accordance with state legislation.

Feral pigs are generally smaller and leaner than domestic pigs, and have more muscular shoulders and necks, and smaller hindquarters. While they have descended from domestic pigs, environmental constraints usually do not allow them to develop to their genetic potential. Their appearance may be anything from inferior domestic pigs to the so-called 'razorbacks' of the dry interior and the northern dry tropics.

They generally have longer snouts and legs than domestic pigs, a straight tail and well-developed tusks, as well as keratinous shoulder shields in males (keratin is a fibrous protein that is found in hair, hoofs and horns). Their hair is long, sparse and coarse and many have a crest running down the spine. Growth rates are dependent on environmental conditions, but adult weights have been reported up to 260 kg for males and 150 kg for females. Studies indicate average adult body weights of 70 to 100 kg for males and 40 to 70 kg for females. Black is by far the most common coat colour, but variations of red, white, browns and agouti (mixtures of colours as patches, spots or stripes) are also prevalent.

Habits

Feral pigs cause extreme damage to the environment they inhabit. Feral pigs with their destructive foraging habits and hard hooves change soil conditions; increase erosion, evaporation and turbidity; degrade water runoff into catchments and reefs; and affect animal and plant populations. They also cause significant agricultural damage ($100 million annually in Qld/NSW), pose a threat to biosecurity and threaten traditional values. Pigs digging at 'poison story places' and tainting drinking water supplies have been reported by Traditional Owners (TO's) as examples of how they affect traditional values. Cape York Peninsula is renowned for how remote, wild and adventurous it is. It was once known for how untouched it was, but it is now more commonly renowned for 'how good the pig

hunting is'. Recent surveys (2013-2017) revealed that pig densities near Aurukun on the west coast of Cape York Peninsula, are the highest recorded in Australia.

Feral pigs are most active at dawn and dusk (crepuscular), or in overcast or rainy weather; they seek dense cover as protection against direct sunlight and high temperatures. To compensate for their limited sweat glands, they drink often and wallow in water or mud to cool off.

Feral pigs have a matriarchal social structure where related sows (mothers, daughters, sisters) live together with their young, with males joining the group for mating. Bachelor groups form when sexually mature males leave or are chased from the group. Older boars live alone or in sibling pairs.

Groups usually range from 5 to 20 individuals, but this varies with age, gender, food and water availability and disturbances such as hunting. Numerous sightings of large (20 +) groups is a good indication of a high-density population, while small groups and many individuals, especially females, usually indicates a low population density.

This mob of pigs and another mob on the other side of the helicopter number around 180 total. The presence of thick trees for refugia can make it difficult to cull them aerially.

Diet

Pigs will dig and submerge their heads for bulkuru (water chestnut, Eleocharis dulcis) and the tasty rhizome at the roots. This behaviour destroys fields of bulkuru.

Feral pigs are highly opportunistic omnivores; meaning they eat most edible items they discover, both animals and plants. They have a strong preference for succulent green vegetation, fruits and seeds, rhizomes and roots and animal material including marsupials, reptiles, ground-nesting birds and their eggs, carrion and invertebrates. Having a simple, single-chambered stomach (monogastric) means pigs are unable to efficiently extract energy from the cellulose in plants; they require supplements of other foods.

Australian animals and plants that were previously not prey items soon became potential food sources for pigs. Freshwater turtles, mussels, water lily bulbs and many more species have been added to the list of foods consumed by feral pigs. Their diet varies, often reflecting the environment they live in. They are not solely grazers (eating foliage above the surface), but also foragers and diggers, creating huge damage in their wake.

They tend to focus on a particular food source when it's locally abundant, then shift to another food source when the first runs out. Pigs have high energy and protein requirements, particularly during lactation and, therefore, exploit any source of protein in the environment. This includes earthworms, carrion, insects, lambs, crustaceans, frogs, mussels, snails and eggs of various ground-nesting animals.

Reproduction

This large family mob with sows (females), young boars (males) and juveniles feed and sleep at a feeding site.

Feral pigs can breed very quickly. Mature females have a 21-day oestrus cycle, and a 113-day gestation period. In good conditions pig populations can increase by 90% or more in a single year. Many piglets are lost to predation (dingoes/wild dogs) and starvation; in tough times, juvenile mortality can reach 100%.

While breeding can occur all year round, environmental conditions usually dictate a birth pulse during or just after the wet season. Sexual maturity is dependent on weight, with sows able to breed at 25-30 kg, irrespective of their age. In good conditions, a sow can wean two litters in 12-15 months; one sow can have up to 20 piglets weaned every 12-15 months (Table 1).

Just before farrowing, sows may make 'nests' in dense reeds, or similar low bushes close to water. The piglets remain in the nest for several days. Sows produce one to two litters per year of around six, but up to 10, piglets which are weaned at around 2-3 months of age.

Table 1: Breeding and general details of feral pigs in Australia.

Gestation period	112-114 days (3 months, 3 weeks)
Litter size	4.6 - 8.2 (up to 10)
Sexually mature	25-30 kg (approx. 6 months)
Weaning	2-3 months
Return of oestrus	Less than 3 months
Litters/year	2 weaned litters in 12-15 months (good conditions)
Sex ratio (M:F)	1.7:1.0 (Cape York, Australia)
Home range size	Male: 43 km^2 Female: 19 km^2
Lifespan	6 years (approximate maximum)
Size	Male: 70-100 kg Female: 40-70 kg

For an example of their potential to breed and difficulty to control see below:

Population:	10,000 pigs	
Females:	3,700	(1.7:1.0 male to female ratio)
Breeding females:	3,000	(exclude 1/6^{th} of population)
Annual piglets born:	30,000	(10 piglets/year, a conservative estimate)
Population increase:	**9,000/year**	(with 70% mortality of piglets)

With this example, an area with 10,000 pigs has a **huge** potential to recover from any control conducted each year. The scale of this problem is enormous and needs to be acknowledged. Limitations within the ranger groups to conduct consistent large-scale control also need to be acknowledged. When consistent control isn't possible, permanent methods, such as asset protection using exclusion fencing may be the best option available (see 'Exclusion and Spit Fencing' handbook).

Distribution

Feral pig groups generally have a defined home range making use of the same trails, shelter areas, feeding and watering areas (subject to availability), rubbing and tusking trees and wallows. While the home ranges of groups and individual boars may overlap considerably, there is no evidence that either gender is territorial.

Boars are typically solitary with home ranges varying from 8 to 50 km^2, while females and juveniles tend to live in family groups over a 2 to 20 km^2 range. Range size depends on the season and food availability.

Feral pigs need to drink every day, and are generally found within a few kilometres of water. However, individual boars have been known to travel more than 20 kilometres, yet soon return to their home range. Intense aerial shooting has been known to displace feral pigs by over 100 kilometres.

Seasonal conditions affect the distribution and population size of feral pigs. A good wet season will enhance pig condition and breeding will increase. A short dry season will reduce mortality and body condition stress.

The Cape York Story

Timeline

Feral pigs are commonly thought to have arrived in Australia with the First Fleet in 1788. However, it is unlikely that they spread to Cape York and established in the 1700s. Several accounts suggest pigs established in Cape York in the mid to late 1800s, therefore, they have had an impact on country health for the past 160 years. Wetlands have been dug up and destroyed annually, affecting the function of the freshwater systems. Nests of several species of ground-nesting animals have been pillaged every year (magpie geese, freshwater turtles, sea turtles). Resources that were once important to Traditional Owners are now also exploited by feral pigs and their quantity or quality

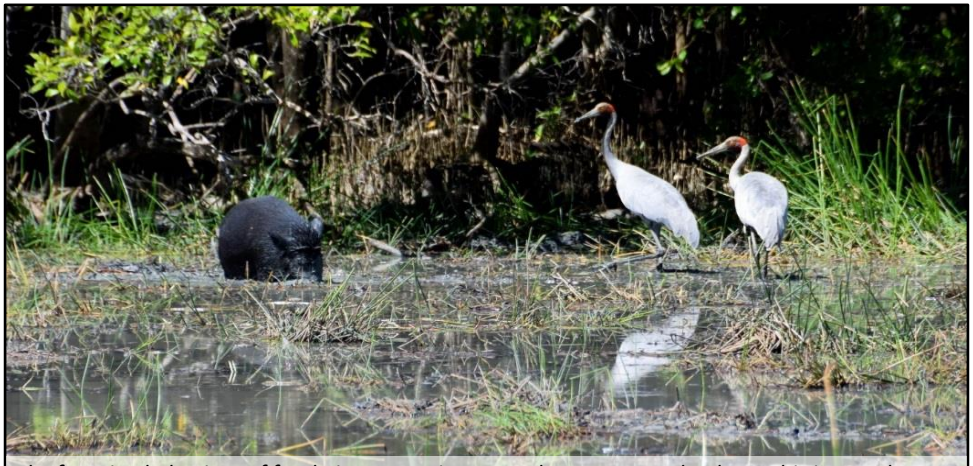
Cape York Peninsula, Australia

is severely diminished (yams, bulkuru, fresh drinking water). Due to gaps in traditional, historical and scientific knowledge, we don't know how much impact this has had on what used to be a 'natural system'. It is our job to try and return the country to its once pristine, healthy state.

Biosecurity Threat

Australia is fortunate to be geographically isolated from other continents, owing to the surrounding oceans. This provides the country with an extra layer of protection against biosecurity threats – biological threats, such as viruses, pest animals and weeds. The closest part of Australia to another continent is Cape York. Here, the Torres Strait Islands between the northern tip of Cape York and Papua New Guinea can potentially act as stepping stones for viruses (e.g. foot and mouth disease), pest animals (fruit flies, yellow crazy ants, red-eared slider turtle) and weeds.

It is critical for local communities and the entire country that this biosecurity pathway is kept free of potential intruders. A foot and mouth disease (virus) outbreak in Australia, could initially spread through Cape York via the wild cattle and pig populations and eventually through domestic herds, where it would wipe out 70% of Australia's livestock. It is estimated that such an outbreak would cost $5 billion through lost export revenue alone. The freedom of pigs to move, and their likeness to humans and cattle, makes them a seriously dangerous vector for the transmission of disease.



The foraging behaviour of feral pigs causes immense damage to wetlands. In this image the foreground was once thick with tall, green bulkuru (behind the brolgas) before it was dug up.

What is the Importance of These Projects?

As Cape York is a highly likely pathway for biosecurity threats to enter Australia, feral pig projects in this region are incredibly important. The landscape has been altered by feral pigs for over a century and many species are now under serious threat due to the presence of feral pigs. Marine turtle rookeries are collapsing due to widespread, intense pig predation. Magpie geese are displaced due to their competition with pigs for their main food source; bulkuru. Wetlands and water regimes are altered, with increased evaporation rates, higher turbidity and lower oxygen available for fish to breathe and other factors giving rise to severely degraded water quality, affecting aquatic and terrestrial animals relying on these water sources.

Ranger staff inspect a sea turtle nest that pigs have dug and eaten. Pig tracks can be seen around the nest. This nest (an olive ridley) would have had 100-120 eggs.

The pig control programs in Cape York have the ability to reverse some of the damage the landscape has experienced over the past century. By reducing the numbers of pigs in the landscape we can hopefully restore some form of natural regime and see a healthy country again. Monitoring the change in pig population and landscape health is imperative to understand the success of pig control and allows us to understand how these projects are functioning.

First Steps

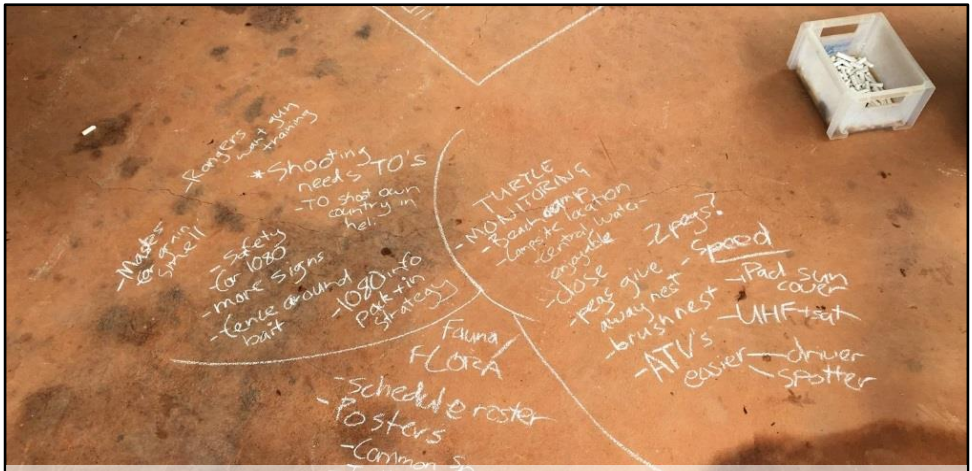
Community Collaboration/Participatory Planning

Frequent planning and review meetings are critical in projects. Here Indigenous rangers, CSIRO staff and government funders meet to plan for the year and review the past year.

The backbone of any project should be good community collaboration and participatory planning. Skipping this step may not lead to failure but could result in a waste of time and funding, poor efficiency and limited outcomes. Consulting the TO's for permission to access country for the work is critical. Keeping TO's and locals informed of what is going on helps maintain healthy relationships. Consider having an open shed day or open community event for the community to attend. These can be held before the start of work, and at the end to share your results – these are often very well received!

The initial planning is some of the most important work that can be done in the project. This should be repeated with the team on frequent occasions to review success and whether changes are needed. Here, several minds with different areas of knowledge (traditional, historical, scientific and business) are put together to problem-solve. Planning does not always need to be complex or at a

proper location. Some of the best planning happens spontaneously and smaller groups often encourage quieter voices to speak up.



Planning can take several forms and all should be important. Spontaneous brainstorms like this with rangers often provide gold nuggets of opinion, information and foresight.

Steps:

- Meet with TO's to request permission to access country
- Build a picture of the problem and history using local information from TO's
- Instigate participatory planning sessions, inviting relevant TO's and stakeholders
- Develop a management AND monitoring plan
- Conduct initial field test
- Review data, results and method success
- Adjust if necessary
- Repeat

Identify

Taking the time at the start of the project to identify your purpose, goals, sites, risks and strategy is critical in the planning phase.

Purpose

The success of a pig control program for biodiversity conservation or any other purpose needs to be assessed in the context of success criteria (i.e. clearly state

what you want to achieve before starting a control program). Here you must ask yourself 'why are we conducting feral pig control?' and 'what do we want to achieve?' Without a purpose (e.g. reduce feral pig damage to 50% of the current level at sites A, B and C) it is difficult to measure the success of the program and let your funder know if their investment in your program has been worthwhile. Note, that in order to reduce pig damage to 50% of the current level, it is necessary to have completed baseline assessments to understand what the extent of the damage was at the beginning of the project. These can be quantitative (measured numerically using standard methods) or qualitative (observation-based using agreed and standardised categories) methods and you may need help from specialists to design such a baseline assessment and ongoing surveys.

An example of how to define your purpose could be:

- Why are we conducting feral pig control?
- What do we want to achieve?
- How long do we want to control for?
- What is our ultimate goal?

Important Sites (Asset Protection)

One of the other critically important steps before beginning control is to identify your important sites. These may vary, according to what your group's values are placed on. For example, a man-made dam that has pig damage would be less important (environmentally) to protect than a natural lagoon (unless it was the last water source in the region). However, if the man-made dam has consistently more pig damage than the natural lagoon, it may act as a good indicator to show if your control program is working or not (see more in the 'Monitoring Feral Animal Populations' handbook).

'Asset protection' identifies sites of importance which may be of interest to protect. These may be environmentally, culturally, historically or structurally important sites. An example of this might be a lagoon that was once fished by TO's 50 years ago for freshwater turtles, but feral pigs have now removed all turtles from the lagoon. This would be a site of cultural importance to protect with exclusion fencing – a method of asset protection.

Choosing the important sites for both your control program and monitoring is a very important step before beginning either process. Having control and monitoring at the same site is also important - if you want to monitor how your control program is affecting your environment. Choosing wrong sites at the start of the project could be detrimental to your overall success – you will waste time and money at sites that may have little relevance to the project. A 'recon' to identify important sites with specialists at the start of the project is essential!

General

Defining consistent and sensible site names at the beginning of a project is absolutely essential. Without consistent site names, there will likely be confusion about site location, especially with the turn-over of workers. Having printed maps and directions at the ranger base is a critical tool for ranger efficiency and inclusion.

Threats and Risks

Once you have identified your purpose for conducting control and your important sites, your next step is to identify what threats and risks there may be to the project success. Threats to the project can be either predictable or unpredictable, so spending time trying to list potential threats is a good idea to protect your project.

Common threats include fire, floods, wet season access, remote logistical problems, animals and people. Country closures for sorry business are a common and significant threat if not carefully navigated.

The weather in Cape York can drastically affect work and access to country.

Management Strategy

Defining a management strategy means doing all of the above, and then selecting appropriate control techniques (and also monitoring techniques). One technique may be all that is required; however, a combination of techniques is often the

most successful. This doesn't mean that you should use every technique listed in these handbooks; instead, pick the ones that work well together. For example, some pigs get used to aerial shooting and hit the thick vegetation well before the helicopter arrives – so using 1080 baiting in the thick vegetation can target these cheeky pigs.

The *most* important thing to note about selecting a control strategy is:

- What is most interesting and appealing to you, may *NOT* be the best choice for your area.

For example, because you may think aerial shooting is fun, it may actually be too costly and yield little results for your area because it is too heavily wooded or there aren't enough pigs. Again, selecting the wrong option could lead to a waste of funding and time in your project.

Selecting Your Method

Many factors will go into selecting your method, including; funding, rangers available, access, time and expertise. A good planning phase to select the best method(s) is critical. When selecting your method, choose which method is most practical with your limitations in mind, rather than a method that seems fun.

Integrated Pest Management

Integrating (combining) the methods described above will provide better control outcomes than any one method alone. A good combination of control methods, such as aerial shooting, trapping and opportunistic ground shooting would target most problem animals and provide great outcomes for the environment. If possible, try and select a couple of methods that would complement each other well to get those cheeky pigs that evade one of the control types.

Adaptive Management

Even with the best-informed planning possible there are often unpredictable challenges. It is important to be flexible with your management approach and monitor things closely. If a control technique is not having the desired effect, perhaps it needs to be reviewed. This is where adaptive management comes in. Having the ability to change your management approach will allow you to achieve the best results for your program.

Resourcing Your Project

Writing Grant Applications

Writing grant applications can be daunting; however, submitting something is necessary to get a chance at receiving a grant. Your application should be well researched and not rushed. These handbooks are designed to provide options to help design projects relevant to feral pigs and marine turtles and can be used as a reference. Contact people who are experts in the field first, to gain insight into the topic and what might work best in your area (every area is different).

Keep your application realistic, transparent and within budget. Spend sufficient time calculating a budget for your proposed project and provide enough detail in the application. By proposing a project with realistic aspirations you are more likely to be approved, and you will also be able to achieve it when the project hits the ground.

Sources of Funding

Funding can be hard to find, and there are many places to look. Keep an eye on news for political changes, media releases and current headlines that may suggest new funding is available. Stay in touch with regional organisations and build relationships with research organisations to improve your chance of getting funds. Many research organisations have various projects running that may fit into your work schedule.

Gaps, Opportunities and the Future

There are still many gaps in research in feral pigs. Their distribution and behaviour is still poorly understood. Control methods have not changed for decades. Within these handbooks we propose new methods of control and asset protection (spit fencing, chemical fencing and landscape scale trapping) that could be applied successfully in other regions. Groups across Cape York must align interests and efforts to improve the health of country and for the sake of Australia's biosecurity.

Glossary

Adaptive management	Management that adapts based on data, observation or new knowledge.
Body pit	A hole left in the sand by a sea turtle that has attempted to dig an egg chamber but decided it wasn't the right spot and moved on.
BioCollect	An online data collection base for ecology projects run by the Atlas of Living Australia (ALA).
Biodiversity	The variety of plant, animal and fungi life living in a particular habitat.
BRUV	Baited Remote Underwater Video – an underwater camera setup for recording aquatic animals.
Database	Sets of data stored on a computer or online storage facility.
eDNA	Environmental DNA, a technique where a sample of water can be analysed for the presence of a particular animal using DNA.
EHP	Queensland Department of Environment & Heritage Protection.
Elliott trap	A small, compact aluminium trap used to catch small mammals.
Experimental design	A research method whereby various factors are tested against various effects, including surveys and controls.
Free feeding	When food without poison is placed at a feeding site to attract animals.
Georectified	Digital alignment of images over a map from the same area.
GIS	Geographic Information Systems – in these handbooks often referring to 'GIS Kit/Pro' - an iPad application for project mapping.
Inundated	Covered with water. A turtle nest is 'inundated' if it has been covered by the tide and the tide has receded, causing damage to the entire nest.
Intellectual property	Knowledge that is the result of research, creativity etc.
KML/KMZ/GPX	Types of files associated with GPS and GIS mapping.
Macroinvertebrate	Invertebrates (insects, snails, crayfish etc.) that are not microscopic.
NESP	The Australian Government's National Environmental Science Program.
Pick kits	Various tools for picking small animals out of samples e.g. tweezers and pipettes.
Replicates	Repeating a survey, site or task multiple times, to have enough data to analyse and examine for difference.
Rookery	The collective term for a beach where marine turtles nest.
Stratifying	To separate or classify.
Systematic	Describing a survey that has been methodically planned.
Terrestrial fauna	Animals (fauna) found primarily on land (as opposed to aquatic or marine fauna).
TO	Traditional Owner, a person of Indigenous descent that is from, and has knowledge of and rights to a specific area of land.
Transect	A survey line on which observations are made.
Ungulate	An animal with hooved feet e.g. pigs, goats, cattle.
Water Quality Logger	A device that records continuous water quality data including temperature, turbidity and dissolved oxygen.

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