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Quick guide

Orange-bellied parrots

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What is the orange-bellied parrot? The orange-bellied parrot (*Neophema chrysogaster*; Figure 1) is a small bird (~40 g) endemic to coastal areas of Southeastern Australia and is part of a group of six closely related 'grass parrots'. Orange-bellied parrots form the subgenus *Neonanodes*, along with four other similar looking species. Orange-bellied parrots are classed as Critically Endangered by the IUCN (111 of 398 of extant species in their family Psittaciformes are Threatened). Their population size has been precariously low (<100) for more than two decades and a nadir was reached in 2016 when only three wild females returned from migration.

Migration? Yes, this is unusual for a parrot! Although all grass parrots are capable of long-distance dispersal (including partial migration and nomadism), orange-bellied parrots are obligate North–South migrants with strong natal site philopatry. Each year, their entire population crosses the Bass Straight between their breeding habitat in southwest Tasmania and their wintering habitat along the coasts of the southeast Australian mainland. Orange-bellied parrots prefer coastal areas, where they forage in saltmarshes and other wetland habitats for seeds and flowers of herbs, sedges and grasses. In Tasmania, they occur only in the rugged and remote Southwest World Heritage Area, where vast plains of buttongrass moorland are dotted with patches of forest and bisected with jagged mountain ranges. This wild region is wet and cold, with over two meters of rainfall per year and a mean temperature maximum of 15.4°C. The vegetation in the area is highly flammable, and Tasmanian Aboriginal people used fire as part of their cultural practices. These practices limited forest encroachment on moorlands and resulted in large-scale mosaics of different succession stages after fire. The preferred Tasmanian food plants of orange-bellied parrots are early to mid-successional herbs and sedges that grow in the decluttered ground cover layer of moorlands after fire. Orange-bellied parrots nest in tree hollows of Smithton peppermint (*Eucalyptus nitida*), and the extent of suitable breeding habitat was probably limited by availability of hollow-bearing trees in close proximity to recently burned areas of moorland. However, knowledge of the ecology and life history of these birds is limited because detailed ecological studies were not undertaken until the 1980s when they were already rare.

Why are they threatened? The dispossession of Tasmania's Aboriginal

Figure 1. Orange-bellied parrots (*Neophema chrysogaster*).
Orange-bellied parrots (top: an adult male, bottom: nestlings in the wild) are one of the most endangered birds in the world, and in 2016 only a single wild-born female produced a surviving descendent. They have been subject to the most intensive conservation program in Australia.

people of their land by Europeans resulted in a shift from small scale, regular and cool fire regimes to larger and more intermittent and intense wildfires. This may have reduced the availability and quality of breeding habitat. Concurrent widespread loss of the species' wintering habitat along the coasts of southeast mainland Australia due to agricultural and urban development (e.g. expansion around the city of Melbourne) probably reduced winter survival. Orange-bellied parrots are also vulnerable to infectious disease, particularly Psittacine Beak and Feather Disease Virus, which has intermittently afflicted the population. A combination of loss of diversity at immune genes, disease 'fade out' (when a population becomes too small to sustain circulation of coevolved pathogens, leaving them vulnerable to non-endemic disease) and repeated disease spill-over events have taken a severe toll on the already diminished population. Their population has been small for a long time, and over the last 20 years the mortality rate of juveniles embarking on their first migration has doubled for unknown reasons. Today, orange-bellied parrots persist only at one Tasmanian breeding site, where an intensive recovery project has been implemented since 1979.

Can't we breed them in captivity? A captive breeding program for orange-bellied parrots was established in 1986. Despite intensive efforts, and annual releases of captive birds into the wild since 2013, the population continued to decline. When only three wild females returned from migration in 2016, two bred but only one produced a surviving descendent. This loss of family lineages eroded genetic diversity in orange-bellied parrots. Thus, despite the perilously small wild population size, in 2010/11 the species' recovery team decided to capture half of the wild juvenile cohort to bolster genetic diversity in captivity. This action had both positive and negative consequences. Without it, the genetic diversity of the captured birds would certainly have been lost. Instead, with the help of a carefully managed studbook across multiple partner agencies a captive population of more than 400 parrots has been maintained. However, wild genetic diversity decreased, exacerbating the population bottleneck.

How are they doing now? They have narrowly avoided extinction. Recent releases from captivity have increased the population size, corrected adult sex ratio skews and increased the number of wild-born juveniles produced each year. In tandem with these efforts, veterinary support and supplementary food are provided, along with intensive citizen science monitoring of uniquely marked parrots at feed stations. But, the species remains conservation-dependent. The population would quickly become extinct if releases from captivity were to cease, as wild juvenile mortality rates during migration and winter remain unsustainably high. Unless juvenile mortality rates can be reduced from 80% to about 60%, the wild population will not be self-sustaining. Presently, there are no known mitigation options for reducing mortality rates other than optimising the body condition of nestlings. Orange-bellied parrots may also suffer from Allee effects, i.e. inverse density dependence depressing fitness at small population sizes. Their small population size may in fact be their most existential threat. For example, small flocks of juveniles may be less effective at finding suitable migration routes and winter habitat. Until mortality rates of juveniles improve, the recovery program is locked into a cycle of management dependency.

What can orange-bellied parrots teach us about conservation? Globally, the extinction crisis is driving conservation managers to turn to increasingly interventionist approaches, foremost among them captive breeding. By the time a species needs this type of intervention, their population is often so small that research needed to inform management is impeded. In this respect, orange-bellied parrots are unusual because annual monitoring of the wild and captive population records a census of births and deaths, and other, rich datasets. Such unusually rich information is exceedingly rare among global conservation programs, making it an important resource for difficult-to-study species. For instance, few conservation programs can scrutinise individual fitness at such fine resolution as is possible for orange-bellied parrots. Likewise, understanding the mortality consequences of early life body condition has important implications for habitat management in the breeding grounds, selection of which captive individuals for release and management of diets to overcome the gap between wild and captive nestling body condition. Notably, captive-bred orange-bellied parrots have differently shaped wings compared to their wild conspecifics. This negatively affects their survival prospects after release, an important reminder that captivity can have unintended consequences, which is an emerging problem for conservation.

Where can I find out more?

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DECLARATION OF INTERESTS

The authors declare no competing interests.

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