Occupation rates of artificial and restored natural nest cavities by yellow-shouldered Amazons *Amazona barbadensis* on Bonaire, Caribbean Netherlands

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SUMMARY

The breeding success of obligate secondary cavity nesting birds, including most parrots, can be limited by the availability and quality of nest cavities. Habitat degradation can reduce the number of large cavity-containing trees. This reduction in available cavities can be exacerbated by destructive nest poaching practices, which leave cavities damaged and unusable. Yellow-shouldered Amazons *Amazona barbadensis* inhabit degraded dry-forest areas on the island of Bonaire (Caribbean Netherlands), and were suspected to be limited by the number of suitable nesting cavities. We compared two approaches to increasing the availability of nesting sites, measuring occupation rates of 10 nest boxes and 10 repaired natural cavities over three years. While none of the nest boxes were used, two of the restored cavities were occupied within five months of repair, and a third in the following year. Only one of the breeding attempts in restored cavities (33%) was successful, compared to the population average of 56%. Sample sizes are small, but restoring natural nest cavities led to a higher rate of uptake than nest boxes and was a considerably quicker and cheaper intervention. However the effectiveness of this intervention depends on the threat of poaching, and there is a risk that restoring poacher-damaged nests may attract breeding pairs away from safer cavities.

BACKGROUND

Obligate secondary cavity nesting birds are highly sensitive to habitat degradation (Cornelius *et al.* 2008), particularly degradation targeting mature trees which contain most potential nesting cavities. This reduction in nesting cavities can have a detrimental impact on productivity of these birds (Newton 1994). Among species that are captured for the pet trade, cavity availability can be further reduced by the practice of cutting access holes to poach nestlings, which can render the cavity unusable for future breeding attempts. Nest box provision is a frequent intervention used to address concerns over nest site limitation in cavity nesting birds, particularly parrots. However few data exist on the effectiveness of nest boxes or alternative interventions to improve nest cavity availability for parrots.

The yellow-shouldered Amazon *Amazona barbadensis* is a secondary cavity nesting parrot, found in Venezuela and Bonaire, Caribbean Netherlands, and is categorised by the IUCN as Vulnerable. On Bonaire the parrot inhabits the extensive but highly degraded dry-forest. Widespread felling in the early 1800s removed most mature trees from Bonaire and invasive herbivores, including goats and donkeys, have prevented a significant amount of regeneration (De Freitas *et al*. 2005). The remaining forest is dominated by young trees, too small to contain suitable nest cavities. Historically high levels of nest poaching for the pet trade have suppressed parrot populations on Bonaire and destructive poaching methods have damaged suitable cavities. However, the fact that the population of yellow-shouldered Amazons on Bonaire has been increasing steadily over the past 15 years (DRO 1999, DRO 2014), combined with the frequent agonistic interactions between parrot pairs around nest sites, suggest that the availability of suitable cavities may currently limit population growth (Martin 2009).

Herbivore exclusion areas and native tree planting initiatives on Bonaire are beginning to restore the dry-forest habitat, and will ultimately result in an increase in the availability of cavities. However the long generation time of trees means that it will be many years before these benefits are realised (Manning *et al.* 2012). As such, short-term mitigation measures to improve cavity availability need to be developed.

Though widely used, the success of providing nest boxes to increase breeding rates in wild parrot populations has been inconsistent (e.g. Brightsmith & Bravo 2006, Manning *et al.* 2012, Olah *et al.* 2014). Nest boxes placed in the locations of previously occupied cavities have seen more rapid rates of uptake than those placed in other areas, suggesting that breeding parrots may favour traditional nesting sites. For example, out of 30 nest boxes provided for Cape Parrots *Poicephalus robustus* the only nest box occupied was positioned a few metres from where a tree which contained a previously occupied cavity blew down a few months before (Downs 2005). Of all nest boxes (total number not reported) occupied by Puerto Rican Amazons *Amazona vittata* only one was not placed at a previous nest cavity (White *et al.* 2005). Restoration of poacher-damaged cavities is a quicker and cheaper intervention than provision of nest boxes, and the apparent preference of parrots for nesting in previously used locations should facilitate rapid rates of uptake.

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Figure 1. Poacher-damaged nest cavity of a yellow-shouldered Amazon with access hole cut using machete. Arrow indicates nest entrance.

Figure 2. Repaired yellow-shouldered Amazon nest cavity, with metal sheet covering the hole. The metal sheet was then painted to make it blend in with surroundings. Arrow indicates nest entrance.

To investigate the effectiveness of repaired poacher-damaged natural cavities and artificial nest cavities (nest boxes), we compared rates of occupation and breeding success by yellow-shouldered Amazons in the two types of nesting cavity over a three year period.

ACTION

This study was carried out in degraded dry-forest on the island of Bonaire, Caribbean Netherlands found between 68°11'W - 68°25'W and 12°1'N - 12°9'N. Known nesting areas of yellow-shouldered Amazons were searched for potentially suitable nesting cavities in 2006, and 10 cavities in which access holes had been cut by chainsaws or machetes were identified (Figure 1). It was assumed that these sites had been previously active yellow-shouldered Amazon nest sites, as interviews with former poachers confirmed that access holes would only be cut if nestlings were thought to be inside. There was no evidence of recent occupation, such as feathers or fragments of eggshell, in any of the cavities and it was assumed they had been unoccupied for at least one breeding season prior to repair.

The 10 identified nest cavities were repaired between January and mid-April 2007. All repairs were completed at least one month prior to the earliest date at which breeding attempts are known to be initiated (Williams 2009). Repairs were made using zinc metal sheets 1 mm thick, bent into shape and nailed to the tree to fully cover the damage (Figure 2). Brown, green and black spray paints were used to make the metal repairs less conspicuous within the natural surroundings. Repairs were checked visually from the inside to ensure no light could enter. Each repair typically took one hour or less to complete, required minimal tools (sheet metal cutters and a hammer) and cost approximately $15 in materials.

Ten plywood board nest boxes were placed in and around known nesting areas. Nest boxes were placed on trees and on cliffs at least 2 m from the ground. Boxes were up to 1 m wide at the bottom, and narrowed to approximately 20 cm at the top, with a perch placed at the opening (Figure 3). An access door in the bottom of the box enabled the boxes to be easily monitored. Boxes took up to five hours to complete and place, required the use of specialist tools (including circular saw and electric drill) and cost approximately $30 each.

Repaired nests and nest boxes were checked weekly for signs of breeding activity from mid-May until mid-June in 2007, 2008 and 2009. If no breeding activity was detected during that period, nests were checked every 2-3 weeks until the end of July. No breeding attempts were initiated after mid-June in repaired cavities or nest boxes. If eggs were found the nests were inspected twice a week until the breeding attempt ended through natural failure, poaching or fledging.

CONSEQUENCES

Between 2007 and 2009, three of the 10 restored cavities were occupied, representing an occupation rate of 11% (out of a total 27 nest-years). Each cavity was occupied only once. One breeding attempt was successful, fledging three chicks (Table 1).

Seven of the 10 restored cavities remained intact for the three years of the study. The remaining three nests were 're-opened' by poachers. Only one of these 're-opened' nests

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Table 1. Occupation rates of repaired cavities formerly damaged by poachers and nest boxes by breeding yellow-shouldered Amazons

	Year	Cavities available at start of breeding season	Cavities occupied	Breeding attempts initiated	Breeding success	Number of chicks fledged
Repaired nests	2007	10	2 (20%)	2	0	0
	2008	9	1 (11%)	1	1	3
	2009	8	0 (0%)	0	0	0
	Total	**27**	**3 (11%)**	**3**	**1**	**3**
Nest boxes	2007	10	0 (0%)	0	0	0
	2008	10	0 (0%)	0	0	0
	2009	10	0 (0%)	0	0	0
	Total	**30**	**0 (0%)**	**0**	**0**	**0**

contained a breeding pair at the time, and the chicks were presumed poached.

None of the 10 nest boxes were occupied by parrots during the period of the study (Table 1). Four of the boxes were occupied by invasive bees and a fifth was occupied by termites.

DISCUSSION

Simple and inexpensive repairs to nest cavities previously damaged by poachers induced yellow-shouldered Amazons to nest in three out of 10 cavities that had recently been unoccupied on Bonaire. Ten nest boxes placed during the same period were not occupied. Although sample sizes were small, the rate of occupation of repaired nests was relatively high compared with other interventions to increase nest cavity availability, including provision of nest boxes elsewhere (Table 2). In addition, the repair of nests as described in this study was relatively quick and cheap when compared with constructing and installing nest boxes, at 50% of the cost and taking less than 20% of the time.

Two of the three instances of nest cavity use occurred within five months of the cavities being repaired, suggesting that this intervention has the potential to rapidly increase the number of breeding opportunities for yellow-shouldered Amazons on Bonaire. As the population of yellow-shouldered Amazons on Bonaire has been increasing over the past 15 years (DRO 1999, DRO 2014) it is possible that competition for nest cavities will continue to increase, and further repaired cavities would also be used. In contrast the occupation of artificial cavities by parrots can often take several years, with yellow-shouldered Amazons on Margarita Island taking four years to begin using nest boxes (Sanz *et al.* 2003). That study also found that all restored cavities (15 in total) were occupied in the first season available. It is important to note that this intervention is only possible in situations where destructive poaching was a cause of cavity loss and the mature trees containing the damaged cavities still stand. Where these conditions do not apply, but the availability of suitable cavities is suspected to limit the breeding population, nest box designs should also be trialled.

None of the repaired cavities were used for breeding on more than one occasion. One nest cavity was damaged by poaching activity, however two others remained intact and were not reoccupied, despite one nest successfully fledging three chicks. Yellow-shouldered Amazons on Bonaire typically have high nest site fidelity (73.6%) (Martin 2009) and rates of breeding success are 56% (Williams 2009). Breeding failure and lack of re-occupation may indicate that repaired nests are of poor quality. Recent studies on scarlet macaw breeding in natural and artificial cavities found no significant difference in breeding success between natural and artificial cavities (Olah *et al.* 2014). Further investigation is needed into nest failure and rates of re-occupation to determine the effectiveness of this intervention for yellow-shouldered Amazons on Bonaire.

Despite actions to reduce poaching (Montanus 2003) three (30%) of the repaired nests were reopened by poachers during the period of the study. Poaching from natural nests during the study period was similar (23.5% of 34 otherwise successful nest attempts) (Martin 2009). Though poaching was not significantly higher in repaired cavities in this study, poached nests may be more vulnerable than un-poached nests, due to proven accessibility and locations known to poachers. Care should be taken to repair nests considered of lowest risk of re-

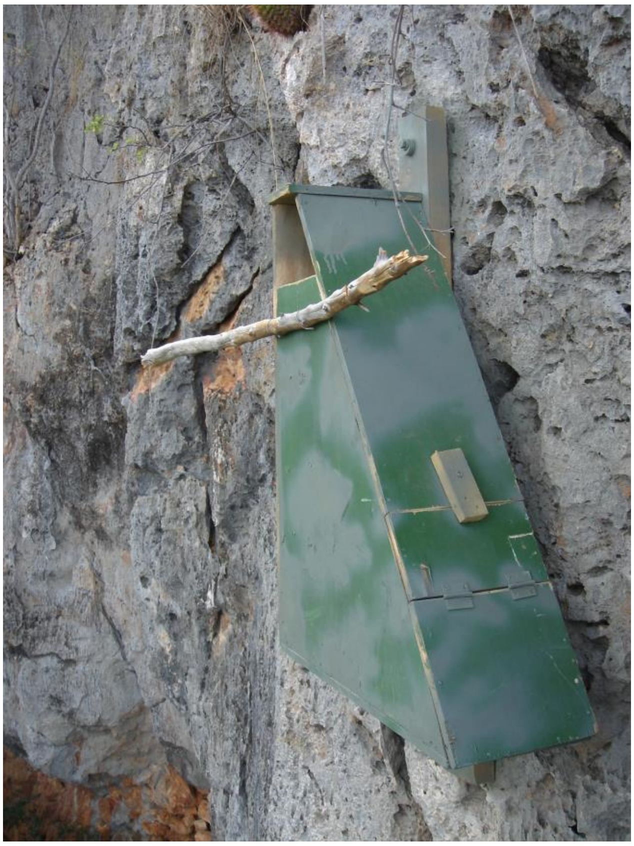

Figure 3: Nest box for yellow-shouldered Amazon attached to cliff.

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Table 2. Occupation rates of nest boxes by parrot species in other studies.

Study	Species	Total nest boxes available	Nest boxes occupied
Sanz *et al.* 2003	Yellow-shouldered Amazon	88	5 (5.6%)
Vaughn *et al*. 2003	Scarlet macaw *Ara macao*	190	11 (5.8%)
Brightsmith & Bravo 2006	Blue-and-yellow macaw *Ara ararauna*	10	0 (0%)
Lindenmayer *et al.* unpublished data (reported in: Manning *et al*. 2012)	Superb parrot *Polytelis swainsonii*	3200	0 (0%)

poaching, and in some cases additional guarding, observation visits or work with nearby residents may also be beneficial.

Importantly, it is not known whether the pairs that occupied restored nest cavities were new recruits into the breeding population, or whether they were breeding pairs that moved from alternative cavities. The small sample sizes used in this study make it difficult to draw robust conclusions as to the effectiveness of nest repairs for boosting the breeding population. Therefore further investigation into the rates of breeding success and poaching among restored nests compared with ‘natural’ cavities should be conducted to ensure that nest repairs do not act as an ‘ecological trap’, enticing breeding pairs away from other, potentially safer, cavities.

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