Activity Class	Day	Night
feeding	36.5	63.5
loafing	55.3	44.7
swimming	46.8	53.2
comfort	65.9	34.1

Table 1. Percentage of each activity divided between day and night.

under the shade of Willow trees, but at night they remained partially or completely surrounded by water, selecting either the mud banks at the water's edge or floating on the open water. Feather maintenance occurred at low levels throughout the day and night, but intensive preening was observed mostly between 0900 and 1000 hours. This period devoted mainly to comfort movements provided restoration of feather condition after extended hours of feeding during the night and in the early daylight hours. Swimming was recorded at similar levels during the day and night (Table 1), although a marginal increase occurred at night, suggesting that general activity levels were higher.

Use of image-intensifying passive binoculars for nocturnal observation can extend the study of bird behaviour to the whole of a 24-hour cycle. Use of this technique provides a new insight into the feeding ecology of Pacific Black Duck and may be appropriate for other species.

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THE RESULTS OF A BREEDING PROGRAMME FOR THE NOISY SCRUB-BIRD (*ATRICHORNIS CLAMOSUS*) IN CAPTIVITY.

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INTRODUCTION

Many techniques have been devised to aid the survival of rare and endangered birds (Temple 1977), one of which, captive propagation, often being considered a last resort (Conway 1977). While our attempts to breed the Noisy Scrub-bird in captivity were not a last resort, they were designed to provide the techniques and identify the problems, should such a move be necessary.

The background to the study lies in the rediscovery of the Noisy Scrub-bird in 1961 (Webster 1962) and the subsequent request to CSIRO by the Western Australian Department of Fisheries and Wildlife to undertake a study of the bird's ecology. The initial census of the population in 1970 indicated that there were 43 breeding pairs, which had increased to 44 in 1971. These data indicated a decline in the population since 1968 when there were thought to be about 50 breeding pairs (Smith and Forrester 1981). This apparent decline suggested the need to start planning to breed the species in captivity, as one potential method of ensuring its survival. Althought the population continued to increase slowly in the following years (Smith and Forrester 1981), the programme was continued because a small isolated population is always at risk, and a knowledge of the techniques of captive propagation may be needed in the future.

METHODS

In 1973 a large aviary (25m x 8m x 3m) was constructed and early in 1974 it was planted with trees, shrubs and rushes, in an attempt to recreate a cross section of a scrub-bird territory. By 1976 the plants had grown enough to make the aviary suitable for scrub-birds. In addition we placed a one metre high strip of asbestos sheeting around the bottom of the outside of the aviary, and covered the rest with 50% and 80% Sarlon shade cloth. These features helped to create a light regime in the aviary that was similar to the bird's habitat and also reduced the wind. We considered that our best chance of breeding the birds would be from nestlings, collected just prior to fledging, and then hand-reared to a stage when they could fend for themselves. In August 1975 a 16 day-old chick was collected in her nest at Two Peoples Bay and taken to Perth where it was hand-reared by one of us (C.A.N.). When the nestling was 90 days old it was placed in a small holding aviary (3.5m x 2m x 2m) that had been planted with trees and shrubs. In August 1976 two female (19 and 17 days old) and one male (18 days old) nestlings were collected and taken to Perth where they were hand-reared as for the first nestling by C.A.N. The first female collected (Nob) was placed in the large aviary in November 1976, and the other two females (Red and Green) in January 1977 after spending six weeks in the holding aviary. The male was placed in the large aviary in May 1977.

In June 1976 Nob built a nest and laid an egg which was replaced with a fertile egg from Two Peoples Bay. The nestling hatched in July but died after six days. The cause of death was unknown. The nestling had been growing slowly, but within the range of growth rates for nestlings in the wild. At five days old it was seen to void loose faeces, and had become unresponsive to touch. As soon as the chick was hatched Nob reduced her intake of the artificial diet (Table 1) which had formed the bulk of her food until then. She also reduced her intake of the live food that we regularly provided (termites, mealworms and blowfly pupae and larvae), and compensated by eating some of the various live invertebrates that were collected especially for the chick. This experience indicated that if we were to rear scrub-birds we would need large numbers of a variety of insects for both the females and nestlings. We started a programme to produce large numbers of crickets, (*Teleogryllus oceanicus*), cockroaches (*Periplaneta americana*), slaters (unidentified local species), earwigs (unidentified local species), mealworms (*Tenebrio molitor*) and potato moth pupae (*Phthorimaea operculella*), and also the production and storage of large numbers of blowfly (*Lucilia* spp.) larvae and pupae. Additional live insects were obtained from an insect trap that was operated every night.

24	parts	minced lean meat (lamb or beef)
6	"	wheat germ
6	"	egg and biscuit mix
4	"	whole egg powder
4	"	dried fish food (Daphnia, mosquito larvae)
1	"	multi-vitamin and mineral powder
1	"	ground charcoal and oyster shell
1	"	yeast extract

The ingredients were mixed and made into small cylindrical pellets approximately 10mm x 4mm.

Table 1. The number of parts by volume of the ingredients of the artificial diet.

In April each year large quantities of rush (*Lepidosperma* sp.) and shrub cuttings were collected at Two Peoples Bay to construct nesting sites and provide nesting material. In addition, quantities of litter were collected and placed near the nest sites to provide additional food for the birds. In the period 1977 to 1979 this process was repeated in July to revamp the nest sites.

In May 1977, when the male was transferred to the large aviary he was still in immature plumage and had only just started to develop his territorial song. By June he had a short territorial song. During the summer of 1977/78 he moulted into full adult plumage and had by this time developed a full territorial song. The females are capable of breeding in their first year (Smith 1979), although they do not acquire adult plumage until their second year.

RESULTS

Breeding records for all females from 1976 to 1980 are shown in Figure 1.

I 1977

In 1977 five nesting sites with adjacent feeding areas were constructed around the aviary. All birds had free access to all parts of the aviary. There was a considerable amount of aggressive behaviour between the male and the females, and between the females, who all nested late and laid infertile eggs. During the summer of 1977/78 fewer aggressive interactions were seen between the male and Red and Green, and, on a number of occasions in the following months he was seen to feed both birds. Nob, on the other hand kept well away from the male, and the other females.

II 1978

In June 1978 Red laid an infertile egg. Although the male was in adult plumage we were not sure if he was reproductively mature. In an attempt to stimulate him, we replayed recordings of three males from Two Peoples Bay from 0700-1000 hours and 1430-1730 hours each day from the start of August. This was just before Red had finished her second nest and Green, her first nest. The attempt was apparently unsuccessful as both females laid infertile eggs. Nob started a nest in May, but abandoned it after two days and made no further attempt to nest.

Our experience during the 1977 and 1978 breeding seasons had shown that although the aviary was large and planted thickly with trees and shrubs, with the nesting and feeding sites well separated, there was still a considerable amount of aggressive behaviour between all the birds. Probably, this behaviour was the cause of the late start to nesting in 1977 and to a lesser extent in 1978 when there were fewer aggressive encounters. The close proximity of another bird interrupted at least one copulation attempt, although it is likely that the male was still reproductively immature.

III 1979

Before the breeding season in 1979 we attempted to overcome the aggressive behaviour between the birds, by placing the females in separate compartments within the aviary. Red was placed in one 8m x 4.5m in one corner of the aviary, and Nob and Green had adjacent compartments (5m x 4m) at the opposite end of the aviary (Fig. 2). Each compartment had a nesting and feeding site and some shrubs to provide cover. To stimulate the male, the territorial songs of two males were played each day from 0600-0900 hours and from 1500-1800 hours from opposite sides of the aviary. The male was given access to the female after she had finished building her nest, (the single egg is laid 7 to 12 days later, Smith and Robinson 1976) and was excluded from the compartment after the egg was laid.

Both Green and Red laid fertile eggs. Red's egg was found some four metres from the nest shortly before it was due to hatch and Green's egg, at a similar stage of development was found in the nest with half the shell removed. These losses were thought to be caused by mice (*Mus musculus*).

Both Red and Green started second nests and the male was given access to both compartments at the same time, even though Green had not finished her nest. We did this because Green appeared very agitated and anxious to get out of her compartment. She promptly abandoned her nest and built another in Red's compartment. Both laid infertile eggs.

Nob lined her nest three times and it was not until 53 days after she started her nest that the egg was laid. The nestling hatched after 31 days of incubation (36-38 in the wild, Smith and Robinson 1976). It was a runt with no down and died the same day. Nob started her second nest two days after the nestling

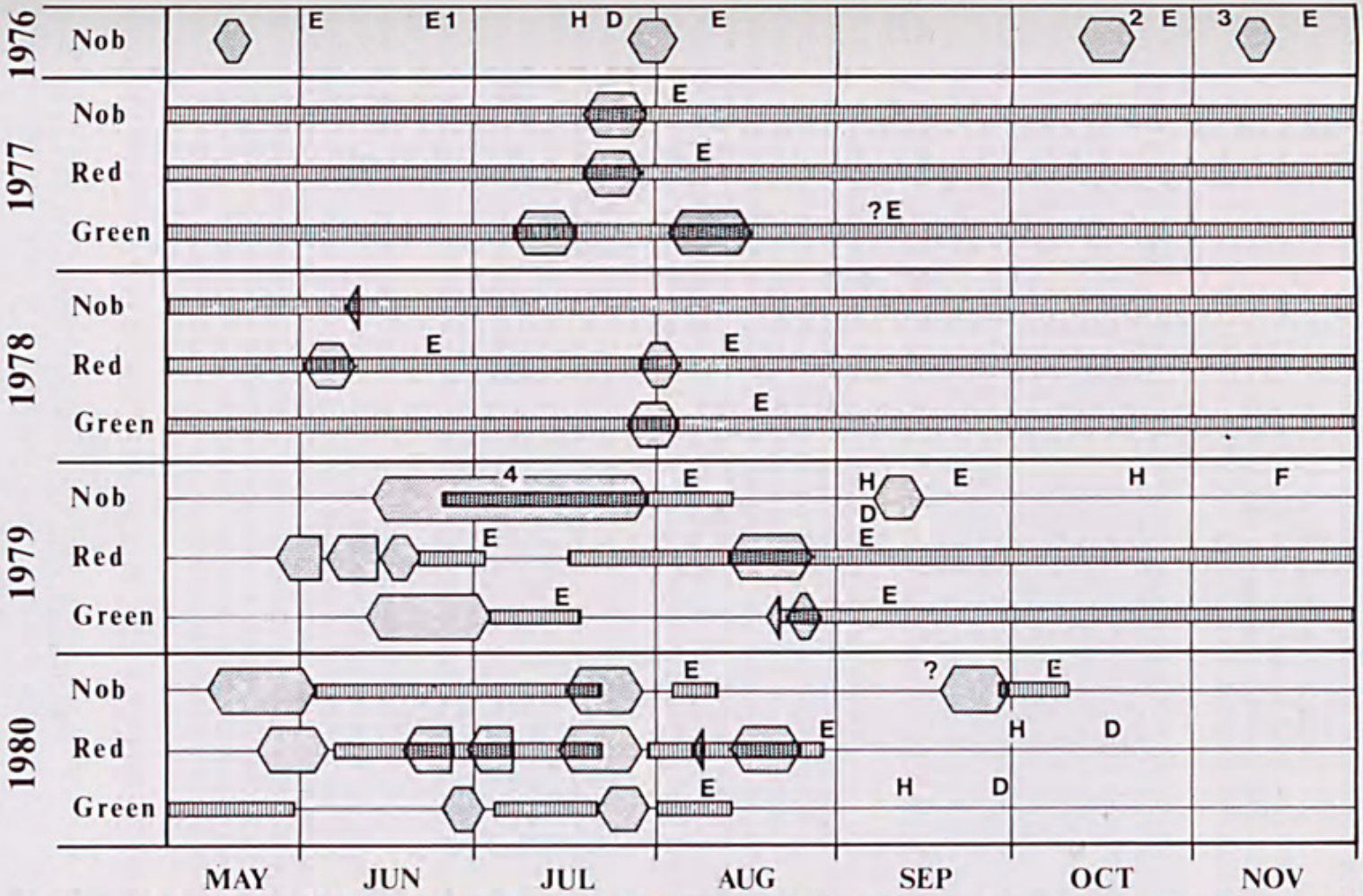

Figure 1. Breeding records for three female Noisy Scrub-birds in captivity at Helena Valley, Perth, W.A.<nest start, >nest finished, <nest abandoned. D, chick died; E, egg laid; H, chick hatched; ▭ period of time when male had access to a female.
1. infertile egg replaced by fertile egg. 2. second nest relined. 3. egg removed. 4. nest relined three times.

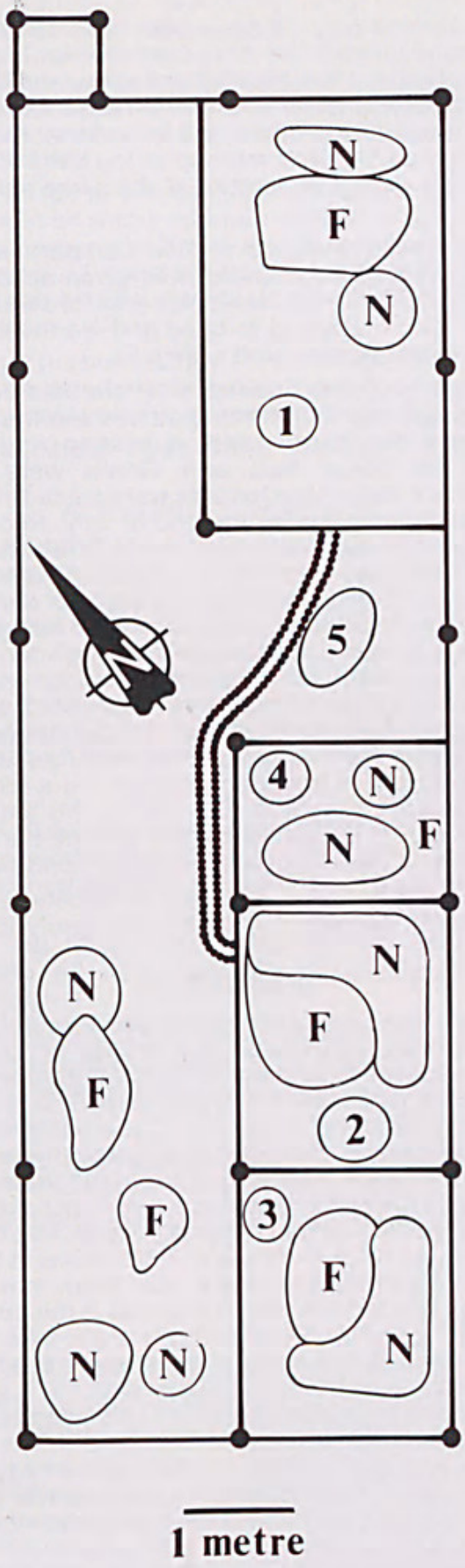

Figure 2. Plan of the aviary in 1979 and 1980. Compartment used by: 1 - Red in 1979 and 1980. 2- Nob in 1979 and 1980. 3 - Green in 1979 and Noblet in 1980. 4 - Green in 1980. 5 - Tunnel connecting compartments one and two in 1980. F, feeding area. N, nesting area.

died and laid her second egg 13 days later. The female nestling (Noblet) hatched after 30 days incubation. Although the nestling's growth rate was slower than wild nestlings, it was healthy and active and fledged at 26 days old when its weight was at the lower end of the range for wild female nestlings (Smith, unpublished data). Nob continued to feed the chick after fledging with decreasing frequency until it was weaned at the start of March 1980. At this stage it was the same size as its mother at the same age.

IV 1980

In 1980, Red and Nob were placed in their compartments and Noblet was placed in Green's compartment. Green was given access to the rest of the aviary with the male. By the end of May, Nob and Red were building nests, but Green showed no sign of starting to build and we therefore placed her in a compartment (4m x 3m) next to Nob's (Fig. 2).

When Red's compartment was opened, after she had finished her nest, she abandoned it and made two half-completed nests in the male's area. Shortly after she had made the fourth start, a broken egg was found in her compartment. At this stage Nob and Green were also out of their compartments. A week later all the females were placed in their compartments again and all had finished nests by the end of July. Red's compartment was opened first, followed two days later by Green's, and Nob's a further two days later. Green laid a fertile egg which hatched after 33 days of incubation. The chick died at 16 days old after showing symptoms of severe rickets for about three days. Nob laid an infertile egg two days after being given access to the male. Obviously, access was given too late. Red abandoned her nest and built another in the male compartment, where she laid and hatched a nestling after 32 days incubation. This chick also died at 16 days old, apparently of rickets. An autopsy on the chick indicated that calcium deficiency was the most likely cause of death (D. Pass, pers. comm.). When Red had laid her egg, the male was put in her compartment and given access, via a tunnel of plastic mesh (40cm wide and 40cm high), to Nob who had by this time built another nest. Her egg was infertile. Locking up the male in the compartment caused him to stop singing and presumably to go off breeding condition.

Noblet made no attempt to breed and was extremely secretive, behaving in fact, like a wild bird. Her diet was live insects, she rarely, if ever, took any of the artificial diet.

DISCUSSION

Whilst this was a part-time project with a restricted budget, we have shown that it is possible to maintain scrub-birds in a healthy condition for at least five years. Also, that it is possible to create the right environment for them to breed. However, the study highlighted two major problems, one dietary and the other concerned with management of the aviary. Our artificial food, plus live insects was adequate to rear healthy birds and to maintain the adults in good health for four to five years. Both Red and Green lost their 1980 chick from a calcium/phosphorus/vitamin D_3 deficiency, and both have had thin egg shells. Nob, on the other hand has not had these problems. The major reason for this difference would appear to be in the slight differences in feeding during early life. Nob, during the hand rearing phase, was given more artificial diet than either Green or Red, and in 1976, when she was in the holding cage her main food item was the artificial diet. She has continued to take the artificial diet. On the other hand, Red and Green were given far more live food after they were reared and would rarely take the artificial diet after 1977. In addition, Nob was more aggressive while nesting and probably less affected by our activities in the cage. She also took novel food items more readily. The first sign of thin egg shells was Red's second egg in 1978. In 1979, all four eggs produced by Red and Green had thin egg shells despite increasing the vitamin and mineral supplements in the insect food. Prior to the 1980 breeding season, we reduced the amount of live food in an attempt to force the females to take more artificial diet. We also attempted to further increase the calcium, phosphorus, and vitamin D_3 content in our insects by increasing the amount of these ingredients in their food. In the week prior to feeding the insects to the birds the amount of these ingredients in the insects' food was further increased, in the hope that even if they did not absorb them at least some would be in their intestines when the birds ate them. All the birds refused to take insects coated with minerals and vitamin powder. We did not find Green or Red's egg shell in 1980, but presumably they were adequate since they hatched successfully. The growth rate of both chicks was comparable with Noblet's, but both died of

calcium/phosphorus/vitamin D_3 deficiency. One solution to the problem would be to ensure that the females are kept on a diet of mainly artificial food, with the amount of live insects kept to a minimum, even when the nestlings have hatched. This does not solve the problem for those females reared in captivity, unless they are removed from the nest and hand-reared. Obviously more research needs to be done on providing insects that will give the birds an adequate and balanced diet.

The other problem relates to the management of the aviary. Clearly, three females and one male in an aviary makes it difficult to give the male access to one female at a time. Larger and better designed aviaries with no more than two females per male would make the management easier. Removal of some nests would prevent the synchrony which meant that females required the male at the same time.

While these are difficult problems, they are not insurmountable, provided that any future worker who attempts to breed these birds is aware of the high labour requirement necessary and is given sufficient funding.

The project ended in March 1981 when the birds were given to private aviculturalists.

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PSYLLIDS AND MEAT ANTS ON THE TREE *ALBIZIA LOPHANTHA*

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Inspection of an isolated plant of *Albizia lophantha* (family Mimosaceae) about 3 m high, at Pallinup River, 13 km NW of Groper and 106 km NE of Albany, showed it to be covered in meat ants, *Iridomyrmex purpureus*, Fig. 1. Of the total population of 13 *A. lophantha* plants examined on December 5, 1982, three trees exhibited this massive ant invasion. Closer inspection showed an even greater abundance of minute orange eggs (400 um long, 200 um wide, Fig. 2), especially in the grooves running along the stems and leaf petioles. These were accompanied by many free-living nymphs at various stages, their rejected exoskeletons (exuviae) and fewer winged adults, 3-4 mm long. These insects proved to be psyllids (Hemiptera), possibly belonging to two unnamed species of *Psylla*, which are usually very host specific (see references).