stands. The crops of 75 birds were examined and the average number of sunflower seed consumed was 38.5/bird. The amount of weed seeds was small. The diet of collared doves was more varied (Barthos, 1957; Keve, 1943; Rekasi, 1980). Beside the sunflower seeds a lot of weed species seed was found in crops and stomachs. The most frequently found species are listed in Table 1. Beside the listed plant species other harmful weeds such as *Echinochloa crus-galli, Hibiscus trionum, Panicum* sp., *Setaria viridis, Sinapis arvensis* and *Sorgum halepense* were found in crops. *S. decaocto* which produced 4 — 5 broods per year caused considerable damage to agricultural farms not only by feeding on crops, but by spreading some animal diseases as well. Because of much more organised harvests, better storage of crops and heavy hunting of birds, collared dove populations were controlled a few years ago.

Table 1. The most frequent seeds found in the crops and stomachs of 372 birds *(Streptopelia decaocto)*.

Species	Total Number of times found	Total Number of Seeds
Helianthus annuus	372	13605
Polygonum convolvulus	114	1496
Zea mays	99	618
Setaria lutescens	83	1711
Amaranthus retroflexus	69	919
Cannabis sativa	66	5655
Triticum aestivum	43	2453
Vitis vinifera	33	206
Chenopodium album	32	565
Sambucus nigra	32	552

Loss surveys indicate a gradual decrease in percentage of damaged plants. Losses during the seedling stage do not exceed the 10% level. Losses are caused by *Phasianus, Columba livia* and hares. The losses in commercial productions aren't important, but in seed production fields losses are considerable. In our surveys conducted during the ripening stage losses weren't as great as those reported by several other authors (Besser, 1978; Camprag, 1974; and Henne, 1978), but they were considerable. Losses in seed production fields were larger than in commercial fields. After checking many thousands of heads the percentage of attacked heads was about 10%, but the most (76.5%) of the attacked heads belonged to category 1. Damaged heads in categories 2 and 3 were 15.5% and 5% respectively. Heads belonging to categories 4 — 8 were rare. In our region the losses caused by birds rarely exceeded 5%.

Use of repellent chemicals (Mesurol, Morkit), carbide exploders and devices inducing ultrasounds (Csernavolgyi, 1974) proved to be ineffective. The only effective chemical is the desiccant Reglone. Firstly it accelerates maturity and secondly it acts as a repellent for sparrows and turtle doves. According to the observations *Columbas* feed more intensively on desiccated stands. Emerging stands can be saved by spreading bait (worthless broken and small crop seeds) around sunflower fields. Plastic foil belts attached on rods and put on the edges of fields can be also useful against birds, but ineffective against hares, so farms badly need chemical repellents against mammal pests. In some regions hares and roe deers cause considerable losses. The very precious stands of parent stock productions and performance trials must be protected with light nets, or webs of poly-acryl-nitril must be laid on plants.

Planting large sunflower fields, concentrating the production and avoiding planting sunflower close to larger shelter belts and marshes could also be of use in reducing damage. Reducing the periods emergence and maturity by better seed bed preparation, by choosing proper planting dates, by using vigorous, uniform and early maturing hybrids and by spraying desiccants always decreases losses due to birds. Well organised and quick harvest is of great importance as well. Delaying the burning or ploughing in of cereal stubble may delay bird attack on sunflower fields. In general by making it more difficult for birds to feed on sunflower crops (by growing uniform quick maturing hybrids with desirable head inclination and employing procedures already discussed) losses can be minimized and the birds will revert to their original diets and their populations will decrease to the usual levels.

ACKNOWLEDGEMENTS

We are very grateful to Mr Mihaly Perczel for his useful advice and help.

LITERATURE CITED

BARTHOS, Gy. 1957. Quantitative data about the food of the Indian ring dove. *Aquila,* LXIII-LXIV. 344.

BESSER, J.F. 1978. Birds and Sunflower. In *Sunflower Science and Technology.* 263 — 278.

CAMPRAG, D. 1974. Harmfulness of birds (Aves) on maturing sunflower plants in north-east regions of Yugoslavia. *Proceedings of the 6th International Sunflower Conference.* 701 — 705.

CSERNAVOLGYI, L. 1974. Agricultural losses caused by birds and some possibilities for their reduction. *Aquila,* LXXX-LXXXI. 239 — 247.

GLUTZ, U. and BAUER, K. 1980. *Handbuch der Vogel Mitteleuropas.* 9:1148.

HENNE, D.R. 1978. Ground application of Avitrol to control blackbirds in sunflowers. *Proceedings of the 8th International Sunflower Conference. 172 — 177.*

KEVE, A. 1943. Die Ausbreitung der orientalischen Lachtaube in Ungarn im letzten Dezennium. *Aquila,* L. 264 — 298.

KISS, J.B. and REKASI, J. 1981. Zur Ernaehrung der Turkentaube in der Nord-Dobrudscha/Rumaenien. *Der Ornith. Beobachter,* 78:13 — 16.

REKASI, J. 1974. Nahrung der von Sonnenblumenfeldern gesammelten Turkentauben. *Aquila,* LXXX-LXXXI. 305.

REKASI, J. 1980. Adatok a balkani gerle taplalkozas-biologiajahoz. *Allattani Kozlemenyek,* LXVII. 1-4:99 — 108.

PEST STATUS OF PARROT SPECIES ON SUNFLOWERS IN NORTHERN NEW SOUTH WALES.

D.N. JONES
Department of Ecosystem Management, University of New England, Armidale, N.S.W. 2351. Australia.

ABSTRACT

A number of parrot species were found to be pests in sunflowers in mid-northern New South Wales, although the distribution and importance of these species varied greatly. The galah *Eolophus roseicapillus* and sulphur-crested cockatoo *Cacatua galerita* were the main pests throughout the area, with the cockatoo being important

close to watercourses. The cockatiel *Nymphicus hollandicus* was a serious pest in the dryer marginal areas to the west. The pest status of a species was found to be a product of the tendency to flock, the mobility and the feeding behaviour.

INTRODUCTION

The slopes and tablelands of mid north-eastern New South Wales provide one of the most reliable dryland sunflower-growing environments in the State. Although the tablelands are regarded as the most favoured growing areas, at present the majority of sunflower production occurs in the climatically less reliable western slopes and eastern edge of the plains.

The first major plantings of sunflower in the region occurred around 1971 — 1972 (N.S.W. Oilseeds Marketing Board, 1980) establishing sunflower with sorghum as the two main summer crops. Crop damage by birds began to be reported soon after (Dale, 1975). Galah (*Eolophus roseicapillus)* and sulphur-crested cockatoo (*Cacatua galerita)* were usually mentioned as the main pests but their importance, distribution and preferred areas were not clear. Also many other species were noted but little could be said of their status as pests.

Studies into aspects of bird pests on sunflower in the area began in 1977 and are continuing. Information has been sought on the relative pest status of all the species involved, the ecological aspects of crop attack and the most useful means of mitigation of the problem. This paper summarises past and current research into the importance of the pest species, most of which are parrots.

The growing area extends from the hilly forested country east of Inverell, through the wooded slopes around Delungra to the plains around Moree. This area may be divided into three main growing areas showing differences in climate, topography and soil type. **Area 1** around Inverell is climatically favoured for sunflowers, though crop areas tend to be small (10 — 30 ha, Broome, 1978) due to the hilly, dissected terrain. **Area 2** is situated in the mid northern slopes in hilly to undulating country close to Delungra. Crop areas are 10 to 40 ha on average. **Area 3** includes the flat plains from the edge of the slopes to Moree. Crop areas tend to be large (average 50 to 300 ha). Climatically the area is regarded as less reliable for sunflower and west of Moree as marginal to unsuitable for dryland sunflower production.

MATERIALS AND METHODS

Four techniques were used to gather information on the bird pest problem. Firstly an overview was obtained by a mail-distributed questionnaire to almost 400 oilseed growers located throughout the region. The response was outstanding (Bennett, 1978) with a return of about 50% indicating the importance with which the problem was viewed. Bennett (1978) also conducted a large scale aerial survey of the region to obtain distributions and habitat associations of the main species. Some detailed data were obtained by interviews with farmers and information on the numbers and feeding behaviour of birds on crops was obtained by crop-based operations.

RESULTS

The galah was most frequently mentioned as the major pest on sunflower crops from all parts of the area. These reports were evenly distributed throughout the region and were not associated with any specific environmental features. The sulphur-crested cockatoo was the second major pest species. This large parrot was closely linked with the riverine vegetation and forested country immediately adjacent to crops. In areas where crops were grown close to timbered watercourses, cockatoo damage was commonly severe and occasionally sufficient to exclude further sunflower production. This gave the cockatoo a critical pest status in certain localised areas while the galah was rarely more than important. The cockatiel *(Nymphicus hollandicus)* (known locally as the quarrion) was the only other species to be frequently regarded as a pest. It became the main pest species in the plains and increased in importance with areas further to the west. The importance of other parrot species varied considerably. While some smaller species occurred on most properties, they were regarded as being important pests on some only, and rarely as serious.

The distribution and relative regional pest status of the main species are presented diagramatically in Figure 1. Information is derived from aerial survey (Bennett, 1978) and ground observations (Broome, 1979; present work 1980 — 1981). In terms of distribution the species fall into three main groups: those found consistently throughout the region (e.g. galah, red-rumped parrot), those based in the eastern slopes and hills (e.g. rainbow lorikeet, crimson rosella) and those found mainly in the flatter western areas (e.g. blue-bonnet, mallee ring-neck, pale-headed rosella). Table 1 shows the average flock size for species encountered on sunflower crops in three separate growing areas. The species are grouped as Mobile or Non-Mobile. The data were taken from observations on at least 10 crops from each area.

Table 1. Average flock size for parrots on sunflower crops in northern N.S.W.

Species	Area 3 (Moree-Milguy) Western plains	Area 2 (Myall Creek) Lower Slopes	Area 1 (Oakwood-Swan-) Vale) East. Hills
Mobile			
Galah	275	93	66
Cockatiel	24		
King parrot		2	19
Rainbow lorikeet		123	
Red-winged parrot	8	5	
Non-Mobile			
Sulphur-crested cockatoo	433	276	64
Red-rumped parrot	29	46	15
Eastern rosella		5	12
Crimson rosella			20
Blue-bonnet	5		
Mallee ring-neck	3	1	
Pale-headed rosella	4	3	

The relative importance of each species within its range depended mainly on the size of flocks formed and on mobility. The main pest species varied considerably in these two factors. The galah and cockatoo were both found in fairly large aggregations but while the galah ranged widely and travelled considerable distances to feed the cockatoo flocks did not move far from riverine areas. These strips of watercourse vegetation were important as corridors enabling the cockatoo population to penetrate far into the western areas. Almost all crops seriously affected by cockatoos were located close to such areas. By contrast the cockatiel preferred the plains and flocks of 1,000 — 30,000 were commonly recorded west of Moree. Further east cockatiel flocks rarely exceeded 30. Like galahs the cockatiel was

found to move considerable distances to feed. The parrots found in the timbered slopes were very localised in their movements and formed smaller groups. However when flocks of several species combined to feed on the smaller crops of the hill country damage was often significant.

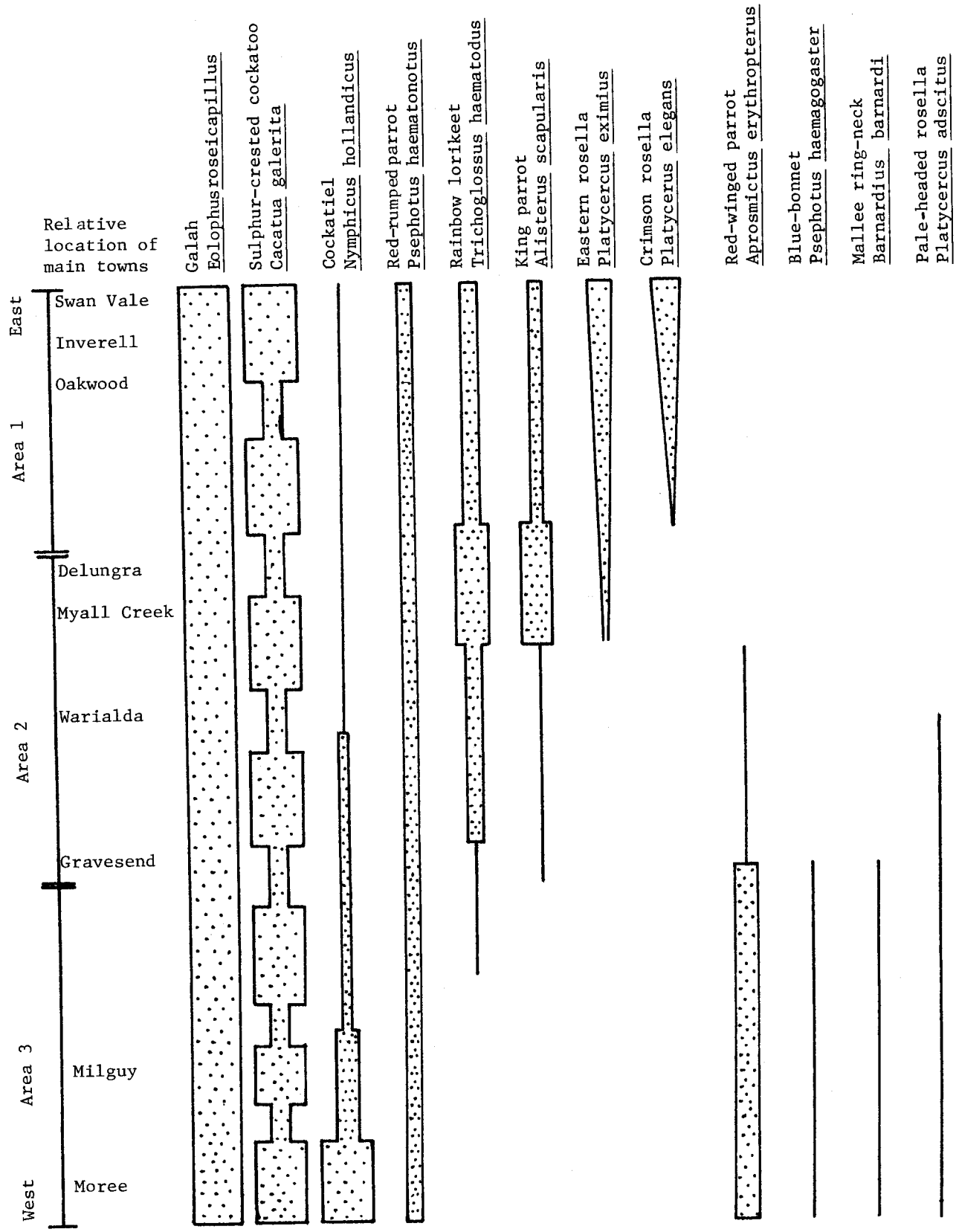

Figure 1. Distribution and relative pest status of parrot species in sunflower crops or northern New South Wales.

The species found in the most western areas typically occurred in small groups, were mainly sedentary and did not congregate at the crop. An exception was the red-winged parrot which did form feeding flocks, usually of 10 to 20 but occasionally up to 60. It was also quite mobile; one group observed flew about 10 km to feed on sunflower.

As well as showing differences in tendency to flock and in mobility the species differed in their feeding behaviour at the crop. The species which fed in groups, such as the galah, cockatoo and cockatiel, fed in sessions immediately after dawn and before roosting at dusk. The duration of feeding varied considerably but was usually from 1 to 2 hours with the morning session being slightly longer. For other parrots, notably all non-flocking species, feeding was not restricted to these times though it was minimal in the midday period.

Many of the smaller parrots were able to perch on the sunflower head or on the stalk and deftly extract individual kernels. However the galah and cockatoo commonly caused considerable head damage by removing bracts and large pieces of capitulum. These large species often bent or broke the stalks while perched and the cockatoo would occasionally remove an entire head. These types of excessive damage increase the average loss of seed per individual of the species. Broome (1979) estimated sunflower seed lost per bird to be about 55 g per day for cockatoos and 40 g per day.

DISCUSSION

The pest status of the parrots attacking sunflower crops is essentially a product of three non-independent factors: the tendency of the species to form flocks, the mobility and the feeding behaviour of individuals and of flocks. The most serious pests of sunflowers (and many other crops) tend to form large, well co-ordinated feeding aggregations, to be highly mobile locally and regionally, and to cause much damage per individual. These characteristics are shown by the galah in mid-north western N.S.W. as well as most of the important bird pests throughout the world (Ward and Zahavi, 1973).

The tendency to flock is of critical importance as it allows a large number of birds to efficiently locate and exploit sparcely distributed food resources. Prior to agricultural development this strategy allowed many parrot species to survive in regions of low variable rainfall where patches of grasses were the main food. With the advent of cropping in these areas, large areas of native grasses disappeared and were replaced by monocultures of highly attractive seeds. It is not surprising that the parrots began to use these crops for food and that those species pre-adapted to exploit the new food resource with the greatest efficiency became the major pests.

To date many attempts at management and mitigation of the bird pest problem have been predictably ineffective and expensive. The parrot species differ from each other sufficiently in their feeding and flocking behaviour for there to be no single simple method for preventing their feeding on sunflower crops. However the efficiency of management decisions should be improved if each locality is investigated individually with attention to the ecological characteristics of the main pest species.

LITERATURE CITED

BENNETT, M.T. 1978. Sunflower cropping and the bird pest problem. *Diploma of National Resources Thesis.* University of New England. Armidale. N.S.W.

BROOME, L.S. 1979. The use of decoy crops to combat the bird pest problem on sunflower crops. Dept. Ecosystem Management Report. University of New England. Armidale. N.S.W.

DALE, A.P. 1975. Birds and grain crops in northern N.S.W. In *Jarman, P.J. (ed.) Agriculture Forestry and Wildlife: Conflict or coexistence?* University of New England. Armidale. N.S.W.

N.S.W. OILSEEDS MARKETING BOARD 1980. *Growers Oilseeds Production Guide.* N.S.W. O.M.B. typed pp. 11.

WARD, P. and ZAHAVI, A. 1973. The importance of certain assemblages of birds as "information-centres" for food-finding. *Ibis* 15, 517 — 534.

AN INNOVATION IN THE CONTROL OF GALAHS, *CACATUA ROSEICAPILLA*, AND SULPHUR-CRESTED COCKATOOS, *CACATUA GALERITA*, IN SUNFLOWER.

L.R. ALLEN
Department of Ecosystem Management, University of New England, Armidale, NSW. 2351, Australia.

ABSTRACT

In eastern Australia, damage to sunflower by granivorous birds constitutes a major production problem. Methods of improving uniformity of head-height and evenness in plant density are encouraged. These practices, together with shooting and the use of recorded distress calls are currently the most useful in the mitigation of bird damage. A new method of bird control was explored based on the observation that galahs and cockatoos prefer crops, and locations in crops, that provide feeding birds with a maximum degree of horizontal vision. A three metre border of tall-growing forage sorghum was grown around each of two 40 hectare irrigated sunflower crops in the Boggabri area of New South Wales. This visual screen unsettled the birds' feeding behaviour and resulted in an 85% reduction in predicted seed loss to birds. Similar reduction in the time and cost of patrolling the crop was also achieved. Severe damage was restricted to those areas of sunflower immediately opposite "holes" in the screen where the sorghum had not germinated. In both screened trial sites, estimated bird damage was less than 5% of yield. With more intensive use of vegetative screens it is predicted that traditional bird controls will be more effective and loss of sunflower due to birds will be negligible.

INTRODUCTION

In the sunflower growing areas of New South Wales and Queensland, the sulphur-crested cockatoo, *Cacatua galerita,* and the galah, *C. roseicapilla,* regularly destroy many hectares of sunflower annually. While there are some 15 parrot species that attack sunflower in these two states, only the two *Cacatua* species (and occasionally the quarrion, *Nymphicus hollandicus*), assume economic importance.

There are two critical factors which predestine the cockatoo species to be of economic importance: (i) cockatoos are large birds with destructive feeding habits and (ii) these species roost and feed communally. Communal roosting and flock feeding are characteristics of all major bird pest-species throughout the world (Ward and Zahavi, 1973; Dyer and Ward, 1977). Cockatoo feeding behaviour is significant because these birds waste or destroy several times the amount