HUNTING AND MANAGEMENT OF *CYGNUS ATRATUS* IN NEW ZEALAND

M WILLIAMS

Introduction

Lacking the virginal whiteness, the character of regency and the emotive protection afforded its northern relatives, *Cygnus atratus* throughout its native range of Australia and its introduced range of New Zealand has been subjected to extensive exploitation. Protection is now extended to it on the Australian continent and hunting occurs only irregularly in Tasmania. But in New Zealand *C. atratus* is firmly established as a minor game-bird and, although its exploitation is now limited in both area and numbers and the annual harvest probably lower now than at any time this century, it is unlikely that in the near future it will enjoy total protection.

There are approximately 80 000 waterfowl hunters in New Zealand who collectively harvest about 1.2 million birds during the month-long waterfowl season (Caithness 1978, 1979). *C. atratus* comprises about 0.4% of this kill — an almost negligible proportion which may suggest that little 'management' is required. However, swan hunting is restricted mostly to a handful of large lakes, all of which are major breeding areas for swans. Young swans tend to remain in their natal area throughout most of their first year of life (Williams 1977, unpubl) and intensive hunting on any of the major breeding areas could remove the bulk of each year's production — the long-term consequences of which are obvious. Swans are a 'sensitive' game species requiring close annual monitoring and frequent adjustment of hunting restrictions.

Hunting

Hunting of *C. atratus* extends back over 100 years. Within ten years of its introduction into New Zealand (1864) it was declared a legal game-bird, being initially hunted at Lake Ellesmere near the site of liberation and, by 1900, in every district of the country.

Some details about the intensity of hunting since 1960 are available from two populations — Lake Ellesmere and Waikato lakes. Estimates of kills elsewhere in the country vary but, overall, it seems that during the 1960s the average annual harvest was 10 000 to 12 000, perhaps 8% to 10% of the national swan population.

Part of this kill was made by means of swan drives. These were organized shoots in which swans were herded by boat (sometimes even light aircraft) towards and over

Fig 1. Place names and districts mentioned in the text.

a line of hunters. Drives were held on Tauranga Harbour, Invercargill Estuary and Lake Ellesmere and were sometimes very successful. (Sites mentioned in the text are shown in Fig 1).

The rationale for these drives at Lake Ellesmere was as a further means of population control. At Tauranga Harbour and Invercargill Estuary, the vastness of the tidal mudflats afforded swans a safe refuge from shore-line hunters and it was only by concerted effort that some could be obtained by the sportsman.

During the 1960s and up to 1974 swans were legal game throughout the country, being hunted over a five-week period (three months at Lake Ellesmere) and mostly without limit. Where daily limits were imposed they were usually so high (8—15) that they allowed, in effect, hunting without limit. Band returns for three populations indicated very different rates of population turnover and levels of exploitation.

(i) *Waikato Lakes:* Banding commenced here in 1962, but no bird older than nine years had been shot by 1974, and from cohorts banded 1962 to 1969 only 30 (3.9%) of 768 recoveries had been made of birds in their fifth year of life or older. By 1973 an average of 21.3% (SD 3.9%) of each year's banded sample from 1962 to 1969 cohorts had been reported shot and average of 17.2% (SD 4.5%) of each banded cohort 1962 to 1972 had been reported shot two years after banding. Over the period 1967 to 1973 the age structure of the kill was, on average, 66.7% swans in their first year of life, 15.0% in their second year, 10.7%, 4.7%, 1.9% and 1.0% swans in their third, fourth, fifth and sixth year of life respectively. These statistics are derived from a period during which the daily bag limit varied from no limit to ten, eight and finally five, yet the percentage of each year's banded sample returned after two years showed no correlation with bag limit.

In 1974 the daily limit was reduced to two and has remained so every year since, except that in 1978 four were allowed. Over this period an average of 8.4% (SD 1.9%) of each year's banded sample (ie 1974 to 1978 cohorts) were reported shot two years after banding and the age structure of the kill was, on average, 44.4% swans of the year and 15.5%, 9.6%, 13.9%, 7.0% and 9.6% swans of successive age classes. Thus the main change was a lowering of the harvest, especially on birds of the year, and more swans are now surviving to older ages.

(ii) *Lake Ellesmere:* Banding of cygnets commenced here in 1956. Hunting continued up to 1974 but has not occurred since then, a consequence of the long-term effect of cyclonic storm in 1968 (Williams 1979), discussed later in this paper.

Swans at Lake Ellesmere live longer than in the Waikato. Bands from 20-year-old swans have been returned and, of the 2704 recoveries made of birds banded from 1956 to 1963, 15.3% were of swans 7 to 12 years old. Of all the cohorts which by

1968 had been exposed to six years' hunting, an average of 18.7% (SD 5.7%) of the initial number banded had been reported shot, and an average of 11.3% (SD 4.5%) of the 1956 to 1967 banded samples were reported shot two years after banding. Of the swans shot in their first to sixth years of life during the period 1961 to 1968, 35.8% were in their first year, 24.6% in the second, and 15.6%, 10.8%, 6.0% and 7.2% in their third to sixth year respectively.

Following the 1968 storm, almost no cygnets fledged in 1968, 1969, 1970 and 1972 and only 450 in 1973. Only in 1971 when 3200 fledged was there any production of consequence. However, hunting continued throughout this period and band returns showed that adults were heavily shot. Of the 583 bands returned from 1969 to 1974, 19.3% were first-year swans (all from 1971), 7.9% in their second year, 11.7%, 5.3%, 4.3% swans in their third, fourth and fifth years, and 51.5% birds in their sixth year or older (Williams 1979).

When, in 1974, hunting at Lake Ellesmere finally ceased, it was also prohibited over most of the southern half of South Island, the area over which birds from Lake Ellesmere dispersed. This prohibition remains in force.

(iii) *Other populations:* Swans at Lake Wairarapa are hunted heavily and monitoring of the harvest commenced in 1975 when cygnets were first banded there. After five years' hunting, 23% of the 1975 banded sample have been reported shot; four cohorts have now been exposed to two years' hunting and an average of 15.3% (SD 1.9%) of each have been reported shot in that time. This population has been hunted with daily bag limits of two, two, four, three and five in the years 1975 to 1979 respectively. The percentage of bands returned in the year-of-banding, an index of hunting pressure, was 9.4%, 9.4%, 13.4%, 16.0%, 16.7% respectively in these years, indicating that daily bag limits there are not a particularly sensitive regulator of harvest.

Moulting adults banded annually at Farewell Spit since 1976 have dispersed widely throughout New Zealand (Williams 1981) and many have been shot at Lake Wairarapa. As a 'population', these birds have not been hunted heavily. The year-of-banding recoveries for the years 1976 to 1979 have been 1.5%, 5.1%, 2.6% and 1.7% respectively of the numbers initially banded and 3.8%, 8.9% and 8.4% of the 1976 to 1978 cohorts respectively were reported shot two years after banding. The low year-of-banding recovery rate occurs because most swans do not disperse from the protected area of the moulting site until late during the hunting season. The increased second-year recoveries may result from many banded swans not returning again to the moulting site and therefore being available to hunters throughout the full hunting season.

At present, swans of the Manawatu, Lake Ellesmere and Otago/Southland regional populations may not be hunted. The annual harvest of swans in New Zealand has been reduced from the 10 000 to 12 000 of the 1960s to between 4000 and 5000.

The present harvest represents approximately 6% to 8% of the national swan population but 10% to 12% of the hunted populations.

Management

Regulating the annual harvest

Hunting of swans is restricted to the six-week-long waterfowl hunting season during May and June each year. The impact of this hunting is regulated by (a) season length – swans may be hunted throughout the entire season or for only part of it; (b) a daily limit on the number of swans that may be shot – nowhere in the past five years has this limit exceeded five and it is more usually one or two.

The information on which the administrators base their decisions on season length and daily limits is derived from three sources: aerial surveys, band returns and hunter opinion. Two nationwide censuses of swans are conducted annually: in November, coinciding with the peak of cygnet emergence and nesting to indicate what proportion of the population may be breeding; and again at the end of January, to estimate the season's production and size of the adult population. Band returns, especially the numbers of bands returned from cygnets shot in the year of banding, are used as an index of hunting pressure. They also reveal how the total harvest is distributed amongst birds of various ages. Hunter opinion is sampled in two ways: a diary scheme, to which about 5% of New Zealand's hunters contribute, requests hunters to indicate their impressions of waterfowl abundance simply as 'more', 'some' or 'less' than the previous year, and hunter's associations (Acclimatisation Societies) are requested to suggest limits and season lengths which they think would be appropriate for the game waterfowl species in their districts.

Season lengths and limits vary in different regions of New Zealand. Data from the locations of recoveries of banded birds and from dispersal studies involving conspicuously collar-marked swans have identified the principal areas of dispersal of each major breeding population (Williams 1981). Hunting restrictions relevant to a particular population are now applied uniformly throughout that population's 'area of dispersal', a change from past practices of applying them unevenly over a variety of administrative districts.

Habitat destruction

In New Zealand, where agriculture is, and is likely to remain, the basis of the national economy, the demand for increased agricultural production and more pastoral land is often the sole rationale for major wetland drainage schemes. Attempts to justify wetland retention on hydrological, recreational, aesthetic and other bases are seldom appreciated by land developers nor understood by planning authorities, especially when government subsidies for 'marginal' land development are so freely available. Peatlands, which formerly covered 1600 km^2 (approxi-

mately 1% of the New Zealand land area) and contained much excellent swan and waterfowl habitat, have suffered more than any other wetland type. Montane bogs, small and large, have remained largely unmodified but lowland peatswamps have not been so fortunate. In the Waikato and Northland districts of the North Island, where approximately 45% of the country's lowland peatswamps occurred, over 500 km^2 have been converted to pastoral land, a highly dubious long-term proposition.

Protection of low-lying farmland from flooding has also been advanced as the *raison d'etre* for extensive wetland modification. Rivers have been channelled, extensive stopbanks created and drainage patterns altered to prevent lowland flooding. As a result, there remain in New Zealand almost none of the ephemeral wetlands typically associated with lakes, rivers and lagoons. These highly productive areas (for swans and other waterfowl) have been irretrievably lost and converted to pasture.

Loss of these ephemeral or seasonal wetlands is bad enough, but now the trophic levels of many lowland lakes are rapidly altering. As they become permanently eutrophic or even polytrophic, the previously extensive beds of aquatic macrophytes are replaced by dense, year-round phytoplankton blooms and the carrying capacity of the lakes for swans and other grazing waterfowl is drastically reduced. In the past decade, three major lakes, Ellesmere, Rotorua and Waikare, have all suffered severe eutrophication problems. All three receive sewage from nearby municipalities, the sewage undergoing only primary maceration but no nutrient stripping. All three have predominantly agricultural catchments, the source of high nitrate and phosphate inputs. *C. atratus* adapted quickly to these changed limnological conditions by becoming increasingly dependent on lakeside pastures for food, posing new management problems in the process.

There is now a widespread appreciation amongst controlling authorities of the desirability of limiting especially nitrate and phosphate inputs to major lowland lakes and so preventing the year-round presence of phytoplankton blooms and concomitant problems. There is now much greater public awareness of the value of estuarine areas as important feeding and nursery areas for birds, fish and invertebrates and increased public objection to their use as areas for reclamation and the establishment of industrial complexes. Public requirements of lakes and estuaries are sympathetic with those of swans. The greatest threat to swan habitat remains the indiscriminate conversion of wetlands to agricultural land. Concessions by developers to the requirements of waterfowl are occasionally made by leaving one or two small areas permanently flooded but, to date, no wetland drainage scheme has been substantially modified or stopped by arguments on behalf of wildlife.

Pasture depredation

This problem, an old one to northern hemisphere wildlife managers, is novel for

New Zealand farmers. It is mainly seasonal, occurring mostly in winter and early spring when seasonally high lake levels make aquatic plants unavailable. Of the Waikato lakes, for example, the principal breeding and feeding area is Lake Whangape whose level fluctuates considerably according to the level of the adjacent Waikato River. In winter this lake may rise 2 m or more above its summer level and its dense beds of *Egeria densa* are unavailable to swans. In the past, swans left this lake in winter to concentrate on nearby Lake Waikare, whose level is controlled, fluctuating by less than 1 m throughout the year. Its beds of *Egeria densa* were the main winter food for about 10 000 swans until permanent phytoplankton blooms arose, destroying the macrophytes and preventing their re-establishment. With few other winter feeding areas available, these swans now graze lakeside pastures and many swans, it seems, are now exploiting this food source throughout the year.

At Lake Wairarapa changes in lake level also promote pasture grazing by swans. This lake has extensive marginal flats which, when inundated, allow swans to feed over them. But for flood control purposes the lake level is kept low during winter and spring, the marginal flats are dry and barren, and swans are again forced to feed on lakeside pastures. Low river flows and high evaporation rates during summer ensure that the lake margins remain dry for much of the season, thus establishing pasture depredation by swans as a year-round phenomenon at Lake Wairarapa.

Complaints from farmers are responded to by using scaring tactics (these include gas-powered automatic bangers, irregular shooting, fixed mechanical devices and gas-filled balloons) or fencing the lake margin with electrified wire. None of these scaring methods has proved satisfactory other than for very short periods and the most successful deterrent to date has involved farmers stocking very heavily the pastures on which swans were concentrated. The 'control' measures continue to ignore the fact that swans are grazing pasture because food is not available in the lake. Their scaring off one pasture merely shifts the problem to another. The obvious solution of providing swans with grazing, a basic technique in the management of geese in Britain and Europe (Owen 1973), is a suggestion unappreciated by the farming community. When 'control' measures fail to achieve a long-term reduction of the problem, strong demands are made for a permanent and substantial lowering of the swan population.

Lake Ellesmere population

Perhaps the most interesting management problem New Zealand has with *C. atratus* is a consequence of a natural catastrophe. A cyclonic storm ravaged Lake Ellesmere in April 1968, destroying the beds of aquatic macrophytes and killing thousands of swans (Williams 1979). In the decade since that storm, the aquatic macrophytes have failed to re-establish, inhibited by the continuous removal of the lake's finer bottom sediments by wave action and the dense phytoplankton blooms which occur throughout the year. In the decade since that storm, the number of swans at

the lake has steadily declined and is now barely 25% of that present prior to 1968. Extensive breeding failure, poor cygnet survival, increased adult mortality and/or permanent emigration — all natural responses to the impoverished food supply — and intensive hunting have all contributed to this population decline.

In each year since the storm only a small percentage of the adult birds present appear to have attempted to breed. Immediately after the storm the population probably exceeded 25 000 but only 1200 nests were established; in 1969 only four nests were located. Only in 1976 and 1977, when approximately 2200 and 1600 nests respectively were established, have 50% or more of the estimated number of birds older than four years (the likely age of first breeding) present attempted to nest.

No cygnets fledged in four of the five years immediately after the storm and in only one year (1971) since 1968 have more than 1500 cygnets survived to independence. However, many of these independent youngsters have been extremely light (less than 4.0 kg when fully feathered); some were incapable of flight and heavy post-fledging mortality undoubtedly occurs.

Since the storm, there is some evidence to suggest that fewer of the swans which dispersed from the lake as juveniles returned there upon reaching sexual maturity than was previously the case (Williams 1977). In addition, the mortality rate of adults at the lake may also have increased.

For six years after the storm, intensive hunting and control of pasture-feeding swans resulted in several thousand adult swans being shot. Prior to the storm, the hunters' kill comprised approximately 15% birds over four years of age; during 1969 to 1974 they comprised 56% of the kill.

The consequence of these events is that many age classes have few or no representatives in the population. At present there are few five- to ten-year-old swans alive, normally the largest breeding component of the population. The last major input into the breeding population were progeny from 1967, the cohort which suffered most during the storm and which experienced considerable shooting pressure in subsequent years. The number of swans hatched since the storm and now of breeding age comprises less than 10% of the total adult population.

A construction of the present size and age structure of the Ellesmere population (assumptions made in this construction are explained fully in Williams 1979) and a projection forward by four years (Fig 2) suggests that the breeding component of the population will decline further, perhaps by about 50%.

How does one 'manage' a population like this? Obviously hunting cannot be considered, although there is strong pressure to allow it. Swans continue their conflict with lakeside farmers and 'destructive' control measures are sought. The full

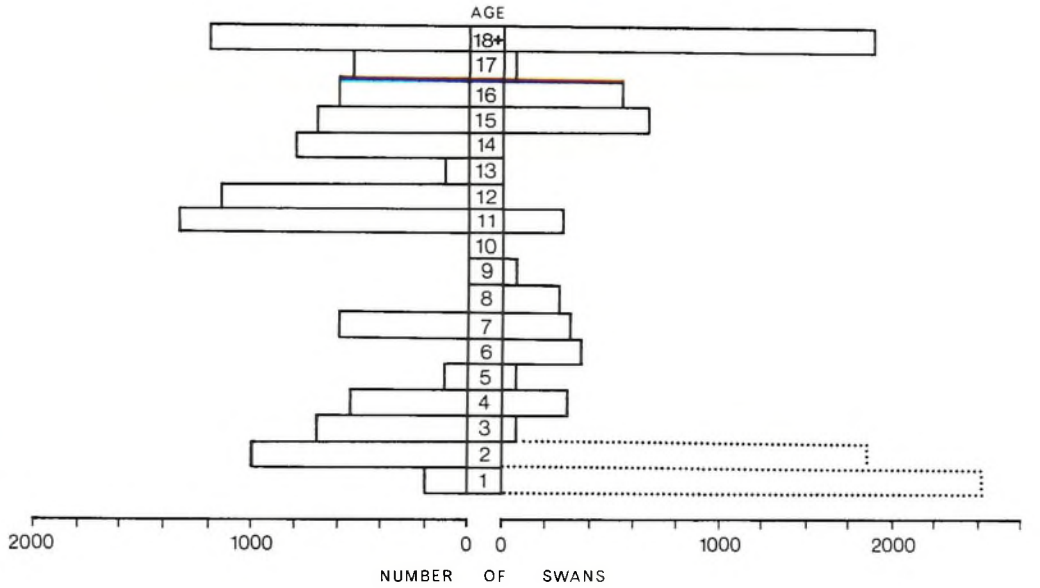

Fig 2. The theoretical size and age structure of the Lake Ellesmere swan population in January 1978 (left) and its likely structure four years later in January 1982 (right).

Cygnets fledged in 1978/79 and 1979/80 seasons are depicted as three- and four-year-olds in 1982, the size of the 1982 one- and two-year-old cohorts assumes a production of one cygnet per pair of swans five years of age or older.

reproductive potential of the population is obviously not being realized and it is important to understand why. Is it simply the quality and quantity of food in the lake that are the determining factors? Lake Ellesmere is a polytrophic lake and as such is deteriorating as a swan habitat. There is little the wildlife manager can do within the bounds of economic reality to reverse this trend and, by so doing, enhance cygnet and adult survival. Apart from providing lakeside grazing, the wildlife manager may have to allow the population to re-adjust naturally to the reduced carrying capacity of the lake; laissez-faire is also a benign form of the manager's art.

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Summary

Approximately 6% to 8% of New Zealand's *C. atratus* are shot annually, the harvest now being less than half that a decade ago. Newly-fledged cygnets and breeding adults comprise most of the kill; pre-breeders frequenting the estuarine areas effectively avoid being hunted. Hunting intensity varies through New Zealand: 17% of each year's banded cohort from the Waikato Lakes were reported shot two years after banding compared with 11% at Lake Ellesmere and 15% at Lake Wairarapa.

Season length and daily harvest limits regulate each year's hunt. Hunting regulations are based on: aerial surveys (conducted before and after each breeding season); the harvest of the previous year as determined from band returns; and opinions of the hunters (expressed individually in hunting diaries or collectively by recommendations from hunters' associations). The regulations relevant to a particular breeding population are applied throughout the 'area of dispersal' of that population.

The preservation of quality habitat is becoming increasingly difficult as eutrophic conditions arise in more of the important lowland lakes and as wetlands are drained. Swans are adapting to the changed limnological conditions by becoming increasingly dependent on lakeside pastures for food. This conflict with agriculture brings with it strong demands for a substantial lowering of New Zealand's swan population.

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M WILLIAMS
Wildlife Service
Department of Internal Affairs
Wellington
New Zealand