SURVIVAL AND AGES OF FIRST BREEDING OF GALÁPAGOS SEABIRDS

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INTRODUCTION

This paper presents data collected during nesting studies of seabirds in the Galápagos Islands from 1965 through 1977. The figures update those presented previously (Harris, 1969a, b, c, 1970, 1973), and the reader is referred to those papers for ecological interpretations of the results. Although these data are incomplete, they are unlikely to be improved upon in the near future because some of the numbers on the monel bands have become illegible. Since data are scarce for equatorial seabirds, they are presented here.

METHODS

Data were obtained by placing numbered monel bands on breeding birds and their young and systematically searching the colonies for returning birds. Two study areas were utilized. The first was the small island of South Plaza, off eastern Santa Cruz (=Indefatigable) where there were some 500 pairs of Audubon's Shearwater (*Puffinus lherminieri*), 600 pairs of Band-rumped Storm Petrel (*Oceandroma castro*), 50 pairs of Red-billed Tropicbird (*Phaethon aethereus*), and 400 pairs of Swallow-tailed Gull (*Larus* (*Creagrus*) *furcatus*). The second area was at Punta Suarez, Española (=Hood) where ca. 800 pairs of Waved Albatross (*Diomedea irrorata*) and several hundred pairs of Masked (*Sula dactylatra*) and Blue-footed boobies (*S. nebouxii*) nested.

I spent two main periods in the field, November 1965 to July 1967, mainly at South Plaza, and February 1970 to September 1971, mainly at Punta Suarez with approximately monthly visits to South Plaza. From 1972 to 1975 I caught birds on South Plaza on one to four days each year between November and January. During the years 1972 to 1978 inclusive personnel from the Galápagos National Park Service retrapped samples of incubating Waved Albatrosses, the totals varying from 140 in 1978 to 638 in 1972. From 1972 to 1975, I spent single days each year retrapping samples of nonbreeding albatrosses and breeding boobies. A few retraps were made by other ornithologists.

Because of the fragmentary nature of the recent retrapping effort many survival rates are only calculated up to the end of 1971. Waved Albatross, Red-billed Tropicbird, and Masked Booby bred annually, so survival rates and ages of first recorded breeding are presented in calendar year terms. However, individuals of other species bred at less-than-annual intervals so the survival rates for Audubon's Shearwater and Swallow-tailed Gull are calculated on the basis of the mean interval of nine months between consecutive layings in these species.

All survival rates are minimal as no allowance is made for the loss of

TABLE 1.

Survival of adult and young Waved Albatross in or near the study areas on Hood Island up to 1970.

Year banded	Number banded	Number alive in 1970	Annual survival (%)
a) Adult survival			
1961	1,212	791	95.4
1962	286	207	96.0
1964	21	16	96.7
b) Chick survival			
1961	234	137	94.2
1963	96	60	93.5
1964	100	74	95.1
1966	229	194	95.9

bands, movement of birds to inaccessible nest sites, or emigration from the study areas.

RESULTS

Waved Albatross

The survival of adults was extremely high, averaging 96.2% over a 10-year period (Table 1). Between 1970 and 1971, the survival of color-banded birds was even higher with only 6 out of 302 not being recovered the second year. The survival rate of other adults was slightly lower and there was a suggestion (Table 2) that birds which had been banded longest had a lower survival rate than had more recently banded birds, due either to differential mortality or to the older bands starting to fall off.

Chicks survived almost as well as did adults (Table 1) and the 1966

TABLE 2.

Survival of Waved Albatross between 1970 and 1971 in relation to the year in which they were first banded. All birds were originally banded as adults.

Year first banded	No. recaptured in 1970	No. known to be alive in 1971	% surviving to 1971
1961	461	435	94.4
1962	112	107	95.5
1963	21	21	100
1964	14	13	92.8
1969	22	21	95.5
1970	453	439	96.9
Total	1,083	1,036	95.7

TABLE 3.
Age of first recorded breeding of Waved Albatross.[1]

Young banded in	Age (years)								
	3	4	5	6	7	8	9	10	older
1961							49	16	9
1963					21	13	5	2	1
1964				23	21	8	2	1	3
1966		7	37	34	47	10	9	4	4
1969	0	0	2	1	1	1			
1970	0	0	20	21	25	4			
1971	1	4	15	45	16				
1972	0	1	4	2					
1973	0	0	1						

[1] Few breeding adults were handled between 1963 and 1969, but virtually every bird breeding at the study colonies was caught in 1970 and 1971. Between 1972 and 1978, 10–40% of breeding adults have been caught annually.

year class had a higher annual survival rate than adults banded in 1961. The overall mean annual survival rate was 94.5%, which included losses between banding and fledging and during the (presumed) vulnerable postfledging period when young learn to feed for themselves.

In 1970 and 1971, the approximate hatching dates were known for some young. In 1970, 19 out of 32 young hatched before 30 June were caught in later years, as were 14 out of 29 hatched between 1 and 17 July, but only 4 out of 11 later young have been seen again, suggesting that later hatchings were less successful than early ones. In 1971, there was again a suggestion that late young survived less well than early young: the numbers banded and retrapped for three banding periods were 23 banded and 12 retrapped (hatched before 29 June), 43 and 22 (30 June to 11 July), and 26 and 10 for young hatched after 11 July.

The youngest bird found incubating an egg was three years old (Table 3) but a two-year-old caught in December regurgitated food. Breeding adults frequently regurgitate food when handled, whereas I have no record of a definite nonbreeder doing so. Possibly this two-year-old had a young. The average age at first breeding was difficult to determine because only about 20–25% of adults were caught each year since 1972. However, it is unlikely that more than a few breeders and nonbreeders visiting the colonies in 1970 and 1971 were not caught. To judge from the 1966-cohort, about 30% bred first when aged between 3 and 5 years, 22% the next year, and at least 31% in the 7th year. Some birds did not breed until older; for example 10% of the 1961-young retrapped apparently bred only at 11 years or older.

Audubon's Shearwater

Of 321 breeding adults banded from 1965 to 1967, 299 survived at least one breeding cycle (nine months)—a survival of 93.1% per cycle.

Of 34 birds banded in 1961, 18 survived to mid-1966—a mean survival of 93.2% per cycle for 9 cycles.

Three out of 121 young were recovered back at the colony. The youngest, aged 37 months, was caught in a hole within 3 m of its birth place, another was found breeding when aged 8 years 7 months, and the third was found dead after four years.

Band-rumped Storm Petrel

Two distinct populations bred in the same nest holes on South Plaza. Each population bred annually but approximately six months out of phase. Over nine years, 1,953 and 1,411 full-grown birds from these two populations were handled and no interchange between the two populations was recorded. Three of 264 young banded were retrapped, all at the same time of year as when they were reared. One was caught in a mist net within 2 m of its natal burrow four years later, the others were both aged five years. None was breeding.

Swallow-tailed Gull

Many of these gulls nested on cliffs where they were difficult to catch and the best estimates of adult survival were obtained by observations of individually color-banded birds. From 1965 to 1967, 41 out of 42 breeding adults survived at least two breeding cycles, a survival of 98.8%. In 1970 and 1971, 87 out of 92 adults returned to breed in a later cycle—a survival of 94.6%.

In 1971, I attempted to catch as many as possible of the oldest banded birds, identifiable as such by unusual band design. Twenty-three of 51 breeding adults banded in 1963 were found, a survival of 93.5% per cycle over 10 cycles. Four of 18 adults banded in 1961 were also caught, but the apparent survival rate of only 89.3% over a mean of 13.3 cycles was probably lower than actuality because the bands were made of thinner metal and some had probably fallen off.

In 1963, D. W. and B. K. Snow marked 126 young with a single color band; 19 survived to 1970 (survival of 81.4% per cycle) and nine to 1975 (84.7% over 16 cycles). One of these young was found breeding on Champion Island, 75 km from South Plaza.

Fourteen banded young were later found breeding. The youngest was 40 months old. Six others aged between 48 and 54 months were thought to be nesting for the first time, but the remainder, aged 60 to 114 months, had possibly bred before.

Red-billed Tropicbird

Of 51 breeding adults banded between 1965 and 1970, 42 (82.3%) survived at least one year.

Five out of 27 banded young were recaught, an annual survival of 71.4% over five years. The youngest was first caught as a nonbreeder in its fourth year, two were breeding, probably for the first time, in their fifth year and two in their sixth year.

Masked Booby

In 1970, 100 breeding adults were banded; 74 were alive in 1972 (a mean survival of 86.0% per year), 61 in 1973 (mean survival 84.8%), and 48 in 1974 (mean survival 83.2%). The 1974 results were based on a single check of the colony before most pairs had laid so the true survival was undoubtedly higher. No adult was found more than 5 m from the place of banding (cf. Kepler, 1969).

Twenty of 132 young banded in 1971 (from eggs laid in 1970) were retrapped. The youngest were two in November 1973 (i.e., almost three years old), one of which was defending an empty nest. In December of the next year a male was found incubating eggs, three other birds were defending nest sites, and one was unattached. In December 1975, an additional nine had nesting sites but five did not, but this was early in the season before many pairs had laid.

Blue-footed Booby

Of 70 breeders banded, 43 survived two full breeding cycles giving a survival of 78.3% per cycle. Little information is available on the return of young birds. The youngest birds found at the colonies, a female caught on eggs, and the two other females and a male protecting empty nest sites were all aged 36 months. Five other birds aged between 46 and 67 months were breeding.

DISCUSSION

The survival rates of Galápagos seabirds banded as adults and nestlings were extremely high, those for Waved Albatross and Swallow-tailed Gull, spanning 10 years and 13–16 breeding cycles, respectively, are among the highest recorded for any bird. However, the figures for Masked Booby and Red-billed Tropicbird were probably lower than would be expected due to the relatively small retrapping effort. These species fledged only 0.63 and 0.32–0.55 young per pair per year (Harris, 1977), respectively, and had long periods of immaturity. The populations appear to be more or less stable, so the survival rates of adults would need to be even higher than those recorded for the relatively low recruitment to balance even the few adults lost every year. The same situation probably applies in the case of the Blue-footed Booby.

SUMMARY

The mean annual survival rates of the Waved Albatross were about 96% for adults, 94.5% for birds banded as young. Most birds started breeding when aged between five and seven years old. Breeding Audubon's Shearwaters and Swallow-tailed Gulls had survival rates of about 93 and 93.5–98.8% between breeding cycles. Swallow-tailed Gulls first bred when 40–54 months old and survival of young was also high (81–85% per cycle). The observed survival rates of Red-billed Tropicbird (82.3% per annum), Masked Booby (ca. 85% per annum) and Blue-

footed Booby (ca. 78% per cycle) were thought to be too low due to inadequate retrapping. The first recorded breedings in these three species were for birds in their fifth year, fourth year, and third year (36 months), respectively.

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